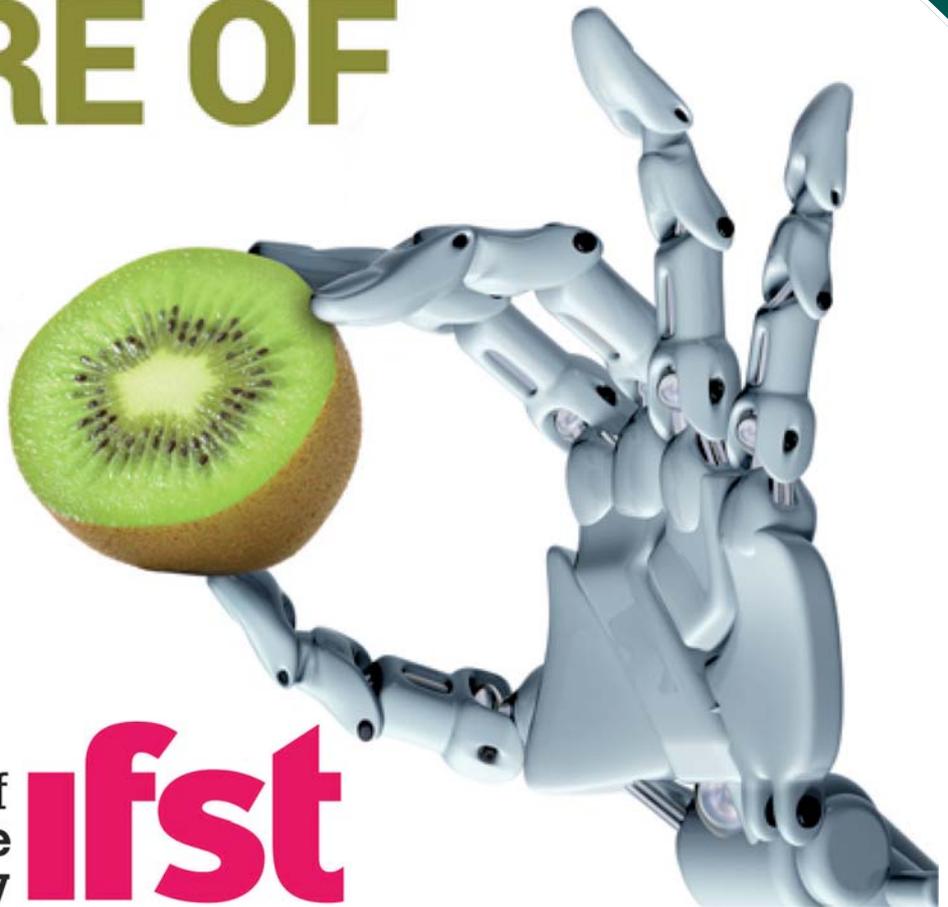


SCIENCE IN PARLIAMENT

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THE FANTASTIC FUTURE OF FOOD



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The Journal of the
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Inside: The University of Nottingham is celebrating the 10th anniversary of its campus in Ningbo China this year. Read about the impact that we have made over the last decade through developing innovative partnerships between China and the UK.

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Andrew Miller MP
Chairman, Parliamentary and
Scientific Committee

It is now nearly 50 years since Dorothy Hodgkin won the Nobel Prize for Chemistry.

Since no British woman has won a Nobel science prize since, it is not possible to test whether the appalling sexism of the British media at that time has moved on. Typical of the coverage was “British housewife wins Nobel Prize” and “Oxford mother wins Nobel Prize”. Whilst it is of interest that Professor Hodgkin was married and the mother of three, it is hardly central to the story.

But the problem is worse than we would like to admit. Since 1964, all UK laureates have possessed a Y chromosome BUT not a single story in the press when they won recorded

“Brighton father wins prize” or “London husband triumphs”.

The Select Committee on Science and Technology (which I also chair) has recently investigated some of these issues. We focused on the academic sector and again observed the gender imbalance in the higher echelons. Even today, Nancy Rothwell is the only woman vice-chancellor at a Russell Group University.

It is however a fact that recruitment of women at 18 into universities is not a problem in the biological and life sciences – more than 55% of entrants are female. In physics and engineering, it remains below 30%.

The Minister, David Willetts, elaborated on this issue when he addressed the event which we organised jointly with BIS, on 20th March.

He pointed out that young women, in particular, are encouraged to think about Medicine as a career. They therefore abandon studying either Maths or Physics after GCSE. The English educational system is by many international standards, narrow, and our University admission system, equally narrow. Perhaps Michael Gove (educated

in Scotland) would like to reflect on this.

David Willetts pointed out that the only university degree over which the Government maintains control on admission numbers is Medicine.

It is ironic that science, uniquely, has failed to address the employment issues arising from the simple fact that it is women who bear children. Many professions (accountancy, the law, teaching etc) have managed to work out how to re-integrate women returners. Science needs more organisations like the Daphne Jackson Trust (and those bodies which support it). One Nobel Laureate (Brighton father!) expostulated that had he had ten years out in mid career, he could not have won a Nobel. The fact that 20 other males in the room had not had ten years out, but had still not won a Nobel prize, seemed to have passed him by.

We also need a system in science which recognises the contribution of all, including teachers and technicians, none of whom are likely to win a major prize, but who nonetheless make a major contribution to the wealth, health and happiness of our nation.



The Journal of the Parliamentary and Scientific Committee.
The Committee is an Associate Parliamentary Group of members of both Houses of Parliament and British members of the European Parliament, representatives of scientific and technical institutions, industrial organisations and universities.



Science in Parliament has two main objectives:

1. to inform the scientific and industrial communities of activities within Parliament of a scientific nature and of the progress of relevant legislation;
2. to keep Members of Parliament abreast of scientific affairs.

CONTENTS

THE LATE SIR DAVID PRICE The Rt Hon Lord Jenkin of Roding	2 DIGITAL DIPLOMACY Dr John Preece	14 HOUSE OF LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE 41
THE UK SCIENCE AND DISCOVERY CENTRES Dr Penny Fidler	3 BADGERS Addresses to the P&SC by Adam Quinney, Professor Christl Donnelly and Professor Rosie Woodroffe	15 HOUSE OF COMMONS SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY 42
CARDIFF STRENGTHENS LINKS WITH CHINA Juliet Davies	6 VALUING NATURAL CAPITAL Addresses to the P&SC by Julian Harlow and Professor Brett Day	18 HOUSE OF COMMONS LIBRARY SCIENCE AND ENVIRONMENT SECTION 44
CELEBRATING A DECADE OF INNOVATIVE PARTNERSHIPS WITH CHINA Chris Rudd	8 SET FOR BRITAIN 2014	PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY 45
THE FANTASTIC FUTURE OF FOOD Jon Poole	10 VOICE OF THE FUTURE 2014	23 SELECTED DEBATES 47
CHAMPIONING THE PEOPLE WHO CHAMPION INNOVATION Professor Sa'ad Medhat	12 MARINE SCIENCE NATIONAL SCIENCE AND ENGINEERING WEEK SEMINAR Addresses to the P&SC by Dr Brian Bett, Professor Manuel Barange, Dr Stef Kapusniak, Dr Paul Bell, Dr Carol Turley and Professor Kevin Horsburgh	26 SCIENCE DIRECTORY 48
THE WOMEN IN ENGINEERING PROGRAMME Petra Gratton		28 SCIENCE DIARY 56

THE LATE SIR DAVID PRICE

A Tribute by the Rt Hon the Lord Jenkin of Roding

It is a frequent complaint about the House of Commons that far too few MPs have firsthand experience in manufacturing industry. Indeed, this is nothing new; in the early 1960s when I was working in the chemical industry, my bosses, knowing of my interest in politics, complained to me “that there are far too few people in Parliament who know anything about industry”. My response was immediate: “You name me an industrial company and I will tell you the name of an MP they sacked”. This led to their agreeing that if I were elected, they would not sack me immediately!



There was one notable exception to this dismal record: ICI, then by some margin the leading UK chemical company, had kept David Price on after his election to Parliament in 1955. For me, David had always been a beacon on whom I set my sights.

Even before I entered the Commons in 1964, he had urged me that if and when I was elected, I simply had to join the Parliamentary and Scientific Committee, and of course I did so. Very quickly I realised the value of the P & Sci and was a fairly regular attendee at its meetings. So it was no surprise when, in 1973, the then Chairman, Sir Harry Legge-Bourke MP, felt obliged to resign due to illness, that David Price was elected to take his place. He quickly established his authority. Under his leadership, the Committee prospered, with programmes of meetings, speakers and visits which attracted rising attendances. He always made it his practice to undertake some research in the Commons library on any topic due to be discussed, so that if, following the opening speeches, there was any hesitation in the discussion, he was able to start it off with a well-chosen question or comment. He also personally wrote to the speakers after an event to thank them for addressing the Committee – a courtesy which many appreciated. He was re-elected in 1974.

Then again, in 1979, the post fell vacant, and David was elected and served a second term, this time for the full three years. Though he described himself as a ‘retread’, this election for a second term was in fact a great tribute to the reputation he had built up, and so far as I can find, has never been equalled. There is no doubt that the Parliamentary & Scientific Committee owed a big debt of gratitude to Sir David Price.

Though David Price was a very independent-minded Conservative MP, he held a number of junior offices in the Government, and in 1962, after the “Night of the Long

Knives” he was appointed Parliamentary Secretary to the Board of Trade. In the Heath Government of 1970/74 he held a series of Junior Ministerial roles in Technology, Aviation and Aerospace, subjects in which he made himself a considerable expert. He found himself at the eye of the storm when Rolls Royce, facing imminent collapse over the RB211 Aero Engine, had to be propped up by Government; when he was dropped by Ted Heath it was in part because of the fall-out from the Rolls Royce affair.

With his experience in industry, he spoke with authority on the subjects where he held Front Bench positions and earned a merited reputation for knowing what he was talking about. He was a One Nation Tory who did not hesitate to express views somewhat out of line with many of his colleagues! After his wife, Rosemary, broke her back in a serious fall, David became a great champion of the disabled, and campaigned tirelessly for improved access to public buildings for people in wheelchairs.

Through all this David’s support for the Parliamentary & Scientific Committee could always be relied on; there is no doubt that over the years in which he was in Parliament, this support was greatly valued by his colleagues in all Parties. He will be sadly missed.

THE UK SCIENCE AND DISCOVERY CENTRES

Inspirational science for schools and families across the UK



Dr Penny Fidler
Chief Executive of the UK
Association for Science and
Discovery Centres

As a nation and as a global society we have some major challenges ahead, especially in relation to climate and energy. More than ever we need our young people to be inspired by science and engineering and to see it as something they want to be part of. This is vital for both our future economic success and societal well-being. Equally we want every UK citizen to feel sufficiently confident with science and the process of

major hands-on science engagement organisations including science and discovery centres, national museums, environment centres and learned societies.

Together these trusted organisations encourage over 20 million children and adults every year to delve into science in a hands-on, intriguing and personal way. Over ten million of those who participate are

backgrounds to take part in high-tech science practicals, science workshops, discussions and science visits. Science centres are in all parts of the UK and are the UK's largest infrastructure dedicated to inspiring children and families with STEM and supporting school science. They are charitable enterprises embedded in their communities, acting as regional science hubs, with excellent local relationships with schools, teachers, families, university scientists and industrial partners. Largely they are self-sustaining, achieving income through fundraising, entry tickets, and a variety of revenue-generating business enterprises. What they offer is valued highly enough that in most science centres, families and schools pay

... Science centres are in all parts of the UK ...

science to ask questions, assess evidence and discuss matters and policies that will have a big impact on their lives.

The UK Association for Science and Discovery Centres brings together over 60 of the nation's

female and science centres are signatories of the No10 / BIS 'Women into Engineering and Technology' Compact launched in May 2014.

Each year, teachers bring two million school students from all

ASDC is an educational charity. If you are an MP and would like to find out more or to visit your local science centre please contact Dr Penny Fidler on 0117 915 0186 or the science centre direct. The ASDC National conference is on Sept 24 2014 at the Royal Society www.sciencecentres.org.uk



At-Bristol Science Centre. Courtenayphotographic.co.uk

to visit science centres, and visit repeatedly.

Working together as a national network, science centres can deliver excellent practical science and science programmes to schools, students and their families in all parts of the UK.

As an example of this, The UK Association for Science and Discovery Centres secured funding from the Wellcome Trust to run a national strategic programme 'Hands-on DNA'. In partnership with three expert science centres, we trained, equipped and supported 15 science centres from Dundee to Cornwall to run high level

... Supporting school science across the UK ...

molecular biology workshops with school students. Students ran DNA experiments and used techniques that are regularly used in labs and hospitals across the UK, and are in the curriculum, but rarely undertaken in UK schools.

Many thousands of students have now done these *Hands-on DNA* workshops. We collected evidence of impact on the first 1,500 students at 15 science centres (half aged 14-16 half aged 16-18). The results from students aged 14-16 after just two hours are shown below:

95% felt it increased their confidence in them being able to understand this area of science

89% felt it increased their interest in science

90% of students had never used this type of equipment before in school

74% felt it made them think that working in science might be interesting

And their teachers said...

100% felt that more workshops like this would

increase students' motivation to study science

85% felt that the workshop will have made them more likely to consider a career in science

100% of the teachers said that they would recommend the workshops to their colleagues

100% felt that the workshop inspired their students

80% of a school child's time is spent out of school. To assume that science can only be taught inside a classroom is to give students a very limited view of science, and they miss out on all the excellent opportunities which have been developed to



Hands-on DNA

support teachers across the UK. In many countries science centres form an integral part of the national science learning strategy. Indeed, in Finland (which regularly tops the OECD PISA scales in science) student teachers have placements within science centres to ensure all

teachers are confident and trained to deliver inspirational science. This approach would be particularly valuable to UK primary teachers.

Schools are, however, the tip of the iceberg. The majority of the 20 million visitors to science centres are families, exploring and experimenting together.

The recently published 5-year ESRC-funded ASPIRES research, on young people's science and career aspirations age 10-14, revealed that the amount of

... inspiring interest in both girls and boys ...

'family science capital' is key to young people deciding to pursue a career in STEM. One of the major goals of science centres is to build this science capital by engaging young people in science activities in family groups, so the

conversation continues after they leave. There is now considerable evidence showing that science learning happens in a lifelong and life-wide manner. We ignore the non-school component at our peril. China has taken this data and invested heavily in a variety of hands-on

science experiences that happen in informal contexts as they feel it is vital to the future wealth and prosperity of their nation. They now have the largest science centres in the world.

The ASPIRES data also demonstrated that science interventions need to begin at primary school to broaden students' career aspirations in STEM. Interventions solely at secondary school are likely to be too little too late.

Science centres champion both these approaches and

work with huge numbers of primary students. For example ASDC ran a national strategic programme between 2012 and 2014 called 'Explore Your Universe' in partnership with the Science and Technology Facilities Council (STFC). The programme aimed to 'inspire a new sense of excitement among young people around the physical sciences by sharing the amazing stories and technologies of STFC'.

The project created an exceptional set of equipment and resources, and trained and supported ten UK science and discovery centres to run cutting-edge physics and engineering schools workshops, family shows and meet-the-expert events. The equipment included a solar telescope, a cloud chamber, a thermal imaging camera, meteorites, levitating magnets (using superconductors), a piece of CERN and even a minidemonstration of a particle accelerator using a Van de Graaff generator. Along with the training academies for scientists and science centres, this enabled a large range of physics experiments to be carried out in science centres.

In the first year, 156,880 children and adults took part in *Explore Your Universe* with their families or schools. Crucially, scientists and engineers working with STFC went into science centres and met families and school children discussing all

sorts of topics including their careers. Over 50,000 children and adults met female and male space scientists, physicists, engineers and technicians through this programme.

King's College London assessed the impact on the first 3,883 students and 369 teachers who took part in the workshops, making it the UK's largest multi-centre dataset of the impact of informal science learning.

One notable finding was that this physics programme had been equally successful in inspiring interest in both girls and boys. 56% of girls and boys aged 10-13 said the workshop made them feel *more* interested in studying science, and 41% said it had made them *more* likely to consider a career in science. This effect was found after just one hour of physics experiments and discussions.

... ensure school children from less advantaged areas visit more often...

Science and discovery centres are keen to do more. They have the capacity and expertise to inspire more families and more primary and secondary students in a creative, innovative and highly cost-effective manner.

They (like ASDC) are charitable enterprises that exist to engage people from all backgrounds with science. They are poised



Girls using a Van de Graaff generator in *Explore Your universe*

and ready to offer more bursary schemes to ensure school children from less advantaged areas visit more often, and return with their families. They want to inspire girls to get more involved in science, and to run high-end science practicals for which schools do not have the equipment or specific expertise.

Science and Discovery Centres run successful sustainable day to

day operations and are nimble and creative in securing mixed income streams to support their mission. However, unlike arts, sports or heritage organisations, future-focused hands-on science and discovery centres are generally ineligible to apply for capital funds from public sources. This poses a major challenge and we are hopeful this situation will soon change,

Excellent and innovative science learning is vital to the UK's future economic success as well as our health and well-being. If we want to keep our position as world leaders in science, we need to invest in nurturing the curiosity and inventiveness in our young people and use every mechanism at our disposal to inspire them – not simply school.

Cardiff strengthens links with China to create more effective cancer treatments



Juliet Davies
Executive Officer at the Cardiff University-Peking University Cancer Institute, Cardiff University



Professor Wen G Jiang
Professor of Surgery and Tumour Biology and Academic Director of International Relations, Cardiff University

Working collaboratively by pooling the best researchers, facilities and resources from likeminded, world-leading institutions has always been a priority for Cardiff University. In the field of medical research and in particular cancer research, this approach has led to the development of partnerships between Cardiff University and some of China's leading cancer organisations.

The University's latest venture has resulted in the Cardiff University-Yiling Group Joint Medical Research Centre. This was established in 2013 in partnership with a leading institution, the Yiling Group Medical Research Institute. It will develop new treatments for cancer and infectious diseases, with a focus on Chinese medicine. The Centre will also offer training opportunities for medics and scientists.

Cardiff, along with colleagues at Peking University and at the Yiling Group, have been testing the benefits of the Chinese herbal medicine *Yangzheng Xiaoji*. The herbal formula had been shown to be beneficial to cancer patients, but until now the way in which it works had remained unknown. The collaboration investigated how the formula works and discovered that it blocks a pathway involved in reducing

conventional therapies such as chemotherapy. The Centre will also extend the research collaboration to other areas of medicine.

Cardiff's collaboration with Yiling has also allowed the creation of new scholarship opportunities for Chinese medical scholars, enabling them to undertake study and training in the UK. Likewise, UK students will be able to gain overseas experience by spending time in China. By 2017, 17% of Cardiff University's home students will have studied, worked or volunteered abroad for at least a month.

The venture between Cardiff University and Yiling, with the support of the Welsh Government, will also create

... new treatments for cancer and infectious diseases ...

The Yiling Group Medical Research Institute was formed in 1992 by Professor Yiling Wu, a highly accomplished scientist, medic, academician, entrepreneur and politician. Yiling Pharmaceuticals is one of China's high-tech pharmaceutical companies, devoted to R&D, manufacture and marketing of new medicines. It has some unique approaches in therapeutic development for diseases such as arrhythmia, heart failure, flu and cancer.

Cardiff University has been collaborating with Yiling Group for the past two years, initially investigating the potential mechanism(s) of some anti-cancer medicines. The team at

the spread of cancer cells around the body. The Chinese formula has been shown to be beneficial to patients with certain solid tumours when used alone, and in particular when used as an adjuvant treatment alongside



Launch of the Cardiff University – Yiling Group Joint Medical Research Centre by Professor Yiling Wu and Cardiff University's President and Vice Chancellor Professor Colin Riordan

opportunities to attract inward investment to the UK for R&D in anti-cancer medicines.

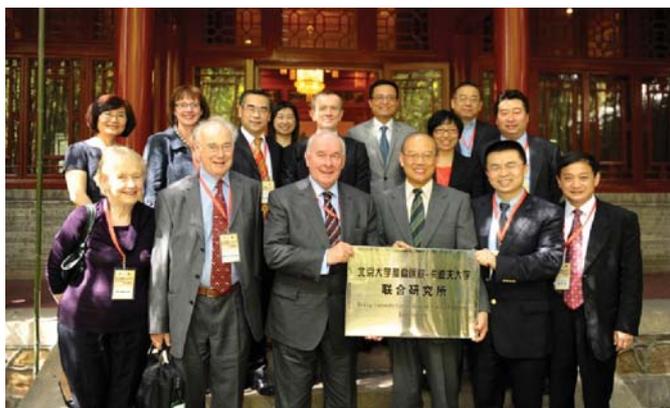
As one of the UK's leading centres for cancer research, Cardiff University established the Cardiff University-Peking University Cancer Institute in 2011. It has been collaborating with Peking University in Beijing for over a decade and has hosted many of their scientists and specialists. Peking University is the top ranked university in China and one of the premier universities in the world. The Cardiff-Peking Cancer Institute consists of two centres. Cardiff University has invested in the provision of new space, equipment and research posts to support the collaboration. At Peking, the Institute is located in the University Cancer Hospital and Beijing Cancer Institute, one of the leading hospitals and research centres. Joint directorship and management synchronise the research, training and education activities.

... reducing the spread of cancer cells ...

Currently, the focus is on some of the most aggressive forms of cancer, including gastrointestinal cancers, pancreatic cancer, lung cancer and endocrine-related cancers, which are amongst the priority areas in both the UK and China. Research also concentrates on cancer metastasis, angiogenesis, biomarkers and new methods of treatment, including alternative medicine such as traditional Chinese medicine.

Every year, a symposium is held either in Cardiff or Beijing at which speakers present their latest research on cancer biology, genetics and treatments. It highlights key areas in cancer research and cancer treatment to explore in the future.

Based on the success of the Institute, Cardiff University went



The official launch of the Cardiff University - Peking University Cancer Institute



The official launch of the Cardiff University - Capital Medical University Joint Centre for Biomedical Research

on to establish the Cardiff University-Capital Medical University Joint Centre for Biomedical Research. Cardiff

University and Capital Medical University (CMU) have enjoyed a fruitful relationship since 2003. CMU ranks among the top academic medical institutions in China and is one of the key universities in Beijing. Capital Medical University is the world's largest medical university, with 22 affiliated hospitals and more than 23,000 beds. It delivers a full range of health, medicine and life science related subjects.

This has created opportunities for research in a number of fields. Research has been advancing on the metastasis of breast cancer examining how the disease spreads around the body. To date, the collaborative research has discovered new biomarkers not only for breast cancer but also for prostate and kidney cancer. Other research

projects have focused on brain metastasis and gastrointestinal cancers.

Cardiff's relationship with CMU has led to a Cardiff University China Medical Scholarship. This has already supported more than 50 Chinese medics in the last 5 years to spend time in Cardiff. The scholars have the opportunity to undertake some research away from their workplace and the chance to share views and expertise with

... focus is on some of the most aggressive forms of cancer ...

Cardiff's academic staff. This programme has led to many joint papers. Scholars benefit from the chance to live and learn in a different city and University, and to make contacts and friends that will be for life. Cardiff is also keen for its staff and PhD students to spend time in China. Last year for the first time, 2 PhD students from Cardiff spent 6 weeks working with scientists at Capital Medical

University. This gave them the opportunity to embrace a different environment and learn different techniques and approaches which complement their experiences in Cardiff.

World-wide partnerships are important in helping a University to build a global reputation. Cardiff University's aim is to be consistently ranked in the top 100 universities, and such

... not only for breast cancer but also for prostate and kidney cancer ...

collaborations play a role in achieving this ambition. More importantly however, it is through such collaboration that advances in the understanding and treatment of global diseases will be made.

Cardiff's ground-breaking cancer research partnership work with China won the International Collaboration category at the annual *Times Higher Education* awards in 2011. All 3 partnerships are under the directorship of world-leading breast cancer researcher Professor Wen G Jiang. Professor Jiang is a Professor of Surgery and Tumour Biology and Academic Director of International Relations at Cardiff University.

For further information please contact Juliet Davies:

cardiffpeking@cardiff.ac.uk



CELEBRATING A DECADE OF INNOVATIVE PARTNERSHIPS WITH CHINA



Chris Rudd
Pro-Vice-Chancellor (External Engagement), The University of Nottingham

In 2004, The University of Nottingham became the first foreign University to establish a campus in China, in the city of Ningbo, based south of Shanghai on the East China Sea. Developed on grounds occupying 144 acres, the establishment of the University of Nottingham Ningbo China (UNNC), with the full support of the Chinese government, marked an historic moment in the opening up of Chinese Higher Education and its development of the knowledge-based economy. It also signalled an increase in the level of collaboration between Chinese businesses and the UK.

Ten years on, and UNNC now admits more than 1200 of the most talented young people of their generation each year, from provinces and municipalities across China. More than 6,300 students at undergraduate, masters and PhD level are now based at our Ningbo campus. UNNC graduates have

transferable skills, a creative and critical outlook and a sense of team spirit and are sought after by major employers around the globe. All students who have graduated from UNNC since 2004 have found jobs or moved on to postgraduate studies at top international universities within six months of passing their final exams.

Pushing the boundaries of science

At the end of last year, during the Prime Minister's visit to China, we announced our most ambitious project yet in Ningbo, a £25 million cooperative agreement between the Ningbo Municipal Government, the University of Nottingham Ningbo China and Zhejiang Wanli Education Group to form the first International Academy for Marine Economy and Technology (IAMET).

The marine economy is one of China's key strategic development areas and the IAMET will be based at a purpose-built facility at the

Ningbo campus. It will work with companies around the world in areas such as port services and logistics, marine advanced materials, natural products and environmental management. The Academy will also have a dedicated team of international academic leaders and research and business engagement staff, and will draw on the input and advice of independent world-leading academic and industry experts to deliver innovative and internationally competitive programmes.

There are a number of other notable areas of scientific research in which academics at the University of Nottingham Ningbo China (UNNC) are pushing forward the boundaries of science. Engineering researchers are working very closely with the Additive Manufacturing and 3D Printing Research Group in the UK to develop the next-generation, multimaterial and multifunctional additive manufacturing and 3D printing technologies with a focus on end-use functionalised

3D structures and components. In 2013, UNNC organised a highly influential conference in Ningbo to explore how 3D printing has developed and its potential for improving the efficiency of manufacturing in the city.

Energy is another important area of expertise at UNNC. Our Centre for Sustainable Energy Technologies, based in Ningbo which opened in 2008, will provide solutions to problems arising from sustainability issues relating to the environment, energy, engineering and technology. For example, our researchers have recently invented a material that can retain and release heat according to the specific requirements of a building. The material, known as novel non-deformed energy storage phase change material (PCM), is a major scientific breakthrough with long-term environmental benefits. Cheap to manufacture, PCM will dramatically reduce bills and cut a building's energy use by up to 35%.



The first cohort of graduates from the Sondrel integrated circuit design programme in 2013

The award of the Nobel Prize to Nottingham academic Sir Peter Mansfield for his work in MRI and the groundbreaking research within the University's Sir Peter Mansfield Magnetic Resonance Centre, means that The University of Nottingham is internationally recognised for its expertise in MRI. Consequently, UNNC has also identified MRI as an area for its own strategic development, with an unrivalled opportunity to become a significant player in MRI education and training in China.

Training the brightest researchers

We are also supporting scientific research at UNNC through doctoral training. In 2011, The University of Nottingham and the Ningbo Municipal People's Government signed a Memorandum of Understanding to pave the way for more cooperation in international scientific and technological development. Four topics were identified, including the digital economy, marine technology, energy and environmental protection, and manufacturing.

Funded by The University of Nottingham, the University of Nottingham Ningbo China, the Engineering and Physical Science Research Council and Ningbo Municipal Government, the £17m International Doctoral Innovation Centre (IDIC) will train 100 of the brightest PhD researchers over the next six years to become leaders in the fields of energy and digital technologies.

The four-year PhD programme, split between the University's campuses in China and the UK, exposes students to research, industry and entrepreneurship on an international scale. The unique model of the Centre integrates a number of co-dependent strands, Doctoral Training Centre, Innovation-led Research and Accelerator Fund

to achieve an exciting new environment for world-leading research.

The city of Ningbo has also granted around £1m in funding to UNNC for an ambitious project to produce at least 25 manufacturing engineers and 25 patents for new technologies over five years. UNNC researchers will work with at least 50 companies in Ningbo to invent low-carbon technologies and develop new business models that reconfigure the manufacturing sector in the city to enhance profitability and sustainability and minimise environmental harm.

A significant number of Chinese high fliers have also been working with us through the Chevening Young Leaders programme. Organised on behalf of the Foreign and Commonwealth Office and the All-China Youth Federation, the course is tailor-made for leaders of the future, helping to develop high-calibre people to take on senior political and industrial posts later in their careers.

Building new academic partnerships

Our work in China extends far beyond Ningbo. In 2012 we established a new joint venture in conjunction with the East China University of Science and Technology. The Shanghai Nottingham Advanced Academy (SNAA) is a joint collaboration in the fields of life sciences, green technology, aerospace, and global food security – all of which are key strengths of The University of Nottingham and the East China University of Science and Technology (ECUST).

One of our most exciting collaborative projects with a Chinese university has just been launched in Guangzhou – the Guangdong Nottingham Advanced Finance Institute

(GNAFI). A partnership with Guangdong University of Finance, the Institute will provide advanced training to senior managers from industry, commerce, financial institutes and government organisations and will train up to 2,000 Chinese financial specialists each year to support the thriving financial centre in Guangzhou.

In addition to the work with Guangdong University of Finance, we have also established many research collaborations with other Chinese Universities, including Fudan, Shanghai Jiaotong, China Agricultural University and Zhejiang University.

Another example of the breadth of our collaborative work is the Sino-UK Geospatial Engineering Centre. This is a project jointly supported by The University of Nottingham and the Chinese Academy of Surveying and Mapping, the research arm of China's National Administration of Surveying, Mapping and Geoinformation (NASG). The Sino-UK Geospatial Centre operates in both Beijing and in Nottingham. The centre offers Executive Training for Chinese leaders working in surveying and mapping companies, in areas such as technology, management and business.

Doing business with China

We are helping British companies obtain the skills they need, and, in the first partnership of its kind, the University has been working with British company Sondrel, an Integrated Circuit design services consultancy for the semiconductor industry, to offer three-month training programmes at UNNC. The first two cohorts, each of around twenty students, who completed the course earlier this year were all offered jobs by the sponsor.

In addition, we are also working

extensively with many Chinese businesses. In recent years, we have established research and training collaborations with the likes of the aerospace giant, AVIC; the automobile manufacturers FAW and Changan; the railway company China South Rolling Stock (CSR); China Resources Group, and many other major companies.

However, it is not just the bigger businesses that are benefiting from our China connections. For instance, through our Brewing Science department, we have been helping a number of microbrewers in the East Midlands to develop beers for the Chinese market, and with the support of partners such as UKTI and British Craft Beers, they are now exporting to merchants in China. In addition, we also enable SMEs to make links more generally with Chinese businesses and officials through activities such as our On Location dinner, which is held in Shanghai, and via the many Sino-UK events we organise in Nottingham.



L-R Dr Li Jun, President of FAW's R&D Centre with Professor Chris Rudd, Pro Vice Chancellor of The University of Nottingham

As our partnerships with business, academia and government extend across China, and as our Ningbo campus matures, The University of Nottingham is increasingly able to help British companies make vital links with China and we are looking forward to building many more partnerships in the future.

THE FANTASTIC FUTURE OF FOOD: 50 YEARS OF FOOD SCIENCE & TECHNOLOGY



Jon Poole,
Chief Executive, Institute of
Food Science and Technology

The Institute of Food Science and Technology (IFST) this year celebrates its 50th Jubilee. While we will not miss the opportunity to celebrate the past, the focus for the Institute's celebrations is on looking to the future.

The important role of food science and technology in ensuring a sustainable supply of safe and nutritious food seems never to have been so critical. Barely a month goes by without at least one significant news story hitting the headlines on a related subject. In the recent past we have seen a plethora of stories relating to the horse meat scandal and its

Sadly these stories often pick up on negative aspects of food, nutrition and health. As an institute and an independent professional membership body involved in this sector, we do not see this as a threat. These stories reinforce the important message that food science and technology lie at the heart of the **solutions** to these issues rather than being the **cause**.

which have evolved as a result of being used under crisis. Indeed, some of the technologies which are now being utilised on a routine basis have only become available on a mass and economical scale in the last few years.

It is only through effective scientific research that we can continue to advance the profession and continuously improve the quality, production and safety throughout the supply chain. IFST has recently published a new Information Statement entitled *Modern Techniques Used in Food Authenticity Testing*. This was written and peer-reviewed by our members, and is available on our website.

... ensuring a safe and reliable food supply chain ...

implications in terms of food authenticity and ensuring a safe and reliable food supply chain. Similarly, the number of stories relating to obesity, diet, nutrition and health is increasing faster than the UK waistlines on which they are reporting.

Slightly slower burning news items but just as critical include the sustainability of our food supply – within the UK but also on a global scale. Other subjects related to sustainability and which also regularly vie for headline status include the introduction of new technologies such as genetic modification and nanotechnology.

Many of our members are involved in critical research and development targeted at reducing the prevalence of food-borne diseases and ensuring the production of food that is safe

... safe from chemical and physical contaminants ...

from chemical and physical contaminants. This highly complex work often goes unnoticed by the general public. During the horse meat scandal, food analysts were responsible for testing meat samples using a number of techniques, some of

In reality, even given the recent horse meat scare, consumers generally do not fear going into a supermarket. Consistently safe and reliable food is considered a hygiene factor – something which the public expects. From time to time we hear of food

product recalls. Some of these are voluntary, and are just one further course of action at the end of a very thorough testing process that aims to ensure that the food we eat is reliably safe and of the highest quality.

That said, food scientists are in no way complacent. They know that the increased complexity of a globalised food supply chain along with increasing food prices may lead to more opportunities and greater temptation for food fraud. This is a subject at the heart of the recent *Elliott Review into the Integrity and Assurance of Food Supply Networks* due for final publication in early summer 2014. There is no doubt that the horse meat incident has highlighted some important issues and further steps that can be taken to tighten the food supply chain.

One unintended consequence of many of these news stories has been the negative impact they have put on the image of the food industry. As with many other sectors, food – from farm to fork – struggles to attract high

... recognised code of conduct around food safety ...

quality young people needed both today and for the future. This is especially acute in terms of attracting the next generation of food scientists and technologists. This is even harder to do against such a negative backdrop of reporting.

In our 50th Jubilee year, IFST is focusing on the future needs of the sector and is pleased to be delivering two important new

projects in support of these issues and the food sector.

REGISTER FOR FOOD SAFETY PROFESSIONALS

The first of our Jubilee projects is our planned Register for Food Safety Professionals. Currently EU Regulation 852/2004 (Article 5) requires all food business operators to implement and maintain hygiene procedures based on

... greater temptation for food fraud ...

HACCP principles. HACCP (Hazard Analysis and Critical Control Point) is an internationally recognised way of managing food safety and protecting consumers.

Food business operators are required to identify Critical Control Points (CCPs) and then establish procedures to monitor these and take corrective actions where needed. All of this, of course, must be recorded and HACCP procedures carefully verified on an ongoing basis. HACCP principles are normally established at a senior, strategic

level in a food business, then carefully managed, and delivered on a day-to day basis by those responsible for production.

IFST's new voluntary register aims to provide a four tier framework that will recognise and encourage the professional development of all levels of food safety professionals. It will also establish a recognised code

of conduct around food safety which we believe will support the Food Standard Agency's principles of risk-based enforcement and assessment. Ultimately this register will ensure that those involved in delivering food safety are recognised as having the necessary level of knowledge, skills and experience required to deliver HACCP processes at the level at which they are working.

Prevention of food fraud, as highlighted in the Elliot Review, is often the responsibility of food safety professionals. Our new register will ensure that a focus on the prevention of food fraud is incorporated within the assessment criteria for attaining accreditation. All food safety professionals will then be required to maintain a record of their continuing professional development – critical for scientific professionals in such a fast moving subject.

FoodStart – IFST'S LEGACY PROJECT

Celebrating the *Fantastic Future of Food* is the main theme for our 50th Jubilee year. But, as highlighted earlier, pivotal to the future of food is the need to attract sufficient talent to deliver this. A second key project for IFST is the development of our *FoodStart* project. We are designing and building a website which will provide a single point of contact for students wishing to experience working in the food sector. Food employers will be able to post work experience

placements, graduate placements and internships free of charge for students to browse and apply.

Provided placements meet minimum standards set by IFST, students will be awarded achievement 'badges' which they can include within their CV, building their profile and improving their employability. To deliver this ambitious legacy project IFST is currently raising funds from its members as well as directly from employers. We already have some major food brands supporting us but need further support to bring this to reality.

Our *FoodStart* project is being formally launched at our Jubilee conference on 14-15 May and our Register for Food Safety Professionals will be formally launched at our House of Lords Reception on 2 July hosted by Lord Rooker, an event which will also be a celebration of our 50th Jubilee theme – *the Fantastic Future of Food*.

For more details of both of these projects and our Jubilee events please visit our website: www.ifst.org or email Jon Poole, Chief Executive, j.poole@ifst.org.



CHAMPIONING THE PEOPLE WHO CHAMPION INNOVATION



Prof Sa'ad Medhat, FIKE, CEO Professor Medhat is the founder of NEF with an established reputation for driving forward initiatives from policy through to implementation.

Innovation is an important differentiator in highly competitive markets. It has become a more sophisticated function that is mandated by organisations. However, to achieve and maintain innovative cultures and practices an active leadership for innovation is required.

NEF: The Institute recognises the critical contribution that innovation plays in addressing business, economic, social and environmental challenges. As a professional body and 'do-tank', the Institute supports people who drive innovation and acts as a channel for discussion on issues relating to innovation with Government. Guided by the Innovation Council¹ of over 40 Chief Officers representing our economy, the Institute is stimulating innovation through sector-to-sector knowledge transfer and horizon-scanning in areas of potential common interest. Subsequently, this critical industrial intelligence is fed through to educational institutions, enabling them to prepare for future skills development in new and emerging technology areas of growth.

THE INNOVATION MANIFESTO

The Innovation Council's vision has culminated in the Innovation Manifesto, which articulates what we have pledged to do in support of Government's policies and provide an inspirational reference point for innovators:

1. Create and sustain a culture of innovation

- Promoting access to effective practice by successful innovative organisations, so that people working in industry, education and the public sector can improve performance on innovation
- Providing development, training and standards which encourage entrepreneurial mind-sets and approaches

2. Develop talented people to drive and manage innovation

- Promoting the uptake of standards and frameworks which help to identify, recognise and exploit innovation talent and drive business growth
- Designing and delivering programmes which develop the knowledge, skills and attitudes capable of supporting innovation

3. Design and implement a regulatory framework to drive innovation

- Working with industry and Government to prioritise areas for regulatory change which can make a significant impact on levels of innovation and business performance

4. Promote and secure investment that enables innovation to flourish

- Bringing Government and industry together to design funded initiatives which will enable innovation and provide real return-on-investment through growth

- Supporting policy initiatives, funding and incentives which improve the impact and take up of innovation, particularly by SMEs and across a wider purview than just the private sector

5. Embed innovation in new business models and organisational design

- Networking emerging practice that supports growth in innovation organically and/or through acquisition
- Recognising and sharing organisational structures and behaviours which have proven to be successful in driving innovation

6. Improve the rate of innovation through investment in research and development

- Promoting sustainable mechanisms to improve the rate of innovation through R&D investment in, for example, the innovation pipeline, diversification and innovation diffusion
- Promoting the adoption of new approaches that combine science, industry and education in effectively harnessing innovation and in successfully supporting new business creation

7. Support infrastructure development which enables growth

- Identifying and promoting enablers for innovation and growth – access to space, access to funds and access to support
- Providing tailored support to, and development for, young people involved in new business creation, innovation and growth

8. Sensitise the market and support market innovation

- Promoting new frameworks for market innovation such as

cities as 'test beds' for developing new market models

- Assisting SMEs with product and service innovation and with access to new markets

9. Facilitate cross-sector innovation transfer

- Improving the capacity to innovate across sectors and access new international markets through new approaches to cross-sector and cross-cultural engagement

10. Protect and harness intellectual property

- Providing SMEs with advice and guidance on the Intellectual Property landscape, litigation and challenges

ENABLING INNOVATION

NEF: The Innovation Institute is experienced in working with Government, industry, education and the public sector to stimulate change and improvement. The Institute will:

- Champion the innovation agenda with Government, industry, education and the public sector through a range of interventions
- Work with industry and education to promote the uptake of the Investor in Innovations standard to stimulate and benchmark innovation
- Accredit programmes that recognise and drive innovation to enable knowledge exchange and continuous improvement

¹ Innovation Council: AMEC, Arla; Balfour Beatty, BASF, BBC, BOSCH, Britvic, BT, Bupa, Buro Happold, Cobham, Cobra, Costain, Crossrail, DHL, Dunhill, DuPont, EDF Energy, EMC2, Evolvi, Extrinsic, GE Healthcare, GSK, Lego, Mars, MBDA Missile Systems, Medvivo, Microsoft, MITE, National Grid, Plessey Semiconductors, Rolls Royce, Royal Mail, Tate & Lyle, Telefonica, Thales, UK PIA, Unilever, UCS.

THE WOMEN IN ENGINEERING PROGRAMME

Petra Gratton, Programme Manager, Women in Engineering, Brunel University



At a Women in Engineering workshop held at Brunel University in March, engineering employers were represented by BAESystems, Ford, Mabey, Millbrook, Network Rail, Robert Bosch Group, Lucy Switchgear and Cavendish Nuclear Ltd.

Engineering contributes a huge amount to the UK economy: £1.06 trillion in turnover for the year ending March 2011, which is nearly a quarter of the turnover of all UK enterprises. Some contribution is from manufacturing, which makes up almost half of UK exports, and accounts for 72% of UK business research and development. However, there is more to engineering than manufacture. It also includes all the operation and maintenance of society's infrastructure, such as energy, communications, transportation, mining, construction, property, defence and emergency services.

The Royal Academy of Engineering has estimated a need for 100,000 STEM graduates each year to serve all these various sectors, which represents a shortfall of about 10,000. The fact that the female half of the population has not traditionally pursued engineering careers, and women are not very

much in evidence in industry, is something Brunel University's *Women in Engineering* programme addresses. This programme has been enabled by funding and support from a number of sources including the Higher Education Funding Council for England, the Babcock International Group, the Institution of Mechanical Engineers and TWI Ltd.

Jobs for engineers are there, and they pay well. According to EngineeringUK, engineering enterprises predict having 2.74 million job openings during this decade to 2020. The starting average salary is £27,415 for those who go to work for engineering companies rather than for non-engineering companies (which is 15.7% more than the mean for all graduates, and less than only those in medicine and dentistry). It is worrying to find from the HESA statistics that only 51% of female (compared with 68% of male) STEM graduates continue

into STEM roles. The pipeline is leaking!

From the point of view of a 14-year-old girl considering careers in school, the problem is that there are very few women in evidence in engineering, and a very small number at the top of their profession (however that might be defined by our teenager). The *Women in Engineering* programme aims to support women who have

... women are not very much in evidence in industry ...

graduated in engineering, and want to develop the necessary business acumen and leadership skills to propel them up their career path, whilst they are studying for their MSc degree. Through contact with industry, networking and visiting sites, they will have the opportunity to get a better understanding of the roles available to them. As well as benefiting the individual women who participate in the programme, this will give those

in school thinking about careers some excellent female role models with whom to identify. The engineers will be required to participate in promoting the profession, in line with the requirements of Engineering UK's *Standard for Professional Engineering Competence*.

To encourage women engineers who are eligible for UK/EU fee status to join the programme, Brunel is offering 40 scholarships, covering tuition fees and a living allowance of £15,000 for the academic year 2014-15. As well as qualifying for a place on one of the selected MSc courses, applicants must provide a personal statement which demonstrates their commitment to their chosen engineering profession. Priority will be given to those who have not studied beyond Bachelor's degree level before, and to those who have worked (paid or unpaid) preferably in the sector of their professional studies.

Reception of the *Women in Engineering* programme has

been overwhelmingly positive since its launch in January, and it is anticipated that we will see more women engineering graduates from Brunel University in 2015 than ever. There will be many opportunities for engineering enterprises to promote themselves to the graduates. If you are interested in supporting this initiative, please contact womeninengineering@brunel.ac.uk.

The most interesting article on digital diplomacy you'll read all day

Dr John Preece

Science and Innovation Network, Toronto, Canada

You're browsing a news site, and see the following link: *12 risky British discoveries that changed our world*. Do you click it? Even though it's recognisably link bait, carefully crafted to entice you into spending more time on a site, research suggests that you would.

Captivating headlines are in some ways an expected response to the fire hose of new information on the Web. With over 2 million blog articles and 50 million tweets posted every day, content creators need to deploy every technique they can to make their stuff stand out from everything else. According to viral media site Upworthy, traffic on an article can vary by up to 500% depending on the headline – and more traffic means more potential advertising revenue.

... communicate British science ...

In digital diplomacy, we're less interested in making money (though saving money by delivering government services through digital channels is a big priority) and more interested in making sure that information is easily findable and widely read. Here in the UK Science and Innovation Network, one of our aims is to communicate British science – discoveries, announcements, policy – to our stakeholders. In the past, we have relied on press releases and speeches to get our message out; today, we have a vast array of digital tools to reach a much wider audience.

A 2013 University of Bristol study looked at the differences between several new websites' "Top Stories" (what editors think is important) and "Most Popular" (what people are actually reading) lists. Perhaps unsurprisingly, serious topics like politics and business were poorly-read, while the tabloid staples of crime, natural disasters, celebrity and the weather were universally popular. Similarly, a Conductor survey found that headlines containing numbers (*10 Female British Scientists You Should Know About*) were far more popular than other ways of expressing the same information, as were headlines with fewer superlative statements (*10 Female British Scientists You Really Should Know About*).

This is a tendency that viral media platform BuzzFeed has exploited mercilessly. Virtually every headline on the site is strategically written to maximise the chances of you reading it, with about half being of the "number" type. And while you may sniff at the déclassé subject matter (*12 Celebrities Whose Facial Hair is Worse Than Yours*), you may be in the minority – BuzzFeed attracts over 85 million unique visitors per month, more than the BBC, CNN, New York Times and Reuters combined.

Does this mean that, in order to maximise readership, we should be publishing most of

our messaging through high-traffic platforms? It's an intriguing thought (*15 Important Reasons to Collaborate with the UK on Regenerative Medicine Research*), but there isn't really a one-size-fits-all approach to science communications. We use tools like Twitter to add a very personal touch to civil service duties; Tumblr to deliver

... very personal touch to civil service duties ...

visually rich content to a different audience; Facebook to answer questions from another audience. BuzzFeed has a place too – our colleagues in Washington DC run a popular channel about life in the UK (*11 Stats That Prove British Music Rules*) and the USA (*Baseball: You're Doing It Wrong*).

Government communications have not disintegrated into anarchy with the advent of digital tools; most official channels – as anyone who's worked on an intergovernmental agreement will know – are still rigorously shaped and refined. However, we now have a more human element to communications, with a multitude of individual employees working on engagement as a part of their job that's slightly separated from the official machinery of the organisation. The Government Digital Service's *Inside GOV.UK* blog (formerly *Inside Inside Government*) is a good example of an initiative to engage citizens and let them take a peek behind the frontend of their digital services.

Strategies like these ultimately serve prosperity goals. In the Science and Innovation Network, we are aiming to communicate British excellence and expertise so well that when someone thinks of science – for research collaborations, study, policy advice or anything – they think of the UK and come to us. We also aim to communicate our

own activities and successes, to raise our profile in the countries in which we work and inspire new scientists and research groups to work with us. For example, here in Canada we have taken advantage of the fact that official FCO blogs appear quite high in Google search results to showcase our collaborative projects and allow British and Canadian scientists to talk informally about their work. We are also working on creating a somewhat rarefied reputation on Twitter for science diplomacy with the UK and on public outreach through digital events (such as our recent Google Hangout on open data). While we are not setting up randomised controlled trials of these channels, they are something of an experiment and we will be looking closely at the results to see if they deliver what we want them to.

And congratulations on your engagement and attention span if you read this far – research also suggests that only 20% of readers get past the headline.

BADGERS

Meeting of the Parliamentary and Scientific Committee on Tuesday 21st January

BADGERS



Adam Quinney
Vice President, NFU

The summaries of the talks given at the meeting by Adam Quinney and Professor Rosie Woodroffe are based on an article by Edward Stansfield CMath FIMA CSci published in *Mathematics Today*.

Adam Quinney spoke about farming and the effect that TB in cattle is having on the industry. He stressed that the NFU is anti-TB and not anti-badger. He pointed out that not only can badgers transmit TB to cattle, but cattle can transmit TB to badgers. The usual mechanism is via the animal latrines ie in the urine which gets absorbed into the food. TB is a very complicated disease. Animals can be infected but not infectious. The time during which an animal is infected before becoming infectious is very variable – from weeks to months. The infection can also be spread when infected animals bite other animals.

Badger proofing farms is very expensive, and not practical, as it requires fences around fields to be buried to a considerable depth. Experiments using

proximity sensors have shown that badgers tend to live in family clusters and generally do not move more than 2km from their setts. Unfortunately, such results have proved to be more useful for learning about badger behaviour than their effect on cattle.

Badgers tend to be up and about at night and sleep in the day, whereas cattle tend to do the opposite – up and about in the day and lying down chewing the cud at night. Hence the importance of badger latrines and cattle fodder. Tests have shown that raising the troughs for cattle food and water reduces the level of TB in cattle.

The primary test for TB in animals is a skin test, which is said to be 90% effective ie on average 10% of infected animals will not be detected to

have the disease. The NFU would like to have an effective vaccine for badgers, but this is not easy to find. The best current vaccine has to be injected, which first requires the animals to be caught – no easy task. Oral vaccines are available, but are much less effective. The NFU would also like an effective vaccine for cattle, but this is even more difficult to achieve as cattle are part of the human food chain. Moreover, different parts of a cow or bull are exported to different countries depending on local tastes and requirements; hence many different tests would be required to show that the vaccine is not detrimental to human health.

In conclusion, Adam said that there is no single answer – TB has not so far been stopped, but it has been slowed down.

BADGERS

BADGER CULLING AND ITS EFFECTS ON CATTLE TB



Professor Christl Donnelly
MRC Centre for Outbreak Analysis and Modelling, Department of Infectious Disease Epidemiology, Imperial College London

Cattle tuberculosis (TB) is a serious animal health problem. The disease is caused by the bacteria *Mycobacterium bovis*. Public health measures include pasteurization, which kills any *M. bovis* in milk and dairy products. Routine testing of cattle identifies *M. bovis*-infected cattle to limit onward cattle-to-cattle transmission, to avoid cattle suffering due to TB and to secure public health. Following confirmation of *M. bovis*

infection, cattle sales and movements are restricted, and farmers are given detailed biosecurity advice.

Transmission from British wildlife, in particular badgers (*Meles meles*), has hampered cattle-focused efforts to control, and eradicate, the disease. Badger culling has been undertaken, in various forms, since the 1970s. Yet, the role of badgers continues to be fiercely debated, as do the appropriate

approaches to limiting badger-to-cattle transmission.

The Independent Scientific Group on Cattle TB (ISG, of which I was the deputy chair) designed, oversaw, analysed and interpreted the Randomised Badger Culling Trial (RBCT). In the RBCT, 30 large (100km²) areas were selected in ten sets of three, within which one area was randomised to proactive culling, one to reactive culling and one to no culling. Proactive

culling was undertaken annually on all accessible land, whereas reactive culling was undertaken only once on and around farmland on which cattle had been confirmed with bovine TB. All badgers culled within the RBCT were captured using baited cage traps and shot.

In 2003, reactive culling was suspended because the incidence of confirmed cattle TB in reactively culled areas was found to be significantly higher than in the matched uncultured areas¹. This unforeseen result caused considerable debate about potential mechanisms for the increased risk and about the robustness of the RBCT. Subsequent analyses of data within the reactive areas (ignoring data from the uncultured areas) identified an association between reactive badger culling and increased confirmed cattle TB risks on nearby farms. Furthermore, affected herds in reactively culled areas took longer to clear TB from their cattle than herds in uncultured areas.

... affected herds in reactively culled areas took longer to clear TB ...

An ecological hypothesis proposed to explain the reactive culling finding was that one-off localized culling disrupted badgers' territorial behaviour, thereby increasing contacts between infected badgers and cattle. The impacts of culling on badger activity, in particular ranging behaviour, were measured using bait marking. Coloured baits were fed to badgers at their setts (dens) and the resulting colour-marked bait returns (faeces) were mapped for proactively culled, reactively culled and uncultured areas, as well as on land up to 2km outside proactively culled areas². Badger home ranges, estimated from bait returns, were consistently larger and

overlapped more in culling areas. Furthermore, in uncultured areas, badger home ranges increased with proximity to the boundaries of proactive culling areas. The finding that badger behaviour was affected up to 2km from the proactive culling areas suggested to the ISG that cattle TB incidence should also be examined up to 2km outside RBCT areas.

... the role of badgers continues to be fiercely debated ...

In 2006, the ISG and colleagues reported that proactive culling had reduced the incidence of confirmed cattle TB among herds in proactively culled areas, compared with herds in uncultured areas³⁻⁴. However, we also reported that proactive culling increased the incidence of confirmed cattle TB among herds on land up to 2km outside proactively culled areas, compared with herds on land up to 2km outside uncultured areas, though this increase disappeared after annual culling stopped³⁻⁴.

These results, although biologically sound, have created particular challenges for policymakers and stakeholders. The estimated positive and negative impacts of proactive culling are such that the net benefit (that is the cattle herd incidents prevented inside the culling area minus the cattle herd incidents caused up to 2km outside the culling area) will be greater for larger roughly circular culling areas.

Everything else being equal, the best shape for a landlocked proactive culling area is circular as it minimizes the ratio of land up to 2km outside the culling area to the land area within the culling area. For example for a

100km² circular culling area, 83.5km² of land is up to 2km outside it (ratio=0.835), whereas for a 200km² circular culling area, 112.8km² of land is up to 2km outside it (ratio=0.564). It was on this basis that we found, in 2010, that we could only be (95%) confident of avoiding net increases in confirmed cattle TB across the entire affected area

for circular culling areas greater than 141km² in size⁴.

In 2011, Defra published details on an approach to license farmer-led badger culls⁵. The approach differed importantly from proactive culling in the RBCT in that

- i) it allowed the shooting of free-ranging badgers, as well as cage-trapping, raising concerns for animal welfare and for health and safety;
- ii) it allowed culling to take place over a 6-week period each year (instead of the intensive 11 consecutive nights of cage trapping and shooting in the RBCT);
- iii) it required culls to be organised and undertaken by farmers and their contractors rather than government Wildlife Unit staff.

In order to be licensed, applicants had to demonstrate that they would meet several licensing requirements including that culling areas were large, at least 150km² in size. This was informed by the finding on net benefits from idealised circular culling areas greater than 141km² in size⁴.

Because shooting free-ranging badgers was an untested culling method, there was concern over whether these culls could remove the minimum number of badgers required to reduce

the estimated badger population of the culling area by at least 70%⁵. Moreover, to provide statistical confidence that at least 70% of badgers had been removed, the minimum number of badgers to be culled was considerably more than 70% of the estimated size of the local badger population, due to imprecision in the population estimate⁶.

In late 2013, initial culls were undertaken in two pilot culling areas, in Gloucestershire and Somerset, following delays due to difficulties in estimating the resident badger population. The Independent Expert Panel reported that "The combined approach of controlled shooting and cage trapping also did not remove at least 70% of the population inside either pilot area; substantially fewer than 70% were removed in both areas."⁷ The government announced on 3rd April 2014 that annual culling will resume in the pilot areas, but no new cull licences will be granted for the time being⁸.

Time will tell whether subsequent culls in the pilot areas will be more effective than the initial culls. If they are not, the risk is that herds within the pilot areas will experience increased TB risks (as in reactively culled areas) rather than decreased TB risks (as in proactively culled areas).

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Excerpts from the Independent Expert Panel's report: **Monitoring the efficacy of badger population reduction by controlled shooting during the first six weeks of the pilots**⁷

Para 4.6 "In the Gloucestershire pilot area a total of 708 badgers were removed during the first six weeks of culling, with an estimated cull efficacy of 27.5 to 39.1% from cull sample matching and 21.8 to 50.8% from capture-mark-recapture analysis. The number removed by shooting was 543 and was 165 by cage trapping, giving an estimated shooting efficacy of 25.3 to 37.1% from cull sample matching and 16.7 to 39.0% from capture-mark-recapture analysis. ..."

... particular challenges for policymakers ...

Para 4.7 "In the Somerset pilot area a total of 866 badgers were removed during the first six weeks of culling, with an estimated cull efficacy of 34.5 to 48.1% from cull sample matching and 45.5 to 101.9% from capture-mark-recapture analysis. The number reported to be removed by shooting was 398 and was 467 by cage trapping, giving an estimated shooting efficacy of 14.6 to 24.8% from cull sample matching and 20.9 to 46.8% from capture-mark-recapture analysis. ..."

BADGER CULLING AND VACCINATION

Professor Rosie Woodroffe

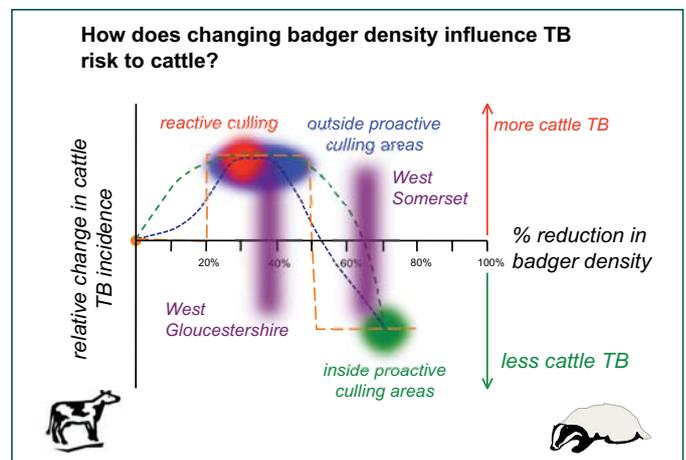
Senior Research Fellow, Institute of Zoology

Rosie Woodroffe entitled her talk Badger Culling and Vaccination. What she did was show how the results described by the previous two speakers can be explained in terms of mathematically modelling the way that diseases spread across an area. This involves three kinds of animal: those that are susceptible, those that are immune, and those that are infected. Disease spreads by infected animals mixing with susceptible animals, some of which then also become infected. The progress of a disease depends on many factors, not least of which are the level of mixing, the area over which they roam, the rate at which the young are born, the rate at which the old die and the effect of the disease on mortality. Of course, culling and vaccination both directly affect the model.

Rosie referred to these effects as "disease dynamics". New born animals in the wild are susceptible, but can become immune either by vaccination or by getting better after being infected after mixing with the infectious. Culling in general will affect both the susceptible and the immune, and will change the balance, but it does provide fewer opportunities for infected and susceptible animals to mix. Culling can produce two opposing consequences – fewer badgers (which is good), but the proportion of infected badgers may increase (which is bad). The graph illustrates this, based on the results of the recent trials in Gloucester and Somerset ending on 1 November 2013. When possums were culled in New Zealand some years ago, similar effects were observed.

For vaccination programmes to be effective, all young badgers need to be protected, and this means that the programme has to be repeated every year. Over time, this will eradicate the disease. Each year the risk of infection will be reduced. Studies have shown that in the

first year the overall risk of new infections is reduced by 76%, and 79% in cubs if more than 30% of the adults have been vaccinated. This doesn't reduce the number of badgers, but it does reduce the risk of infection. *However, the effect that this has on TB in cattle is not yet known.*



HOW DO WE VALUE OUR NATURAL CAPITAL?

Meeting of the Parliamentary and Scientific Committee on Tuesday 25th February

VALUING NATURAL CAPITAL



Julian Harlow
Natural Capital Committee
Secretariat, Defra.

Valuing changes in natural capital can help stop its decline – but only if we do it properly. Over the next year, the Natural Capital Committee¹ (NCC) will develop its advice further about how to prioritise action to conserve and enhance our natural assets in order to meet the Government’s ambition to be “the first generation to leave the natural environment of England in a better state than it inherited”².

Throughout my career as a Government economist, my science colleagues have often accused my profession of ‘*knowing the price of everything and the value of nothing*’. I hope to dispel that myth and argue that the degradation of our natural environment is occurring precisely because its value is not being adequately recognised and included in our decision-making processes.

By incorporating these values into decisions made by Government, businesses and individuals, scarce resources can be used more efficiently, economic growth can be better supported, and our wellbeing can be increased. Society would be a lot better off if we valued natural capital properly.

... its value is not being adequately recognised ...

The emerging interdisciplinary field of ‘natural capital’ has given rise to a new set of terminology that many find confusing. This presents some, well recognised, communication challenges. Natural capital refers to those elements of nature that produce (or are of) value³.

Natural capital is a stock concept. Any economy, be it

Germany’s or Gabon’s, has a capital stock which it uses to produce output. This stock can be broken down into:

- produced capital (such as roads, railways, housing),
- human capital (knowledge and skills),
- social capital (trust, behavioural norms and institutions), and
- natural capital (for example, forests, water, land, soils, and wild species).

These different capitals are combined in different ways to produce goods and services that we consume. We derive value from them. Natural capital is different from other forms of capital in that we do not have to ‘make it’ – it is a gift of nature. Indeed, many assets (the living ones at least) are capable of sustaining themselves indefinitely, if used wisely.

However, like other forms of capital, natural capital can be overused and degraded. Investment is typically required to maintain natural assets so that they can continue to provide the goods and services from which we derive value.

Evidence demonstrates we are not investing enough in our natural capital. The UK’s National Ecosystem Assessment⁴

concluded that “*although UK ecosystems are currently delivering some services well, others are in long-term decline*”. Similar patterns of degradation are being observed across the world. In 2005, the Millennium Assessment⁵ concluded that “*nearly two thirds of the services provided by nature to humankind are found to be in decline worldwide. In effect, the benefits reaped from our engineering of the planet have been achieved by running down natural capital assets*”.

Why is this happening? Why are we failing to conserve and invest in our natural assets? The answer is a wide range of complex, interrelated factors, but a very important one, perhaps the most important in fact, is our inability to measure adequately and value changes in those assets. We don’t have readily observable values. Because of this natural assets are often assigned a value of ‘zero’ in the decisions we take; the inevitable consequence of which is degradation over the long-term.

When economists talk about placing monetary values on the environment, it is not because we lack moral principles or because we do not recognise that nature has a value beyond

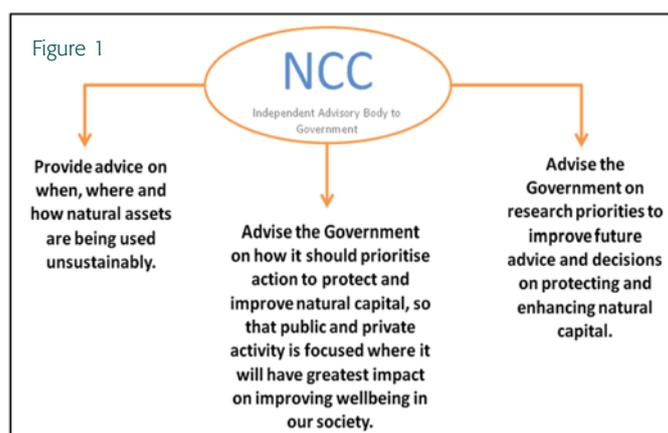
human use. It is because we want to be able to compare different things using a common unit of measurement. All of us compare different things using money every day – that is one of its main functions, and doing so allows us to make informed choices easily. This is the basic rationale for trying to value natural capital – to avoid a default value of zero and to facilitate comparison between different investments.

As a proponent of valuation, I am not recommending that we estimate the 'total value' of all natural capital. This is a futile exercise although several studies have attempted it. Most economists agree that such initiatives do not produce reliable results and are not useful for policy or decision-making purposes.

... Natural capital is different from other forms of capital ...

Neither are proponents of valuation attempting to estimate values of changes in natural assets so that they can be assigned a price and exchanged for cash⁶. Price and value are very different things. Let me illustrate using woodlands as an example. Few would disagree that they are an important and very valuable natural asset. But how important and how valuable are they compared with schools, roads or hospitals⁷? That is the investment decision we always face.

Woodland areas are obviously a source of timber when harvested and the price of timber acts as a good indicator of timber value. In order to produce timber, the skills and expertise of foresters are needed (human capital), along with reproducible capital (saws and machinery) and natural capital (good soils, water and the tree species themselves).



However, woodlands provide a whole series of other things that are of value to us – they sequester carbon from the atmosphere, they regulate water flows in catchments and provide spaces for outdoor recreation, to name but a few. By including the value of these benefits in planting decisions, the amount and location of new woodlands

would look different to a situation where only the value of timber and the forgone losses in agricultural output are considered. Professor Ian Bateman (a member of the NCC) and colleagues from the University of East Anglia have modelled these issues and conclude that society could be hundreds of millions of pounds better off each year by taking into account carbon and recreational values in new woodland planting decisions⁸.

... natural assets are often assigned a value of 'zero' ...

THE NATURAL CAPITAL COMMITTEE

The Natural Capital Committee has been set up to advise on this vital issue. Figure 1 outlines its terms of reference.

The Committee has recently published its second 'State of Natural Capital' report which has three key messages:

1. Some assets [*in England*] are currently not being used sustainably. The benefits we derive from them are at risk, which has significant economic implications;

2. There are substantial economic benefits to be gained from maintaining and improving natural assets. The benefits will be maximised if their full value is incorporated into decision-making; and,

3. A long-term plan is necessary to maintain and improve natural capital, thereby delivering wellbeing and supporting economic growth.

Over the next year, the NCC will formulate advice and recommendations to Government about how we should conserve and invest in our natural assets. We will explore issues including: national and corporate accounting; developing better ways of measuring changes in natural

capital; improving the use of cost-benefit analysis; and, importantly, how Government, businesses and society might approach formulating a long-term plan to improve our natural assets.

These initiatives will make a significant contribution to improving our knowledge and

informing management action to conserve our natural assets. What is already clear is that if we continue to ignore their true value and fail to tackle the growing pressures that are being placed on them, we will surely be much worse off.

References

- 1 The Natural Capital Committee is an independent advisory committee set up by the Government to advise on how society can take better account of the value of nature and ensure this value fully informs decision-making. More information can be found at www.naturalcapitalcommittee.org.
- 2 HM Government (2011) *The Natural Choice: Securing the value of nature*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228842/8082.pdf
- 3 NCC (2014) *Towards a framework for measuring natural capital*. Working Paper 1. www.naturalcapitalcommittee.org.
- 4 UK National Ecosystem Assessment (2011) *Synthesis and key findings*. <http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx>
- 5 <http://www.millenniumassessment.org/en/index.html>
- 6 See article by George Monbiot, <http://www.theguardian.com/commentisfree/2012/aug/06/price-rivers-rain-greatest-privatisation>.
- 7 See Lázaro-Touza, L. & Atkinson, G. (2013) *Nature, roads or hospitals? An empirical evaluation of sustainable development preferences*, *Ecological Economics*, 95, 63-72.
- 8 The details of which can be found the NCC's second State of Natural Capital report and the forthcoming UK National Ecosystem Assessment Follow-On (NEAFO) project.

The Committee also heard from **Professor Rosie Hails MBE**, Science Director for Biodiversity and Ecosystem Science at the Centre for Ecology and Hydrology (CEH).

She is a member of the UK government's 'Natural Capital Committee', as well as a member of the Advisory Committee on Releases to the Environment (ACRE).

A summary of her presentation will appear in the next issue.

HOW DO WE VALUE OUR NATURAL CAPITAL?

VALUING NATURAL CAPITAL



Professor Brett Day
Professor of Environmental
Economics, University of East Anglia

Economists and ecologists are not obvious bedfellows. The world of the power-dressing economist, pre-occupied with issues of finance, investment and growth, would seem to have little in common with that of the welly-wearing ecologist, engrossed in the complex interactions of the natural world. Over recent years, however, an unlikely alliance has developed between the power-dressers and the welly-wearers centred on their mutual concern for natural capital.

Natural capital comprises that wide array of environmental assets and processes that directly or indirectly contribute to the well-being of people. That's a lot of stuff. The air, oceans, land, soil, rivers, minerals and forests are all examples of natural capital: each contributes in some way to a flow of benefits. Sometimes those flows are in the form of tangible entities (economists would call them goods) like coal, timber or fish. Sometimes those flows are in the form of less tangible entities (services) such as

through the regulation of floods, the breakdown of waste and pollution or the existence of natural areas in which to enjoy recreational time.

Amongst economists, there has been a growing understanding that natural capital is as fundamental to economic activity as other productive assets such as built and human capital. Unlike those other assets, however, natural capital is rarely owned ... who owns the atmosphere, or the oceans, or processes of nutrient cycling? As a result, the flow of goods and services coming from natural capital, especially those of a less tangible variety, are rarely paid for in markets ... who pays for clean air, or the pollination services provided by insects, or a walk in the woods? Since these goods and services are provided for free, their value to society is easily overlooked. Until recently, policies and projects have been evaluated with only cursory consideration of their impacts on natural capital. That is regrettable since ignoring those impacts can lead to poor decisions, decisions that

... services coming from natural capital are rarely paid for in markets ...

fail to acknowledge the very real losses that people endure when flows of non-market environmental goods and services are damaged.

For ecologists the great value of the natural world has always been self-evident. Rather, the issue has been one of conveying their concerns in a language that resonates with policy makers. When presented with hard figures on the

beneficial impact of a proposed policy on profits, jobs and economic growth it's all too easy to ignore counterbalancing costs enumerated in, for example, hectares of lost natural habitat, declines in species diversity or increases in pollutant concentrations.

Some twenty years ago, economists and ecologists made their first tentative attempts to work together in understanding natural capital.

... the banner of the ecosystem services approach ...

Ecologists were able to explain to economists the mysterious workings of the natural world. Now it would be possible to estimate how flows of environmental goods and services might be affected by changing policies. Economists brought a toolkit of non-market valuation methods which allowed ecologists to express the value of the natural world in terms of hard cash. Tentative collaborations turned into major projects and from that a whole new area of academic pursuit

has evolved, brought together under the banner of the ecosystem services approach.

From the outset, the UK has been a leading player in this. We now have an established forum for the exchange of ideas and the development of research capacity through NERC's Valuing Nature Network. DEFRA's Natural Capital Committee provides a high-profile conduit for those ideas to be communicated to

government. Countless reports and research publications emanate from UK academics (Hoepner et al, 2012). Indeed, the latest large-scale UK contribution comes in the form of the National Ecosystem Assessment – Follow On (NEAFO) project whose final report will be released later in 2014.

One of the analyses in the NEAFO project resulted from the work of myself and colleagues at

the University of East Anglia (Bateman, Day et al, 2014). Complementing our own expertise in economics, climate and hydrology with that of ecologists from the University of Aberdeen, the British Trust for Ornithology and the Forestry Commission, we set out to build a computer programme that could estimate the impact of policy decisions on the value of ecosystem service flows across Britain over the next fifty years. Affectionately nick-named TIM (The Integrated Model), this programme links state-of-the-art models of economic, ecological, climate and hydrological subsystems in one spatially-explicit super-model of ecosystem service flows in Britain.

TIM's central focus is the capital asset of land. Policies that change decisions concerning the use of land (whether it is dedicated to agriculture, forestry, nature or to housing and factories) have far-reaching ramifications for ecosystem service flows. For example,

dedicating land to agriculture results in outputs of food that can be sold in markets for a profit. At the same time, intensive agricultural practices harm bird populations and generate diffuse pollution that damages freshwater ecosystems. Alternatively, displacing farmland with woodland reduces food production but generates a flow of timber, another market good that can be sold for profits. Woodlands also provide a habitat for birds, provide a wonderful recreational resource for people and have the

... reduces food production but generates a flow of timber ...

potential to lock up carbon from the atmosphere. The beauty of TIM is that it brings all these different consequences together, turns them into economic values and allows policy makers to explore the impacts of land use policy through one interface.

While there have been other attempts to create integrated models of land use (Schaldach and Priess, 2008) none has been as ambitious, detailed or far-ranging as TIM. TIM's most innovative feature is that rather than simply calculating the particular changes in ecosystem service value flows resulting from a particular change in policy, TIM has the intelligence to search across different options and design policies that generate the most value. That intelligence requires intense data-processing made possible by TIM's use of high-performance computing hardware and high-speed computational algorithms.

To illustrate TIM's capabilities, the UEA-led research team explored proposals to significantly increase the area of woodland in England, Scotland and Wales (IPF, 2012). The

analysis considered a case study in which each country plants 250,000ha of new woodland (roughly 3% of land area) over a 50 year period. TIM examined the costs and benefits of planting in every location in Britain and through its computing intelligence was able to identify planting locations which maximise values.

Figure 1 illustrates some of the key findings of that analysis. The left hand side map shows where Britain's new woodlands should be planted if the only ecosystem service flows considered are

those whose values are readily observable in market transactions. In this case, the calculus reduces to a simple comparison of the value of timber production with the value of agricultural output. As shown on the map, the conclusion of such an analysis is that the best place to plant new woods is in remote upland locations where the value of displaced agricultural output is at a minimum. Even so, because

profits from timber are generally lower than those from farming, the policy still yields an overall negative sum of about £134m per annum: an amount which taxpayers would have to pay in compensation to farmers in order to induce them to allow the afforestation to go ahead.

There are other, generally positive, ecosystem service flows that result from this proposed afforestation: carbon sequestration, the creation of recreational opportunities and improvements for wildlife and in water quality. Since those ecosystem services are ignored in the analysis, the choice of planting locations does little to ensure these value flows are optimised. For example, planting trees in upland locations often disturbs carbon-rich peat soils releasing large quantities of carbon into the atmosphere. When taken together, the values resulting from these additional ecosystem services are insufficient to offset the market costs of the scheme. Accordingly, overall, the taxpayer incurs a net loss of roughly £66m per annum (see details in Table 1). In short, locating new

woodlands without considering wider ecosystem service benefits results in poor decisions and negative value for money to the taxpayer.

The right hand side map of Figure 1 shows where new woodlands would be located if decisions took into account both market-priced and non-market ecosystems service flows (the analysis shown particularly considers carbon and recreation values). Relative to the previous map, a dramatic shift is evident in the location of Britain's new woodlands, bringing them off remote upland peat areas and adding a 'green fringe' of woodland around Britain's major population centres.

As Table 1 shows, since we would now be planting on more productive farmland, initial financial outlays more than double to £287m per annum. However, the value of avoided and stored greenhouse gases increases substantially. Likewise, recreation values increase massively due to the much greater accessibility of these new woodlands. Overall, non-market values increase more than ten-fold such that value for money changes from negative to a very strong positive balance of over half a billion pounds per annum.

... taxpayers would have to pay in compensation to farmers ...

The impact of these different approaches to decision-making is perhaps made most visible through Figure 2 which illustrates the location of new woodlands relative to the two largest urban centres in England: London and the West Midlands. In both cases the use of market prices alone to determine planting locations results in a

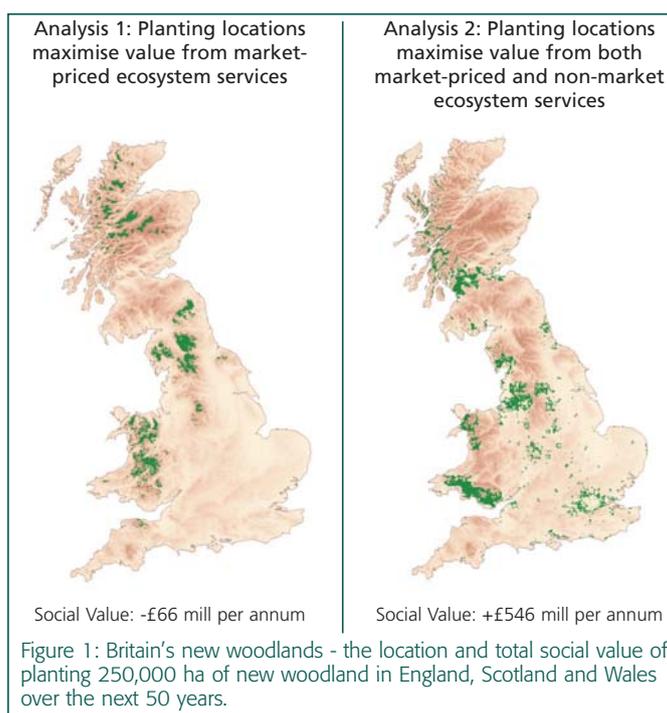


Figure 1: Britain's new woodlands - the location and total social value of planting 250,000 ha of new woodland in England, Scotland and Wales over the next 50 years.

Table 1: Market, non-market and total social values of planting Britain's new woodlands under two decision rules (£million per annum)

	Analysis 1: Planting locations maximise value from market-priced ecosystem services	Analysis 2: Planting locations maximise value from market & non-market ecosystem services
Market Value	-£134	-£287
Non-Market Value	£68	£833
Total Social Value	-£66	£546

Table Notes:

- Market values = agricultural and timber output
- Non-market values = greenhouse gases and recreation (water quality impacts and impacts on wildlife are quantified but not monetised although afforestation improves both of these measures);
- Total social values = Market values + Non-market values
- Greenhouse gas values priced using low range carbon equivalent prices (see Bateman, Day et al, 2014)

References

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Hoepner, A et al (2012). "Environmental and ecological economics in the 21st century", *Ecological Economics*, 77, pp. 193–206.

Independent Panel on Forestry (2012). *Final report*, Department for Environment Food and Rural Affairs, London.

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complete absence of woodlands around these urban centres, primarily because the recreational values of woodland are ignored. In contrast, when wider ecosystem services are accounted for, optimal planting decisions result in woodland fringes being generated around each city and town in the region: a policy that would create a legacy of multipurpose, high value woodlands for generations to come.

The NEAFO project demonstrates how far the study of natural capital and ecosystem services has come. Interdisciplinary teams of economists and natural scientists are now working together using state-of-the-art models and computing methods to provide decision makers with a solid evidence base upon which to make policy decisions about the natural environment. The way things are going, we could well find that the next generation of economists are as comfortable in a pair of muddy wellies as they are in their pin-striped city suits! What a horrible thought!!

... woodland fringes being generated around each city ...

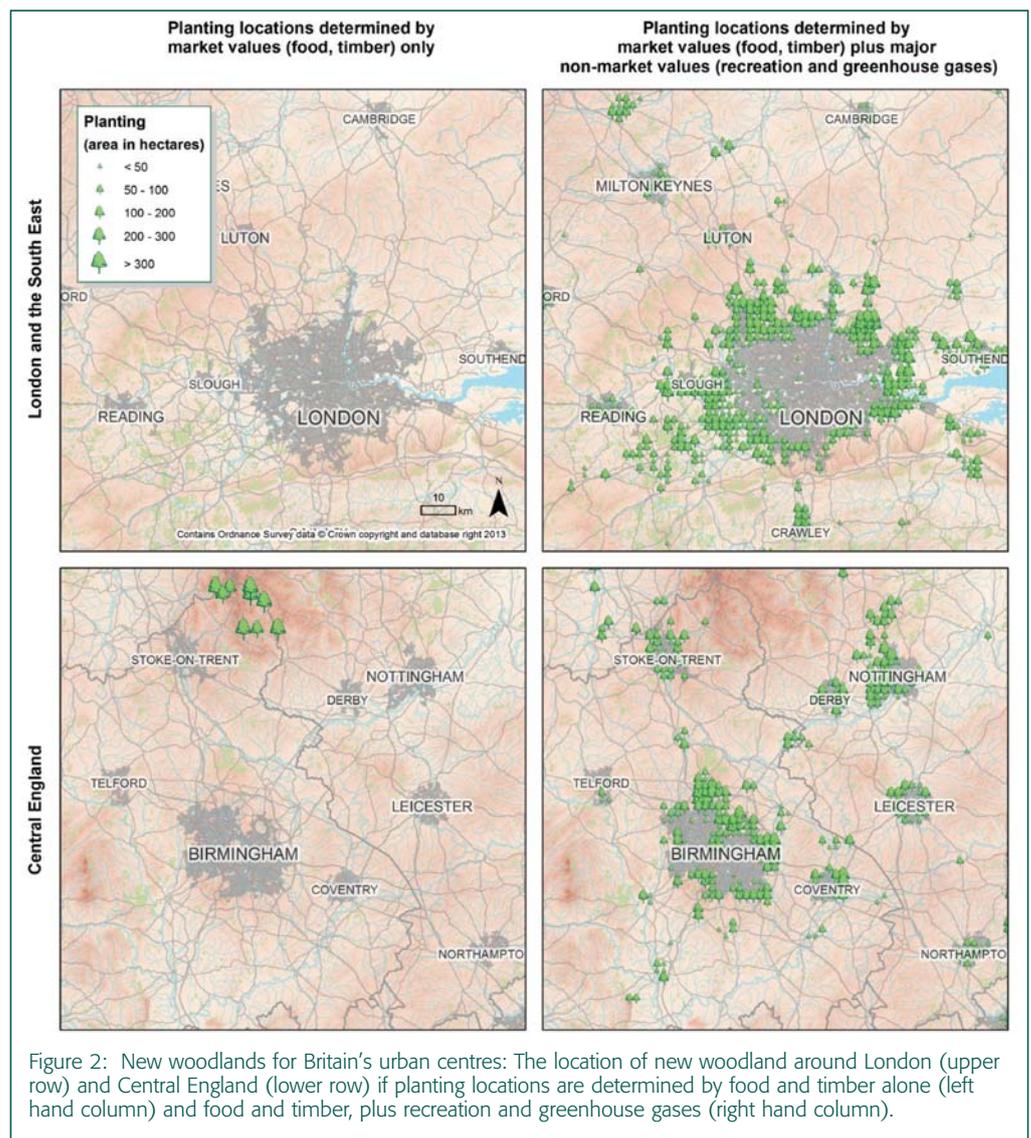


Figure 2: New woodlands for Britain's urban centres: The location of new woodland around London (upper row) and Central England (lower row) if planting locations are determined by food and timber alone (left hand column) and food and timber, plus recreation and greenhouse gases (right hand column).

SET FOR BRITAIN 2014

Parliament Showcases Britain's Future

Scientists Engineers Technologists Mathematicians

SET for Britain 2014, the annual poster competition and exhibition for early-career researchers, was held on Monday 17th March in the House of Commons Terrace Marquee. Andrew Miller MP, Chairman of the Parliamentary and Scientific Committee, acted as host to scientists, engineers, technologists and (for the first time) mathematicians from all over the country who brought their posters to Westminster to take part in the competition and to present their research to their local Members of Parliament. During the course of the day the SET for Britain organisers were delighted to welcome 84 Parliamentarians from both Houses.

Medals, certificates and cash prizes were awarded to the Gold, Silver and Bronze winners. These awards were made possible by generous donations from INEOS Group, BP, Essar Oil UK, Clay Mathematics Institute, WMG, Germain's Seed Technology, Boeing, Bank of England and the Institute of Biomedical Science.

The competition was divided into five sections: Biological and Biomedical Sciences, Chemistry, Engineering, Mathematical Sciences and Physics. The posters in each section were judged by experts from the Society of Biology, The Physiological Society, the Royal Society of Chemistry, the Royal Academy of Engineering, the Council for the Mathematical Sciences and the Institute of Physics.

The judges' difficult task had begun two months earlier with the selection of 210 posters (60 Bioscience and Engineering; 30 in each of the other sections) for the exhibition from a field of over 500 high quality entries.

Finally, the winners of the four Gold awards competed for the Westminster Medal, donated by the SCI in memory of Dr Eric Wharton. The judges for this part of the competition were Pallab Ghosh, Science Correspondent, BBC News; Professor Michael Elves and Andrew Miller MP. In view of the diversity of subject matter, their challenge was to assess the presenters on the strength of their skill in communicating the scientific concept in their poster. The Westminster Medal was presented by Derek Heywood, Board of Trustees SCI, and Mrs Sue Wharton to Dr Maria Jose Marin Altaba, University of East Anglia, winner of the Gold award in the Chemistry section.



SET for BRITAIN

Presentations by Britain's Early-Stage Researchers
in Science, Engineering, Technology and Mathematical Sciences
at the House of Commons



Monday, 17th March 2014

Engineering and Mathematical Sciences Exhibitions

12.15 pm - 2.40 pm

Biological and Biomedical Sciences Exhibition

3.30 pm - 5.30 pm

Physical Sciences Exhibition (Chemistry and Physics)

6.30 pm - 8.45 pm

Presentation of Westminster Medal

9.00 pm



IOP Institute of Physics





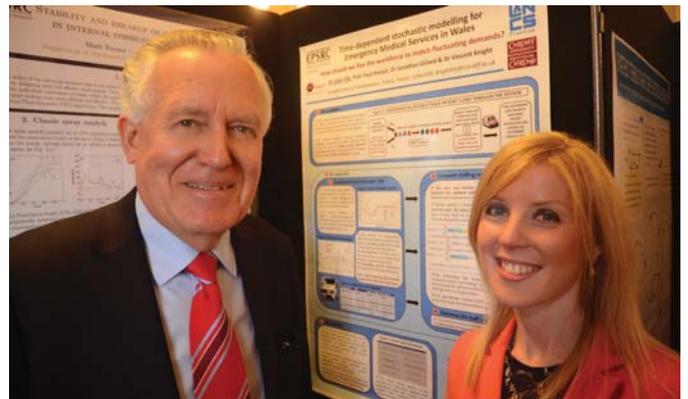
Presentation of the Engineering Medal and Gold Award to Dr Stephen Hicks, University of Oxford. L-R: Volker Schultz, CEO Essar Oil UK Ltd, Stephen Hicks, Andrew Miller MP, Sir John Parker, President, Royal Academy of Engineering.



Nicola Blackwood MP with Dr Llion Evans, Culham Centre for Fusion Energy



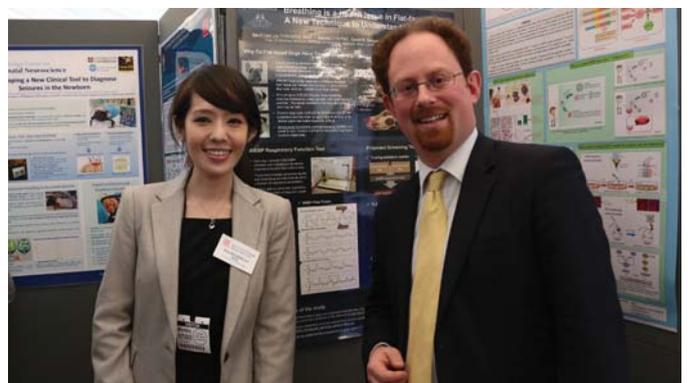
Presentation of the Mathematical Sciences Medal and Gold Award to Dr David Platt, University of Bristol. L-R: Dr Platt, Professor Nick M J Woodhouse, Clay Mathematics Institute, Andrew Miller MP.



Rt Hon Peter Hain MP with Dr Julie Vile, Cardiff University, who won the Bronze Award for Mathematical Sciences.



Graham Robertson, University of Strathclyde, receives the GW Mendel Medal and Gold Award. L-R: John Pierce, Chief Bioscientist, BP; Dr Philip Wright, Chief Executive, The Physiological Society; Dr Mark Downs, Chief Executive, Society of Biology, Graham Robertson, Andrew Miller MP.



Miss Nai Cieh Liu, University of Cambridge, with Dr Julian Huppert MP

PRIZE WINNERS

ENGINEERING

Gold Award and Engineering Medal

Dr Stephen Hicks, University of Oxford
SMART GLASSES TO HELP THE BLIND SEE

Silver Award

Dr Claire Donoghue, Imperial College London
TEACHING MACHINES TO DIAGNOSE KNEE OSTEOARTHRITIS FROM MRI

Bronze Award

Mr Christopher Spargo, Newcastle University
RELUCTANCE REVOLUTION: ENGINEERING A SUSTAINABLE FUTURE

MATHEMATICS

Gold Award and De Montfort (Mathematical Sciences) Medal

Dr David Platt, University of Bristol
PROVING GOLDBACH'S WEAK CONJECTURE

Silver Award

Dr Christian Yates, University of Oxford
CONTROLLING LOCUST PLAGUES: MATHEMATICAL MODELLING LEADS TO UNDERSTANDING OF HOW CANNIBALISM STABILISES SWARMING IN DESERT LOCUSTS

Bronze Award

Dr Julie Vile, Cardiff University
TIME-DEPENDENT STOCHASTIC MODELLING FOR PREDICTING DEMAND AND SCHEDULING OF EMERGENCY MEDICAL SERVICES



Miss Morelia Camacho-Cervantes, University of St Andrews, with Rt Hon Sir Menzies Campbell MP



L-R: Professor Paul Hardaker, Chief Executive, Institute of Physics; Richard Longden, INEOS Group, Dr Tessa Baker, University of Oxford, winner of the Cavendish Medal and Physics Gold Award; Andrew Miller MP.



Rt Hon Vince Cable MP, Secretary of State for Business, Innovation and Skills, with Dr Elly Martin, National Physical Laboratory.



Rt Hon David Willetts MP, Minister for Universities and Science, and Dr Alexander Merle, University of Southampton, listen to Jan Mertens, winner of the Physics Silver Award.



Dr Maria Jose Marin Altaba, winner of the Roscoe Medal and Chemistry Gold Award, with L-R: Professor Lesley Yellowlees, President, Royal Society of Chemistry; Richard Longden, INEOS Group; Andrew Miller MP.



Dr Maria Jose Marin Altaba, winner of the Westminster Medal, seen here with L-R: Pallab Ghosh, Science Correspondent, BBC News; Mrs Sue Wharton; Dr Stephen Benn, Society of Biology; Derek Heywood, SCI; Andrew Miller MP; Professor Michael Elves.

BIOLOGICAL AND BIOMEDICAL SCIENCES

Gold Award and GW Mendel Medal

Mr Graham Robertson, University of Strathclyde
HEALTHY COMMUNICATION: BRAIN DISORDERS ON A CHIP

Silver Award

Miss Amelie Heuer-Jungemann, University of Southampton
CANCER DETECTION AND TREATMENT VIA DNA-GOLD NANOPARTICLE CONJUGATES

Bronze Award

Miss Morelia Camacho-Cervantes, University of St Andrews
THE ADVANTAGES OF BEING SOCIAL IN A GLOBALLY INVASIVE FISH

CHEMISTRY

Gold Award and Roscoe Medal

Dr Maria Jose Marin Altaba, University of East Anglia
QUICK AND SIMPLE DIAGNOSTIC FLU TEST USING GOLD AND SUGARS

Silver Award

Dr Adrian Boatwright, University of Leicester
NANOPARTICLES WITH MAGNETISM APPROACHING THE THEORETICAL LIMIT

Bronze Award

Mr Daniel Toolan, University of Sheffield
DYNAMICAL STUDIES OF SPIN-COATED POLYMER FILMS

PHYSICS

Gold Award and Cavendish Medal

Dr Tessa Baker, University of Oxford
TESTING GRAVITY WITH COSMOLOGY

Silver Award

Mr Jan Mertens, University of Cambridge
GRAPHENE CONTROLS COLOUR OF PLASMONIC NANOANTENNAS

Bronze Award

Dr Kerry O'Shea, University of Glasgow
PLAYING LEGO WITH ATOMS: FUNCTIONAL OXIDES FOR TECHNOLOGICAL APPLICATIONS

WESTMINSTER MEDAL

Dr Maria Jose Marin Altaba, University of East Anglia

VOICE OF THE FUTURE 2014

The Boothroyd Room was packed to the hilt with young scientists and engineers for this year's highly successful *Voice of the Future* event again organised by the Society of Biology on behalf of the science and engineering community. It was opened by the Speaker of the House of Commons, Rt Hon John Bercow MP, who praised both the Society for its leadership and the event itself as a real contribution in bringing science and Parliament together.

... "no other event like it on the planet" ...

Andrew Miller MP, Chair of the House of Commons Science & Technology Select Committee, said there was "no other event like it on the planet" as proceedings were streamed live on the Parliament.uk website and subsequently broadcast on the BBC Parliament Channel.

Four panels totalling about 100 young researchers from 22 of the UK's most important science



organisations, and aged between 16 and 35, were invited to question key political figures including the Government's Chief Scientific Adviser, Members of the Science & Technology Select Committee,

the Science Minister and Shadow Science Minister.

The Rt Hon David Willetts MP, Universities and Science Minister, defended the Coalition's record on science funding, science education and

skills shortages in the face of questions from young scientists and engineers.

He was asked by young panel members about why the Government seems to be focused on research projects





discouraging overseas students from studying here.

"We do not have a cap on the numbers of students who can benefit from coming here to study," he said. "We have heightened the criteria – for example they must have a certain standard of English,

... think about the potential implications of their research ...

with direct economic impact. The Minister assured the assembled panel that there was "no policy to move funding away from fundamental and curiosity-driven research".

"The impact agenda is about getting researchers to think about the potential implications of their research, not to get them to study something else," he said.

... often forced to make decisions ...

He was also forced to defend the Coalition's immigration policy when asked if it had damaged science and engineering in the UK by

which ensures classes aren't held back for that reason. The challenge is to communicate around the world that if you come to study here you will get a warm welcome."

Earlier Sir Mark Walport, the Government's Chief Scientific Adviser, said the UK



Government has "the best embedded science advice in any government in the world", in response to questions about using evidence in policy-making. But he said that politicians are often forced to make decisions on a time scale that means evidence is incomplete or not available.

The Rt Hon Liam Byrne MP, the Shadow Minister for Universities, Science and Skills, pledged his full support to the idea of funding postgraduate education through Government-backed student loans. "Managers at Barclays and NatWest should not be in charge of who is funded for further study if we want to increase our skills base," he said.

... held back by countries such as Germany ...

Members of the Select Committee – used to sitting round the horseshoe asking the questions rather than at the witness table *answering* them – were asked why the development of GM crops was still being held back despite

overwhelming evidence that they are safe. Committee member and Liberal Democrat MP David Heath said the EU was looking at allowing countries that want to use GM crops to use them, because most of Europe was being held back by countries such as Germany who are "completely unmovable on the issue".



A video of the full session is available on the UK Parliament website and the Society of Biology has created a storify of the tweets.



BIODIVERSITY, DOING THE MATHS (WITH ALAN TURING)



Dr Brian J Bett
National Oceanography Centre

We live in the age of biodiversity, but are in danger of forgetting what it means. Church, State, we the people, and most certainly the media use the word so frequently it must be important. So what does it mean? How do you assess it, measure it, monitor it, protect it, and value it? Too many topics to address in one short article, so consider some of the numbers, the mathematics and the arithmetic of biodiversity.

BIOLOGICAL DIVERSITY

Biodiversity is a measure of variety in things biological. It refers to the variety of species present in a sample, or some given area. It can refer to any level of biological organisation – the genes within an individual, the biological community types present in a landscape, or the ecosystem types on a planet.

HIGHER, HIGHER, LOWER, LOWER

At its simplest, biodiversity could be a count of the number of different species in a collection. More species, higher

diversity, fewer species, lower diversity. But life is never as simple as that. In most cases, the more specimens you examine the more species you will encounter – how do you compare diversity between samples of different sizes? And how do you deal with common species and rare species, do we count them as equals?

DOING THE MATHS (PART 1)

There are several ways of measuring diversity. The following is chosen for its common use and for its connection to Alan Turing, recently recognised for his exceptional contribution to many branches of computational science (including biology)¹. The measure in question is the Shannon Index (H'), proposed by Claude Shannon in 1948², pioneering the field of information theory. Like Turing, Shannon was a war time code breaker, the two meeting when Turing shared the Bletchley Park Cypher School's methods with the US Navy's cryptanalytic service. Shannon's formula is very simple, where S is the

$$H' = - \sum_{i=1}^S p_i \log_2 p_i$$

number of species and p_i is the proportion of individuals belonging to the i -th species, and has units of bits of information per individual. This formula is used in Information Theory (*war time code breaking, compressing the photo files on mobile phones*)

and Thermodynamics (*building a better steam engine, understanding black holes*). It is perhaps easier to understand as probability – the bookmaker's odds on making a successful guess about future events (see Box 1).

Sample	Blue odds	Blue %	Species no.	Shannon Index
(a)	1:7	14.3	7	2.81
(b)	1:5	20.0	5	2.32
(c)	1:3	33.3	3	1.58
(d)	3:7	42.9	7	2.25
(e)	5:7	71.4	7	1.60

The diversity of coloured marbles. The samples are ordered by the chance of picking a blue marble at random. This is a measure of the dominance of blue (Blue %). The number of colours (species) present also influences diversity. The Shannon index attempts to combine the dominance and species richness aspects of biological diversity.

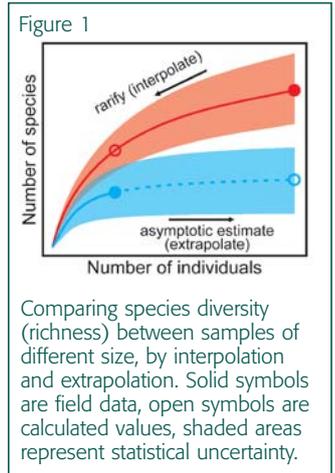
DOING THE MATHS (PART 2)

The Shannon Index, and many other diversity measures, deal with the question of counting both common and rare species. How do we compare diversity between samples of different sizes? A simple 'paper and pencil method' was developed by Howard Sanders in 1968³. Soon after a more formal method was published by Stuart Hurlbert⁴, that examines the 'probability of interspecific encounters', the chances of two individuals of different species bumping in to each other, to predict the number of species expected to be present in a subsample of x individuals,

$$E(S_x) = \sum_i^S \left[1 - \frac{\binom{N-n_i}{x}}{\binom{N}{x}} \right]$$

where S is the number of species, N is the total number of individuals in a larger collection, and n_i is the number of individuals in the i -th species.

This method is known as 'rarefaction', rarifying a larger sample to make it comparable with a smaller sample (see red sample in Fig 1).



Rarefaction is useful, but is costly in the sense that it discards much of the hard won field data by rarefying all larger samples down to the size of the smallest sample. The power to discriminate between real field differences may also be substantially reduced in the process. Fortunately Alan Turing comes to the rescue again through 'Good-Turing frequency estimation', as published by Irving Good^{5,6}, a statistical assistant to Turing at Bletchley Park. Following on from war time code breaking experience, the concept is that common words (or species) provide little

information about words (species) not yet encountered, while the rarest words (species) provide the majority of information about these so far unseen words (species). Nicholas Gotelli and Anne Chao⁷ review this approach in contemporary assessments of biodiversity, through the development of 'non-parametric asymptotic species richness estimators' such as the Chao1

$$\hat{S}_{Chao1} = S_{obs} + \frac{f_1^2}{(2f_2)}$$

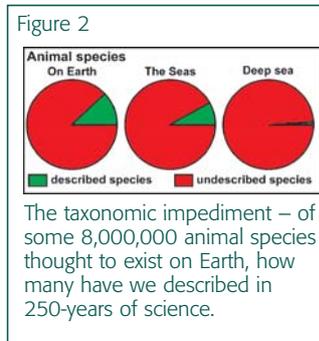
estimator, for $f_2 > 0$, where S_{obs} is the number of species observed in the sample, f_1 is the number of species represented by a single individual only (singletons), and f_2 is the number of species represented by two individuals only (doubletons). This approach allows the number of species observed in a sample to be extrapolated to the expected number of species observed in a larger sample (or perhaps an entire community) (see blue sample in Fig 1).

BIODIVERSITY, DOING THE ARITHMETIC

The first step in monitoring, protecting, and valuing biodiversity would seem to be understanding what it is, and how it can be appropriately measured (see above). There is, however, one step that must come before that – identifying the species in the first place. And here we encounter the "taxonomic impediment"⁸ – a world-wide shortage of taxonomic knowledge, trained taxonomists and curators. Taxonomy is the science of recognising, describing, naming, classifying, and cataloguing life on Earth, taxonomists are those who carry out that work, and curators are those who obtain, maintain and sustain the specimens and data required by taxonomy.

The arithmetic of this problem is simple and staggering. In about 250 years of taxonomic endeavour, we have described about 1,000,000 animal species on Earth, about 12% of those that are currently thought to

exist, or in other words some 7,000,000 animal species remain to be described⁹. The situation is a little worse in our seas where only 8% of the animal species thought to exist have been described, in remote sea areas (e.g. deep sea) that number will be appreciably lower, and for the smaller animals in remote seas that number will be approximately 0% (see Fig 2). Is there a vast army of taxonomists tackling this problem? The world total of professional taxonomists is numbered at a few thousand, who each describe a few new species each year – I leave you to do the final piece of arithmetic.



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MARINE SCIENCE

THE ROLE OF THE OCEANS IN SECURING SUSTAINABLE FOOD FOR 9 BILLION PEOPLE



Professor Manuel Barange
Director of Science, Plymouth
Marine Laboratory

Human societies face two challenges over the 21st century: anthropogenic climate change and population growth. The impacts of these will be significant, and the most urgent of these will be to produce enough food to feed 9 billion people while maintaining our natural ecosystems in a long-term sustainable state.

According to the FAO we will need 60% more food in 2050 compared to the present. Buried in this figure is that recent global economic development has increased demand for animal protein. We consume approximately 41kg of meat and 19kg of fish per person per year, 50% more than our consumption in the 1980s. This increase is even larger in the developing world for both

sources of protein. If we expect these trends to continue, where will protein come from?

Marine ecosystems provide a significant proportion of the animal protein we consume. Capture fisheries and Aquaculture production yield approximately 170Mt of protein, roughly a third of the global protein production. Maintaining or even growing this will be

essential in the future. Fisheries have two additional considerations that make them crucial to human societies. Over 500 million people depend directly or indirectly on fisheries, and a large proportion of these are in Asia. Fishing is a geographically-skewed activity in terms of volume, and thus in terms of livelihoods. 40% of all fish caught is internationally traded, bringing over 20 billion US\$ to developing countries, a volume larger than their combined income from coffee, rubber, cocoa, bananas, meat, tea and sugar! Thus, fisheries sustainability has global trade implications, particularly for the developing world. Aquaculture, the fastest growing agricultural production industry, is responsible for a part of this trade, and is already exceeding global beef production in volume.

... 40% of all fish caught is internationally traded ...

THE OCEANS AND FOOD

The ocean is responsible for 50% of the primary production of the planet, and this fuels the food web that ultimately results in the 85Mt of fish (plus an additional 20Mt as estimated discards) that we catch annually. With so many examples of overfishing, can we count on capture fisheries to continue feeding our protein cravings? After decades of inefficient management there are indications that some of our fisheries have turned the sustainability tide. Recent work has shown that the majority of European stocks are now being fished sustainably, while at global level over 40% of assessed stocks are now on a sustainable trajectory. Assuming these trends continue and we develop sustainable practices, how much fish can the oceans produce? It has been estimated that this figure is between 100-

200Mt, depending on the diversity of species caught, the upper figure achievable if we developed fisheries for species such as Antarctic krill and mesopelagic fish. But what are the expected impacts of climate change on these estimates?

IMPACTS OF CLIMATE CHANGE ON FISHERIES PRODUCTION

As the IPCC reminds us, climate change is happening, and its impacts will become more apparent in coming decades. How will this affect the production of the oceans? A consortium of UK institutions led by the Plymouth Marine Laboratory investigated this from basic principles. Knowing that the majority of fish is

caught along a very narrow margin around the continents (the Shelf Seas), which roughly coincide with the national Exclusive Economic Zones, we developed high resolution models capable of capturing the dynamics of tides, coastal upwelling, and other physical processes that determine production in these regions. We run these models for a present day scenario, and then for 2050, driven by the IPSL ocean-atmosphere climate change model, itself forced by the A1B IPCC greenhouse gas emissions scenario. A1B described a future of rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of more efficient technologies. As there is a degree of natural variability in the natural world, our model results were an average of 10 years of daily

runs around the "present day" and the "2050" time slices.

We then used the output of these models to estimate fish production change, by country. The methods are explained in detail in Blanchard et al (2012).

... some of our fisheries have turned the sustainability tide ...

The results indicated increased potential fish productivity at high latitudes and decreased productivity at low/mid latitudes, but with considerable regional variation. Overall, increases and decreases in fish production by 2050 are estimated to change by less than 10%, with a mean of +3.4% from present yields (Barange et al 2014).

Because we observed differences in production in different countries, we developed an index of fisheries dependency, based on the importance of fish and fisheries to national economies – in terms of trade and livelihoods – and to national food provision.

We then plotted individual nations on a 2D domain determined by the predicted changes in fish production by 2050, and their current sensitivity to fisheries (figure 1). Among the nations covered, those most nutritionally and economically dependent on fisheries are in West Africa (from Senegal to Nigeria), the Bay of Bengal (Bangladesh and Burma) and in SE Asia (Indonesia, Cambodia). Fisheries also played a significant role in the economies and food systems of Peru and Ecuador, Iceland, NW and SW Africa, India, Thailand, Vietnam and Japan. While other nations such as Norway, Chile and China have significant fisheries interests, they also have diverse economies to which fisheries contribute little overall. Combining dependency with projected impact of climate change on fish catches suggests that these impacts will be of greatest concern to South and South East Asia, South West Africa (from Nigeria south to Namibia), Peru, and some tropical small-island states.

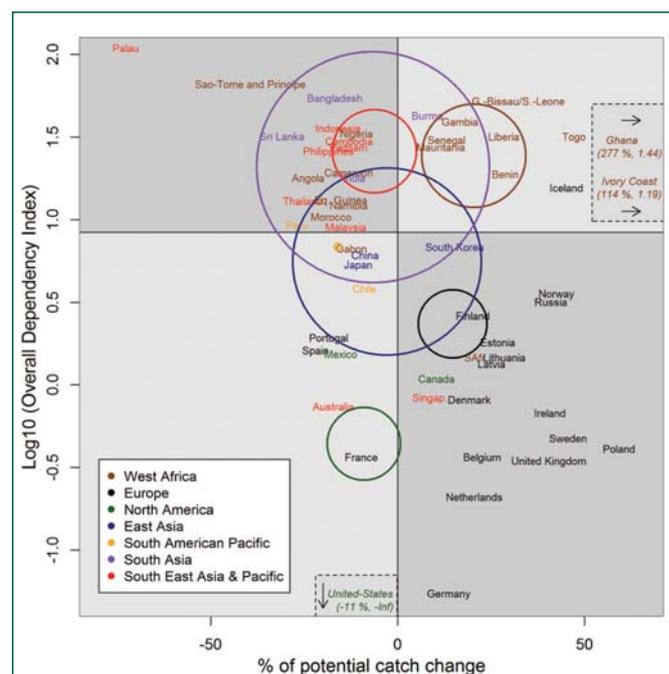


Figure 1. Potential catch change by 2050 and national dependency on fisheries. Circles correspond to the regional centroid, scaled by the expected population in the regions by 2050 (from Barange et al 2014).

These rely relatively heavily on their fisheries sector in terms of wealth, food and employment creation, while climate change is projected to impact negatively their potential fish catches. Our results indicate greater instances of negative impacts in parts of the tropics, where countries have a greater economic and nutritional dependence on fish and fewer available resources to invest in climate adaptation.

FOOD FOR THOUGHT

Earlier in this article I made reference to the dramatic rise in aquaculture production, while the results so far only reflect trends in future capture fisheries. If human population growth continues as expected, and if fish production from the seas is expected to grow by only 3.4%, can we maintain current per capita fish consumption rates in the future? The answer can only be if aquaculture continues to grow. In a parallel study (Merino et al 2012) we used our fish production predictions, human population estimates from United Nations, fishmeal and oil

price estimations (these commodities are used as feeds in aquaculture), and technological development projections in the aquaculture industry, to investigate the feasibility of sustaining current per capita fish consumption in 2050. The results were cautiously optimistic. We

... importance of fish and fisheries to national economies ...

concluded that meeting current consumption rates is feasible, despite a growing population and the impacts of climate change on potential fisheries production, but only if the following conditions are met:

- Global fish resources need to be managed and used efficiently and sustainably,
- Aquaculture industry must reduce its reliance on wild fish for feed through significant technological development,
- The distribution of wild fish products from nations and regions with a surplus to

those with a deficit needs to reflect food rather than trade needs.

Climate change will impact on marine ecosystems and their resources by changing their production patterns. Overall a small growth in fish production is achievable, consistent with



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recent projections from the World Bank. The impacts of the production changes will not be consistent across regions and countries: there will be winners and losers, with potential for conflict to arise. Our results challenge existing predictions of inevitable shortfalls in fish supply by the mid-21st century, contingent on successful implementation of strategies for sustainable harvesting, industrial development and trade efficiencies. Changes in management effectiveness and trade practices will remain the major influence on gains or losses in global fish production.

MARINE SCIENCE

UNDERWATER MINERAL EXTRACTION – “What’s Happening Already?”



Dr Stef Kapusniak
Soil Machine Dynamics Ltd

Lately, many projections have been made about the future of mining in the oceans and seas. The views expressed are wide-ranging, particularly from an environmental perspective. There is also significant debate on scientific and technical aspects, and on the best policy and regulation (both in territorial and international waters). This article gives a view of where the industry is now, the drivers behind it and the viability of the emerging industry, from both a

commercial and environmental perspective. It also contemplates the future size of the industry.

WHAT’S HAPPENING NOW?

Recent seminars, summits and workshops refer to “deep-sea”

... “How deep is deep?” ...

mining. Oddly, there does not appear to be a consensus about “How deep is deep?” Therefore, let’s take a look at what has been

happening recently from the coast out to a depth of 6000m.

Beaches have been mined for some time for minerals such as titanium. Mining is taking place in the surf- zone, using walking jack-up platforms and crawler-

mounted suction equipment for diamonds and gold. Shallow deposits (such as tin and magnetite) are being mined off

the coast of Malaysia and Indonesia. The Russians have mined polymetallic nodules in the Baltic Sea in the Bay of Finland using a standard suction

... much of this technology is already available ...

dredger. Diamond gravels have been mined for quite a while off the coast of Namibia at a depth of approximately 150m. Dredging is taking place at a variety of depths in softer materials for a variety of reasons (civil construction, flood alleviation, aggregate extraction etc). Extended dredging equipment is being lined up for the extraction of phosphates, off Namibia, Mexico and New Zealand, and of iron sands off the coast of the latter.

Some of these techniques may achieve extraction of softer material at depths of roughly 400m. With harder rocks and with increasing depths, it becomes more difficult (as it does with underground mining on land). At greater depths, different technology is required for cutting, sensing, positioning, navigation, ore-lifting and in

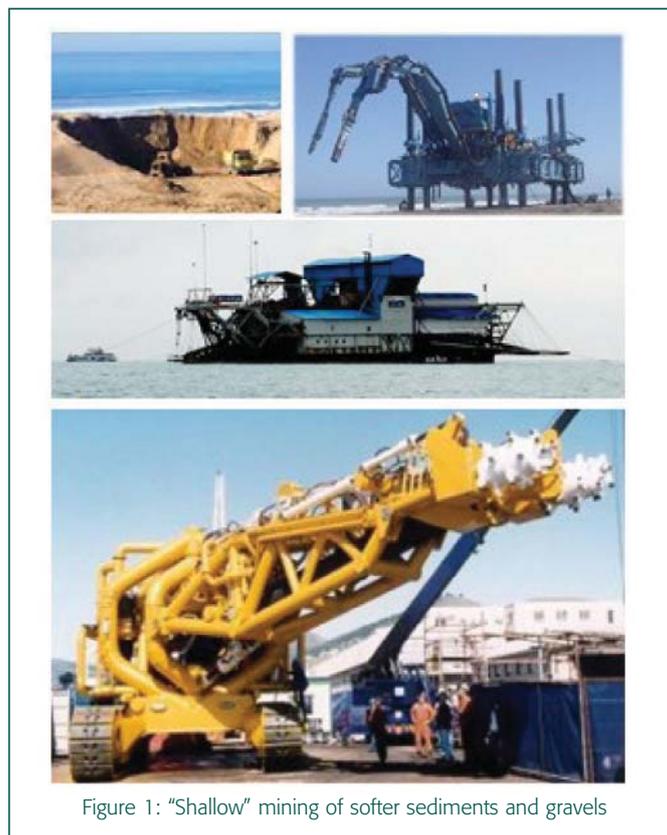


Figure 1: "Shallow" mining of softer sediments and gravels

some cases primary separation of the target minerals from the host rock or sediments. Fortunately, much of this technology is already available

... vast deposits of the Kalahari desert ...

from the oil & gas and subsea trenching industries.

At greater depths the focus is currently on polymetallic

sulphides, rare-earth muds, ferromanganese crusts (on seamounts) and polymetallic nodules (in abyssal plains). The equipment which has been

designed for extraction of these materials ranges from high-power, heavy duty cutting equipment to lighter lower power collection devices. Examples include the Nautilus equipment (designed for harder materials at a depth of approximately 2000m) and a Korean prototype collector (designed for collection of nodules – potentially at depths of 6000m) - both shown in Figure 2. Similar advances have been made in Japan and India.

WHAT ARE THE DRIVERS?

In addition to an amount of entrepreneurial spirit, the drivers for these developments include:

- Decreasing average ore grades on land
- High grade quality of some of the ores offshore

- Absence of overburden or waste rock (stripping ratio advantage)
- Population Growth which is compounded by increased urbanisation and per capita metal requirements as economies develop
- Improved underwater technology
- Strategic reasons (in the case of rarer metals)

Some of these make offshore mining irresistible to so-called "Big territory/Small Island" states and present opportunities in a number of British Overseas Territories.

VIABILITY OF THE EMERGING INDUSTRY

Commercial viability

In the case of seafloor massive sulphide (SMS) deposits, such as those explored by Nautilus Minerals, JOGMEC and Neptune Minerals the commercial viability is based on reserve quality. The projected head-grade of copper is approximately 7 times that of the average inland copper mine. The "by-product" of gold is projected at a head-grade of approximately 5.5 times that of the average inland gold mine. The quality is so good that it can be sold and shipped from the site as a pre-concentrate. This is with a negligible stripping ratio and a mobile infrastructure that can sail off to the next deposit. Some of these deposits are in relatively calm sea areas. The commercial and technical barriers are comparatively small.

Crusts on seamounts and abyssal nodules have similar metal concentrations. In terms of the manganese grade of these deposits, this is below that found inland in the vast deposits of the Kalahari desert and in Ghana. However, some contain attractive percentages of cobalt, nickel and

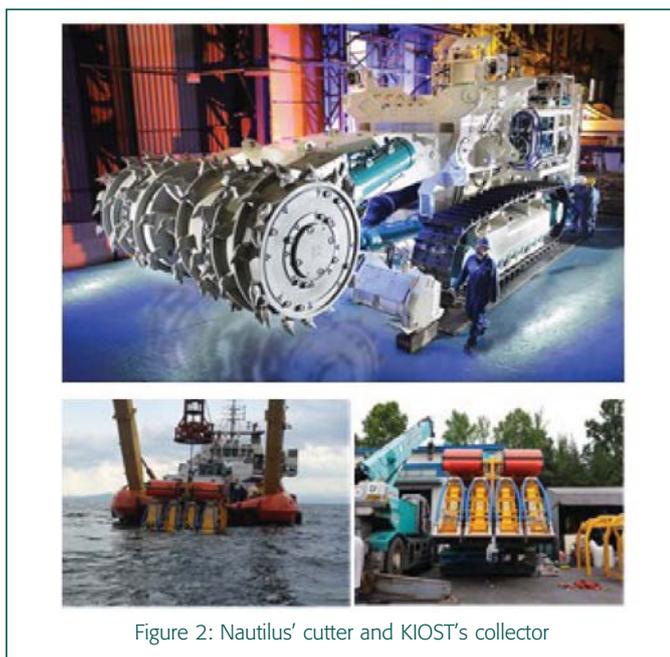


Figure 2: Nautilus' cutter and KIOST's collector

titanium and they also contain rare earth elements (REE's). It must be stressed however that the total metal content in these precipitations is not necessarily 100% recoverable. "Nodules are not nuggets" and with some processing methods increasing the recovery rates of one mineral can reduce the potential recovery of the next. Advances in targeted industrial and organic solvents are however occurring with a number of recent patents.

... because plumes are effectively "gold-dust"...

Smart investors will want to look at relative risks and opportunities across the whole value chain from exploration to market as well as the social, strategic and environmental implications.

Many relatively low-volume-requirement and rare minerals are also present in the gangue material of inland mines in small quantities. They currently pass through processing plants into tailings. With improving technology and a growing market there is scope to syphon off some of these.

COMPARATIVE ENVIRONMENTAL IMPACT

Some view this emerging industry as part of a wider human plague which is hazardous to the planet. I think of it as evolution and make a number of comparative observations:

- Mining and dredging is already occurring at sea and has been for a long time – particularly in shallow areas of territorial waters.
- Industrial effluents and waste materials are pumped directly into the sea in many parts of the world already.

- We "mine" approximately 1,400Mt of crude oil per annum offshore already. What are the comparative risks for solid minerals?

- We "mine" approximately 150Mt of seafood and slaughter over 2000 whales (that we know of) per annum already.

- Flat-topped seamounts exist which are the size of Kent. Some of them have been scoured by bottom trawling. A bottom-

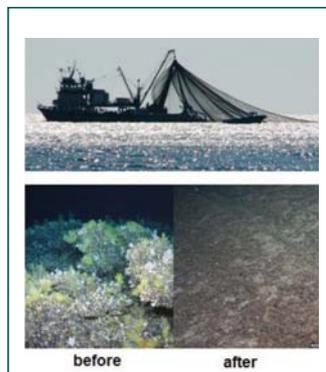


Figure 3: Effects of bottom-trawling

trawling fishing unit can scour 10km² of seamount per day. With a typical crust thickness, this equates to an area allowing approximately 2 years of mining. So there is perhaps some room for **vertical integration of all activities in the water column.**

- Recycling efforts are improving (such as street sweeping to collect REE's from clean fuel exhaust technology).

- Some of the metals targeted by subsea mining are used in "green" technology – indeed they are critical to it (electric car batteries, clean fuel technology and high power magnets in wind turbines for example).

- In shallow, low turbidity environments, plume generation can be a problem due to the importance of light in shaping the ecosystems found there. But



Figure 4: Black smokers, fresh volcanic deposits and rainforest clearance

many SMS deposits are too deep to be penetrated by light and are characterised by "black smokers". The creation of a mining plume in this situation would have a negligible impact. Design of the collection apparatus of subsea equipment for this sort of deposit aims to minimise the generation of plumes – because plumes are effectively "gold-dust" and because low turbidity enhances pilot visibility.

- The environmental risks in metalliferous mining are usually higher in the processing arena

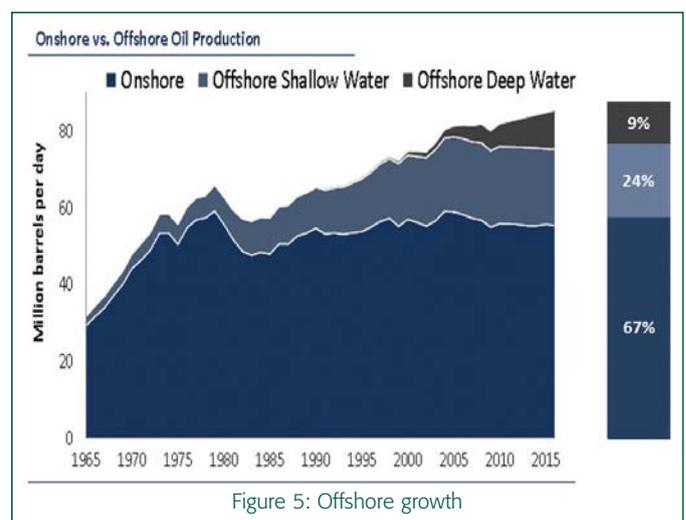
than in the mining activity itself.

- Is volcanic activity in the oceans a renewable source of minerals and how much is created naturally per annum already? Should we harvest this rather than strip further tracts of tropical rainforest to get the minerals we require?

- The International Seabed Authority (ISA) has adopted robust precautionary principles and set aside conservation and monitoring areas. There is perhaps some room for further **horizontal integration of policies, practices and regulation across territorial boundaries.**

FUTURE VOLUMES

The EU relies on the rest of the world for 80% of its consumption of strategic minerals (100% in some). As reserves and grades are depleted on land and demand grows it is inevitable that offshore mineral extraction rates will increase. There will be acceleration if strategic reasons emerge – as they did previously in the oil & gas industry, where approximately one third of the volumes are "mined" offshore and where there is an increasing trend towards deeper deposits already – (Figure 5).



MARINE RENEWABLE ENERGY



Dr Paul S Bell
National Oceanography Centre

Paul Bell has worked at the National Oceanography Centre in Liverpool since 1992, and leads the NERC/DEFRA funded FLOWBEC project investigating the interactions of marine renewable energy devices with the environment, and also leads NERC's Marine Renewable Energy Knowledge Exchange Programme.

During 2014-2015, installation of the first arrays of small numbers of tidal stream turbines are expected to begin in UK waters, with plans for the first commercial arrays of wave energy devices also in the advanced stages of development.

The UK is home to plentiful tidal energy resources, as well as large areas of ocean exposed to the full force of Atlantic waves. This wealth of natural resources has stimulated the development of dozens of designs for marine energy harvesting devices¹, many originating with UK universities and SMEs. Some of the leading developers have now tested several generations of devices at sites such as the European Marine Energy Centre² in Orkney. Many other test sites and facilities such as

the National Renewable Energy Centre (Narec)³, Strangford Lough, and Wave Hub⁴, are able to offer a range of different marine conditions or test facilities.

During the last 2-3 years as more prototypes have been successfully tested in the ocean, many of the device developers have received major investments from or been acquired by large multinational companies⁵. This shows the sector is entering a new phase as prototypes give way to the first commercial installations of multiple devices, backed by established industry and energy companies.

The large areas, extreme conditions and relative inaccessibility of many of the potential sites, particularly for wave energy may lead to some novel approaches in how energy is actually used, as electricity cables to shore may not always be practical or affordable. Alternatives to cabling include usage of the energy at the point of generation to manufacture high energy-cost products, fuels or even fresh water through desalination of seawater.

... tested several generations of devices ...

THE CHALLENGES

Developing an understanding of the type of high energy marine environments suitable for energy harvesting is a challenging task for scientists and engineers. Key questions are:

- Where are the greatest concentrations of energy and how much is harvestable?
- What forces should the devices be designed to survive?

- What effects will energy-harvesting devices have on the environment both individually and cumulatively?

- How can the costs and risks of operating in such extreme environments be minimised?

These issues are the focus of significant research in the academic sector, funded in part by UK Research Councils and partly by industry. The Engineering and Physical

... may lead to some novel approaches ...

Sciences Research Council (EPSRC) has focused largely on the resource and engineering challenges through the SuperGen programme⁶, and the Natural Environment Research Council (NERC) together with the Department for Environment, Food and Rural Affairs (DEFRA) funded a number of research projects which are currently under way investigating the environmental costs and benefits of marine energy⁷.

WHERE IS THE ENERGY?

In 2007 the UK Department for Business, Enterprise and

Regulatory Reform (BERR) commissioned the production of the Atlas of UK Marine Renewable Energy Resources⁸, which used computer simulations (models) of the tides and waves to produce maps of the available energy, validated against a variety of measurements such as the tide gauge measurements from the National Tidal and Sea Level Facility⁹ (NTSLF) and a range of wave buoy records. This was

later refined to provide more detail. The Crown Estate¹⁰ has leased a number of the most promising sites to developers for both testing purposes and commercial energy extraction, with some of those now having received consent and additional funding¹¹ to install the first arrays of devices.

Site developers usually commission more detailed studies using computer models based around highly detailed

seabed surveys together with measurements of the waves and currents at their sites. The computer models used fall into two broad types:

- 2D Models – Assume simplified vertical differences in flow from surface to sea bed, but can often run on a desktop PC as a result and hence popular with industry users.

- 3D Models – Allow different water layers to behave more realistically, but the increased level of complexity necessitates the use of high-performance computing facilities usually only available in academia and large research organisations.

All models depend on the quality of input data – with availability and cost of high-quality seabed maps being a critical issue. Models also need to be checked (validated) and in some cases calibrated against measurements.

MEASURING CURRENTS AND WAVES

The industry-standard approach to wave and current measurement is to deploy wave buoys and acoustic (sonar)

current meters at specific places of interest. Unfortunately, the inherently high energy of these sites leads to a significant risk of equipment loss or damage. Additional costs of recovering lost equipment can more than double the original planned cost of the measurements, a particularly difficult issue when resources are limited.

The type of sites with strong tidal currents can also be very spatially variable, with headlands, tidal channels and shoals all causing variations in currents and wave patterns. As a result, the usual approach of taking measurements at a small number of points may not provide an adequate representation of conditions across such complex sites.

Not surprisingly, there has been significant interest in the use of remote sensing techniques based on a variety of radar, camera and satellite methods to map various aspects of the ocean from shore based vantage points, from the air or from space. The NERC/DEFRA funded FLOWBEC¹² project for example includes the use of two different types of radar for mapping tidal currents and waves at different study sites.

The drawback of remote sensing methods is that they are an indirect measurement of the ocean and the quality of the results is often dependent on

local conditions at the time. Despite this, there are significant advantages to being able to locate the equipment out of the water in terms of ease of operation and maintenance, and it can allow near immediate access to the resulting data rather than having to wait for an instrument to be recovered from the sea bed. The ability to map ocean conditions across a site can provide a valuable spatial context to the point measurements and help plan the best places to put future in-water measurements.

DEVICE – ENVIRONMENT INTERACTIONS

In order to understand the interactions between devices and the flow and wildlife at a site, it is necessary first to have an understanding of the undisturbed environment and how the various types of wildlife are using these areas. Then one can begin to investigate whether the wildlife are likely to be in the same place at the same time as operating devices, what physical effect they might have and whether this might be an issue.

The methods of assessing what forms of wildlife are present at a site and how that wildlife may be using that site include:

- Visual observations by expert human observers on shore or on a vessel

- Video/camera surveys, eg from aeroplanes or from boats with underwater cameras
- Passive underwater recordings of marine mammal sounds
- Active sonar tracking of marine wildlife underwater such as seals, diving birds, fish etc



A radio tagged harbour seal (*Phoca vitulina*) with GPS/GSM transmitter glued to its fur. Photo courtesy of the Sea Mammal Research Unit.

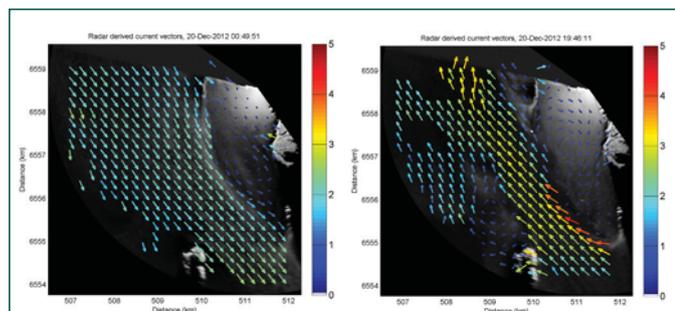
- Radar tracking of birds in flight, and possibly larger marine species when on the water surface, such as whales
- Satellite images of large marine mammals
- Tagging and tracking of individual animals

Concurrent observations of wildlife above the surface (radar, visual) and below the surface (sonar) made during the FLOWBEC project show the advantages of this approach when combined with environmental information (eg from radar).



A reward poster for the return of electronic fish tags – image courtesy of Dr Stephen Cottrell, The Marine Biological Association of the UK

Tagging of specific individuals to observe longer term behaviour is becoming more common and tags suitable for attachment to birds, seals and fish are now available. The larger tags may transmit their information back to the researchers via satellite, radio or phone networks, but the smaller ones on birds and fish usually rely on being returned on a voluntary basis by those that find them once they are separated from their host or following capture of the animals involved. Two of the NERC/DEFRA funded projects, RESPONSE and QBEX¹³, are employing such methods to track seals and fish respectively. What is becoming apparent is that individual animals of the same species tagged at the same location may behave in



Examples of marine radar remotely sensed tidal currents (left: flood tide and right: ebb tide) overlaid on marine radar images at the European Marine Energy Centre tidal test site. The radar is operated by the National Oceanography Centre as part of the FLOWBEC project. The arrow colours indicate current speed in metres per second.



The FLOWBEC sonar frame being prepared for lowering to the sea bed for a 2-week period monitoring marine wildlife at the European Marine Energy Centre tidal test site in 2012. The OpenHydro tide turbine platform can be seen in the top right of the image. Photo by Dr Beth Scott, University of Aberdeen.

very different ways, demonstrating the need for information on sufficient numbers of individuals to capture these natural variations in behaviour.

Embarking on studies such as this highlights how much we still have to learn about marine wildlife, as there is often relatively little information available about presence and behaviour of marine animals individually and collectively at particular sites.

AND FINALLY

What is undeniable is that there is energy available, and in quantities significant enough to

be harvested, provided costs and environmental effects can be minimised.

The ongoing work investigating the interactions of marine renewable energy devices with the environment is driving innovation across all environmental technologies to develop novel tools and methods to support both industry and regulators. Ultimately this will begin to allow society to move towards low-carbon electricity¹⁴ with a clarity of understanding regarding the trade-offs between methods to support both industry and regulators.

Further Information:

1. <http://www.aquaret.com/> An e-learning site with illustrations of the main types of marine energy harvesting devices.
2. <http://www.emec.org.uk/> The European Marine Energy Centre website
3. <http://www.narec.co.uk/> The National Renewable Energy Centre website
4. <http://www.wavehub.co.uk/> The Wave Hub website
5. <http://www.renewableuk.com/en/publications/reports.cfm/wave-and-tidal-energy-in-the-uk-2013> Wave and Tidal Energy in the UK, Conquering Challenges, Generating Growth, Report by RenewableUK, February 2013
6. <http://www.supergen-marine.org.uk/> Supergen Marine website
7. [http://www.nerc.ac.uk/research/funded/programmes/mre/NERC & DEFRA Marine Renewable Energy Programme](http://www.nerc.ac.uk/research/funded/programmes/mre/NERC&DEFRA%20Marine%20Renewable%20Energy%20Programme)
8. <http://www.renewables-atlas.info/> Atlas of UK Marine Renewable Energy Resources website
9. <http://www.ntsif.org/> National Tidal and Sea Level Facility website
10. <http://www.thecrownestate.co.uk/energy-infrastructure/wave-and-tidal/> Crown Estate Wave and Tidal Energy web pages
11. <https://www.gov.uk/government/news/20-million-boost-for-uk-marine-power> Marine Energy Array Demonstrator funding announcement
12. <http://noc.ac.uk/project/flowbec> FLOWBEC project webpage
13. <http://www.mba.ac.uk/simslab/QBEX> QBEX project webpage
14. http://www.lowcarboninnovation.co.uk/working_together/strategic_framework/overview/ Coordinating Low Carbon Technology Innovation Support, The LCICG's Strategic Framework

MARINE SCIENCE

OCEAN ACIDIFICATION: THE SILENT STORM



Dr Carol Turley OBE
Plymouth Marine Laboratory

It will last for 10,000's of years, cover three quarters of Earth's surface and impact us all. We cannot hear or see or feel it but its effects are already being felt, from oysters and the multimillion dollar aquaculture business on the west coast of North America, to the sea butterfly, a key link in the ocean food web in polar and sub-polar waters.

This silent storm is called ocean acidification but despite our normal senses being unable to detect it scientists and their sensors can measure it accurately at long term stations in the ocean. These sensors show a year on year change in the chemistry of the ocean (Figure 1) and these changes are affecting the organisms, including humans, that live in

and depend on the ocean for their food and livelihood. The cause is global – carbon dioxide (CO₂) produced from our fossil fuel combustion, emitted to the atmosphere. Half of emitted CO₂ remains in atmosphere (causing climate change) and the remainder is absorbed nearly equally by ocean and land. The ocean absorbs 24 million tons of CO₂ every day. The average person is responsible for 4kg of the CO₂ that is absorbed by the ocean each day.

These observations have been conducted over decades by hundreds of researchers (Figure 1). CO₂ when combined with water forms an acid (carbonic acid). By definition, an acid produces hydrogen ions when added to water. When CO₂

enters the surface of the ocean it rapidly causes a series of chemical reactions, which increase the acidity of the surface seawater. Acidity may be thought of as simply the hydrogen ion concentration (H⁺) in a liquid, and pH is the logarithmic scale on which this is measured. Acidity increases as the pH decreases. The pH of the open-ocean surface layer is unlikely to ever become acidic (ie drop below pH 7.0), because seawater is buffered by dissolved salts. The term "acidification" refers to a pH shift towards the acidic end of the pH scale, similar to the way we describe an increase in temperature from 2°C to 4°C it's still cold, but we say it's "warming." Ocean acidification is changing seawater carbonate chemistry –

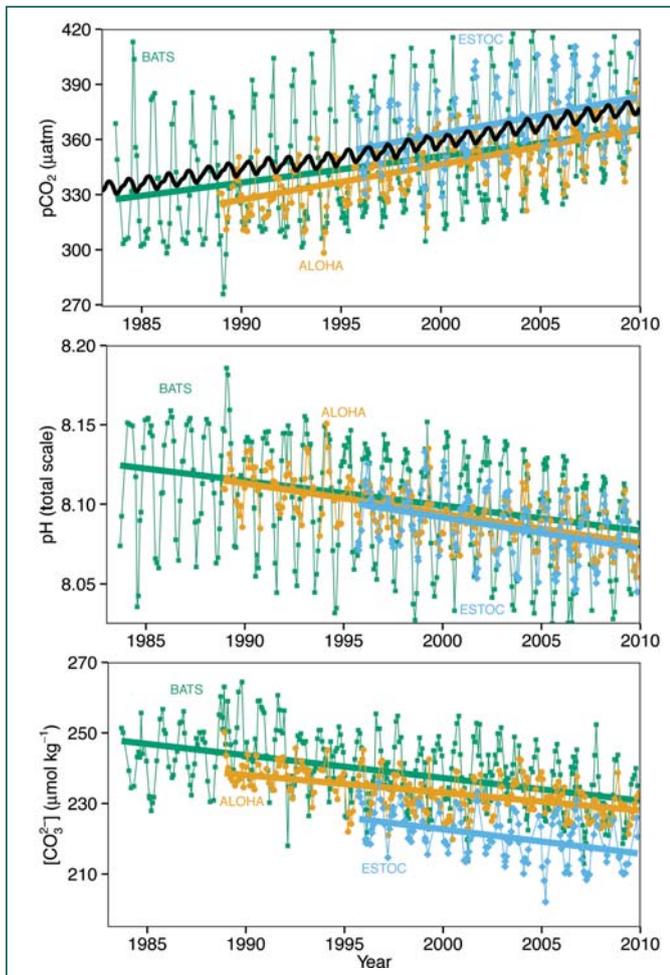


Figure 1: Long-term trends of surface seawater pCO₂ (top), pH (middle), and carbonate ion (bottom) concentration at three subtropical ocean time series in the North Atlantic and North Pacific Oceans, including: a) Bermuda Atlantic Time-series Study (BATS, 31°40' N, 64°10' W; green) and Hydrostation S (32°10', 64°30' W) from 1983 to present, b) Hawaii Ocean Time-series (HOT) at Station ALOHA (A Long-term oligotrophic Habitat Assessment; 22°45' N, 158°00' W; orange) from 1988 to present and c) European Station for Time series in the Ocean (ESTOC, 29°10' N, 15°30' W; blue) from 1994 to present. Atmospheric pCO₂ (black) from the Mauna Loa Observatory Hawaii is shown in the top panel (IPCC AR5 WG1 Report, Chapter 3, 2013).

concentrations of dissolved CO₂, hydrogen ions, and bicarbonate ions are increasing, and the concentration of carbonate ions is decreasing.

The ocean has already removed about 25% of anthropogenic CO₂ over the last 250 years. This can be considered beneficial, since it has slowed the accumulation of CO₂ in the atmosphere and the rate of global warming; without this ocean sink, atmospheric CO₂ levels would already be greater than 450 parts per million. However, the

continuation of such a fundamental and rapid change to ocean chemistry is bad news for life in the sea. The current rate of acidification is more than 10 times faster than at any time during the last 56 million years. If we keep emitting CO₂ at the same rate (Business as Usual) ocean acidity is projected to increase to more than double by 2100.

Changes in pH and carbonate chemistry force marine organisms to spend more energy regulating chemistry in their cells. For some organisms,

this may leave less energy for other biological processes like growing, reproducing or responding to other stresses. It will not only cause problems for many organisms with calcium carbonate skeletons or shells (such as oysters, mussels, corals and some planktonic species) but could also affect the physiology, metabolism and behaviour of many other organisms, ecosystems and processes, with potentially serious implications for society. The biological impacts of ocean acidification will vary, because different groups of marine organisms have a wide range of sensitivities to changing seawater chemistry (Figure 2). Impacts from ocean acidification at any life stage can reduce the ability of a population to grow or to recover from losses due to disturbance or stress, even though juvenile forms tend to be most vulnerable to acidification (eg Pacific oyster larvae).

Corals and shell builders are expected to decline, seagrasses may increase, some fish become disoriented and there may be changes in how prey and predators interact. Some species will not be directly affected but if their prey or predator, or their habitat or ecosystem changes then they could be indirectly impacted.

Natural laboratories occur where CO₂ bubbles rise through the seafloor acidifying the surrounding water close to the vents (Figure 3). This creates a gradient of pH. As you move away from the vents pH increases and gives us a glimpse into what a high CO₂ ocean may look like. Numerous studies show that the closer to the vents (and the higher the CO₂ and lower the pH) there is less biodiversity, fewer calcifiers, more fragile, dissolving shells, more invasive species, more seagrasses and degraded corals. These observations support the

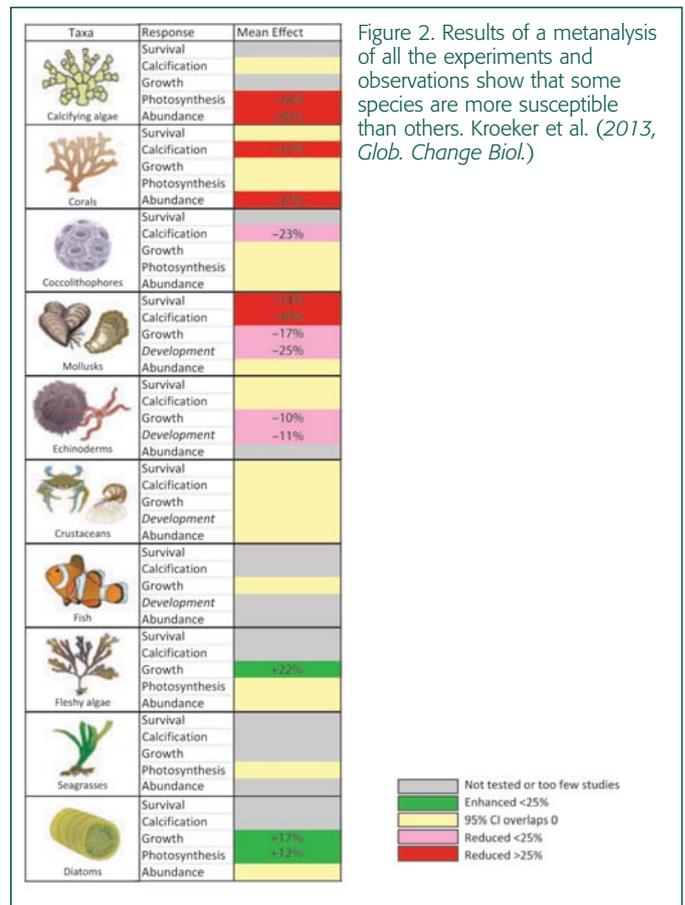


Figure 2. Results of a meta-analysis of all the experiments and observations show that some species are more susceptible than others. Kroeker et al. (2013, *Glob. Change Biol.*)

Legend:
 - Not tested or too few studies (grey)
 - Enhanced <25% (green)
 - 95% CI overlaps 0 (yellow)
 - Reduced <25% (pink)
 - Reduced >25% (red)

conclusions of controlled experiments in the laboratory that marine ecosystems and the organisms within them will change.

Predicting what marine ecosystems will look like in a future high CO₂ world is difficult but as fish is a primary source of animal protein for 1 billion people, mostly in developing countries there must be a risk to food security and livelihoods. There may be a decline in wild fish catches due to decreases in their prey, weakened foodwebs and deteriorating ecosystems like coral reefs. Shellfish aquaculture may experience increasing difficulty as already seen on the Pacific coast of North America. Coral reefs seem particularly vulnerable. They provide home for millions of species, storm protection for coastlines, houses and



Figure 3. CO₂ bubbles rise from seafloor at Ischia, Bay of Naples, a natural lab to study acidification. Photo credit: Jason Hall-Spencer, University of Plymouth.

infrastructure, income from tourism and a biodiversity legacy.

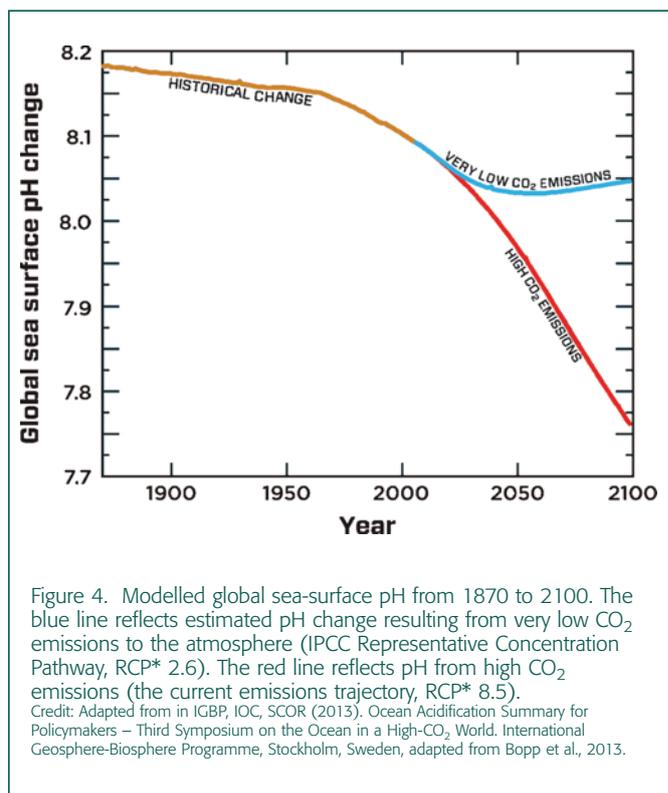
In addition, ocean acidification can also make species more susceptible to the impacts of warming waters, which have decreased oxygen levels, further stressing marine organisms. Acting together, these three major stressors (warming,

acidification and deoxygenation) could more rapidly threaten biodiversity, biogeochemical cycles, ecosystems and the goods and services the ocean provides to society, thereby increasing the risk to human food security and industries that depend on productive marine ecosystems.

The Working Group II contribution to the IPCC Fifth Assessment Report (Climate Change 2014: impacts, adaptation and vulnerability) concluded in its Summary for Policy Makers (http://www.ipcc-wg2.gov/AR5/images/uploads/1_PCC_WG2AR5_SPM_Approved.pdf) that:

“For medium- to high-emission scenarios (RCP4.5, 6.0, and 8.5), ocean acidification poses substantial risks to marine ecosystems, especially polar ecosystems and coral reefs, associated with impacts on the physiology, behavior, and population dynamics of individual species from phytoplankton to animals (medium to high confidence). Highly calcified mollusks, echinoderms, and reef-building corals are more sensitive than crustaceans (high confidence) and fishes (low confidence), with potentially detrimental consequences for fisheries and livelihoods. Ocean acidification acts together with other global changes (eg, warming, decreasing oxygen levels) and with local changes (eg, pollution, eutrophication) (high confidence). Simultaneous drivers, such as warming and ocean acidification, can lead to interactive, complex, and amplified impacts for species and ecosystems.”

The world is already committed to some acidification (Figure 4) and we are now detecting impacts from it. We need to consider adaptation



strategies, as well as the all-important mitigation strategies, to prevent further acidification. If we keep emitting CO₂ at the same rate (Figure 4: High CO₂ emissions) then ocean ecosystems and the goods and services that they provide humankind will change rapidly from both warming and acidification. However, if we reduce CO₂ emissions to the atmosphere we will keep global temperature between 0.9° - 2.3°C and reduce risks from ocean acidification too (Figure 4: very low CO₂ emissions).

A partnership of research programmes and institutions has been bringing the science of ocean acidification to the delegates at the UNFCCC climate negotiation meetings since 2009 and at the UN Conference on Sustainable Development, Rio+20. The partners include Plymouth Marine Laboratory, UK Ocean Acidification Research Programme, European Programme on Ocean Acidification (EU), Mediterranean

Sea Acidification in a Changing Climate Programme (EU), Biological Impacts of Ocean Acidification Programme (Germany), SCRIPPS Institution of Oceanography (US), OCEANA and the Ocean Acidification International Coordination Centre (IAEA, Monaco). Working together we have shared the cost, the effort and our findings and synthesised them in different media for policy- and decision-makers. To help increase awareness of the key issues impacting on the ocean in a high CO₂ world, the partnership has produced an Ocean Stress Guide (www.oceanunderstress.com). It is imperative that international decision-makers, in particular, understand the enormous role the ocean plays in sustaining life on Earth and the consequences of high CO₂ emissions for the ocean and society. The publication has already received support from a number of significant bodies including the World Bank, European Union and UN bodies.

Short guides to ocean acidification:

Hot, Sour and Breathless: ocean under stress – a short guide for policy makers: www.oceanunderstress.com

Ocean Acidification Summary for Policymakers from the Third Symposium on the Ocean in a High-CO₂ World: <http://www.igbp.net/news/news/news/oceanacidificationsummaryforpolicymakerreleased.5.30566fc6142425d6c911265.html>

Short films on ocean acidification:

A powerful 12 minute film on Ocean acidification: Connecting science, industry, policy and public: https://www.youtube.com/watch?v=_BPS8ctVW2s

A 5 minute film on ocean acidification "The Other CO₂ Problem" produced by the World Bank as part of its first Massive Open Online Course on climate change "Turn Down the Heat: Why a 4°C Warmer World Must be Avoided" <http://www.youtube.com/watch?v=Dr4jhg>

[xDQSI&list=PLk8mh9aWmPaRzVoQTI-mjuBHOJ0x4y113&index=5](https://www.youtube.com/watch?v=xDQSI&list=PLk8mh9aWmPaRzVoQTI-mjuBHOJ0x4y113&index=5)

And for the younger readers try this amazing award winning 7 min animation by school children aged 11-15 yrs from Ridgeway School, Plymouth: https://www.youtube.com/watch?v=F5w_FgpZkVY. They researched it, wrote and acted the script, produced the characters and animated them and even wrote and produced the music. The children have a clear message to policy makers and it is now in six other languages.

Useful web sites:

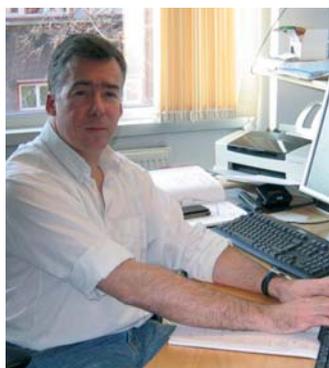
The UK Ocean Acidification Research Programme (UKOA): <http://www.oceanacidification.org.uk/>

The Ocean Acidification International Coordination Centre (OA-ICC): <http://www.iaea.org/ocean-acidification/page.php?page=2181>

The Intergovernmental Panel on Climate Change (IPCC): <http://www.ipcc.ch/index.htm>

MARINE SCIENCE

NATURAL HAZARDS AND SEA LEVEL RISE

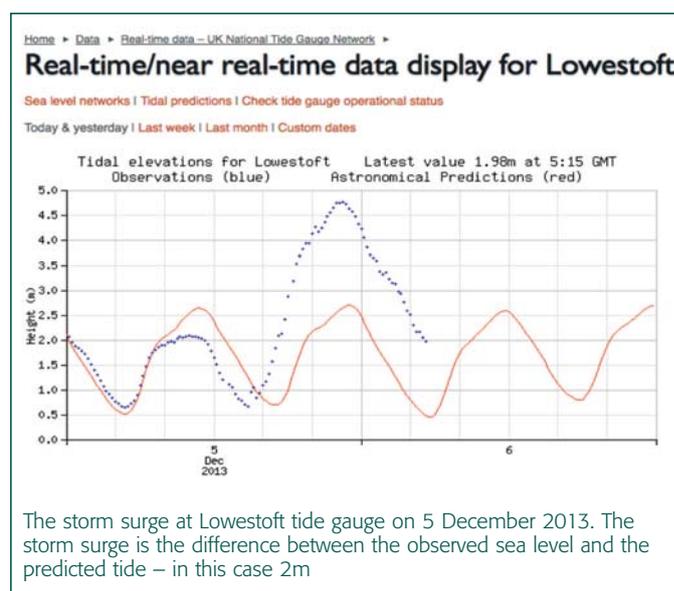


Professor Kevin Horsburgh
Head of Marine Physics and Ocean Climate
Chair of the IOC/WMO JCOMM
Expert Team on Waves and Coastal Hazards
National Oceanography Centre

A storm surge is a large scale increase in sea level due to a storm. They can last from hours to days and can elevate sea level over an area of hundreds of square kilometres. Low atmospheric pressure allows sea level to rise and gale force winds, combined with the Earth's rotation, force water towards the coastline. Storm surges are caused by our European weather systems (extra-tropical cyclones) and also tropical cyclones (hurricanes). They affect low lying coastlines around the globe and are responsible for significant damage and loss of life. In 1970 a devastating storm surge resulted in approximately a quarter of a million deaths in Bangladesh. In the USA, Hurricane Katrina and Superstorm Sandy are recent reminders of this global hazard. Storm surges can raise sea levels by up to 8m in tropical areas and by over 3m in the North Sea.

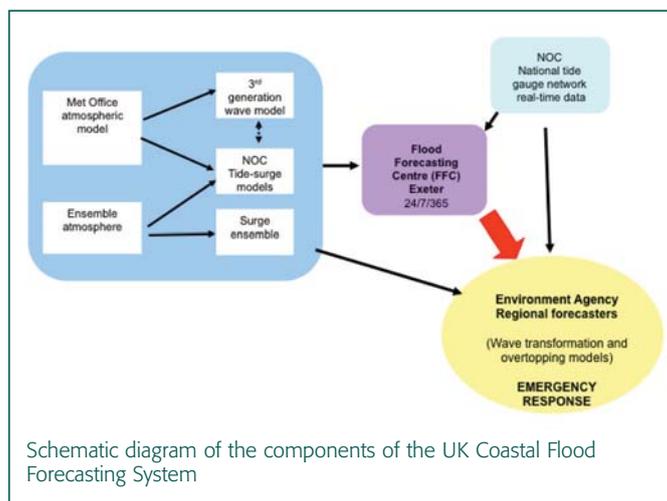
Coastal flooding around the UK is a threat to life as well as to economic and environmental assets. The worst natural disaster in modern times was the North Sea storm surge of

The storms that battered the UK during December 2013 and January 2014 marked some of the most severe weather in recent years. During 5th and 6th December, sea levels in parts of the North Sea were the highest since the 1953 floods and the Thames Barrier and Dutch flood barriers were closed for several tides. The largest storm surges struck the north east coast of England from Tyneside to Norfolk. Some flooding occurred (with 400 homes flooded near Hull and about 10000 homes being evacuated in East Anglia).



forecasts are combined with real-time monitoring of coastal sea levels, and are interpreted by a team of forecasters working around the clock at the Flood Forecasting Centre to provide regional forecasts. The numerical models of both atmosphere and ocean are subject to continuous improvement as more powerful computers and new scientific insight becomes available. The system also makes use of a technique called *ensemble forecasting* to quantify the inherent uncertainty in short-term weather prediction. Multiple model runs are made, adjusting model boundary conditions and parameters, to provide a range of outcomes that can then be used to judge the reliability of the forecast and provide a probabilistic approach to flood warning.

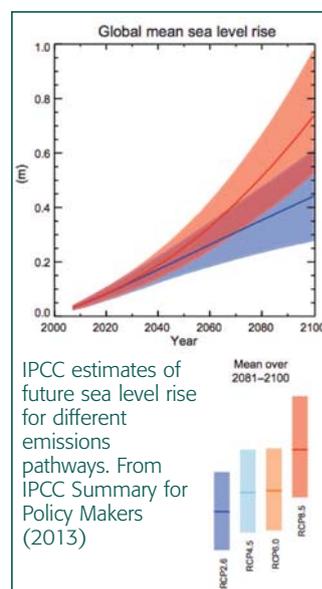
We now have a sophisticated network of 42 tide gauges around our coastline to support coastal flood forecasting but there are fewer data from 1953, so making a direct comparison of the two events is difficult. Water levels on north east coastlines (at North Shields) were approximately 0.5m higher in December 2013 than in 1953, and the December 2013 water level at the Hull Barrier was the highest ever recorded. On the other hand, water levels in the Thames estuary on 5th December were about 0.5m lower than those seen in 1953. The emerging picture is of a storm surge in 2013 very similar to that of 1953 but with greater severity in the northern part of the North Sea, most likely due to the December 2013 storm tracking in a more north-eastwards direction. Those who study our highly variable weather know that no two storms are identical, which is why complex statistical methods have been devised to estimate extreme water levels around the UK



coastline. These *joint probability techniques* estimate the likelihood of extreme storm surges coinciding with higher than average tides, and they are the basis of coastal defence design standards.

Any worldwide change in coastal flood frequency or amplitude could significantly affect coastal populations and the global economy. In studies based on tide gauge data, any observed trends in extreme sea level have been shown to be controlled by changes to mean sea level rather than changes in storminess; and for the UK there is no observational evidence of any long-term trend in storm surges⁴. The latest generation of climate models provide no significant evidence for future changes to storm-related extremes (due to low confidence in their ability to simulate extreme winds). Of course, the natural variability of our climate system makes it possible that we may experience more consecutive wet and windy winters like the most recent. There is a wealth of historical information⁵ to suggest that European climate in the 17th century was dominated by several decades of cool, wet and windy weather, with 1628 dubbed a "year without summer". Whilst the winter of 2013/14 saw an unusual

number of severe, consecutive storms and was exceptional in terms of record breaking rainfall for some parts of the UK, it was not unprecedented in a climatic context. Since it is not possible to predict accurately future changes to mid-latitude storminess we must assume that changes in extreme water levels around Europe will be governed by mean sea level rise.



The Intergovernmental Panel on Climate Change (IPCC) is unequivocal in its assessment of the gradual rise in mean sea level⁶. The projected rise in globally averaged sea level for the year 2100 is in the range 0.29-0.82m, depending on greenhouse gas emissions. On the basis of observed data over

the past century, sea level rise around the UK is consistent with global averages. Even with no change to the storm climate of northern Europe the rise in mean sea level will increase the frequency of extreme water levels (since storm surges and waves will be superimposed on a higher mean sea level); any particular threshold (eg a sea wall) will – on average – be exceeded more often. This will place greater demands on flood warning systems to deliver more accurate forecasts and with longer lead times, in order to protect lives and property. It follows that sustained investment in flood warning mechanisms and coastal defences would be wise.

References

- 1 McRobie, A., Spencer, T. and Gerritsen, H. (2005) The Big Flood: North Sea storm surge, *Philosophical Transactions of the Royal Society of London A*, 363, 1263-1270
- 2 Environment Agency (2009) Flooding in England: A national assessment of flood risk. Environment Agency, Bristol, UK. <http://publications.environment-agency.gov.uk/pdf/GEHO0609BQDS-E-E.pdf>.
- 3 <http://www.environment-agency.gov.uk/research/policy/116129.aspx>
- 4 http://www.mccip.org.uk/media/18620/2013arc_backingpapers_4_slr.pdf
- 5 Geoffrey Parker (2013) *Global Crisis: War, Climate Change and Catastrophe in the Seventeenth Century*, 904pp, ISBN: 9780300153231
- 6 IPCC, 2013: Summary for Policymakers. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, US



HOUSE OF LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE

The members of the Committee (appointed 16 May 2013) are Lord Dixon-Smith, Baroness Hilton of Eggardon, Lord O'Neill of Clackmannan, Lord Krebs (Chairman), Baroness Manningham-Buller, Lord Patel, Lord Peston, Baroness Perry of Southwark, Lord Rees of Ludlow, the Earl of Selborne, Baroness Sharp of Guildford, Lord Wade of Chorlton, Lord Willis of Knaresborough and Lord Winston.

International STEM students

In January 2014, the Committee launched a short follow up to its 2012 report on higher education in science, technology, engineering and mathematics (STEM) subjects. This focused specifically on the effect on international STEM students of immigration policy. Forty or so written submissions were received, seven oral evidence sessions were held in February and March, and a report published on 11 March 2014.

Waste and the bioeconomy

The Committee launched an inquiry into waste and the bioeconomy in July 2013. The Call for Evidence closed on 27 September. Evidence was collected on the technology used to exploit bio-waste and waste gases to generate high-value products. The inquiry aimed to assess the potential for this technology to enable bio-waste and waste gas to replace current feedstocks, and the contribution this could make to a bioeconomy. Oral evidence sessions were held across autumn 2013 and early 2014. The Committee published its report on 6 March 2014. A Government response is expected in May.

Scientific infrastructure

The Committee launched an inquiry into scientific infrastructure in May 2013. The call for evidence closed on 22 June. Oral evidence was taken across June and July on the large and medium-sized scientific infrastructure currently available in the UK with a particular focus on: future needs and strategic planning, funding and governance arrangements, international partnerships and partnerships with industry. The Committee published its report on 21 November 2013. The Government responded in February 2014.

Regenerative medicine

The Committee launched an inquiry into regenerative medicine before the 2012 summer recess. A group visited the California Institute for Regenerative Medicine. Oral evidence was taken from October to March 2013. The Committee reported on 1 July 2013 and a Government response was received on 1 October. A debate was held in the Chamber on 13 March 2014.

Nuclear follow-up

In July 2013, the Committee undertook an evidence session with Professor David Mackay, Chief Scientific Advisor at the Department of Energy & Climate Change, to follow up on its November 2011 report, Nuclear research and development capabilities. A further follow-up session was held with the Minister for Energy, Rt Hon Michael Fallon MP, on 10 December 2013.

Science spend

In May 2013, ahead of the Comprehensive Spending Review, the Committee held a one-off session on science spend. This resulted in a letter being sent to the Chancellor of the Exchequer on 4 June 2013 calling for an increase in the science budget. In a separate but related development, on 4 December 2013, the Committee wrote to the Rt Hon David Willetts MP, Minister for Universities and Science, to seek clarity on claims in the media suggesting that the ring-fenced science budget may be used to shore up the Department's budget in other areas.

Open access

The Committee undertook a short inquiry into the implementation of the Government's open access policy. It issued a call for evidence to key stakeholders. The Committee took oral evidence in January 2013 and published its report in February. The report was debated on 28 February. It followed this up with a letter to RCUK expressing concern about its revised open access policy in March. A Government response to the report was published in May 2013.

FURTHER INFORMATION

The reports, Government responses, written and oral evidence to the Committee's inquiries mentioned above, as well as the Calls for Evidence and other documents can be found on the Committee's website. Further information about the work of the Committee can be obtained from Chris Clarke, Committee Clerk, clarkechr@parliament.uk or 020 7219 4963. The Committee Office email address is hlsience@parliament.uk.



HOUSE OF COMMONS SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

The Science and Technology Committee is established under Standing Order No 152, and charged with the scrutiny of the expenditure, administration and policy of the Government Office for Science, a semi-autonomous organisation based within the Department for Business, Innovation and Skills.

The current members of the Science and Technology Committee are:

Jim Dowd (Labour, Lewisham West and Penge), David Heath (Liberal Democrat, Somerton and Frome), Stephen Metcalfe (Conservative, South Basildon and East Thurrock), Andrew Miller (Labour, Ellesmere Port and Neston), David Morris (Conservative, Morecambe and Lunesdale), Stephen Mosley (Conservative, City of Chester), Pamela Nash (Labour, Airdrie and Shotts), Sarah Newton (Conservative, Truro and Falmouth), Graham Stringer (Labour, Blackley and Broughton), David Tredinnick (Conservative, Bosworth) and Hywel Williams (Plaid Cymru, Arfon).

Andrew Miller was elected by the House of Commons to be the Chair on 9 June 2010. The remaining Members were formally appointed to the Committee on 12 July 2010. Caroline Dinéage, Gareth Johnson, Sarah Newton and Hywel Williams were formally appointed to the Committee on 27 February 2012 in the place of Gavin Barwell, Gregg McClymont, Stephen McPartland and David Morris. Jim Dowd was appointed on 11 June 2012 in the place of Jonathan Reynolds. David Morris was re-appointed on 3 December 2012 in the place of Gareth Johnson. David Tredinnick was appointed on 4 February in place of Caroline Dinéage. David Heath was appointed on 25 November 2013 in place of Roger Williams.

CURRENT INQUIRIES

The European and UK Space Agencies

On 15 February 2013 the Committee announced an inquiry: The European and UK Space Agencies.

The written and oral evidence received in this inquiry is on the Committee's website. A report was published on 28 October 2013. The Government response was published as a special report on 6 March 2014.

Climate: public understanding and its policy implications

On 28 February 2013 the Committee announced an inquiry: Climate: public understanding and its policy implications.

The written and oral evidence received in this inquiry is on the Committee's website. A Report was agreed and was published on 2 April 2014: *Communicating climate science*, HC 989.

Government Horizon Scanning

On 23 October the Committee took evidence from Alun Huw Williams, Principal, SAMI Consulting, Doug McKay, Vice President, International Organisations, Shell International, and Natalie Day, Head of Policy, Oxford Martin School, University of Oxford; Dr Martyn Thomas, Royal Academy of Engineering, Jonathan Cowie, former Head, Science Policy, Institute of Biology, and Professor Ann Buchanan, Academy of Social Sciences.

On 27 November the Committee took evidence from Fiona Lickorish, Head, Institute for Environment, Health, Risks and Futures, Cranfield University, Jessica Bland, Technology Futures Analyst, Nesta, and Marcus Morrell, Senior Futures Analyst, Arup; Professor Burkhard Schafer, Professor of Computational Legal Theory, Edinburgh School of Law, Professor Paul Newman, Mobile Robotics Group, University of Oxford, Nick Reed, Intelligent Transport Systems UK, and Dr Graeme Smith, Business Manager, Connected Services, Control and Electronics, Ricardo UK Ltd.

On 4 December the Committee took evidence from Sir Mark Walport, Government Chief Scientific Adviser, and Jon Day, Chair, Horizon Scanning Oversight Group, Cabinet Office.

The written and oral evidence received in this inquiry is on the Committee's website. A Report is being prepared.

Women in STEM careers

On 16 October the Committee took evidence from Dr Bryn Jones, Visiting Fellow, School of Physics, University of Bristol, Jenny Marsden, Principal Physicist, Hull and East Yorkshire NHS Trust, and Dr Nicola Patron, Head, Synthetic Biology, Sainsbury Laboratory.

On 30 October the Committee took evidence from Dr June McCombie, former Chair of IOP Project, Juno Panel, Institute of Physics, Sarah Dickinson, Manager, Athena SWAN Charter, Equality Challenge Unit, Professor Dame Julia Higgins, Chair of Diversity Programme, Royal Society, and Dr Pia Ostergaard, Senior Fellowship Advisor, Daphne Jackson Trust; Professor Uta Frith, Emeritus Professor of Cognitive Development, University College London, representing Russell Group, Professor Jane Powell, Deputy Warden, Goldsmith's, University of London, representing 1994 Group, and Clem Herman, Senior Lecturer, Computing and Communications, Open University.

On 4 November the Committee took evidence from Dr Lesley Thompson, Engineering and Physical Sciences Research Council (representing the Research Councils UK), and David Sweeney, Director, Research, Innovation and Skills, Higher Education Funding Council for England.

On 18 November the Committee took evidence from Rt Hon David Willetts MP, Minister of State for Universities and Science, Department for Business, Innovation and Skills.

The written and oral evidence received in this inquiry is on the Committee's website. A Report was agreed and was published on 6 February 2014: *Women in scientific careers*, HC 701.

GO Science Review of Science Advisory Councils

On 2 April the Committee took evidence from Professor Sir Mark Walport, Chief Scientific Adviser to HM Government and Head of the Government Office for Science; Professor Les

Iversen, Chair, Advisory Council on the Misuse of Drugs and Professor Chris Gilligan, Chair, Defra's Science Advisory Council.

The oral evidence received in this inquiry is on the Committee's website.

Antimicrobial resistance

On 18 December the Committee took evidence from Dr Pat Goodwin, Society of Biology, Professor Laura Piddock, British Society for Antimicrobial Chemotherapy, Professor John Threlfall, Society for Applied Microbiology, and Professor Sharon Peacock, Cambridge Infectious Diseases Initiative, University of Cambridge.

On 8 January 2014 the Committee took evidence from Professor Anthony Kessel, Public Health England, Dr Michael Moore, Royal College of General Practitioners, Professor Alison Holmes, Imperial College London and Dr Susan Hopkins, Royal College of Physicians; John Hardcastle, Novolytics, Dr David McIntosh, Novartis, Professor George Lewith, University of Southampton Medical School and Doris-Ann Williams, British In Vitro Diagnostics Association.

On 29 January 2014 the Committee took evidence from Phil Sketchley, National Office of Animal Health, John FitzGerald, Responsible Use of Medicines in Agriculture Alliance, Catherine McLaughlin, National Farmers' Union and Cólín Nunan, Alliance to Save our Antibiotics.

On 26 February 2014 the Committee took evidence from Professor Jeremy Farrar, Wellcome Trust, Professor Sir John Savill, Research Councils UK, Kush Naker, Universities Allied for Essential Medicines UK and Professor Sir Anthony Coates, Antibiotic Discovery UK; Dr Louise Leong, Association of the British Pharmaceutical Industry, James Anderson, GlaxoSmithKline, Dr David Williams, Discuva and Michael McIntyre, European Herbal and Traditional Medicine Practitioners Association.

On 12 March 2014 the Committee took evidence from Professor Dame Sally Davies, Chief Medical Officer, Sally Wellsteed, Department of Health, and Nigel Gibbens, Chief Veterinary Officer; George Eustice MP, Department for Environment, Food and Rural Affairs, Jane Ellison MP, Department of Health, Professor Dame Sally Davies, Chief Medical Officer and Professor Peter Borriello, Veterinary Medicines Directorate.

The written and oral evidence received in this inquiry is on the Committee's website. A report is being prepared.

Blood, tissue and organ screening

On 5 February the Committee took evidence from Mark Ward and Joseph Peaty, TaintedBlood, Liz Carroll, Haemophilia Society, Dr Matthew Buckland, UK Primary Immunodeficiency Network and Christine Lord; Professor Marc Turner, Advisory Committee on the Safety of Blood, Tissues and Organs Prion Group, Dr Roland Salmon, Advisory Committee on Dangerous Pathogens and Dr Sheila MacLennan, UK Blood Services Joint Professional Advisory Committee.

On 5 March 2014 the Committee took evidence from Dr Steven Burton, ProMetic Biosciences Ltd, Dr Kelly Board, DuPont Chemicals and Fluoroproducts, Dr Alex Raeber, Prionics AG, Nigel Talboys, Terumo BCT and Professor John Collinge, MRC Prion Unit.

On 26 March 2014 the Committee took evidence from Professor

Richard Knight, National CJD Research and Surveillance Unit, Professor Sheila Bird, Medical Research Council Biostatistics Unit, Dr Paula Bolton-Maggs, Serious Hazards of Transfusion (SHOT) Haemovigilance Scheme and Dr Simon Mead, Association of British Neurologists.

REPORTS

In addition to the above, the Committee has also published:

Pre-appointment hearing with the Government's preferred candidate for Chair of the Arts and Humanities Research Council (AHRC)

On 29 January 2014, the Committee published its Seventh Report of Session 2013-14, *Pre-appointment hearing with the Government's preferred candidate for Chair of the Arts and Humanities Research Council (AHRC)*, HC 989

FURTHER INFORMATION

Further information about the Science and Technology Committee can be obtained from the Clerk of the Committee, Stephen McGinness, or from the Senior Committee Assistant, Darren Hackett, on 020 7219 2792/2793 respectively; or by writing to: The Clerk of the Committee, Science and Technology Committee, House of Commons, 7 Millbank, London SW1P 3JA. Enquiries can also be e-mailed to scitechcom@parliament.uk. Anyone wishing to be included on the Committee's mailing list should contact the staff of the Committee. Anyone wishing to submit evidence to the Committee is strongly recommended to obtain a copy of the guidance note first. Guidance on the submission of evidence can be found at www.parliament.uk/commons/selcom/witguide.htm. The Committee has a website, www.parliament.uk/science, where all recent publications, terms of reference for all inquiries and press notices are available.



HOUSE OF COMMONS LIBRARY SCIENCE AND ENVIRONMENT SECTION

Staff in the Science and Environment Section provide confidential, bespoke briefing to Members and their offices daily. They provide support to Commons Select Committees, and produce longer notes and research papers which can be accessed at <http://www.parliament.uk/topics/topical-issues.htm>

Opposite are summaries of some recently updated published briefings.

For further information contact:
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RECENT PUBLICATIONS

Mitochondrial Donation

SN06833

New treatments could provide an option for women with mitochondrial DNA mutations to enable them to give birth to healthy children. These new techniques involve using donor mitochondria in an in vitro fertilisation (IVF) treatment.

The Human Fertilisation and Embryology Authority (HFEA), following scientific and ethical review and a public consultation in 2012, advised the Government that there is support for the introduction of these treatments. However, they have recommended that research is still needed and the treatment should be offered within a strict regulatory framework.

In June 2013, the Chief Medical Officer, Professor Dame Sally Davies, announced that draft regulations to allow mitochondrial donation would be published later in the year. It is estimated that the introduction of this treatment could save around 10 lives a year. These draft regulations were published on 27 February. There will be a public consultation on these until 21 May 2014.

There is a number of safety and ethical considerations which have been raised in regard to these techniques. The treatments involve changing the embryo's mitochondrial DNA prior to implantation. The nuclear DNA, which makes up over 99% of our total DNA will not be altered by these treatments. There has been opposition to their proposed introduction and the media have reported that the techniques will lead to three parent babies.

This note provides a summary of the role of mitochondria, mitochondrial disease and the proposed new techniques. It outlines the investigations into these techniques that took place prior to the Government announcement; an HFEA scientific review of the safety and efficacy of methods, an ethical review of the techniques for mitochondrial replacement undertaken by the Nuffield Council on Bioethics and an HFEA public consultation. The main safety and ethical considerations associated with the introduction of these techniques into clinical practice will be discussed.

Standardised packaging of tobacco product

SN06175

Standardised packaging (or 'plain packaging') of tobacco products is generally taken to mean the removal of all attractive promotional aspects. Except for the brand name (which would be presented in a standardised way), all other trademarks, logos, colour schemes and promotional graphics would be prohibited. The package itself would be standardised and display only information (such as health warnings) required by law.

During the House of Lords Grand Committee stage of the Children and Families Bill in November 2013, cross-party amendments were introduced to provide regulation-making powers on standardised packaging of tobacco products with the purpose of improving children's health. Following extensive debate the amendments were withdrawn but it was advised they would be returned to at the next stage of the Bill.

On 28 November 2013, Jane Ellison, the Parliamentary Under-Secretary of State for Health, announced an independent review into the public health evidence on standardised tobacco packaging. She confirmed that the Government would table an amendment to the Children and Families Bill to establish regulation-making powers in this area. This was tabled at the Report stage in the House of Lords on 29 January 2014 and was agreed by both Houses.

On 3 April 2014, the report of the public health review undertaken by Sir Cyril Chantler was published. He concluded that it was very likely that the introduction of standardised packaging would lead to a modest but important reduction in the uptake and prevalence of smoking and would have a positive effect on public health. Jane Ellison announced that the Government were minded to introduce regulations to provide for standardised packaging and these would be subject to a short final consultation.

TB Vaccination in Badgers and Cattle

SN06447

The vaccination of badgers against TB is an alternative approach being investigated to address the problem of the disease in cattle. The current vaccine for badgers, which is injectable, reduces the burden of disease in badgers. However administering the vaccine involves baiting and

trapping, and is resource intensive. There is no evidence yet that use of the vaccine in badgers would reduce disease in cattle. There is as yet no date for when an oral badger vaccine, which would be easier to administer, will be available.

TB vaccination of cattle is also being explored as an option, with the Government expecting to commence field trials in 2015. This is expected to take between two and five years. For this to be a useful option the test needs to be effective at distinguishing between infected and vaccinated cattle. TB vaccination of cattle would also have to be approved at EU level, which the Government expects would take up to 2023.

The Welsh Government suspended a badger cull programme in 2011 and replaced it with a five year trapping and vaccination programme. It published its first report in January 2013.

An additional standard note, Badger Culling: TB Control Policy - SN05873, provides information and analysis of the badger cull trial that took place in West Gloucestershire and West Somerset in summer 2013.

Regulation of herbal medicines SN06002

Herbal remedies for human use have for some time been regarded as medicines under UK legislation, subject to the same licensing procedures as pharmaceuticals. Efficacy requirements have been difficult to meet. Most EU Member States developed pragmatic arrangements to tackle this. In the UK herbal remedies have historically been exempted from licensing.

A review of herbal regulation at EU level was prompted by safety concerns and the need for market harmonisation of various national herbal regulatory regimes.

The Directive on Traditional Herbal Medicinal Products (Directive 2004/24/EC) replaces most existing member state regulations and creates a unified licensing system for traditional herbal medicine products (in use for at least 30 years, of which 15 must usually have been in the EU). The Directive came into full effect on 30 April 2011.

The Directive has met with some opposition from suppliers and users of herbal medicines. Objections include perceived disproportionate costs of regulatory compliance and the difficulty some non-European herbal traditions may have in meeting the requirement. There are concerns that this will result in threatening the viability of businesses and a reduction in consumer choice.

In February 2011, a statutory regulation scheme for herbal practitioners was proposed which would allow prescribing of unlicensed preparations by registered herbalists under a clause in the 2001 Medicines Directive. It was planned that this scheme would come into force in 2012. In July this year, the Under Secretary of State for Health, Dr Daniel Poulter highlighted issues which have made the introduction of the scheme difficult. He announced the setting up of a working group to consider options. It will meet early in 2014.

ACTIVITIES

Announcements on planning in the Budget and the publication of new web-based planning practice guidance led to updates of standard notes on planning reform proposals, permitted development rights and the green belt, in addition to a Library blog piece on garden cities.

The section contributed to the House of Commons Research Paper for the Second Reading of the Deregulation Bill providing background and analysis of the clauses on: rights of way, climate change, air quality, noise, household waste, health and safety and other environmental measures.

The note on standardised tobacco packaging was updated to take account of the progress of the Children and Families Bill, which provides powers for later implementation of standardised packaging. The Bill received Royal Assent (and became an Act) on 14 March 2014.

In the first quarter of the year the section has had an increased role in producing debate packs including on international wildlife crime (06/02/14), managing flood risk and Government levies on energy bills (03/03/14), and the Elliot review and food crime (02/04/14).

Staff visited Lancaster University and University College London to deliver presentations on how academia can engage with Parliament. This included highlighting the work of POST, the Library, and committees, and encouraging the building of contact with specialists in parliament and submission of evidence to select committees – all in the name of evidence-based policy making. The blog from the Lancaster trip is available at: <http://commonslibrary.blog.com/2014/03/17/reaching-out-from-westminster/>

Our planning specialist went to Royal Town Planning Institute on 11 February for meetings with their policy and communications team.



PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

RECENT POST PUBLICATIONS

Electricity Demand Side Response

January 2014

POSTnote 452

Demand-Side Response describes electricity users (the demand side) changing their patterns of use in response to incentives. It is one of several options eligible for Government support introduced

by the 2013 Energy Act. This POSTnote outlines DSR, how it is provided, its role for the UK and its potential future development.

Livestock Emissions

January 2014

POSTnote 453

Livestock farming results in the emission of the greenhouse gases (GHG) methane and nitrous oxide. Such emissions are difficult to accurately quantify and control. This POSTnote examines current policy and prospects for further reductions in emissions.

Risks from Climate Feedbacks

January 2014

POSTnote 454

The Fifth Assessment Report of the IPCC concluded that human activities are causing the climate to warm, but there is uncertainty in how the climate will continue to change. Climate feedbacks could both increase and decrease global warming. This POSTnote discusses what climate feedbacks are, as well as the challenges they present for climate change mitigation policies.

Electronic Cigarettes

January 2014

POSTnote 455

Electronic cigarettes produce a vapour typically containing nicotine, which users inhale. There is debate about their potential role in tobacco smoking reduction and cessation. This POSTnote summarises the evidence on the safety and quality of electronic cigarettes, explores some of the social issues raised and reviews current UK and EU regulation.

Telehealth and Telecare

February 2014

POSTnote 456

The UK's elderly population is growing and with it the number of people with long-term health problems. This is putting pressure on the health and social care systems. Increased use of technology such as telehealth and telecare may help to improve quality of care and reduce costs. This note describes current UK telehealth and telecare initiatives and the role they may play in delivering future care.

New Nuclear Power Technologies

February 2014

POSTnote 457

Nuclear power stations provide a low carbon source of electricity, which could help the UK achieve its policy to reduce greenhouse gas emissions by 80% by 2050. This POSTnote reviews new and potential future nuclear power technologies. It also outlines the regulatory approach toward new nuclear build and summarises some of the related challenges.

Ambient Air Quality

February 2014

POSTnote 458

National and European regulations have improved UK ambient air quality. However, current air pollution levels continue to harm human health and the environment. This POSTnote summarises the evidence for effects of air pollutants and policies to address them.

Stroke

February 2014

POSTnote 459

Stroke is the third largest cause of mortality in the UK, and the largest cause of adult disability. It has a high clinical and societal burden, and can have a profound effect on people's lives. This POSTnote summarises the different types of stroke, and examines treatment, prevention strategies and recent service re-organisation.

Social Media and Big Data

March 2014

POSTnote 460

Analysing large quantities of readily available data from social media has created new opportunities to understand and influence how people think and act. This POSTnote examines the application of 'big data' approaches to social media in three key areas: elections and polling, commercial applications and security. It also covers the regulation of social media data and public concerns around privacy.

Transparency of Clinical Trial Data

March 2014

POSTnote 461

Results from many clinical trials are not published or made available. Recently there have been calls for clinical trials data to be

made more accessible. This briefing examines ways of achieving greater transparency and the issues that they raise.

Surveillance of Infectious Disease

March 2014

POSTnote 462

Microbes such as bacteria and viruses cause a wide range of infectious diseases. They can be highly adaptable and evolve rapidly to changing environments. This can change their ability to spread and their susceptibility to antimicrobial drugs. Surveillance is key for detecting and responding to novel and re-emerging microbes. This briefing describes current surveillance efforts and examines new technological developments and their likely impacts on UK and international public health.

HIV Prevention in the UK

April 2014

POSTnote 463

Preventing HIV is a priority for research and public health. Research developments and the trends in the nature of the epidemic mean that policy is continually revised in order to educate the public, reduce transmission of the virus and treat those affected. This note describes patterns of infection and policies to increase HIV testing. It also summarises evidence for using antiretrovirals as a preventive measure.

Intermittent Electricity Generation

April 2014

POSTnote 464

Sources of electricity that exhibit uncontrolled increases or decreases in output are often referred to as intermittent. This POSTnote examines the effect of wind, solar, wave and tidal intermittency on the provision of electricity to meet demand, electricity prices and carbon dioxide emissions. The note also describes measures to manage intermittency.

CURRENT WORK

Biological Sciences – Minimum Age of Responsibility, Childhood Allergy, Population Health Management, GM Crops

Environment and Energy – Short Lived Climate Pollutants, Ancient Woodlands, Reducing Diffuse Water Pollution from Agriculture, REDD+, Smart Metering of Electricity, Gas and Water, Energy Storage, Phosphate Resources

Physical sciences and IT – Unmanned Aerial Vehicles, Big Data Overview and Big Data in Business

Social Sciences – Alternative Currencies, Big Data, Crime and Security, Big Data and Transport, End-of-Life Care

CONFERENCES AND SEMINARS

Could the Lights Go Out?

On January 7th, POST hosted a roundtable briefing entitled 'Could the Lights Go Out in 2015/16?' supported by the Royal Academy of Engineering. The event followed recent estimates from National Grid Plc and the electricity market regulator Ofgem that show levels of spare electricity generating capacity falling to low levels in winter 2015/16. The briefing gave MPs and Peers the opportunity to discuss with external experts the risk to the security of electricity supply over the period 2014-18 and approaches to mitigate the risk. The briefing was attended by 4 MPs, 6 peers as well as committee and members' staff. The event was chaired by Lord Oxburgh, with external experts from the Department of Energy and Climate Change, National Grid, Ofgem, the Royal Academy of Engineering, UK Energy Research Centre, industry body Energy UK and energy company NPower.

Risks from Climate Feedbacks

On 28th January, POST hosted a breakfast briefing to launch the

POSTnote on Risks from Climate Feedbacks and for parliamentarians to discuss the uncertainties and evidence of their role in the climate system and their likely implications for adaptation with representatives from academia, the insurance industry, NGOs and policy. It was chaired by Andrew Miller MP and presentations were made by: Professor Colin Prentice, AXA Chair in Climate Impacts, Imperial College London, Professor Pierre Friedlingstein, Chair in Climate Modelling, University of Exeter, Chris Jones, Head of Earth System Research, Met Office Hadley Centre, Professor Tim Lenton, Chair in Climate Change, University of Exeter, Trevor Maynard, Head of Exposure Management, Lloyds, Professor Bill Sutherland, Chair in Conservation Biology, University of Cambridge & British Ecological Society President and Leo Hickman, Climate Change Chief Advisor, WWF UK.

Food Aid Provision

On 9th April, POST hosted a seminar on Food Banks in collaboration with the All-Party Parliamentary Group (APPG) on Hunger and Food Poverty. This event was an opportunity for parliamentarians to hear from leading researchers about the latest findings of research on food poverty and food aid provision across the UK. It was chaired by Sarah Newton MP and presentations were made by Professor Elizabeth Dowler, Professor of Food and Social Policy, University of Warwick, Ms Hannah Lambie-Mumford, Researcher, University of Sheffield, Dr Filip Sosenko, Research Associate, Dr Nicola Livingstone, Researcher, Heriot-Watt University and Dr Matt Barnes, Research Director, National Centre for Social Research.

STAFF, FELLOWS AND INTERNS AT POST

Fellows

Adriana De Palma, Natural History Museum, Biotechnology and Biological Sciences Research Council
 Oscar Branson, University of Cambridge, Natural Environment Research Council
 Mark Richardson, University of Reading, Natural Environment Research Council
 Rosalind Davies, University of Birmingham, Engineering and Physical Sciences Research Council
 Daniel Rathbone, Imperial College London, Engineering and Physical Sciences Research Council
 Maria Thorpe, University of Manchester, Engineering and Physical Sciences Research Council
 Elizabeth Duxbury, University of East Anglia, Biotechnology and Biological Sciences Research Council
 Helen Brewer, Rothamsted Research, Biotechnology and Biological Sciences Research Council
 Clare Wenham, University of Aberystwyth, Nuffield Council on Bioethics
 Rachel Stocker, University of Durham, British Psychological Society
 Paul Gilbert, University of Sussex, Economic and Social Research Council
 Stephen Hanley, University of Leeds, Economic and Social Research Council



Listed opposite (grouped by subject area) is a selection of Debates on matters of scientific interest which took place in the House of Commons, House of Lords or Westminster Hall between 21st January and 10th April 2014.

A full digest of debates and PQs on scientific issues during the 2013/14 session of Parliament can be found at <http://www.scienceinparliament.org.uk/publications/uk-digests/>

SELECTED DEBATES

ENVIRONMENT AND CONSERVATION

Badger Cull	13.3.14	HoC 456	Mrs Anne Main
Deep Sea Mining Bill	7.2.14	HoL 391	Baroness Wilcox
Forestry: Independent Panel Report	12.2.14	HoL 675	Baroness Royall of Blaisdon

EDUCATION & SKILLS

Apprenticeship	26.3.14	HoL 560	Lord Young of Norwood Green
Higher Education	9.4.14	HoL 1303	Lord Ahmad of Wimbledon

ENERGY

Carbon Capture and Use	21.1.14	HoC 65WH	Laura Sandys
Fracking	17.3.14	HoL GC42	Lord Borwick

FOOD AND HEALTH

Dementia	22.1.14	HoL 722	Baroness Gardner of Parkes
Elliott Review and Food Crime	2.4.14	HoC 233WH	Laura Sandys
Innovative Medicine	1.4.14	HoL 909	Baroness Thomas of Winchester
Medical Records (Confidentiality)	11.2.14	HoC 215WH	George Mudie, George Freeman
Mitochondrial Transfer (Three-Parent Children)	12.3.14	HoC 164WH	Jacob Rees-Mogg
Neglected Tropical Diseases	6.2.14	HoL GC127	Baroness Hayman
NHS Patient Data	25.3.14	HoC 49WH	Barbara Keeley
NHS Patient Data	27.2.14	HoC 173WH	George Freeman
NHS: Competition	10.2.14	HoL GC214	Lord Turnbull
Patient Medical Records	4.3.14	HoC 240WH	Roger Godsiff
Regenerative Medicine: S&T Committee Report	13.3.14	HoL 1936	Lord Patel

MISCELLANEOUS

Bletchley Park	12.3.14	HoL 1819	Baroness Trumpington
Defence & Cyber Security (Sel Co report)	4.3.14	HoC 787	James Arbuthnot
Development: Post-2015 Agenda	2.4.14	HoL 1005	Baroness Kinnock of Holyhead
World Water Day	11.3.14	HoC 291	Naomi Long

Science Directory

Research Councils UK

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Each year the Research Councils invest around £3 billion in research covering the full spectrum of academic disciplines from the medical and biological sciences to astronomy, physics, chemistry and engineering, social sciences, economics, environmental sciences and the arts and humanities.

Research Councils UK is the strategic partnerships of the seven Research Councils. It aims to:

- increase the collective visibility, leadership and influence of the Research Councils for the benefit of the UK;
- lead in shaping the overall portfolio of research funded by the Research Councils to maximise the excellence and impact of UK research, and help to ensure that the UK gets the best value for money from its investment;
- ensure joined-up operations between the Research Councils to achieve its goals and improve services to the communities it sponsors and works with.

Biotechnology and Biological Sciences Research Council (BBSRC)



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BBSRC invests in world-class bioscience research, innovation and training on behalf of the UK public. Our aim is to further scientific knowledge to promote economic growth, wealth and job creation and to improve quality of life in the UK and beyond. BBSRC research is helping society to meet major challenges, including food security, green energy and healthier lifespans and underpins important UK economic sectors, such as farming, food, industrial biotechnology and pharmaceuticals.

Economic and Social Research Council



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The ESRC is the UK's leading research and training agency addressing economic and social concerns. We pursue excellence in social science research; work to increase the impact of our research on policy and practice; and provide trained social scientists who meet the needs of users and beneficiaries, thereby contributing to the economic competitiveness of the United Kingdom, the effectiveness of public services and policy, and quality of life. The ESRC is independent, established by Royal Charter in 1965, and funded mainly by government.

EPSRC

Pioneering research and skills

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EPSRC is the UK's main agency for funding research and training in engineering and physical sciences, investing around £800m a year in research and postgraduate training, to help the nation handle the next generation of technological change.

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Medical Research Council



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Over the past century, the MRC has been at the forefront of scientific discovery to improve human health. Founded in 1913 to tackle tuberculosis, the MRC now invests taxpayers' money in the highest quality medical research across every area of health. Twenty-nine MRC-funded researchers have won Nobel prizes in a wide range of disciplines, and MRC scientists have been behind such diverse discoveries as vitamins, the structure of DNA and the link between smoking and cancer, as well as achievements such as pioneering the use of randomised controlled trials, the invention of MRI scanning, and the development of therapeutic antibodies. We also work closely with the UK's Health Departments, the NHS, medical research charities and industry to ensure our research achieves maximum impact as well as being of excellent scientific quality.

Natural Environment Research Council



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NERC is the UK's leading public funder of environmental science. We invest £330 million each year in cutting-edge research, postgraduate training and innovation in universities and research centres.

Our scientists study the physical, chemical and biological processes on which our planet and life itself depends – from pole to pole, from the deep Earth and oceans to the atmosphere and space.

We partner with business, government, the public and the wider research community to shape the environmental research and innovation agenda. Our science provides knowledge, skills and technology that deliver sustainable economic growth and public wellbeing.

Science & Technology Facilities Council



Science & Technology Facilities Council

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The Science and Technology Facilities Council is one of Europe's largest multidisciplinary research organisations supporting scientists and engineers world-wide. The Research Council operates world-class, large-scale research facilities and provides strategic advice to the UK Government on their development. The STFC partners in two of the UK's Science and Innovation Campuses. It also manages international research projects in support of a broad cross-section of the UK research community, particularly in the fields of astronomy, nuclear physics and particle physics. The Council directs, co-ordinates and funds research, education and training.

Alzheimer's ResearchUK

Defeating Dementia

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Alzheimer's Research UK is the UK's leading dementia research charity. Currently, we support 130 projects worth over £21.5m. As research specialists, we fund pioneering research at leading universities across the UK and the globe with the aim of defeating dementia. Our expertise helps bring together leading dementia scientists to share ideas and understanding.

We work with people with dementia to reflect their concerns and firmly believe that science holds the key to defeating dementia.

Association of the British Pharmaceutical Industry



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The ABPI is the voice of the innovative pharmaceutical industry, working with Government, regulators and other stakeholders to promote a receptive environment for a strong and progressive industry in the UK, one capable of providing the best medicines to patients.

The ABPI's mission is to represent the pharmaceutical industry operating in the UK in a way that:

- assures patient access to the best available medicine;
- creates a favourable political and economic environment;
- encourages innovative research and development;
- affords fair commercial returns

AIRTO



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AIRTO – The Association for Independent Research and Technology Organisations – is the foremost membership body for organisations operating in the UK's intermediate research and technology sector. AIRTO's members deliver vital innovation and knowledge transfer services which include applied and collaborative R&D, frequently in conjunction with universities, consultancy, technology validation and testing, incubation of commercialisation opportunities and early stage financing. AIRTO members have a combined turnover of over £4bn from clients both at home and outside the UK, and employ over 40,000 scientists, technologists and engineers.

AMPS

AMPS

The Association of
Management and
Professional Staffs.

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We are a Trades Union for Management and Professional Staff working in the pharmaceutical, chemical and allied industries.

We also have a section for Professional Divers working globally. We represent a broad base of both office and field based staff and use our influence to improve working conditions on behalf of our members.

We are experts in performance based and field related issues and are affiliated to our counterparts in EU Professional Management Unions.

Biochemical Society

Advancing Molecular Bioscience

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The Biochemical Society exists for the advancement of the molecular and cellular biosciences, both as an academic discipline and to promote its impact on areas of science including biotechnology, agriculture, and medicine. We achieve our mission through our publications and journals, scientific meetings, educational activities, policy work, awards and grants to scientists and students. The Biochemical Society is the largest discipline-based learned society in the biosciences with 6800 members.

The British Ecological Society



The British Ecological Society
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Ecology into Policy Blog
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The British Ecological Society's mission is to advance ecology and make it count. The Society has over 4,000 members worldwide. The BES publishes five internationally renowned scientific journals and organises the largest scientific meeting for ecologists in Europe. Through its grants, the BES also supports ecologists in developing countries and the provision of fieldwork in schools. The BES informs and advises Parliament and Government on ecological issues and welcomes requests for assistance from parliamentarians.

British In Vitro Diagnostics Association (BIVDA)

BIVDA

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BIVDA is the UK industry association representing companies who manufacture and/or distribute the diagnostics tests and equipment to diagnose, monitor and manage disease largely through the NHS pathology services. Increasingly diagnostics are used outside the laboratory in community settings and also to identify those patients who would benefit from specific drug treatment particularly for cancer.

British Nutrition Foundation



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The British Nutrition Foundation (BNF) was established over 40 years ago and exists to deliver authoritative, evidence-based information on food and nutrition in the context of health and lifestyle. The Foundation's work is conducted and communicated through a unique blend of nutrition science, education and media activities.

BPS | BRITISH PHARMACOLOGICAL SOCIETY

Today's science, tomorrow's medicines

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The British Pharmacological Society is the primary UK learned society concerned with research into drugs and the way they work. Our 3000+ members work in academia, industry, regulatory agencies and the health services, and many are medically qualified. We cover the whole spectrum of pharmacology, including laboratory, clinical, and toxicological aspects. Enquiries about the discovery, development and application of drugs are welcome.

The British Psychological Society



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The British Psychological Society is an organisation of over 48,000 members governed by Royal Charter. It maintains the Register of Chartered Psychologists, publishes books, 11 primary science Journals and organises conferences. Requests for information about psychology and psychologists from parliamentarians are very welcome.



The British Society for Antimicrobial Chemotherapy

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www.bsac.org.uk | www.antibiotic-action.com
www.e-opat.com | www.nas-pps.com
www.appg-on-antibiotics.com
www.bsacsurv.org

The BSAC is an inter-professional organisation with over forty years of experience and achievement in antibiotic education, research and leadership. The Society has an active international membership and:

- Is dedicated to saving lives through the effective use and development of antibiotics, now and in the future.
- Communicates effectively about antibiotics and antibiotic usage via workshops, professional guidelines and its own high impact international journal, the Journal of Antimicrobial Chemotherapy.
- Is home to the UK-led global initiative Antibiotic Action
- Serves as secretariat to the All Party Parliamentary Group on Antibiotics

British Society for immunology

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The BSI is one of the oldest, largest and most active immunology societies in the world. We have over 4,000 members who work in all areas of immunology, including research and clinical practice.

The BSI runs major scientific meetings, education programmes and events for all ages. We disseminate top quality scientific research through our journals and meetings and we are committed to bringing the wonders and achievements of immunology to as many audiences as possible.

Brunel University



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Brunel is a world-class university based in London. Our distinctive mission combines teaching and research excellence with the practical and entrepreneurial approach of our namesake, Isambard Kingdom Brunel.

Brunel works closely with business to bring social and economic benefit by undertaking groundbreaking research to find solutions to major problems and producing graduates with the knowledge and skills sought by employers.

Cavendish Laboratory



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The Cavendish Laboratory houses the Department of Physics of the University of Cambridge.

The research programme covers the breadth of contemporary physics

Extreme Universe: Astrophysics, cosmology and high energy physics

Quantum Universe: Cold atoms, condensed matter theory, scientific computing, quantum matter and semiconductor physics

Materials Universe: Optoelectronics, nanophotonics, detector physics, thin film magnetism, surface physics and the Winton programme for the physics of sustainability

Biological Universe: Physics of medicine, biological systems and soft matter

The Laboratory has world-wide collaborations with other universities and industry

Chartered Institute of Patent Attorneys



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Members of CIPA practise in intellectual property, especially patents, trade marks, designs, and copyright, either in private partnerships or industrial companies. It advises government and international circles on policy issues and provides information services, promoting the benefits to UK industry of obtaining IP protection, and to overseas industry of using British attorneys to obtain international protection.

Clifton Scientific Trust



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Science for Citizenship and Employability,
Science for Life, Science for Real

We build grass-roots partnerships between school and the wider world of professional science and its applications

- for young people of all ages and abilities
- experiencing science as a creative, questioning, human activity
- bringing school science added meaning and motivation, from primary to post-16
- locally, nationally, internationally (currently between Britain and Japan; also the Ukraine)

Clifton Scientific Trust Ltd is registered charity 1086933

The Council for the Mathematical Sciences



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The Council for the Mathematical Sciences is an authoritative and objective body that works to develop, influence and respond to UK policy issues affecting mathematical sciences in higher education and research, and therefore the UK economy and society by:

- providing expert advice;
- engaging with government, funding agencies and other decision makers;
- raising public awareness; and
- facilitating communication between the mathematical sciences community and other stakeholders

Eli Lilly and Company Ltd



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Lilly UK is the UK affiliate of a major American pharmaceutical manufacturer, Eli Lilly and Company of Indianapolis. This affiliate is one of the UK's top pharmaceutical companies with significant investment in science and technology including a neuroscience research and development centre and bulk biotechnology manufacturing operations.

Lilly medicines treat schizophrenia, diabetes, cancer, osteoporosis, attention deficit hyperactivity disorder, erectile dysfunction, depression, bipolar disorder, heart disease and many other diseases.



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EngineeringUK is an independent organisation that promotes the vital role of engineers, engineering and technology in our society. EngineeringUK partners business and industry, Government and the wider science and technology community: producing evidence on the state of engineering; sharing knowledge within engineering, and inspiring young people to choose a career in engineering, matching employers' demand for skills.



The Food & Environment Research Agency

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The Food and Environment Research Agency's overarching purpose is to support and develop a sustainable food chain, a healthy natural environment, and to protect the global community from biological and chemical risks.

Our role within that is to provide robust evidence, rigorous analysis and professional advice to Government, international organisations and the private sector.

GAMBICA Association Ltd



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GAMBICA Association is the UK trade association for instrumentation, control, automation and laboratory technology. The association seeks to promote the successful development of the industry and assist its member companies through a broad range of services, including technical policy and standards, commercial issues, market data and export services.



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The Geological Society is the national learned and professional body for Earth sciences, with 11,000 Fellows (members) worldwide. The Fellowship encompasses those working in industry, academia and government, with a wide range of perspectives and views on policy-relevant science, and the Society is a leading communicator of this science to government bodies and other non-technical audiences.



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The GGF is the main representative organisation for companies involved in all aspects of the manufacture of flat glass and products and services for all types of glazing, in commercial and domestic sectors.

Members include companies that manufacture and install energy efficient windows, in homes and commercial buildings, the performance glass used in every type of building from houses to high-rise tower blocks and the components that are used to manufacture every type of glazing.



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IFST is the independent qualifying body for food professionals in Europe. Membership is drawn from all over the world from backgrounds including industry, universities, government, research and development and food law enforcement.

IFST's activities focus on disseminating knowledge relating to food science and technology and promoting its application. Another important element of our work is to promote and uphold standards amongst food professionals.



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Established in London in 1889, the IMarEST is a leading international membership body and learned society for marine professionals, with over 15,000 members worldwide. The IMarEST has an extensive marine network of 50 international branches, affiliations with major marine societies around the world, representation on the key marine technical committees and non-governmental status at the International Maritime Organization (IMO) as well as other intergovernmental organisations.



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The Institute of Measurement and Control provides a forum for personal contact amongst practitioners, publishes learned papers and is a professional examining and qualifying organisation able to confer the titles Eurlng, CEng, IEng, EngTech; Companies and Universities may apply to become Companions. Headquartered in London, the Institute has a strong regional base with 15 UK, 1 Hong Kong and 1 Malaysia Local Section, a bilateral agreement with the China Instrument Society and other major international links.

IOP Institute of Physics

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The Institute of Physics is a leading scientific society. We are a charitable organisation with a worldwide membership of more than 50,000, working together to advance physics education, research and application.

We engage with policymakers and the general public to develop awareness and understanding of the value of physics and, through IOP Publishing, we are world leaders in professional scientific communications.

In September 2013, we launched our first fundraising campaign. Our campaign, Opportunity Physics, offers you the chance to support the work that we do.

Visit us at www.iop.org, follow us @physicsnews



Institute of Physics and Engineering in Medicine

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IPEM is a registered, incorporated charity for the advancement, in the public interest, of physics and engineering applied to medicine and biology. It accredits medical physicists, clinical engineers and clinical technologists through its membership register, organises training and CPD for them, and provides opportunities for the dissemination of knowledge through publications and scientific meetings. IPEM is licensed by the Science Council to award CSci, RSci and RSciTech, and by the Engineering Council to award CEng, IEng and EngTech.



The Institution of Chemical Engineers

With over 38,000 members in 120 countries, IChemE is the global membership organisation for chemical engineers. A not for profit organisation, we serve the public interest by building and sustaining an active professional community and promoting the development, understanding and application of chemical engineering worldwide.

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Institution of Civil Engineers



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Representing over 80,000 professional civil engineers around the world, ICE actively contributes to the development of public policy at all levels of government in areas concerning infrastructure, engineering and our quality of life.

Established in 1818, ICE is recognised worldwide for its excellence as a centre of learning, as a qualifying body and as a public voice for the profession. Our members design, build and maintain the infrastructure that keeps our country running.

Under our Royal Charter, we have a duty to provide independent, expert advice on infrastructure issues for the benefit of the public and to serve wider society. We are seen by Parliament and industry alike as the authoritative voice of infrastructure.

Institution of Engineering Designers



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The only professional membership body solely for those working in engineering and technological product design. Engineering Council and Chartered Environmentalist registration for suitably qualified members. Membership includes experts on a wide range of engineering and product design disciplines, all of whom practise, manage or educate in design.



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The IET is a world leading professional organisation, sharing and advancing knowledge to promote science, engineering and technology across the world. Dating back to 1871, the IET has 150,000 members in 127 countries with offices in Europe, North America, and Asia-Pacific.

Institution of Mechanical Engineers



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The Institution provides politicians and civil servants with information, expertise and advice on a diverse range of subjects, focusing on manufacturing, energy, environment, transport and education policy. We regularly publish policy statements and host political briefings and policy events to establish a working relationship between the engineering profession and parliament.

LGC



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LGC is an international science-based company and market leader in the provision of analytical, forensic and diagnostic services and reference standards to customers in the public and private sectors.

Under the Government Chemist function, LGC fulfils specific statutory duties as the referee analyst and provides advice for Government and the wider analytical community on the implications of analytical chemistry for matters of policy, standards and regulation. LGC is also the UK's designated National Measurement Institute for chemical and biochemical analysis.

With headquarters in Teddington, South West London, LGC has 36 laboratories and centres across Europe and at sites in China, Brazil, India, South Africa and the US.



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The Linnean Society of London is a professional learned body which promotes natural history in all its branches, and was founded in 1788. The Society is particularly active in the areas of biodiversity, conservation and sustainability, supporting its mission through organising open scientific meetings and publishing peer-reviewed journals, as well as undertaking educational initiatives. The Society's Fellows have a considerable range of biological expertise that can be harnessed to inform and advise on scientific and public policy issues.

A Forum for Natural History

L'ORÉAL UK AND IRELAND

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L'Oréal employs more than 3,500 scientists worldwide and dedicates over €600 million each year to research and innovation in the field of healthy skin and hair. The company supports women in science research through the L'Oréal UNESCO For Women in Science Programme and engages young people with science through the L'Oréal Young Scientist Centre at the Royal Institution. L'Oréal also collaborates with a vast number of institutions in the UK and globally.

Marine Biological Association



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Since 1884 the Marine Biological Association has been delivering its mission 'to promote scientific research into all aspects of life in the sea, including the environment on which it depends, and to disseminate to the public the knowledge gained.' The MBA represents its members in providing a clear independent voice to government on behalf of the marine biological community. It also has an extensive research programme and a long history as an expert provider of advice for the benefit of policy makers and wider society.

Met Office



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The Met Office doesn't just forecast the weather on television. Our forecasts and warnings protect UK communities and infrastructure from severe weather and environmental hazards every day – they save lives and money. Our Climate Programme delivers evidence to underpin Government policy. Our Mobile Meteorological Unit supports the Armed Forces around the world. We build capacity overseas in support of international development. All of this built on world-class environmental science.

National Physical Laboratory



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The National Physical Laboratory (NPL) is the United Kingdom's national measurement institute, an internationally respected and independent centre of excellence in research, development and knowledge transfer in measurement and materials science. For more than a century, NPL has developed and maintained the nation's primary measurement standards - the heart of an infrastructure designed to ensure accuracy, consistency and innovation in physical measurement.

Natural History Museum



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We maintain and develop the collections we care for and use them to promote the discovery, understanding, responsible use and enjoyment of the natural world.

We are part of the UK's science base as a major science infrastructure which is used by our scientists and others from across the UK and the globe working together to enhance knowledge on the diversity of the natural world.

Our value to society is vested in our research responses to challenges facing the natural world today, in engaging our visitors in the science of nature, in inspiring and training the next generation of scientists and in being a major cultural tourist destination.

NEF: The Innovation Institute



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The Innovation Institute aims to drive innovation and growth in science, technology and engineering to achieve growth, prosperity and wellbeing in the UK. Our partners, clients and stakeholders include:

- Businesses
- Education providers
- Government bodies

New Engineering Foundation, our charitable arm, focusses on SciTech skills development. NEF work in vocational training and further education is supported by a Panel drawn from key industries.

Our Institute of Innovation and Knowledge Exchange is a professional body and a "do tank", led by the Innovation Council to support the role of innovation in society.

Nesta



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Nesta is the UK's innovation foundation with a mission to help people and organisations bring great ideas to life. We do this by providing investments and grants and mobilising research, networks and skills.

Nesta doesn't work alone. We rely on the strength of the partnerships we form with other innovators, community organisations, educators and investors too.

We are an independent charity and our work is enabled by an endowment from the National Lottery.

Nesta is a registered charity in England and Wales with a company number 7706036 and charity number 1144091. Registered as a charity in Scotland number SC042833. Registered office: 1 Plough Place, London, EC4A 1DE.

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The University of Northampton is a Top 50 UK University*. We are committed to science education through initial teacher training, a STEM Ambassador network which works within the community and teaching and research to doctoral level. We are only UK University with Ashoka U 'Changemaker Campus' status recognising our commitment to social innovation and entrepreneurship.

(*Guardian University Guide 2014)



The University of
Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

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With 43,000 students and campuses in Nottingham, China and Malaysia, The University of Nottingham is 'the nearest Britain has to a truly global university.' With more than 90 per cent of all research of international quality according to the most recent Research Assessment Exercise, the University is ranked in the World's Top 75 universities by the QS World University Rankings.



PHARMAQ Ltd

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PHARMAQ is the only global pharmaceutical company with a primary focus on aquaculture. Our mission is to provide environmentally sound, safe and efficacious health products to the global aquaculture industry through targeted research and the commitment of dedicated people. We have a product portfolio that includes over 20 fish vaccines along with specialist feed additives, anaesthetics, antibiotics, sea lice treatments and biocide disinfectants. Through our sister company, PHARMAQ Analytiq, we also offer a range of diagnostics services that can be used to help safeguard fish welfare and improve productivity.



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Physiology is the science of how molecules, cells and organs work in the body. Representing over 3000 life scientists, The Physiological Society supports scientific research through its grants schemes, conferences and its three open access journals.

The Society also supports the teaching of physiology in schools and universities, and works to promote an understanding of physiology amongst policy-makers and the general public.

Prospect



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Prospect is an independent, thriving and forward-looking trade union with 117,000 members across the private and public sectors and a diverse range of occupations. We represent scientists, technologists and other professions in the civil service, research councils and private sector.

Prospect's collective voice champions the interests of the engineering and scientific community to key opinion-formers and policy makers. With negotiating rights with over 300 employers, we seek to secure a better life at work by putting members' pay, conditions and careers first.



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As the UK's national academy for engineering, we bring together the most successful and talented engineers for a shared purpose: to advance and promote excellence in engineering. We have four strategic challenges: drive faster and more balanced economic growth; foster better education and skills; lead the profession; and promote engineering at the heart of society.



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RBG Kew is a centre of global scientific expertise in plant and fungal diversity, conservation, and sustainable use, housed in two world-class gardens. Kew is a non-departmental public body with exempt charitable status and receives approximately half its funding from government through Defra. The key strategic priorities of Kew's science programme are to:

- understand and conserve biodiversity
- accelerate discovery and global access to plant and fungal diversity information
- map and prioritise species and habitats most at risk
- promote sustainable local use of plants and fungi
- collect and store seed from 25% of plant species through the Millennium Seed Bank Partnership
- restore and repair habitats
- inspire interest in plant and fungal science and conservation

Kew's mission is to inspire and deliver science-based plant conservation worldwide, enhancing the quality of life.



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The Royal Institution (Ri) has been at the forefront of public engagement with science for over 200 years and our purpose is to encourage people to think further about the wonders of science. We run public events and the famous CHRISTMAS LECTURES®, a national programme of Masterclasses for young people in mathematics, engineering and computer science, educational activities at the L'Oréal Young Scientist Centre and policy discussions with science students. And through the Ri Channel we share the stories behind cutting-edge science with people around the world.



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The Royal Society is the UK academy of science comprising 1400 outstanding individuals representing the sciences, engineering and medicine. It has had a hand in some of the most innovative and life-changing discoveries in scientific history. Through its Fellowship and permanent staff, it seeks to ensure that its contribution to shaping the future of science in the UK and beyond has a deep and enduring impact.



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The Royal Society of Chemistry is the world's leading chemistry community, advancing excellence in the chemical sciences. With 48,000 members and a knowledge business that spans the globe, we are the UK's professional body for chemical scientists; a not-for-profit organisation with 170 years of history and an international vision of the future. We promote, support and celebrate chemistry. We work to shape the future of the chemical sciences – for the benefit of science and humanity.



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SfAM is a UK organization, serving microbiologists internationally. It works to advance, for the benefit of the public, the science of microbiology in its application to the environment, human and animal health, agriculture, and industry. With Wiley-Blackwell, SfAM publishes five internationally acclaimed journals. Value for money and a modern, innovative and progressive outlook are its core principles. A friendly society, SfAM values integrity, honesty, and respect, and seeks to promote excellence and professionalism and to inspire young microbiologists.



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The Society for General Microbiology is the largest learned microbiological society in Europe with a worldwide membership based in universities, industry, hospitals, research institutes and schools. The Society publishes key academic journals, organises international scientific conferences and provides an international forum for communication among microbiologists. The Society promotes the understanding of microbiology to a diverse range of stakeholders, including policy-makers, students, teachers, journalists and the wider public, through a comprehensive framework of communication activities and resources.

Society of Biology



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 Website: www.societyofbiology.org

The Society of Biology is a single unified voice, representing a diverse membership of individuals, learned societies and other organisations. We are committed to ensuring that we provide Government and other policy makers – including funders of biological education and research – with a distinct point of access to authoritative, independent, and evidence-based opinion, representative of the widest range of bioscience disciplines. Our vision is of a world that understands the true value of biology and how it can contribute to improving life for all.

Society of Maritime Industries



Contact: John Murray
 Society of Maritime Industries
 28-29 Threadneedle Street,
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 E-mail: info@maritimeindustries.org
 Website: www.maritimeindustries.org

The Society of Maritime Industries is the voice of the UK's maritime engineering and business sector promoting and supporting companies which design, build, refit and modernise ships, and supply equipment and services for all types of commercial and naval ships, ports and terminals infrastructure, offshore oil & gas, maritime security & safety, marine science and technology and marine renewable energy.



The Welding Institute

Contact: Chris Eady
 The Welding Institute, Granta Park, Great Abington, Cambridge, CB21 6AL

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 Website: www.twi-global.com

The Welding Institute is the leading institution providing engineering solutions and knowledge transfer in all aspects of manufacturing, fabrication and whole-life integrity management.

Industrial membership provides access to innovative problem-solving from one of the world's foremost independent research and technology organisations.

Non-Corporate services include membership and registration, education, training and certification for internationally recognised professional development and personnel competence assurance.

TWI provides Members and stakeholders with authoritative and impartial expert advice, knowhow and safety assurance through engineering, materials and joining technologies.

SCI



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 Website: www.soci.org

SCI is an inclusive, multi-disciplinary forum connecting scientists and business people to advance the commercial application of chemistry and related sciences for public benefit. SCI is open to all to join and share information, ideas, innovations and research. Members can network with specialists from sectors as diverse as food and bio-renewables, water, waste and environment, energy, materials, manufacturing and health.

STEMNET



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 Website: www.stemnet.org.uk

STEMNET is an independent charity which enables young people to meet inspiring role models, understand real world applications of STEM and experience practical activities that bring learning and career opportunities to life. We do this through three core programmes:

- STEM Ambassadors - We run the UK network of STEM Ambassadors: over 27,000 inspiring volunteers
- STEM Clubs Programme - We provide free, expert advice and support to all schools which have set up or plan to develop a STEM Club
- Schools' STEM Advisory Network (SSAN) - We deliver free impartial advice to teachers and use our business links and partnerships to enhance the STEM curriculum in secondary schools in the UK

Society of Cosmetic Scientists



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 Secretary General
 Society of Cosmetic Scientists
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 Fax: 01582 405217
 E-mail: ifsc.scs@btconnect.com
 Website: www.scs.org.uk

Advancing the science of cosmetics is the primary objective of the SCS. Cosmetic science covers a wide range of disciplines from organic and physical chemistry to biology and photo-biology, dermatology, microbiology, physical sciences and psychology.

Members are scientists and the SCS helps them progress their careers and the science of cosmetics ethically and responsibly. Services include publications, educational courses and scientific meetings.

Universities Federation for Animal Welfare



Contact: Dr Robert Hubrecht
 Chief Executive and Scientific Director
 The Old School, Brewhouse Hill
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 Website: www.ufaw.org.uk
 Registered in England Charity No: 207996

UFAW, the international animal welfare science society, is an independent scientific and educational charity. It works to improve animal lives by:

- supporting animal welfare research
- educating and raising awareness of welfare issues in the UK and overseas
- producing the quarterly scientific journal Animal Welfare and other high-quality publications on animal care and welfare
- providing advice to government departments and other concerned bodies.



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The production of this issue has been supported by contributions from the Institute of Food Science and Technology, the University of Nottingham, the Society of Biology, Brunel University, the New Engineering Foundation and those organisations with entries in the Science Directory (pages 48 to 55).



Andrew Miller MP, Stephen Metcalfe MP and Dr Julian Huppert MP
invite you to attend on behalf of the science and engineering community

Parliamentary Links Day 2014

Science and Public Trust

Tuesday 24 June 2014 10:00 - 13:00
The Attlee Suite Portcullis House
House of Commons London SW1A 0AA

RSVP events@societyofbiology.org



SCIENCE DIARY

THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

Tel: 020 7222 7085
annabel.lloyd@parliament.uk
www.scienceinparliament.org.uk

Tuesday 17 June 16.30
Annual General Meeting

followed at 17.30 by
Did we Realise our Potential?

Thursday 26 June

Why are Chemicals good for you?

Discussion meeting part of a week-long science event at Liverpool John Moores University

Tuesday 15 July 17.30
A Levels

THE ROYAL SOCIETY

Details of all events can be found at royalsociety.org/events

THE ROYAL INSTITUTION

Details of future events can be found at www.rigb.org
Booking is essential. For more information and to book visit www.rigb.org
There is a charge for tickets. Members go free.

ROYAL STATISTICAL SOCIETY

Wednesday 25 June 18.00

2014 Beveridge Lecture Better Informed Policymaking

Rt Hon Peter Riddell CBE, Institute for Government

For details visit:

<http://www.statslife.org.uk/events/events-calendar/icalrepeat.detail/2014/06/25/71/-/2014-beveridge-lecture-peter-riddell-better-informed-policymaking>

Contact: events@rss.org.uk

EPSRC

Tuesday 10 June 19.00
Recognising Inspirational Scientists and Engineers (RISE)

Awards Evening Reception
House of Commons Terrace
Contact: EPSRCRISE@epsrc.ac.uk

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

For details of events organised by POST visit <http://www.parliament.uk/mps-lords-and-offices/offices/bicameral/post/post-events/>

THE INSTITUTION OF MECHANICAL ENGINEERS

For details visit: www.imeche.org/events

THE LINNEAN SOCIETY OF LONDON

For details visit: www.linnean.org

More information on P&SC members' events can be found at: www.scienceinparliament.org.uk/members-news

Published by the Parliamentary and Scientific Committee, 3 Birdcage Walk, London SW1H 9JJ.

Published four times a year. The 2014 subscription rate is £80. Single numbers £20. ISSN 0263-6271

All enquiries, including those from members wishing to take the front or back covers, advertise in the journal or appear in the directory to Mrs Annabel Lloyd, Tel 020 7222 7085

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TEN.