

FUTURE DIRECTIONS IN BBSRC-FUNDED RESEARCH RELATING TO ENVIRONMENTAL CHANGE



Input from the National Oceanography Centre, Southampton.

The National Oceanography Centre, Southampton (NOCS) is a collaborative Centre owned by the *Natural Environment Research Council (NERC)* and the *University of Southampton*. NOCS is based at a purpose-built waterside campus in Southampton, and is home to some 520 research scientists, lecturing support and seagoing staff as well over 700 undergraduate and postgraduate students.

NOCS is the national focus for oceanography in the UK with a remit to achieve scientific excellence in its own right as one of the world's top five oceanographic research institutions. NOCS delivers a diverse mission, which ranges from managing the national research vessel fleet and other major facilities, to programmes of strategic research for NERC, and academic research and education in ocean and earth sciences in support of the University's mission.

NOCS activities encompass major ocean technology development, long-term observations, managing international science programmes, promoting enterprise and knowledge transfer, providing advice to Government, business and charities, and the engagement between science and society. The Centre is specifically charged with working with the wider science community to provide strategic leadership, coordination and facilitation for the whole of the UK marine and related earth sciences.

We welcome the opportunity to contribute to the BBSRC consultation on future directions in BBSRC-funded research relating to Environmental Change. Our scientists were asked to contribute comments, and the following question responses are based on their feedback, particularly that of Dr Chris Hauton.

Consultation questions

Please address as many questions as you wish. Please keep answers as concise as possible.

Q1. In your view, what are the most important **objectives** for BBSRC-funded research in relation to environmental change over the next 10-20 years?

1.1 **Understanding the mechanisms** by which environmental change (anthropogenic and 'natural') will affect the balance between hosts (livestock and marine species of commercial importance) and pathogens, the incidence of new pathogenic infections and the spread of existing diseases.

This would need to be supported by **fundamental research** on the **immune systems** of the species concerned.

Our knowledge of **host/pathogen interactions** is woefully inadequate in some areas.

1.2 Identifying the mechanisms by which the future **acidification of marine environments** will have a toxic effect on marine species, including those of commercial importance. Importantly this should consider not only calcifying species (which have received substantial press) but also species with limited homeostatic ability with respect to acid/base balance.

1.3 As above but incorporating multifactorial understanding of acidification with temperature change

1.4 Integrating these studies at different levels of biological organization and across conventional research council ‘boundaries’.

1.5 Investigating how the production of food for human consumption, including through **aquaculture** will be affected by changing land and sea temperature and acidity.

1.6 Investigating how warming waters may allow for **new marine and freshwater species to be farmed commercially**.

Q2. What are the key **barriers** to meeting the above objectives, and how might they be overcome? In what topics might there be particular skills shortages?

2.1 **Research on marine species**, particularly species of commercial importance, is sometimes seen to **fall between the gaps** of NERC, BBSRC and DEFRA. Support for applied research, of global relevance, in this field lags behind other countries across the EU and the world. There are particular concerns over the need to **fund long-term time series** observations. We do have some excellent facilities for statutory monitoring (e.g. CEFAS Fish Disease Laboratory, Weymouth) but these should be supported by similar investments in research infrastructure to support studies of both the pathogens and their hosts.

2.2 **Co-ordination of research activities relating to acidification needs to be improved** on a national, European and global scale. UK investment in acidification research needs to be integrated into a global effort. This is an important and fast moving area of research which is currently seeing rapid expansion and investment. This is to be applauded but at the same time co-ordination is required to ensure that research is pursued in a strategic manner and to avoid potential for duplication of effort.

2.3 In the marine context, forthcoming developments following from the 2009 Marine Act, and the European Marine Strategy, may result in the closer coordination of many marine related research areas. The European requirement for Member States to be able to demonstrate ‘**Good Environmental Status**’ will be a catalyst for joined-up research related to the health of the marine environment, including fisheries and aquaculture.

2.4 Colleagues consistently say that they are concerned that there is a **shortage of taxonomists**. In general there is a concern about the retention of young, motivated researchers. Post-doctorate scientists leave the sector for longer-term and better-paid work outside of the science and research community.

Q3. What are the main **strengths** and **weaknesses** of BBSRC-funded research in relation to environmental change, and the key current **opportunities** and **threats**?

3.1 Strengths: **Collaboration between institutes** is considered to be more common than in the past. Collaboration should be supported including across academia, government agencies and industry.

3.2 Weaknesses: At our Centre, many staff are **unaware** that there are opportunities to seek BBSRC funding in relation to environmental change, and do not know where to find out further information.

3.3 Opportunities: Public awareness of the issues of climate change is improving. Evidence from the national press suggests that the public perceive issues of environmental change are important now, even in the current economic climate. This support should be exploited to support future funding rounds.

3.4 Threats: i) Cost-cutting in the current economic and political climate. ii) Media-driven ‘public knowledge’ is stifling scientific progress and endeavour in certain quarters. Research in gene manipulation of food crops and species is controversial but we will never be able to reach informed

decisions on its merits or otherwise if we are not able to conduct carefully-controlled and properly regulated experiments. iii) There is still **public distrust of science** and scientists following much publicised issues such as BSE, cloning, and MMR.

Q4. Please comment on the potential priorities for future research (identified from the panel's initial discussions) set out in Annex 3. Please suggest alterations or additions to these priorities if you wish.

A - Understanding and predicting the incidence of diseases and pests - Proposed priorities **1, 2 and 3** (New Theories and models including environmental change data to predict pests, disease impacts on crops; Exploitation of new technology including gene technology; Systems-based approaches) are **strongly supported**.

B – Understanding and predicting the effects of environmental change on crop production/Alerting growers to new opportunities – priorities 4, 5, and 6 – NOCS has no comment on crop-specific research. We would add that NOCS staff, when giving climate/environment change talks to the general public, **often receive questions from farmers and smallholders** who are interested to know how they might **adapt their farming practices or crop choices in a changing environment** – this suggests that the farming community is keen to engage in exploring future options, not least for commercial advantage over competitors who have not adapted so well.

C – Improving agricultural practice and informing land use strategies for the management of multiple ecosystem services – We support 7 (develop strategies to increase carbon sequestration/reduce emissions) but it could **be extended** to include consideration of the potential for **carbon sequestration using micro algae**. There is growing industrial interest in the potential of using iron fertilization of the oceans to increase carbon sequestration from the atmosphere. The mechanisms by which this might operate are poorly understood and research is required to inform this debate. Perhaps as a cross-council theme involving NERC (ties in with 14).

8 (novel pesticides and growth enhancers)– The **aquaculture industry would also welcome work on pesticides** that could target pest species such as sea lice that infect salmon farms.

9 (requirements for test sites)– The establishment of **marine protected areas** and similar offshore conservation zones will provide areas suitable for 'land-use' research.

D – Understanding impacts on biodiversity:

10 (Improved theories of how systems respond to change)– It is important that BBSRC, NERC and Cefas work very closely together on marine biodiversity and aquaculture issues so as to ensure that nothing **'falls between the gaps'**.

E – Understanding impacts on soils – priorities 11, 12 – No NOCS Comment

Section F – **Marine environment. We support 13 (calcification research) but would argue that it is too narrow. It ignores the equally significant problem of acid/base balance in marine organisms**, some of commercial significance. Not all species which are important to marine food webs calcify.

14 (understanding photosynthetic mechanisms, nutrient uptake in picoplankton)– we support.

NOCS fully agrees with the cross-cutting issues that have been identified (a to d – facilities collaboration, interdisciplinary approaches, training and public/stakeholder engagement).

Q5. To what extent, and by what means, should BBSRC-funded research on environmental change be done in collaboration with industry?

NOCS believes that **collaboration with industry is important**, providing a wide range of benefits. These include helping industry to take advantage of the latest research, and our researchers gaining an insight into commercial practices and the need to produce results to short deadlines, and even the

possibility of forming spin-out companies. The BBSRC could strengthen efforts to identify relevant industrial partners on a national and international scale. These industrial partners will help to identify research priorities and may also provide avenues for partial funding. In the marine context, industrial partners such as those in the oil and gas industry also provide a means of access to the deep ocean environment in addition to the access provided by research ships, satellite remote sensing and autonomous vehicles. The SERPENT project is an exemplar of what can be achieved if a visionary approach is adopted. <http://www.serpentproject.com/index.php>

Q6. Should BBSRC focus on science addressing primarily UK-related problems of environmental change, or take a more international perspective and look to the European or worldwide context?

The BBSRC **should have an international perspective**. Many of these issues are of a global nature and we need to ensure that global research is pursued strategically and without overlap. Some projects are best addressed by multiple partners. At the same time researchers in the UK are world leaders in certain fields and their work should be supported for the benefit of people outside the UK.

Q7. How should BBSRC take into account any potential impacts of the research it funds on developing countries?

Developing countries, particularly those with coastal zones, face huge impacts from changing environment, but often lack the expertise and human/resources to identify problems and develop solutions. BBSRC (and the other research councils) should be investing in **capacity-building and technology transfer**, in partnership with the Department for International Development (DfID) and perhaps with the Foreign and Commonwealth Office and EU. There are great potential benefits for developing countries from BBSRC-funded work.

Q8. In considering agricultural systems, what should be the balance between research primarily relevant to local, low-input production and large-scale intensive systems? How might the current debate on long-term issues of livestock production be considered? What about long-term food security vs. energy needs?

If this question is **widened to include aquaculture**, there is much to be gained from research regarding the relative benefits of small scale fish/shellfish farming for the benefit of local communities versus large scale marine operations designed primarily to supply fish for the export markets or city dwellers. Given the need to **supply protein to growing urban populations**, perhaps the emphasis needs to be on the larger scale solutions. **Biofuels derived from marine algae** could be a substantial industry in the future that does not remove food from the human food supply chain.

Q9. What other specific considerations should be taken into account – e.g., potential use of gene technologies to address problems of environmental change, or the possible impact (positive or negative) of research outcomes on animal welfare?

The utilization of gene technologies should definitely be considered for the future. However, they will obviously require rigorous testing. This can only be achieved in a more favourable media/public climate. Perhaps more effort is required in area of ‘public perception of science’. See also our comment about in-vitro meat at Q13.

Q10. On what topics should BBSRC research effort be focused to enable the greatest social, environmental and economic benefits?

Topics relating to the **efficient provision of food** (from whatever source) and the impact of food provision on biodiversity and incidence of disease. Also the use of innovative technologies to allow **food or biofuel production in marginal quality** land (deserts, high salt-content regions, brackish

water). **Bioremediation** of contaminated land or water could also be a field with large economic pay off in the future.

Q11. How should BBSRC encourage consideration of the potential **social impacts** of research relating to environmental change? How should ethical or other social considerations be taken into account in awarding funding?

BBSRC should reflect UK policy on ethical issues, for example by encouraging **technology transfer and capacity building** to developing nations. There should be consideration of animal welfare and the need to address issues such as over-fishing and deforestation. BBSRC is not the appropriate funding body for research into issues such as farmer's income, land ownership, urbanisation etc. – these are well catered for by other bodies.

Q12. BBSRC's current vision is "towards a predictive biology". In the context of climate and other environmental changes, to what extent should BBSRC focus its research capacity on **prediction** of future change?

BBSRC should work closely with NERC and others to ensure that prediction systems are geared towards providing information that is helpful from a BBSRC context, for example to enable predictions of soil moisture, pest migration potential, rainfall, on as regional/local a basis as possible. **Interaction by BBSRC with the well established climate change community is not currently as good as it could be.** In particular there is a great need in many aspects of climate and environmental science for **sustained long-term observations and easy access to data sets.** Funding for these activities is hard to obtain on a consistent, long-term basis, yet these long-term datasets are extraordinarily valuable to researchers.

Prediction (and potential mitigation) are undoubtedly important aspects. However, both areas need to be supported **by fundamental research of the mechanisms involved.** For example we currently know so **little about certain host/pathogen interactions** (especially within the marine environment) that it would be impossible to make robust predictions as to the effects of any particular environmental change.

We would like to add that there is also scope to link into the work of ERFF's new **Environmental Observations Framework.**

Q13. Please provide **any further comments** on any issues that are relevant to the review.

In view of the need to supply protein to growing urban populations, balanced with possible shortages of land, water and feedstock might BBSRC devote research resources to **in-vitro meat production**? Fish or animal flesh might be more efficiently produced, with less vulnerability to a changing environment, in an industrial setting. Advances in gene technology and the controlled growth of muscle fibres without the rest of the animal offer huge potential for intensive food provision without the ethical issues of animal welfare, and avoiding the damage being done to the environment by over-fishing, deforestation to provide ranch land, and animal methane production.

In terms of BBSRC and NERC collaboration, we would support close **links between BBSRC and the NERC next generation strategy**, in particular by ensuring that the **NERC theme leaders are engaged with BBSRC colleagues.** We would also add that we understand that NERC is considering an ocean acidification programme, an area where there is great scope for engagement with BBSRC.

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