NERC Environmental 'Omics Strategy Final Report and Recommendations October 2010

SHORTENED VERSION

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1 EXECUTIVE SUMMARY

It is recognised that there is an overriding need to develop a NERC 'omics strategy that is both scalable and responsive to changes in technology and user demands to deliver world class environmental science with impact. The strategy should:

- ***support and develop core facilities, services and competencies in 'omics to provide a sustainable long-term National Capability (Recommendation 1);***
- ***recognise the on-going need to integrate, coordinate and prioritise the complex pattern of investments as well as manage the interface with other funders, in a cost-effective way that maintains the key link between environmental scientists from across the NERC remit and access to technologies (Recommendation 2);***
- ***support strategic Research Programme investment in 'omics to address emerging challenges that deliver against NERC's Strategy (Recommendation 3).***

Priorities for implementation:

- ***secure support for continuing function of NBAF and restore NEBC support to previous levels (Recommendation 1A & B);***
- ***establish a virtual Environmental 'Omics Synthesis Centre (EOS) in order to coordinate, integrate and prioritise future investment (Recommendation 2A-C);***
- ***identify priorities for strategic research and for additional investment in core facilities, services and competencies (Recommendation 1C).***

The recent development of 'omics technologies including genomic, transcriptomic, proteomic, and metabolomic approaches, has provided us with the ability to characterise on a molecular level critical details of how organisms and communities respond to and interact with the environment. Such understanding is essential to meet the challenges of environmental change, reducing uncertainty and safeguarding sustainability, roles central to the NERC Strategy "Next Generation Science for Planet Earth"[1]. 'Omics approaches are therefore a critical set of enabling technologies and skills for the delivery of NERC science.

Previous NERC investments through the Environmental Genomics[2] (EG) and Post Genomics and Proteomics[3] (PGP) programmes have developed capacity and resulted in an informed internationally competitive environmental 'omics community. NERC has ensured community access to a growing array of 'omics technologies by investment in facilities and key skills through the NERC Environmental Bioinformatics Centre[4] (NEBC) and NERC Biomolecular Analysis Facility[5] (NBAF). These investments should be capitalised on (Recommendation 3A).

Strategic thematic research investment resulted in an initial significant increase in 'omics based Responsive Mode (RM) funded science. Following the impetus created by this targeted investment, there is some evidence of a recent levelling-off for the uptake on 'omics approaches in RM. In direct contrast, evidence from the over-subscription of NBAF pilot projects, saturation of established and new NBAF nodes, together with community feedback, has identified both un-tapped application areas and novel opportunities for 'omics to deliver against NERCs remit. Notably some areas of NERC science which would most benefited from 'omics approaches include those where UK scientists are recognised international leaders, such as polar and climate science. Future strategic research investment should support 'omics approaches in these areas (Recommendations 1D, 2A, 3B, 3C & 3E).

In order to maximise the opportunities offered by 'omics approaches, a coherent strategy is required that is continually responsive to changes in user demand and emergent technologies, exploiting fully the unique strength of NERC, namely the breadth of its science portfolio together with the skill base, quality and commitment of the science community it supports (Recommendation 2). NERC needs to fully integrate 'omics approaches at both the laboratory and PI levels (Recommendation 1D). The foundation for continued success in exploiting 'omics is the

[1] http://www.nerc.ac.uk/about/strategy/ngscience.asp
[2] http://www.nerc.ac.uk/research/programmes/genomics/
[3] http://www.nerc.ac.uk/research/programmes/proteomics/
[4] http://nebc.nerc.ac.uk/
[5] http://www.nerc.ac.uk/research/sites/facilities/details/mgf.asp

sustained development of key National Capability (Recommendation 1) as well as strategic Research Programmes that focus advances onto NERC Strategy (Recommendation 3).

The delivery of National Capability through the distributed structure of NBAF, with infrastructure embedded within domain-specific research groups, has been particularly effective in improving the uptake of ‘omics approaches by NERC scientists, incorporating new technical advances and responding to community demands. Its success is reflected in the steady rise of Responsive Mode projects supported, most notably during the periods of EG/PGP investment, the continued demand for access associated with graduate training and high level of community support received in the Service Review Group assessment (2010). The continued provision of leading edge 'omics facilities to meet NERC’s specific needs is essential to maintain the effectiveness of UK environmental science (Recommendations 1A & 1C).

The growing and critical role played by informatics in processing, interpretation and integration of ‘omics data was recognised in the RCUK Large Facilities Roadmap which highlighted the need for substantive informatics infrastructure to support environmental ‘omics science, proposing a £30M investment to establish an “Environmental Omics Bioinformatics Facility”. Although, the need for this level of investment is required to support the environmental ‘omics community it was concluded that a more cost effective and efficient model of delivery could be achieved through embedding core skills within the community, supported by a number of informatic knowledge hubs. In this context, particular concern was raised as to the current temporary nature of NEBC support, and provision for long term support should be addressed as a matter of priority (Recommendations 1B & 1C).

Cost effective delivery of NERC science may also, in part, be achieved by strategically tensioning its investments with other funders at a national and international level. NERC should, where appropriate, align support for ‘omics to benefit from the significant investments made by others. (Recommendations 2C & 3D). For example, the two NBAF Next Generation Sequencing (NGS) nodes are co-located with the recently established regional MRC NGS nodes, with both organisations benefiting from synergies in tools and expertise. Other significant investments, such as BBSRC’s Genome Analysis Centre, are focused on a discrete suite of model organisms and, as with the expanding commercial sector, do not provide the diversity of domain-specific expertise required by NERC community, highlighting the need for NERC to maintain and develop capability and capacity to meet its own specific requirements.

Similarly NERC must seek to leverage its investments in ‘omics with international initiatives such as ELIXIR (Recommendation 2C). This EU programme is an emerging bioinformatics infrastructure comprising a trans-European “hub and node” network structure that identifies the environment as one of its core areas. However ELIXIR provides no direct funding to support environment-based informatics. Instead, it relies on the establishment of independently funded national “nodes” that represent specific communities. This highlights the need for NERC to maintain its own ‘omics community, providing a strong, coordinated voice to enable it to play a leading role in such international initiatives.

The complex array of functions required to support ‘omics science requires overarching strategic coordination and integration to ensure effective delivery of NERC science (Recommendation 2). The speed of technical advance and the multifaceted nature of ‘omics has limited the level of detail this review has been able to deliver in some areas. The pace of change means that any ‘omics strategy must constantly evolve, refresh in response to user demands and rapid technological development. To ensure that the UK community can provide leadership, there needs to be a vehicle for proactive horizon scanning exploiting teams with the appropriate interdisciplinary expertise to identify emerging strategic research opportunities, and coordinate the development of novel applications where ‘omics has the potential to contribute but is presently under-utilised. Thus, NERC needs to develop mechanisms to apply our current collective knowledge to embed and coordinate ‘omics strategy within the wider NERC community. This should also provide the necessary leadership and directed scientific input to emerging business sectors, including the emerging industry in environmental technologies and services.

In making its recommendations, this review has recognised that there is an overriding need to develop a strategy that is cost effective, scalable, and responsive to changes in technology and user demands. The recommendations have therefore focussed on the immediate key strategic requirements, setting the overall direction of travel. Where further work is required (e.g. in identifying specific priorities for research) this is indicated.

2 SUMMARY OF CONCLUSIONS

3 RECOMMENDATIONS

This report identifies key areas the strategy should support and the priorities for implementation.

3.1.1 Recommendation 1: National Capability: Core facilities, services and competencies

Ongoing provision of core infrastructure is the minimum requirement to ensure 'omics approaches are accessible for grass roots science delivery. This requires support and development of core facilities, services and competencies in 'omics in order to respond to changes in user demand and emergent technologies. In particular, this review recommends the following.

A. The existing functions and services currently provided to a very high standard by the NBAF model should be maintained, with services distributed and embedded within key user communities. This "distributed model" provides a cost-effective mechanism for the delivery of key facilities, services and skills to the NERC community, capable of responding to changes in user demand and technology development. It is further recommended that more detailed evaluation of the need for NBAF to incorporate new 'omics platforms (including in proteomics and lipidomics) be carried out. This could be part of the role of the proposed Environmental 'Omics Synthesis centre (Recommendation 3).

B. -The current transitional support for NEBC—provided to maintain function in bioinformatics and data management, archival and standards—should be placed on a longer term, sustainable basis, initially at levels comparable to those provided under the previous EG/PGP programmes. This would enable NEBC's development in response to future challenges, including the development of new tools and increased data volumes. As with NBAF, the proposed Environmental 'Omics Synthesis centre could play a key role in identifying future requirements for bioinformatics and data management.

C. The review of future requirements for core facilities and services should be an on-going process, responsive to changes in demand and technology. It should also consider how best to support such capabilities in the long-term, ensuring a funding model that addresses issues of both sustainability and cost-effectiveness.

D. Investment in training, in both laboratory skills and informatics, should be increased to assist researchers at all levels of career development, including support for PhD access to 'omics facilities and the delivery of awareness and training courses to promote the understanding and uptake of 'omics approaches, respectively, across the environmental science community.

The continued support of all NBAF nodes at their current level of funding over the next five years would require £6.5M, this is required to satisfy current research demand and is unanimously supported by the community. Additional resource to support the development of environmental proteomics and lipidomics, over a 5 year period, is estimated at £2.6M. Additional resource for increased bioinformatics and biostatistics support and maintenance and enhancement of other national data management activities at NEBC (to equivalent levels previously supported under EG/PGP) is estimated to cost a total of £5M over the same period. Support is also needed for PhD student access to 'omics facilities, coupled with directed specialist training courses, estimated at £1.5M over 5 years. Additionally, ~£2.5M made available to support ongoing technical development of the facilities. Total costs over a 5 year period: £18M (£3.6M/yr).

3.1.2 Recommendation 2: Integration and prioritisation: Coordination, delivery and management

Given the rapidly changing and evolving technological background, there is a critical need to ensure that the scientific capabilities are fully realised. In other words, development of scientific priorities needs to keep pace with evolving technologies in terms of novel approaches and new problems that can be addressed. Moreover, there is an on-going need to integrate, coordinate and prioritise the complex pattern of investments in 'omics as well as to manage the interface with other funders, in a cost-effective way that maintains the key link between environmental scientists from across the NERC remit. It is proposed that integration activities should provide overall community coordination, prioritisation and integration of 'omics investments in a way that can respond to changes in user demand and technology development. It is recommended that there should be:

A. a strong coherent voice for environmental 'omics, promoting uptake of these approaches across the NERC remit;
B. a coordination of existing and future activities, including horizon scanning research and technology drivers, identification of skills and training needs, and prioritisation of future needs, including on-going advice to NERC on investment in research and facilities that is flexible, scalable and responds to changes in user needs and emerging technologies;
C. development of a unified interface and strategy to engage and influence key national and international partners and stakeholders including Research Councils, Charitable Trusts, industry (e.g. Sanger, BGI), EU (e.g. ELIXIR) to help maximise the impact of NERC investment in 'omics.

It is recommended that these functions are best delivered through the establishment of a virtual Environmental 'Omics Synthesis (EOS) centre whose primary role is to coordination and integrate existing investment, provide advice to NERC on how 'omics could deliver against strategic science challenges, act as an interface with national and international partners and promote stakeholder engagement. Examples of where EOS may contribute immediately would be to act to evaluate the requirement of new NBAF nodes or to provide a liaison point for dialogue with ELIXIR. A modest investment in an EOS has the potential to leverage substantial funding from NERC Research Programmes. The estimated costs of an EOS would total £2M over five years.

3.1.3 Recommendation 3: Research Programmes and Responsive Mode: Science delivery

There is a continuing need for NERC to support research investments in 'omics that deliver NERC's Strategy (RP) and:

A. build on previous strategic investment to maintain and develop core capability and capacity in 'omics within the NERC research community (RP);
B. provide targeted support to foster 'omics development in areas where NERC sciences has demonstrated international leadership and which may yield particular benefit from exploitation of 'omics approaches (RP);
C. encourage diversification in the application of 'omics together with support for novel technical innovations (RP/NC);
D. promote, where appropriate, partnerships with other national and international funders in joint programmes (RP);
E. further embed 'omics across the full NERC remit ensuring future sustainability (RM).

Where appropriate, the proposed virtual Environmental 'Omics Synthesis (EOS) centre (1.1.2) should provide advice to NERC on priorities for investment. However establishment of EOS should not preclude or delay early investment in key areas identified in this report.

To deliver these recommendations it may be envisaged to invest in, over a 5 year period, three medium sized coordinated strategic Research Programmes at ~£5M each, which should also encourage collaboration with key external partners; an annual pilot project scheme, modelled on the current NBAF NGS small project initiative but applied to all NBAF nodes, at £0.4M pa to encourage novel technical innovation of 'omics approaches. Total cost over 5 year period: £17M.

3.2 Priorities for implementation:

First, NERC needs to maintain National Capability investment in facilities support to NBAF and restore NEBC to previous levels funded through EG/PGP. Secondly, in order to realise the full potential of integration of 'omics technologies into environmental science, investment in novel mechanisms for scientific synthesis and integration at a community level should be developed. Finally, NERC should explore opportunities for strategic investment in 'omics research.