BBSRC People and Skills Expert Working Group

Report and Conclusions

Executive Summary

1. In response to discussions at the BBSRC Exploiting New Ways of Working and Bioscience Skills and Careers Strategy Advisory Panels, BBSRC convened an Expert Working Group to consider issues related to People and Skills relevant to the Exploiting New Ways of Working Enabling Theme. The Expert Working Group considered background information and discussion topics provided in previous working groups, as evidence for some of the issues raised, and conducted a community survey.

Conclusion 1: Applied skills, such as statistics, to plan statistically rigorous experiments, and skills in computational tools, to modify tools and use custom tools and platforms, are particularly important.

Conclusion 2: There is a perception that technology and instrumentation specialists within the biological sciences have to fulfil extra criteria, as both experts and leaders in their own field, and also being able to demonstrate their application on a leading biological problem. This can be exacerbated by the difficulty in recording scientific outputs, such as continuing innovation in software, technology or instrumentation, with conventional markers of esteem such as publications in high impact journals. Provision of equipment funding without resource to support trained staff remains a point of concern. As in all disciplines, the transition from postdoctoral level to academic positions is difficult.

Conclusion 3: Fellowships can be a route from postdoctoral to research leader positions, but the low numbers of fellowship awards risks failing to take full advantage of the available talent pool, and, in terms of numbers supported, represents a poor return on investment. The high value of the award makes the transition from postdoctoral researcher to David Philips Fellow exaggerates an already significant step.

Conclusion 4: The UK has a strong base to build on, with provision of e-Learning through the DTP programme a positive step. It is, however, difficult for researchers to be able to reach outside of their own discipline to access skills and training. Without exposure to multidisciplinary skills in mathematical and computational topics, biological research teams may be increasingly reliant on researchers with skill sets from outside the biological sciences, and outside the UK. The decline in funding for MSc programmes has weakened a route for 'discipline-hopping' and advanced specialist training. Exposing students to SySMIC[1] may have positive consequences beyond the skills learnt by exposing students to self-directed online learning.

Conclusion 5: A series of approaches are available to deliver training. A number of the strategically important skills discussed as part of the ENWW enabling theme are particularly suited to delivery, in whole or part, via e-Learning approaches. SySMIC has been a successful example of this approach.

Conclusion 6: The success of training is strongly influenced by when it is applied, or whether learners have access to training materials when they apply their learning. Similarly, motivation will be driven by immediate need. Researchers need to be able to select from a range of topics and approaches and apply them when needed. Information about length, quality, topics and difficulty is also important.

[1] http://sysmic.ac.uk/home.html

Conclusion 7: The survey information provided valuable background evidence on the skill levels of both postgraduate and postdoctoral researchers. A refined version of the survey, produced for the postdoctoral researchers, will be a useful tool for monitoring progress of any implementation of findings from the Expert Working Group.

Conclusion 8: Networks for postgraduate students may make a valuable contribution to raising awareness of training opportunities and disseminating information.

Recommendation 1: Researchers skills need to be increased for all career stages in the following areas; basic skills in scripting, coding and bioinformatics. Applied skills in mathematical modelling, applied statistics (experimental design) and data management, including data visualisation are required by all researchers and should be the focus of efforts.

Recommendation 2: BBSRC should pay close attention to the career transition from postgraduate researcher to research leader for researchers working in ENWW topics, in particular instrumentation/technology specialists, and should establish whether the evidence for difficulties in career transition match the perception and should seek to support them where possible.

Recommendation 3: The numbers of fellowships for technical and instrumentation specialists should be examined, and BBSRC should consider whether there are particular risks in the numbers and value of fellowships awarded[2].

Recommendation 4: BBSRC should consider how to increase awareness of and availability to different mechanisms of training in ENWW topics. E-approaches are particularly suited to ENWW topics. Researchers need the ability to be able to access the training that they require and apply it when needed. A mechanism to support course catalogues and information regarding course quality, and where appropriate, accreditation would support researcher decisions.

Recommendation 5: BBSRC should consider clarifying guidance to ensure researchers consider providing adequate provision for training in grant proposals.

Recommendation 6: The surveys should be followed up and continued with a view to monitoring progress in key areas. The surveys can be tailored to track progress in, and use of particular courses or mechanisms.

[2] Since the report was completed, review of BBSRC strategy for investing in fellowships has concluded, see http://www.bbsrc.ac.uk/about/policies/reviews/consultations/1503-review-investing-in-fellowships/

General Context

1. BBSRC has a role in supporting researchers at all stages of the research careers 'pipeline', including researchers who move into a role outside academia. The Bioscience Skills and Careers Strategy Advisory Panel provides advice to BBSRC on all aspects of this pipeline, and in doing so has developed a Research Careers Framework (**Annex 1**) to help illustrate different elements of a research career and associated skills provision. It may be useful in considering BBSRC strategy for support of ENWW skills.

2. The Exploiting New Ways of Working (ENWW) Strategy Advisory Panel provides advice to BBSRC on issues relating to the Exploiting New Ways of Working Strategic Priority. ENWW covers cross-cutting science areas such as synthetic biology, bioinformatics, computational biology, instrumentation, technology development and systems biology[3].

Bioscience Context

3. There have been a number of reports on scientific disciplines and applications within the purview of the ENWW Strategy Advisory Panel over the past five years. The issue around the provision of skills and career structures has been identified in many of these reports.

4. For example, skills and careers issues in e-Science and computational biology were highlighted in two reports on e–Infrastructure, for BIS in 'A Strategic Vision for UK e-Infrastructure[4]' and in the RCUK Review of e-Science[5]. In biological sciences, the need for skills in this area was highlighted in the BBSRC Review of the Computational Requirements of the Biological Sciences[6].

5. Mechanisms for skills underpinning technology development and instrument operation have been discussed. ERA-Instruments (the ERA-net in Instrumentation) considered skills provision as a component of instrumentation facilities, where they can be embedded alongside provision of services. Current large-scale European projects in instrumentation and technology in the life sciences consider training elements[7] as an important part of their projects. Training for many of these disciplines, including bioimaging and 'omic technologies, will require skills in both instrumentation and also in data handling[8].

General Training Opportunities

6. BBSRC has been heavily involved in supporting ELIXIR, the European data and bioinformatics project. ELIXIR is an inter-governmental organisation, which builds on existing data resources and services within Europe. It follows a hub-and-nodes model, with a single Hub located in a new building alongside EMBL-EBI in Hinxton, Cambridge, UK and a growing number of Nodes located at centres of excellence throughout Europe.

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[3] http://bbsrc.ac.uk/research/new-ways-of-working.aspx
[4] http://www.bis.gov.uk/assets/biscore/science/docs/s/12-517-strategic-vision-for-uk-e-infrastructure.pdf
[5] http://www.epsrc.ac.uk/newsevents/pubs/rcuk-review-of-e-science-2009-building-a-uk-foundation-for-the-transformative-enhancement-of-research-and-innovation/
[6] [Reference/webpage no longer available – May 2016]
[7] E.g. EuroBioImaging http://www.eurobioimaging.eu/content-page/wp13-training
[8] http://www.era-instruments.eu/downloads/final_report.pdf

7. The UK ELIXIR node will focus on training. This is intended to be delivered in specialised centres, in courses, and through e-Learning, in partnership with other ELIXIR Nodes and agencies. ELIXIR-UK will initially train postgraduate, postdoctoral and mid-career scientists, and will focus on the research-intensive bioscience and environment industries.

8. The Genome Analysis Centre (TGAC - a BBSRC strategically-funded Institute) also has a role in training, and is developing strategy in this area.

9. The Global Organisation for Bioinformatics Learning, Education and Training (GOBLET) is a foundation which aims to provide a global education and support network for both students/trainees and trainers in bioinformatics. GOBLET intends to bring together bioinformatics trainers and trainees from across the globe.

10. GOBLET provides a website[9], which includes a training portal with links to training materials in bioinformatics. GOBLET also aims to facilitate capacity building in bioinformatics across the world, and to develop standards and guidelines for bioinformatics training.

11. The Software Sustainability Institute (SSI) is an EPSRC[10]-funded project based at the universities of Edinburgh, Manchester, Oxford and Southampton that works with researchers across all RCUK disciplines. The project is based around four themes, of skills and training, recognition and reward, career paths, and reproducible research.

12. As well as workshops and guidance on training materials, the SSI also operates training courses (Software Carpentry). Software Carpentry[11] is a collaboration to teach researchers software development, via training courses. These training courses, termed 'boot camps' are interactive, two-day workshops which give researchers basic training in software development skills.

13. Horizon 2020 has proposed activities aimed at the development of computational skills. For example, under the European research infrastructures (including e-Infrastructures) workprogramme, INFRASUPP-4-2015 –New professions and skills for e-infrastructures, aims to define university curricula, develop and execute training programmes, support professional development and support networking activities.

14. The European Medicines Research Training Network[12] (EMTRAIN) is a project funded via FP7. The project seeks to establish a pan-European platform for education and training covering the whole lifecycle of medicines from basic research through clinical development to pharmaco-vigilance. The consortium consists of six pan-European biomedical research infrastructures from the ESFRI roadmap. EMTRAIN contains workpackages that look at both Masters and PhD training, as well as continuing professional development.

e-Learning

15. At its broadest e-Learning has been defined by researchers at EMBL-EBI as the "delivery of education though electronic media"[13]. More specifically it can be defined as "the current

[9] www.mygoblet.org
[10] At the time of discussion – the latest renewal has co-funding from BBSRC and ESRC
[11] http://www.software-carpentry.org/
[12] http://www.emtrain.eu/index.php/about
[13] Wright *el al*. *Brief Bioinform*. 2010 , 11, 552-62

technological solution to the problem of finding the best match between the needs of a given set of learners to a given content, using a given set of learning tools"[14]. These definitions include both synchronous methods where training activities are simultaneously delivered to other locations (e.g. through tele- or web conferencing) and asynchronous programmes where trainees can access training material and interact with each other online at their own pace. The use of "blended courses" can allow the combination of face to face interactions at teaching institutions with asynchronous learning through the provision of training material on an e-Learning platform.

16. A challenge associated with e-Learning courses is ensuring the teaching materials are of good quality. Achieving this can be problematic due to a lack of recognition for trainers and the time involved in creating content for good quality teaching; it is estimated that eight hours is required to plan one hour of good teaching material[15].

17. Those providing training may be from a technical rather than a communications background and this can also create problems for effective teaching[16]. Furthermore, although trainers may have technical knowledge, they lack formal training themselves and so again may be unaware of the best mechanisms by which to teach their material. This has been noted in bioinformatics[17]. With the increasing demand for training, there is also therefore a need to train the trainers so that they are expert in both the science and methods they are teaching and the communication skills required to pass on this information effectively. One of the GOBLET network's aims is to hold activities that address the quality of training, training resources and trainers.

18. A further challenge faced by those wishing to sign up for e-Learning courses is in finding those courses that are most relevant and judging the quality of the course. A lack of awareness from trainers can also result in a duplication of effort, with different online courses covering the same material. The SSI has suggested that one way to address these problems is the creation of a central training portal where trainers can list their courses, and participants can leave reviews of those they have taken part in[18]. A pilot of this portal has been developed by STFC[19].

MOOCs

19. Asynchronous e-Learning includes massive open online courses (MOOCs). These allow trainers to train large numbers of geographically dispersed trainees at times that are most convenient for the training to be undertaken. Such courses could therefore be used to efficiently train large numbers of researchers in skills such as bioinformatics.

20. Provision of training through MOOCs has become more popular as large Higher Education Institutes have provided an increasing variety of free courses. These take place through the provision of online video lectures, activities, tests and platforms to interact with other participants. Courses normally run for cohorts of students over a set time, with tests taking place periodically. These types of highly centralized MOOCs have been called xMOOCs and can be contrasted to "connectivist" cMOOCs which are not typically sponsored or run by

[14] Cohen & Nycz. *J E-Learning & Learning Objects*. 2006, 2, 23-34
[15] Outcomes from the workshop for e-Infrastructure trainers, Software Sustainability Institute, 2013 Cohen
[16] & Nycz. *J E-Learning & Learning Objects*. 2006, 2, 23-34
[17] Schneider *et al*. *Brief Bioinfom*. 2010, 11, 544-51
[18] Outcomes from the workshop for e-Infrastructure trainers, Software Sustainability Institute, 2013
[19] [Reference/webpage no longer available – December 2016]

Higher Education Institutes but rather tend to be organised by large groups of individuals getting together to study a particular topic at their own pace[20].

21. Taking part in the course content of MOOCs is frequently free of charge, but xMOOCs may charge fees for taking exams and gaining certification. The major providers of xMOOCs are Universities who offer their courses through an organisation that provides a common platform for course delivery. Based in the USA the major platforms are Coursera (www.coursera.org) that was established by academics from Stanford University and has around 9.5 million users[21], the not for profit EdX (www.edx.org) that was established by MIT and Harvard University, and Udacity (www.udacity.com) which features courses from the University of Virginia and San Jose State University. In the UK, FutureLearn (www.futurelearn.com) has recently been established by the Open University and features courses from Universities around the world including Bristol University, the University of Nottingham and Monash University.

22. Common to most MOOCs is a high number of registered trainees and a high dropout rate; courses have an overall completion rate of less than 7% with the most completed courses having a completion rate of 19%[22]. However, this low completion rate is often not viewed as a failure by course providers, who point to the fact that many who sign up do so only to find out the basics of a subject and never intend to complete the course. The completion rate of those registrants who go on to show an active interest in the course, e.g. through completion of a first work assignment or payment of an examination fee have been found to increase to around 45% and 70% respectively[23].

BBSRC Support for e-Learning

23. To further the skills and training remit towards the utilisation of systems approaches to biology in particular, the Integrative and Systems Biology Strategy Panel, working together with the Bioscience Skills and Careers Strategy Panel, selected development of a custom web-based resource package as a key mechanism to expand mathematical skills across the UK bioscience community.

24. This package was solicited via an open call for applications to an initiative titled ‘e-Learning for System Biology’. The closing date for this call was in March 2010, and the fund had a value of £1m.

25. The call requested that:

- Courses should be developed that comprise at least 3 modules to enable training to be provided at different levels to researchers:

- Basic mathematics suitable for systems biology.
- Introductory/ basic module in systems biology.
- Intermediate / advanced module in systems biology.

[20] http://moocnewsandreviews.com/ultimate-guide-to-xmoocs-and-cmoocso/
[21] Kellog. *Nature*. 2013, 499, 369-71.
[22] Parr. *Times Higher Education*. 2013. 9 May.
[23] Kolowich. *The Chronicle of Higher Education*. 2013. 8 April.

The call text for eLSA, including timescales, is included as **ANNEX 2.**

26. The successful project (SySMIC) was led by Professor Geraint Thomas at University College London, with Edinburgh, Birkbeck College and the Open University acting as project partners, and is titled SySMIC. http://SySMIC.ac.uk/home.html . The initial phase of funding will run up to 2017, with the project expected to transition to becoming self-supporting thereafter.

27. The course was adopted as a mechanism for delivering training in mathematical and systems approaches to the BBSRC Doctoral Training Partnerships[24]. The course is based on core skills, and focuses initially on use of the software packages R and Matlab. While R is free open source software, Matlab is distributed by Mathworks, and attracts a license fee. This is supported for students registered as being funded by BBSRC.

28. BBSRC has currently funded 1250 free SySMIC places over four years for BBSRC-supported researchers. Not all BBSRC Doctoral Training Partnerships (DTPs) utilise SySMIC, but completion of at least the first module of SySMIC is compulsory for students in those DTPs that do. These students are currently being given priority for the course.

29. Demand for the course has been higher than anticipated with students and postdoctoral researchers from outside the DTP system requesting to join. As the model for SySMIC clearly signposts that the project should move towards becoming self-supporting, the project leaders have been actively soliciting interest from other research councils and industry.

30. SySMIC e-Learning activities can also be supported through BBSRC's Modular Training Partnership (MTP) scheme. MTP funding can be used to pump-prime the development of new training modules for industrially-relevant short training courses at Masters level. The courses need to be developed in close collaboration with industry to ensure the content meets industrial training needs. The courses can be delivered through a variety of mechanisms, including using e-Learning techniques to deliver courses remotely.

Initiation of the Expert Working Group

31. Issues related to People and Skills in ENWW topics were discussed at the December 2012 Exploiting New Ways of Working Strategy Advisory Panel Meeting. The Strategy Advisory Panel commented:

- There remains a clear need to address the skills requirements of bioscience researchers at all levels as they relate to computational and bioinformatics skills.
- There is a clear need for skills in this area, particularly in distributed computing, statistical analyses, optimization, machine learning, information retrieval, algorithms and data structure and visualization.
- However, more traditional laboratory skills e.g. building small pieces of laboratory apparatus and experimental set-ups, synthetic chemistry, were also needed.
- There is a large focus on multidisciplinarity and on particular thematic areas, but this should not undermine support for 'conventional' experts The focus in all cases should be on problem-solving skills

[24] http://www.bbsrc.ac.uk/funding/studentships/doctoral-training-partnerships.aspx

- A prescriptive approach might be possible across all the DTPs but it was noted the DTPs themselves cover different strategic areas (e.g. food security versus molecular biology) so this may not be appropriate, noting also the many different post-PhD career paths.
- The Panel questioned whether skills provision was too focused on postgraduate training rather than continuing professional development of the existing workforce (PDRAs and also academics). There is potential to use DTP training materials here, and for DTPs to work together to exchange training materials.
- The move towards an era of data intensive bioscience means that biologists must be able to use informatics tools competently, not just a need to develop developers. There is potential to use online tools to help the DTPs enable each other. This is also applicable to PDRA training/ CPD.
- The Panel supported the establishment of an Expert Working Group for ENWW people and skills.

32. The Bioscience Skills and Careers Strategy Advisory Panel concurred with these conclusions. Following this meeting, the process of initiating an Expert Working Group was started. Professor Julian Dow (University of Glasgow) agreed to act as Chair. Professor Dow is a current member of the Exploiting New Ways of Working SAP and provided the necessary continuity with the ENWW SAP. Professor Richard Reece (University of Manchester) was nominated by the Bioscience Skills and Careers Strategy Advisory Panel as their representative.

33. After selecting the Chair, the remaining Expert Working Group members were selected to provide a balance of representation of strategic areas, plus expertise in provision of training.

Expert Working Group Membership and Scope

34. The membership and scope of the Working Group is included as **ANNEX 3.**

Framework for Discussion

35. The Expert Working Group was invited to consider all aspects of people and skills as they relate to the Exploiting New Ways of Working Strategy. This enabling theme includes technology development and instrumentation; synthetic biology; data-driven biology; computational biology and bioinformatics; genomics; and systems biology *inter alia*.

36. The Expert Working Group was provided with a number of pieces of evidence and relevant reports; or extracts of reports.

37. These included; relevant extracts from the BBSRC Review of the Computational Requirements of the Biological Sciences, the BBSRC Strategy for Software as an Infrastructure, comments on training from the BBSRC Expert Working Group on Digital Organisms, ERA-Instruments report on the needs of young scientists, and the report from ELIXIR on training in bioinformatics.

Consultations

38. One of the areas in scope for the Expert Working Group was to "Identify any gaps in understanding and advise on what further evidence is required in order to make informed strategic decisions". A second area of the scope to "Consider the current evidence for people and skills issues and identify whether there are any particular areas on which BBSRC should focus its efforts, particularly in relation to science topics; and advise BBSRC on whether there should be a focus at any particular career stage". At their first meeting, in order to address the areas of the scope, the EWG requested that BBSRC initiate a community consultation to solicit information from students currently studying at their Doctoral Training Centres.

39. The survey was intended to evaluate the level of bioinformatics, mathematics and statistics knowledge and skills within the BBSRC postgraduate community.

40. In developing the survey, all members of the Expert Working Group were consulted for their input. The subject classifications used in this survey were taken from the Joint Academic Coding System (JACS)[25] for consistency of approach across other surveys of the academic community. It was noted that the current primary JACs classifications were not splitting evenly across the remit of BBSRC, hence the second survey additional fields were added that were absent from the primary JACs list: 'Bioinformatics' and Plant Biology.

41. To disseminate the survey, the questionnaire was created in SurveyMonkey and sent out directly to the PhD students funded by BBSRC. In total, this survey reached 1,279 students and received 277 responses, giving a response rate of 22%. All responses were anonymised.

42. At their second meeting, the EWG requested a second survey to solicit information from postdoctoral researchers. After discussion of the postgraduate survey results, the EWG agreed

[25][Reference/webpage no longer available – September 2016]

on a modified survey that was intended to garner information both on researchers' self-identified ability in particular areas, as well as their perceived need for those skills.

Expert Working Group Scope

Scope Item 1. Consider the current evidence for people and skills issues and identify whether there are any particular areas on which BBSRC should focus its efforts, particularly in relation to science topics.

43. This topic covers the EWG discussions concerning whether there are particular areas relating to people and skills in the ENWW remit to which efforts should be particularly directed. The EWG requested two consultations (described in paragraphs 41-45) that provided evidence for the needs of researchers.

44. The surveys focussed on computational, mathematical and statistical skills, as other skills within the ENWW underpinning theme (such as genomics, synthetic biology or technology development) could be provided through research-specific training.

45. The consultation requested respondents to rate their own abilities in different categories on scales of 1-5. The first survey was distributed to PhD students, and a second, refined version to postdoctoral researchers. Refinements included giving benchmarking examples to the scale to encourage consistency, and a second set of questions where respondents were asked both ability and perceived need. The limitations of the surveys are inherent to self-reporting. Firstly, respondents with a lack of knowledge or training in the area tend to be less able to report accurately on their ability in that topic. Similarly, respondents with little knowledge or training in an area are less able to gauge the utility of those topics to their own research.

46. With those caveats, self-reported skills in scripting, modelling and coding were low. As a general rule, an acceptable level in most topics would be for the majority of respondents to report their ability at the mid-point of the scale, i.e. a ‘3’. The ability to apply knowledge is as important as having the knowledge in the first place. For example, the ability to customise tools was considered more important and urgent than improving the absolute knowledge of computational approaches. Non-commercial custom designed platforms to enable automated data acquisition (such as LabView or MicroManager) also require some technical knowledge and understanding of workflows. Similarly, while some ability in statistics was considered to be a necessity, researchers must be able to apply this to plan and execute statistically rigorous experiments.

47. In comparing the self-reported abilities with reported years of postdoctoral experience, there was no major difference apparent between more postdoctoral experience and increased skill levels. It can be inferred that postdoctoral researchers were not acquiring these skills with experience, instead utilising skills that they already had. There is some evidence that skilled individual are also leaving the field. This implies a requirement for training courses in the basic ENWW skills for PDRAs.

48. Topics important to BBSRC including systems biology, plant science/food security and industrial biotechnology may require particular skills sets, which may require particular attention and monitoring. Newer areas such as stem cells, tissue engineering, genome editing and Information theory are also areas that require skills that should be monitored in the future. Finally, engineering, including biochemical engineering, is one area that was not greatly discussed and BBSRC may consider investigating skills in this area in the future.

Conclusion 1.
Applied skills, such as statistics, to plan statistically rigorous experiments, and skills in computational tools, to modify tools and use custom tools and platforms, are particularly important.

Recommendation 1.
Researchers skills need to be increased for all career stages in the following areas; basic skills in scripting, coding and bioinformatics. Applied skills in mathematical modelling, applied statistics (experimental design) and data management, including data visualisation are required by all researchers and should be the focus of efforts.

Scope Item 2. Consider people and skills issues at all career levels and advise BBSRC on whether there should be a focus at any particular stage.

49. The second scope item is intended to examine whether the issues affect any particular career stage above any other, and whether an intervention at one particular career stage will have benefits over and above any other stage

50. A balance between specialist and multidisciplinary researchers needs to be struck to enable effective research across the BBSRC remit. However, there remains a perception of barriers to career progression, thought to be particularly difficult for researchers who specialise in technology or instrumentation in the biological sciences.

51. The biological sciences are seeing an increasing reliance on advanced technologies, both in areas where instrumentation has been established, and also in newer areas. This in turn increases the requirement for technology specialists across the biological sciences. Although technology specialists can be leading in their own areas, it can be difficult to secure the required markers of esteem (publications, grant funding) in the biological sciences without a compelling biological question, frequently provided via collaboration. Without this, it can be difficult to secure a research leader position. There are limited opportunities for career progression without being a research leader. There is recognition that there is a bottleneck at this transition, and the provision of more flexible technical roles has been suggested as a possible solution[26].

52. The numbers of David Philips (DF) Fellowships awarded annually is relatively low, and are of high value. A fellowship is a useful mechanism to use for researchers who are intending to move from postdoctoral to research leader positions. However, the low number of fellowships awarded means that those opportunities are restricted within the BBSRC remit. Applicants in ENWW topics may have impacts such as software or technology that are not reflected or captured proportionally as publications.

53. A broader point is that the low numbers of fellowships awarded does not necessarily represent a contribution to selecting the best researchers. Given that researchers may not fulfil early promise, or they may leave the field, a low number of awards risks a poor return on investment. Furthermore, as the value of the award is high, new DP Fellows could potentially be leading groups consisting of up to two PDRAs and a technical post. This represents a significant increase in responsibility from a postdoctoral research post and may be an

[26][Reference/webpage no longer available – May 2016]

additional risk[27]. In light of these points, there may be merit for an interim fellowship stage in between an early career postdoctoral researcher and the DP Fellowships[28].

54. While previously, there was a reasonable expectation that recipients of fellowship posts would also be offered permanent academic positions, this is not currently necessarily true. There needs to be a clear career path for fellows, otherwise they may continue their career by applying for a second or third fellowship, or simply leave the field.

55. Many of the schemes noted are good training for early career researchers to enter academia: far fewer prepared researchers for entry into industry. Given the low numbers of postdoctoral researchers who will receive an academic position, there may be virtue in considering industry as a destination (and other training outside academia).

56. There is no evidence that the issues discussed affect any one career stage more than others. Training and education should be available for all researchers, from postgraduate students to group leaders.

Conclusion 2.
There is a perception that technology and instrumentation specialists within the biological sciences have to fulfil extra criteria, as both experts and leaders in their own field, and also being able to demonstrate their application on a leading biological problem. This can be exacerbated by the difficulty in recording scientific outputs, such as continuing innovation in software, technology or instrumentation, with conventional markers of esteem such as publications in high impact journals. As in all disciplines, the transition from postdoctoral level to academic positions is difficult.

Conclusion 3.
Fellowships can be a route from postdoctoral to research leader positions, but the low numbers of fellowship awards risks failing to take full advantage of the available talent pool, and, in terms of numbers supported, represents a poor return on investment. The high value of the award makes the transition from postdoctoral researcher to David Philips Fellow exaggerates an already significant step.

Recommendation 2.
BBSRC should pay close attention to the career transition from postgraduate researcher to research leader for researchers working in ENWW topics, in particular instrumentation/technology specialists, and should establish whether the evidence for difficulties in career transition match the perception and should seek to support them where possible.

Recommendation 3.
The numbers of fellowships for technical and instrumentation specialists should be examined, and BBSRC should consider whether there are particular risks in the numbers and value of fellowships awarded[29].

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[27] Since the Expert Working Group report completion, the amount that can be requested by DPFs is now limited to 1M, and this risk has been ameliorated

[28] Since the Expert Working Group report completion, the Future Leader Fellowship scheme has been initiated, which may contribute to closing this gap (http://www.bbsrc.ac.uk/funding/fellowships/future-leader-fellowship/)

Scope Item 3. Analyse the strengths, weaknesses, opportunities and threats of people and skills issues in the area of ENWW. Identify areas and mechanisms of best practice and use this to identify what currently works well in the UK and abroad.

57. This item was largely discussed by the Expert Working Group at their first meeting. This was used as a guide for later discussions and the comments incorporate discussions from later meetings.

Strengths

58. UK researchers receive excellent core skills training in all areas, and the DTP model and presence of interdisciplinary fellowships were considered particular strengths.

59. The UK research base is well served by the strategic investment in UK research institutes and through the ability of research funders to jointly fund research and infrastructure projects.

Weaknesses

60. The UK skills base could be improved in areas related to data integration and data visualisation. There needs to be community building in all areas of data driven biology. Many researchers working on ENWW topics operate in research silos and the quality of their research would benefit from more data integration and resource sharing. Such activities would be aided by common standards in databases and datasets. The US data infrastructure iPlant[30] was noted as a good example of a platform through which this could be achieved.

61. RCUK began core investment in bioinformatics some time ago, but there is a perception that there has not been a clear strategy since to build upon it.

62. The removal of core funding for MSc level courses has degraded the ability of researchers to 'discipline-hop' as it is harder to formally retrain.

63. As noted in the previous section, particular weaknesses were identified in funding for fellowships and in provision for technology/instrumentation specialists.

64. Recent funding awards for instrumentation and equipment from BBSRC are welcome: but capital awards often have no provision for staff to operate and develop the equipment. This further complicates support for technology development specialists.

65. Many researchers reported that they were self-taught outside of formal training routes, and that there were few formal courses available in the skills that they were interested in acquiring. There is an apparent lack of available courses in ENWW topics in the UK for researchers.

Opportunities

66. Researcher mobility has pros and cons for the UK research community in ENWW topics. Subjects such as mathematics have been strengthened by inward migration, but UK researchers may also move abroad, or into non-research roles.

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[29] See Footnote 2

[30] [Reference/webpage no longer available – September 2016]

67. Having funding SySMIC as an e-Learning platform, and using it to deliver training to postgraduates in the DTP system, there is a significant opportunity to build on this, either by expanding SySMIC itself, or by increasing the numbers of courses on offer. There are a number of different training options available in this area. Exposing postgraduate students to SySMIC and e-Learning can drive awareness of mechanisms like SySMIC and others as a legitimate way to receive training, driving culture change.

68. Increasing awareness of, and participation in, software development could provide a significant opportunity to foster the bioscience open source community.

Threats

69. The availability and numbers of fellowships had been identified as a threat. There is a significant risk of not making the best investments here, due to the numbers and value involved.

70. Training by its very nature is frequently targeted and advertised by practitioners in the same field. A significant threat for new researchers trying to learn core skills in a multidisciplinary field is that they will not be exposed to the right training opportunities, and if they do find out about them, those opportunities will not be targeted towards them.

71. Clearly if UK researchers lack the necessary skills they will be unable to compete globally. Similarly, if bioscience researchers lack the necessary skills, they will also fail to compete against researchers from physical sciences who do have coding, programming, computational or statistical skills that they can apply to different topics. This in turn leaves the entire field vulnerable, reliant on a workforce with valuable skills who can be hired away into other roles, not just within the research sector but also outside.

72. Industry must not be neglected when considering provision and receipt of training. Many potential training providers exist, both in industry and academia.

73. All teaching curricula are currently very crowded, and it is not clear where, or whether space can be made to include newer topics or allow students to train to develop more contemporary skills.

Conclusion 4.
The UK has a strong base to build on, with provision of e-Learning through the DTP programme a positive step. It is, however, difficult for researchers to be able to reach outside of their own discipline to access skills and training. Without exposure to multidisciplinary skills in mathematical and computational topics, biological research teams may be increasingly reliant on researchers with skill sets from outside the biological sciences, and outside the UK. The decline in funding for MSc programmes has weakened a route for 'discipline-hopping' and advanced specialist training. Exposing students to SySMIC may have positive consequences beyond the skills learnt by exposing students to self-directed online learning. Provision of equipment funding without resource to support trained staff remains a point of concern.

Scope Item 4. Advise BBSRC on its approaches to supporting multidisciplinary skills for researchers in ENWW areas.

74. The question of when training should be accessed to be most effectively applied is frequently discussed. Training undertaken where there is a significant period between access and use can fail to have the desired outcome. As there is limited time available for learning, the major driver will always be what is immediately required for research. While this can mean that skills, once learnt, are immediately applied, it can place a limiting factor on opportunities to bring new skills into disciplines where they are not immediately applied. The entry of new skills, methods or techniques into fields of study often requires the entrance of researchers, who already have those skills, into the discipline.

75. There are, therefore a number of strands to bring together. Learners must be able to access and use learning at the right time. There also needs to be a facility to allow learners to access courses and materials that they have already taken, either physically, or through virtual networks.

76. Learning needs to be available throughout the career pipeline, so that PIs are able to access learning, as well as postdoctoral, postgraduate and graduate researchers.

77. Clearly, some of the responsibility for training lies outside of the research council. However, it would be useful to be able to 'calibrate' the level of knowledge that graduate entrants have in order to be able to decide what type and level of training is required. Some level of introductory self-assessment would be useful.

78. Project supervisors are keen to ensure that their PhD and postdoctoral students don't become swamped with learning requirements to the extent that it impacts on their research work. The terms and conditions of grants permit up to ten days per year for postdoctoral staff to undertake training. One way to track the training provided is to issue training tokens which can then be 'spent' on courses and training. This would give supervisors confidence that their students (and postdoctoral staff) will not be required to spend excessive time training.

79. The view of SySMIC is particularly positive. It is a long course, but delivers core skills that are considered to be important. The skills that are learnt in modelling, coding and statistics may not be utilised immediately, but may instead be useful at different points through research projects. SySMIC materials remain available for access and can be returned to. E-Learning approaches lend themselves to topics such as coding, computing and statistics, and given the apparent success of SySMIC, they are sensible mechanisms to explore disseminating ENWW training. E-Learning approaches can also incorporate trainer-led sessions, using a 'blended' approach.

80. In taking these approaches, it is important to note that significant sums have been spent to develop large-scale e-Learning courses, and that they may require dedicated staff to run. The implications of this are that there needs to be consideration of the resource implications for instigating and sustaining e-Learning approaches, and for support staff involved in training.

81. A number of training courses, modules and boot camps are already in existence. Those suitable should be brought to the attention of researchers. There is always value in providing or supporting a mechanism to help researchers discriminate and select for quality, length, suitability and level required or provided. Each provider will have slightly different models of operation. GOBLET, for example, has a training catalogue as part of the GOBLET website.

Significant value will be added in matching people with the right courses. This may also require a glossary to ensure that there is common understanding of terms that can be applied inconsistently such as ‘bioinformatics’ and ‘systems biology’.

82. Potential areas for e-Learning to cover include NGS approaches, biological image analysis, programming and statistics. DTPs could be polled for topics. Related topics that could also be useful include data management and standards, including the ethics of managing large datasets.

83. Some basic skills will be required in all topics, in statistics, for example. It is also reasonable to consider with the increasing automation of data collection and multiplication in the number and quality of open source software available, that some basic skills in scripting and coding will be required. Beyond that, the requirements for further training will be dependent on the topic under study.

Conclusion 5
A series of approaches are available to deliver training. A number of the strategically important skills discussed as part of the ENWW enabling theme are particularly suited to delivery, in whole or part, via e-Learning approaches. SySMIC has been a successful example of this approach.

Conclusion 6
The success of training is strongly influenced by when it is applied, or whether learners have access to training materials when they apply their learning. Similarly, motivation will be driven by immediate need. Researchers need to be able to select from a range of topics and approaches and apply them when needed. Information about length, quality, topics and difficulty is also important.

Recommendation 5
BBSRC should consider how to increase awareness of, and availability to different mechanisms of training in ENWW topics. E-approaches are particularly suited to ENWW topics. Researchers need the ability to be able to access the training that they require and apply it when needed. A mechanism to support course catalogues and information regarding course quality, and where appropriate, accreditation would support researcher decisions.

Recommendation 6
BBSRC should consider clarifying guidance to ensure researchers consider adequately the provision of training in grant proposals.

Scope Item 5. Identify any gaps in understanding and advise on what further evidence is required in order to make informed strategic decisions.

84. As discussed in paragraphs 41-45, the Expert Working Group requested two surveys to form an evidence base for discussions on background skills. The first focussed on postdoctoral students, the second on postdoctoral researchers.

85. The EWG also requested a presentation from Professor Geraint Thomas, the principal investigator of SySMIC, on progression and numbers currently registered on SySMIC.

Conclusion 7.The survey information provided valuable background evidence on the skill levels of both postgraduate and postdoctoral researchers. A refined version of the survey, produced for the postdoctoral researchers, will be a useful tool for monitoring progress of any implementation of findings from the Expert Working Group.

Scope Item 6. Advise BBSRC on criteria for monitoring implementation and outcomes of the Expert Working Group recommendations, including timeframes.

86. Existing courses and resources could be catalogued and rated via peer approval or accreditation to give confidence to training seekers. Mechanisms should be explored to federate these opportunities.

87. The survey data gathered will serve as a useful baseline. To track the effect of the initiatives proposed, the survey needs to be repeated. Follow-up, in depth interviews may also contribute. Surveys can be tailored to ensure accurate information regarding the progress on courses, with feedback to respondents. Further information can be gathered, for example through entry and exit questionnaires.

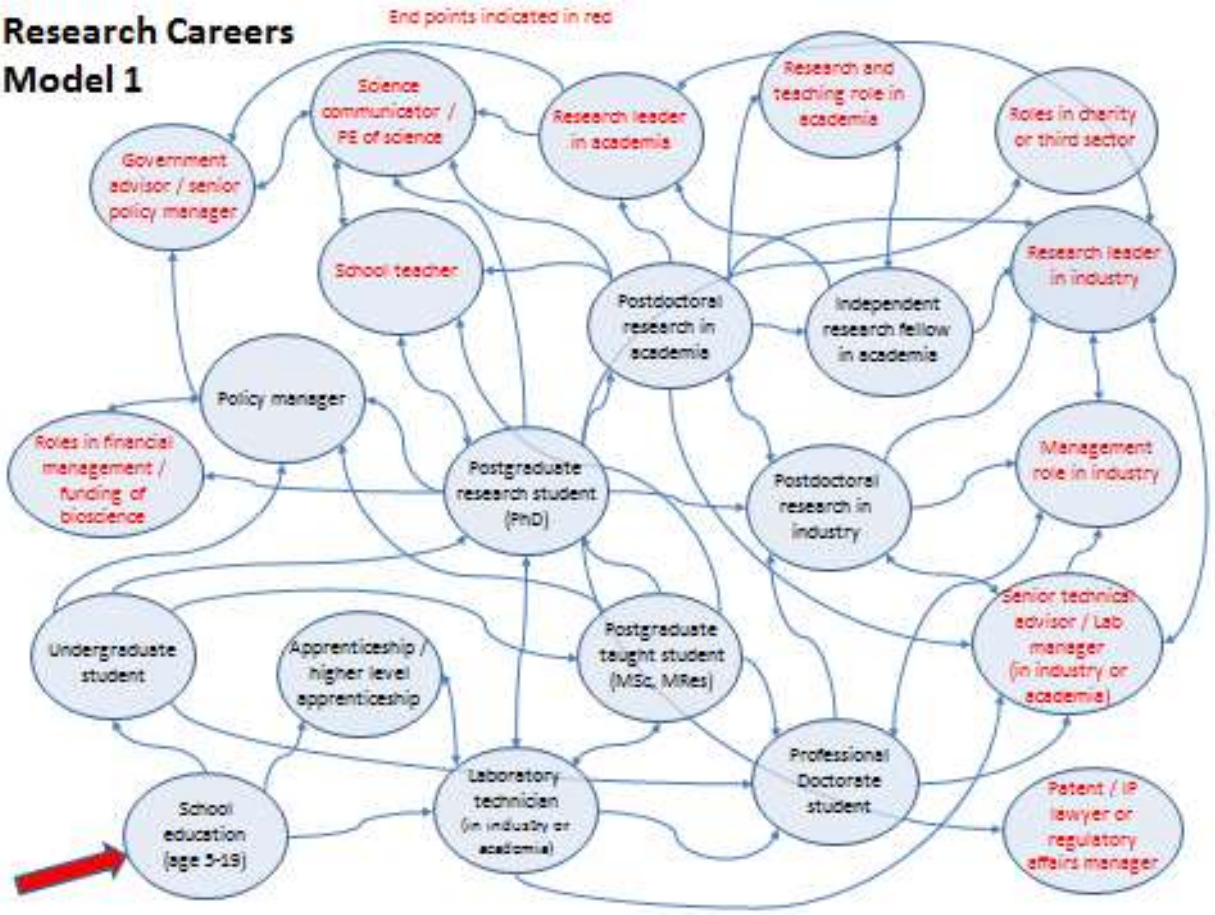
88. Networks have been successful mechanisms for disseminating information and best practice. Given the importance of raising awareness of courses and of peer recommendations of suitability, this could be a valuable contribution to embedding training for ENWW topics. Demonstrator projects using ENWW approaches can also highlight the utility of approaches.

Conclusion 8.
Networks for postgraduate students may make a valuable contribution to raising awareness of training opportunities and disseminating information.

Recommendation 6.
The surveys should be followed up, and continued with a view to monitoring progress in key areas. The surveys can be tailored to track progress in, and use of particular courses or mechanisms.

ANNEX 1

Careers Framework, as developed by the Bioscience Skills and Careers Strategy Advisory Panel.



ANNEX 2

SySMIC project details can be accessed via Gateway to Research

here.

ANNEX 3

Expert Working Group Membership

Membership Julian DOW (Chair)	**University of Glasgow**
Neil CHUE HONG	University of Edinburgh/Software Sustainability Institute
Paul FRENCH	Imperial College London
Sophien KAMOUN	Sainsbury Laboratory
Liz REYNOLDS	General Bioinformatics
Vicky SCHNEIDER	The Genome Analysis Centre
Alison SMITH	University of Cambridge
Fiona TOMLEY	Royal Veterinary College
Michael WHITE	University of Manchester
Darren WILKINSON	University of Newcastle
Richard REECE	University of Manchester

In considering people and skills in the area of Exploiting New Ways of Working, the Working Group should:

- Consider the current evidence for people and skills issues and identify whether there are any particular areas on which BBSRC should focus its efforts, particularly in relation to science topics.
- Consider people and skills issues at all career levels and advise BBSRC on whether there should be a focus at any particular stage.
- Analyse the strengths, weaknesses, opportunities and threats of people and skills issues in the area of ENWW. Identify areas and mechanisms of best practice and use this to identify what currently works well in the UK and abroad.
- Advise BBSRC on its approaches to supporting multidisciplinary skills for researchers in ENWW areas.
- Identify any gaps in understanding and advise on what further evidence is required in order to make informed strategic decisions.
- Meet three times before Spring 2014 and advise on the need to continue meeting beyond this date.
- Report to the ENWW and BSC strategy advisory panels by Spring 2014.
- Advise BBSRC on criteria for monitoring implementation and outcomes of the Working Group recommendations, including timeframes.