Institution: University of Southampton

Unit of Assessment: 07 Earth Systems and Environmental Sciences

Title of case study: 07-02 Explore the Deep: Public Engagement with Deep-Ocean Research

1. Summary of the impact

By putting public engagement at the heart of our deep-sea research, we have delivered benefits to society of *generating inspiration and curiosity about science*, *raising public awareness of our research insights and their context*, and *providing cultural enrichment by supporting lifelong learning*. We have achieved these impacts through: interactions with print, online, and broadcast media that have brought our research to millions; series of talks and events that have inspired specific audiences of tens of thousands; and a network of interactive online resources that has enabled people worldwide to share in our exploration of deep-ocean environments and their biodiversity.

2. Underpinning research

This impact case study is underpinned by a research programme investigating deep-sea environments and their biodiversity, undertaken by academic staff in Ocean & Earth Science at the University of Southampton, and funded by a series of grants from NERC and other sources. The key researchers involved are Prof Paul Tyler (Deep-Sea Biology), Prof Rachel Mills (Marine Geochemistry), Prof Alberto Naveira Garabato (Physical Oceanography), Dr Jon Copley (Senior Lecturer in Marine Ecology), with 2 postdoctoral researchers (Drs Alfred Aquilina & Kate Stansfield) and 5 PhD students (Diva Amon, Jeff Hawkes, Laura Hepburn, Leigh Marsh, Verity Nye).

Our research programme seeks to understand the patterns of life in deep-sea environments such as hydrothermal vents, which support lush colonies of marine life on the ocean floor. These island-like seafloor environments provide a model system for understanding interactions between ecology, evolution and biogeography that determine global patterns of marine biodiversity. The deep ocean is under increasing pressure from human activities such as resource exploitation, and the need to raise awareness of our research insights therefore provided a key driver for embedding public engagement in our research programme.

Our research programme has achieved several scientific "firsts" since January 2008, which have underpinned our public engagement work:

- the discovery of hydrothermal vents in the Cayman Trough of the Caribbean, including the world's deepest known vent field **[3.1]**;
- the discovery of high-temperature hydrothermal vents in the Antarctic, revealing a new province of vent biogeography **[3.2]**;
- the discovery of at least 30 new animal species, resolving phylogenetic and biogeographic relationships of deep-sea fauna worldwide (e.g. **[3.3]**);
- the first human-directed exploration and sampling of fauna at deep-sea vents on the ultraslow-spreading SW Indian Ridge.

Our fieldwork programme has targeted geographic areas identified as priorities for investigation by the international Census of Marine Life ChEss (Chemosynthetic Ecosystems) project, which was Co-Chaired by Tyler (2001-11). Our research programme has also contributed to achieving the scientific objectives of InterRidge, the international organisation coordinating research at mid-ocean ridges, which was Co-Chaired by Copley (Jan 2010-Dec 2012).

3. References to the research (the best 3 illustrating quality of work are starred)

***[3.1]** Connelly DP, Copley JT (joint lead authors), Murton BJ, Stansfield K, Tyler PA, German CR, Van Dover CL, Amon D, Furlong M, Grindlay N, Hayman N, Hühnerbach V, Judge M, Le Bas T, McPhail S, Meier A, Nakamura K, Nye VE, Pebody M, Pedersen RB, Plouviez S, Sands C, Searle RC, Stevenson P, Taws S & Wilcox S (2012). Hydrothermal vent fields and chemosynthetic biota on the world's deepest seafloor spreading centre. *Nature Communications*, **3**: 620, doi:10.1038/ncomms1636

***[3.2]** Rogers AD, Tyler PA (joint lead authors), Connelly DP, Copley JT, James R, Larter RD, Linse K, Mills RA, Naveira-Garabato A, Pancost RD, Pearce DA, Polunin NVC, German CR, Shank T, Alker B, Aquilina A, Bennett SA, Clarke A, Dinley RJJ, Graham AGC, Green D, Hawkes JA, Hepburn L, Hilario A, Huvenne VAI, Marsh L, Ramirez-Llodra E, Reid WDK, Roterman CN, Sweeting CJ, Thatje S & Zwirglmaier K (2012). The discovery of new deep-sea hydrothermal

vent communities in the Southern Ocean and implications for biogeography. *PLoS Biology*, **10(1)**: e1001234, doi:10.1371/journal.pbio.1001234

***[3.3]** Amon DJ, Glover AG, Wiklund H, Marsh L, Linse K, Rogers AD & Copley JT (2013). The discovery of a natural whale fall in the Antarctic deep sea. *Deep-Sea Research II*, doi:10.1016/j.dsr2.2013.01.028

Grants

NERC Consortium Grant: *Chemosynthetic Ecosystems of the Southern Ocean (ChEsSo): Biogeography and Ecology*; £3.2m; awarded to Tyler PA (consortium PI) & UoS Co-Is Copley JT, Naveira-Garabato A, Mills RA; 2008-2013

NERC Standard Grant: *Hydrothermal Activity and Deep-Ocean biology of the Mid-Cayman Rise*; £486k; awarded to Copley JT (PI) & UoS Co-Is Tyler PA, Naveira-Garabato A; 2009-2014

NERC Small Grant: *Biogeography and Ecology of the First Known Deep-Sea Vent Site on the Ultraslow-Spreading SW Indian Ridge*; £35k; awarded to Copley JT (PI); 2011-2012

4. Details of the impact

The deep ocean is our planet's largest realm, in which we are all "stakeholders" through our use of its resources and the environmental impacts of our everyday lives. But beyond the research community, there is limited awareness of deep-sea environments and their biodiversity. We have therefore created an integrated programme of public engagement with our research, to share ongoing discoveries in deep-sea science with a global audience, and to inspire and inform specific communities of interest and place with our work. This programme has been highlighted by Research Councils UK as an example of "best practice" for generating impact from research **[5.1]**.

Our public engagement programme combines three elements. Firstly, we have worked with the media to share the findings of our research with non-academic audiences worldwide. At key milestones in our research process -- awards of funding, preparation for fieldwork expeditions, discoveries during fieldwork, and publication of papers -- we have produced press releases and worked with science journalists to generate extensive coverage by print, online, and broadcast news outlets **[5.2]**. In addition, we have collaborated with documentary-makers to produce TV and radio programmes featuring our findings and research process.

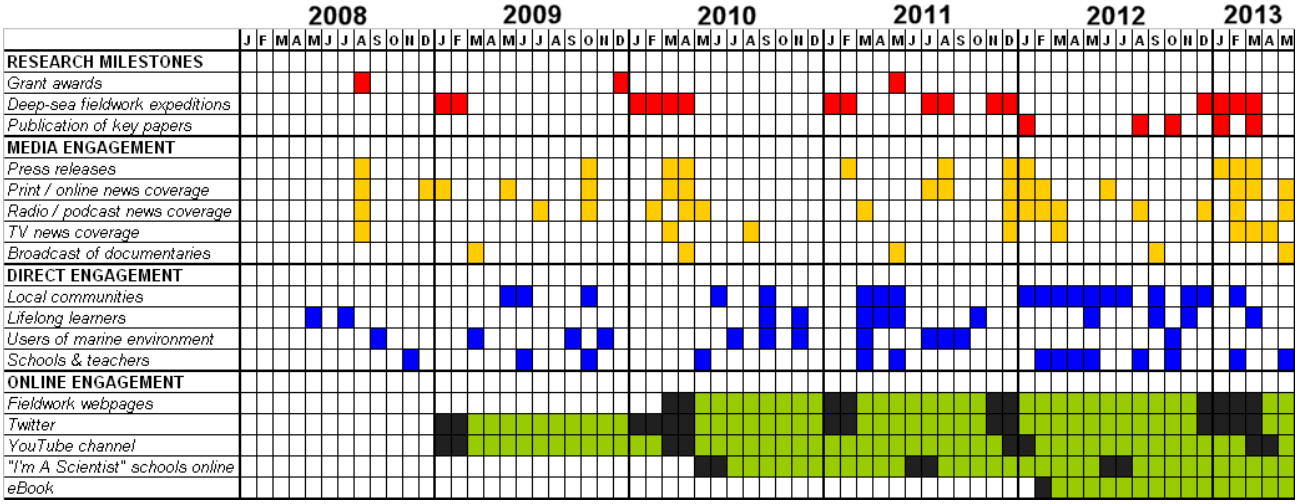
Secondly, we have presented and discussed our research directly with public audiences through a series of talks and events **[5.3]**. For these "face-to-face" engagement activities, we have targeted four "communities of place" and "communities of interest": (i) our local communities in the southern UK; (ii) users of the marine environment, at events such as the Southampton Boat Show; (iii) retirees / life-long learners, through networks such as Probus and University of the Third Age; and (iv) school pupils and teachers, including live video links to classes from deep-sea research expeditions, and contributions to Continuing Professional Development (CPD) events for teachers. Our direct engagement programme has also included the production of exhibits such as a life-size display of deep-sea hydrothermal vents, to engage people with our research at venues such as a music festival and a regional airport.

Finally, we have developed a network of resources for online engagement. This network consists of an interactive website **[5.4]** enabling audiences to follow "live" updates from our fieldwork expeditions and ask questions; Twitter feeds enabling direct dialogue with individual research team members at sea; a YouTube channel delivering video highlights from previously unseen deep-sea regions; and free eBooks distributed by iTunes, WHSmiths.co.uk and other online outlets **[5.5]**.

As the three strands of engagement activities are embedded in our research process (shown in the timeline summary below), their impacts during the REF period are underpinned by our most recent research outputs, rather than earlier papers. Our direct and online programmes have also captured feedback from audiences, using a variety of methods from comment boxes to video interviews, to inform and refine further engagement, and the benefits of our programme have been two-way, with audiences providing insights and wider perspectives of issues related to our research.

"Reach" of impact for media engagement activities is quantified by audience numbers, and coverage of our research has reached audiences of millions worldwide. For example, on 11/04/10, an article about our Cayman Trough fieldwork discoveries was viewed by 1.5 million people on Yahoo! News, making it the most viewed news story of the website on that day (source: AP science journalist Raphael Satter **[5.6]**). On 28/12/11, BBC online coverage of our Indian Ocean fieldwork discoveries was viewed by more than 750,000 people, making it the third most-read article of the

BBC news website on that day (source BBC science journalist Rebecca Morelle **[5.7]**). Our work has featured twice on BBC Radio 4's *Today* programme during the REF period, with audiences of 7-8 million, and live BBC TV news broadcasts on 21/02/13 from our deep-sea fieldwork were watched by more than 10 million people worldwide (source BBC Science Editor David Shukman **[5.8]**).



Summary timeline showing the integration of public engagement activities with our research during the REF period: months containing "research milestones" (red); press releases related to research milestones and resulting media engagement (yellow); continuous direct engagement activities throughout our research process (blue); interactive online resources produced during fieldwork (black) that subsequently build a persistent online presence for engagement (green).

By working with National Geographic TV during three fieldwork expeditions, our research also featured prominently in a major documentary series broadcast in more than 170 countries; and following training in science communication and podcasting, our PhD students recorded audio material at sea used extensively in two programmes for BBC Radio 4's *Costing The Earth* series, with audiences of 1.4 million (source BBC producer Alisdair Cross **[5.9]**).

"Significance" of impact for media engagement is demonstrated by (i) follow-on coverage by other media outlets; (ii) social media shares of coverage among the public; (iii) feedback comments recorded from audiences of media coverage; and (iv) testimonials from journalists and producers with whom we have worked to achieve our engagement goals. While our team members gave more than 100 direct media interviews about our research during the REF period (please see **[5.2]** for full details), follow-on coverage has totalled several thousand articles. For example, more than 520 online news outlets (tracked by Google News) covered our Cayman Trough discoveries in April 2010 alone, and other research milestones achieved similar levels of follow-on coverage. Social media shares of coverage among members of the public, which demonstrate stimulated interest of audiences, exceed tens of thousands; for example, Facebook "likes", Tweets, Google+ recommends, Stumbleupon shares, and email forwards tracked for just four articles about our *PLoS Biology* paper **[3.1]** total more than 11,000.

Audience comments on media coverage further demonstrate outcomes of generating inspiration and curiosity about science, and raising awareness of our research interests, for example: *"It's amazing to see finds like this"* and *"So exciting. How I wish I would have gone into oceanography"*. After covering our research in February 2013, BBC Science Editor David Shukman reported in his blog that he was *"still picking up messages from people amazed at getting such an extraordinary vision of the reality of the deep sea"*. Testimonials from journalists and producers also show the significance of our media engagement, through comments such as *"one of the most riveting television moments for many years"* and *"one of the best examples I have ever known of cooperation from scientists"* **[5.8]**.

For direct engagement activities, "reach" of impact is similarly quantified by audience numbers, and we presented and discussed our research with more than 20,000 people at more than 80 face-to-face events during the REF period (please see **[5.3]** for full list), not only to "science-interested" audiences at cafés scientifiques and science centres, but also at less traditional venues for public engagement with research, such as a music festival and Selfridges in London. "Significance" of impact for direct engagement activities is demonstrated by feedback comments

recorded from audience members that show outcomes of stimulating curiosity and raising awareness of our research findings (presented in **[5.3]**), such as *"I now have 2 children wanting to be marine biologists!"*, *"I came home and spent hours Googling hydrothermal vents"*, and *"Like everyone else I was gripped… And there is so much more to discover!"*.

At just one of 13 local schools with whom we have worked in our direct engagement, we interacted with more than 1,100 pre-GCSE to A-level pupils, through talks, visits, and the first live video links from a UK research ship to school classes. This Comprehensive School has reported a year-on-year increase in pupils applying to study marine sciences at University, with staff also noting *"a massive and positive impact on teaching and learning with those groups of students"* and that our contributions to CPD events for teachers *"inspired me and many other teachers to include more contemporary marine science and ocean research examples in our day-to-day teaching"* **[5.10]**. In three years of participation in the Wellcome Trust sponsored *I'm A Scientist* schools engagement programme, we also interacted with pupils at 30 further schools, answering more than 400 posted questions, and received a prize voted for by pupils for the most engaging presentation of research.

In online engagement activities, "reach" of impact is quantified by visitor traffic to online resources. Our core engagement website received more than 279,000 visitors from at least 90 countries since April 2010, and combined with our YouTube channel and other resources, there have been more than 1 million visitors to online engagement materials generated from our research since January 2009 (data summarised in **[5.5]**). "Significance" of impact in online engagement is shown by feedback comments from audiences, and social media shares of online resources among the public. Feedback comments on our core website provide evidence of inspiring and informing audiences with our research (summarised in **[5.5]**), such as *"This is the coolest expedition and surely the best ever website for communicating science news to the public"* and *"This (baby) Boomer on Long Island (NY) will think far beyond the surf on next visit to the Fire Island lighthouse"*. Public comments on a *Guardian* website article (05 July 2013) by one of our team about our fieldwork include *"Fascinating and awe-inspiring"* and *"Amazing. Best article I've read on here today"*. Meanwhile, reviewer comments on our free eBooks include *"An excellent read that made me feel like I was out on the expeditions with them"* (GoodReads.com), and widespread social link-sharing of our online engagement materials among audiences demonstrates inspiration and stimulation of curiosity (example data presented in **[5.5]**),

Overall, using these recognised metrics for reach and significance of impact in public engagement, our integrated programme has delivered the defined benefits of generating inspiration and curiosity about science and raising public awareness of our research insights. The significant impact of our public engagement programme has also been recognised by the award of the Biosciences Federation Science Communication Award for Established Researchers to one of our team during the REF period, and testimonial comments from science communication professionals that highlight the overall skill of our team in engaging wider audiences with our research, such as *"The world of science should treasure clear-voiced ambassadors like him"* **[5.8]**.

5. Sources to corroborate the impact

[5.1] **http://www.rcuk.ac.uk/media/brief/impactcase/pe/Pages/copley.aspx**
(RCUK feature of our public engagement programme as a "case study" of a "Pathway to Impact")
[5.2] **http://www.southampton.ac.uk/~jtc/REF/MediaEngagement_data.pdf**
(a summary of evidence for "reach" and "significance" of impact for media engagement activities)
[5.3] **http://www.southampton.ac.uk/~jtc/REF/DirectEngagement_data.pdf**
(a summary of evidence for "reach" and "significance" of impact for direct engagement activities):
[5.4] **http://www.thesearethevoyages.net/** interactive website enabling audiences to follow "live" updates from our fieldwork.
[5.5] **http://www.southampton.ac.uk/~jtc/REF/OnlineEngagement_data.pdf**
(a summary of evidence of "reach" and "significance" of impact for online engagement activities)
[5.6] Journalist contact to confirm viewing figures for Cayman Trough article in April 2010.
[5.7] BBC Science journalist.
[5.8] BBC Science Editor.
[5.9] BBC producer of *Costing the Earth* on Radio 4.
[5.10] Testimonial from a science teacher from Thomas Hardye School