

Oceans 2025 Annual Science Meeting: Plymouth, 11-13 May 2010

## Summary reports from 'TAPs and Gaps' breakout groups

Five parallel discussion sessions each of ~1 hour were held on the morning of 13 May, to consider forward-planning issues relating to NERC Theme Action Plans, cross-cutting initiatives and activities not currently included in TAP planning. Overviews of the current status of theme development were provided to the preceding plenary session of the ASM, covering Earth System Science (Tim Jickells); Sustainable Use of Natural Resources (Chris Franklin on behalf of Louise Heathwaite); Climate System Science (Richard Wood); Risks and Hazards (John Rees); Environment, Pollution and Human Health (Tim Jickells on behalf of Roy Harrison); and Biodiversity (Phil Williamson on behalf of Ken Norris).

The topics covered by discussion groups (not an exact match to themes) were as follows:

- NERC Arctic programme (*Chair: Helene Hewitt, MetOffice*)
- Marine biodiversity (*Mel Austen, PML*)
- \*Shelf-edge exchanges & mesoscale processes (*Jonathan Sharples, NOC*)
- \*Coastal sediment dynamics (*John Rees, BGS*)
- Marine environmental health, including offshore decommissioning (*Ian Boyd, SMRU*)

Note that i) additional information on 2008 and 2009 TAP actions (including topics marked \* above) can be found at [www.nerc.ac.uk/research/themes/tap](http://www.nerc.ac.uk/research/themes/tap); and ii) the Technology theme had been covered in separate sessions on 12 May, with four associated discussion groups (collated reports available as separate document).

### 1. NERC Arctic programme

Summary points from discussion:

- Given that there is a funding opportunity upcoming and that as yet only limited information has been available to the community, the focus was on questioning the three members present from the Arctic Programme Advisory Group.
- It was recognised that whilst UK research in the Antarctic is well coordinated, UK Arctic science is historically uncoordinated and its logistic support often independently organised. This was being addressed by the establishment of a NERC Arctic Office involving UK researchers across NERC institutes with relevant polar logistic experience. This was seen as a move to improve organisation and support to UK Arctic activities and sourcing /negotiating both access to the Arctic and its logistics.
- The upcoming Arctic Research Programme is intended to provide a valuable opportunity for UK researchers to address significant Earth System questions in the Arctic and to gain access to logistic assets of other polar nations. This would potentially help develop greater UK institutional coherence for Arctic activities.
- Arctic research has a obvious capability to feed into science policy and the TAP leaders see this as important, so projects will need to forge links with FCO, Defra, DECC, DoT, MCA and MoD. Such links are being initiated by the Arctic Office but should also be taken on by the Arctic programme.
- It is intended that the programme should provide a unique UK contribution and with a budget limited by logistic constraints the funded projects will need to interact where practical to get best value. It was considered appropriate to identify research holes to fill later in the programme and that a final synthesis could usefully bring the project outputs together.
- It is intended that an AO will be made in early summer with full proposals being submitted towards the end of the year and that a mixture of consortium and standard grants would likely be funded. It is hoped to attract researchers from outside the polar community to potentially broaden the community and acquire fresh approaches.
- The programme as outlined currently has no regional or environment focus (e.g. polynas, ice edge) – that will be dictated by the proposals – so it was difficult to visualise at this time the shape of the programme.
- The programme is intended to have both field observational and modelling activities and it was recognised that these should be linked to develop more effective predictive capabilities for time periods ranging from days to decades.

- To initiate the programme a six month study has been funded to compare the top six climate models recognised by IPCC and tease out major sources of uncertainty, so helping focus the community on key issues within the programme before full proposals are submitted.
- Biogeochemical cycling is a significant element of the proposed programme. Although the modellers present noted that this is now included in certain large models it was felt by the group that biogeochemical cycling is as yet not that particularly well represented and this should be a concern in developing effective coupled models for the Arctic.
- Working in the extreme Arctic environment would benefit from access to new technologies and this could be usefully discussed with the technology TAP leader once outline proposals are to hand.
- There are possibilities of UK using naval submarines and assets such as Autosub 6000 for studies beneath the sea-ice and the availability of the UK-led Cryosat mission for remote sensing represents a major asset for the Arctic programme.
- There were concerns about accessing appropriate marine platforms for the programme. It was suggested that ice-breakers may be necessary to address the relevant questions, and these vessels are both few in number and expensive to lease. It was felt that the programme would have to look to partnering with groups in Arctic Rim nations to fit the available budget. There should be the possibility of bringing elements of the NERC/BAS fixed wing aircraft to the Arctic to support the programme.

*Cynan Ellis-Evans (BAS)*

## **2. Marine Biodiversity**

### **2.1 Context and background**

As stated in the ASM plenary session, the Biodiversity Theme Leader (Ken Norris) is developing research programmes of two main kinds: i) with focus on specific ecosystems or specific ecosystem processes; and ii) cross-cutting activities, e.g. taxonomy and systematics, systems approaches, and valuation. To develop ideas for (i) in the marine area, a Marine Ecosystems Working Group will meet on 18 May. The ASM breakout group provided the opportunity for wider input to those discussions.

The marine research community has had two previous opportunities to consider NERC Biodiversity Theme Challenges, and hence contribute to theme planning and implementation. The first was a NERC Workshop “Large Scale Biodiversity, Environmental Gradients and Ecosystem Sustainability” (Reading, 15 December 2008; <http://nora.nerc.ac.uk/6339>) that explored the linkage between biodiversity and ecosystem function, in the context of policy-relevance and interdisciplinary integration.

That workshop focussed on ecosystem responses to natural and anthropogenic change (sensitivity, resilience and thresholds), requiring improved knowledge of scaling and connectivity processes. Major advances in these areas were considered achievable through a nested, multi-site study that would:

- build on existing time series
- combine experimental, observational and modelling work
- contribute to, and benefit from, international collaborations
- be closely coupled with socio-economic research
- be developed with stakeholders and partners
- complement equivalent terrestrial and freshwater work.

A second marine biodiversity workshop involving Oceans 2025 researchers was held at NOC Southampton on 1 October 2009, with Professor Norris. Eleven topics were then discussed, as identified in Table 1. The wider context was then provided by the 2009 TAP action, BESS (Biodiversity, Ecosystem Services and Sustainability) that had been recently developed and approved to address terrestrial and freshwater biodiversity issues.

### **2.2 Ideas for a marine BESS, on risks and benefits of biodiversity change**

To make rapid progress in planning a 2010 TAP action on marine biodiversity in an ecosystem services/processes framework, it is important that the Marine Ecosystems Working Group does not spend not too long on re-inventing the wheel. The Oceans 2025 meeting participants agreed that the research objectives defined at the 2008 and 2009 workshops were still largely valid and were representative of the research directions that the Oceans 2025 community feel are important and relevant. The Working Group should therefore be familiar with previous workshop outcomes, developing a synthesis of ideas that might usefully focus on three broad areas:

*Linkage to marine renewable energy development.* Major habitat changes will occur in UK shelf seas over the next decade, probably greater than all the changes over the past century. Unlike offshore oil and gas developments, most marine renewable energy structures will be just a few km off the coast and without the potential complications of pollution impacts. Unique opportunities are therefore available for both fundamental and applied research on ecosystem responses to change, with scope for strong stakeholder/partnership engagement. The overall goal would be to enhance biodiversity benefits, and minimise risks, of marine renewable developments from an ecosystem services perspective.

*Linkage to physical-biogeochemical modelling.* Marine biodiversity is not only affected by climate change but can provide either positive or negative feedback. Increasingly there are concerns about global loss of biodiversity and the ecosystem services it contributes. It is looking increasingly likely that biodiversity-based global assessments may be developed along similar lines to the IPCC through an International Platform on Biodiversity and Ecosystem Services (IPBES). A wide range of survey-based (e.g. CPR, SMRU seal surveys) and site-specific (e.g. Western Channel Observatory; BAS time series) biodiversity observations are supported through NERC National Capability in the marine area. Whilst these observations should support, not drive, the science, it is important that maximum use is made of available information, particularly within a modelling framework - with potential synergisms to an ESS theme action on shelf sea biogeochemistry... A focus on research that enables implementing of predictive marine biodiversity modelling at this time would place NERC at the forefront of developments in this area.

*Biodiversity change at marine interfaces.* A key area of research focus could also include the spatial and temporal changes of biodiversity across interfaces. These could include between different habitats such as benthic –pelagic and estuarine-coastal, but also between different trophic levels and between fisheries and their underpinning ecosystems (building on NERC’s Sustainable Marine Bioresources Programme, co-funded with Defra and Marine Scotland).

These interfaces should not only consider human impacts upon the system but also the resources, services and benefits gained from marine ecosystems. Considering humans as embedded within the marine ecosystem rather than as interfacing with marine ecosystem would require a change in marine science perspective but given the increasing diversity and extent of human activity in the marine environment would be timely..

### 2.3 Drivers for marine biodiversity related research within NERC

The group discussed that such research is highly relevant at this moment because there are clear and urgent policy needs to understand the role of humans in marine ecosystems, as beneficiaries and as agents of disturbance and change. This is particularly relevant within the context of new legislation at European level (Marine Framework Strategy Directive) and at UK level (UK Marine and Coastal Access Act, 2009; Marine (Scotland) Act, 2010), all of which place a high importance on the need to understand the ecological status of marine systems and on strong scientific underpinning for the implementation of policy.

In addition, global change is affecting marine ecosystems and their biodiversity more rapidly that it is on land yet we still do not understand the consequences in terms of further feedbacks on the climate and also for humans who are increasingly utilising marine resources for food, energy, transport and recreation. A concerted effort towards predictive marine biodiversity related research would place NERC in a high profile position in the event of the introduction within the next 1-3 years of an IPBES.

**Table 1.** Marine biodiversity topics discussed at Oceans 2025 workshop, Southampton, 1 October 2009. Full report, with two pages on each topic, available from [mcva@pml.ac.uk](mailto:mcva@pml.ac.uk) or [p.williamson@uea.ac.uk](mailto:p.williamson@uea.ac.uk)

Topics that directly contribute to 2009 NERC theme actions	<ul style="list-style-type: none"> <li>• Biodiversity and ecosystem service sustainability (BESS)</li> <li>• Quantifying and valuing ecosystem services</li> <li>• All change across the Arctic</li> <li>• Biodiversity impacts of renewable energy and offshore structures</li> </ul>
Ecosystem dynamics and connectivity	<ul style="list-style-type: none"> <li>• Invasive species, parasites and pathogens</li> <li>• Space-use ecology</li> <li>• Biodiversity science for Marine Protected Areas (MPAs)</li> </ul>
Opening the black box	<ul style="list-style-type: none"> <li>• Microbial processes and molecular approaches</li> <li>• Twilight zone biodiversity, processes and ecosystem services</li> <li>• Extreme environments</li> </ul>

Melanie Austen (PML)

### 3. Shelf-edge exchanges and mesoscale processes

Summary points from discussion:

- Model and observational estimates of cross-shelf edge exchange tend to be of the same order, though observational estimates are consistently greater than those based on models.
- Any investigation of cross-shelf exchanges between ocean and shelf needs to consider the whole shelf – How far does oceanic water penetrate? What is the residence time of oceanic water?
- Recognise that the shelf edge exchange problem is a large scale, 3D issue. Compared to OMEX and SES we now have the advantage of significantly greater modelling (multit-cpu, unstructured grids) and observational (gliders, long-range HF radar) techniques.
- Technology that can be brought to bear: gliders, long range HF radar, drifter “swarms” (require development, but big advantage is that statistics of fluxes would be useful for testing models), EO data (e.g. frontal and mesoscale feature identification – particularly from SST imagery which has potential to yield altimeter-like pictures without the problem of de-tiding over the shelf).
- Key processes: wind-driven flows, slope current and downwelling, internal tides, processes that break down geostrophy.
- There is a requirement for a very clear identification of what is in scope for the Ocean Boundary Layer research programme (OBL RP). In particular, it should be made clear whether biogeochemical processes are in scope (e.g. impact of chlorophyll on heat/light attenuation, production of DMS, vertical nutrient fluxes). Likewise deep convection.
- The OBL RP will be primarily be open-ocean based. It will be geared to the development of improved descriptions of air-sea interactions that are thought important but currently missing from existing climate models.
- New wide-swath satellite techniques are being developed – probably too late for the OBL RP, but the community should still engage with these developments.
- An important issue with most present large-scale models is that they rely heavily on parameterisation of sub-grid processes: many of the important processes are sub-grid. There is scope for improvements to parameterisations based on (1) better, more compatible observations, and (2) high-resolution process-orientated models that explicitly resolve sub-grid physics. This applies to both topics considered. An end-to-end link from process observations through to improved parameterisations is a challenging but important goal.

*Jonathan Sharples (NOC)*

### 4. Coastal sediment dynamics

[Notes from PowerPoint presentation given to plenary session as summary of discussions]

#### 4.1 New NERC Action

- Geomorphic models needed fast – can't wait for fully physics based models to develop accurate predictive capability
- General lack of literature on morphological scale features and their evolution & modelling – review needed?
- Use of rule based models e.g. cellular automata to predict behaviour. Potential to move 'zero' dimension models to cellular models to investigate behaviour of coastal systems – Venice lagoon – example of behavioural model
- Simple rules can sometimes work better than complex models.

#### 4.2 Need for physical and biologically based understanding and models

- Observations are expensive but needed into the future to develop fundamental understanding of physical and biological features
- Lack of understanding of what regulators need to know – needed to inform direction and funding of basic research
- How to integrate biological interaction with what are currently physics based morphological models

- How do different scales of biological effects interact at the larger scale? e.g. biofilm patches, bed armouring, viscous mixing (fish)...

#### 4.3 Links to marine renewable

- Impact of tidal turbines on vertical mixing in estuaries – will this change the net sediment flux in estuaries by altering density driven flows – switch from net siltation to net erosion? This might be a good thing in some places.
- Potential to move tidal amphidromes through large scale tidal schemes – what effect will this have on sediment transport?
- Issue of consultant's reports and models of specific areas not being available to the scientific community – missing a potentially very useful resource.

*John Rees (BGS), Paul Bell (NOC), Reg Uncles (PML), David Todd & Oliver Way (Bangor/NOC), Jay Willis (HR Wallingford), Jerry Blackford (PML)*

## 5. Marine Environmental Health including Offshore Decommissioning

### 5.1 Scope

This breakout group discussed marine issues relevant to NERC's Environment, Pollution and Human Health (EPHH) theme. However, the scope of the discussions was wider than just how the marine environment might affect human health<sup>1</sup>, since many other aspects of marine waste management and 'ocean health' are also of crucial scientific and policy importance.

There was unanimity that the overall approach needs to be in a shelf-sea modelling framework, building on existing capabilities and expertise to include additional pollution-related parameters developed from focussed fieldwork, integrated longterm observations and well-designed experimental studies, eg using mesocosms for manipulations based on chemical mixtures. Such an approach had previously been discussed at the SOFI Workshop on Marine Environment and Human Health (Cefas Weymouth; 8-9 February 2010). Furthermore, close links with the SUNR, ESS and Biodiversity themes are essential, together with involvement of key stakeholders in programme planning (Defra/Cefas, Marine Scotland, EA; also industry)

### 5.2 Research issues

Four topic areas were considered to offer opportunities for 'excellence with impact', either contributing a marine dimension to existing EPHH TAP actions or providing the basis for new single or multi-theme initiatives:

- *Radioactivity*. The proposed increase in coastal nuclear energy generation, the associated need for nuclear waste depositories, and the simultaneous decommissioning of existing nuclear energy power plants all require the best possible understanding of marine pathways and processes relating to low-level and accidental releases of radio-isotopes. UK expertise in this area has greatly decreased in the past 20 years, and a comprehensive national research programme urgently needs to be developed. [Fit to EPHH Environmental Radioactivity action]
- *Chemical pollutants*. Chemicals that are used for hours, days or weeks by industry, agriculture, health-care and in domestic products subsequently occur for years, decades or centuries in coastal and shelf seas. National and EU regulations focus on the effect of single compounds, without sufficient scientific understanding to address the additive and potentially synergistic effects that occur when organisms are simultaneously exposed to several hundred pollutants, each at 'safe' levels. The consequences may be manifested in high disease rates in natural populations (eg 15-30% liver cancer rates in North Sea flatfish) and, perhaps, declines in abundance of top predator species (eg ~50% decline in UK harbour seal populations since 2000), although the specific causative factors are unknown. [Link to EPHH actions on Waste Management; Defra/EA models for decision-making; and Non-Infectious Diseases].
- *Pathogenic organisms, including harmful algal blooms (HABs)*. An increasing incidence of HABs, including 'alien' species, gives cause for concern, with major financial consequences for aquaculture and significant implications for human health. Linkages to climate change (temperature and stratification) and nutrient enrichment are still poorly understood. [Relevant to SUNR/EPHH Macro-nutrients action]

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<sup>1</sup> Human health is also wider than (absence of) disease, encompassing well-being and quality of life.

- *Decommissioning offshore structures.* Current OSPAR regulations require the complete removal of offshore oil and gas installations when no longer operational, on the application of the precautionary principle for human waste in the marine environment. Total UK costs for the North Sea are estimated at £20-30 billion for several thousand structures, with ~70% paid by the taxpayer. Risks and benefits of alternative end-of-life options urgently need to be considered, since from an environmental perspective removal is not necessarily the best solution; e.g. habitat enhancement via 'rigs to reefs'. Also see 5.4 below.

### **5.3 Policy drivers**

National policy drivers primarily relate to Defra's vision of "clean, safe, productive, healthy and biodiverse seas", with pollution-related issues of current concern identified in Charting Progress 2 (2010) and the Scottish equivalent. The UK is also committed to Good Environmental Status (GES) for marine waters by 2020, under the EU Marine Strategy Framework Directive.

It is important that GES and associated indicators are defined in realistic terms; i.e. what habitat conditions are achievable under 21st century climatic and human use conditions, rather than 'pristine' conditions for a century or so ago. Indicators should also be closely linked to modelling work, for comparison of observed and expected parameter values.

### **5.4 Next steps**

Whilst three of the bulleted topic areas above should be familiar to the EPHH Theme Leader (and others), there is probably less NERC awareness of offshore decommissioning issues. This topic area warrants further exploration, sooner rather than later, to identify the existing evidence base and key environmental evidence needs (i.e. the research gaps) – that might allow substantive national cost savings (£5-10 bn?) through application of an ecosystem approach. This issue is also relevant to RCUK's energy programme, and the Energy Technology Institute. Initial contacts/actions to be developed with Chris Franklin (NERC Swindon Office), with possibility of a SOFI workshop on this topic within 2-3 months.

*Ian Boyd (SMRU); Phil Williamson (UEA/NOC)*