



MASTS/MREDS Marine Renewables Workshops
20/22 October 2010
SPEAKER LISTS and ABSTRACTS (in order of presentation)

Day 1 (Wednesday) Marine Renewables and the Environment

Name	Title and Abstract
Side, Jonathan Heriot-Watt	<u>MREDS introduction overview</u>
Mair, Hamish Heriot-Watt	<u>MASTS introduction overview</u>
Baston, Susana Heriot-Watt	<p data-bbox="461 688 1356 720"><u>Hydrodynamics in the Pentland Firth: understanding the energy source</u></p> <p data-bbox="461 730 1356 1535">The Pentland Firth and Orkney waters have been recently provided with licences by The Crown Estate for 'Round 1' marine energy development sites. However, the physical environment and the ecology of, in particular, the Pentland Firth are still not well understood. In order to be able to predict the environmental effects of 'extensive' installation of marine energy devices, baseline environmental conditions must be clearly understood, which includes fundamentals of the hydrodynamics of the study area. SUNTANS is a three-dimensional non-hydrostatic numerical model developed by Stanford University, which is presently being applied by researchers at ICIT to model the water surface and tidal currents in the Pentland Firth. The preliminary results confirm the complex hydrodynamics of this area, identifying eddies and sites of high flow rate (≈ 3.5 m/s). Although the implementation of the SUNTANS model to the Pentland Firth is at an early stage, it has been validated in other worldwide areas but not in regions of such highly dynamic flow. However SUNTANS has been developed to deal with complex hydrodynamics, capable of modelling regions of high turbulence including density gradients and is regarded as a valuable tool, capable of providing information leading to a better understanding of the resource and intervention effects at Marine Energy Converter (MEC) sites, in particular the Pentland Firth.</p>
Woolf, David ERI/UHI	<p data-bbox="461 1591 1356 1665"><u>Towards determining the exploitable resource of a real tidal channel; the inner sound of the Pentland Firth</u></p> <p data-bbox="461 1675 1356 1879">Summary of observations and measurements in the Inner Sound. Discussion of characteristics that may present obstacles to commercial development. A few initial modelling results that describe the scale of changes likely to result from substantial energy extraction will be presented. Discuss the types of environment study appropriate for this and other tidal channels of interest.</p>



Shields, Mark Aberdeen	<u>Go with the flow: Understanding the ecological implications of altering the hydrodynamics of the marine environment</u> The spatial scale and magnitude of potential ecological implications associated with a single demonstration device will be very different from that of a large commercial array of >100 devices. Given the ever-growing interest in developing technology for the extraction of energy from dynamic marine environments, it is important to understand the ecological consequences of changes in water flow and turbulence. Specialist communities of plants and animals exist in energy-rich marine environments suitable for the development of wave and tidal energy industry. However, the ecological implications of altering the hydrodynamics of the marine environment remain poorly understood.
Porter, Joanne Heriot-Watt	<u>Bryozoan diversity in Scottish Waters in Space and Time</u> In this project historical and recent records of Bryozoan distribution were assessed, selected and analysed using GIS mapping and diversity indexing. This is the first attempt at a comprehensive view of changes in Bryozoan diversity from the 1700's through to present day. In this presentation key patterns identified from the study will be discussed and suggestions for future development of the research will be put forward.
Bell, Michael Heriot-Watt	<u>Fishery interactions with marine renewable energy developments</u> Fisheries are arguably the longest standing users of the marine environment, but in the modern world they must exist alongside an increasing variety of other activities that rely upon sea areas for space or resources. The emergence of a new 'wet' marine renewables industry, targeting resources of kinetic energy in waves and tides is perhaps the most recent such activity. Given the rapid development of this sector, and the high potential seen by government, developers and investors, there is an urgent need to understand how marine energy extraction might interact with fisheries. The wave and tidal energy is as yet too young to provide real information on the extent to which fish or their habitats may be damaged or disturbed, or fishing activities displaced from their traditional grounds, but spatial overlaps between recent landings and the wave and tidal power resources provide an indication of the potential for interaction. At a national scale, the potential overlaps are relatively small, but it appears that there may be considerable potential for interaction at a local scale. This would most likely involve small inshore vessels for which there are few data on the fine-scale distribution of catch and effort. Simple spatial fishery models indicate that exclusion of fishing activities from areas around developments may have some potential to protect spawning potential and to increase resilience of yield at high



	<p>levels of fishing effort. However, at realistic levels of fishing ground closure, the benefits are likely only to apply to species of very limited mobility, i.e. shellfish. Potential for habitat creation around developments is also greatest for shellfish, e.g. settlement surfaces for mussels and creation of juvenile lobster habitat. In addition to improving the information available on fine-scale distribution of fishing effort, future research should concentrate on understanding how fish and shellfish are likely to move and aggregate around developments. Information is also needed on the near- and far-field effects of removing kinetic energy from waves and tides and the implications for biological productivity.</p>
<p>Batty, Bob SAMS</p>	<p><u>Predicting the abilities of marine vertebrates to evade collision with tidal stream turbines.</u></p> <p>Encounter models can be used to predict rates of encounter of animals with renewable energy devices. Actual collision frequency results from the product of encounter rate and the probabilities of avoidance and evasion. The use of encounter models highlights the need to have more detailed knowledge of the abundance and behaviour of animals at risk in tidal stream environments and to be able to both predict the likelihood of avoidance and evasion. Collision evasion by animals, taking action to avoid striking part of a device when on a collision course, depends both on the sensory cues, visual and sound, provided by the device and the sensory capabilities, behaviour and locomotor performance of the animal. An evasion model based on visual responses to looming objects and locomotor performance indicates that, for fish, the probability of evasion increases with fish size, as maximum swimming speed increases but is also critically dependent on blade thickness. Thin blades present a smaller looming target that will only exceed the animal's looming response threshold at too close a range allowing insufficient time for evasion. The relative velocity of the blade to the water is also critical. Below 6 m s^{-1} the probability of evasion is near to 1 but declines rapidly above that velocity. It is essential, therefore, that we obtain a better understanding of animals' use of tidal stream environments above this velocity. This will be a useful tool to estimate the probability of evasion for fish and may be extended to include mammals and birds. A transient sound stimulus evoked evasion model, based upon the pressure fields around turbine blades, will also be developed.</p>
<p>Guerin, Andrew ERI/UHI</p>	<p><u>Ecological impacts of marine renewables: research at ERI</u></p> <p>Tides and waves around Scotland will provide an extensive resource for generation of renewable energy. There is increasing interest in extracting this energy, but little is known about the environmental consequences. At ERI, we</p>



	<p>are working to improve our understanding of marine habitats in extreme hydrographic conditions, the species that use these habitats and how they interact with the physical environment. Data on 'baseline' ecological conditions prior to extraction of energy will be essential if we are to predict the scale and nature of potential impacts associated with deployment of marine renewable energy devices. We are quantifying distributions of seabed species and habitats using modern equipment including sidescan sonar and a remotely operated vehicle. Also of interest, is the colonisation of renewable energy devices by fouling organisms, including invasive species, while ecological models will be used to investigate how seabirds may be affected by these structures. Information gathered during these investigations will be invaluable for the statutory consenting process prior to deployment and for comparison with any changes occurring during use.</p>
<p>Last, Kim SAMS</p>	<p><u>Sensitivity of biogenic reef forming organisms and commercially important benthic invertebrates in an era of marine renewable development</u></p> <p>Scottish waters are at the forefront of developing marine renewable devices. The extent to which such devices will impact upon benthic marine organisms has not been fully assessed, and is largely unclear. More specifically, sedimentation shifts are expected during the offshore construction/decommissioning phases with possible long term changes associated with the use of underwater turbines and wave energy installations. Here I will outline some of the proposed behavioral and physiological assays we are developing to address the impacts of sediment burial and altered suspended sediment regimes on benthic invertebrates.</p>
<p>Want, Andrew Heriot-Watt</p>	<p><u>Biological sentinels of change in exposure to wave energy on rocky shores</u></p> <p>Exposure to wave energy is an important factor in determining the community structure and relative abundance of species found on the rocky shore. Removing energy by wave energy converting devices (WECs) might be expected to change exposure characteristics shoreward of their location. In addition, it is assumed that rising sea temperatures, as one component of observed global climatic change, will also alter the composition of species on the rocky shore. Interpretation of observed shifts in community structure following concurrent alterations in both of these two important environmental variables (i.e. energy exposure and sea temperature), as well as seasonal and other variables, will be challenging.</p> <p>Detecting wider ecological trends may be possible by observing population</p>



	<p>changes in sentinel species. Candidate species for monitoring should be adapted to specific exposure levels, are potentially located at or near their geographical distribution limits, and are sufficiently accessible and prevalent to allow reliable sample collection. Four littoral species have been short-listed for consideration on the wave exposed West Mainland of Orkney: <i>Chthamalus stellatus</i>, <i>Fucus distichus anceps</i>, <i>Gibbula umbilicalis</i>, and <i>Patella ulyssiponensis</i>.</p> <p>Discrimination between the relative roles played by energy exposure and sea temperature might be possible by monitoring changes in the relationship (such as littoral zone width and height, and abundance) between sentinel species and similar 'matched' species which respond differentially to changes in these environmental variables.</p> <p>The selected species are being monitored for distribution, abundance, density, and growth. Sampling regimes include: biometric measurements, quadrat photography, and density determination on intact and cleared sites that will provide baseline/control data for the west coast of Orkney, an important area to the future deployment of this developing technology.</p> <p>Key Words: wave energy, rocky shoreline, ecological monitoring, environmental variables.</p>
<p>Wilding, Tom SAMS</p>	<p><u>The Loch Linnhe Artificial Reef - an experimental arena to facilitate multidisciplinary research into the consequences of offshore structures</u></p> <p>Anthropogenic interventions in the coastal zone are increasing through land-reclamation, offshore power generation and the construction of artificial reefs to protect coastlines. However, relatively little is known about the impacts and potential secondary benefit of this ongoing expansion into our seas.</p> <p>The Loch Linnhe Artificial Reef (LLAR) is an experimental reef matrix that was completed in 2006 following a five year construction phase. The main reef complex consists of 30 separate reef modules each of 4000 concrete blocks (200 x 200 x 400 mm). Two types of blocks were used in the reef construction; one was solid (simple blocks), the other contained two voids (complex blocks) which were used to create either simple or complex block reefs (15 of each). Each replicate reef module is roughly conical in shape, stands 3.5 – 4.5 m off the seabed and lies at a depth of between 12 and 30 m in a varying current regime. The entire reef complex consists of 175,000 blocks equating to 6250 tonnes making it one of the largest experimental reefs in the world.</p>



	<p>The purpose of the LLAR is to promote research into the impacts of offshore structures and how they can be designed to promote fisheries. To that end SAMS has, over the last 10 years, conducted multidisciplinary reef-based research which is currently focussed on flow structures around the reefs (through physical and mathematical models) and the quantification of scale-dependent topographic complexity of the reef as drivers of biological assemblage structure and function.</p> <p>The objective here is to give an overview of the reef, from concept to construction, and to initiate additional collaborative effort to maximise the utilisation of this unique Scottish marine facility.</p>
<p>Side, Jon Heriot-Watt</p>	<p><u>End of session summary and filling the gaps</u></p> <p>This ‘catch all’ talk was designed to cover some aspects of HWU’s Orkney Campus work that had not been covered by other staff.</p> <p>It highlighted work on the terobuoy, a device designed to provide a quantitative measure of “exposure” on the shore, showed preliminary results from the initial deployments of these units, and highlighted the advantages of cheap, robust and site specific measurement that could be deployed alongside biological monitoring.</p> <p>The talk also summarised the work completed on the west coast of Orkney mainland to produce habitat/biotope maps from multi-beam and side scan surveys. This used site specific biological data in supervised classification methods.</p> <p>Also included was work undertaken for the measurement of the sound signatures of diving seabirds and the development of a buoy for this purpose and for the general measurement of underwater background noise.</p> <p>Work with Scotrenewables has resulted in a novel collision detection system to be installed on the prototype SRTT tidal turbine. This will provide for the first time actual data on collisions, of all types, with the rotors of the turbine.</p> <p>Finally the development of the multi-institution RASCAL HF radar project was summarised to provide near real-time data on wave and tidal currents over a wide-spatial area.</p>

**Day 2 (Thursday) Marine Renewables and Marine Spatial Planning**

Name	Title and Abstract
Mair, Hamish Heriot-Watt	<u>MASTS introduction overview</u>
Side, Jonathan Heriot-Watt	<u>MREDS introduction overview</u>
Johnson, Kate Heriot-Watt	<p><u>Governance, stakeholders and the European ambition for marine space</u></p> <p>The European Commission and member country governments have signalled their ambition to create jobs and economic growth from the marine environment. In 2009, European Commission President asserted the aim of economic growth from the seas with the objective that the growth should be sustainable and employ ecosystem based management. Historic mobile activities like shipping and fishing will have to compete with new fixed space occupying activities such as renewable energy, large multi-functional offshore platforms and artificial islands. Technologies open up new prospects for minerals, rare metals and biotechnologies from the seas. The recent and rapid change in the character of marine space from open commons into regulated international and national jurisdictions has required different thinking about marine property rights and the introduction of conflict resolution mechanisms such as Marine Spatial Planning (MSP). The emerging legal and regulatory frameworks are examined through the development of governance institutions balanced between state, markets and civil society. Examples are drawn from the UNCLOS Article 76 Commission work on jurisdictional claims and recent legislation from Scotland (the Marine Scotland Act 2010) with its emphasis on the existing and potential socio-economic benefits from the seas. A series of research questions arising from enclosure of the marine commons are identified focussed on public understanding and the decision-making process.</p>
Hull, Angela Heriot-Watt	<p><u>Marine Spatial Planning - a mechanism for conflict resolution; Lessons from terrestrial planning</u></p> <p>The use of the seabed and sea surface within the UK territorial waters is increasing with the growing market in marine renewable energy technologies. Aspirational targets by Marine Scotland and the Crown Estates set a tight timescale for the operation of the first tranche of energy devices by 2020.</p> <p>The presentation deals with the concept of 'Marine Spatial Planning' drawing first on what we can learn from the implementation of the terrestrial 'spatial planning' system, specifically the strengths and weaknesses of the UK land-based planning system. Research shows that the centralised nature of spatial</p>



	<p>planning in the UK leaves “left over” land to be planned by elected lower tiers of government. Many key strategic activities are managed and prioritised outside the formal planning system through other regulations, which diminish the area of land to be planned through UK democratic procedures. These activities include military bases and operations, installation of energy infrastructure, and the operational activities of public service operators.</p> <p>A hierarchy of plans is being prepared for Marine Spatial Planning in Scotland shaped by international obligations, EU Directives and through UK regulations such as the UK Marine and Coastal Act (2009). These plans mimic the structure and the process of terrestrial plans. There are several issues still to be addressed including:</p> <ul style="list-style-type: none"> • the interface between land and marine resource management • embedding an understanding of marine ecosystem interactions into decision making criteria, including the effects of anthropogenic pressures on resource use • defining a clear purpose for Marine Spatial Planning, for example, is the prime purpose data collection to inform sector management; to ensure policy integration across all the existing and proposed activities within 12 nautical miles from the high tide mark; or a mechanism to resolve conflicts between fisheries developments, renewable energy development and marine conservation. <p>These substantive issues remain to be addressed by Marine Scotland and the Crown Estates as well as achieving stakeholder engagement and consensus formation.</p>
<p>Goldschmidt, Pippa Marine Scotland</p>	<p><u>Marine Scotland’s Pentland Firth and Orkney Waters pilot marine spatial plan</u></p> <p>Abstract to follow</p> <p>The presentation explained the stages in the PFOW MSP and locational guidance for marine renewables in the area. Giving the background the talk explained why this pilot had been chosen and the studies and stages needed to move to the statutory plan. Key outstanding questions and future updates of the SEA and HRA were explained.</p>
<p>Kerr, Sandy Heriot-Watt</p>	<p><u>Planning For Marine Energy: Research Opportunities</u></p> <p>The commercialization of marine energy development will present the UK planning system with a number of challenges and this in turn creates opportunities for research. Three areas are considered:</p> <p>(1) <u>Data gathering and its management</u>: the availability of reliable</p>



	<p>environmental data is a prerequisite to efficient planning. Indeed much of the early development of marine planning in Scotland has focused on data gathering. A SRDG stakeholder workshop (held in December 2010) revealed a number of concerns and issues about environmental monitoring and the management of environmental data. There was a lack of understanding of basic concepts and a lack of clarity of the division of responsibility between state and private sector for the collection of environmental data. Furthermore a general acceptance that sharing data was a good thing was tempered with concerns about commercial sensitivity and a belief that any data sharing would have to be facilitated or even regulated for.</p> <p>(2) <u>The interface between marine and terrestrial planning systems</u>. Marine energy systems have significant onshore requirements which are as yet not well understood. Because marine energy systems cross the land sea divide this will result in interaction (and potentially conflict) between relatively more centralized marine planning and more localized terrestrial planning systems</p> <p>(3) <u>Public perceptions of marine energy futures</u>. The current deployment of marine energy devices is on a small scale compared to future plans. We are in what could be described as in a “honeymoon period” in terms of public acceptability. The situation mirrors the early development of wind energy technology in Scotland where the first full scale prototype devices were generally welcomed but stakeholder positions have since diverged and hardened as the onshore industry has commercialized. If stakeholder perceptions of marine energy futures diverge significantly from reality then there is scope for conflict as the sector commercializes.</p>
<p>Benjamin, Jonathan Wessex/Edinburgh</p>	<p><u>Cultural heritage and the marine environment: research, management and cooperation with industry</u></p> <p>Current research in the archaeology of marine environments demonstrates that Scotland’s coastal zones represent an important, though poorly-understood, area for heritage managers. While marine industry and the general public are familiar with maritime archaeology and naval history (i.e. shipwrecks, ancient ports, etc.), less emphasis has been placed on the prehistoric archaeological potential despite significant underwater discoveries taking place elsewhere throughout northern Europe. Due to post-glacial sea-level rise (of up to 130 m during the past 18,000 years), many of Scotland’s prehistoric terrestrial landscapes are now underwater. Understanding these processes requires an analysis of long-term environmental and cultural variables. There is thus a need to share data (and standards) and work collaboratively within the marine</p>



	<p>sciences and marine industry to help evaluate and prioritise areas where Scotland's cultural heritage now exists offshore.</p>
<p>Downes, Jane Orkney College/UHI</p>	<p><u>Marine renewables and marine historic environment assessment: an Orkney perspective</u></p> <p>The unique and diverse nature of the land-based and coastal cultural heritage in and around the Scottish highlands and Islands is well known, but the submerged historic environment is more of an unknown quantity. The development of capabilities and facilities to fill this research and development need as part of Orkney's knowledge base will be outlined and, using case studies from the Orkney waters and Pentland Firth, approaches to the rapid and effective characterisation and evaluation of the marine historic environment will be discussed.</p>
<p>Bates, Richard Aberdeen</p>	<p><u>Paleolandscape Reconstructions; the archaeological potential of the marine sector</u></p> <p>The UK, and Scotland in particular, has a diverse and intricate coastline that we are all familiar with. The shape and extent of the coast was not always what we see today. Over the past 400ka changes in sea level due to isostatic and eustatic conditions caused by glacial/interglacial fluctuations has resulted in periods when the UK was joined to the continent by a large land bridge and times when we were an island. Archaeological evidence suggests that this land, which is now submerged beneath the North Sea was extensively used by man. Furthermore, following the last cold period at 11-10ka man not only occupied this submerged land but had to retreat closer and closer to our present day shore as the sea level rose. The submerged zones last occupied by man will be those that new marine renewables developments are likely to be targeted within. Further research is necessary to assess the impact of developments on this cultural resource.</p>
<p>Dawson, Sue Dundee</p>	<p><u>Relative Sea Level Changes in Orkney</u></p> <p>The reconstruction of relative sea level change for Orkney is complex, caused by the interplay of glacio-isostatic rebound and the global eustatic rise in sea level following the melting of the last Scottish ice sheet. The variable ice extent and thickness of the last ice Late Devensian ice sheet mean that for some areas of Scotland raised beaches are evident in the landscape (e.g. Jura and around Oban on the west coast); whilst other areas are dominated by submergence and evidence for former changes in the level of the sea are buried (e.g. Outer Hebrides and Orkney). GIS reconstruction using the position of the coastline 10,000 years ago and detailed bathymetry allows the former</p>



	<p>extent of the coastline to be determined. For Orkney this places sea level c. 30m below present and therefore it becomes one large island. The separation of that one large island would have taken place as sea level rose in the early and middle Holocene.</p> <p>Models of relative sea level change (after Peltier and Lambeck) are speculative as there has been limited detailed study of the region to date. Strath Halladale in N Sutherland provides the nearest estimation to Orkney and shows a rise from -8m below present at c 8000 years and reaching present levels 3-4000 years ago. Detailed stratigraphic work around the Loch of Stenness (mainland Orkney) shows sea levels approached present day levels around 4000 years ago. Recent maps detailing the present day rates of change in sea level as measured by GPS show variability across Scotland and reflect the lack of detailed study in Orkney. The Rising Tide project is currently working on Holocene rates of change and therefore will contribute to the accuracy of such Scotland-wide maps in the future.</p>
<p>Wickham-Jones C Aberdeen</p>	<p><u>Transition Zone Prehistory: studying Early Holocene sea-level change in Orkney</u></p> <p>Work on Holocene sea-level change in Orkney indicates that relative sea-levels only reached present position c.4000 years ago, substantially later than the arrival of the first population of Orkney c.9000 years ago, and nearly two millennia after the development of farming in the islands c.6000 years ago. Significant sites may survive below present sea-level.</p> <p>The Rising Tide was set up in 2005 with two aims</p> <ol style="list-style-type: none"> 1. To build a sea-level curve relating to past changes in relative sea-level around Orkney 2. To investigate the possibility that remains of past human settlement might be preserved on the seabed. <p>The project uses eight different strands of work:</p> <ol style="list-style-type: none"> 1. Sediment coring to date the rising relative sea-levels and construct a sea-level curve 2. Remote sensing to record submerged palaeo-shorelines, landscape features and possible archaeological sites 3. Diving to ground-truth the results of remote sensing 4. Inter-tidal survey to record surviving stone structures and the processes of decay. 5. Palaeo-environmental analysis on land and in the inter-tidal zone to



	<p>provide information on changing landscape and environment.</p> <ol style="list-style-type: none">6. Aerial photography to investigate the visibility of material on the seabed7. Archive searches to provide information on past uses of the seabed8. Ethno-archaeology to combine information from recent and older myths and stories that relate to sea-level change <p>Work to date focuses on the Bay of Firth in order to provide detail of a contained, but promising area. The bay was selected as a case study due to its position at the heart of the archipelago offering classic sheltered conditions conducive to site survival after submergence; the geographical conditions of the bay offer the potential for the survival of pockets of sediment as well as sheltered waters to facilitate survey; finally there is a strong ethno-archaeological record relating to the bay. It is hoped that the Bay of Firth will act as a test case and provide an indication of the potential of other areas of Orkney.</p> <p>Current conclusions are preliminary. It is clear that a submerged landscape exists and is a real issue around Orkney: first indications suggest that submerged structures of varying date may survive on the seabed. In addition to building a sea-level curve for Orkney we are shaping a methodology by which to study and assess submerged sites. This is important for the management of the seabed. In the long run this should be of use elsewhere in Scotland.</p>
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Day 3 (Friday) MASTS Mapping JRT Workshop

Name	Title and Abstract
<p>Mair, Hamish Heriot-Watt</p>	<p><u>MASTS JRT on 'Marine Biodiversity and Ecosystem Function' - introduction and some mapping studies (Scotland and Latin America) plus potential for international collaboration</u></p> <p>Abstract to follow</p> <p>The presentation first explained the background to MASTS, the nine joint research themes (JRTs) and several cross cutting issues including renewable energy. It went on to describe the Centre for Marine Biodiversity and Biotechnologies (CMBB) at Heriot-Watt University and explore the policy impacts of CMBB based research with examples from the UK, Panama and the Darwin Project (Panama and Colombia)</p>
<p>Roberts, Murray Heriot-Watt</p>	<p><u>Developing a partnership approach to marine habitat mapping: the MINCH project and the discovery of Scotland's only known inshore coral reef</u></p> <p>J Murray Roberts, Centre for Marine Biodiversity & Biotechnology, Heriot-Watt University</p> <p>To date the only known inshore cold-water coral reef is the Mingulay Reef Complex discovered in 2003 by the MINCH project partnership. The evolution of the MINCH (Mapping Inshore Coral Habitats) partnership provides a case study of how academic and regulatory agencies can pool their resources to collaborate on successful marine habitat mapping. Following historical literature review and exploratory echosounder and sampling surveys, the MINCH partnership was formed to conduct one of the first Scottish marine habitat mapping surveys to use a multibeam echosounder alongside targeted ground-truthing with seabed video and bottom sampling. This is now the standard approach for many marine habitat mapping operations. The project was led by the Scottish Association for Marine Science with the British Geological Survey, TOPAZ Environment & Marine (University of St Andrews) and the Department of Agriculture & Rural Development (DARD Northern Ireland). Ship time was provided by DARD in return for access to the multibeam echosounder equipment (contracted to Kongsberg-Simrad & Fathoms Ltd). Partner costs were provided largely in kind and funding to hire the sonar equipment was provided by the then Scottish Executive and Scottish Natural Heritage. The 2003 survey succeeded in locating three areas of cold-water coral reef formed by <i>Lophelia pertusa</i>. Subsequent mapping by the Royal Netherlands Institute for Sea Research through the European Commission HERMES project discovered two additional regions,</p>



	<p>including a large predominantly live area nick-named the 'banana reef'. Work through the HERMES project has also examined the hydrographic environment surrounding the Mingulay coral reefs revealing two food supply mechanisms, a periodic rapid downwelling of surface waters (hydraulic jump) and advection of bottom waters across the reefs. Studies are on-going into several aspects of reef development (e.g. U/Th and ¹⁴C dating coral cores) and the processes that control local patterns of biodiversity. The reef complex is currently a candidate Special Area of Conservation (SAC). Through MASTS, Heriot-Watt University and Marine Scotland Science have established a new collaboration to establish a pre-SAC monitoring survey including both visual video surveys and sediment sampling for particle size analysis. The MINCH project provides a good example of how a low-cost partnership approach not only has led to a novel candidate conservation area but has promoted a rapid growth in basic ecological understanding of a key vulnerable marine ecosystem. This approach demonstrates the benefits of collaborative interdisciplinary research in the marine environment to achieve scientific advances that inform policy while making the most effective use of available resources, fulfilling the maxim 'to do more with less'.</p> <p>References</p> <p>Roberts JM, Davies AJ, Henry L-A, Duineveld GCA, Lavaleye MSS, Dodds LA, Maier C, van Soest RWM, Bergman MIN, Hühnerbach V, Huvenne V, Sinclair D, Watmough T, Long D, Green S, van Haren H (2009) Mingulay reef complex: an interdisciplinary study of cold-water coral habitat, hydrography and biodiversity. Marine Ecology Progress Series 397: 139-151</p> <p>Roberts JM, Brown CJ, Long D, Bates CR (2005) Acoustic mapping using a multibeam echosounder reveals cold-water coral reefs and surrounding habitats. Coral Reefs 24: 654-669</p>
<p>Sanderson, Bill Heriot-Watt</p>	<p><u>Mapping Marine Protected Areas to inform management and conserve biodiversity</u></p> <p>Abstract to follow</p> <p>The presentation considered issues of habitat mapping and environmental management focussing on survey of <i>modiolous</i> reefs at sites around the Irish Sea. Survey methods were reviewed and results analysed to determine longevity and stability of the reefs over time. The presentation described how mapping informed MPA boundary setting; spatial fisheries management; condition monitoring and enforcement.</p>
<p>Bates, Richard Aberdeen</p>	<p><u>Sensor technology suitable for biodiversity mapping</u></p> <p>Over the past 10years there has been considerable development in marine survey in both sensors and the technologies used for deploying sensors.</p>



	<p>Standard practice for benthic habitat mapping and monitoring has changed to reflect not only the increasing resolution that advanced sonar technology is providing but also the ability to routinely survey with near 100% coverage of the seafloor. In particular, multibeam sonar and very-high resolution sidescan sonar provide centimetre detail on a cost-effective basis with deployment on bespoke vessels but also vessels of opportunity. A new generation of sonar instrumentation is now becoming available that can be deployed on remotely operated vehicles and autonomous underwater vehicles. It is postulated that these new platforms will offer significant advantages for survey and monitoring. In particular, these technologies could provide specific support for survey at many of the marine renewable sites and across the infrastructure support zones as requirements move into increasingly shallow water.</p>
<p>Stewart, Heather BGS</p>	<p><u>Marine Environmental Mapping – Perspective from the British Geological Survey</u></p> <p>The British Geological Survey (BGS) has been acquiring offshore data for more than 40 years. This summer the BGS Marine Geoscience Team launched MAREMAP (Marine Environmental Mapping Programme) a joint scientific marine mapping venture with the National Oceanography Centre, Southampton (NOCS) and the Scottish Association of Marine Science (SAMS). This collaborative project will produce a new series of marine environmental maps that will include layers of acquired data such as multibeam echo sounder, as well as interpreted layers such as sea-bed sediments, geomorphology and Quaternary geology. Where possible, collaboration with other partners would result in other data layers being included such as observed/mapped habitats or biological associations.</p> <p>The BGS shallow water boat <i>The White Ribbon</i> has been used these last few months to acquire multibeam echo sounder data in Lake Windemere, the Firth of Forth, The Firth of Clyde and Loch Eribol. The BGS is keen to collaborate with other partners on scientific mapping of near shore areas and lochs with <i>The White Ribbon</i>. Data acquired will feed into the MAREMAP project.</p> <p>Ongoing areas of work for the author centre on the approaches to the Forth of Forth and the deep-water areas to the west of Scotland. The approach to the Firth of Forth is an area where UK Hydrographic Office data reveals a complex sea-bed topography documenting the advance and retreat of glaciers during the last British Ice Sheet indicating that the Wee Bankie is a much more complex</p>



	<p>moraine than previously thought. Data acquired for the Strategic Environmental Assessment (SEA)¹ of Hatton Bank, East Rockall Bank, Anton Dohrn and George Bligh Bank in the NE Atlantic in 2005 and 2006 have been used to interpret the sea-bed sediments and geomorphology of those deep-water areas. These data have been augmented with data acquired during the JNCC funded SAC survey² to East Rockall Bank and Anton Dohrn Seamount in 2009. The geological interpretations have been utilised as a framework on which to place smaller-scale biological interpretation. The relationship between the biological communities and the underlying geology has been used to extend the biological interpretation over the entire survey area which is crucial for the development of a network of Marine Protected Areas.</p>
<p>Crawford-Avis, Oliver JNCC</p>	<p><u>Marine Protected Areas in the Seas Around Scotland: Conserving Scotland's seas for both people and nature</u></p> <p>The Marine (Scotland) Act and the UK Marine & Coastal Access Act include new powers to designate Nature Conservation Marine Protected Areas (MPAs) in the seas around Scotland to protect nationally important species, habitats and features of geological/geomorphological interest, enabling Scotland to better make its contribution to UK commitments for an ecologically coherent network of MPAs. The identification of Nature Conservation MPAs will be a science-led process, underpinned by a detailed set of Site Selection Guidelines³ and undertaken as part of a joint project between Marine Scotland (Scottish Government); Scottish Natural Heritage (SNH) and the Joint Nature Conservation Committee (JNCC). The Site Selection Guidelines set out a vision and principles for the identification of Nature Conservation MPAs in the seas around Scotland and have been agreed in conjunction with stakeholders. We are keen to work with MASTS on improving our knowledge of the distribution and presence of the features which are underpinning the identification of Nature Conservation MPAs - 'MPA Search Features' - to better ensure we use the best level of scientific evidence available to underpin site selection.</p>

¹ The SEA surveys were paid for by the UK Department of Trade and Industry (now the Department of Energy and Climate Change www.offshore-sea.org.uk) and Defra (Department of Environment, Food and Rural Affairs www.defra.gov.uk/).

² LONG, D, HOWELL, K L, DAVIES, J, and STEWART, H. 2010. JNCC Offshore Natura survey of Anton Dohrn Seamount and East Rockall Bank Areas of Search. *JNCC Report Series 437*.

³ <http://www.scotland.gov.uk/Topics/marine/marine-environment/mpanetwork/draftmpaguide>

Final guidelines will be published in November 2010. The selection guidelines do not consider future management of MPAs. This will be covered by a separate piece of guidance which will be produced in 2011.



<p>Buhl- Mortensen, Paul IMR Norway</p>	<p><u>Classification and prediction of deep-water habitats in Norway</u></p> <p>Abstract to follow</p> <p>The presentation described the long term work (past, present and future) of the MAREANO project (Marine Arial Database for Norwegian Sea Areas). The project started out with the ambition to map all the Norwegian seas although budget limits will require priorities to be established. Methods and results to date were reported. The main outputs were described as:</p> <ul style="list-style-type: none">• Detailed bathymetric maps• Fine-scaled information about sediment types, habitats, and geological features• Distribution of benthic fauna, biodiversity. Communities, and production• Environmental status for sediments• Arial database for Norwegian coastal and offshore areas <p>The conclusions drawn included:</p> <ul style="list-style-type: none">- Nature types with few characteristic species should be carefully described to avoid lumping together- Analysing samples from very different environments may hide details in classification- More effort to analyse the effect of scale (spatial resolution) on the classification of nature types- Better maps of the seabed environment (currents, temperature, etc) will probably enable better predictions- Make the maps useful for management (fill the naturetypes with useful information, e.g. presence of threatened or red-listed species, normal biodiversity).
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