

## NEWS

### TCBR PhD Studentship Awarded

The TCBR PhD Studentship in Biodiversity and Conservation has been awarded to Alwynne McGeever to work on a project entitled "Quantification of tree population dynamics". Alwynne is a TCD Plant Sciences graduate and will start the PhD in September 2013, supervised by Fraser Mitchell.

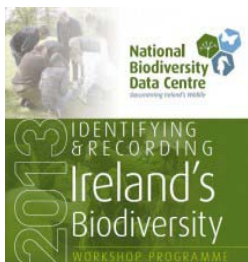


Alwynne McGeever

Disease, climate change and human activities have long term impacts on tree populations, but the longevity of trees challenges the investigation of their dynamics. This project aims to develop models of long term tree population dynamics using pollen data covering millennial timescales analysed by adapting epidemiological methods. Pine and elm have been selected for analysis because of their dynamic but contrasting histories in Europe over the last 6,000 years. The aims will be achieved by collating data from the European Pollen Database and analysing the spatial and temporal trends in declines and recovery of these taxa. Climate, edaphic and human impact data will be analysed to consider possible drivers. This will require collaboration with a statistician in Dublin and palaeoecologists in the UK.

There will be a further focus on pine in Ireland. This tree was extirpated from several countries in Europe in recent millennia but recent research suggests that a population may have survived in western Ireland. This will be tested through pollen and stomatal analysis. Identifying a native stand of pine in Ireland will have significant consequences for conservation and forestry policy.

### Identifying & Recording Ireland's Biodiversity



The National Biodiversity Data Centre has been providing identification workshops since 2009 with the aim of improving identification and field skills of biological groups and raising standards of data collection and

management. The extensive workshop programme for 2013 will focus on areas identified through a recent public survey as well as key knowledge gap areas identified through the 'State of Knowledge on Ireland's Biodiversity' reports. 2013 will see skills taken to an advanced level for some groups whilst still providing a wide range of courses for beginners and refreshers. Places are limited so early booking is advised <http://www.biodiversityireland.ie/home-page/event-registration/>.

### Preliminary Results of the Trinity BioBlitz

The first ever Trinity campus BioBlitz, organised by the MSc. Biodiversity and Conservation class took place on the 22nd of May. During just four hours of recording, we found 126 species on Trinity Campus: 94 species of plant, 19 bird species, 7 insects, 3 non-insect invertebrates, and 1 species each of lichens, fungi and mammals. The latter was the fox, *Vulpes vulpes*, which live on campus. The weather was pretty dismal which probably accounts for the low number of insect species observed on the day. Well done to all the recorders, identifiers, data enterers, and particularly to the MSc class, led by Karen Shevlin and Sheila Murphy who organised the event. The data will be sent to the National Biodiversity Data Centre (<http://www.biodiversityireland.ie/>).



BioBlitz taxon distribution. Courtesy of Ainhoa González.

### TCBR AGM

The TCBR holds its annual general meeting on September 17th. The TCBR Steering Committee will be reviewed and the activities carried out in this academic year presented. The meeting will provide the opportunity to discuss future initiatives. All are welcome. For further information on venue and agenda, contact the TCBR acting director, Trevor Hodkinson at [Trevor.Hodkinson@tcd.ie](mailto:Trevor.Hodkinson@tcd.ie).

## NEWS

### Public Perceptions on Cultural Values of Natural Areas

Sara Gomes, TCBR's intern for the last 4 months, has undertaken a survey to gather public perceptions on the subjective values assigned to the natural areas according to the uses they provide. The preliminary survey results indicate that in urban areas, green parks and gardens are the most valued habitats, while in rural areas agricultural land uses are perceived as most important. Interestingly, peatlands were not perceived by any interviewees as of significant value. The respondents noted that the importance of land uses / habitats is mostly based on the uses they provide.

It is also observed that, for the most part, interviewees selected the predominant habitat of their home place as of most value. Nevertheless, when asking what habitat they would prioritise if they could only choose one, the response in all cases pointed to the protection of forests due to the services they provide in terms of biodiversity and oxygen.

The survey results are currently being analysed and will be made available in the TCBR Website.

### Marine Scientists Explore Biodiversity and Ecosystems in Irish Waters

A team of 14 scientists, led by National University of Ireland Galway's Dr Louise Allcock, recently returned to Galway following a three-week deep sea research survey aboard the Marine Institute's RV Celtic Explorer.

Building on the success of two previous research surveys, the Biodiscovery and Ecosystem Function of Canyons Survey investigated a wide diversity of habitats and underwater communities in the Whittard Canyon system on the Irish Atlantic margin.

Many of the specimens collected by the research team, including a rare five kilogram sponge, will be used in biodiscovery research. Marine organisms, including the bacteria in sediment, often produce complex chemicals, some of which are likely new to science. Biochemists and chemists will extract these chemicals and test them for antibacterial and other pharmaceutical properties with the ultimate aim of synthesising useful new chemicals in the laboratory.

Read more at: <http://phys.org/news/2013-07-marine-scientists-explore-biodiversity-ecosystems.html#jCp>

### Environ 2014

The 24th Irish Environmental Researchers' Colloquium, ENVIRON 2014, will be held in Trinity College Dublin, from Wednesday to Friday 26th-28th February, 2014.

Dr Jane Stout, Prof Fraser Mitchell and Prof Bruce Misstear, members of the TCBR, are in the organising committee responsible for developing and deciding on theme, sessions and workshops. If you have any suggestions, please e-mail Ainhoa at: [agonzal@tcd.ie](mailto:agonzal@tcd.ie).

### Upcoming Workshop: Natural Capital: Ireland's Hidden Wealth

We often say that nature is priceless, but we often treat it as though it were economically worthless: we fail to include the value of natural capital resources, and the ecosystem goods and services that flow from them, in our national accounting systems like GDP. However, that is changing very rapidly: governments and business leaders alike now recognise that there is an urgent need to accurately evaluate the benefits and costs of our relationship with the environment in economic terms, as the impacts of diminishing resources, increasing environmental degradation, and climate change, become more and more apparent.

Ireland is already committed, under EU and national legislation, "to assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020." But there has been very little general awareness of this commitment to date. Work on this exciting – and challenging – endeavour is only beginning here, but some very promising studies have already been done, here and internationally, which unlock hidden wealth in our landscapes.

TCBR is involved in organising a conference to highlight and advance this important task with government, private and semi-state corporations, national institutions and the general public on 28th and 29th April, at the National Botanic Gardens, Dublin.

The aim of the conference is to provide a clearer and more positive understanding of natural capital values, using international and national case studies. In order to value nature's 'priceless' services effectively, we have to learn to put accurate prices on them. We must revise mainstream accounting systems to incorporate natural capital values. This conference will assist this process, outlining current best practice in accounting methodology.

## RECENT PUBLICATIONS

## Journal Articles

**Abdalla M**, Saunders M, Hastings A, **Williams M**, Smith P, Osborne B, Lanigan G, **Jones MB** (2013). Simulating the impacts of land use in Northwest Europe on Natural Ecosystem Exchange (NEE): The role of arable ecosystems, grasslands and forest plantations in climate change mitigation, *Science of the Total Environment*, doi: 10.1016/j.scitotenv.2012.12.030.

**Coote L**, **Dietzsch AC**, Wilson MW, Graham CT, Fuller L, Walsh AT, Irwin S, **Kelly DL**, Mitchell FJG, Kelly TC, O'Halloran J (2013). Testing indicators of biodiversity for plantation forests, *Ecological Indicators*, 32:107-115.

**Davies AR** (2013). Social groups and collective decision-making: Focus Group approaches. In Fahy F, Rau H (eds), *Methods for Sustainability Research in the Social Sciences*, Sage: London, pp53-71.

**Davies AR** (2013). When clean and green meets the Emerald Isle: contrasting waste governance narratives in Ireland and New Zealand. In editor(s) Zapata M, Hall, M (eds), *Organising Waste in the City*, The Policy Press: London, pp63 - 82.

Devoy JK, **Holland CV** (2013). A comparison of *Toxocara canis* embryonation under controlled conditions in soil and hair, *Journal of Helminthology*, 87: 78-84.

Doyle R, **Davies AR** (2013). Future visions for sustainable household practices in Ireland: creating and assessing sustainable home heating scenarios, *Journal of Cleaner Production*, 48: 260-271.

Gautier TG, Wyse **Jackson PN**, McKinney FK (2013). Adlatipora, a distinctive new acanthocladiid bryozoan from the Permian of the Glass Mountains, Texas, U.S.A., and its bearing on fenestrate astogeny and growth, *Journal of Paleontology*, 87(3): 444-455.

**Gray NF** (2013). Pathogen control in drinking water. In Percival S, Gray NF, R. Chalmers R, Sellwood J (eds), *Microbiology of Waterborne Diseases: Microbiological Aspects and Risk*, Academic Press: London, pp1-32.

Kenna KP, McLaughlin RL, Hardiman O, **Bradley DG** (2013). Using reference databases of genetic variation to evaluate the potential pathogenicity of candidate disease variants, *Human Mutation*, 34(6): 836-841.

Lapple D, Hennessy T, **Newman C** (2013). Quantifying the economic return to participatory extension programmes in Ireland: An endogenous switching regression analysis, *Journal of Agricultural Economics*, 64(2): 467-482.

McNabola A, O'Lunaigh N, Gallagher J, **Gill LW** (2013). The development and assessment of an Aspiration Efficiency Reducing system of air pollution control for particulate matter, *Energy and Buildings*, 61: 177-184.

Mullen EM, MacWhite T, Maher PK, **Kelly DJ**, **Marples NM**, Good M (2013). Foraging Eurasian badgers *Meles meles* and the presence of cattle in pastures. Do badgers avoid cattle?, *Applied Animal Behaviour Science*, 143: 130-137.

Noone C, Parkinson M, Dowling DJ, Aldridge A, Kirwan P, Molloy SF, Asaolu SO, **Holland CV**, O'Neill S (2013). Plasma cytokines, chemokines and cellular immune responses in preschool Nigerian children infected with Plasmodium falciparum, *Malaria Journal*, 12:5. doi:10.1186/1475-2875-12-5.

O'Brien RJ, Misstear BDR, **Gill LW**, Deakin J (2013). Applying an integrated hydrograph separation and lumped modelling approach to quantifying flow pathways in Irish river catchments, *Journal of Hydrology*, 486: 259-270.

Perrin PM, **Mitchell FJG** (2013). Effects of shade on growth, biomass allocation and leaf morphology in European yew (*Taxus baccata* L.). *European Journal of Forest Research*, 132, DOI: 10.1007/s10342-012-0668-8.

Power EF, **Kelly DL**, **Stout JC** (2013). The impacts of traditional and novel herbicide application methods on target plants, non-target plants and production in intensive grasslands, *Weed Research*, 53: 131-139.

Power EF, **Kelly DL**, **Stout JC** (2013) Impacts of organic and conventional dairy farmer attitude, behaviour and knowledge on farm biodiversity in Ireland. *Journal for Nature Conservation*, 21: 272– 278.

Smith RJ, **Waldren S** (2013). Gynodioecy in *Campanula trachelium* L., *New Journal of Botany*.

**Stevenson A**, **Rocha C** (2013). Evidence for the bioerosion of deep-water corals by echinoids in the Northeast Atlantic, *Deep-Sea Research*, 71: 73-78.

**Stanley DA**, Knight ME, **Stout JC** (2013). Ecological variation in response to mass-flowering oilseed rape and surrounding landscape composition by members of a cryptic bumblebee complex, *PLoS one*, 8(6), pe65516.

Ugoletti P, Reidy D, **Jones MB**, **Stout JC** (2013). Do native bees have the potential to promote interspecific pollination in introduced *Impatiens* species?, *Journal of Pollination Ecology*, 11(1): 1-8.

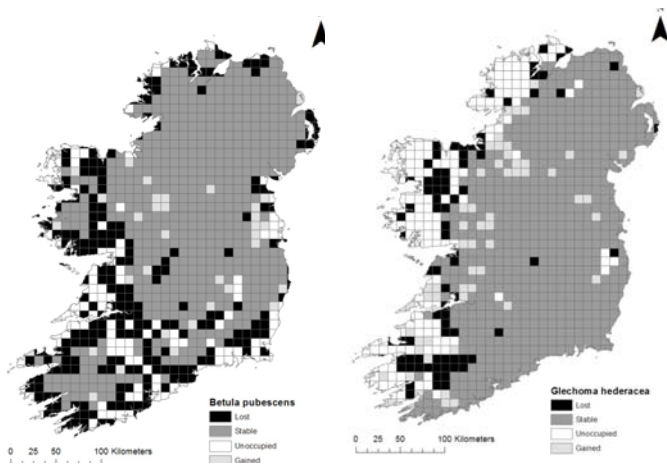
Viana M, **Jackson AL**, Graham N, Parnell, AC (2013). Disentangling spatio-temporal processes in a hierarchical system: a case study in fisheries data. *Ecography*, 36(5), 569-578.

## FEATURED PUBLICATION

**Climate change impacts on woodland species: implications for the conservation of woodland habitats in Ireland** by Sharkey N, Jones M, Bourke D.

Accepted for publication in *Biology and Environment*.

Global climate is rapidly changing and, while many studies have investigated the potential impacts of climate change on the distribution of woodland species in the wider European context, few have focused on the impacts of climate change on the distribution of woodland species in Ireland. This study evaluates the potential impact of climate change on the distribution of species characteristic of woodlands, and assesses the implications for the conservation of woodlands in Ireland. Only some 2% of the land area of Ireland is covered in semi-natural woodlands, including communities which are conservation priorities such as bog woodland, alluvial forests, and *Taxus baccata* (Yew) woods.



Species distribution maps showing the projected change in distribution for *Betula pubescens*, a Eurosiberian species (left) and *Glechoma hederacea*, a Eurasian species (right).

Courtesy of Nova Sharkey.

We applied an ensemble of species distribution modelling techniques, using atlas data for 104 vascular plant, bryophyte, bird and butterfly species from Ireland, baseline climate data (1961-1990) and projected future climate data (HadCM3 GCM; 2031-2060), at a 10 km<sup>2</sup> resolution. Of the 104 species, 44 modelled well in at least 6 of the 8 models. Under a scenario of unlimited dispersal, almost 50% of species which modelled well were projected to lose climate space, with the largest range contraction projected for the butterfly *Aphantopus hyperantus* (Ringlet; -47.7%). The remainder were projected to have increased climate space, with *Thecla betulae* (Brown hairstreak) and *Frangula alnus* (Alder

buckthorn) having the largest projected increases of 886% and 532% of their current ranges. When a scenario of limited long-range dispersal was considered, all species were projected to lose some of their current range, from a decrease of 52.4% for *Carex strigosa* (Thin-spiked wood-sedge) to a decrease of 10.9% for *Saxifraga spathularis* (St. Patrick's cabbage). These results have significant implications for the future of woodlands in Ireland. Conservation management plans for these habitats need greater focus on potential climate change impacts in order to ensure these communities' long-term survival.

The article above is part of the BIOPLAN project (<http://www.ucc.ie/en/planforbio/projects/bioplan/>), funded by Council for Forest Research and Development (COFORD).

## UPCOMING CONFERENCES

**Measuring and Monitoring Biodiversity Offshore**

Dates: 12th and 13th of September 2013

Venue: Marine Court Hotel, Bangor, UK.

This conference is delivered in the context of the imminent new Northern Ireland Marine Bill, and the heightened offshore activity around Northern Ireland, particularly within the renewable energy sector. The aims of the conference are:

- To create a network of people who are stakeholders in, or may become engaged in, offshore biodiversity monitoring.
- Identify the gaps in knowledge, and develop network 'buy-in' to the filling of these gaps.
- Develop prioritised recommendations for future measuring and monitoring of biodiversity offshore.

For further detail visit: <http://www.bto.org/news-events/events/2013-09/mambo-conference>.

**Environment Ireland 2013**

Dates: 12th September 2013

Venue: Croke Park, Dublin.

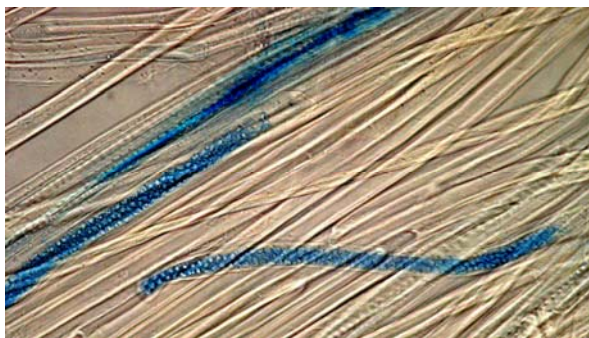
Environment Ireland, now in its ninth year, is Ireland's major annual conference on environmental policy and management. The conference is organised in association with the EPA and the Department of Environment, Community and Local Government. It provides an important opportunity for all the key players in the environment sector to come together for networking and discussion. Further information: <http://www.epa.ie/newsandevents/events/environmentireland2013.html>

## RESEARCH FOCUS

**Isolation of Low Temperature Tolerant Beneficial Fungal Root Endophytes of Barley by Brian Murphy**

There is an increasing chemical load on the environment, partly due to high agro-chemical inputs. More sustainable methods that would reduce chemical use, while still maintaining crop performance, are needed. Bio-control and bio-fertilisation methods are often longer lasting than chemical applications in their effects, can reduce labour time, and are also generally more environmentally friendly. Beneficial endophytic root fungi have been shown to increase yield, enhance stress tolerance and induce pathogen resistance in many crop plants.

A PhD research by Brian Murphy, funded by TCD, supervised by Dr Trevor Hodgkinson and Dr Fiona Doohan (UCD) investigates the natural occurrence, diversity and efficacy of fungal root endophytes in cultivated and wild Irish barley. Competent fungal strains suitable for Irish conditions could be used in various forms for crop inoculation. Irish agriculture could significantly benefit from any positive outcomes from this research, with potential reductions in fungicide, pesticide and fertiliser use. Future global warming may result in altered Irish crop growing conditions, and this area of research could therefore become increasingly relevant.



Root endophytes. Courtesy of Brian Murphy.

**Spring Foraging Resources and the Behaviour of Pollinating Insects in Fixed Dune Ecosystems**

by Aoife O'Rourke

In temperate climates, foraging resources for pollinating insects are especially important in early spring when animals emerge from hibernation and initiate annual life cycles. One habitat, protected under EU law, which provides resources for a range of pollinating insects, but has received little research attention, is fixed (grey) dunes. Fixed dunes often contain creeping willow (*Salix repens* L., Salicaceae), which may be an important early season resource for bees and other visitors.

Researcher Aoife O'Rourke, a TCBR member from the Botany Department, in conjunction with her supervisors Dr Jane Stout (TCBR Director) and Dr Úna Fitzpatrick (National Biodiversity Data Centre - NBDC), examined the springtime activity of flower visitors in fixed dune ecosystems in relation to: sugar concentration and composition in nectar; composition of essential amino acids in pollen; and floral abundance of 13 flowering plant species. They also investigated whether the presence or absence of *S. repens* influenced the abundance and species richness of three obligate flower visiting guilds (solitary bees, bumblebees and hoverflies) in eight sites along the eastern and southern coasts of Ireland.



Bumblebee on *Salix repens*. Courtesy of Aoife O'Rourke.

Results indicated that there were no differences in visitation rates by insects to plants grouped according to their nectar chemistry (sugar concentration and composition), but pollen (composition of essential amino acids) significantly affected visitation by solitary bees. Hoverfly visitation rates were positively correlated with local floral abundance. Bumblebees and hoverflies were both more abundant at sites where *S. repens* was present. It was concluded that pollen amino acid composition influences solitary bee visitation rates in early spring and that *S. repens* is an important spring flowering plant for bumblebees and hoverflies in these habitats.

## REQUESTS

Please send in information concerning current research, calls, news, publications and wildlife photos from field trips for inclusion in our next quarterly newsletter.

## RESEARCH FOCUS

**Reconstructing Past Environmental Change in the Albertine Rift** *by Gayle McGlynn*

The Albertine Rift is one of the most important conservation areas in tropical Africa, with exceptionally high levels of biodiversity (including rare and endemic montane flora and fauna) and high human population densities. Information about past environmental change can improve understanding of how environments function at present, and can also provide an indication of how biota and ecosystems may respond to future climate change-related processes – a particularly important concern in biodiversity hotspots such as the Albertine Rift.

My research involves investigating past environmental change in the Albertine Rift by using sediment-based evidence from sites in the Virunga volcanoes, a chain of volcanoes located along the borders of Uganda, Rwanda and the Democratic Republic of the Congo. As sediments accumulate in lakes and swamps, they preserve a record of environmental conditions at the time of deposition. By analysing proxy indicators in the sediment, such as pollen, charcoal and diatoms, we can reconstruct how the environment has changed in the past. My focus has largely been on examining the nature and causes of long-term environmental change (particularly vegetation change) in the Virunga volcanoes, and the research has shown that while climate has been an important driver of environmental change in tropical montane ecosystems over the past several thousand years, human agency has played an increasingly important role in the past millennium. Current investigations are examining environmental changes in high-altitude aquatic ecosystems during the past few centuries in more detail. This research provides an important insight into the long history of substantial human interaction with the environment, even in relatively remote, biologically diverse areas that are currently the focus of major conservation measures.



Albertine Rift.  
Courtesy of  
Gayle McGlynn

**Biodiversity and Benthic Indices as a Tool for Marine Pollution Monitoring** *by Michelle Giltrap*

Requirements set out in the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) are not just to categorise ecological status but to achieve at least good ecological status within a defined timeframe in both transitional and coastal waters. With funding from the Sea Change strategy with the support of the Marine Institute and the Marine Research Sub-Programme of the National Development Plan 2007–2013, we used indices for ecological assessment to give an insight into the status of the Irish marine environment.

Changes in benthic communities have been used as an index for assessment of marine pollution for many years. A major advantage of using macrobenthic communities as indicators of pollution is that benthic organisms are relatively long lived and spatially stable. Typically, they are not organisms prone to migration, so are excellent integrators over time of water quality. These organisms are also an integral part of the food web and the species of which they are composed show different tolerances to pollution stress and disturbance. Biodiversity-based indices have included spatial integration formulae, mathematical models such as the log-normal distribution, and a variety of diversity/dominance measures such as the Shannon-Weiner distribution which has answered so well in fresh waters before being refined into the current species-based AMBI (AZTI Marine Biotic Index) and Biotic Coefficient (BC).

In our project we have used macrobenthic community analysis as an ecological pollution indicator at three potentially impacted locations around Ireland: Dublin Bay (5 stations), Wexford (4 stations) and Cork Harbour (2 stations). Five samples were taken with a 0.1m<sup>2</sup> grab at each station, sieved through a 1.0mm mesh and preserved in formalin with Rose Bengal staining before being brought back for sorting, identification and counting. Index values were calculated using the PRIMER routines.

All the stations were expected to belong loosely to Thorson's 'Venus community', characteristic of fairly open sea locations on sandy sediments from about 10 to 30m in depth and which can, under the right conditions, provide 'excellent growth centres for young flounder'. However, there was surprising variation, not just among locations but also within samples taken from a single station and location (Table 1).

RESEARCH FOCUS

Table 1. Range of biodiversity across Dublin, Wexford and Cork, showing maximum and minimum number of species (S) and individuals (N) per grab (0.1m<sup>2</sup>).

Location	Max S	Min S	Max N	Min N
Dublin	62	15	1413	25
Wexford	49	2	363	2
Cork	53	22	534	73

The samples from Wexford were the most variable, and one of the stations in particular was very depauperate, with 4 of the 5 samples yielding just 2,2,6 and 6 species respectively represented (with one exception) by a single individual per species. The other locations were less extreme, but typically species' numbers could vary within a location 3- or 4-fold and numbers of individuals by an order of magnitude. Not surprisingly, indices generated from the samples varied considerably as well (Table 2).

Table 2. Index values showing ranges of ES100, Shannon-Weiner (H'), Pielou's Evenness (J') and Simpson's Index of Dominance (d).

Location	ES <sub>100</sub>	H'	J'	d
Dublin	13 – 38	2.2 – 5.0	0.37 – 0.94	3.2 – 10.2
Wexford	2 – 33	1.0 – 4.4	0.51 – 1.0	1.4 – 8.6
Cork	17 – 40	2.2 – 4.8	0.40 – 0.84	4.4 – 10.2

Using rarefaction, it is possible to correct to some extent for the differing numbers of individuals in a sample, and the ES100 based on a notional 100 individuals per sample is less variable (Table 2) than the actual number (S, Table 1) but still wildly varying, again especially at Wexford. The other indices are slightly more robust, with the Shannon-Weiner index (H') giving values in excess of 4.0, which for coastal conditions has been suggested as a background or reference value, at all locations, if not for every sample. The great difficulty in assigning a quality status is the establishment, and acceptance, of the reference value, the more so since under the obligations laid by the WFD and MSFD, failure to meet the standards could necessitate considerable expenditure.

The AMBI and BC, which is derived from it, obviates to some extent this problem, in that this index is based on the accumulated scores of the species found, which in turn have been given a rank based on their known or suspected pollution tolerance. Thus a sample which comprises mostly low pollution-tolerant species will generate a low BC. The overall BC for Dublin Bay is 1.45, indicating that most of the fauna fall into the pollution-sensitive category and also that the Bay would meet the 'good quality' criterion limit of 2.0.

Despite the advances that have been made, particularly in the last ten years in macrobenthic indices, there are still questions to be answered. Is it sufficient to base threshold index values on a large database and an arbitrary statistical limit (95% confidence limit? 90% quartile?) and round off to give a neat figure, however objective that might be (e.g. H' = 4.0)? Or should we rely more on those, like the BC, which are based on species' ecology even if this is not fully known and still rather reliant on 'expert judgment', which must have some degree of subjectivity? The latter is not biodiversity-based, but simply a means of assessing ecological status.



Sampling in action. Courtesy of Michelle Giltrap.

Finally, it must be remembered that some habitats such as estuaries and sandbanks are subject to considerable natural physico-chemical pressures, which may restrict or modify the communities and generate 'poor' scores even in the complete absence of pollution.

Disturbance to the communities may enhance biodiversity (under the 'Intermediate disturbance hypothesis') but may also generate vacant niches to be filled by opportunist species (many classified as 'pollution tolerant' under AMBI and BC) or in the case of estuaries in particular by invasive species. The effect on indices (Table 1) of a one-for-one replacement is neutral, since all species are treated as equals. Sandbanks and estuaries (and associated wetlands) are also priority habitats under the Habitats Directive which generates another layer of management priorities in addition to the WFD and MSFD.

It was concluded that an integrated approach to marine ecological monitoring is needed, covering biodiversity as well as quality status. While indices of the latter are informative and helpful in deciding management and conservation priorities, they do not tell the whole picture. Fine scale marine conservation practice lags behind that on land or even freshwater, and we have to find a way of building this in to the management practices under WFD and MSFD.

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