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The Marine Biologist

The magazine of the marine biological community

An interview with TV presenter and ocean explorer Paul Rose

Plus

- North Atlantic killer whales
- Climate effects: predictions & complexity
- Argentina's dolphins in decline
- The black beaches of Spain

THE MARINE BIOLOGICAL ASSOCIATION
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50 years of the European Marine Biology Symposium

The Marine Biologist
The magazine of the marine biological community

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Submissions
We welcome submissions of original and relevant material, letters and responses to published articles. For guidance, please see the magazine website at **www.mba.ac.uk/marinebiologist** or contact the Editor.

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Editorial

I hope this edition of *The Marine Biologist* will prove to be the most accessible yet. The content is varied, with articles from MBA members, scientists and a wildlife photographer, and the magazine is improving through contributions and feedback from members. I hope you like the new silk finish which should lift and lighten the fantastic images.

So, dive in to articles on marine mammal research (did you know that the global population trend of the bottlenose dolphin is unknown?), and on climate change, seaweed cultivation and ghost fishing. What is marine biology without people? Up-and-coming wildlife photographer Christine Shepard shows how researchers can use human resources to lift the profile of their research, and Paul Rose's infectious energy comes off the page in our interview on page 36.

There is growing interest in MBA membership among students and young people. MBA membership is a means of getting support for travel and study (see pages 28 and 35), but joining the marine biological community is also a positive step towards starting a professional network. The new Young Marine Biologist category has been very enthusiastically received; more on that in the next issue.

We have been including updates on research into plastic in the ocean in the 'In brief' section of the magazine. The most comprehensive study to date[1] estimates there are a minimum of 5.25 trillion particles of plastic in the world ocean weighing 268,940 tons, and the authors point out that this is a highly conservative estimate. It is likely that every bit of plastic ever made still exists. This has implications for 'peak plastic' and the ideas and innovations that will surface to tackle this global problem.

Do you have an opinion about the future direction of *The Marine Biologist*? Would you like to write a short article for the magazine, or even a blog for the website? Have you taken a great picture of marine life or of people interacting with the marine environment? As always, feel free to contact me.

Finally, I would like to say a big "Thank you!" to all the contributors.

1 http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0111913

Front cover: A great hammerhead shark *Sphyrna mokarran* swims away in excellent condition with a custom designed 'Hammer-Tag' attached to its dorsal fin. Image: Christine Shepard.
Back cover: Hinge-beak shrimp *Rhynchocinetes durbanensis*, Ambon, Indonesia. Image: Fiona Crouch.

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Image credits: Top: Andy Foote
Middle: Whalefish
Bottom: Christine Shepard

The lionfish *Pterois* sp. is an invasive non-native species in the western Atlantic. Image: Adam Goodier.

Using the power of the web to help fight invasive species

Native to the Indo-Pacific, lionfish (*Pterois miles* and *Pterois volitans*) were first introduced to the Atlantic in the 1980s by the aquarium trade. Since then lionfish have established a vast range along the east coasts of North and South America. Lionfish are excellent predators, devastating reef ecosystems with their efficient, broad hunting strategies and huge reproductive potential.

Now, a new web portal has been set up by The Gulf and Caribbean Fisheries Institute and NOAA (the US National Oceanic and Atmospheric Administration) to provide crucial information against the current lionfish invasion in the Atlantic.

In an effort to raise awareness and provide invaluable information, the Invasive Lionfish Portal has been launched. A wealth of expertise including NOAA researchers, policy experts and coastal managers has been combined to provide information of the highest quality to aid those working to control the invasion. Whether you're interested in how to treat a sting from their venomous spines, information regarding active control in your area, or even recipes to cook up your sustainable catch, the portal has the answer. To find out more, visit http://lionfish.gcfi.org/.

Charlotte Walker

MMO fit for purpose, review finds

The first Triennial Review of the Marine Management Organisation (MMO)—the UK's agency responsible for licensing, regulating and planning marine activities in the seas around England and Wales—found that it remains appropriate for MMO functions to be carried out at arm's length from Government by a non-departmental public body (NDPB).

Triennial Reviews aim to challenge the continued need for all NDPBs. The review, published in December, found that the MMO is a flexible and dynamic organization that had improved service delivery since vesting in 2010, with committed staff, and a positive working relationship with Defra (UK Government Department for Environment, Food & Rural Affairs).

The review recognises the dynamic legislative landscape in which the MMO operates, noting that there will be further cuts to its funding in 2015/16, requiring an organisation that is already 'stretched' to find further savings, for example by removing unnecessary regulatory duplication.

Ministers stressed the need for decisions that are democratically accountable whilst ensuring the system does not incur excessive delays or become more onerous.

In the longer term the MMO must balance the requirements of the Plan for Growth with those of sustainable development and its environmental protection remit.

Fried fish

The government has licensed 12 ships to conduct electric fishing in UK waters for a 5-year 'scientific trial'. Dutch vessels have been 'pulse trawling' in the southern North Sea since 2010, and currently 85 large vessels (10% of the Dutch fleet) are equipped to fish in this way.

Pulse trawling uses electricity to flush flatfish or shrimp out of the sediments. The electric shock causes them to convulse and flip upwards, into the net.

Supporters claim that pulse fishing is less damaging than conventional beam trawling, which is considered extremely destructive to life on the sea bed and in the underlying sediment. However, we have little knowledge of the impact of pulse trawling because there are very few studies of it.

The pulse trawling vessels have been operating across the southern North Sea, including in the Dogger Bank Special Protection Area, and with the new licenses, UK vessels will be able to operate close to shore, within UK territorial waters which include Special Areas of Conservation. Under the EU Habitats Directive, an appropriate assessment must be made to determine the potential impact of a proposed activity on a protected area. Country agencies are supposed to apply the precautionary principle; i.e. consent cannot be given unless it is ascertained that there will be no adverse effect on the integrity of the site.

Judging by the adverse media

attention, the industry has some work to do to convince the public that it is proceeding with due care.

Samantha Simpson

Mobile technology aids fisheries management

There is growing interest in the potential impacts of small-scale, artisanal fisheries as over 80% of the fishing vessels in the world fall into this category. Succorfish, a small UK organisation, uses innovative communication technology with a simple, cost-effective vessel monitoring system (VMS) linked to a mobile app. The technology provides effective management and enforcement tools allowing local fishermen to fish in close proximities to MPAs whilst protecting sensitive marine habitats.

The technology is being developed further in the candidate Special Area of Conservation (cSAC) in Lyme Bay on the south coast of England, where it is currently being trialled. It is enabling fishermen, managers and scientists to monitor an inshore fishery in terms of fishing effort and at appropriate spatial and temporal scales. The aim is to develop best practice management helping to ensure a sustainable future for the fishery and marine environment. Jon Shuker, a local fisherman, explains its value: "The app will be a valuable tool to help us manage discards by sharing information between other fisherman and fishing authorities. It will also be useful to record shellfish landings electronically saving time and dreaded paperwork."

Harriet Yates-Smith

Mobile technology is being trialled for fisheries management in a marine protected area in Lyme Bay on the south coast of England. Image: Harriet Yates-Smith.

Pitcairn Islands to get world's largest single marine reserve

On 18th March 2015 the UK government approved the designation of the world's largest Marine Protected Area (MPA). Encompassing the pristine seas of the Pitcairn Islands in the southern central Pacific Ocean it will cover an area of 834,000 km^2, making it the biggest single protected space of ocean in the world.

The Pitcairn Islands British Overseas Territory comprises four small islands with a population of just 56. But with an area twice the size of the British Isles, the designation is a significant step in global marine conservation. Deep-sea ecosystems and shallow coral reefs create hotspots for marine biodiversity and seabirds. A 2012 expedition led by National Geographic explorer Enric Sala and presenter Paul Rose (see interview on page 36), found some of healthiest shark populations ever studied supported by over 1,200 marine species.

In an attempt to put a stop to illegal fishing and trade, management of the reserve will be dependent on an agreement between NGO's and Swiss funders. New 'watchroom' technologies will allow vessel activity and likely catches to be monitored via satellites, enabling 'remote policing' of the reserves.

Pitcairn Island Council developed the initiative in partnership with Pew Charitable Trusts and National Geographic. The UK now has the highest percentage of protected waters of any country in the world.

Emily Miles

A world first for marine power

Giving the amber light to the largest project of its kind in the world, the UK Government has entered into formal negotiations with developers over the Swansea Bay tidal power scheme in the Severn estuary, south-west England.

Although the scheme promises to provide 90% of domestic energy for the Swansea Bay area, conservation bodies have expressed concern about its impact on birds and migratory fish. Sarah Kessell, chief executive for the Wildlife Trusts of south and west Wales is worried about the loss of habitats underneath the walls of the lagoon. "That's things like sand, mud, gravels and rockpools which are important for ringed plovers, sanderlings and other birds."

Further lagoons are proposed for the Severn estuary at Cardiff, Newport and Bridgwater in Somerset. Together with other schemes at Colwyn Bay and in Cumbria, tidal flow could potentially provide 8% of the UK's electricity needs.

The go ahead for the Swansea Bay scheme could be given before the general election in May.

References and links for these stories can be found on *The Marine Biologist* website. Scan the QR code to view the web page.

For marine events, see the **UK Marine Science Events Calendar** at **www.mba.ac.uk**

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The killer whales of the North Atlantic

By Andrew D. Foote, Sanna Kuningas and Filipa I. P. Samarra.

Our understanding of killer whale ecology and evolution has come a long way in the last 25 years, but, as **Andrew Foote** and colleagues explain, there are still many gaps in our knowledge.

Studying wide-ranging top predators requires a multidisciplinary and transnational approach to identify movement patterns, ecology and for the effective monitoring and conservation of populations. A workshop was held at the European Cetacean Society conference, Galway, Ireland, on 25 March 2012, on one of the most wide-ranging of top predators in the North Atlantic, the killer whale *Orcinus orca*. A selection of the presentations from this workshop was published in a special section of the *Journal of the Marine Biological Association of the United Kingdom*[1].

By the late 1980s research on killer whales in the Pacific waters of British Columbia, Canada and Washington State, USA had made substantial progress. This was largely due to the pioneering work by the late Dr Michael Bigg, who developed the use of photographs of the dorsal fin and saddle patches to identify uniquely marked individuals (see Figure 1), allowing for the first time an annual census and insights into population dynamics, social structure, life history and movement. Dr John Ford was also reporting the first evidence of a complex pattern of group and population-specific call dialects. At this time, preliminary investigations of the distribution of killer whales in North Atlantic waters based on sighting data, whaling catch statistics or stranding data were just starting to be published. These reviews identified potential hotspots and seasonality in occurrence, and therefore provided the foundations which subsequent dedicated research could build upon. They also identified some of the major prey resources that killer whales appeared to be tracking in the North Atlantic, which included the Icelandic and Norwegian stocks of Atlantic herring (*Clupea harengus*).

The first photo-identification studies of killer whales in Norwegian waters had photographically recaptured a small number of naturally marked individuals between years on the herring wintering grounds in the Lofoten region of northern Norway, and between Lofoten and the herring spawning grounds in the Möre region of southern Norway. Dr Tiu Similä and colleagues have subsequently built upon this earlier work, expanded the photo-identification catalogue to include over 600 individuals, and further demonstrated the association between the movement and site fidelity of killer whales and the migration of the Norwegian spring-spawning herring stock.

Work carried out by the Marine Research Institute, Reykjavík and others, has found that some killer whale groups also follow the Icelandic summer-spawning herring stock, whilst some individuals photographed feeding on herring around Iceland were also reported feeding on the North Sea stock of Atlantic herring, off the coast of Shetland. Over 1,000 individual killer whales have now been photo-identified across the north-east Atlantic, and collaboration among institutions has allowed comparisons of photo-identification catalogues over greater spatial and temporal scales. A general pattern is emerging of site fidelity and association with a particular prey resource at several locations across the north-east Atlantic. However, some groups may switch between different prey resources depending on their seasonal availability.

North Atlantic researchers pioneered new approaches to study killer whales by using underwater cameras and sonar, multi-hydrophone arrays and custom-built multi-sensor acoustic tags to record their movement and behaviour when foraging for herring. During what has become known as carousel feeding, the killer whales appear to work as a coordinated group, flashing their white undersides and releasing bubbles to herd a ball of herring from the school before tail slapping the ball to stun and then eat individual fish. Killer whales feeding on herring off Iceland and Shetland produce a distinctive low frequency call, just prior to tail slapping the herring. These 'herding' calls are very similar to those produced by humpbacks, which also feed on herring, and the low frequency of the call may resonate with the herring's swim bladder, and therefore help herd the herring.

North Atlantic researchers pioneered new approaches to study killer whales

In the Canadian Arctic, Steve Ferguson and colleagues have employed the use of tried and tested methods, in addition to novel and highly innovative approaches to investigate the ecology of killer whales in this rapidly changing ecosystem. As global temperatures rise and the Arctic sea ice retreats, many former 'choke points' are opening up and allowing killer whales to enter the bays and inlets of the Canadian Arctic, resulting in a significant increase in recent sightings

Opposite: A killer whale hunting seals close to shore around Shetland, Scotland.
Above: Fig. 1. The scars and nicks on the dorsal fin and white saddle patch that are used to identify individuals, allowing us to investigate movement, abundance and social structure.
Images: Andy Foote.

1 *Journal of the Marine Biological Association of the United Kingdom*, 2014, 94(6), 1256-1252.

(Figure 2). Interviews with local Inuit hunters suggest that marine mammals are the main prey of killer whales in the Canadian Arctic. Killer whales are known to be able to have a population level effect on prey populations due to top-down effects, and therefore have the potential to significantly shape this rapidly changing Arctic ecosystem. To better understand the potential impact of killer whale predation and how persistent it is over time, Ferguson and colleagues satellite tagged a killer whale in the Canadian Arctic, and found that it moved between areas with known aggregations of marine mammals before heading out into the open North Atlantic in late autumn as the sea ice increased in concentration in the inlets. Therefore, predation on Arctic marine mammals may be seasonal.

Fig. 2. A group of killer whales in the Canadian Arctic, where they are being sighted more frequently coincident with the rising temperatures and melting of the Arctic ice sheets. Image: Gretchen Freund.

We look forward with eager anticipation to the next twenty-five years of research on North Atlantic killer whales. We predict that the recent methodological advances in DNA sequencing technology, which have already been harnessed to sequence a dataset of complete mitochondrial genomes for North Atlantic killer whales, will be further applied to produce a complementary nuclear genomic dataset. The first high coverage marine mammal genomes have now been sequenced and the data made publicly available, and these include a North Atlantic killer whale. These genomic data will allow the comparisons of natural selection upon the genome among populations. The large acoustic datasets that have been collected for the past 25 years have allowed us to better understand the acoustic behaviour of north-east Atlantic killer whales. We anticipate that work currently undertaken will allow for broader geographical comparisons, as well as better understanding of the function of different signals, such as the still little understood high-frequency whistles produced by herring-eating killer whales in the north-east Atlantic. In addition, recent projects, deploying state-of-the-art multi-sensor tags in different locations in the north-east Atlantic, promise to allow for detailed comparisons of behavioural parameters. We expect that together these developments will improve our understanding of the biology, behaviour and ecology of killer whales in the North Atlantic.

The past twenty-five years have seen global temperatures rise, including in the North Atlantic, and these changes have had biological consequences across a range of species, as well as for ourselves. In addition to the diminishing sea ice in the Canadian Arctic during this period there have also been natural shifts in the distribution of prey resources (e.g. herring and mackerel stocks), and subsequently the killer whale lineages that follow them. The next twenty-five years will likely lead to further and more rapid changes in climate, particularly in the Arctic as the sea ice melts. We therefore predict that the prey resources exploited by North Atlantic killer whales will shift their distribution, and they may undergo declines or increases as a result. Additionally, new prey resources may become available to North Atlantic killer whales. Although our understanding of killer whale ecology and evolution has come a long way, there are still many gaps in our knowledge about the extent of geographical movements and consequently connectivity between different locations, the prey preferences and diet composition, the population viability and status of killer whales in different locations in the North Atlantic. Without such information it is impossible to completely critically assess the threats faced by killer whales in these locations and their conservation status. Collaboration between researchers and long-term consistent monitoring effort will be critical to effectively assess these issues. The ecosystems of the North Atlantic are likely to be highly dynamic during the next twenty-five years, and both North Atlantic killer whales and the researchers that investigate them will need to adapt to these ongoing changes and challenges.

Andrew D. Foote[1], Sanna Kuningas[2] and Filipa I. P. Samarra[2,3].

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The black beaches of Spain

Beaches in north-west Spain recovered more quickly than expected after the catastrophic *Prestige* oil spill. By **Juan Junoy.**

Fig. 1. Intertidal sampling at Corrubedo beach. Image: Juan Junoy.

When Europeans think about their holidays, many of them have in mind the sunny beaches of the Mediterranean coast of Spain. Along this degraded littoral buildings have replaced dunes, and the border between the land and the sea is a continuous line of shops where you can buy typical Spanish crafts, most likely made in China, or Pacific seashells as Mediterranean souvenirs. The resort town extends to the dry sand where sun loungers, parasols and towels take over.

But Spain has some very different beaches on its less urbanized Atlantic coast. At these beaches, the tidal range is up to 4 m at spring tides. At low tide the beach has an extensive wet intertidal zone whereas the dry area, the supratidal zone, is usually relatively small (Figure 1). Waves can be very high; a record wave over 27 m in height was measured in January 2014 in Cape Vilán (Galicia, north-west Spain). Winter storms are frequent, and our story starts during one such storm on 13 November 2002.

On this day the *Prestige*, a tanker carrying 77,000 tonnes of heavy fuel oil, sent a SOS signal informing the Spanish coastguard that one of its tanks had burst off the coast of Galicia. Six days later, the ship split in half and sank, releasing the fuel oil into the sea. It was the start of the largest environmental disaster in the history of Spain. The black tide mainly affected Galicia's coast, but the oil also reached the French and Portuguese coasts.

The *Prestige* crisis also meant an opportunity for our research team, who had been investigating the macroinfauna (animals living within aquatic sediments and large enough to be seen with the naked eye) of the Galician beaches since 1982.

But surely, beaches are as barren as deserts? No! There are some invertebrate species adapted to live in these harsh, stressful habitats and you can collect them with an inexpensive methodology. Take the sand with a shovel, sieve it through a 1 mm mesh and dump the contents of the sieve into a tray with some water, then observe several small crustaceans swimming and some worms snaking. You can do this at different tidal levels of the beach and observe the biological zonation.

The dry sand of the upper beach belongs to the supratidal zone. The most characteristic aspect of this area is the dune flora, but our study was limited to the areas devoid of vegetation close to the deposit line where washed-up algae accumulate. This is a food source that is used for many air-breathing arthropods. Sandhoppers such as *Talitrus saltator* and *Talorchestia brito*, which evolved from fully-aquatic amphipods, emerge at night from their burrows. They are scavengers and eat almost anything containing organic matter. These species meet in the deposit line with fully terrestrial arthropods, such as the isopod *Tylos europaeus*, and insects (mainly dipterans and coleopterans).

The area that emerges as the tide retreats is the intertidal zone. This zone is inhabited by fully marine species, mainly

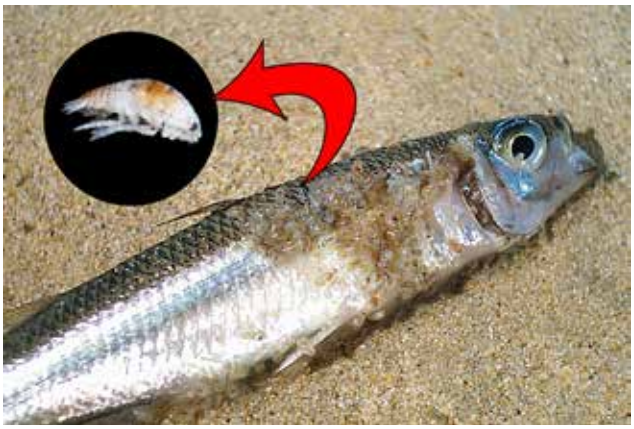

Fig. 2. The isopod *Eurydice* (inset) is a scavenger and predator. Here shown feeding on an injured fish. Image: Juan Junoy.

crustaceans and polychaete worms. Their distribution along the intertidal zone is related to both interstitial moisture levels in sand at low tide and to tide levels or inundation times. Three levels are distinguished: the upper level has damp sand (retention level); the middle level (resurgence level) where the phreatic (saturated) zone is found at less than 20 cm from the surface (the sand that has adequate water content to make sand castles); and the lower level where the phreatic zone is at the surface (saturation level). Macroinfaunal diversity and abundance increase from the upper to the lower level. The polychaete *Scolelepis squamata* lives in retention and resurgence levels; several species of the isopod genus *Eurydice* (see Figure 2), a scavenger/predator species that attacks injured fish, move actively leaving visible grooves in the resurgence and saturation levels. These two levels are also inhabited by the amphipods *Pontocrates arenarius* and *Haustorius arenarius*. The lower saturation level is also occupied by swimmers such as the mysids of the genus *Gastrosaccus* and cumaceans of the genus *Cumopsis*. At this level, we occasionally collected the only dangerous species of the beach, the lesser weever fish, *Echiichthys vipera*.

The beaches studied are all exposed environments, open to wave action, and even in calm weather, they are subjected to considerable swell. The fauna showed very low diversity and consisted largely of small crustaceans (which were numerically dominant) and, to a lesser extent, polychaetes. Severe exposure restricts diversity, reducing the presence of sedentary forms, especially bivalve molluscs, and encourages the numerical dominance of agile swimmers, such as amphipods and isopods. These macroinfaunal species are prey for fish and shorebirds.

The black tide of the *Prestige* oil spill affected cliffs and beaches, mainly those situated in the Galician province of A Coruña, along the 'Coast of Death', so named because of the many shipwrecks there. Beaches of the other two provinces (Pontevedra and Lugo), were less affected.

Our macroinfauna sampling started in May 2003, when most of the Galician beaches had already been cleaned (at least superficially; subsuperficial oil is frequently underestimated). During four consecutive years we studied 18 beaches along the 1,659 km of the Galician coast. Results were compared with previous data, mainly from 1995.

We observed a reduction in the number of species by beach only in the first year after the spill. There was also a negative relationship between the degree of pollution and species number, being lowest in the heavily polluted beach of O Rostro (see Figure 3), with only five species. Rare species occurring on beaches at low density were eliminated, and thus, species number was lower after the spill.

On all but two of the 18 beaches, the macroinfaunal abundance was also significantly reduced after the spill. The decrease in the abundance of the macroinfauna observed after the spill appears to reflect the losses due to oiling toxicity or indirect effects of oiling and clean-up. On seven beaches, the diversity was higher the first year after the spill, but there was not a statistically significant difference between before and one year after the spill, nor was there variation in the pollution grade among different beaches.

Four taxa were significantly reduced one year after the spill: the isopod *Eurydice*; the polychaete *Scolelepis squamata*; the nemertean *Psammamphiporus elongatus*; and the larvae of diptera. Sedentary species would provide the most reliable evidence of the effects of pollution. The abundance of *S. squamata*, a species without swimming activity and

Fig. 3. Samples from O Rostro beach showing oil pellets. Image: Juan Junoy.

Fig. 4. Cleanup activities on beaches affected by the spill. Image: Juan Junoy.

with general low mobility, seems to have been influenced by the spill, although it is likely that the beach cleaning which involved the removal of the sand was more important than the toxic effects of the fuel. One species that could be characterized as opportunistic, the amphipod *Pontocrates arenarius*, showed an increased abundance after the spill. This is quite surprising because substantial mortalities of amphipods were reported in other spills.

Interannual variations throughout the following three years of study (2004–2006) did not show strong differences in macroinfauna assemblage structure on the 18 beaches. We conclude that the *Prestige* oil spill affected the beach macroinfauna for the first 17–18 months.

When the black waves of oil arrived at the coast, the first impression among marine researchers—my own included—was that the catastrophe could affect the ecosystem for many years. Optimistic scientists thought that it would take about five years for the ecosystem to recover. Fortunately, the spill was not so environmentally apocalyptic; the result of our study shows rapid recuperation on the sandy beaches. This conclusion—a few years recovery—can also be extended to other elements of the Galician coast, with the notable exception of marine birds. However, experience shows that we cannot be confident that marine habitats will have an easy recovery after a spill. Each spill has its own characteristics including type of oil, geographical location, weather conditions, and how the cleanup operation is handled (Figure 4).

We must not forget that the *Prestige* oil spill also had strong economic and social impacts. I raise my voice and shout: '¡Nunca mais!' (Never again!).

Dr. Juan Junoy (juan.junoy@uah.es)

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FURTHER READING

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Forecasting climate change impacts on marine systems

Nova Mieszkowska and Brian Helmuth

ask whether a quest for generalizations has compromised our ability to make useful predictions.

One of the 'grand challenges' for scientists, governments, stakeholders and practitioners around the world is to understand and predict how climate change will continue to impact upon natural ecosystems and the social and economic services they provide. This is a Herculean task; changes in climate vary greatly across space and time, attribution of observed changes to anthropogenic climate change is challenging, and climate change acts in combination with other human pressures, resulting in a wide range of impacts on natural systems. However, scientific research can help determine where and when changes to species distributions and ecosystem structure and functioning will occur, and identify which species are likely to be 'winners' and 'losers', providing guidance to assist with adaptive management of ecosystems and the services they provide.

Our understanding of how climate change has affected life on Earth has been driven by important studies of general patterns, and broad-scale correlative modelling of changes in species distributions, and typically communicated as poleward or depth-related range shifts in response to large-scale average change in regional or global climate.

Have we clouded our interpretation of what we observe?

But in our quest for generalizations, and perhaps to communicate complex scientific findings to non-scientists, have we clouded our interpretation and expectations of what we observe? Generalizations and overall trends, whilst useful heuristically, frequently fail to match the observed ecological responses that are driven by local, short-term variability.

For example, 30+ year trends in average sea surface temperature are increasingly being used to project and forecast species' range limits, despite the knowledge that decadal-scale increases in mean temperature—or climate—are not driving performance and survival at organismal scales and are ultimately not the cause of observed changes. Shorter-term variation in local environmental conditions—weather, including extreme events—are the underlying drivers of species distributions and ecosystem functioning via effects on the physiology of individual organisms.

Understanding the mechanisms by which organisms interact with the environment around them (Figure 2) can help to identify regions where species will be most vulnerable to climate change, identify the potential triggers of tipping points in the structure and healthy functioning of marine ecosystems, and devise 'guard tails' to prevent some of the worst impacts from happening. As climate change also interacts with other stressors, identifying areas where species are vulnerable to climate change means that we may be able to alleviate manageable stressors such as pollution or harvesting/fishing.

Fig. 1. We tend to trust daily weather predictions because we can test them against our own observations. Weatherman: Jim Gandy, Chief Meteorologist, News 19, USA.

Communicating impacts

Humans, like other organisms, are affected by weather rather than climate per se, and people's perception of climate change is shaped significantly through their experience of weather and short-term personal experience. Psychological studies into levels of trust between audiences and communicators show that weather forecasters are highly trusted due to their daily predictions being empirically tested by their lay audience, with an acceptable level of error (Figure 1). This is in contrast to current scientific communication of climate change impacts, whereby presenting average trends (akin to the weather forecaster giving the same average forecast each day for a month) that are not observed each day across the timeframe can serve to undermine trust, as no concession was made for variability.

Fig. 2. Zonation of species on a rocky shore due to differing biological tolerances to local environmental conditions. Image: Chris Harley.

Fig. 3. 'Robolimpet'. Image: Fernando Lima.

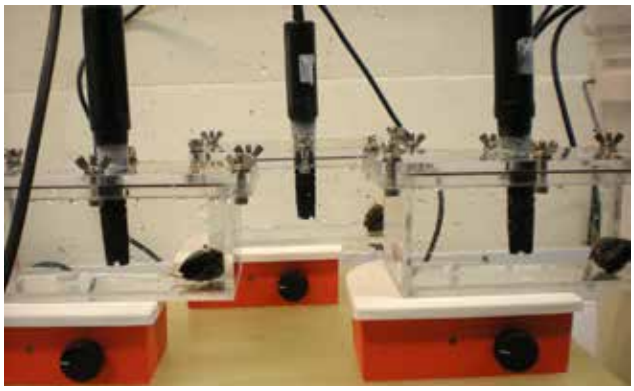

Fig. 4. A respirometry chamber. Image: Gianluca Sara.

Implications for end users

Climate management strategies aim to enhance the resilience of natural and human-managed systems, and maintain sustainable ecosystem services. Implementation of such strategies can be hampered and misled by an over-reliance on simplified trends, as management decisions require forecasts that account for responses at far smaller spatial and temporal scales, for example within individual marine protected areas or catchment areas. As a result of this mismatch, management actions are too often based on broad-scale trends and averages that may have very little to do with the vulnerability of organisms and ecosystems at a local scale, and any deviations from these generalizations can be misinterpreted as counter-evidence to global warming.

Creating biologically relevant metrics of environmental change that include how climate drives weather, and the knowledge of how organisms and ecosystems will respond at appropriate spatial and temporal scales, can offer insight into which aspects of climate change may be most important to monitor and predict. This approach can also enhance our ability to communicate impacts to non-scientists, especially government legislators, policymakers and stakeholders attempting to enact climate change adaptation strategies.

An international approach

INSHORE is an international network for the study of intertidal ecosystems working towards an integrative and multidisciplinary approach to measuring, understanding and predicting the responses of marine organisms to environmental changes.

INSHORE scientists are working to determine the impacts of environmental change at the scale of individual organisms using biological and environmental sensors, collection of micro-environmental data, field and laboratory experiments (Figures 3 & 4), long-term time-series of species distributions and computer models. INSHORE outputs provide biologically-realistic forecasts of current and future species distributions, and vulnerable areas at scales relevant to end users.

It is clear from our findings that shifts in species ranges predicted by over-simplistic, generalist models are likely to be contradicted in any but the broadest terms. Responses differ depending on the level of stress and the location of the organism, as well as species-specific thermal tolerances with respect to the range and mosaic of geographical patterns in temperature experienced across the biogeographic range of any species (Figure 5).

We need to develop mechanistic frameworks that account for local environmental conditions and biological responses, and understand how these impacts translate into ecological responses that affect humans. Whilst it is unrealistic to experimentally study many combinations of stressors and organisms, a better understanding of mechanisms can highlight vulnerabilities in organisms and ecosystems, and incorporate inherent variability within predictions of future distributions and responses of species.

By taking a more joined-up approach we can combine information on climate change, biological responses and the direct impacts for society, and report these findings at scales relevant to managed areas and marine reserves, thereby enhance communication among climate researchers, stakeholders and the general public.

Fig. 5. Starfish and mussels on the shore. Image: Brian Helmuth.

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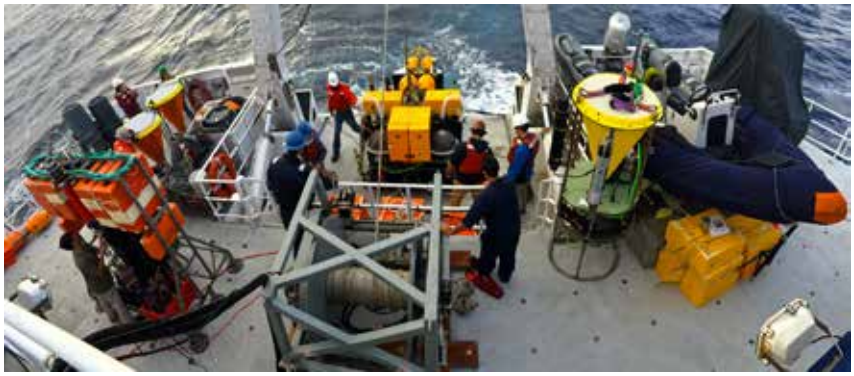
http://rockyinshore.org/#Research

For the full list of INSHORE members see www.mba.ac.uk/marinebiologist/issue-4/forecasting-and-communicating-climate-change-impacts-on-marine-systems

Research in the abyssal north-eastern Pacific

By Kathy Dunlop.

Two hundred kilometres west of the Central California coast and around 4000 m below the surface of the north-eastern Pacific, is Station M. Along with surface oceanic and atmospheric conditions, the fall of marine snow through the water column and benthic community dynamics have been monitored here since 1989. The deep-sea is the largest environment in the world but scientific knowledge of the abyssal area, and in particular its involvement in the global carbon cycle, is limited. Station M represents one of the most detailed long-term time-series studies of an abyssal area and has provided important discoveries about the deep-sea carbon cycle and the effects of climate change for over two decades.



Above: Fig. 1. Panorama of the instrumentation aboard the RV Western Flyer ready for deployment at Station M. Below: Using the ROV Doc Ricketts, the Benthic Rover is observed on the seafloor at Station M. Images: Susan von Thun.

The Station M time-series study is maintained by the Pelagic-Benthic Coupling Group led by Ken Smith, Jr, using an array of unique autonomous and ship-based research technologies (Figure 1).

The Benthic Rover (Figure 3) is an autonomous mobile laboratory that measures the respiration of the deep-sea sediment community. The Rover takes measurements at 3-day intervals, every 5 m, for up to 9 months, to build a detailed time-series of sediment community oxygen concentration. These data are important to understand the role of deep-sea sediment communities in the oceanic carbon cycle.

To understand the deep-sea carbon cycle, it is important to collect data on the marine snow that falls from the sea surface to the seabed as this represents the main food source for deep-sea benthic communities. Marine snow has traditionally been collected using sediment traps, which collect sediment in tubes 10 days at a time; but a recent imaging technology, known as the sediment event sensor, can collect information more regularly than the traditional traps by taking a picture rather than collecting a sample.

The time-lapse camera captures images of mobile animals just above the seafloor (grenadier fish, jellyfish) and on the sediment (brittle stars, sea cucumbers (Figure 4) and sea urchins). The long time-series of time-lapse camera deployments has shown strong seasonal and interannual variation in animal activity that correlates with changes in climate indicators and food supply.

A recent addition to the array of instruments at Station M is a stereo still underwater camera. The aim is to gather accurate and precise measurements of megafaunal animal abundance, size distribution and biomass to further define their role in deep-sea carbon cycling.

Fig. 4. The deep-sea sea cucumber (*Peniagone* sp.) recorded during a transect with the ROV Doc Ricketts.

Data from Station M have enabled significant advances in our understanding of the effects of global warming on the supply of food to the deep-sea, and its ultimate re-mineralization and sequestration in sediments. This long-term dataset has shown that deep-sea communities are strongly affected by climate variation. The next step is to use the dataset to predict the future effect of climate change on the deep-sea using mathematical modelling methods. This information will be essential for policy makers to manage the deep-sea environment in a changing climate.

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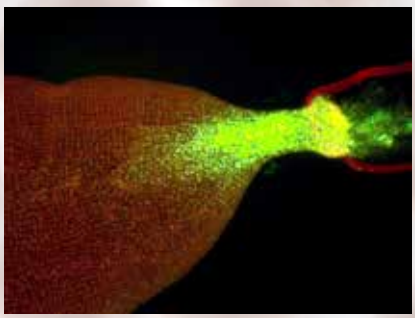
The dawn of seaweed domestication

Claire Gachon looks at a rapidly developing industry.

With the availability of arable land dwindling across the world, farming the sea is often perceived as the next frontier to meet soaring demand for food in the 21st century. Thus, aquaculture has been developing sharply, and recently overtook wild fisheries to become the main source of fish and shellfish for human consumption. Likewise, the cultivation of marine macroalgae has undergone rapid, sustained growth worldwide for over fifty years and is now worth US$ 5 to 10 billion annually. Algae not only have potential as a sustainable biofuel source, but are also consumed as sea vegetables, feed for shellfish, and have many burgeoning applications in the cosmetic and pharmaceutical industries.

With good reason, the cultivation of seaweeds is often perceived as an environmentally-friendly practice; seaweeds mop up nutrients dissolved in the sea and can therefore be advantageously used to mitigate the pollution caused by fish and shellfish farming. In many developing countries, their cultivation provides an alternative source of income for deprived coastal communities that are otherwise reliant on unsustainable fishing practices.

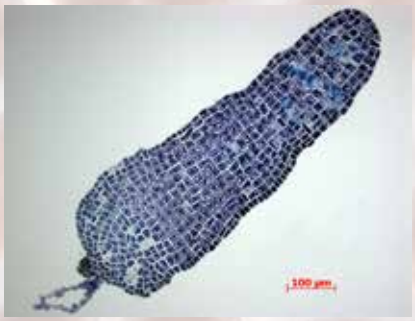
Young sugar kelp (*Saccharina latissima*) viewed under UV light. The chlorophyll appears in red and DNA is stained in green. Scale: Image is 1cm wide.



Yet, the fast—sometimes uncontrolled—introduction of seaweed cultivation throughout the world is posing a number of biological challenges. These include overreliance on genetically uniform breeds that, quite paradoxically, often have unstable performance and get discarded from the production lines after a few years only. This genetic homogeneity also increases vulnerability to environmental stresses and pests; as a result of recent intensification, crop losses and disease management are now among the biggest running costs for farmers producing laver, the seaweed widely used as sushi wrap in Asian cuisine.

Cultivation also poses a distinct threat to natural biodiversity; escapes can become invasive and displace native vegetation; the reason why the cultivation of non-native species is increasingly banned. Yet, the non-native red seaweed (*Kappaphycus alvarezii*) was illegally introduced on the north-eastern Brazilian coast, despite several reports of invasiveness elsewhere in the world. A more insidious yet equally serious problem is the inadvertent introduction of diseases, similar to the crayfish plague accidentally imported form America which now threatens native European crayfish with extinction. Caution is by far the best option, as containment or remediation measures are financially prohibitive and hard to implement in the marine environment.

As a first step towards exploiting and preserving genetic diversity through rapid domestication, researchers now focus on unravelling the genetic resources and natural variation available in wild seaweed stocks. The UK NERC-funded global initiative GlobalSeaweed aims to capture these efforts, and to tackle emerging issues in seaweed aquaculture. In particular, we aim to learn lessons from other countries that have more experience in algal cultivation than the UK and Europe. Our objective is also to increase awareness of the scientific challenges ahead, in order to support the design of policies fit to harness the biotechnological potential of natural seaweed diversity and fulfil the potential of algal aquaculture, whilst preserving genetic resources for future generations.



Above: Young sugar kelp (Saccharina latissima) stained with Trypan blue. Centre page: Lab-reared sugar kelp (*Saccharina latissima*) in a Petri dish. Background image: Somatic cells of a laver blade (*Porphyra* sp.). Scale: cells are approx. 10 microns in diameter.

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http://www.sams.ac.uk/global-seaweed

The author (right) collecting kelp from a wild population with her student Marine Vallet.

Restoring seagrasses under extreme conditions

Emma L. Jackson

Fig. 1. Identifying environmental tolerances using static mesocosms. Image: Emma Jackson.

Increasing pressures on the marine environment necessitate measures that promote resilience in coastal ecosystems. Emma Jackson looks at the science and methodology of restoring seagrass beds in a sub-tropical estuary.

Dr. Emma Jackson at the 11th International Seagrass Biology Workshop, Sanya, China, 2014.

Sentences such as 'Seagrass beds are an important coastal habitat providing many ecosystem services' have adorned the first line of manuscripts regarding these habitats for decades, and their ability to influence the ecosystem functioning and the delivery of ecosystem services is widely evidenced. In a group statement issued by the IUCN Seagrass Species Specialist Group in November 2014, seagrasses were identified as one of the most rapidly declining ecosystems on Earth. Although initiatives for seagrass recovery and conservation are occurring in some areas, all regions of the globe are experiencing seagrass habitat loss from human pollution and coastline development.

Increasing economic prosperity along the Queensland coast of north-east Australia linked with the expansion of port-based international trade and heavy industry has increased the pressures on the marine environment, in particular on sensitive habitats such as seagrass. Port Curtis, which lies within the Great Barrier Reef World Heritage Area, is currently undergoing major port and industrial expansion with the installation of three Liquid Natural Gas plants and significant extensions of dredging programmes. Following concerns that the increased activity in conjunction with storm and flooding events may be negatively impacting the seagrass, with implications for those species relying on the meadows, the Queensland Government is supporting seagrass restoration and habitat creation projects.

A team at Central Queensland University (CQU) has been researching

Fig. 3. Seasnakes (left) are one of the natural hazards of fieldwork on the Queensland coast. The Eastern shovelnosed ray, *Aptychotrema rostrata* (middle). The whelk (*Pyrazus ebeninus*) (right). Images: Emma Jackson.

the science on how these important habitats maintain their populations and how restoration (and creation—where seagrass has not previously been recorded) can help promote resilience within populations. Restoring seagrass beds in a dynamic sub-tropical estuary has a number of challenges and identifying methods for promoting resilience is much harder than just finding a suitable site and planting some plants. There are at least five different seagrass species (*Zostera muelleri* (see Figure 2), *Halodule uninervis*, *Halophila ovalis*, *Halophila spinulosa* and *Halophila decipiens*) each showing different life history traits, succession and thresholds to environmental conditions. Meadows vary from small sparse patches to large dense continuous meadows that are square kilometres in area. They can be monospecific or mixed meadows and the persistence over time of different meadows varies significantly, with some being ephemeral.

Fig. 2. A fragment of *Zostera muelleri*, one of at least five seagrass species in the Port Curtis area. Image: Emma Jackson.

Add to this the sub-tropical climate—flood events, tail ends of cyclones and then of course the multitude of dangerous animals including seasnakes (see Figure 3) sharks, cone shells, deadly jellyfish and saltwater crocodiles—and you will get an idea of the difficulties.

The research being carried out at CQU is tackling the problem from two angles and at two very different scales. First of all *in situ* (Figure 4) and mesocosm-based trials (Figure 1) are being carried out to assess the tolerances and thresholds of the different species of seagrass found in Port Curtis Bay to environmental factors such as sediment type, rate of sedimentation, temperature, turbidity and salinity. This will allow decisions on species selection in relation to site specific conditions to be assessed. Secondly, modelling of landscape level processes (particle dispersal modelling and habitat suitability models) is being used to establish the metapopulation dynamics of the seagrass populations within the bay.

Fig. 4. Volunteers and students help out in the mud and seagrass on Pelican Banks, Curtis Island. Image: Emma Jackson.

A metapopulation is a term originally coined by Dick Levins in 1969 meaning a 'population of populations', each existing on a patch of suitable habitat separated from other occupied patches by unsuitable habitat (too deep, too rocky,

A green turtle *Chelonia mydas*—one of the beneficiaries of seagrass ecosystem services. Image: Emma Jackson.

Local traditional owners form the Gidarjil Development Corporation volunteer to help transplant seagrass and support the sustainable use of their Sea Country. Image: Emma Jackson.

too turbid, etc.). At any moment in time these suitable habitat patches may or may not be occupied by a population due to extinction and colonization processes, immigration and emigration. The long-term persistence of the metapopulation depends on a balance between population extinction and recolonization. Understanding metapopulation dynamics allows us to identify areas where we could successfully create or restore seagrass habitat (i.e. unoccupied but suitable patches where poor immigration may prevent colonization or recolonization respectively); sites where seagrass exists but could be enhanced to a critical threshold whereby it is self-sustaining and able to sustain nearby populations (contributing to the resilience of the metapopulation) and areas where it is not worth spending the time and money restoring these habitats.

Emma Jackson and research assistant Rebecca Hendry check the seagrass growing in CQUniversity's flow-through tidal mesocosm system. Image: William Debois.

Landscape ecology and restoration ecology are two mutually beneficial disciplines. Landscape ecology principles can guide the selection of restoration sites, help to establish realistic project goals and advise on appropriate spatial configurations of restored habitat. Restoration ecology aids landscape ecology by providing an opportunity to experiment over large spatial scales and validate landscape ecology dynamic models.

The modelling methods we are using can identify potential locations (and reasons) for habitat creation and restoration, and the small scale experiments examining species tolerances can guide us on the likely survival of transplants at different sites and from different donor populations. However, large-scale transplantation trials are needed to validate the theories and model predictions. Local-scale environmental limiting factors may influence the long-term survival and growth of the transplants and also influence their ecosystem functioning.

Over the next year, our aim is to combine *in situ* observations of realized seagrass niche, mesocosm experiments with predictive models to identify locations for a large scale restoration trial. Through a partnership with James Cook University (Cairns, Australia) and Griffiths University (Gold Coast, Australia), CQU researchers are taking these approaches to the next scale and increasing pressure on environmental managers to start to redress the damage being caused to these habitats.

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The decline of bottlenose dolphins in Argentina

By Els Vermeulen, Neil Niru Dorrian and Lorenzo Scala of the scientific and conservation network Whalefish.

At Whalefish, we combine the experience and knowledge of marine scientists to promote education, awareness and networking opportunities for those who wish to help in our goal to improve marine conservation efforts. For nearly eight years, Whalefish scientists have been engaged in research and conservation efforts in the Bay of San Antonio, northern Patagonia, Argentina with a primary focus on marine mammals. The Bay of San Antonio is privileged as it has protected coasts and shallow waters (Figure 1) inhabited by unique species such as the southern right whale (Figure 3), migratory birds such as the red knot and several species of dolphin. But why is this area so important?

Located in the north-west of the Gulf of San Matías, in the Province of Río Negro, the Bay of San Antonio is 20 km long, 10 km wide and no more than 30 m deep. The region is not only famous for its shallowness and lack of strong currents, but also for having the warmest waters of the entire Argentine coastline, with maximum temperatures reaching around 24°C in summer and dropping by more than 16°C in winter. Other characteristics of the area are the large tidal range, clear waters, sandy beaches and rocky coasts, and abundant food resources.

All of these characteristics make the Bay of San Antonio the ideal home for a group of bottlenose dolphins, many of which remain in the area year-round. It is also one of the best places to observe them in their natural habitat, allowing an excellent opportunity to study their lives, habits and behaviour. Due to the enormous decrease in bottlenose dolphin sightings in other areas, the Bay of San Antonio may be one of the last remaining homes within Argentina for this species. As a result, the bottlenose dolphins inhabiting this area have become the main focus of our first long-term research and conservation programme.

Research methods

Whalefish Science Director Els Vermeulen began researching the bottlenose dolphins in this region in 2006. Just as humans are unique, with distinctive characteristics to distinguish one from another, most animals are also individually recognizable through unique and distinctive markings that remain throughout their lives. In cetaceans, tail flukes and dorsal fins are most commonly used in identification as they often show the most distinctive scars and/or colour patterns that are unique for each individual.

Once a good photograph is obtained displaying an individual's unique characteristics, it is collated with other data in a photo-identification catalogue (see Figure 2). It is very important to consistently add new pictures to

Fig. 1. The naturally protected Bay of San Antonio, northern Patagonia, Argentina. Image: Whalefish.

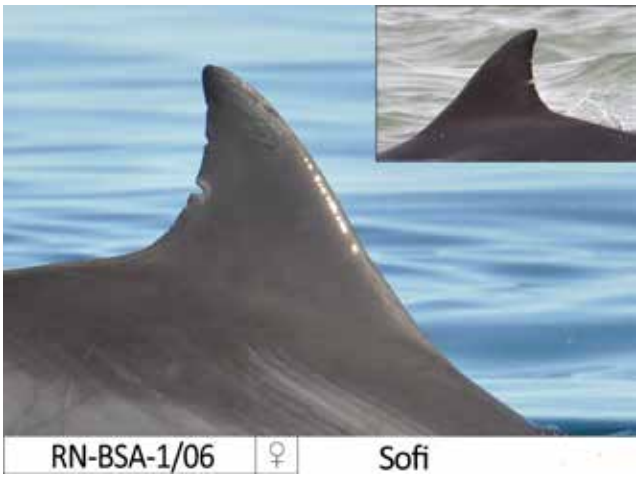

Fig. 2. The scars and colour patterns on the dorsal fin and tail flukes are used to identify individuals. Image: Whalefish.

Fig. 3. The southern right whale *Eubalaena australis*. Image: Whalefish.

the catalogue so that changes in the particular characteristics of the known individuals can be monitored. Using this technique of photo-identification, we can follow the dolphins over an extensive period in a non-invasive way, thereby allowing us to estimate the number of individuals in the population, and to learn about the many aspects of their life history such as their social structure, reproduction status, number of offspring, movement patterns and home ranges.

Results

The first results of our research indicated that the Bay of San Antonio is home to a highly resident population of bottlenose dolphins, and possibly the last remaining one in Argentina. We estimate there are around 80 individuals in this population, making it smaller than most other known coastal bottlenose dolphin populations. Furthermore, results showed that this population is declining over the years due to a calf recruitment rate which appears insufficient to maintain the population at its current size (see Figure 4). The high contamination of heavy metals and overfishing in the area, reported in the literature, is suggested to be among the possible causes of this decline and requires further investigation.

Analysis of social structure indicates that, although this community clearly qualifies as a fission–fusion society typical for the species, the associations within this population were much stronger when compared to other dolphin populations worldwide; this is most likely linked to the population's small size and its closed nature. Additionally, further research showed a clear genetic isolation and low genetic diversity. Considering the continuously increasing urbanization of the country, along with other anthropogenic activities, we suggest that this population is highly vulnerable and at risk of extinction. Bearing in mind the disappearance of the bottlenose dolphin elsewhere in the country, this local extinction risk could have devastating consequences on the general presence of the species in Argentina.

Coastal common bottlenose dolphins are amongst the best-studied cetacean species in the world, due to their accessibility in the wild and common presence in captivity. However, despite extensive research, increasing numbers of coastal populations are reported to be declining worldwide. Unfortunately, local declines of common species are easily overlooked when establishing priorities for conservation. The failure to recognize local population declines, and thus failure to apply precise conservation measures, causes the frequent problem of once-common species sliding towards extinction.

Future research

Most information on the bottlenose dolphin comes from captive studies, and much less appears to be known about wild population structures and

Fig. 4. A mother bottlenose dolphin 'Saffi' with her calf. The birth rate among the dolphins of the Bay of San Antonio is too low to maintain the population at its current size. Image: Els Vermeulen.

ecological needs. Indeed, the global population trend is currently listed as unknown by the IUCN, even though the global population status is listed as of least concern. The largest gaps in information for this species exist in Africa and South America.

Bottlenose dolphins have been among the most frequently observed cetacean species in Argentine coastal waters for decades; however, this situation has drastically changed and current numbers suggest the bottlenose dolphin has become the most endangered marine mammal species in the country. Adding the available abundance estimates from the coastline of Uruguay and south Brazil, the bottlenose dolphin may be seriously endangered in the larger south-western Atlantic. This reveals a gross misconception about the conservation status of the bottlenose dolphin in this part of the world.

The precise cause of the current situation for the Bay of San Antonio population is beyond the scope of the study outlined here, but it reveals the urgent need for continued research and conservation efforts. Consequently, Whalefish scientists are working on a continuation of the bottlenose dolphin research project in Argentina.

The general objective of this project is to study in more detail the population dynamics and viability of the bottlenose dolphins in North Patagonia. Additionally, we aim to reveal the population structure over the larger Argentine coast by multiple site comparison of photo-identification data. In the long term, the project will help identify causal factors affecting the bottlenose dolphins' conservation status, feeding directly into the identification of priority conservation actions. Based on these results, new and improved directives will be proposed to enhance current marine conservation measures with the aim of preserving the bottlenose dolphin in Argentina.

Fig. 5. The Bottlenose dolphins in the Bay of San Antonio are named by the locals as "Tonina". Image Els Vermeulen.

Educational outreach is vital to Whalefish, and the project intends to build upon the educational work undertaken through the book Dolphins of the Bay (*Toninas de la Bahía*——see Figure 5). This educational book was distributed to over 3,000 schoolchildren in the three villages surrounding the Bay of San Antonio, and is freely downloadable via our website.

Visit **www.whalefish.org**

Ghost fishing in the USA

A recent study is amongst the first to quantify the damage caused by derelict fishing traps in US coastal waters. Article by Dana Weiss.

Floating patches of plastic are eye-catching, but less obvious marine debris may have more harmful effects. Fishing gear that has been accidentally lost or intentionally discarded continues to fish for some time. This phenomenon, known as 'ghost fishing', is usually related to nets and lines.

Recently, Courtney Arthur and colleagues at the United States' National Oceanic and Atmospheric Administration (NOAA) reviewed studies from seven key fisheries in US coastal waters to provide one of the first meta-analyses focusing on ecological and economic impacts of derelict fishing traps (DFTs) (Figure 1). These fisheries target the Dungeness crab (*Cancer magister*) in Alaska and Puget Sound, the blue crab (*Callinectes sapidus*) in Maryland, Virginia and North Carolina, the spiny lobster (*Panulirus argus*) in Florida, and coral reef fish in the US Virgin Islands.

According to the analysis, the average number of derelict traps ranges from 5 to 47 DFTs km^2. Their rates of ghost fishing at a given moment amount to 5 to 40%. The yearly catch of a trap is estimated at 4 to 76 target species individuals. For example, 178,874 harvestable Dungeness crabs fall victim each year to derelict traps in the Puget Sound, equalling a monetary value of $744,000 or 4.5% of the average annual harvest. The unintentional catches also include individuals prohibited from harvest, such as non-mature or egg-bearing females, as well as non-target species, such as shrimps, fish, urchins and terrapins. Thus, the traps can impact breeding populations, especially those of threatened species.

Derelict fishing traps continue to ghost fish for longer than anticipated: from 4 months to more than 6 years. Close examinations have revealed that rot cord, a mitigation measure which closes the escape panels, disintegrates slowly. Meanwhile, marine growth and material fatigue disable proper lid opening (Figure 2). In many cases 'self-baiting' occurs where dead organisms serve as bait attracting further victims. Furthermore, storms drive intact traps across the seabed. These tend, for example in the US Virgin Islands, to accumulate in sensitive habitats, where they scrape and break sponges and corals.

Fig.1. Derelict fishing traps may not only continue to ghost fish for years, but may also move about the seabed and harm sensitive habitats.

Fig. 2. Opposing effects: while colonizing communities use traps as substrate, marine growth can disable the opening of escape panels. Images: Randy Clark, NOAA/NCCOS/CCMA Biogeography Branch.

The NOAA-researchers consider the pervasive and persistent effects of derelict fishing traps to be largely preventable. They propose a 'DFT Management Strategy' which comprises constructing traps with biodegradable escape panels, spatial planning to avoid loss of traps due to interference with boat traffic, incentives for proper disposal of fishing gear on land, education to counter vandalism, and regular removal of traps to minimize habitat damage.

Dr Dana Weiss (dana-weiss@gmx.de), MBA member, biologist and journalist.

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The way we were

Geoff Smaldon worked as an Assistant in the Sale of Specimens Department of the MBA from 1962-1966.

The 'Lab' was its people; a family which, like all families, had good times and bad, quarrels, misunderstandings, fun and occasional sadness. I worked there from 1962–1966; here is my take on the way we were.

In the mid-1960s computers were in their infancy, marine ecology was yet to become mathematically-based, and much of the science was essentially a hang-over from the 19th century. In amongst this, however, there were elegant and complex experiments being conducted on cuttlefish buoyancy by Eric Denton, who went on to look at the adaptive camouflage produced by fish scales. Oscilloscopes surrounded the physiologists Trevor Shaw, Quentin Bone and Vic Howarth, whilst Colin Nicol investigated the reflecting eyes of elasmobranchs.Large-scale ecological investigations by Norman Holme of the bottom fauna of the English Channel consumed many hours of ship-time. Malcolm Spooner published on amphipods and aspects of marine ecology, while D. P. Wilson carried out pioneering work on the development of polychaete larvae, devising a rearing apparatus made from Meccano which would have been the envy of Heath Robinson. Bob Forster used SCUBA apparatus in his research on Haliotis while Alan and Eve Southward, always wide-ranging in their work, published some of the first papers on the enigmatic Pogonophora, as well as significant accounts of shore ecology and barnacle populations.

The chemists were in their first-floor laboratories: Dr Cooper; and F. A. J. Armstrong who drove an amazing Austin Atlantic, rare even in those days. The botanists Mary Parke, Gerald Boalch and their team, culturing diatoms and algae in north-facing rooms kept unnecessary visitors at bay to prevent contamination. Overseeing all of this, and more, was the modest presence of Director Sir Frederick Russell, an ex-World War 1 observer with the Royal Naval Air Service and an authority on medusae.

Visitors were the life-blood of the Lab and many were annual regulars. In this period the fundamental and important work on the conduction of the nerve impulse was carried out at Plymouth by Alan Hodgkin, Hans Meves and Knox Chandler, using the giant axons of *Loligo*. The squid were caught fresh each day by RV *Sula* and sent ashore in large vacuum flasks. Experimental work began immediately and often went on into the night. Professor Hodgkin was awarded a Nobel Prize for his work and sent a barrel of beer to the crew of RV *Sula* in thanks. Other marine scientists visited: Gordon Newell in his huge Rolls Royce coupé; Marie Lebour; Vera Fretter, working on molluscs; and Jack Llewellyn and his research students investigating monogenean fish parasites. The list is long and the names in it are significant in the development of marine science in the UK.

Alan and Eve Southward examining material on the deck of the RV *Sarsia* ca. 1964. Image: Geoff Smaldon.

The annual 'Easter Class' was attended by undergraduates from various universities and provided a good grounding in shore and shallow-sea ecology. Norman Holme, Peter Corbin and Malcolm Spooner took groups of students to explore the fauna of Millbay, Salcombe and the muddier shores of the River Yealm. Students witnessed trawling and dredging on the RV *Sula* and RV *Gammarus*. The classes were always popular and fully-booked.

Three research vessels catered for the needs of staff and visiting scientists. RV *Sarsia*, which had been built in Dartmouth in the early 1950s and sadly now lies half-submerged in a Birkenhead dock, was a multi-purpose vessel used for cruises to the Western Approaches and the Bay of Biscay. She was used, for example, by Malcolm Clarke for mid-water trawling for squid, and Alan and Eve Southward in their dredging for Pogonophora off the Spanish continental shelf.

RV *Sula* was a trawler which supplied the daily needs of those working on squid, fish and dredge samples from areas such as the Eddystone shell gravel.

RV *Gammarus* was a willing little launch which worked the estuaries and habitats such as Chelson Meadows. Skippered by Alf Briggs, who had rounded Cape Horn under sail as a young man, she also provided material for the Sale of Specimens Department which supplied university departments with teaching material.

Every year the MBA Council would meet at Plymouth and be given a tour of inspection: the labs; the facilities; and the impressive library, watched over by librarian Leila Serpell and her team. The tall figure of Sir Alister Hardy could not be missed as he viewed the first-floor tank-rooms and their occupants.

The daily rhythm was predictable: in the mid-afternoon the laboratory van's horn was sounded to announce that the ships' catches were on-board and ready for collection from the yard. A scurry of expectant scientists, laboratory assistants, the specimen-sales team and hopeful scroungers sorted out their needs and then all was quiet once again, until tomorrow.

Geoff Smaldon

After a first degree and PhD at Swansea University Geoff Smaldon spent several years in crustacean research.

High impact imagery,

Many scientists worldwide are beginning to recognize the value of visual media in connection to their research and outreach, but are still at a loss for how to begin. Based on my experiences as the full-time Media and Virtual Learning Manager at the University of Miami's Shark Research Laboratory, I would love to share some quick tips and lessons learned for incorporating visual media into your laboratory, so that your valuable marine research can have the greater impact it deserves.

Uncovering a valuable local resource: communications students

In my final year of undergraduate communication studies, I was ready for my work to mean something. I still needed some practice before graduating, so I asked myself: why not practise in a real world setting, where my class projects could further a meaningful cause? Herein was the perfect opportunity ripe for the picking. At almost all universities, there is a communications, art or journalism department. Students are working to develop their skills but often do not have provided content for their projects. As a marine scientist, you have great content, but may not have the skills or time to communicate it in visually engaging forms.

Look into your local communications, art or journalism department to see which classes are offered. Contact individual academic staff members teaching subjects of interest (photography, documentary production, writing for electronic media, infographics, web design, interactive media, etc.) or even internship coordinators to discus how you can partner with them. The STEM (science, technology, engineering and maths) push has trickled down to almost every university department, so this partnership might be just what they are looking for.

Integrating visual media into your research laboratory

- *Scholarly articles* include student photography or have a media student help you design a better figure or diagram for your upcoming publication.
- *Brochures/flyers* find a graphic design student or even a whole class to design a new brochure or flyer for your laboratory. It is a bonus if they also can do photography and writing.
- *Funding report/grant applications* again, find a photography student and/or graphic design student to help spruce up an upcoming grant application. Just including a few extra high-impact images and more modern, approachable design can help make a great impression on your potential funding agency.
- *Video trailer* partner with an intermediate or advanced video production class to have them create a video package about your laboratory or your most cutting-edge research project. Feature the video on your website homepage, share it through social media, and send it over to your university or institution's marketing/PR department.
- *Website* for smaller laboratories, redesigning your website and refreshing its content could make for a perfect undergraduate thesis project. For larger laboratories, highlighting one initiative or research project in a mini interactive website could be more attainable for a student.
- *Social media* while you might be able to run a Facebook or Twitter account yourself, the right media intern will offer you new strategies, fresh perspectives and

low cost investment

By Christine Shepard

hours you do not have. This is a perfect outlet for 'bite-sized' graphics, photos, and videos that will expand your outreach community into the online realm.

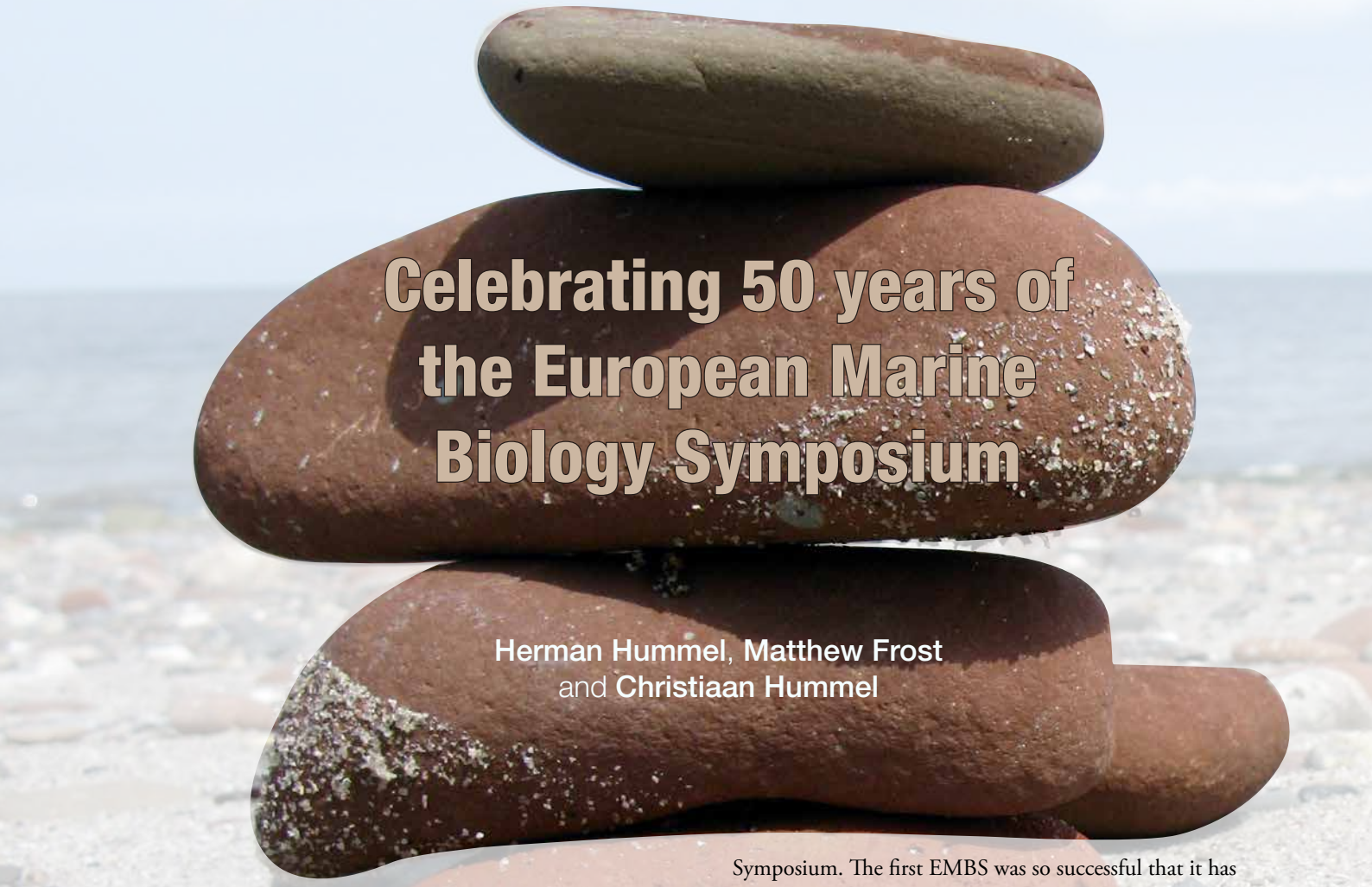
Tips for a smooth and gratifying process

- Be choosy with your media interns and students. Even if you are not a media expert yourself, trust your gut about which students will be strong independent workers and posit themselves as an asset to your team. Prioritize quality over quantity.
- Set realistic, attainable and measureable goals for student projects. This is not their only work all term, so challenge them, but make sure the project is achievable.
- Identify a media advisor for the student to check in with them weekly/monthly and assist with technical aspects of the project. This could be one of their current lecturers, a graduate student, or another lecturer within their department.
- Develop a standardized organizational system for your media projects. Most media students will work on a Mac computer, so keep a hard drive (plus back up) where they will archive their work for you. Organize into folders by research project, type of media project, date, or a combination thereof.
- Require students, especially photographers, to input metadata. By key-wording and captioning each photo they edit and archive, you will be able to more efficiently utilize those assets in the future.
- With top-quality media projects, take some extra time to help students feed them to mass media outlets. This will help your work and theirs to be disseminated and have a larger impact.
- Show and share your appreciation for their work. After all, these students are donating their time to your laboratory, so make sure they know how much they are valued.

Working with communication students to augment your laboratory's outreach goals can be an easy, fun, and surprisingly valuable experience. With all the diverse demands on scientists these days, finding and embracing those mutually beneficial partnerships will streamline and enhance your career.

Christine Shepard is a freelance wildlife photographer.

www.christineshepard.com



Celebrating 50 years of the European Marine Biology Symposium

Herman Hummel, Matthew Frost and Christiaan Hummel

It all began in the autumn of 1966 on the small island of Helgoland off the north coast of Germany, when marine scientists gathered for the very first European Marine Biology Symposium (EMBS). In September 2015, marine scientists from Europe and beyond will once more descend on Helgoland for the 50th EMBS meeting. In addition to presentations and discussions on the latest developments in marine biology, there will also be events celebrating the EMBS as one of the longest running annual symposia specifically focused on marine biological sciences.

The aim of the EMBS is to advance the science of marine biology within Europe and beyond; but in an ever busier calendar of international meetings and conferences, what has been the secret of the success and longevity of this symposium?

A symposium emerged from the sea

The history of the EMBS starts in 1960 when a series of German marine biological symposia was initiated by Otto Kinne, at the time Director of the Biologische Anstalt Helgoland. These symposia attracted marine scientists from all over Europe, and this enthusiasm prompted a questionnaire which found that 98% of the respondents were in favour of a regular European Marine Biology Symposium. The first EMBS was so successful that it has been held every year without interruption since, attracting marine scientists not only from Europe but from all over the world. Each year the host institute also focuses on two or three specific themes, reflecting their core business and interests. The EMBS has from its outset been driven forward and developed in response to the needs of the marine science community, rather than being driven entirely by one specific institute or organization.

Bringing the marine community together

One of the attractions of the EMBS is that it has facilitated networking on an international scale; since 1966 it has been held in a wide number of venues in 20 countries including most recently in St Petersburg, Russia. Networking is also facilitated by the fact that there are rarely multiple parallel sessions, which means that everyone is able to sit in on all presentations and engage in discussions with all colleagues, whether student or senior researcher, up and coming scientists or an established expert. The lack of parallel sessions is appreciated both by speakers, as they know they will be able to present their research to the whole symposium, and the audience who are encouraged to explore new areas and hear new speakers rather than just choose their areas of speciality. The poster sessions are also vital areas

for the exchange of information, with the smaller-scale of the EMBS compared with some conferences (i.e. hundreds instead of thousands of attendees) helping to encourage networking with this. These practical reasons, coupled with the relatively informal atmosphere, mean there is no doubt that a vast number of collaborative research projects over the last 5 decades owe their existence to the EMBS.

Not forgetting to have fun…

An important tradition of the EMBS is the Yellow Submarine contest, an afternoon full of marine related games or activities, in which competition with colleagues from other countries for the trophy can be fierce (see Figure 1) and at times bizarre (from throwing dead sea urchins at balloons in a Norwegian fjord to a potato peeling contest in Germany). There may be cash prizes from the MBA and MARS for best student talk and poster respectively, but the Yellow Submarine trophy is often the most coveted (so much so that the original trophy disappeared after the Swedes had won it and took it to Gothenborg).

The next 50 years…

There have of course been a number of changes over the years. For example, the first symposium proceedings often appeared in books, and sometimes in special issues of various journals. From 2014 onwards, the proceedings will be printed as a special issue of the *Journal of the Marine Biological Association*, thus guaranteeing publication in a well-respected, long-established journal.

The basic format and ethos of the EMBS continues however, and the enthusiasm of marine research institutes and stations to organize an EMBS meeting is as high as ever. Offers have already been put forward for the next three years following the 50th EMBS at Helgoland (www.awi.de/embs50) with the symposium being planned for Rhodes (Greece), Piran (Slovenia) and Wilhelmshaven (Germany), respectively.

Fig. 1. The almost victorious Dutch team (Vincent Escaravage, Herman Hummel, Christiaan Hummel and Sander Wijnhoven) during the Yellow Submarine competition of the 43rd EMBS in 2008, the Azores, Portugal.

So here's to another 50 years!

Herman Hummel[1], Matthew Frost[2] & Christiaan Hummel[1]

1. EMBS Presidency, EMBS Board and MARS Secretariat Monitor Taskforce, Royal Netherlands Institute for Sea Research (NIOZ), Korringaweg 7, 4401 NT Yerseke, the Netherlands

2. The Marine Biological Association, Citadel Hill, Plymouth, Devon, PL1 2PB, United Kingdom

The participants of the 46th EMBS in 2011 at Arendal, Norway.

An MBA student bursary helped fund Joseph Kenworthy's trip to:

the World Conference on Marine Biodiversity, Qingdao, China

In October 2014 I presented my PhD research at this event, in a talk entitled 'The context dependency of multiple stressor effects on estuarine sediment communities: a cross continental study'. This paper detailed experiments undertaken from a collaborative project between the University of St Andrews, in Scotland, and Macquarie University in Sydney, Australia.

My research appeared in a special session on the effects of multiple stressors on marine biodiversity. Not only are multiple stressors likely to coincide in natural systems, but they are also not straightforward to interpret, resulting in additive, cumulative or synergistic effects dependent on the system or stress in question. It was valuable to learn about contemporary research of multiple stressors on different systems and this session allowed me to gain new insights and perspectives on familiar topics.

Besides the fantastic banquets of Chinese cuisine, the international experience of visiting Asia and the conference organized brewery tour, this meeting brought together supervisors from both of my partner universities, a tough feat given they are on opposite sides of the world. It also became a great networking platform to meet researchers from China, the USA as well as from other European countries. As a 3rd year PhD student this was extremely beneficial to start the ball rolling for life beyond a PhD and to get me thinking of career progression as an early career scientist. Other activities included attending a workshop on getting published in international journals. This was extremely beneficial given that publications are the next step on my PhD journey.

I am very grateful to the MBA for granting the financial support that enabled me to see some fantastic talks, meet interesting people, and disseminate my research to a large scientific community. This conference has been beneficial both in terms of career progression and simply gaining valuable experience presenting my research.

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The MBA National Marine Biological Library: Changing Times

The World Association of Marine Stations (WAMS) estimates that nearly a thousand coastal laboratories and institutes are located around the world's oceans including over 60 stations in Europe, over 120 in the USA and over 150 in Japan. Their history and current and future importance was recently emphasized by Professor Mike Thorndyke in this publication (*The Marine Biologist* Issue 2, Spring 2014). Most of us would expect these marine stations to have seawater tanks, state of the art laboratories and research vessels. There is, however, a facility that is just as important for supporting research and that is the library.

At the MBA it was realised from the outset that good research would demand good library facilities. In a taste of things to come however, the financial implications were immediately clear with the first Director's report in 1889 beginning with the statement 'the efficiency of a marine laboratory being in the highest degree dependent upon the completeness of its library' followed by an appeal for donations. In many cases it is the remoteness of the marine stations that leads to the requirement for a dedicated in-house library. For example, the Nikolai Pertsov White Sea Biological Station in Russia is part of Moscow State University, however, the fact that it is in the Arctic Circle and 36 hours by train from Moscow means having closer access to the appropriate literature is crucial (on a recent visit I was delighted to find that there is indeed an excellent library on site with over 35,000 publications, periodicals and other literature).

Challenges—changing use and connectivity

In our modern days of connectivity the practicalities of providing access to literature to remote places—or indeed to any place—have changed dramatically. Libraries of all shapes and sizes are going through a period of substantial change and this is not only due to the changing mode of access to literature.

Throughout much of the 20th century many libraries grew rapidly to account for the ever expanding literature base. The MBA's National Marine Biological Laboratory (NMBL), for example, went from housing around 700 books in a single room in 1889 to over 30,000 items by 1961, and there are tens of thousands of titles today held over three floors. The major issues facing libraries throughout this period therefore tended to be the need for

more space to cope with the rapidly expanding collections and trying to secure funding to keep the collections up to date. Concerning funding it is noticeable that a special MBA library committee set up by the then MBA Director (E. J. Allen) in 1928 reported 'a still very topical complaint about the increasing cost of scientific journals that meant even though library expenditure had doubled […]

Like many marine science libraries the NMBL offers visitors a stunning location.

it was still not possible to buy all the desirable new journals'. With a far higher number of journals being published today, it is little wonder that this is still a major challenge.

It is in the late 20th century to present, however, that the development in information technologies brings about the most rapid change to libraries. On the one hand increasing amounts of traditional library material being published online (and often online only) including journals, reports, monographs and reference works is creating a new hybrid ecosystem of information. This necessitates new strategies for collection, maintenance and securing their future accessibility. On the other hand user expectations have diversified with some expecting books on shelves and corresponding catalogue entries while others expect instant access to material from their office, laptop or mobile devices. Libraries are therefore finding new ways of presenting and delivering resources and frequently offer training in information literacy on the way.

For many marine science libraries these changes have immediate implications. For example, for the first 70 years of the MBA the library was run by able administrators and assistants but today librarians have to be professionally trained information technologists able to deal with everything from copyright issues to digital archives and repositories. As Feltes *et al.* (2012) state in their look at the future of science libraries: 'In the 21st century research institution, librarians/science informationists will play many roles: collaborator, educator, consultant, data manager, developer and preserver of metadata standards and ontologies, a connector, and the curator of the institutional identity'.

There is also the challenge in deciding how to manage physical collections built up over many years. Ironically, after decades where space has been a major issue, many institutes faced with reduced funding have ended up undertaking stock reduction exercises or just getting rid of their physical libraries altogether, using the space for other income generating activities. In facing many of the same issues the MBA, whose library was recognized as nationally and internationally important back in the 1990s, found that much of the stock is unique and irreplaceable including rare books, expedition reports, grey literature and reports (the oldest books date back to 1554) which makes freeing up space a difficult task. Much of this unique collection documents the MBA's history and the evolution of marine biological sciences in Great Britain and beyond. And it is this wider role of the marine science library that is so hard to define, especially to potential funders. The basic challenge though is how to manage, maintain and keep an up-to-date world-class marine collection when there is barely enough funding to maintain the online resources.

The future - changing library services

So why maintain library collections in small or medium sized research institutes? Because within all this change one thing remains the same: libraries exist to enable users to gain access to and use the information that they need. Today, therefore, the NMBL continues to provide essential support allowing users to access the latest scientific literature whether physical or electronic but it could be argued that it serves a larger purpose. The Marine Biological Laboratory at Woods Hole, USA states on its website that 'For over 120 years, the MBLWHOI Library has been the intellectual heart of the Woods Hole scientific community'. This succinctly captures the point that the importance of libraries goes far beyond their role in just providing access to books and journals—they represent the history and development of marine biology itself, and are a stimulus for future study. It is important therefore that we see these resources not as historical repositories of an obsolete format but as constantly evolving resources with a vital role to play in helping marine scientists meet the challenges of the 21st century.

> *"I use desktop services, such as electronic journals, specialised databases and search tools, every working day, and I appreciate the fact that my access is facilitated and managed by staff in the library. That being said, there is a particular thrill to browsing library shelves, searching not to find something particular (there are catalogues and indexes for that), but to find the unexpected, the interesting, the new (to you). What is learning, but to discover and assimilate that which you did not know?"*
>
> Dr Paul Somerfield, marine biologist at Plymouth Marine Laboratory, and former MBA Council member.

Dr Matt Frost (matfr@mba.ac.uk)

FURTHER READING

Feltes *et al.* (2012) Envisioning the Future of Science Libraries At Academic Research Institutions. Available at: http://www.mblwhoilibrary.org/about-library

Brophy, P. (2007): *The library in the twenty-first century - new services for the information age*. Library Association Publishing, London, 240pp ISBN 1-85604-75-4

Marine biology at the University of Portsmouth

Portsmouth is the UK's only island city. It is a city steeped in maritime heritage and intimately linked to the sea. It was the site of the world's first naval dock established in the 1500s to "build the king's ships". In line with the nation's increasing dependence on sea power, the city became a hub of maritime industries with Portsmouth dockyard described in 1800 as the world's largest industrial complex. This industrial and military might has supported some of the most famous ships in the world such as Admiral Lord Nelson's HMS *Victory* (Figure 1), which can be seen today at Portsmouth's historic dry dock. In recent years the economies of the city and the Solent region have had to diversify, but the link to the marine environment of this 'blue economy', for example through tourism (Spinnaker Tower, Figure 2), sailing (Ben Ainslie's racing team HQ) or marine renewable energy (testing off the Isle of Wight) is still paramount.

The ecological heritage of the Solent's coastal habitats and the species within them is nationally and internationally important, and under threat from the expansion of industry and human use within Portsmouth and the wider Solent region. To protect these habitats and species a plethora of conservation areas have been established. The Solent is a European Marine Site (SEMS) with nearly every part of its coast protected under EU Natura 2000 legislation (SACs and SPAs), SSSIs or local nature reserves. The UK government's aim of producing an ecologically coherent network of Marine Protected Areas (MPAs) has also identified many more sites within the region.

As a marine biology student of the University of Portsmouth you are, therefore, ideally placed to study the exploitation, damage and conservation of the marine environment—key themes of 21st century marine biology. The University of Portsmouth has a long tradition of teaching marine biology that started in the early 1960s. However, marine sciences research in Portsmouth has been happening for close to 80 years, and since the late 1990s at the Institute of Marine Sciences (IMS).

Unlike a number of other UK universities which have constrained marine biology research and teaching to city-centre based facilities, IMS is about as close as you can get to the marine environment without getting your feet wet! Located on a shingle spit at the mouth of Langstone Harbour, the sea is only 5 metres away at high tide (Figures 3 and 4). This location provides unrivalled access to the varied ecosystems of the Solent including sediment shores, salt marshes, dune systems, estuaries and numerous manmade facilities (such as marinas and coastal defences). Strong emphasis is, therefore, placed on field and practical skills

Fig. 1. HMS *Victory*

Fig. 2. The Spinnaker Tower

Fig. 3. The Institute of Marine Sciences is located on a shingle spit at the mouth of Langstone Harbour, Portsmouth, on the south coast of England.

(Figures 6 and 7) with a week-long residential field trip in year two and numerous trips embedded within all years to marinas, dune systems, an aquaculture facility, rocky shores and a marina, to name but a few.

IMS also provides access to UK-leading facilities in our purpose-built aquatics centre. Filtered seawater is supplied to over 300 tanks ranging in size from 30 to 6000 litres in both outdoor and environmentally controlled conditions. The systems can provide pristine water quality enabling us to maintain any type of organism (including Home Office licensed species). An inshore and soon-to-be acquired offshore research vessel enable access to difficult-to-reach habitats.

The interaction of humans with the marine environment is an overarching theme of much of the research at IMS and the University of Portsmouth Environment Network (UPEN). This theme is composed of three sub-areas—these are listed below with some examples of recent projects undertaken. Supporting and underpinning these applied areas is the curiosity-driven research across a wide range of habitats and scales including: mangrove and coral reef ecology; plankton; algal biology; soft-sediment ecology; larval biology; trophic interactions; parasitism; and vertebrate ecology.

Exploitation: aquaculture for the marine aquarium trade, coastal fisheries surveys, biofuel generation from marine invertebrate enzymes, biofilms and novel compounds in anti-fouling and marine protection.

Damage: ecotoxicology and the impacts of pollutants such as pharmaceuticals; non-native species, coastal fisheries, and the effects of ocean acidification and climate change.

Protection: conservation and management of fish stocks and benthic sediment systems using MPAs, and mangrove management.

The research-enhanced curriculum (especially in the third year) ensures that students are learning material and developing skills at the cutting edge of marine biology, and taught by academics who are world-leaders in their field. Our recent REF 2014 score confirms this excellence—100% of our research impact in the environmental-related area was classed as outstanding or very considerable in terms of reach and significance, and 72% of our research outputs were classed as world leading or internationally excellent. Our research income also saw a three-fold increase compared to the previous assessment period.

Students will experience this multi-disciplinary research environment

Fig. 4. The Institute of Marine Sciences, University of Portsmouth.

Fig. 6. Students undertaking soft sediment field work.

directly during their final year project (working alongside postgraduates, doctoral scientists and academics in multi-user laboratories). Project supervisors provide titles, which align with their own research areas, but a student's own idea can also be developed as a project. For those students who want a more exotic location than the UK, the project system is flexible, thus enabling students to complete practical work at other research facilities. We have strong links with non-governmental organizations (NGOs), and through the EU Erasmus scheme many European universities and institutes. These links make, if you will pardon the marine-based pun, the world your oyster when it comes to projects.

The university offers a variety of IMarEST accredited and Society of Biology recognized degrees including three year (BSc Marine Biology) and four year (Masters in Marine Biology) degree programmes in addition to taught (MSc in Applied Aquatic Biology) and research-focused MRes, MPhil and PhD programmes. A popular feature of the BSc Marine Biology pathway is that first year units are shared with other degrees. This flexibility allows the student to experience a wide range of subjects before confirming initial selection at the end of their first year, enabling students to tailor their degree to suit their individual interests. For example, basic and scientific SCUBA diving units can be taken that make up part of the second year, or aquatic microbiology or global climate change options can be chosen from in the third year.

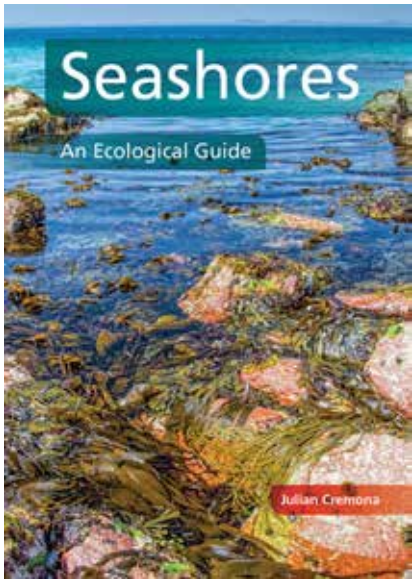
Over the last 50 years our marine-based undergraduate and postgraduate degrees have produced countless students who have gone on to have successful careers in a wide variety of sectors (including environmental consultancies, academic and industrial research, conservation NGOs, government agencies, and teaching), and with many also going on to further study at academic institutions across the globe. As far as the understanding of the marine environment goes marine scientists have only just dipped their toes in the water. However, for the world to have healthy and productive seas for future generations there is so much more to learn, and there is so much that needs to be fixed. We hope that for the next 50 years, we will be able to continue to develop passionate marine biologists who will contribute to making our seas a better place.

Gordon Watson
(gordon.watson@port.ac.uk)

Fig. 7. Students undertaking rocky shore field work on the south coast of England.

Reviews

Seashores: An Ecological Guide



Author: Julian Cremona

ISBN: 9781847978042

Published by: The Crowood Press

Bookshops are awash with seashore ID guides, but these rarely put the species identified into the context of their habitats or communities. This addition to the marine life bookshelf from Julian Cremona fills that gap with a richly illustrated guide to seashore ecology. Already an author of photography books, Julian has produced an easy-to-follow guide to a topic that he is clearly passionate about, having had years of experience with the Field Studies Council.

The book begins with simple introductions to coastal ecological concepts and physical processes, with explanations about tides, waves and nutrient flow which help the reader to see how each component of a habitat is important. This leads nicely onto the main chapters which contain detailed descriptions of the communities, species and ecology of the common UK seashore habitats. Text and photographs are provided for identifying each community and the characteristic species found. Tips are also given for identifying burrows and casts. Sections on the challenges of living in each environment help the reader to understand how adaptations and species characteristics allow them to exist, and special points of interest and caution should help the inexperienced to get the most out of a field visit.

There are good chapters on sand dunes, slacks, shingle and dune succession, which can be overlooked in traditional guides. Saltmarsh plants can be neglected in ID books for the more intriguing invertebrates, but here they are shown as important and interesting in their own right, with descriptions of how they tolerate their tough environment. The final chapter on threats and conservation does not go into great detail, but gives an overview of the different pressures on the marine environment.

This is a lovely introduction to shore ecology for a beginner but the book also provides sufficient detail for those with more experience. This book is beautifully illustrated with photographs of various species to keep the eye interested throughout, particularly in the plankton section. Again, usually omitted from ID guides, these photographs of invertebrate larval stages and phytoplankton are important in understanding ecology and how species interact with their environment. Magnified photographs of hydroids and bryozoans show the reader how complex and beautiful these organisms are, when they are so often glanced over *in situ*.

While a little large to be carried to the shore, and not intended as a comprehensive species guide, this book will complement any good ID book and would make a nice edition to any naturalist's book collection.

Bryony Townhill

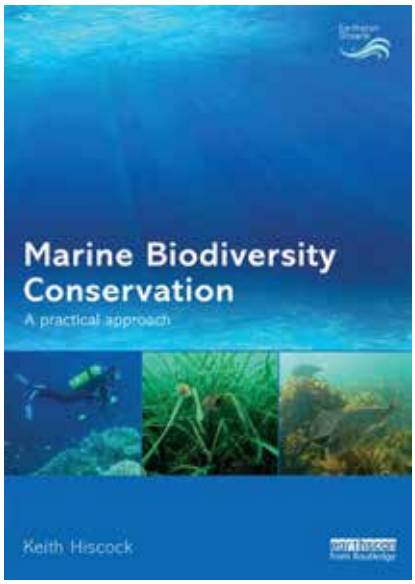
Marine Biodiversity Conservation - a practical approach

Author: Keith Hiscock

ISBN: 978-0-415-72356-5 (pbk)

Published by: Routledge

This excellently produced book 'does what it says on the tin' – it really is a practical guide to the increasingly complex world of marine conservation and is based on Keith Hiscock's career over several decades at the sharp end of marine



conservation. It uses examples from worldwide so will be of value to those working outside Europe and it makes excellent use of case-studies, boxes, figures, tables, flowcharts and decision trees to show the breadth of the topic to those familiar with the subject, students (especially at MSc level) and new practitioners alike.

The book rightly emphasises the functional aspects (i.e. rate processes) of marine systems and not just the structural aspects (the 'what' is present rather than 'why' it is present) which have so often dominated marine conservation. Within this, Keith details the physico-chemical influences on the biological system and collates the lists of activities causing change as well as the mechanisms (the pressures) of change. Hence it gives attention to the effects of human activities and our means of monitoring those using methods, approaches and various indicators. Because of this, it does cross-refer to national, regional and global initiatives for management such as laws, directives and conventions. Hopefully, it will convince practitioners that they cannot remain in their 'ecological bubbles' but in this modern world have to embrace the natural and social sciences if they want to secure successful and sustainable marine management.

The book rightly gives a lot of emphasis to Marine Protected Areas as one of the main tools at our disposal for protecting the seas. It summarises experiences

worldwide in attempting to create successful MPAs although it could give even more attention to the debate regarding the difficulties of designating areas against changing baselines, for example under global climate change, and of the co-location of activities. The analysis gives the design principles for these and other types of protected areas and although some of this has a UK and European emphasis, it will be immensely valuable to those in other areas.

The history of marine conservation mirrors Keith's career and so this reflection should be required reading for all those with, or who aspire to, careers in marine conservation. Its Glossary and very extensive reference list should help the readers to take things further although, as expected in such a fast-moving field, some of the aspects are slightly out of date immediately as the book is published. However, this does not detract from the value of the book. While many of us have complained that some marine conservation and management practitioners don't have the time (or inclination?) to read the primary literature, I am hoping that the wealth of information in this book will be used by them – it may even stop a bit of wheel-reinventing!

Mike Elliott

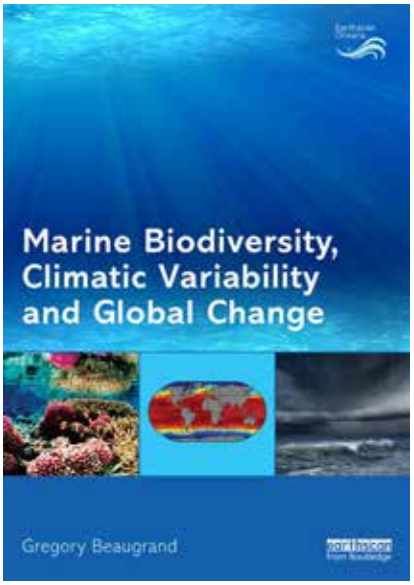
Marine Biodiversity, Climatic Variability and Global Change

Author: Grégory Beaugrand

ISBN: 978-0-415-51703-4

Published by: Routledge

Much writing on marine biodiversity focuses on the depths of our ignorance - how little of the oceans have been explored, how much there remains to find out. But there is an alternative narrative: after centuries of exploration and decades of systematic surveys, we know enough to sketch out the main features of life in our seas. A proponent of this view, pioneering studies of the dynamics of marine biodiversity at large spatial scales, Grégory Beaugrand now brings this perspective to a book promising to expose how life in the oceans has been associated with the Earth's changing climate throughout geological time and into the Anthropocene.



Two aspects of this work particularly appeal to me. Throughout, Beaugrand is refreshingly comfortable using terrestrial examples to illustrate his points, arguing that generalities in ecology ought to cross the land-sea boundary. I also agree that putting emergent properties of marine ecosystems under the 'macroscope' is a good route to uncovering such generalities.

Yet despite these significant points of agreement, this book left me frustrated rather than inspired. The major problem is that Beaugrand covers too much ground. After just two chapters, we have already covered the state of knowledge of marine biodiversity (though with no mention of the global standard World Register of Marine Species), climatology and oceanography. From there, the book races through contemporary and historical patterns in the distribution of biodiversity, followed by a whistle-stop tour of major human impacts on the oceans. The range of subjects inevitably leads to superficial coverage of some important and controversial topics. Moreover, while the breadth of reading is impressive, some sections and statistics seem dated; work from a decade ago is frequently referred to as 'current' or 'recent', even for fast-moving areas like biological responses to climate change.

A book this ambitious is destined to be a difficult read, but this one is especially so. The writing is inconsistent and the structure labyrinthine. It is hard work navigating through a hierarchy of subheadings often four or five layers deep, sometimes with little logic (e.g. 3.2.4.4.4 - 'Bioluminescence' - is a subsection of 'Deep-sea regions'), and with no chapter-ending summaries to help refocus. This is pitched as a text book; a few years teaching it as a course may have helped to separate essential components from superfluous detail. Deciphering sources is hampered by the numbered references and abbreviated reference list; while separating the colour plates means reading requires at least two thumbs - but at least it creates a central catalogue of poor data visualisation.

All of this I put up with in anticipation of Chapter 11's promised 'macroecological theory on the arrangement of life' (although the 'scenarising' in the chapter title is one of numerous words that should have been underlined by an editor, or an English spellchecker). The theory in question is interesting and much needed, but, as the author admits, it is far from finished. 'It may soon become apparent that the theory explains many ecogeographical patterns found in nature', he claims. Should Beaugrand's confidence turn out to be well placed, I would expect a book written at that future point to be more rewarding.

Tom Webb

Aggregate Dredging and the Marine Environment: an overview of recent research and current industry practice

Edited by: Richard Newell and Tania Woodcock

ISBN: 978-1-906410-41-4

Published by: The Crown Estate, and available via www.thecrownestate.co.uk

This comprehensive report continues the excellent series of publications produced under the Marine Aggregate Levy Sustainability Fund (MALSF) which ended in 2011.

The MALSF was set up to reduce the use of primary aggregates and improve understanding of the potential environmental impact and costs. The report shows the scale and use of aggregate dredging and that there

has been significant progress in a number of disciplines. This included assessment of biodiversity in the vicinity of licensed areas, improved understanding of dredging methods and better ways of communicating research to a non-technical audience.

The introductory chapter of the report describes the demand for terrestrial and marine aggregates and how the latter may be used through the use of rail transport to be a viable environmental alternative to lorry based journeys, e.g. contributing to the building of the London Olympics. The report primarily covers marine habitat and conservation issues, the impacts on the environment, recolonization and recovery of different species. Each chapter has been written by a leading exponent of that area of research and this includes the long neglected subject of marine archaeology and heritage. The socio-economic aspects provide useful examples that link with other nationally significant work undertaken by the Natural Capital Initiative.

The report highlights the challenges of assessing e.g. cumulative effects of dredging in adjacent licensed areas and comparing the impact with trawling methods used by different sectors of the fishing industry. Reports of related projects can be accessed at the following website: www.cefas.defra.gov.uk/alsf.aspx

Paul Leonard

MBA members can apply for awards and grants.

We offer £100 bursaries to support Student Members attending marine biology related conferences and meetings. The next quarterly application deadline is on 1st May 2015. To find out more, please visit: www.mba.ac.uk/awards-grants

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MBA MEMBERSHIP (prices per annum)	Price from 1st March 2015
Young Marine Biologist (YMB)	£12.50
Student Member	£25.00
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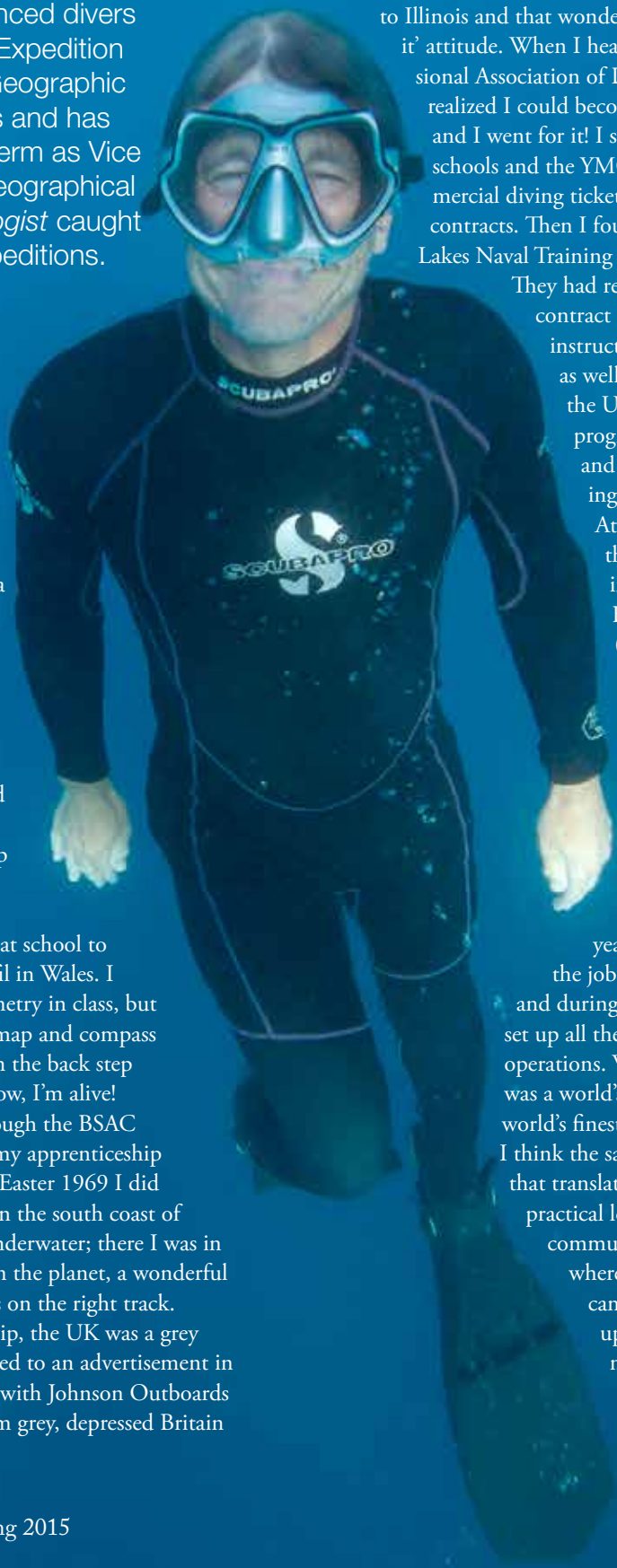
MBA Fellow, FMBA	£120.00 (direct debit discount £5)
Institutional Member	£340.00
JOURNAL SUBSCRIPTION (MBA price added to the above membership fees, with the exception of YMB as no Journal option for this category)	
Online Journal	£20.00
Print Journal	£60.00
Print & Online Journal	£80.00

Going for it: Paul Rose talks about opportunities, communication and pristine seas

Paul Rose is an explorer and one of the world's most experienced divers and polar experts. He is Expedition Leader for the National Geographic Pristine Seas Expeditions and has just finished his second term as Vice President of the Royal Geographical Society. *The Marine Biologist* caught up with him between expeditions.



What first got you interested in marine life?

I grew up in Essex, south-east England in a council flat and you can't get much further from the sea and wild places. I remember watching Jacques Cousteau and Hans Haas on TV, and of course those great black and white shark images; when you're a young boy they get you excited.

You have a great job, how did you get to be where you are, and what have been the turning points?

I certainly do. I was 11 years old and I'd just failed the 11+ and inevitably I managed to fail the 13+ as well! I fell into a bad group and became disconnected from school. Then a geography teacher took us lads who were struggling at school to a youth hostel near Merthyr Tydfil in Wales. I couldn't do trigonometry or geometry in class, but doing night navigation with the map and compass I got it! I remember sitting out on the back step peeling potatoes and thinking, wow, I'm alive!

I got my diving qualification through the BSAC (British Sub Aqua Club) during my apprenticeship at the Ford plant in Essex and in Easter 1969 I did my first sea dive at Chesil Cove on the south coast of England. All of a sudden I was underwater; there I was in the least understood ecosystem on the planet, a wonderful moment that convinced me I was on the right track.

When I finished my apprenticeship, the UK was a grey place; everybody on strike. I replied to an advertisement in the *Sunday People* for toolmakers with Johnson Outboards in the US. So in 1973 I went from grey, depressed Britain to Illinois and that wonderful American 'go for it' attitude. When I heard about PADI (Professional Association of Diving Instructors), I realized I could become a diving instructor and I went for it! I started teaching at high schools and the YMCA, then I got my commercial diving ticket and won some small contracts. Then I found out about the Great Lakes Naval Training Center (GLNTC). They had restructured and a contract came up for a diving instructor, so I went for that as well! I became Director of the US Navy SCUBA diving programme at the GLNTC and I left the engineering world behind me.

At that time I realized there were opportunities in Antarctica with the British Antarctic Survey (BAS) and I became a Field Assistant (a mountain guide for scientists). I've got a good head for science; taking a complex science idea and turning it into practical logistics came naturally to me. After a few years BAS offered me the job as base commander and during my 10 years there I set up all the diving protocols and operations. What a life! Every dive was a world's first with some of the world's finest marine scientists.

I think the same part of the brain that translates a hypothesis into practical logistics also works for communicating it, so that's where the broadcasting work came in and I picked that up with the BBC about nine years ago.It's a beautiful life, to take my love of the sea and

diving and to use that to lead marine life expeditions, it's the perfect slot for me. There's a natural progression in there somewhere [*Laughs*].

Have you had any experiences with marine life that changed your life? Where and how?

I really have. Diving with a bigeye sixgill shark (*Hexanchus nakamurai*) with BBC Oceans off the Straits of Messina in Italy. We'd spent 4 days trying to get there, and we finally hit on the idea of tying 8 kg of fresh tuna to my weight belt, and if there was a shark there it would be attracted to me. I was in 50 m of water and we saw nothing. Then in the last 15 minutes of the dive this 4 m prehistoric-looking shark came over and I was able to touch it as it went past. Looking in those big green eyes was an amazing moment for me. I remember going up and leaving him down there swimming lazy figures-of-eight.

What is the role of communicators like you in tackling big challenges like ocean acidification and plastic in the ocean?

We've got enough data on climate change and ocean acidification that we know what's happening, but we're not going to change anything until we learn how to communicate it properly. My job is finding innovative ways of using science to get these messages across.

The benefit of not being a scientist is I can cut to the chase and get away with simplifying concepts—although not dumbing them down. So if we know that toxic, persistent chemicals are getting into birds, fish and seals via microplastics then it stands to reason they must be in us too.

If we talk about the great Pacific garbage patch and see films of albatross chicks on Marshall Island, guts full of things we throw in the sea, it seems so remote and distant. But if I can walk around the coast of Britain, as I did a couple of years ago, and pick up a dead fulmar and pull out bits of plastic, bits of margarine tubs, then people say, blimey, that's on the coast of Yorkshire.

I do talks for the UK shellfish industry. They are investing a lot of time and effort in communicating about ocean acidification and doing a good job of raising concerns and lobbying for the science that will inform better policies.

Why should we care about big marine reserves?

We take from the ocean through fishing, expecting it to manage all our CO_2 and using it as a dumping ground for all our waste. Then if I talk about a savings bank, we have to put some savings in there—the way you manage your money—and people start to get it. That's my work with National Geographic, we are pushing the point that we have overfished, overused and polluted the sea and we continue to do damage, but remarkably there are still some pristine places and our job is to go to the last wild places in the ocean and help the host countries turn them into marine reserves. So far we've done that for over 1 million km^2 and the one I'm working on now is Pitcairn [the proposed MPAs in the UK Overseas Territories: Pitcairn Islands, Ascension Island and

Antarctic diving: first find your water. Image: Paul Rose.

South Georgia and the South Sandwich Islands]. We have big hopes that they will be announced as a marine reserve by the UK Government before the next election. I can talk in a non-scientific way about marine reserves acting like a volcano of fish, and people get this image in their minds. For scientists its spillover; the whole ecosystem can return to a balance, where you've got that lovely upside-down pyramid—where top predators like sharks make up a much higher proportion of biomass than fish lower down the food chain—a big turnover rate and healthy more resilient corals. The fish don't know where the edges of a marine reserve are and this whole beautiful ecosystem starts bursting after only 4–5 years, the spillover gets massive and fishermen around the edges are doing much better than they were in the first place. Scientists might think: hang on, a volcano of fish is a bit strong, but

Paul Rose with Galapagos sharks in Marotiri. Image: Manu San-Felix and National Geographic Pristine Seas.

people like me in the communications business need powerful ways to get people engaged in the science side of things.

What is the biggest challenge for society if our generation is to reverse decades of marine environmental degradation?

The biggest challenge is to get across why people should care about ocean issues, so that they can influence politicians. In the UK when an ocean issue comes up and we want our politicians to act then we stand a chance of it happening. Similarly in America: look what Obama has just done with

the Pacific Remote Islands marine reserves. There is an ocean constituency and Obama and his team have the political will. Where it is difficult is in places without an ocean constituency. I led an expedition to Mozambique last year. Because of their difficult history and 20 years of civil war, they've lost their connection to the sea. They need to do something about their beautiful waters pretty quickly or they'll go beyond the point of no return. It's a slow job but by working with kids there and then influencing partners who are connected to the Mozambique Government, we are helping them build up an ocean constituency so that we can influence political leaders to make the right decisions.

The UK has the fifth largest marine zone in the world. If the proposed MPAs in the UK Overseas Territories are designated do you think the rules can be enforced in any meaningful way?

Absolutely. Monitoring of illegal fishing used to be almost impossible and until a few years ago the UK Government shied away from designating these big marine reserves. Now, with the satellite Catapult system, regulators know when ships turn their Automatic Identification System (AIS) on or off and can detect and track vessel behaviour such as the pattern of longlining or setting nets. At the World Parks Congress in Sydney in November Google launched Global Fishing Watch. The prototype is using year-old data but soon they will use real-time data and then there will be crowd watching; everybody who is interested can go online for free and say, I know this is a marine reserve, let's see how many ships are going through it. So all of a sudden there's nowhere to hide for these ships. The trick now is how do we manage that in terms of international law? If a Panamanian registered vessel belonging to a Korean fish company goes through UK waters and sells fish in Chile, who prosecutes? Some of the big fish wholesale companies are agreeing to track fish so when it comes to market it is guaranteed legal and sourced from open fishing areas. Consumers will get smarter too. It won't be long before people in supermarkets will be asking to see the stamp that shows that fish are legally sourced. Now with these systems we're almost at the end of illegal fishing. We're in a sweet spot for people who love the sea.

You travel the world a lot. Which countries or regions seem to you to be leading in terms of taking action to protect marine resources?

The UK is a leader. The language used in the US by Obama, Kerry and NOAA on ocean exploration is really good, really inspirational. Palau's Exclusive Economic Zone is closed to commercial fishing. Also, the President of Gabon has outlawed commercial fishing in 23% of his nation's waters.

What advice would you give to a young person who wants to be involved in marine biology?

Go diving. When you finish your degree don't worry if you don't get a job as a scientist; for every field scientist there are two to four science support workers who dive, run boats, drive trucks and keep generators going. There are jobs for plumbers, carpenters, electricians, ground-workers. Get a job in front line science support.

Paul Rose at the Zurich Museum of Design and the amount of plastic that enters the sea every 15 seconds. Image: Paul Rose.

What is your next challenge?

I'm getting ready for four expeditions: the outer atolls of the Seychelles in March; north-west Greenland in summer; Galapagos deep seamounts; and then Patagonia in November. Four big ones this year [*Laughs*].

Are you an ocean optimist? Why?

Totally. I really am. We don't have all the solutions for marine issues but we're working on it. We're not chucking as much in the sea as we used to. I'm working with a team in Hong Kong who can tell where plastic comes from—like plastic DNA. In regions strongly affected by climate change we can see where ecosystems have adapted and some can adapt very quickly. I've worked on corals in Eritrea where its 34°C and they're absolutely thriving. I have been back to reefs in the Seychelles after the 1999 bleaching event and they are absolutely beautiful.

How long you are you going to continue working in ocean exploration?

For the rest of my life. I'm never going to stop.

FURTHER READING:

National Geographic—Pristine Seas (http://ocean.nationalgeographic.com/ocean/explore/pristine-seas/).

The MBA's Coat of Arms

The Marine Biological Association was granted a Royal Charter from Her Majesty the Queen in 2013, in recognition of the Association's long and eminent history and its status within the field of marine biology. The MBA took the opportunity to petition for a Grant of Armorial Bearings, and this was approved in 2014. The Letters Patent granting the Arms will be signed by the King of Arms this year.

Issue 5 of *The Marine Biologist* looks east

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www.mba.ac.uk/marinebiologist