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A world wide problem

Marine litter is a global environmental problem with items of debris now contaminating habitats from the poles to the equator, from the sea surface to the deep sea. This litter has negative consequences for wildlife, for economies and on human health. Over 700 species, including commercially important fish and shellfish are known to encounter marine litter in the environment. The vast majority of the litter found on shorelines and at the sea surface is plastic. It has been estimated that up to 12 million tons of plastic litter could be entering the ocean every year. There are solutions, but there is an urgent need for action.

Discovering microplastics

Research at Plymouth University was the first to demonstrate the widespread occurrence of microscopic particles of plastic debris in the environment. In 2004, Professor Thompson’s team showed that what he described as ‘microplastic’ particles have accumulated in oceans since the 1960s and are now present worldwide. Staff from the International Marine Litter Research Unit described the accumulation of microscopic fragments of plastic debris in the oceans and much of their focus is on these tiny particles.

“Our work has shown that microplastic debris now contaminates shorelines worldwide, that they are present in substantial quantities in remote locations such as the deep and the Arctic. A range of marine organisms including commercially important species can ingest these pieces and laboratory studies have shown there is potential for this to lead to harmful effects.”

In 2015 the US president Barack Obama signed a bill outlawing the sale and distribution of toothpaste and exfoliating or cleansing products containing microbeads which are a type of microplastic. Our work on this topic has helped inform governments around the world. Prof Thompson recently submitted evidence to the UK Houses of Parliament in relation the Environmental Audit Committee enquiry on microplastics.

Expertise

Our findings are underpinned by research conducted by the team at Plymouth University and in collaboration with other leading scientists worldwide. This expertise has guided industry, informed educational and artistic initiatives that raise awareness, and has provided evidence for government agencies and international organisations such as the United Nations.

Our team

International marine litter research draws on a multi disciplinary team of researchers

Professor Richard Thompson, Professor of Marine Biology
Professor Steven Rowland, Professor of Organic Geochemistry
Dr Sabine Pahl, Associate Professor (Reader) in Psychology

Post doctoral researchers and PhD Students

PhD Profile
Imogen Napper
Imogen studied her BSc(hons) in Biomedical Science, and studied for a MSc in Biotechnology at the University of Lincoln. She is presently studying for a PhD at Plymouth University researching ‘The Sources and Fate of Plastic Contamination Within the Marine Environment’; under the supervision of professors Thompson and Rowland.

PhD Profile
Nicolas Biber
Nicolas studied for his BSc in Animal and Plant Biology in 2005 and for a MSc in Animal Biology in 2007 both at the University of Basel, Switzerland. He proceeded to take on a part-time PhD project here at Plymouth University under the supervision of Prof Richard Thompson and Dr Andy Foggo.

PhD Profile
La Daana Kanhai
Funding: Mares Doctoral Scheme, Microplastics distribution across latitudinal gradients. 2015 - Present.
Supervisors: Ian O’Connor (Galway) and Richard Thompson

Learn more about our team at:
https://www.plymouth.ac.uk/research/marine-litter/people
The International Marine Litter Research Unit is proud to stand at the forefront of research. In 2004 our team was the first to reveal the widespread occurrence of microscopic particles of plastic debris at the sea surface and on shorelines – pieces which were described as microplastic.

We have published numerous scientific papers and reports on this topic, have advised governments and international organizations worldwide and we continue to research not only the extent of the problem, but also the solutions.

The International Marine Litter Research Unit has a mission - to further our understanding of the impacts of litter on the environment and society, to identify the solutions and the pathways necessary to achieve them.

Learn more about our published work at:
https://www.plymouth.ac.uk/research/marine-litter/publications

Above: A recent publication in Marine Pollution Bulletin 97 (2015) 5–12, shows the key role that Plymouth University has in the field of microplastics research.

Image: Average quantity of plastic fragments in the digestive tract of Northern Fulmars from the North Sea" Courtesy of J A Van Franeker, IMARES, Netherlands
Identifying and tackling chemical and plastic pollutants in the world’s oceans

For more than 30 years Steve Rowland, Professor of Organic Geochemistry has played a pioneering role in improving the identification of ‘supercomplex’ mixtures that are leaked into the oceans, such as those created by the breakdown of crude oil in the sea.

Within the International Marine Litter Research Unit Steve is also applying his expertise to help understand the potential for plastics to act as vectors in the transport of persistent pollutants and chemical additives in the ocean.

Is there a real risk from nanoparticles of plastic in the environment?

New research led by Heriot-Watt University, in conjunction with Plymouth University, will look at the effect which even the most microscopic plastic particles can have on the marine environment.

While large items of rubbish are known to cause physical harm marine animals by entanglement and ingestion; it is also apparent that there are considerable quantities of plastic debris that are not fully accounted for in the environment. Much of the plastic present in the environment may have degraded into small, microscopic and potentially even nano sized particles.

It is the effect of these nano-plastics, which will be studied under a £900,000 research project, funded by NERC and run by Heriot-Watt and Plymouth Universities. The project, RealRiskNano, will look at the risks these tiny plastic particles pose to the food web including filter-feeding organisms like mussels, clams and sediment dwelling organisms. It will focus on providing information to improve environmental risk assessment for nanoplastics, based on real-world exposure scenarios, replicated in the laboratory.
“I tell my students that what I’m about to teach them isn’t in their text books yet. Hopefully, what we’re doing in the research field at Plymouth is helping to revise future editions of text books”. 

Professor Steve Rowland on the value of research-informed teaching

Team leader Dr Theodore Henry, Associate Professor of Toxicology at Heriot-Watt’s School of Life Sciences, said that the study will build on previous research on nano-material toxicology, but will provide information which earlier studies did not include.

“Pieces of plastic of all sizes have been found in even the most remote marine environments. It’s relatively easy to see some of the results: turtles killed by eating plastic bags which they mistake for jelly fish, or large marine mammals drowned when caught in discarded ropes and netting.

“But when plastics fragment into microscopic particles, what then? It’s easy to imagine that they simply disappear, but we know that nano-particles pose their own distinct threats purely because of their size.

They’re small enough to be transported throughout the environment with unknown effects on organisms including toxicity and interference with processes of the digestive system.” An important component of the project to be investigated by Dr Tony Gutierrez at Heriot Watt will be the study of interactions between microorganisms and the nanoplastics to reveal how these interactions affect their fate and toxicology.

Professor Richard Thompson, of the Marine Biology and Ecology Research Centre, said, “There is considerable concern about the potential effects of microplastic in the environment. Work at Plymouth University has shown this debris can form by the fragmentation of larger items such as plastic carrier bags and from the direct release as of small particles from cosmetics.

We have shown microplastic debris is present in marine habitats worldwide and that it can be ingested by a wide range of organisms including commercially important species. This funding from NERC will allow us to investigate even smaller particles of plastic debris within the nano size range.”

The aim, said Dr Henry, is to provide the information which is needed to effect real change.

“We simply don’t know what effects these nano-plastic particles may pose to the marine environment, to filter-feeders and on to fish, and through the RealRiskNano project we aim to provide this urgently needed information to the people whose job it is to assess risk to the marine ecosystem and decide what steps need to be taken to mitigate it.”

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Research at Plymouth University has shown almost 100,000 ‘microbeads’ could be released in every single application of certain products.

Everyday cosmetic and cleaning products contain huge quantities of plastic particles, which are released to the environment and could be harmful to marine life, according to a new study.

Work by Plymouth University PhD Student Imogen Napper has shown almost 100,000 tiny ‘microbeads’ – each a fraction of a millimetre in diameter – could be released in every single application of certain products, such as facial scrubs.

The particles are incorporated as bulking agents and abrasives, and because of their small size it is expected many will not be intercepted by conventional sewage treatment, and so are released into rivers and oceans.

Writing in *Marine Pollution Bulletin*, estimate this could result in substantial quantities of unnecessary microplastic waste entering the sea every year from use of these cosmetics in the UK alone.
This latest study was led by Imogen Napper, together with Professors Richard Thompson and Steve Rowland.

Microplastics have been used to replace natural exfoliating materials in cosmetics and have been reported in a variety of products such as hand cleansers, soaps, toothpaste, shaving foam, bubble bath, sunscreen and shampoo. There is very little that the users of these products can do to prevent this source of pollution.

For this study, researchers chose brands of facial scrubs which listed plastics among their ingredients, and these were subjected to vacuum filtration to obtain the plastic particles. Professor Richard Thompson said:

“Using these products leads to unnecessary contamination of the oceans with millions of microplastic particles. There is considerable concern about the accumulation of microplastics in the environment; our previous work has shown microplastics can be ingested by fish and shellfish and there is evidence from laboratory studies of adverse effects on marine organisms.”

Professor Richard Thompson
Professor of Marine Biology

Examining fragments of plastic debris
Setting the agenda for G7 marine research

Our scientists have contributed to a new international report on ocean research priorities for the G7 nations:

The Future of the Ocean and its Seas: a non-governmental scientific perspective on seven marine issues of G7 interest

Prof Peter Burkill, President of the Scientific Committee on Oceanic Research (SCOR) and Prof Phil Williamson from NERC, co-edited the document, which provides briefings and advice on seven key topics raised at a meeting of G7 Science Ministers in Berlin in 2015.

Prof Richard Thompson (Plymouth University) co-authored the chapter on plastics in the marine environment, highlighting that “plastic items, including microplastics, are now a ubiquitous component of marine litter in the global ocean”. The document sets out multiple approaches to solving this problem, based around preventing plastic ending up in the oceans.

The seven topics covered are:

• Plastic pollution of the marine environment
• Deep-sea mining and its ecosystem impacts
• Ocean acidification
• De-oxygenation
• Ocean warming
• Biodiversity loss
• Marine ecosystem degradation

GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection”

Prof Richard Thompson, Dr Kayleigh Wyles and Dr Sabine Pahl contributed to two GESAMP WG40 Reports.

See more at:


We have also recently finalised a report for DEFRA on the wider benefits of the “Fishing for Litter” programme.

See more at:

Case study: investigation of microplastic debris in marine surface waters

Saeed Sadri who completed his PhD working with Prof Richard Thompson and Alistair Edwards investigated the photo oxidation and mechanical degradation of floating plastic debris in marine waters that results in their fragmentation into ‘microplastic’ pieces. In order to assess the level of microplastic contamination worldwide; there is a need for comparable data across marine environments that are based on standard methodologies.

Collaborative work between Plymouth University and the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) has shown a significant increase in the abundance of microplastics captured by the Continuous Plankton Recorder (CPR) in the northeast Atlantic between 1960 and 2000. The aim of this project was to further extend this data set and quantify spatiotemporal variations in the abundance of microplastic debris in ocean surface waters.

The preliminary examination of archived CPR samples confirmed the presence of microplastic debris in European waters (see diagrams below), including the North sea, Irish sea, English Channel and North Atlantic. The most common plastic types were Polyethylene terephthalate (PET) comprising 20% of the samples followed by Nylon 6% and Acrylic 5%. It is hoped that the findings of this study will inform several research priorities highlighted by the joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) such as: (a) determining the amount of plastics in the water column; (b) basic mapping of the pelagic/benthic environment.
Professor Richard Thompson and other academics from Plymouth University were among guests who met HRH the Prince of Wales and Duchess of Cornwall during an event to raise awareness of the problem of marine litter.

The royal visit was part of an Ocean Plastics Awareness Day organised by Surfers Against Sewage, the Marine Conservation Society and Clean Cornwall at Fistral Beach, Newquay.

It gave NGOs, local and national government, academia and industry an opportunity to commit to exploring and delivering pilot schemes to prevent the flow of plastics to local beaches by recycling plastic.

It also saw the launch of a Statement of Intent signed by participating NGOs, local government, academia and businesses to explore, develop and deliver innovative circular economy pilot projects.

Plymouth University, its Sustainability and Surfing Research Centre and the Marine Institute are among those to sign up.

During the event, their Royal Highnesses saw first-hand how community action in the county is bringing thousands of people together to help combat the menace of marine plastic litter.

Professor Thompson was delighted to discuss with the Prince of Wales not only the problems, but also the solutions, which he firmly believes must focus on reducing inputs of litter to the ocean and utilising end-of-life plastics as a resource via recycling in a circular economy.
HRH The Prince of Wales has long taken an interest in the health of the marine environment and the need to address waste. Prof Thompson has been collaborating with HRH the Prince of Wales International Sustainability Unit; part of their work attempts to integrate conversations on marine plastic waste with those focusing on the circular economy at a global level, and the activities in south west England showcase what can be done to address waste locally.

There are already some great examples of recycling and recovery projects in south west England that contribute to the circular economy, such as the Kimo Fishing for Litter scheme, fishing net recycling projects and the Finisterre bottles to clothing initiative.

Used as models of best practice, these and other schemes, showcased on Ocean Plastics Awareness Day, could then be rolled out in other parts of the country.

Hugo Tagholm, Surfers Against Sewage Chief Executive is delighted to be working with Plymouth University – and in particular the Marine Institute – on this and a number of other projects, as the expertise of its researchers and students can really help enhance awareness of this local and global issue. The South West of England has some of the most impressive coastlines in the UK, and these are now the focus of growing community efforts to tackle marine litter.
Focusing on the people factor: From public perception to behaviour change
The social and behavioural sciences become very relevant when we start looking for ways of tackling marine litter, and that’s where Dr Sabine Pahl became involved in the International Marine Litter Unit. Her research asks how to best communicate environmental risks to raise awareness and move towards change, both at the individual (e.g., through behaviour change) and societal level (e.g., through community action and concerted pressure on policy). She has worked with Prof Richard Thompson on several related projects: EU FP7-funded MARLISCO; DEFRA-funded Fishing for Litter evaluation; an ESRC/NERC funded PhD studentship, and she is a co-author on two GESAMP WG40 reports.

MARLISCO

The MARLISCO project is a science-in-society project with 20 partners in 15 countries across the four European Regional Seas: North-East Atlantic, Baltic, Mediterranean and Black Sea. The aim of MARLISCO was to raise awareness of marine litter through engaging stakeholders through exhibitions, educational programmes, national debates and more. We were responsible for two large European surveys to establish perceptions, and for evaluating activities such as a Europe-wide primary schools video competition. We showed that a citizen science activity for children increases understanding (Hartley, Thompson & Pahl, 2015). Some of the MARLISCO insights are summarised in a guide for influencing behaviour: http://www.marlisco.eu/tl_files/marlisco/Downloadables/WP%202/MARLISCO_D2.6_M32_v0.5.pdf.

Fishing for Litter

The Fishing for Litter (FFL) scheme aims to reduce marine litter and raise awareness. The Plymouth team was commissioned to complete a social evaluation of FFL. This meant our intrepid PRDAs, Dr. Kayleigh Wyles and Dr. Lauren Carroll, travelled to fishing ports in Southwest England and Scotland to conduct interviews with fishers in all weather. We found that being part of FFL was associated with behaviour change, that the positive media coverage of FFL was seen as a benefit and contributed to a feel good factor associated with participating. Positive features included the simplicity and voluntary nature of FFL; barriers included boat size, fishing practises and limited resources (especially surrounding landfill tax). Overall, FFL fishers rated the scheme as very good (> 8 on a 10-point scale) and strongly voiced hope that it would be expanded.

Marine Litter undermines coastal benefits

The beneficial effects of the blue environment to human health and wellbeing are well documented, but there has been little research into how marine litter might undermine them. We secured funding from the Economic and Social Research Council (ESRC) and the Natural Environment Research Council (NERC) for a PhD studentship (Kayleigh Wyles), now completed, to assess public reaction to the differing conditions of coastlines. Participants were shown images of clean beaches, beaches featuring seaweed (natural debris), fishing debris (such as rope, nets and packaging) or public litter (including drinks cans, plastic bottles, sweet and crisp wrappers). Not only did litter undermine the psychological benefits typically provided by coastal settings, but the type of litter was important. The clean condition was consistently rated most positively, whereas the two littered conditions were rated more negatively, with the public litter condition being rated the worst. This work provides more reasons for addressing marine litter to safeguard human health and wellbeing. Given the increasing litter on our coasts and in our seas, the psychological effects can be expected to get worse.

GESAMP WG 40

The working group of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) invited the Plymouth social team to provide a risk perception perspective on the problem of microplastics in Report No. 90 (http://www.gesamp.org/data/gesamp/files/media/Publications/Reports_and_studies_90/gallery_2230/object_2500_large.pdf). We concluded that public and private sector awareness of microplastics impacts is even less developed than that for macro-litter and that effective education and engagement at all levels of society is essential. Challenge 3 identifies “influencing perceptions and behavior, to complement legislation”, and using social and behavioural science to do so.

These projects integrate insights and methods from the natural and social sciences to tackle the global challenges of today. It is not enough to describe environmental problems without considering the role of people. The social and behavioural sciences offer theories and tools for a systematic study of the human role in terms of perception, communication and interventions for change. This is captured in the Lanzarote declaration from the MICRO 2016 conference (http://micro2016.sciencesconf.org/resource/page/id/7), which calls for collaboration between scientists of different disciplines, industry and policy.
A key part of our work is communicating our research to stakeholders in industry and policy as well as to the public.

- Professor Thompson, Professor of Marine Biology, gave the opening talk at the 2016 New Year Symposium on Marine Litter for G7, held on 23 January at Tokyo University of Marine Science and Technology. Professor Thompson was invited by the Government of Japan’s Ministry of Environment and his talk, entitled “Marine Litter: Are there solutions to this global environmental problem?”, described findings and conclusions of the marine research being conducted in Plymouth.

- Professor Thompson and Dr Sabine Pahl were on the Organising Committee of MICRO2016, a recent conference dedicated to microplastics, see: [http://micro2016.sciencesconf.org/](http://micro2016.sciencesconf.org/)

- Professor Thompson addressed the US State Department’s Our Oceans Conference: Marine Pollution.

See the presentation here: [https://www.plymouth.ac.uk/news/leading-scientists-express-rising-concern-over-microplastics-in-the-ocean](https://www.plymouth.ac.uk/news/leading-scientists-express-rising-concern-over-microplastics-in-the-ocean)

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Microplastic advice given to UK Government by the “father of Microplastics”

The University’s Professor Thompson (pictured), was called to provide evidence to the government’s Environmental Audit Committee in June 2016. Professor Thompson addressed the committee on his research into the threat posed by microplastic particles in the environment. It was the latest in a series of engagements with policy makers for Professor Thompson who was referred to as the “father of microplastics” by the chair of the Environmental Audit Committee. He has been called upon by both the UK and US governments in the past.

PUBLICATION Highlights:


FROM THE EDITOR

Thank you to all who have contributed to Issue 17.

Please provide all your news articles, success stories and innovative collaborations to the following email address: k.pritchard@plymouth.ac.uk titled ‘MINEWS’.

Thank you.

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