

Environmental Audit Committee

Oral evidence: Sustainable Seas, HC 980

Wednesday 5 September 2018

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Watch the meeting

Members present: Mary Creagh (Chair); Colin Clark; Mr Philip Dunne; Zac Goldsmith; James Gray; Caroline Lucas; Kerry McCarthy; Anna McMorrin; John McNally; Dr Matthew Offord; Alex Sobel.

Questions 1 - 95

Witnesses

I: Dr Patrick Vallance, Government Chief Scientific Adviser, Professor Ian Boyd, Chief Scientific Adviser, Department for Environment, Food and Rural Affairs.

II: Professor Rachel Mills, Dean of the Faculty of Environmental and Life Sciences, University of Southampton; Professor Colin Moffat, Office of the Chief Scientific Advisor, Scottish Government; Dr Abigail McQuatters-Gollop, Lecturer in Marine Conservation, University of Plymouth.

Written evidence from witnesses:

- [Marine Biology Research Group, University of Southampton, - written evidence](#) | [PDF version \(751 KB\)](#) 
- [Ocean and Earth Sciences, University of Southampton - written evidence](#) | [PDF version \(74 KB\)](#) 



Examination of witnesses

I: Dr Patrick Vallance, Government Chief Scientific Adviser, Professor Ian Boyd, Chief Scientific Adviser, Department for Environment, Food and Rural Affairs.

Q1 **Chair:** I welcome our guests and witnesses to this, the Committee's first evidence session on sustainable seas. For the purposes of Hansard I ask our guests to introduce themselves, please.

Dr Vallance: I am Patrick Vallance. I am the Government Chief Scientific Adviser.

Professor Boyd: I am Ian Boyd. I am Chief Scientific Adviser at DEFRA.

Q2 **Chair:** You have been spotted in the Polar Regions in the not-too-distant past.

Professor Boyd: Yes, that is right.

Q3 **Chair:** You also got a lot closer to a polar bear than this Committee, so our congratulations on that. I will kick off the session with the publication of the Foresight report on the future of the sea. What do you determine are the greatest risks to the future of the marine environment?

Dr Vallance: I will answer, and then Ian is much more expert than I am on this. My view is there are three things that we ought to be particularly concerned about. One is warming and acidification of the oceans, the second is over fishing, and the third is pollution in all its forms into the sea. Those, I think, are the three biggest threats. Ian, you may want to come in.

Professor Boyd: I think that is a very good summary. As regards fishing, that is something that is probably not changing significantly through time. It is still probably the number one threat. Warming and acidification are getting worse, and chemical pollution is getting worse. There are differing trends among those three, but nevertheless I would completely agree that those are the major factors affecting the marine environment.

Q4 **Chair:** Can you talk us through some of the details of the chemical pollution and where it is coming from? Also on the fishing, one of our surprises in the Arctic was just how much of the pollution was coming from fishing vessels and how much of the plastic mess that was in the sea—80% we were told—was coming from fishing vessels. Can you say a few words about pollution? I also wanted to ask you, Dr Vallance, about this issue of ocean blindness, the fact that we do not see the sea. I thought that was quite interesting.

Professor Boyd: We can see pollution in several forms. There is physical pollution, which is what people see most, and plastics are the best manifestation of that. Of course, there is a lot of awareness now of



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plastics and how plastics get into the marine environment and remain there for a very long period of time. However, that, if I can use the term, is the tip of an iceberg, and the iceberg underneath is the unseen pollution that is composed mainly of microplastics. There are also chemical pollutants, none of which will break down over long periods of time.

There is relatively little evidence right now that says that microplastics are of serious long-term harm, but I think that is largely because we have not looked hard enough yet. With chemical pollutants we have things like persistent organic pollutants, like PCBs, and we also have things like heavy metals, some of which are in decline, but they are persistent and will be there for very long periods of time. Chemical pollutants are a particular danger because some of them bioaccumulate. That means that they are gathered up sequentially as they move through the food chain and they have the biggest impact at the top of the food chain. You mentioned polar bears, Chair. Polar bears are very affected by particularly heavy metals, possibly also things like PCBs. We also know about killer whales, for example, even in UK waters where we believe that reproductive failure is occurring almost entirely because of PCBs.

In some areas with persistent organic chemicals we are making progress. I think we are making progress with PCBs, but it is slow. With other areas we are not. Things like brominated flame retardants, which are in this room on these chairs, get into the marine environment and bioaccumulate. They are not quite as toxic as things like PCBs, but nevertheless they bioaccumulate, and once they get into these top predators they tend to have negative effects.

Dr Vallance: I think it is worth adding to that, a lot of these things dissolve in fat. The fact that you have very fatty sea animals is exactly why they accumulate.

Q5 **Chair:** Where do the PCBs come from?

Professor Boyd: They are mainly coolants used in transformers in electrical systems. They also exist in old-style plastic window frames and things like that, and particularly lubricants.

Q6 **Chair:** How are they getting into the sea?

Professor Boyd: There is a legacy issue in that there are still quite a lot of transformers around in our infrastructure that have PCBs in them. I know the Environment Agency thinks they have a pretty good idea of where all the legacy transformers are, and when they go out of service they will be taken out in a safe way. However, we have probably locked away large amounts of PCBs in things like landfill sites for quite long periods of time, and there is a continuous process of leakage. We cannot stop that happening because PCBs were used so ubiquitously through the system through most of the latter part of the 20th century.



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We do not produce PCBs anymore. However, one of our problems is that we do not have control over PCBs in places like Southeast Asia. Although the Stockholm Convention says we should not be manufacturing PCBs, it is possible they are still manufactured in other parts of the world. They get into the marine system and they are distributed over very, very large areas. Just because PCBs are released somewhere in the southern hemisphere does not mean to say they will not get into the northern hemisphere. They can volatilise, and they end up in the Polar Region. If you went to Arctic Ice or Antarctic Ice and measured the ice there you would probably find PCBs in the ice.

Q7 **Chair:** Not good. Can you say a quick word about sea blindness and the danger of ignorance?

Dr Vallance: That is why the report was so important; it brought together all the different areas in which one needs to think about the sea. I think it is true that it has been rather neglected. People have not thought of it as anything other than just being there—something that has always been there and not something we need to worry about in the same way as some of the other aspects of environmental problems. The report brought it to life, and of course “Blue Planet” was absolutely instrumental in making people think about that. Sea blindness is a real issue that has been flagged up, and it is one that I think is partially sighted now.

Q8 **Chair:** Do you think we have used the sea as a rubbish dump?

Dr Vallance: Ian has given some examples of where we have been ignorant of what things have gone into the sea and what impact they have had.

Q9 **Chair:** Your report talks about thermal expansion. I think a lot of people are unaware that a significant amount of the sea level rise has taken place not because the polar caps are melting but because the water is warmer and it is expanding. That is not something I think that is widely known. How important is meeting the 2015 Paris Agreement on climate change for marine conservation? What happens if we do not meet Paris? What happens if we do meet Paris, because it is still pretty bad?

Professor Boyd: Do you want to have a go at that one?

Dr Vallance: I will say a word, and then you have a go. I think it is absolutely important. As I said, the thing I picked out as a really big issue was warming and acidification, and those things are going to continue if we do not do something about it.

Professor Boyd: There have been quite a number of modelling studies done to look at how it will change the distribution of species in the ocean, for example. There are some species that will move and adapt fairly quickly. For example, in UK waters we are now seeing bluefin tuna here and there was a report of ocean sunfish from the west of Scotland recently. We are seeing an increasing number of tropical-type species or



temperate-type species moving northwards. There are these species that can adapt, but there are also a lot of species that cannot adapt as quickly as climate change is happening. There will be biodiversity loss as a result of climate change. There is no doubt about that at all.

Going to Patrick's point about ocean acidification, that will also be an additional stressor on marine organisms. They have stressors as it is. We have talked about pollutants; we have talked about fisheries. If you add in ocean acidification, it is yet another stressor. There is not a lot we can do directly about ocean acidification in the short term, apart from take carbon dioxide out of the atmosphere, but what we can do is try to reduce a lot of the other stressors there are in the system. For example, if we find ocean acidification is stressful to larval cod we need to catch fewer cod in order to maintain cod populations. I am just using that as a very simplified example.

Q10 Chair: You mentioned the species. We heard in Svalbard about the mackerel being seen; they were never seen off the coast of mainland Norway and they are now being seen up in arctic waters there. Clearly some fish are adapting very quickly, and that is going to disrupt our fishing patterns, treaties and so on in the future, is it not?

Professor Boyd: Yes. Fish move, and when you have shared stocks, and shared stocks for which there is uncertainty about where those stocks are going to be from year to year, it is very difficult to set fishing quotas. That is all the more reason for wanting to be part of a unit of assessment that is biologically significant rather than politically significant. It has to be biologically sensible. If we are talking about North Atlantic mackerel, for example, we need to assess North Atlantic mackerel as a whole for the North Atlantic, not just for the UK Continental Shelf area or the Norwegian area, or something like that. We need to exploit them with the exploitation levels of other countries in mind as well.

Q11 Chair: Absolutely. Foresight recommends improving our understanding of climate change and its impacts. Is the UK doing enough to monitor climate impacts, particularly on ocean warming and acidification? I see that the monitoring of the carbonate chemistry of the UK's mainland waters appears to have ended a couple of years ago. It was being done by the University of Plymouth; that has stopped. Is it still going on?

Professor Boyd: Yes. Some of the colleagues sitting behind me might be able to give you more chapter and verse about exactly what is going on. My understanding is that the monitoring is still going on; what is happening is that the funding for some of that monitoring has stopped. There is a move to try to get that back on-stream. However, the question is: are we doing enough monitoring? In my view, and I know that not everybody agrees with me about this, we need to know what we would do with the information we get from monitoring.

We know ocean acidification is happening. The two main sites that we have, one on the Western Approaches and one off Stonehaven in the



North Sea, are providing us with information to know that in the UK Continental Shelf area ocean acidification is happening, and we know it is happening globally as well. Do we need more detailed information about what is happening around the UK shelf in order to be able to create appropriate policy? That is an open question, but I would question whether we do need that. I think that if we were going to spend money it would be on how you respond to ocean acidification rather than how you measure it more accurately.

- Q12 **Chair:** This is something the Science and Technology Committee looked at, but they did not write their report because of the General Election. They said that a state-of-the-art carbonate chemistry facility at the National Oceanography Centre in Southampton was established with funding from that programme, but since 2015 and 2016 it can only analyse sea water samples on an ad hoc basis with piecemeal project-specific funding. It does seem short-sighted to set something up, both Plymouth and Southampton, and to then stop funding it. Why do we need to know how much it is acidifying by? Are you saying that we know it is happening; therefore, it is better to work out how we adapt to it or stop it than it is to keep monitoring why it is happening?

Professor Boyd: In an ideal world you can do both. The question that I pose, and I am not quite sure I know the answer to this, is: would more detailed monitoring, particularly around the UK coast and different areas, add significant value to how we are going to intervene to control the consequences of ocean acidification? At the moment I do not think there is a clear answer to that question. That does not mean to say we should not do more measuring of ocean carbonate chemistry. I would much rather see it done in the context of specific, what I would call, process studies about understanding what the impacts of ocean acidification might be for certain key species in the ecological system, or for farmed salmon, or for shellfish that we have an agriculture for, for example.

- Q13 **Chair:** But we have to know what is going on. Your own science advisory council reported in May and said acidification is occurring, and asked for consistent and widespread monitoring to support identification of trends at a global level. The UK has an opportunity to support and drive data collection, to support not only policy—which I think is what you are talking about, specific species issues—but also national and international reporting commitments. Is that something that you are arguing for?

Professor Boyd: I would certainly support that. I think in the UK we are relatively well off in knowing what is happening on our continental shelf in terms of ocean acidification. Acidification is happening at different rates in different places. What the UK can do is use its expertise internationally to help other countries understand their vulnerabilities around ocean acidification, and that could include monitoring.

- Q14 **Chair:** But you need to monitor constantly, do you not? It is not a stop and start thing, because otherwise you have natural variabilities.



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Professor Boyd: Absolutely. Yes. I agree with that. You do need to monitor constantly.

Q15 **Chair:** Okay. What monitoring of climate impacts has been carried out in the Overseas Territories?

Professor Boyd: Do you mean impacts on the oceans?

Chair: Yes.

Professor Boyd: I think I will need to get back to you on that one with the details.

Q16 **Chair:** Are we monitoring acidification?

Professor Boyd: There is nothing that I know of that is going on around ocean acidification in Overseas Territories. In fact, there was quite a lot of discussion around the recent CHOGM meeting that happened about how we can help Commonwealth countries develop monitoring methodologies for ocean acidification, although I would say one of the best time series for ocean acidification comes from Bermuda. That is probably one of the best in the world.

Dr Vallance: That was a specific thing we discussed at the CHOGM meeting, and there is a follow-up meeting this month to discuss what the opportunities are to look at monitoring across all of the Commonwealth countries.

Q17 **Mr Philip Dunne:** Noting what you said, Professor Boyd, about biologically sensible areas, nonetheless we live in a political environment and you are Chief Scientific Adviser of a Government Department. Could you give us some idea about how the UK is going to achieve its sustainable development goal commitment to prevent and significantly reduce marine pollution of all kinds by 2025?

Professor Boyd: What the UK has to do is play its role internationally. The UK itself has to make sure that it has its own house in order first of all, to make sure that it is not polluting the ocean from its own systems, but in addition to that I think it then has to use its expertise—and this is where I think science comes in—to help other countries to understand where their sources of pollution are. Also that brings influence in the international community to make sure the treaties that we have, like the Stockholm Convention, are complied with.

I think that science is really central to this, because as I have already said, there are certain types of pollution that are much more damaging than others, and it is about understanding where that pollution is coming from. I could use the issue about CFCs. There has been a recent problem there about increasing amounts of CFCs. Science has allowed us to try to find out where that is coming from. I would say the same about PCBs; scientifically we can try to help other countries into a better place.

Q18 **Mr Philip Dunne:** Much Government action is about preventing release



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of more plastics into the water sources and the oceans. Is there anything that can be done to tackle the plastics that are already there in the environment?

Professor Boyd: There is quite a lot of thinking going on about this. In fact, there are some people with some really imaginative ideas to extract plastics from the oceans. Some of them are really very good, but will only really work in areas where there is very high plastic concentration. When you are dealing with highly distributed plastics across many parts of the oceans the carbon cost, for example, of drawing nets through the water to pick up plastics is something that has to be taken into consideration.

There are some pretty good ideas for areas where we know there are very high concentrations in river estuaries, on beaches, and those sorts of things. I think we will see some new technologies coming out in the not-too-distant future that will be there to clean up some of those areas. We will still be faced with highly distributed plastics in quite remote parts of the world. Cleaning up the Arctic is an enormously difficult thing to do, for example.

Dr Vallance: It is worth remembering that if nothing is done about the input it trebles in 10 years. Stopping the input is clearly the major way in which we prevent it from continuing.

Professor Boyd: Yes. I think we absolutely must not rely on technologies to clean up the oceans. We have to rely on stopping the inputs. That is absolutely clear.

Q19 **Caroline Lucas:** Can you please explain, sir—I did not understand—how do you mean it trebles?

Dr Vallance: The amount.

Q20 **Caroline Lucas:** Just over a 10-year period the volume goes up by a factor of three?

Chair: Is that based on past historic data?

Dr Vallance: Yes, modelling.

Professor Boyd: If the future is like the past that is what will happen. We have to have a different future, basically.

Q21 **Chair:** When does it double by? Five years? Eight years?

Mr Philip Dunne: This is a global issue you are talking about? Not a UK issue?

Professor Boyd: It is a global issue, absolutely. Yes.

Dr Vallance: I am sorry; I do not have the figures.

Q22 **Chair:** If you could remodel that would be great and get us some new data.



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Mr Philip Dunne: That is a very interesting statistic you have given us. Can you put the role of plastics versus other major pollutants in the oceans in a similar sort of context?

Dr Vallance: That is a plastics figure.

Professor Boyd: Yes, that is a plastics figure.

Q23 **Mr Philip Dunne:** You started out, Dr Vallance, by talking about other things other than the plastic contribution.

Dr Vallance: Yes. It is worth remembering some things are coming down. Things like heavy metals and so on are coming down, and so there is a good-news story around some of those things. There is a worry about run-off of nitrogen-based fertilisers. That is an area that, again, can increase. There is a potential concern—I think we are unclear of the magnitude and effect—around pharmaceuticals getting into the water supply. It is clearer for some than others. Those are areas where we will get increases, and there are others that you have mentioned as well.

Professor Boyd: Yes. I think for things like heavy metals there is evidence that we are controlling them. For things like PCBs there is some evidence that we are controlling them. The things I worry about are the unseen things. We are creating new chemical species all the time and we are using them in all sorts of imaginative ways in our economy. Very often we do not worry they are a problem until they turn up in the oceans in some way or another. Brominated flame retardants are an example of that.

Q24 **Mr Philip Dunne:** DEFRA is updating its UK Marine Strategy, I think later this year. Is there anything in relation to pollution from plastics and others that you can give us as a highlight ahead of publication?

Professor Boyd: I am afraid I cannot, because I have not seen it. I would be guessing. I think I would be 100% certain in saying that there will be a lot in there about plastics and what we need to do about it.

Dr Vallance: If I may just build on that, it is not just a DEFRA thing. It comes back to the point of this report, which is multi-department. I think FCO are leading on getting ocean strategy together, with obviously major help from DEFRA.

Q25 **Mr Philip Dunne:** We talked about research around the UK shelf and around the Overseas Territories. Are there any areas where you think further research would help deepen our understanding of the non-plastic pollutants that you would recommend undertaking?

Professor Boyd: There is space for a huge amount of more research in this area. I think the transfer pathways through the marine system of chemicals generally is relatively poorly known. We know they turn up in top predators. We do not know where they go in between, and what is more important, we do not know where they get sequestered. One of the reasons the heavy metals are declining is because they are being



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sequestered into sediments. If we then do development work, let's say in estuaries, and disturb those sediments, these will re-emerge. Knowing more about those dynamics would be really helpful.

Q26 Mr Philip Dunne: Last question from me. As the seas get busier with more and more marine activity are you concerned about noise and light pollution from increasing volumes of shipping impacting on the oceans?

Professor Boyd: Light less so. Noise, definitely. I do not think there is any doubt that there is an impact of noise. Exactly what that impact is is quite hard to measure at the moment. I did quite a bit of research on this prior to coming into Government. There are some species that are very sensitive to noise in the ocean, and we make a huge amount of noise in the ocean. You can put a hydrophone in the sea just off the UK coast and you can hear a ship leaving the east coast of the US. Noise travels over huge distances. Not all of that is bad, because some marine organisms use that noise to their advantage. Many cannot even hear it, but some are negatively affected by it.

Q27 Chair: How loud is that noise on the hydrophone? How many decibels by the time it gets to your monitoring phone?

Professor Boyd: Decibels measured in the air are different to decibels measured in the sea.

Q28 Chair: Of course they are.

Professor Boyd: I cannot give you an equivalent, really. In the ocean 210 decibels is a loud noise. That is the kind of noise you get from quite a large sonar system. Military sonar will go up to 220 or 230 decibels.

Q29 Chair: What you are saying is basically that we do not understand how pollution gets in? We understand plastic pollution, but we do not understand chemical pollution and its pathways into the sea?

Professor Boyd: I think we understand it in broad terms, but there are a lot of unknowns there. If we want to manage that process better there would be advantages to knowing a lot more about that. Again, I would say the same for chemicals as for plastics; the best thing to do is not release them at all in the first place. Perhaps the research needs to be done initially on what the toxic effects are of these chemicals, and making sure that when we understand the toxic effects they are managed at source better than once they get into the marine system.

Q30 James Gray: A very quick question on the noise; presumably it is not just a question of the volume of the noise so much as how the type of noise will affect particular creatures. That is item one. Item two is to what degree can anything be done about noise. How much of this is needless noise and how much is noise that commerce and defence demands?

Professor Boyd: You are absolutely right that the quality of the noise makes a huge difference. There are different frequencies—low



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frequencies, high frequencies, that sort of thing. Not all marine organisms are able to hear in all those spectrums. Shipping noise tends to be quite low frequency and relatively high energy, and transmits over very long distances.

We could do a lot more to quieten down our ships, for example. There is no doubt about that. If it was a design characteristic that was put in right from the beginning of designing a ship, ships can be made to be quiet. We make submarines very, very, very quiet, and we could, if we thought about it, and with not much added cost, make ships a lot quieter than they are.

- Q31 **Caroline Lucas:** I remember a lot of work on the military's use of sonar and that being linked to beached whales, and so forth. That is just for the record. My question was to Professor Boyd about the extent to which you would say that the Government has achieved their obligations to protect marine protected areas under the Aichi targets and SDG 14?

Professor Boyd: I think we are making progress. With the Aichi targets, in relation to marine protected areas I think the UK is doing rather better than many others. We have significant areas on our own continental shelf that are protected, and in our Overseas Territories we have very significant areas that are declared as protected at least to some extent. I would say with all these sorts of things we are on a journey and we are learning how to do it. The most important thing is not so much how much we protect or where, but it is whether it is having the effects it is supposed to be having. That is a matter, again, of research and science, and we need to get out there and be able to measure those things appropriately.

- Q32 **Caroline Lucas:** We have received evidence that suggests that the fixation on the 10% is overlooking the fact of quality, rather than, as you say, the quantity. Would that be fair to say?

Professor Boyd: I absolutely agree, yes.

- Q33 **Caroline Lucas:** Could you say anything more about the quality? Is the problem that we need greater connectivity between the different MPAs? What could you say about quality rather than just quantity?

Dr Vallance: I definitely agree that just getting lots of MPAs out there is not the way to deal with this. You have to have the quality; you have to have the right measurements, and link-up across is important. As Ian said earlier on, the sea moves and fish move, so the idea that you end up with high quality in one is not good enough. Therefore, the link-up across is a key part of what needs to happen.

- Q34 **Caroline Lucas:** Would you go as far as to say that you think the Government have not performed as well as they should within that 10%? As I say, we have had evidence from WWF and others who basically say, "Yes, it is 10%, but if you look at how well it is managed it is not managed very well at all".



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Professor Boyd: I am going to generalise the answer to that and say that I do not think governments around the world are doing enough on that. If that includes the UK Government then we need to—

Q35 **Caroline Lucas:** That is the one we have some influence over, some slim influence.

Professor Boyd: Can we do more? Yes, of course we can do more. Can we do it better? Yes, of course we can do it better, and we should do.

Q36 **Caroline Lucas:** What specifically could the UK do better?

Professor Boyd: What I would say we should do a lot better is getting out and looking at the areas we have already protected to understand whether they are really having the effects that we hope they will have. At the moment I am not sure that we have that information. In fact, I know we do not have that information.

Q37 **Caroline Lucas:** Notwithstanding what I have just said about quality being as important as quantity, nonetheless there was also the point where the Government abstained on the IUCN target of 30%. Do you think that was the right decision?

Professor Boyd: I think that is probably a political decision. We have already talked about percentages. It is about the outcome.

Q38 **Caroline Lucas:** That is being a bit too coy. You advised the Government. The question we want to ask you is: is there evidence to suggest that the Government should support the IUCN target for MPAs to cover 30% of the ocean by 2030?

Professor Boyd: My problem with that is whether 30% the right number. I do not know the answer to that. It sounds like it is a number that is just picked out of the air because it is something that IUCN have felt they can press for, and that is fine.

Q39 **Caroline Lucas:** They persuaded 89% of the other countries around the table that that was a good thing to do. Yes, the IUCN motion received 89% support from states and government agencies, 94% from NGOs, but the UK Government abstained.

Professor Boyd: Okay. I was unaware of that. I will give you my immediate response to it. In the UK we like to be evidence based. My suspicion—this is a suspicion—is we probably felt that the 30% was not an evidence-based target and that we probably ought to have some more evidence around that. Just saying 30%—why not 40%? Why not 50%? Why not 20%? I cannot tell you why 30% is a good target.

Dr Vallance: Can we come back to you with an answer on that?

Caroline Lucas: That would be very nice, thank you.

Dr Vallance: I do not know the answer to that.



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Q40 **Chair:** I just have a supplementary question. Professor Boyd, you said, “We are not sure about the marine protected areas, and we are not sure if the ones we have protected in the Overseas Territories have delivered what we wanted”. Is that because we have not measured that? Or is it because we have measured it and it has not had the results that we wanted?

Professor Boyd: It is too early, really. What we ought to be doing is evaluating them all the way along.

Q41 **Chair:** Are we doing that? Is that valuation happening?

Professor Boyd: As far as I am concerned we are not. We need to do more of that.

Q42 **Chair:** The fact that we do not have the information is not a reason not to designate more, because we have not been looking for the information.

Professor Boyd: That is true, except that we need to know where to designate and what to designate. At the moment some of that information is really not available.

Q43 **Caroline Lucas:** I just had one last question about where you think there might be conflicts of interest between increased protection for the high seas on the one hand and the desire to develop new marine industries in those same areas. Where would you see the flash points and what tensions would you see?

Professor Boyd: Okay. The coastal zone is highly pressured in many parts of the world, and Northern Europe is one of the most pressurised areas. There is always going to be pressure there. If your question is addressing what are the new areas, marine industry is moving continuously offshore towards the continental shelf break, and sometimes kind of over the continental shelf break to some extent. It is getting into deeper and deeper water.

You mentioned noise. That is bringing noise to a whole group of organisms that tend to live out there—and I am mainly talking about marine mammals—that have never experienced that before. Our own gas industry, for example, is moving into deeper and deeper water all the time. We have potential for deep ocean mining and these sorts of things as well, although that has not taken off at this stage. It is still in the exploratory stages. I would just be concerned that development is encroaching further and further offshore into areas that have not really been exploited before.

Q44 **Caroline Lucas:** Do we have the tools to try to resolve that, would you say?

Professor Boyd: I think we have some of the tools. Our knowledge of those areas is increasing. We in the UK in particular have very good knowledge of our own continental shelf. It could be better, but I think we



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have good knowledge of it. We have excellent research. We have two ocean-going research vessels that work in those areas. I think we are reasonably well equipped, but whether we are well equipped enough to know what the trade-offs are and to be able to licence things in an intelligent way that is going to have the minimum impact is something where there is a lot of trial and error.

I could point to the offshore wind industry. When the initial developments were being proposed we really had no idea what the impacts of that industry were going to be. What we have done in an iterative way is we have licensed some, we have monitored them, we have found out what the kinds of impacts are, and we have moved forward based on the evidence that we have. I think overall we can be reasonably confident that the wind industry is not causing environmental damage in the ways that were sometimes predicted.

Q45 Kerry McCarthy: You were talking about coastal zones being highly pressurised in terms of economic exploitation. You will probably be aware that there is an issue in Scotland with wild-kelp harvesting, or licences being applied for to harvest wild kelp.

Professor Boyd: I was not.

Kerry McCarthy: Right. Sorry. I guess because it is a devolved issue.

Professor Boyd: Wild kelp has been harvested in Scotland for the last 200 years.

Q46 Kerry McCarthy: They are basically looking at trawling, so 30,000 tonnes worth of kelp being harvested. Environmentalists have said that this is equivalent of clear felling virgin rainforest. I guess I know the answer now, given your response then, but I just wondered what assessment is being made of the damage that that sort of industrial-scale harvesting of kelp would have.

Professor Boyd: I know that my colleague Colin Moffat will be speaking to you after we leave, and Colin will be in a better position to answer that from a Scottish perspective. I do not agree with the comparison with virgin rainforest. Kelp forests grow on an annual basis and die on an annual basis, so it is not equivalent.

Q47 Kerry McCarthy: But kelp does play a really important role.

Professor Boyd: Kelp is a very important ecological community in the coastal seas. Again, just coming back to the previous question, it is a matter of knowing what the costs and benefits are of the activity and making sure that the activity is scaled appropriately. It is very difficult for me to understand what a harvest of 30,000 tonnes of kelp would look like when scaled against the total resource of kelp that may be around Scotland, which is probably in terms of millions of tonnes. It may not be very much, but if it is focused on one particular location it might have quite a high impact.



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Kerry McCarthy: I think it was also the method used, if you are trawling the seabed. That has come up.

Professor Boyd: Yes, absolutely.

Kerry McCarthy: I think it is being used for heartburn medication, which we can probably live without.

Professor Boyd: It depends whether it is proportionate. It has to be proportionate.

Q48 **Colin Clark:** Can I follow up? You were saying about oil and gas and speaking about how with the renewable industries the damage that it has done has been pretty limited. The oil and gas industry thinks it has a very good track record. Would you like to comment on that? They are exploring into deeper and deeper seas west of Shetland. Are they responsible guardians of our ocean?

Professor Boyd: I think the oil and gas industry does a very good job. They are highly regulated and they are very careful to stick to the regulations. The problem with the oil and gas industry is when it goes wrong it really goes badly wrong, and we saw that in the Gulf of Mexico a few years ago. There is always this overlying risk that sits with the oil and gas industry and the ecological impact that it may have if it goes wrong. Otherwise I think the oil and gas industry does a pretty good job. Going back to noise, I think noise is the big thing that they need to try to deal with.

Q49 **John McNally:** Can I just go back to one earlier point before I ask my question, Chair? It was about pollution. I do not know if you were involved in the commissioning of the film last week that we showed in the mapping of the litter around the coastline of Scotland. I do not know if you happened to see it.

Professor Boyd: I have not seen it, sorry.

Q50 **John McNally:** It was absolutely terrifying to see the amount of litter, and they had no indication of where a lot of it was coming from. Vast amounts of litter washed up in rivers, around the coastline, everywhere around about. It was really quite something.

Anyway, could I move you on to farmed salmon? As you know, farmed salmon is Scotland's biggest food export; it is something like £600 million a year on exports, there are 2,500 jobs involved in it, and thousands more supported by the aquacultural sector in the rural and the coastal communities. The Foresight report talks about the opportunities for the UK to meet the growing global demand for Atlantic salmon. There has also been a report that Scottish salmon farms are now having major problems with sea lice. How can we ensure that any expansion is done in a sustainable matter?

Professor Boyd: You are absolutely right, salmon farming is a very important part of the rural economy, particularly in Scotland. It is also



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conducted, I think, in a very well-planned way. The planning regulations about where salmon farms can be put are really very mature. The localised environmental impacts of salmon farms are very well controlled. Again, my colleague Colin Moffat might be able to give you more detail on this, but I think that there is probably room for expansion, maybe a doubling of the salmon industry in Scotland. Probably not much more than that, but again, I am doing this from my long-term memory.

The biggest impacts from salmon are—you have mentioned sea lice—there are potentially localised impacts on the wild salmon populations as a result of transference of sea lice. That is a known problem from the point of view of the salmon fishing industry. The other major impact is not local, it is the global footprint associated with salmon farming because of the kind of feeds that are used for salmon. Essentially we feed fish to fish, so we catch fish in various parts of the world, process them into salmon food, and then feed them to salmon. That is highly inefficient. The environmental impacts of that are felt in places like Antarctica, because Antarctic krill are fished partly for that purpose, Peruvian anchovies are fished for that purpose, and in the North Atlantic probably blue whiting as well. Big industrial fisheries are supporting the aquaculture feed industry.

You cannot ignore those environmental impacts. There is a solution to this and it sits at Rothamsted research station, where they have a genetically modified camelina that produces omega 3 oils, so it produces essentially marine oils in a crop that can be grown in a field. If we were able to grow genetically modified camelina to produce omega 3 oils we could create fish food entirely out of vegetable products. A lot of the fish food is very vegetable based, but the fish have to be finished at the moment on marine oils, and the only way of getting those marine oils is through things like krill, and anchovies, and blue whiting. There is a technological fix to this, but at the moment we have problems because we cannot develop that technology because of the GM regulations.

Q51 John McNally: I can see the contradiction going on with the policies right away. I never knew that. That is very interesting. Coming back to the actual sea lice themselves, there was a report, I think last week, saying we had been growing cleaner wrasse. The cleaner wrasse live off the farmed salmon and would then in turn help to clean up the wild salmon that go through the same rivers. Is that something you know about, and is that a likely way to solve the problem of the lice?

Professor Boyd: I know there is a lot of work being done on cleaner wrasse. Whether it is a whole solution or not is another matter. I would say, however, one of the great things about the Scottish salmon fishing industry is that it is relatively free of disease. You are right, there is a sea lice problem, but relative to, let's say, Chile, which is one of the main competitors, and even Norway, the Scottish salmon farming industry is a really very disease-free type industry, so there is a premium there.



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The issues around sea lice are a big problem. There is a lot of research going on around that. I cannot tell you in detail how successful that is looking to be, but I know the kind of pharmaceuticals that have been used to get rid of sea lice in the past are less and less successful. Also, if we can avoid those emissions then we should.

- Q52 **John McNally:** It is also interesting to note that the Norwegian Government are not going to issue any more licences until they deal with the problem with the sea lice. Is that something we should be doing here in the UK?

Professor Boyd: I am not sure I can answer that question, because I do not know the depth of the problem. I would need to come back to you about that.

- Q53 **James Gray:** One of your most striking conclusions in the Foresight report was that there was insufficient linkage between science, industry and the Government in dealing with the oceans. The Government, as a result of that, came up with this notion of producing an ocean strategy. Two questions, really, on that. First, would you agree with me that there is a risk that the governments produce these things called ocean strategies and then they gather dust on the shelf for all eternity? Is it a way of the Government shoving something out of the way? That is question number one. Leaving that slightly cynical view to one side, what do you want to see in it? What should the oceans strategy have in it?

Dr Vallance: I think the oceans strategy has come about in part because of this report, and I welcome that. It is cross-departmental; it is exactly what it should be. I think it is due to read out later this year. I will give it the benefit of the doubt and say that we look forward to seeing what is in that strategy. It is an important bit. If it builds on this report I think it would be a good strategy.

Related to what happens next is the question of what we should do in GO Science to make sure that when we write a report we follow up. That is one of the things I am very keen to make sure we do going forward; to have a process to look back after a certain period and say, "What has happened as a result of the recommendations, and if nothing has happened, what should happen?"

- Q54 **James Gray:** Give me the three or four main strands that you would like to see in it. That is perhaps a way of doing it. What are the main things you would like to see in the Government's oceans strategy?

Dr Vallance: I think we have touched on some of them. First of all, we need to absolutely take an international approach on this as well as a UK approach. There needs to be an international push on many of the areas we have touched on. There needs to be something around pollution into the sea and how we can tackle that, which includes plastics, but goes beyond plastics. We absolutely need to have some agreement around how to tackle, monitor and deal with both certification warming, and that includes measures beyond things in the oceans themselves, of course.



I think there needs to be a clear strategy around fishing, which is the third major area, but it should go beyond that as well. We need to think about the move into deep oceans and the question about how deep oceans are protected. Just as we have talked about sea blindness at the beginning, I think deep-ocean blindness is something we cannot afford to have.

- Q55 **James Gray:** Perhaps you could answer a different aspect of this. You talk in the report about the siloed approach to policy creation between the three bits. I was simply wondering what the main barriers are that you come across preventing cross fertilisation between the three. For example, just to posit one possible problem, is it that, for example, the fishing industry wants one thing but the environmentalists want something different, or the oil and gas industry wants one thing but the environmentalists want another? Are there irreconcilable pressures involved here that have created this siloed approach to Government policy making? Will BEIS take a different approach to DEFRA because of that?

Dr Vallance: I think it is noteworthy that in this report, which is before my time as Chief Scientific Adviser, this was multi-departmental. You look at it, and look at the Ministers who have signed at the bottom to say it is their report, but I think that is an indication that people are trying to work together on this. Is it true that there are going to be conflicting interests? Of course; there are bound to be. There is no way that this is going to be a strategy that comes with every part of it being easy, and there are direct tensions between a desire to increase the marine economy and the question about how you do that in a way that is sustainable and takes account of conservation. The strategy needs to deal with that and needs to come up with something that will tackle the limits of that and make sure that that does not become a sticking point.

- Q56 **James Gray:** One last thing. What more could the Government be doing to support marine science? Obviously we have Attenborough coming along, but are there other things that we ought to be doing to support marine science that we are not currently doing?

Dr Vallance: I think the research councils would argue that this is a high priority for them. They are looking at all sorts of programmes coming up bottom up from academia. Of course, the formation of UKRI provides an opportunity to look across research councils and to think about this in a more strategic way. I know that, for example, in the Strategic Priorities Fund there is a sort of thing that this area is appropriate for. Ian, this is very much your area of science.

Professor Boyd: I think we should start by saying we have world-leading marine science in the UK. We have some really excellent marine science institutions. To answer your question directly, it is about supporting those institutional structures and the excellent scientists within them with the highest level of equipment, but also the capacity to take their messages into the international community. Marine is very



international, but the UK has the capacity to show real leadership here through UNCLOS and other kinds of forums. It does that already, but we could do it more and even better.

- Q57 **Chair:** Thank you very much indeed. That concludes our first session. I think we are just at the tip of the iceberg, but we certainly dipped our toes in the water. Thank you both very much indeed.

Examination of witnesses

II: Professor Rachel Mills, Dean of the Faculty of Environmental and Life Sciences, University of Southampton; Professor Colin Moffat, Office of the Chief Scientific Advisor, Scottish Government; Dr Abigail McQuatters-Gollop, Lecturer in Marine Conservation, University of Plymouth.

- Q58 **Chair:** I call our guests to order. We are now going to start our second session on our first inquiry into sustainable seas. Can our witnesses introduce themselves from my left to my right, please, starting with Professor Moffat? We have heard a lot about you. No pressure.

Professor Moffat: Good afternoon. My name is Colin Moffat. As of 1 April I became Chief Scientific Advisor Marine to the Scottish Government.

Professor Mills: I am Professor Rachel Mills. I am Dean of Environmental and Life Sciences at Southampton, but I am also president of the Challenger Society, which is the layman society representing marine academics.

- Q59 **Chair:** Thank you. Could you sit a bit further forward and speak into the mikes, please. Thanks.

Dr McQuatters-Gollop: Thank you for having me. I am Dr Abigail McQuatters-Gollop, and I am a lecturer in marine conservation at University of Plymouth, but I am also leading implementation of the EU Marine Strategy Framework Directive for pelagic habitats for the UK and for OSPAR, and I am on the Brexit Policy Working Group for the British Ecological Society.

Chair: Great. You are all very welcome. We are going to kick off with a question from Alex.

- Q60 **Alex Sobel:** Yes. This is to Dr McQuatters-Gollop initially, and then maybe the others would like to come in. When we were in Svalbard and in Tromsø we heard about the north migration of certain species due to climate change. Is there any evidence of climate change having an impact on the biodiversity generally of our seas and oceans?

Dr McQuatters-Gollop: Yes. We have seen impacts of climate change at all levels of the food web, and the northern migration that you mention—I



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know it came up earlier about fish—but we have also seen northern shifts in plankton, which are the microscopic plants, algae and animals at the base of the food web. You can imagine when the very fundamental base of the marine food web changes that could have repercussions on higher levels of the food web.

I think we heard the example earlier where we are now starting to see bluefin regularly around Cornwall, and mola mola, ocean sunfish. We are seeing these big shifts because of climate change, but we are seeing other biodiversity changes too. We are seeing changes in productivity. For example, we have seen a decrease in primary productivity in the North Sea in the last 30 or 40 years. In a recent paper we have worked on we have linked that to changes in fisheries productivity. We have seen changes in species composition at all levels of the food web again, where some organisms are more adaptable to living in our waters than other organisms. That comes right from the plankton up to our commercial fish species.

If we think about that from a management of policy perspective, these range shifts and species shifts will have real implications on, for example, fisheries, how we catch fish, what we are catching, and how much. These are real fundamental changes to the biodiversity in UK waters that are driven by climate change.

Alex Sobel: Does anybody else want to come in on that?

Professor Moffat: I totally agree with what has been said. The other thing is that there is the possibility that certain members of the lower food webs, so some of the zooplankton, for example, which will appear, might change. If they change then the food source for some of the young fish might not be there because they may come along at a different time of year and not the time of year that is required. We are seeing a number of changes occurring, and that could have quite significant implications not just for the change in the species themselves but for the changes in species further up the food web.

Q61 **Alex Sobel:** Taking all that into account, will meeting the Paris climate change targets stop the deadly trio of climate change pressures on the marine environment?

Chair: In particular, warming, acidification and pollution.

Dr McQuatters-Gollop: It is not going to stop this from happening—we are locked into climate change—but meeting the Paris Agreement is absolutely critical for minimising these impacts of climate change. Climate change basically is degrading the resilience of our ecosystem, so the ability to recover from other pressures that we as humans are putting on the marine ecosystem, like fishing, so how we catch our fish with trawling, or how many fish we take, or nutrient pollution, or noise. The better we can manage climate change and these direct human pressures holistically will reduce the overall impacts on our marine ecosystems and



functioning biodiversity, and the processes that are happening. It is absolutely critical that we meet the COP targets from Paris.

Professor Moffat: One thing I would say is there is climate change and there is ocean acidification. I do not call ocean acidification climate change. Ocean acidification is a consequence of the increased concentrations of carbon dioxide in the atmosphere, which is also causing an increase in the temperatures in the sea, which is the climate change. I always like to say climate change and ocean acidification because we need to separate them out because we need to better understand the implications of ocean acidification because the solution to try to reduce ocean acidification is to reduce the CO₂ concentration in the atmosphere. Climate change is coming about because of other greenhouse gases as well. We need to just be careful in how we are communicating this to the public and get a strong message out that ocean acidification is related to carbon dioxide concentrations in the atmosphere and the wider climate change issue is greenhouse gases, which is resulting in increased temperatures.

Q62 **Alex Sobel:** That is a complex message to convey to the public though. We will do what we can to help. Obviously, we have been focused on our own territorial waters and going north into the Arctic but what impacts could climate change have on UK Overseas Territories and where should we focus our efforts to mitigate those?

Professor Moffat: In terms of UK Overseas Territories, you will probably be aware of the current Blue Belt programme that is running, which is looking at the various Overseas Territories. They are primarily in the southern hemisphere but at the same time the approach is quite common across all of the seven island archipelagos that are a part of that.

The first thing is that regardless of whether it is our Overseas Territories or whether it is our shelf seas, we need to improve the scientific understanding of that particular marine system, because the system around the Pitcairn Islands is quite distinct from the system around the UK. There are different fish in that environment, coral, all sorts of things, whereas here we have cold water coral and other things. It is about understanding the ecology, the ecosystem, that is operating in that area.

The other thing is that we want to understand what the human pressures are and what they are doing to that area. If we undertake fisheries in an area, how we fish will obviously determine the impacts that we have. What is the biodiversity in those areas and by doing certain human activities what is going to impact on the biodiversity? As we put in marine protected areas into these areas we need to understand, as Professor Boyd was saying, what they are doing. Are they doing what we want them to do?

In some areas we are beginning to get the information to help us to better regulate it but also we are modelling quite a lot of the information.



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Chair, you mentioned connectivity earlier on, and we are trying to model the connectivity between them.

In terms of our Overseas Territories it is about understanding the ecosystems, understanding what human activities are going to take place in that environment, and then trying to understand what impact those human activities are going to have, and then try to manage them.

Q63 Alex Sobel: You have outlined the challenges. Do you feel that the UK is responding to those challenges? Is the work being put in?

Professor Moffat: In several ways we are. The Blue Belt programme, which runs to 2020, is making a difference and I think earlier the Chair mentioned the ocean acidification report that came out earlier. Again we looked very much again at the Overseas Territories. How can we work with the Overseas Territories to identify ocean acidification? Is it happening in these areas? You cannot set up the necessary infrastructure on all these islands but can we bring samples back to the UK, have them analysed in the UK? It is about working with the governance of those islands and that is happening through it.

Also, and very critically, it is about having very good data management, because if we can get all the data from all the different islands, rather than having it scattered, and also from the UK, and from other operations, then that should give us a better opportunity to model what might happen in the future and therefore to direct where we should be going.

Q64 James Gray: Can I just see if any of you are familiar with one particular example—as I am sure you all three probably are—namely the way the warm water is moving southwards in and around South Georgia, and then the fantastic biodiversity in South Georgia is therefore being fundamentally changed and the krill are moving down towards the Antarctic continent, and all that? It is alleged that the penguins are changing their habitats and the albatross even are doing things differently, and so are the whales. I am trying to get a clear example of the way in which climate change is clearly affecting—we confirm this is true—biodiversity in the Southern Ocean. Am I correct or is that a press story?

Dr McQuatters-Gollop: What is the question? How is climate change affecting biodiversity in the Southern Ocean?

Chair: Is that a good example?

James Gray: It is alleged that the krill are being forced southwards by the warm Atlantic waters coming down into South Georgia, and because of that the penguins, seals, whales and other things are equally having to change their lifestyle to take account of that change. If that is true, it has been widely reported in the papers, it would be a good example of the kind of thing that we are talking about.



Dr McQuatters-Gollop: That is true and it is a good example. One more thing about krill, because I am a plankton and krill expert, is that somebody mentioned earlier that we are fishing krill. Much of the Southern Ocean food web is based on krill, these tiny little crustaceans, which whales eat and penguins eat. Like you said, they are under pressure because of climate change, so that is a good example of how these changes are affecting an entire food web.

But there is another pressure on krill, which is that we are fishing krill, the very base of the food web—we are removing it. We need to think carefully about how that fishing is occurring and the quantity that we are taking and where we are taking it, because this important diverse food web is largely dependent on availability of krill. It is another example of how climate change is changing our oceans but there are cumulative pressures because of what humans are directly doing to the sea; like fishing, like pollution.

Q65 **Chair:** Following on from James, could you say what it looks like if we do not stop it? People have an understanding of melting polar ice caps and more extreme temperatures. We have an idea of what it means to us as humans and we view climate change from our physical perspective—what it is like to live in a city, or a flooded city, or extreme weather, or a hot city. What would the tipping points in the ocean be? Is it corals, is it colony collapses? What are you most worried about as scientists?

Dr McQuatters-Gollop: There are lots of different aspects to climate change and ocean acidification. I think of climate change and ocean acidification together often, so I should be more explicit when I say both together. You mention coral, and coral is a great example of one huge change we are seeing. In 2015 and 2016 the Great Barrier Reef had a mass bleaching event because of El Niño combined with climate change, so hot weather. A large part of the Great Barrier Reef, for example, is dead and probably will not come back. That is a tragic story but the good thing about it was that it was in the press and easy to capture on video and with pictures. There is whole movie called “Chasing Coral” where they captured that. It was moving to see and it is the kind of story that gets the public involved, because public opinion is important here.

As climate changes we can expect to see big visible changes, maybe like with our coral reefs, but we have corals here in the UK. Particularly with ocean acidification, we are likely to see changes in those corals. They are very deep. They are called *Lophelia*. They are important to our deep-water ecosystems, but because they are corals they are susceptible to changes in pH caused by ocean acidification. Even though they are not as visible as the Great Barrier Reef, those kinds of changes that we are seeing because of warming or ocean acidification we will be seeing here and we are starting to see them in UK waters as well.

Chair: Are we seeing the bleaching thing happening here?



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Dr McQuatters-Gollop: There will be changes in our deep water—they are deep water coral so they are different to tropical corals but, yes, they will suffer with these increases in ocean acidification, this decrease in pH. A lot of the changes that we are seeing in other parts of the world, we are absolutely seeing here.

Somebody mentioned kelp earlier. My colleagues in Plymouth are looking at kelp and they are seeing changes in the species composition of kelp around the UK. Kelp is another good species where people can see what it is. You know what it is and when you go to the shore when you are a kid and growing up you can see bits of kelp on the strand line. The reason that matters is because these different species of kelp support other communities and act as habitats in different ways. So it is another visible change that is happening with climate change and with warming.

Chair: Thank you, that is very helpful.

Q66 **Dr Matthew Offord:** We can envisage what climate change looks like, whether it is retreating glaciers, certainly rising ocean levels, and species migration. Can you walk us through the evidence of ocean acidification and try to illustrate to us what the level of that will be? Does it mean that I will not have to de-foul the bottom of my boat in future because all the barnacles will have fallen off? Particularly, what does it mean for the United Kingdom?

Professor Mills: I think Plymouth had the ocean acidification answer.

Dr McQuatters-Gollop: Plymouth does quite a lot of work on ocean acidification. Again, it manifests at all different—it is apparent at all different parts of the food web, so there are behavioural changes, changes in how organisms are structured.

An interesting example could be mussels. Shellfish that lots of people eat have these hard shells and are made out of the compound calcium carbonate, so a structure that is affected by these changes in pH. As pH decreases we are starting to see difficulties forming these shells or thinner, more fragile shells. There are good cases in the Pacific Northwest of America, for example, but it is likely to happen here in UK waters.

There are a few reasons why we are starting to understand more what these changes in ocean acidification may look like. One is through lab experiments. We can do lab experiments, putting different organisms in water with different pH concentrations.

There are lots of unpredictable effects though because it is hard to transfer a lab result to nature because there are lots of things happening in nature. There is rising temperature, as we talked about. There is fishing. Organisms might behave differently. Even though our understanding is developing about how ocean acidification will affect UK waters, there is a lot we do not know.



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One of the instances we are monitoring is key. Not just monitoring the changes in the chemistry, in the pH, but also monitoring the changes in the biodiversity; so the fish, the plankton, the different elements of the food web that we have here in UK waters. Because we need to understand this precious relationship—so how ocean acidification and changing temperature affect the biodiversity of our waters.

Q67 Dr Matthew Offord: You anticipated my second question, which was about how it has affected biodiversity. You did say in one of your points, and maybe it is just semantics, that it is possible that we are seeing thinner shells in mussels and other crustaceans. Have we seen that yet, because that would certainly be a procedure and experiment that would have to take place over a longer period of time?

Dr McQuatters-Gollop: Have we seen that yet in the UK?

Dr Matthew Offord: Yes.

Dr McQuatters-Gollop: I will have to talk to my colleagues about that. Perhaps you know, Colin.

Professor Moffat: The answer is yes. Professor Boyd mentioned the Stonehaven site, which is one of the ecosystem monitoring sites. There we have been monitoring the change and the acidity of that environment. But we have also been looking at the shells of the small animals and we are beginning to see pitting in the shells, which to the best of our ability we believe is associated with this change in acidification; so yes.

Q68 Dr Matthew Offord: Brilliant. That is very helpful. I turn to you, Professor Moffat, and ask about monitoring that the UK should be doing. No doubt Plymouth are doing their work and other organisations have undertaken work in Scotland. What do you think we should be doing, particularly in the Overseas Territories, to monitor the impact? When I say "UK" what should we be looking at in the OTs that should be different from what we are looking at in the United Kingdom?

Professor Moffat: Two points: measuring pH in the sea is a real challenge. We can do it in a laboratory because we have—and you have probably all done it at school where we have popped a pH meter in or a piece of litmus paper or something like that. We cannot do that in the sea because the sea is salty. We have to measure other parameters and calculate the pH. Unfortunately, currently, there is no simple device to pop in the sea.

Various companies and technologies are coming along, which means in the not too distant future we might be able to do it. If we can do it, that is going to make a huge change because then we can put these devices out that might be autonomous that can then send signals back. But at the moment that is not possible.

What we have to do is collect samples of water. We then have to stop these samples of water changing while we transport them to laboratory.



Again, that is one of the biggest challenges in terms of our Overseas Territories because we have to get the water sample from there, back to a laboratory that can undertake the analysis. One of the products we use is mercury chloride and, understandably, people do not like that being transported around.

We have a bit of a challenge because these Overseas Territories do not have big enough infrastructure for us to necessarily set up the full devices for monitoring. Ideally, what we would like to do is collect samples, find a way of preserving them, bring them back to the UK and analyse them here in the UK. The other thing is we want to better understand the biodiversity in their respective locales, and part of that is coming through from the Blue Belt strategy that is going on at the moment.

The final thing is what are the prevailing conditions around the islands? The important thing is that at the moment we are seeing a change in pH from about 8.2, which is slightly alkaline, down to about 7.9. But pH in the environment does not stay the same all year, just like plankton varies and temperature varies, pH varies. What we are seeing is that the general decrease is slightly less than the variance in any period of time.

Again, measuring and getting precise data that allows us to say absolutely definitively we are seeing this change is quite complex. What does that mean? It means that we need several years' data in order to be sure that what we are seeing is the change. What we need to be doing is putting in place long-term programmes because a year's data is not worth anything. In fact, you can say three, four, five years' data may not be.

The challenge we have with some of these locations is that it will be a long time before we have enough data. The advantage of the Bermuda Time-series Study is that it is very long. That is why we are able to be so positive about what we are seeing there.

Q69 Dr Matthew Offord: I have asked parliamentary questions in the past about acidification but I do know that the UK has now closed its ocean acidification programme. What impact is that going to have on the long-term monitoring? Will that be a great hindrance to not only your work but also just the general research programme?

Professor Moffat: I can speak specifically on how Scotland has responded. Scotland is going to fund the ecosystem monitoring site of Stonehaven and we are going to open a second one on the west coast at Loch Ewe.

Professor Mills: The site in Bermuda is led by a chap called Professor Nick Bates, who I think came and gave evidence here just before the election. He is a joint appointment between the University of Southampton and the Bermuda Institute of Oceanographic Sciences. He works both in the UK and in Bermuda, so we have a good link between an



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Overseas Territory and the UK organisation. We have samples run in both places. The point is, we need international monitoring in international waters because this is a global phenomenon.

While the UK waters are very important, probably maintaining that Bermuda site indefinitely is far more important, so we have our 50-year record of pH change.

Chair: The evidence he gave was to the Science and Technology Committee, not this. That is why we are blissfully ignorant. Although right now blissfully full of knowledge, thanks to you.

Q70 **Anna McMorris:** Programmes such as “Blue Planet” have shone a spotlight on the issue of pollution and pollution in our oceans, marine litter, plastic pollution, in particular. First, Professor Mills, what forms of pollution are most prevalent in the oceans and what impact are they having?

Professor Mills: I know you covered this in the previous session quite thoroughly, so I will probably say some of the same things again.

Plastics are important and “Blue Planet” has done a fantastic job of showing the world how important are plastics, and then microplastics, which are the unseen end product once it has been broken down to these tiny particles. Alongside those pollutants that we can see are the important dissolved chemicals that either stick to the surface of the plastics and they are transported with them, and then diesel will come off the surfaces when the conditions change and they get into the food chain.

Professor Boyd made this point very well, that it is the unseen chemicals that change all the time and that are regulated once we know they have an impact, but that they are constantly changing and constantly coming onstream. That is probably the biggest unknown in the system. We do not know how important they are, but we worry that they are going to be important.

We have talked about marine noise, we have talked about something that—I will use the word “nutrification” but it is putting nutrients into the ocean, stimulating plankton growth, changing the biochemistry of the ocean. Our nutrient run-off impacts the ecosystems. We have toxic viruses and microbes that get into the ocean that have horrible effects on our fisheries and our aquaculture, so norovirus and other unpleasant microbes are important. I think I have them all. Heavy metals was the other one that Professor Boyd mentioned that again are very important. The one that trumps them all is the carbon dioxide. Carbon dioxide is the pollution that is increasing, set to increase, that is not going to decrease and is going to acidify our oceans. We know that. It is the interaction between that acidification and the other pollutants that is very much an unknown.



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What happens to plastic in a more acid ocean? What happens to those toxic microbes in a more acid ocean? What happens to heavy metals in a more acid ocean? We do not know. It is the interplay between these different pollutants that is going to be key for understanding to be able to answer your question properly.

Q71 Anna McMorris: That is interesting. Do you think there is a risk though here with heightened awareness on plastics, for example, and media coverage that we overly focus efforts on one form of pollution over another?

Professor Mills: It is our job to remind people there are other things going on. Those messages are complicated, as you have just seen. The plastic stuff is great because people can see it; they can do something individually and be accountable and proud of their two-minute beach clean. That is important. I am a fan of using something that gets the public attention and gets the message out there.

Our job as politicians and scientists and educators is to say that it is more than just that. If you can take that individual accountability around plastic and then take it to the next step in terms of everything that ends up in landfill, in the waterways or the ocean, then you can take it to the sustainability of fish that you choose to eat in the supermarket or in the restaurants. You can take that philosophy and roll it out across all of the other elements. That is a more complicated message to get across.

Q72 Anna McMorris: You can focus on just plastics in terms of litter, beach clean-up, and we see a lot of single use plastics being washed up. There is also packaging from producers and the type of packaging that is used. For example, the Welsh Government in 2011, and more recently the UK Government have taken action on reduction in plastic bag use—the 5p carrier bag to reduce all of that. But how far do those kind of solutions go in tackling the real problems?

Professor Mills: They are part of the solution. It has been impressive, the 5p tax led to 86% reduction in plastic bag usage. We need to go further. Other countries have gone further. Other countries have either banned plastic bags completely or at least have a more significant tax. We can go further with that. The plastic straws, the single use plastic—it all adds up.

I did a beach clean this last weekend and most of the debris I found near Southampton was fishing debris—it is fishing line, it is stuff from the fishing industry on the south coast of England. It is very different in Scotland. You referred to the Scotland drone footage of the plastic waste on the beaches in Scotland. It is a different story in different parts of the UK. We have all seen the images coming in from other countries that are again very different.



One size will not fit all but part of the solution certainly is dealing with single use plastics; straws and plastic bags will certainly be part of the solution.

Q73 Anna McMorris: Would you say that extended producer responsibility then would play a part—the producers taking more responsibility?

Professor Mills: Absolutely. We need two things. One is some innovation. We have some great chemical engineers in this country, and material scientists. We need to produce plastics that are more readily recyclable. We need to be pushing innovation in that direction so that the next generation of plastics we are using are much easier to handle, to separate and to process. We need innovation in our recycling industry. We need innovation in our landfill management, so it does not spill over during storm season. Innovation is required all the way through that chain between land and ocean, and that will help us solve this problem.

Anna McMorris: Can I open those questions out to the other witnesses?

Professor Moffat: First, the advantage of the “Blue Planet” programme was that it highlighted an awareness of marine in itself, and that is phenomenal. Then they have highlighted a specific problem with marine litter. As Rachel said, we then have a foot in the door and we need to capture that opportunity, capture this moment to help put out stuff to people to emphasise that, yes, plastic is there but it is one of a number of issues in terms of pollution that we have to consider.

As we look at the microparticles, and now the nanoparticles that are increasingly become part of it as technology moves, we have to consider, when we are producing these particles for use in televisions, or whatever they might be used for, whether we are trying to find out what the impact of those might be further down the line. Because ultimately most of our modern equipment has a relatively short life and goes somewhere. So what are we doing?

The other thing is that there are situations where we are still losing containers off ships. They contain the nurdles. The nurdles are the little pre-production pellets. We could probably go around a lot of beaches around the UK and go nurdle hunting. We could probably find nurdles. If you do that then please do go on the nurdle page website and report it, because again the more information we have—this is also a good opportunity for citizen science. We have heard about cleaning beaches, but going out and doing the nurdle hunts and putting that information on to the website again is, first, captivating individuals in terms of their attention to the marine environment, but then we wrap it around other aspects. For example, in Aberdeen on Saturday it is Doors Open Day and the marine laboratory has opened its doors. Yes, we have a stand on plastics and stuff like that but we are opening it out to other issues to make our visitors aware of the wider things that are happening.

Q74 Anna McMorris: But there is only so much that people can do if it is



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being produced. There are a lot of campaigns. There is a campaign in my own constituency that they are trying to become single use plastic free. There is only so much that we can do. What are the Scottish Government doing on that? Surely, it should be for Governments to take a lead on setting out what legislation there should be and what manufacturers, what producers, should correct.

Professor Moffat: The facial scrubs and those sorts of things are a start. We are moving along a process. It is not going to happen overnight. The good thing is that we have this increased awareness, so therefore we are able to take that forward. But I do feel that we need to ensure that we have the information to very rigorously back up what we are saying about the plastics to ensure that any legislation is evidence-based in terms of its delivery and encourage folk.

It is a challenge that even if you want to buy loose bakery or loose vegetables you probably have to put them into one of these very thin one-off use plastic bags. The only other option you have is to drop it into your basket, which you have taken in from outside, so you are probably not wanting to do that. Again, it is how we sell the products in the shops.

Can we work with the retail industry to change how we are displaying things and how we are selling products? Again, encouraging people to come in, maybe with their own container that they can drop their buns in, or whatever. Certainly, that is where I am moving, together with my wife, and we have started thinking about all these sorts of things. Also challenging the shops as well in terms of the only way I can buy this is if I use this little plastic bag, which is not very good.

Dr McQuatters-Gollop: We have this water on the table here, and I am glad some people brought reusable bottles, so that is encouraging. The positive thing about the plastic debate is that it is encouraging non-scientists to take personal action and capitalising on that momentum. It is opening the conversation for, "Oh no, you took a plastic bag, that is really bad" and you are like, "Yeah, it is really bad" and there are lots of things we can do to make our environment better besides just reducing plastics. How do we get around? Do we take public transportation? Do we ride bikes? There are just a lot of conversations we can have once people get the awareness that they can take actions that will help change our environment, such as saying no to the plastic bag or bringing a cup. Pret this morning gave me 50p off my coffee because I had a reusable mug with me.

Me must get people to say, "Oh look, I can do something to change this" and then help them think more widely about what else can they do to change their behaviour that could help the environment.

Q75 **Anna McMorris:** Finally, one of the Pitcairn Islands was recently found to have the highest density of manmade debris anywhere in the world. What support would you say, Professor Moffat, that could be given to Overseas Territories in preventing and tackling this marine pollution.



Professor Moffat: First, the tragedy of the situation is that we will not be able to prevent it in terms of the islands themselves. There is nothing the islands themselves can do to prevent it because they are getting caught up in the global ocean circulation, and they happen to be in a location where the rubbish is being dumped on their shores. They are not generating it, it is coming from roundabout.

We are all well aware—you have probably all heard of the floaties, which are the rubber ducks that were spilt in the Pacific and some of them have made their way into the Atlantic. That gives you an indication of the flow. The first thing is we have to do something. The world that is generating the rubbish has to do something.

As far as helping the islanders, the key thing is that once it has landed we want to remove it. That is very expensive so we need to find ways of going in there. The boat is once every three weeks or something that you can get off the island because of its remoteness, and that is the case with many of our Overseas Territories. To go in there and take it out is going to be expensive but I suspect that physically removing it is what we have to do.

We also have to think about where we put it. It has to go somewhere and burning it is not a solution because that is going to produce a whole lot of toxic chemicals that are going into the environment. It is about changing certain things that we are doing, but we have become so used to it that it is a significant challenge.

Q76 **James Gray:** I have to be elsewhere at 4.00 pm so I want to race through a couple of questions on MPAs, if we may. Let us be controversial, they are just a piece of paper, aren't they? They do not do anything, do they? Are MPAs achieving anything? Or are they just a way of Governments and people telling themselves they are doing a good job?

Dr McQuatters-Gollop: With the UK MPAs we need to carefully consider all of our MPAs and make sure they have clear conservation objectives and management plans because those are not happening everywhere right now. For our MPAs we need to think, "What do we want to achieve with these MPAs and how will we achieve it?" So put in effective measures of protection.

If we have an MPA and we allow every activity that always went on there to go on there, is that doing much? Maybe not.

Q77 **James Gray:** You are tending in your answer there to agree with me. You are tending to say these things need to be done now therefore the implication is that they are not currently happening.

Dr McQuatters-Gollop: I am saying that there are big improvements we can make. We have the MPAs designated and that is a huge achievement. I know that effort took years. The positive thing is we have the MPAs covered. Lots of them manage different features that are in that MPA and they have some level of protection. But what we have now is an



opportunity to say, "Can we do this better?" So for all of our MPAs how clear are our objectives? What do we want that MPA to manage? Can we do better than just managing individual features?

Q78 James Gray: That is right. All those things are correct although those are questions that need to be asked. We are asking the questions. My suggestion is that these things have been created and not much is happening, the biodiversity in our oceans is just as bad post-MPA as it was before MPA. Is that a reasonable presumption?

Dr McQuatters-Gollop: It is a presumption but we do not even have monitoring in a lot of the MPAs so we do not even know that. That is a huge negative—we have no way to even tell if they are working or changes have happened.

Q79 James Gray: What about global MPAs? Would it be right not to support the IUCN move towards 30%?

Dr McQuatters-Gollop: No. We need to manage much more of the ocean. We manage everything on land. In the UK, for example, our terrestrial areas are well managed. We have places where people live. We have designated farmland, designated parks. We must think about how we can manage our ocean more holistically where we conserve larger areas of the ocean, and more effectively manage the areas where we already have MPAs. A critical part of this is starting to integrate our different types of management, so instead of just saying, "Let's manage fisheries one way, MPAs over here, manage this over there", we should start integrating that with an ecosystem approach. We should start managing our marine environment holistically where MPAs are part of the picture. Managing fisheries are part of the same picture, and managing the other biodiversity components are also part of that strategy.

Q80 James Gray: All those things—that is a very good essay on what is good about MPAs and why they were invented. It does not inform us as to whether or not any MPAs are working and why was it the British Government did not support the IUCN move towards 30%. I understand and we have talked about that. What are we doing to make the Russians and Chinese allow us to bring MPAs into the world sea and elsewhere? Should we make the global oceans MPAs or is that an entirely pointless paper exercise that might make us feel better, make politicians claim they have done something, but nothing has changed?

Dr McQuatters-Gollop: There is no point putting in place an MPA that does not have a management strategy with effective measures of management. The ocean needs to be managed, which is why we have marine spatial planning. I do not think the whole ocean needs to be an MPA because obviously we do need to use the ocean. But we need a clear idea and a clear plan for the MPAs that we do have. I do not think we could go wrong with better managing the marine environment. That includes expanding the amount of the marine environment that we do designate as MPAs.



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Q81 **James Gray:** I agree with the first statement—of course you must manage it better. But increasing MPAs is pointless unless they are being managed.

Dr McQuatters-Gollop: They need to be managed, sure.

James Gray: That was in relation to my question.

Dr McQuatters-Gollop: IUCN probably meant 30% of your water could be MPAs but they need to be high quality MPAs and not just designated MPAs with no management measures.

Q82 **James Gray:** And we who voted against it probably did not believe that was going to happen. My thesis is and I am sorry to keep going—

Chair: Because it is scientifically not. What Professor Boyd said was it was not based on science.

Q83 **James Gray:** You can have IUCN or anybody else saying, “Oh, let’s make it 30% or 50%, whatever you like, MPAs” but if they are not being managed not only is there no point in doing it but it might be damaging because politicians and others can say, “Look, what we have done, is it not marvellous? We have designated 30% of the world’s oceans to MPAs. Are we not fantastic?” Nonetheless we are all slightly different. I suspect from her body language Professor Mills may have rather a different view on this.

Professor Mills: No, I was very interested by your questions. Professor Boyd was very clear that there is not an evidence base to underpin the 30%. There is not an evidence base that is good enough for any sort of political decision here yet, so clearly the answer has to be—Abigail is entirely right, we have to manage the ones we have, monitor the impact of them, measure that impact and then come back with some evidence that can inform policy. That is all I was going to say.

James Gray: We will end it there. Do I mind if I scoot off?

Chair: No, that is fine.

Q84 **Kerry McCarthy:** Again, I am in the same position, I have an AGM at quarter past. Perhaps I can ask Professor Mills some questions about some deep-sea mining. A starting point is the lack of information about potential environmental impacts. Do you share the view that we need to do a lot more homework on what the environmental impact will be?

Professor Mills: There is a whole EU programme dedicated to looking at the impact of potential deep-sea mining. The evidence from those shows that we are not in a position to be able to—we do not even have the baseline knowledge of what the biodiversity of these systems is, let alone what the impact of removing forever some of the substrate, and what impact that will have on those ecosystems. I have become convinced of late that we are not in any position to be even at the starting blocks for starting that deep-sea mining. We do not have enough evidence for what



the impact will be on those very unique ecosystems on the seafloor that we are defining by our work in the deep sea.

- Q85 **Kerry McCarthy:** There was a little bit in “Blue Planet” about hydrothermal events and the miniature ecosystems. I wish that had got as much attention as the plastic pollution—

Professor Mills: So do I, but—

Kerry McCarthy: It is fascinating that these ecosystems exist but at the same time quite alarming that people might think that there is scope to start mining.

Professor Mills: There are two things. One is that every time we dive a new hydrothermal vent site, which we still are discovering every time we go out, we find new species that we did not know at all existed before. We are still at that stage of finding new species. We are nowhere near defining how the ecosystem works.

We used to think that we could set that aside—we could say, “Okay, we will not touch the active vents but maybe the inactive vents because nothing much is going on there.” But when you go and look there are huge complex ecosystems associated with the inactive vents that might be tens of thousands of years old but they are still integrally linked to what is going on in the active vents. It is not as simple as saying, “Mind that, do not mind that”. The whole system is much more connected than we previously thought. We are just not in a place to be able to start that process and we still have a long way to go.

- Q86 **Kerry McCarthy:** When the Deep Sea Mining Act 2014 was going through a few years ago, there was some discussion about environmental impact assessments being conducted. My concern there was that it is the companies that have the licences that would carry out the assessments as they get it. You are talking about something that has happened miles down underground and we cannot see what is happening and we are very much reliant on their assessment. There would not be any monitoring of whether their assessments are accurate, is that right? You would have to have a lot of faith in them to have carried out that assessment?

Professor Mills: So a good environmental impact assessment would have review from experts that were independent from the company that were planning to do the mining. It would have that stakeholder engagement and consultation with a range of different stakeholders that were both informed and could challenge that evidence and were being entirely transparent. I do not think we are quite there yet because people have underestimated how difficult it is to carry out a good environmental impact assessment two miles beneath the sea surface to the quality that we need to be able to be informed to make those decisions.

We should be up for having a go at that. I am not saying stop, do not do anything, but we certainly need to challenge the industry and the International Seabed Authority to define what a good environmental



impact assessment is. We should set in place a structure that means that that will occur properly and can be challenged by stakeholders, and those stakeholders include us. Those stakeholders include the people living close to these environments and the global members of this planet that will be impacted by deep-sea mining.

Q87 Kerry McCarthy: In terms of the governance structure, how does that need to be improved?

Professor Mills: There is a consultation out at the moment and I know the UK is contributing to that. It has to be about challenging the way that environmental impact assessments are done—they must be done properly. There must be an independent body set up to scrutinise and monitor the impact of any activity we have on the seafloor. I see the point you are making about conflicts between the people who hold the licence and doing the monitoring. There needs to be some sort of independent scrutiny of that.

There needs to be some sort of legislation internationally—a treaty that defines all this, that we have to be accountable to and held to account by. A whole load of things need to be done before we are ready to start this process.

Kerry McCarthy: At the moment it is at the exploration stage?

Professor Mills: We are certainly at the exploration stage.

Kerry McCarthy: There should not be exploitation.

Professor Mills: Until we have nailed what is an environmental impact assessment—does setting aside areas of the seafloor work, what size do you have to set aside to be useful, and the MPA argument? We can then put in place some international legislation and sign up to a treaty that we can all operate within

Q88 Kerry McCarthy: With the set aside areas, does that work? If you are talking about something like overfishing it makes sense to have marine protected areas where there are no-take zones or whatever, and that is clearly going to have an impact on numbers. But if you are talking about these unique ecosystems, unexplored territories, it is not a case of numbers, is it? If you were to set aside certain areas we protected you still could be creating a huge amount of damage to other areas. Does that numerical approach work?

Professor Mills: If you look at the Clarion-Clipperton Zone, the manganese nodule field in the Pacific that everyone is—a lot of licences have been awarded in the Clarion-Clipperton Zone. The approach has been to set aside essentially areas of special environmental interests. So great big swathes of that. Big blocks of the Pacific have been designated for no trawling, no impact at all. They are interconnected between the licensed blocks but we do not know what impact that will have. We do not know whether they are big enough to be useful for recolonisation of the



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potentially mined sites, and we do not even know what timeframe those ecosystems are reproducing on. We do not even know what role the half substrate of the manganese nodules holds for the life cycle of those organisms living near the seafloor. There are so many unknowns that to start this process not knowing how big, how interconnected, and how long do you need to do this for would be very dangerous.

Q89 Kerry McCarthy: In terms of the ISA exploitation regulations, is there anything that you would like to say included in that?

Professor Mills: In addition to what I have said?

Kerry McCarthy: Yes.

Professor Mills: No, I think I have covered everything I wanted to say. Did you want to come in, in addition to that? No, if the ISA dealt with the issues—I will not say them again—then we will be in a good place to be able to move forward.

Q90 Kerry McCarthy: Do you feel that there is a political will? What are the politics of the ISA in terms of issues? Are they motivated by the desire to protect the seabed or the desire to exploit the resources on the seabed?

Professor Mills: I cannot comment on the collective motivation. There are individuals in there with a whole range of opinions, just like there are in this room.

Kerry McCarthy: Which view is likely to hold sway?

Professor Mills: No, I would not like to say. People are very clear that we need to protect our oceans, but we are very clear that we already—we get a lot of our resources from the ocean and we need those resources. So we need to develop a framework within which we can extract the resources that are possible to extract sustainably and do it within a framework that is internationally binding, so that we can monitor that sensibly and say what impact is happening. People are motivated to do that. I just sense that we are not quite ready to go yet. We have a long way to go before we are ready to start.

Q91 Kerry McCarthy: One last quick question. The Deep Sea Mining Act was about granting licences, and the UK seems to be at the forefront of wanting to do that, but if no are licences granted over particular areas, is it a free-for-all that any company can go in?

Professor Mills: No, they have to apply for a licence.

Kerry McCarthy: So anywhere in the high seas?

Professor Mills: In the high seas, yes.

Kerry McCarthy: They would have to be—

Professor Mills: Something like 26 licences have been granted to date and essentially there is a consultation out about what happens next. It is a small amount of activity at the moment and people are watching and



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waiting and seeing how things land. You do not see the big major mining companies involved. It is still at the very early stages of any actual mining of the deep ocean.

Kerry McCarthy: There is time to get the right regime in place.

Professor Mills: There is time but now is the time to get involved.

Q92 **Chair:** Final question and this is primarily to Professor Moffat but do feel free to jump in. We have seen concerns raised about the Marine Stewardship Council's blue tick certification scheme, and criticisms that it is too lenient when it comes to certifying fisheries. Do you share any of those concerns or do you support the counterargument, which is all the low-hanging fruit or sustainable fishing has already happened and they are a key driver in terms of bringing the next tier down into the level of good management?

Professor Moffat: In terms of the stuff that has come from the Marine Stewardship Council, a lot of that is good stuff. The key thing is that we have managed to secure certain things. We have gone through a period of change. In terms of fisheries, the fish stocks, especially in the North Sea, are improving. They are improving because of the changes that have been brought about in terms of regulation, but also as a result of close working with the industry and the application of science.

Q93 **Chair:** This is a question about the MSC, so it is about that certification scheme. Do you have concerns about that scheme?

Professor Moffat: I would have to revise and look at it again before I made any real comment on it.

Professor Mills: I would like to comment on it. It has led to some change in behaviour at my university, certainly the canteen where I work, and it only has fish served that is MSC accredited, that is a good thing. Again, it is back to the plastic point you were making. People become more aware by that approach. That has to be a good thing.

The point that my scientists in Southampton made was the key point is traceability. It does not matter what framework you have if the fish you are eating is not really cod, so you can tell genetically that it is not what you think it is or it does not come from where it says it has come from.

Chair: You are not saying that that is a problem with MSC certification?

Professor Mills: Not with the certification but if you do not have a governance structure that means you can enforce that traceability from the blue tick to the plate, there is no point in it at all. We have to also think about the traceability of the product before it gets to our plates. There is evidence the things we eat are not quite what they say they are.

Q94 **Chair:** What about you, Dr McQuatters-Gollop? Your submission argued that the carbon footprint of fisheries is not factored in and should be.



Dr McQuatters-Gollop: Our submissions, and my colleagues, have looked into this. It is not just the amount of fish that we take from a fishery but how we capture those fish. Are they trawled or net caught and what else is caught that helps the MSC decide if it is going to get the blue tick? Right now, the carbon footprint in the fishery is not considered. That could be quite significant because a lot of fishing takes place with huge industrial vessels that go very far off the shores. I am lucky that I live in Plymouth and we have a small local fleet. They go and come back on the same day but a lot of global fishing is not fished that way.

The concern with my colleagues at Plymouth is that the amount of carbon spent catching these fish needs to be considered when awarding the blue tick. The other concern is that in most locations we do not just fish one thing. There are multispecies fisheries where a net comes back with multiple species in it or in one location we do have multiple single species fisheries. Consideration of the interactions between how fish are caught in different fisheries and how the different fish stocks are managed should also be considered when awarding a blue tick to a fishery.

Q95 **Chair:** That is an argument for them expanding and refining their scheme. It is not an argument against the scheme.

Dr McQuatters-Gollop: Yes, I think so. What Rachel said is true about how having a very clear label on fish. It is easy to recognise. If you have a fish that does not have the blue tick and a fish product that does it is very easy to make the choice to take the product, to buy the product, with the blue tick. What we need to make sure is that the integrity of what that blue tick stands for is preserved and real and it is meaningful.

Chair: Thank you all very much indeed. We are going to close the session now.