

Wonders of the Living World

Curiosity, awe, and the meaning of life



Video transcripts, Sessions 1-3

Session 1

1.1: Ruth Bancewicz - Introduction

Every scientist experiences some sense of awe and wonder in their work, whether it's something mathematical, something very beautiful, something very surprising, something that just logically fits together so wonderfully, there's always that sense. And for a Christian there is also something that goes further - their sense of awe and wonder can feed into their worship of God, the great creator who made it all. And from their science there comes knowledge that is useful, there are ethical decisions they have to deal with, but there's something extra, there's something in their work sometimes that reminds them about something to do with the character and purposes of God. We're not talking about proof for God, but it's more something that might resonate with their faith as well as leading them to worship. It might make them think a little bit about the character and purposes of God. So what we're trying to do in this study series is to help you to appreciate the intricacies, the complexities of the science, to celebrate creation and enjoy it, but then also to think about these questions of meaning and purpose that science can raise.

1.2: Alister McGrath - What can we learn about God from science?

I find it very helpful to think of theology as a lens, now it's not an original idea I get this from C.S. Lewis okay, but it really is helpful because what does a lens do? It brings things into focus. And we all need lenses I mean a theory is basically a way of looking at something, it's a lens through which you look and if a lens is out of focus you don't see anything or you see something amorphous and so you say there is nothing there to be seen. And one of the things that excites me about Christianity is it's a lens that brings my experience, my observations of the world into far sharper focus than anything else I've discovered up to this point. We need that clarity, we need that sense of being able to see things properly and for me the Christian faith is all about the healing of our vision so that we see things as they really are, not as we'd like them to be.

So what can we learn about God from science? Well I think lots, actually, I mean for example I often think of Psalm 19 verse 1 "The heavens declare the glory of the Lord" and if you're a Christian you know God made the universe but actually being presented with a rich deep vision of what the universe is like, that gives you an imaginative enrichment of this, so in other words you know God made this but actually it becomes even more real, even more exciting by having this amplification of what it means to think about the world.

1.3: Jeff Hardin - Why are you a scientist, and a Christian?

Well, I became a Christian when I was in the 7th grade, and a friend invited me to an event at a local church, and I heard a lot of new ideas about who I was and who God is, and how it might be possible for me to have a personal relationship with God. And that started a lifelong journey for me. I went through high school, and then went off to college, and I became a science major in college. I have always wanted to be a scientist. Initially I had wanted to be a physicist, in fact I took German in high school because all of the really smart physics guys spoke German. But then I got to college and realised I wasn't very good in math. I was pretty good in math but not good enough, and so I changed to zoology and took biology courses, continued to love science and initially I was going to pursue a medical degree and a PhD - a combined degree - but instead I decided to go to theological seminary where I received a Master of Divinity degree, so I'm a little bit odd in the sense that I have theological training, but then at the end of my divinity school education I felt a strong call to return to academic science. And so I pursued a PhD in biophysics, and there I discovered embryos. I looked at an embryo developing under the microscope for the first time and I was absolutely hooked, and so that's been my lifelong research interest is understanding how embryos develop, and for me that has always been pursued from a profoundly Christian perspective.

1.4: Jeff Hardin - What questions about meaning and purpose does your work make you ask, and how does your faith begin to answer them?

I study embryonic development, and it really causes me to think pretty deeply about where did I come from? Where does each of us come from? What are the processes that underlie how each of us arose as an embryo? Those are pretty profound questions when you stop to think about it. We really have humble beginnings. We start as a cell that is 1/10th of a mm in diameter - you can barely see it with the naked eye, in fact if you don't look carefully you'll miss it! That's how we all began. And so the fragility of each of our lives is something to think about, I think "wow that's, that's an amazing process that leads to who we are". And yet those processes of development are incredibly reproducible, most of us turn out pretty much the same way with the same structures. So those processes themselves are amazing, but it does cause me to think about who I am and the fact that the processes

that gave rise to me are something pretty special and something that causes me to think about myself pretty humbly, frankly. I think one of the other things that for me... I happen to be a Christian, and one of the key ideas in historic Christianity is the idea that Jesus of Nazareth is actually God in the flesh. For that to be true, he's human, and so he went through the very same steps that all of us went through, and that fills me with a sense of complete amazement, and helps me to see just how thoroughly and completely God identifies with us as human beings.

1.5: Jeff Hardin - How do you think science and faith fit together?

For me, studying the wonders of the living world is an exercise in art appreciation. For me, God is the creator of everything, and so discovering how that creation works - that's what science is about for me. So for me the joy of discovery is also the joy of appreciating the world that God has made. And discovering the intricacies of how that living world works, especially in my case, understanding how embryos develop is really an exercise in saying "aha, that's how God has made the world!" And understanding in a way that no one else has actually ever understood - that that's how it works - that's really part of the thrill of discovery for me, and leads me to thank God for the amazing world that we have to enjoy and to explore.

1.6: Jeff Hardin - You have been known to use the Bible in one of your lectures - how does that work?

I teach undergraduate students every spring, and I teach a course on embryonic development. And I open that course by saying that one of my goals for my students is that they would... by the end of the semester - that they would think that embryos are cool. And I start by pointing out that people have been thinking about embryos for a long time. And one of my favourite passages that reflects that is from the Hebrew part of the Bible - a poem called Psalm 139. There the psalmist is considering all that God is involved in, and he is reflecting on the fact that God is everywhere. In fact God was present when the person writing this poem was an embryo, and he reflects on that, and he doesn't really understand how embryonic processes work but he says that he... in some sense, through the processes of development God wove him in his mother's womb, and he further says that he is "fearfully and wonderfully made", in other words his own... the processes by which he himself came about are absolutely awesome, and it fills with a sense of wonder. For me that's what drives what I do too, that these fearful and wonderful processes... what a joy! What a privilege it is, I get to study these things, I get to understand them in ways that no one else has thus far understood them. That is amazing, and for me that's an exciting thing that I get to do, and something that really flows in profound ways out of my own Christian faith.

1.7: Jeff Hardin - What thoughts are prompted by the beauty you see in the lab?

Beauty, yes that's something very important to me. So for me, the world that God has made is beautiful. And that when I perceive things that are beautiful, to me that's a pointer to God himself, the author of things that are beautiful - things that are true. When I look at embryos as they're developing, the images that we capture with our microscopes reflect this beauty. Some of the images that we generate are to me as beautiful as a stained glass of a cathedral or a beautiful painting by a master artist, and they cause me to ponder "Who is author of this beauty?" CS Lewis, the famous British academic and author, he talked about these kinds of experiences as what he called "patches of Godlight", and for me that's what they are. And so when I see an amazing image that our lab or some other lab has generated - many of them end up in text books because they're so beautiful - those cause me to stop, to pause with wonder, to stand really stand rapt in awe and to thank the God who lies behind all of this beauty.

1.8: Jeff Hardin - What do you think we can find out about God from his creation?

Well I think one of the things that we learn about God is that he loves amazing variety. He loves intricacy, I think that he must delight in the wonderful complexities of the world. I share the perspective that some writers in the Old Testament portion of the Bible seem to express very well. In a poem called Psalm 19 the poet says "The heavens declare the glories of God. The skies proclaim his handiwork..." and that's the great big world, but I can say the same as I look through a microscope and look at embryos, to look at the creation that God has made that allows for this kind of incredible splendour and richness. For me too, I think pondering these great works that I can observe in nature fills me with a sense of wonder and majesty. And you know oddly, thankfulness. And thankfulness is an attitude that can you can really only express to a person, and for me as I experience that feeling of thankfulness, I realise that there is a person whom I can thank - and that's God himself.

1.9: Jeff Hardin - Can we use the language of purpose in biology? What do people mean by it?

You can think about purpose in multiple senses, and you probably need to make it clear when we're talking about one versus another. So I think it's very appropriate to talk about purpose with a capital P, big purpose - and certainly the entire natural world fits into that. God has purposes for the universe. One of those important purposes is that it generates creatures like us who can develop a relationship with him, and Christian faith says that God has gone to incredible lengths to make it possible for creatures like us to relate to him. So it's clear in that sense, that the world is here so that we might exist, and that's a big purpose for the world. So the processes by which we arose certainly reflect that larger purpose which transcends the universe itself. So that's a great way to think about purpose as it relates to biology.

Now I think the question also had something to do with whether we can talk about purpose in more kind of mechanistic ways, as it has to do with biology. Scientists talk about purpose in some senses in that way as well, in the sense that certain processes have to happen in order that a structure in an organism or an organism's function in an ecosystem occurs. Those don't really presuppose someone behind the scenes tweaking things in a biological process in any particular way from the outside. What biologists mean by that is that the mechanisms within the biological process are leading to some event, and those are required for the final outcome that typically results from some sort of biological process. So often that's what biologists are meaning when they use purpose language. They're not meaning there's someone behind the curtain pulling strings rather like a puppet - that's not what they mean.

I think biologists and Christians who are biologists in general want to say that creation is robust on its own. Built into the creation are the internal processes which give rise to really complicated organisms. And that the universe is sufficient, on its own, to generate the rich complexity that we see. Otherwise you feel a bit like - I don't know if this is true in the UK - but certainly in the US breakfast cereals often have little toys in them for children, and these toys include these little cars that you can ratchet back to load the spring and then you let them go. The car goes in a straight line, that's all it can do - it has no steering mechanism. To get it to go in a different way you have to kick with your foot - you have to move it - and I think that's not how the world works. God has imbued it with this rich, complex capability and that's what scientists are discovering, and those lead to outcomes in terms of how organisms develop and how they function. And that's really what biologists are talking about most of the time when they talk about purpose. Now, stepping back from that, I do want to say that the operations of the universe do fit into this larger plan that God has for all of reality.



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Curiosity, awe, and the meaning of life



Session 2

1.1: Ruth Bancewicz – Introduction

Every scientist experiences some sense of awe and wonder in their work, whether it's something mathematical, something very beautiful, something very surprising, something that just logically fits together so wonderfully, there's always that sense. And for a Christian there is also something that goes further - their sense of awe and wonder can feed into their worship of God, the great creator who made it all. And from their science there comes knowledge that is useful, there are ethical decisions they have to deal with, but there's something extra, there's something in their work sometimes that reminds them about something to do with the character and purposes of God. We're not talking about proof for God, but it's more something that might resonate with their faith as well as leading them to worship. It might make them think a little bit about the character and purposes of God. So what we're trying to do in this study series is to help you to appreciate the intricacies, the complexities of the science, to celebrate creation and enjoy it, but then also to think about these questions of meaning and purpose that science can raise.

2.1: Alister McGrath - How can a feeling of awe and wonder prompt people to ask questions that science can't answer?

I think my most vivid experience of wonder took place in the 1970's when I was on vacation in Iran. We were travelling on a bus in the middle of the night because it wasn't hot then, and the bus broke down. We found ourselves in the middle of this solemn black desert, and the night sky shone with a brilliance like I had never seen before. That just overwhelmed me, it made me think there is something really wonderful here. Now I was a Christian by that time and I knew how Christianity could answer that but it just struck me, that sense of wonder has two possible outcomes. One is science - this universe is wonderful, what's it all about? But of course it is also about religion, the deeper levels of things that science can't really engage. I think one of the things I have discovered over time is that maybe this sense of wonder both opens the gateway to science and to faith, and that those two together are able to answer questions which on their own they simply couldn't.

I think science is wonderful at asking questions. Some of those questions can be answered, but very often when you do answer them they simply open up yet more questions. But of course there are some more fundamental questions I think science simply cannot answer - they transcend its capacities to answer, and you might think of non-empirical questions like, "Why am I here? What is the meaning of life? What is good and how do I live a good life?" These are real questions and they're good questions but they're not scientific questions. And the psychologists tell us that we really need answers to those questions if we are to lead a fulfilled human existence. You find some scientists who say, "Well because science can't answer them there are no answers to be given", but actually most realise that there are answers waiting to be discovered - it's just that science can't deliver them. Science fills in part of a big picture but there are parts of the picture you have to fill in from somewhere else. Science is part of the answer but only part, and faith supplements it, giving us a vision of life that is exciting and reliable and also something that we can inhabit meaningfully.

2.2: Stephen Freeland - Why are you a scientist, and a Christian?

Why I'm a scientist is purely a function of the way that life took me, rather than an active decision. I learned at school that I was academically able. The biggest surprise was getting into Oxford, which was going from a sort of small town - nothing special - to this place that everyone has heard of. And that did transform my world, I think. I think it gave me a lot more self-confidence and for the first time taught me that it was possible to want to be anything. I think that was probably the greatest gift I got as an undergrad, was the confidence - arrogance even - to think that I got to choose my life. And I think it was somewhere during my undergraduate career where it began to occur to me that these lecturers were real people. Some of whom... Well they came from very varied backgrounds, some of which were not so different from mine. And I think I began to, at first secretly and then more openly, wonder if I could possibly ever become one. So by the time I finished undergrad I knew that I wanted to do a PhD, and I just hoped beyond hope that I could become one of these weird things called an academic. And it just unfolded. I see a lot of the grace of God in that. I still don't know how I got to do many of the things that have happened since, but it's been a joy all the way through. So that's the science half.

The Christian half is not so very different. If you were a secular sceptic you'd just look at me and say, well, he was raised a Christian. And I was. Sometimes secular sceptics have said to me, "Well were you just indoctrinated at a young age?" Maybe! All I can really tell you is it works for me, and every year that passes it works for me more. It brings me happiness, it brings me peace, it brings me satisfaction. My faith is that it is a deeper truth than the science that I do. And I think that, particularly as I reach middle-age, I've convinced myself of seeing God transform lives in a way that I haven't seen for politics, or philosophies. And that just confirms in me this deep sense that this is something that works for me. That's the best I can do on why I'm a Christian.

2.3: Stephen Freeland - What is your research, and how does that fit in with your faith?

I'm an evolutionary biologist, fascinated with the process of evolution and its outcomes. Ever since I began my PhD that has been focused on events that occurred very early in the history of life on our planet. In particular life appears extremely diverse to us, from jellyfish to gorillas to oak trees. But you scratch the surface and what is remarkable is how similar all life is. At the chemical level we're doing the same thing as a bacterium, let alone oak trees and mushrooms. That tells an evolutionary biologist that life on our planet made some 'decisions' very early on, which it stuck with ever since. Those 'decisions' fascinate me as outcomes of evolution.

Now the questions of meaning and of purpose that come out of this work really are where my faith begins to interact with my science. This is being deliberately over-simplistic but I think there is a lot of truth in the statement that faith is about meaning if we include in faith rational philosophies, statements about things we cannot know for certain, but statements of belief. Beliefs is where meaning... meaning and belief to me co-exist. Science can tell us a lot about how's and mechanisms and histories, but meaning and purpose - they require us to step beyond science into whatever realm we choose to put our faith in. So that in a nutshell, is where my faith meets my science. My work to me would be relatively meaningless without my faith. I think one of the things which has surprised me growing into a career is that I feel that God has called me to do this career. I remember a point when I was trying to get a PhD and I couldn't, and I was deeply frustrated that the funding situation meant that I'd been turned down again. And it was the time of the Rwanda crisis, and I was like, for goodness sake why am I not literally volunteering to be one of those people driving a truck to Rwanda with supplies? How could God possibly want me to do an evolutionary biology theoretical PhD, which I can't seem to get anyway, when I could be doing something practical for people? But for reasons I don't understand, I think God's purpose for my life was to become a theoretical evolutionary biologist. No sceptic will ever be convinced by that, but that felt like the meaning and purpose in my life. And the only way that I feel it is a meaningful life is because I feel called to it.

2.4: Stephen Freeland - Explains his work on how proteins are formed

Life uses 20 building blocks to make these molecules known as proteins. Now everything is made of protein - you, me, a bacterium - everything is made of proteins. So the fact that there are only 20 building blocks at first sight might seem surprising, but then remember that everything that has been written in this library in the English language has been built of 26 letters. Same, very good analogy. So, the question then is what would be a good set of letters? Whether it's biochemical or English. And in fact at one point when I got stuck with this research I collaborated with some folk in Sweden who are asking similar questions about the alphabet of sounds that we make, and we brainstormed with each other. What makes a good set of building blocks for language? Our hypothesis in the end was that you wanted building blocks that span a broad range in key properties that related to the functions that you might want to build later on. I'll give you a simple example, size. You'd want to span a broad range of size from small to large, but you'd also want to try to space the options equally between the extremes so that at any given moment when you're called upon to find an amino acid of a particular size, you can approximate it, rather than have them all bunched up very big and very small. So a very simple hypothesis, we want them evenly spread across a broad range in properties we know are important to building protein molecules. That was what we tested and we found out that it is very difficult to pick a set of 20 building blocks that are better spread across a broad range in the properties we know are important than the ones that nature is using. In other words, we interpret that as a sign that natural selection picked a set of building blocks that were evenly spread over a broad range, and there is no accident to the building blocks that life is using.

2.5: Stephen Freeland - Explains the deeper scientific meaning of his work, and the questions it raises

The genetic code is clearly very special. It's what we mean by special, and there are multiple ways in which it is special, and probably a lot more that we haven't discovered yet, but right down to this fact that it has curious deep properties that seem to be more or less predictable. Do I think that another origin of life - or if we could magically rewind history and let it play out again - do I think we'd end up with the same code? If I had to guess right now on the evidence we've got I'd say no. We wouldn't end up with the same one. We'd end up with one with similar properties. And that leaves all sorts of unanswered questions.

For me, one of the things that drives me to think astrobiology is both exciting and important, is to allow science to redefine our relationship to the cosmos. There are scientists in the twentieth century who confidently expressed opinions that science told us our relationship to the cosmos was one of meaninglessness. That's very much a late twentieth century point of view, that we are a cosmic accident of no significance. That we are an accident of chemistry - an unlikely accident of chemistry, on one speck amongst countless billions of specks. Without even commenting on how good the science was for that point of view in the late twentieth century, let me say that in the twenty-first century science does not support that view. Questions that range from evolution of the genetic code through to the formation of planets around stars in general are telling us that this universe seems to be very life-friendly. The one example of life that we know has been in this universe for at least one third of the age of the universe. That's interesting. Everything we're learning tells us that there may well be much, much more life out there; that any robust cosmology is going to have to make some sort of statement about life, because life is an inherent part of the universe. We are formed of the most abundant chemical elements in the universe. We formed

so early in the history of this planet that apparently wherever the conditions are right, life is likely to arise - it's not difficult. This to me does redefine our sense of place, but to make that redefinition complete we'll need to go beyond science into whatever else we choose, be it rational philosophy, politics, faith... We're going to have to go there to really make statements of meaning and purpose. I think the science tells me that this universe is very, very intimately associated with life in a way that is consistent with way that I read Genesis.

What do I discover as I explore creation? Just a sense of wonder and surprise. I discover a God who isn't tame, because it's never what I'm expecting. I think I discover a God who is beyond understanding, and that's the God I want. I want a God who is sublime, who is un-understandable, who's wild, beyond a tame God who fits neatly into what I'm expecting. That's what I discover through discovering the natural world. And just being surprised on a consistent level, as much other people's work as my own. I think that truth is God, and God is truth. That science can see a part of that, but there will always be more than science can see. That hopefully makes me humble, not only to things beyond my science, but also to those who are convinced that they're seeing it right, and they're seeing it differently. All I can know is what works for me.



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Curiosity, awe, and the meaning of life



Session 3

1.1: Ruth Bancewicz – Introduction

Every scientist experiences some sense of awe and wonder in their work, whether it's something mathematical, something very beautiful, something very surprising, something that just logically fits together so wonderfully, there's always that sense. And for a Christian there is also something that goes further - their sense of awe and wonder can feed into their worship of God, the great creator who made it all. And from their science there comes knowledge that is useful, there are ethical decisions they have to deal with, but there's something extra, there's something in their work sometimes that reminds them about something to do with the character and purposes of God. We're not talking about proof for God, but it's more something that might resonate with their faith as well as leading them to worship. It might make them think a little bit about the character and purposes of God. So what we're trying to do in this study series is to help you to appreciate the intricacies, the complexities of the science, to celebrate creation and enjoy it, but then also to think about these questions of meaning and purpose that science can raise.

Video 3.1: Alister McGrath - Does the natural world have any value in and of itself (intrinsic value)?

I think one of the questions that many people ask is - whether there's some intrinsic value to the natural world? I think here is an area where Christian theology has some very helpful things to say. Let me just begin to tease these out. One of them is that Christianity gives us this framework, this way of seeing nature, which means that we think of it as God's creation. And of course that has many implications. For example, we can see something of God in the natural world because he made it. But much more importantly, there is this fundamental affirmation that this is not our world, it is God's. If anything, it has been entrusted to us but it has an intrinsic value because it is created and beloved by God. And because we love God, we love what God loves and therefore we have to respect the created order. It's not there in an instrumental capacity, we just use it for our own advantages, we have to value it and trust it, and then hand it on to those who come after us. So if you like, the Christian faith gives us the basis for an environmental ethic for respecting nature, for not exploiting it, for realising we have to live in it but at the same time we have to live within limits rather than simply exploiting it. I think that is a very important point to make.

But there is another point which is this, what will the new creation look like? Now part of the answer to that is that we're not absolutely sure. But one stream of thought which is there right throughout the Christian Bible is that the creation will be re-created. In other words, there will be some continuity between what we know and what will be. And this has led some writers, so for example John Wesley, to talk about questions as to whether there'll be animals in heaven. In other words, is the new Jerusalem the re-creation of nature? And we don't really know. But the key point is, there is some connection between this order and the order that is to come. It is not going to be absolutely destroyed, it will be perfected, it will be restored. And that means I think we respect the created order partly because of what it's going to become in the future. So theology, for me, gives us this framework which screams at us, this is not ours! We can't just do with it as we please. We've got to respect it, we've got to hand it onto those who will come after us, and you know that's something that really needs to be said in today's intellectual environment.

Video 3.2: Margaret Miller - Why are you a scientist, and a Christian?

I would say that both of those aspects of my life at some level are inherited - in the sense that I grew up in a Christian home, and so I had exposure to Christianity and that context for my life from my beginning. And also within my family, experiencing nature and hiking and travelling and being able to see different places and environments was also very important in my early life and in my upbringing. In both cases I think - in the case of faith we may have an inherited faith in terms of family heritage - but as we mature, as we grow, there is a point where that has to be adopted as one's own, as opposed to something that's inherited. So that was a process that I went through as an adolescent. I had a period of time actually where I lived overseas and had the opportunity to worship in a church of a very different culture than I had grown up in, and that was very instrumental in the process of me incorporating Christian faith as my own, as opposed to something that was inherited.

In terms of becoming an ecologist, it's something that I've always intended, and to be not just an ecologist but a field ecologist - somebody who studies nature, out in nature. And I had always wanted to pursue that as my career. When I was going through schooling and applying to graduate school, everyone will tell you that "Of course everybody wants to be a coral reef ecologist, so that's pretty much impossible so you should come up with a more practical plan for what kind of scientist or what kind of ecologist you might be able to be. So I had my backups in stream ecology and some other areas, but I always intended to be a field ecologist, to be able to be in nature and understand nature and to study how nature works. And so that had always been my intention. It's been the blessing of my life that I have indeed been able to have a career - have somebody pay me as my day job - to have the opportunity to experience coral reef systems on a regular basis, and to have that be the focus of my study.

Video 3.3: Margaret Miller - How do you think science and faith fit together?

I would say that for me both realms help me with the other. For much of my life - I am older now - but for much of my life they were quite distinct in my life, and when I was working, nobody really talked about faith and when I was at church nobody really talked about science and I didn't tend to bring it up. As I've gotten a little bit older, maybe, and a little bit more bold, perhaps, I have been able and had opportunities here on the science side, but somewhat in my church as well, to be able to bring some of my science knowledge into that context. And in both cases it's been quite enriching in terms of being able to talk about the two together. I've always conceptualised them as being complementary, but being able to be in a position to discuss that and talk about these types of ideas with others has been very enriching.

Certainly within the type of science that I do, I'm involved in studying nature... studying organisms... ecology is the name that we give the area of science but what that means is studying organisms and how they interact, both with each other - with different types of organisms - but also how they interact with the environment and the non-living world. And so the opportunity to have as my research work the actual attention to and ability to focus on understanding how God's creation interacts and how it relates to itself, and how the needs of each type of organism are met and how that system also supports human needs is - has always intrigued me and made an important demonstration to me of how God provides for us, of how God loves us in providing us the beauty of those systems, but also provides for human needs through the functioning of ecosystems as well.

Video 3.4: Margaret Miller - What do you think we can find out about God from his creation?

Part of the reason I think I am drawn to understand nature - I do see God reflected in his works, in the sense of the amazing beauty that I experience in nature but particularly in coral reefs. I think that many people who don't know anything about coral reefs have an understanding that they're beautiful! And this is certainly something that we understand to be a reflection of the creator. I find also this concept of many different creatures interacting together in complex ways to provide function and to provide mutual sustenance for each other - for the entities within that system and also to humans - I find this a beautiful illustration of God's intent and provision and providence in creating a system that works together, and that functions in a system of mutual sustenance for the members, and for people as well.

Video 3.5: Margaret Miller - What is the value of creation and what does that have to do with us?

I certainly have always had the perception of nature having intrinsic value; of creatures within nature having value and existence in and of themselves. And I think Christian scripture describes God's creation as good, and as each of the different components as God creates them being deemed good. And I think that's indicative of the natural tendency I feel I have to ascribe intrinsic value to creatures in nature. Working with and studying corals can be a discouraging endeavour. The bad news tends to be much more predominant than the good news. Certainly as a Christian I derive hope from the good news, that Christianity offers, that there is a God who cares about us and a God who has created a plan for us as humans to be redeemed, and I think also a plan for all of creation to be redeemed. I think that humans have a role in that - we know that we have responsibility as stewards of creation. We don't do a great job of that, but God has promised... I think the concept we have of partnership with God in that stewardship, and maintenance, of nature gives me hope that it's not just me trying to save the corals, but there is a partnership. And as I said it's participating in, to some extent, God's interest in the maintenance of those ecosystems functioning.

Video 3.6: Margaret Miller - The ethics of 'interfering' in ecosystems

So there are several aspects of my work and research that I guess point to important questions for the appropriateness of different types of actions. As we anticipate corals declining, as we have determined that there's some risk in the future that they may in fact go extinct, we're contemplating 'meddling' in natural ecosystems in ways that we have not done before. Humans over their history have certainly made adjustments in interactions with other types of animals and plants, but it's been in the context of domestication and agriculture, and there's 'meddling' that we've done in biology that way that has helped to serve human purposes. We haven't taken those types of meddling steps in natural ecosystems because natural ecosystem are natural and the intent is to leave them that way - to simply step back and allow them to... with natural resilience those systems have, or the Bible calls it fruitfulness (God created creation to be fruitful) and natural systems should take care of themselves that way.

We're now coming to understand that human impacts in the world may have taken natural systems to a point, and I think some of these coral species are some of our first examples of this, where leaving them alone may no longer be good enough for them to be able to persist in the functions that they are supposed to perform. And so we're contemplating these more profound types of interventions. Even in secular realms, people refer to this as 'playing God', right? In terms that we talk about genetic modification, or maybe not even, but more mild actions such as moving species or organisms from one geography to a totally different geography. These are types of interventions that we perceive - I think even secularly - to be a little bit out of human's proper place, that natural systems should remain natural. And I certainly would have agreed with that.

As I said, I think my professional process of watching so many corals die and coming to the understanding that I think we have passed a threshold where more proactive intervention is needed for these species to be preserved, that's a very humbling and scary prospect. And I guess for me, my understanding that God's intent is for the natural world to persist in its functional form, and that God has an interest and a love of nature performing in the way that he intended, gives me some capacity to walk down that path of using our science to take those steps as wisely as we possibly can... but to take those steps that maybe appear to be necessary to preserve nature in some semblance and to preserve the functions and the services that human depend on from the natural world as well.

Video 3.7: Margaret Miller - What is coral?

Coral is an animal, but it's a special type of animal because it actually incorporates the classical typology of animal, vegetable, mineral. It incorporates all three in that the main part of the coral is an animal, but it has a very special relationship with very small plant cells that actually live inside its body. And so the coral is part plant. That gives it the capacity that plants have, for example, to make their own food from sunlight. And the subsidy that corals receive from carbohydrates, or energy, that they get from the sun via their plant partners enable them to build rock structures. That's what we refer to as coral reefs. The limestone skeleton that the coral builds as it grows is enabled by the plant partnership, but that's the entity that we refer to as a coral reef: the architectural structure that's produced by that mineral phase of the coral - the skeleton that it leaves behind.

Video 3.8: Margaret Miller – How does climate change threaten coral reefs?

Climate change is a significant aspect of threat, and it operates in several dimensions with regard to corals. Corals are particularly sensitive to warming because their optimum temperature, where they're most comfortable and happy, is only one or two degrees away from what we call their 'thermal lethal limit' - the temperature at which they simply die. And so this means as we now have events, periodically, where the temperature in the ocean reaches one to two degrees higher than its normal temperature, we observe corals dying at very high rates. This is an aspect of climate change that we believe is related to the diseases. We observe these disease mortality events happening - this is also becoming more clearly linked with temperature stress as well. So those factors interact.

There's another aspect of climate change. As we change the composition of the atmosphere by adding more carbon dioxide it not only traps heat in the earth, but also a lot of that carbon dioxide is absorbed into the ocean water. This has an added effect of changing the chemistry of the ocean water. And so this is a totally different by-product of our adjustment of the atmosphere that we're coming to understand also has serious consequences for corals, because one of their main functions in terms of creating calcium carbonate... that carbonate is part of the chemistry in the ocean that's being disrupted. The acidity of the ocean is changing with those chemical changes, and we're understanding that that has an effect on the corals ability to grow, and to build that skeleton that forms the coral reefs. In some locations now there are scientific studies that show that there is less new calcium carbonate - less new limestone being created by the corals than is removed by other types of natural processes. So the balance of the limestone is already negative in many coral reef areas, and that's another aspect that we expect to worsen with the carbon dioxide increase in the atmosphere and the ocean.

Video 3.9: Hilary Marlow - Where can we find hope when we find the task of creation care too difficult?

The Old Testament talks a lot about the fracturing of the relationship between people and the natural world, between people and God, and that is very often the picture that is portrayed, but it's not a completely hopeless picture. There are some parts which talk about the restoral or the renewal of the created world that has been left desolate and mourning as a result of human activity, and those are great passages of hope that point to a future where not just human suffering ceases, but also the land - the dry land, the barren land, rejoices. Isaiah 35 is an example which talks about the wilderness rejoicing, and the desert blossoming because God comes back and visits the land.

So in the book of revelation when it talks about our future hope, the future of this world, it doesn't talk about us being transported away from this broken world up into heaven. It talks actually about a new heavens and a new earth coming down, and the sense of the Greek word for 'new' there is not something completely brand new that has never existed before, but of renewal of what is. And so there's a sense there that God is going to somehow renew this broken world, both the natural world and human society, and make it a place that is perfectly fit to be inhabited. But it's a world that includes the natural world, it doesn't separate us from it, and that to me as someone who absolutely loves nature, is really important. I would hate the thought of not having nature in the world to come. So that gives us great hope for the future. That's what the theologian Richard Bauckham calls our 'ultimate hope', that one day God is going to right all the wrongs - both ecological and social, and spiritual - of our world, and that's something that we look forward to. It's not something that we cannot ourselves do anything to hasten. We watch and pray, as the scripture says, but it's something that gives us hope in times of darkness and sorrow.

But there is another kind of hope that the Bible speaks quite a lot about, and I think this touches on the question "so what now?" So what about us, what can we do, and that's something that Richard Bauckham calls proximate hope. It's about how we can, in the power of the Holy Spirit, bring or help to bring into being some of God's

purposes for his world. For a Christian who's concerned about things like environmental issues, it's about asking "So what do we do now? And does it matter if we do anything?" Another way of thinking about that is to think about the concept of the kingdom of God on earth. When we pray "Your kingdom come, your will be done", we say "on earth" - and how does that happen? Well God doesn't just wave a magic wand and it happens. He actually asks individual Christians and groups of Christians to be his spokespeople - to be his hands and his feet in this world. Bringing the kingdom of God on earth is actually something that we are all tasked to do as Christians in our own ways, and that's something that can extend to the way we view the natural world, the way that we look after it, the way that we give it a sense of hope, the way that we can help creation - all creation - to flourish, and to fulfil its God-given potential to worship God on earth.

