Slide 1 - My name is Nick Harvey, and this is the first of three lectures that are looking at conservation and how we protect the natural world and the reasons why we need to be protected and natural world.

So I'll introduce myself in a minute, but in this first one we're just going to have a very quick introduction to global environmental change, so what changes are humans are causing for the natural world, why is that important and what knock on effects is that having for species and ecosystems and why is that important.

Slide 2 - So just first a little bit about me so like I said, my name is Nick I've actually just submitted my PhD which was looking at the conservation of the eastern black rhino in Kenya. And as part of this, I went out to do field work in Kenya I tracked black rhinos and I carried up doing something so I picked up fecal samples. Which is allowing us to study the gut health of these animals so we're looking at their diet, as well as the bacteria and the nematodes that living their guts and we're comparing this to their habitats and we're hoping to get some idea of what type of habitats, promote healthy diets and guts for these animals. So, as I said, i've just finished just finished my fourth year of just submitted my PhD waiting for my waiting for my oral exam in a couple of months. And so, this has given me a lot of time to think about conservation about the issues surrounding it, and hopefully I can give you a bit of an introduction to some of that in this lecture and the two coming up in this course.

Slide 3 - So the learning objectives for this lecture are to understand spatial and temporal patterns of anthropogenic impacts on climate and land use so we'll talk a bit a bit more about this in a second. But it's just to have a look at how humans have impacted the world over time and how this varies over time and over space. A biome is an area of land that contains a broadly similar habitat type so one type of biome is a tropical tropical rainforest for us in northern Europe it's temperate forests temperate grasslands things like that and then Arctic tundra is another type of by him so because these the impact that humans have on the natural world varies across space, and it means that there are different impacts on these different items around the world. And we're then going to link this the anthropogenic land use change, so the conversion of land for human uses, and we're going to link that to protected areas and the bias in the types of land that they cover. Protected areas are one of the main ways that humans used to try and conserve the natural world to conduct conservation. We mark an area of land and we only use it for particular things. which is designed to try and let other species thrive and to try and conserve the biodiversity that is contained within those areas. But the way we do this it hasn't been completely methodical and systematic and it competes with other land use it so we're going have a think about how human, economic interest conflict with conservation and, last of all we're going to look at a case study from South Africa.

Slide 4 - The first thing we're going to have a look at is extinction records, so an extinction is, when all individuals of a species die so that species disappears from the globe, and this is one of the fundamental processes of life on Earth. It's been it's been happening since life evolved and, as you can see here. This only goes back to up 1500 but before that, before humans were having impacts on the natural world extinction was a natural process, and that was happening, as you can see here with the background rate of extinction. So, as long as different species have been evolving some of those species having an extinct, so this isn't an unnatural process. However, as humans have

increased their population size as they've taken more resources from the world as they've converted land for their and uses and other impacts it's caused species to go extinct at a greater and greater rates. As we can see here so starting around sort of 1700 for mammals and a bit later for some of the other vertebrates and even earlier for birds. Humans starts to cause lots of these extinctions, which is why we see these rates going up very quickly, which, on the y axis here is the cumulative extinctions as a percentage of IUCN evaluated species, so the IUCN evaluate the species is a species that has had its numbers and trends of populations assessed by the International Union for conservation nature, which is the IUCN here. So these just species that we have data for and as you can see we've had this great acceleration in a number of species going extinct. Which is almost completely due to human actions so human actions on the natural world are causing these species to go extinct, and this is kind of the fundamental thing that conservation is trying to protect against. If you ask different people they will give you a different answer but arguably the main driver of conservation, the fundamental thing we're trying to avoid is extinctions of species.

Slide 5 - And, as I said it very starts, one of the primary ways that conservation has of trying to avoid this is to create protected areas. And so, these take many different forms in a different parts of the world but basically, what it means is we mark an area of land and we restrict what can take place in the area, so in some places we completely restrict any human activity whatsoever, other than kind of visitation and tourism and things like that. And we do that, for the purposes of trying to protect the species, the ecosystems, the processes that the natural processes that take place in that area. In other places it's a bit more of a mix, so we don't completely ban all activities, but we restrict certain ones to try and balance human interests and the interests of the natural world. And as you can see from these graphs we've done a pretty good job at this we've managed to if we're just looking kind of the area of land and see that we're protecting. And the amount of land we're protecting has increased very quickly, since kind of the middle of the 20th century, and there are certain targets for this. And we I think we're on track now to meet some of the targets that were set out in an international treaty, which is to try and protect I think it's 17.5 percent of the global land area and a bit less for the marine area and so we're probably on track to meet those targets. However, kind of just setting targets in terms of area protected isn't guaranteeing that we're meeting our goals, because even though the protected areas state has grown massively. As we saw on the previous slide species is still going extinct at much faster rate than they would be if humans weren't impact of the natural world. So the question is we, we seem to meeting some of our targets in in protecting kind of protecting parts of the planets in terms of area, we aren't meeting our targets in terms of preventing extinction. So why is that happening, why is there a mismatch there why, why are we meeting some targets but it's not translating into prevention of extinction.

Slide 6 - And the main reason is despite the fact that we are protecting large areas of the world, our activities are still altering the natural world. There are other reasons why the protected area state isn't as useful as it potentially could be it isn't doing its job as effectively as it could be, and which we'll get into that later in the lecture.

Slide 7 - But for now we're just going to have a think about what human activities that are what the human actually these are that are also in the natural world and are driving these extinctions. So this is from a paper that tried to estimate the relative effects of different drivers of extinction with along the X axis here, so we have we have land use change, climate change and nitrogen deposition, which is mainly from the runoff from fertilizers used in farming. We have biotic exchange, which is the movement of species around the world mediated by humans, so this is, you may also call her termed as invasive species, so these animals and plants that get moved from their native ranges to other areas of the world on boats and in other ways. And because they move into a system that where the

species that are adapted to cope with them certain species, when this happens, can cause extinctions. An example of this is on Guam which is a US territory. So Guam is a US territory in the Pacific, a brown tree snake was introduced there, and there were lots of bird species, including some flightless bird species that had lost the ability to fly over evolutionary time and because those birds were adapted to be able to deal with a predator, like the brown tree snake. That snake drove extinction of lots of these bird species by eating adults juveniles and eggs. So that's one of the reasons why these invasive species can lead to extinctions. And then, climate change and increasing atmospheric CO are here separately, because whilst increasing atmospheric CO is one of the main drivers of climate change, and it also has other impacts on the natural world, including ocean acidification and which makes it more difficult for corals and other species that deposit calcium carbonate as part of their exoskeleton and shells and other things that that makes it more difficult to do that, and it also has impact other impacts in the natural world so that's why it's here twice.

Today we're going to focus on the two most important ones, which are land use change and climate change.

Slide 8 – There are two maps here, one that shows the potential vegetation types, that would be present all around the world, in the absence of human impacts, and so the is broadly aligned with the biome that I talked about at the start of the lecture. So, as you can see, on the right here, there are different types of biases tropical woodland there's temperate woodland, boreal woodland, which is up in the in the very far north and then we have different types of grassland so savannah, shrubland and things like that. So these are the biomes or the potential vegetation types, that would be present if humans have had an impact on the natural world. And this research, what they did is they compared that those potential booms with the anthomes, which is a term that they use that we actually see in the present day, so what these anthomes are these are the realized the types of land cover that we get due to human actions. So, instead of just having kind of the forests and grasslands, that we would see in the absence of human impacts, we have things such as a dense settlements, which is cities, and then we have villages, so we actually have the kind of the areas that humans have built and live on. But relative to other human impacts these actually take up quite a small land area so whilst we might think of land change and land use changes as building roads and building cities it's not those things that actually have the biggest impact in terms of land area, the things that do are the conversion of land for farming. So we have large the yellow here as large areas that have been converted to cropland and you can see those thing the biggest impact of those is in Eastern Europe kind of the steps of Western Asia, North America and southern Australia. But even larger than those again are the rangelands So these are areas of the world that are used to raise livestock and often use for this, because it's too dry to grow crops and then we also have the semi natural land cover, which are places that have been altered to a certain extent by humans, but not completely changed. And then we have the wild lands, which tend to occur in places that aren't that useful for farming, and so the far north, where it's very cold ,in the desert and there are some areas the left of the deep tropical rainforest, so some parts of Central Africa and Southeast Asia, which should be tropical forests in the absence of human impacts. There are still some parts of those wild areas left in those tropical rainforests. And so, as we can see the conversion of land to for human interest very spatially.

And we talked to the start of the lecture about how there's a spatial variation in human alteration, the natural world. And one of the reasons for this is that, as I just said, different places have different value for human and human, economic activities. The places that are very suitable for growing crops, most of those have already been converted to do that because growing crops is so economically valuable for humans, but also valuable for ongoing human life, because we need to

grow our own food to sustain the global population of people. And then if the land isn't suitable for growing crops and then we can use it for rangelands we can use it to graze our livestock. And it is only the areas that are either very unsuitable for agriculture or very difficult to access to those deepest parts of the tropical rainforests and that haven't been converted for human uses.

Slide 9 - And so, why is this spatial variation important? Before we get on to that this is just a quick look at land use change that occurs in Southeast Asia. So green areas are places that haven't been converted to a great extent yellow areas that have been converted to some extent, and then red areas have been very heavily converted by humans. And as we can see in Myanmar the central part of the country sort of a strip running north or south. has been quite heavily converted, and that is where the agriculture is concentrated in the country and then around the edges and there has been less conversion partly because it is less accessible, there's less infrastructure and things like that, and so that's just an idea of how land use changes occurred in in Southeast Asia.

Slide 10 - But why is the spatial variation important? So as we can see here this diagram shows how from 1700 to 2000 how much the land cover has changed depending on the biome depending on the potential vegetation type. And the amount that has been changed massively varies depending on which, by and we're looking at so most anthropogenic transformation has occurred in tropical and temperate deciduous forests and grassland troubles. So if we look towards the left hand side of these vertical bars these are the ones where natural and semi natural lands, so the light green and dark green and have been displaced by the other colors which is either agricultural land or settlements. So, especially the temperate deciduous forests, we can see that over half of temperate deciduous forests, which is the fourth from the left has been converted to human line uses and that's, also the case for some of the other ones like the tropical forests. But on the right, we have open shrubland and grassland steppe. Less of those areas has been converted to settlements and cropland but there's huge areas of those that are now given over to range plans so given over to the raising livestock. But other areas, so, especially if you look at the boreal forest, which is the fifth on the left there, we can see that only a little bit of a Boreal forests have been converted to agriculture and human land uses and a lot of those still remains either semi natural and over half as wildland. So there's the spatial variation in human land use conversion and why is that important? Well each of these different booms has a different has contains different ecosystems and different species that are adapted to that particular habitat. And so, by converting large areas of the temporal temperate deciduous forests, for example, we are making the space available and the habitats that are available for the species that live in those areas, making much less space available for those. So it's more likely that we've been affecting those species more than, say species in the Boreal forests we're just looking at land use change here so Boreal species might be more vulnerable to other human impacts, such as climate change, which we'll talk about soon. But when we look at this this spatial variation means that just by kind of thinking basic level here that temperate deciduous species and also tropical deciduous species will be very vulnerable to extinction potentially because we've had a very large impact on their habitat. So, so we might need to in conservation like to think very carefully about how we protect what's left right temporary deciduous forests and maybe how we can possibly restore them in the future, because it might be those species that are very vulnerable now to extinction. And the other thing to think about is how this interacts with the diversity we see in different biomes. Tropical rainforests, are the most species rich biomes on the planet and so by converting large areas of those forests we're putting large numbers of species at risk because they contain a very high abundance and diversity of species.

Slide 11 - Okay we've had a bit of think about land use change the next thing to think about is climate change and which is the, as we saw earlier on it's the second most important driver of threats or natural world and extinctions that we see. And so, this is just some graphs I've taken from a US report on climate science, so we can see that lots of different measures of climate change indicate that temperatures are increasing around the world. At the top we have land surface temperature, we have sea surface temperature and then we have sea level. Sea level rises are caused by melting ice and also by thermal expansion so as water gets warmer the molecules that make up get slightly further apart, and so we, we have a kind of a double driver of sea level increases around the world.

Slide 12 - As well as those we have all these other impacts of climate change, as well as just temperature. So we also have humidity which seems to be increasing and then measures of snow and ice cover are decreasing so northern hemisphere snow cover, Arctic Sea ice and the amount of glacier mass is declining rapidly even over the 50 or so years that we have data available for.

So, climate change is having all these impacts in the natural world and there's now incontrovertible evidence that it is not only taking place but it's being driven by a human.

Slide 13 - Oh, this is just a quick video to have to show how temperatures have been changing. And so what this video shows is just how temperatures have been increasing over the past hundred years or so. So each of the different bars represents temperatures taken a different country and the scale here which goes around the chart starts at 0 degrees So these are thermal anomalies, it takes around 1900 of baseline and it shows on average, how the temperature is either higher or lower than that so that anomaly. As you can see, as we go forward in time and these bars get taller and they get redder, which means that the thermal anomalies get greater. So, on average temperatures are rising around the world.

Slide 14 - And this shows some projections about how that's going to change into the future.Each of the different colours here just represents a slightly different scenario into the future, so on the left, we have the A1fi one, which shows a fossil fuel intensive future and that, broadly is the same as the RCP 8.5. RCP stands for representative concentration pathways. And that's the one on the left is the one that this US organization uses and the one the right is the one that the IPCC, the International Panel on Climate Change, is the one that they use so it's just different scenarios of how climates going to change in the future, depending on the actions that humans take so whether or not we just keep burning fossil fuels at the same rate which we do now, which is the A1Fi one or RCP8.5.

Whether or not we reduce our our fossil fuel use a bit, which is the middle ones, or if we take all the actions required to try and keep global warming at around 1.5 degrees, which is the commitment that was made at a Paris agreement back in 2016. So, but this just shows the kind of projections of how temperature change is going to take place in the future in degrees Fahrenheit.

So, as we can see, unless we take drastic action very soon temperature going to continue to rise, into the future and continue to have greater and greater impacts, both on humans, but also on the natural world.

Slide 15 - But not only is temperature increasing it's also a spatially variable in how it is increasing. So this is similar to what we think about land use change about how land use change is more severe in some biomes than others. So land use change is more severe in the temperate woodlands, and the tropical woodlands than in other areas. The amount that the temperature is going to change around the world is especially variable. So, as you can see, it seems like most change will happen in the

Continental areas, so in Central Asia in South America and North America, and so this is important because it's going to affect different biomes differently.

Slide 16 - However, it's not just the variation in the actual temperature change that's important. Also very, very important is how sensitive different biomes and different species are to this temperature change. So it may be that some species are 'winners' in climate change, because their potential habitat will expand. So obviously as a general rule on Planet Earth its hottest around the equator and then it gets colder towards the poles. So if you can imagine, as it warms though the kind of the lines that go around the world that show a roughly even temperature will move towards the poles as the temperature gets warmer. And so it may be that Equatorial species, all those adapted to very warm biomes and maybe that their potential habitat increases. However, the polar regions and species that are adapted to those places that are very cold, they may lose potential habitat, as well as those that are at high altitudes. And so, if we think about high altitude species, and as you go up and in altitude, the climate generally gets colder. And so, instead of the habitats and the temperatures moving towards the polls in this case they're moving up in altitude. So those species that are already at the top of mountains or very high areas such as this dwarf willow that we get in Scotland and they have nowhere else to go they can't go further up. Therefore, if climate change continues and they're not going be able to move any further up or potentially in polar regions any further north so those kind of species, like this one here may completely lose their habitats. While some species may be winners potentially there's going to be lots and lots of losers that that we may not only decrease the area, they can have it, that may lose their habitat completely.

Slide 17 and 18 - And i'm going to bring it back to protected areas. Humans are doing lots of things to try and tackle this and one of the primary ways of doing this, as I said, is protected areas. And even though we're we're creating a lot of protected areas we're protecting a lot of land we're still seeing those extinctions and so why is that happening why our climate change and land use change still driving extinctions even though we're protecting these areas. And so one of the reasons is that land use change and climate change, continue to happen so even if you know if even if we protect an area the protection. How well that prevents extinctions is very much dependent on how strict that protection is or how well it works, so if we protected area, even if land use change continues to happen within the area then extinctions will still continue. Protected area creation doesn't really directly tackle climate change. Whilst it might make species and ecosystems more resilient to climate change, because they're better protected from other human impacts if climate change continues and species within that particular area are vulnerable to climate change, and they will continue to go extinct. And so, protected areas aren't necessarily directly stopping the impacts of land use change and climate change, but, as well as that is the protected area estate is not as well designed as it could be. There are their flaws in it, that means that it's not protecting places as effectively as it should. One of the reasons for this is the bias in the location of our protected areas. And so, as I talked about earlier when we create a protected area, it is likely to prevent certain economic activities happening in that area, so conservation as a land use, creation of protected areas conflicts with other human interests. And unfortunately often it's conservation and Protected Area placement that loses out when it comes into contact when it comes into conflict with other human, economic interests, such as farming. And the result of this is a lot of our protected areas are placed in areas that are not particularly valuable for farming or other economic activities. So, as we saw with the map of the anthomes I saw earlier in the lecture which I will just bring up now, and the places that haven't been converted on Planet Earth, and are still classed as wild are deserts, polar areas that aren't very useful for farming and also places that are very inaccessible so there's very deep tropical forests. What that means is that, when we place a protected area, it tends to be in those kind of places. Here we see all the red countries on here and there's a positive correlation

between the characteristics which we'll talk about in a second and Protected Area placement. So it tends to be that are protected areas occur in high places so places of high altitude, very steeply sloped places because those kind of places aren't particularly valuable for farming so it's harder to farm high altitude areas that are on steep slopes. They also tend to be far from urban centers and far from roads. So again, those deep tropical forests they're very inaccessible they're difficult to convert to for economic activities because they don't have the infrastructure to set those things up and so protected areas, not only are they on places that are difficult to farm, there are also places that are far away from population centers or infrastructure. It may be that a lot of the places where we have these protected areas are valuable for conservation, but there's no guarantee, so if we're mainly basing our placement of protected areas on the areas that aren't very useful for humans we're going to be missing large parts of the biodiversity of our globe. Because we're not systematically trying to protect it and instead we're kind of doing it in a way it's convenient for us so it may be that we're not doing in the most effective way possible, we might not only be missing certain species, but we might be missing very important biomes. So in the UK, lowland areas next two rivers are very useful for farming because they're well irrigated and they're very useful for growing crops, so if we only place protected areas in high places far from river basins we're going to miss all the diversity that is adapted to those lowlands and river basins. And so, therefore, our protected areas won't be working for the diversity as a whole, of the UK that only be protecting certain parts of it.

Slide 19 - And it also means that lots of species, as I was talking about don't exist within these protected areas, and so a gap species is a species that none of it right, none of its range occurs within a formerly protected area, a partial gap species is a species were a portion of its range does not fall within a formerly protected areas and large portions of our are endangered species, so those species that are threatened with extinction. And as, according to the IUCN our class as gap species or partial gap species So by creating the protected area estate largely according to lessening the conflict with other human, economic interests were missing large parts of diversity of Planet Earth.

Slide 20 and 21 - And not only is the actual the practice of conservation as here, represented by a protected area placements known as that bias, so is that the actual geographical standpoint of research. And so the pie chart to the top here, show the difference between global and use, and so we have blue protected areas, we have read for agriculture, green condensed settlements and purple for others. So that's the kind of an estimate of the global extended these land uses, but on the right is the number of observed sites so kind of research places, and so, whether or not that's a field station or a field site, or something like that it shows the how it's very different to the places where those research centres are is very different to the actual representative global and to us so we're tending to study protected areas, much more intensely in comparison to the amount of land on earth is actually protected. And we're doing much less research in urban centers, on agricultural land and these other places. So, even though those three land use types make up probably around 85% of the global land use. They make up probably around a third of our of our research into the natural world, so we don't understand the kind of the nature that exists in these spaces, particularly well, even though they make up the vast majority of the global land cover. So we're probably getting a biased idea of what how nature functions in the modern world, because much of that nature doesn't actually exist in protected areas which we're studying quite intensely exists in unprotected areas, so you may be getting a biased view of what the nature of the earth today actually looks like and how it functions.

So we're not only biased by land use type roles are biased by geography so she can see the number of research sites that we have are very densely clustered in North America and Europe and then something that you're still quite high density is in New Zealand and Australia and other places. There

are large parts of the world where there are very few research sites, so we have kind of that are very few in Central Africa, there were very few in the Middle East and southern Asia, very few across much of Russia and central Australia so there's large parts of the world here that we're probably not studying particularly effectively so whilst we might understand the nature of North America and Europe very, very well, there are large parts of the world where we probably don't understand it, that well and we've so not only do we have a conservation, do we have a bias in the practice of the field, we also have a bias in the in the research of the field and the theory that it's based on.

Slide 22 , 23 and 24- So we've had to look at what's driving extinctions in the modern world we're having we've had a look at why. Even though we're trying to protect against that using protected areas and other mechanisms and why those aren't functioning as well as they could be because they conflict with other human interests and so as humans have tended to prioritize those other economic activities were biasing not only the practice of conservation, but also our understanding of the natural world. Conservation isn't keeping pace with those other interests so whilst we are starting to understand what is causing the degradation of the natural world and how to protect against it. We still don't have a complete understanding of how that's occurring, and what we're actually trying to protect and when we do try and protect it we're doing it a biased way that sort of undermines those conservation activities. So we're going to have a quick look at case study, now that exemplifies some of the things I talked about. So we're going to look at the Cape Floristic region, which is a part of South Africa that contains a huge diversity of plant species that exist nowhere else in the world they're endemic to this area exist here, but nowhere else. And this means that this area is very important for conservation, because if we lose these plant species, here we lose them globally and they won't be present anywhere on earth. This is a map of the Cape floristic region. At the top here we can see how the placement of protected areas around this region, so the dark blue places are statutory reserves so legally protected reserves and the light ones are our reserves that don't have as strong legal protection. And as we can see, they tend to be clustered around these upland areas which are the yellow areas here so as we talked about before, protected areas tend to occur in high end far places so high altitude and far from urban centres. And these protected areas in this region are again clustered in these up and areas that are particularly useful for agriculture or farming. We do have some and lowland areas, especially around the coast and but they're tending to protect these up and regions, and what this means is that we're missing large parts of these habitat units or we're missing some of these habitat units aren't being protected very well at all, so if we look at these kind of bluish purple regions on the bottom map, on the coast and lowland areas, we get an interesting region and we are not protecting much of those places at all, really, we tend to have protected areas are clustered around the edge of it. But if this coastal renosterveld region habitat type is very useful for agriculture for farming it's very productive it may be that that as clashed with the desire to protect these places, and so they're not being protected they've been transformed. So if we compare the that those purple areas to the Gray areas on the top map they've been transformed much of those purple areas have been transformed, and that means that we may be losing a lot of the species in those places and threatening them with extinction, because their habitat is getting smaller and smaller. So this is just a kind of a real world example of how our bias in protected area placement is having real world impacts for particular habitat types.

Slide 25 - And we can see that here. Where some of these different habitat types have been protected and transformed to much greater much different extent. And so, if we look at this XST on the far left is grass, this is xeric succulent ticket. And a lot of this has not been transformed, which is the kinds of dark coloration on this graph however it's not really protected and so whilst a lot of it hasn't been transformed it may be vulnerable to future trans transformation, because it hasn't been properly protected. And then, if we look at MC which is montane fynbox, so this is one of those high

altitude places and a lot of that over I think over % has been protected in statutory and non statutory reserves. So here we can see that these high altitude areas are being protected and potentially because they're not particularly useful for farming. However, if we look at that coastal renosterveld, which was that kind of bluish purple color at the bottom here the bottom map, almost all of that so around 85% of that have that type has been converted or transformed it is restorable, but it has been transformed so we're losing a lot of these low altitude habitat types in in this area of South Africa, and if we think back to what I was saying about endemic species, if there are particular plant species and animal species that are adapted to this habitat type and they're endemic to that habitat type of this area, so they only exist in that small area of this small area of this country. It may be that they'll go extinct everywhere, if we continue to transform these lowland coastal regions.

And these are photos of what each of these habitat types looks like. And importantly I know we talked about kind of mostly plant species here because that's what this cape floristic region is named after. But the coastal renosterveld is also prime habitat for the cape mountain zebra which will actually talk about in my next lecture. So they like this habitat type because it's very grassy and it's got good nutritional dietary resources for this species, however, because we've converted, a lot of it, it may be that we're threatening this species with extinction because we're getting rid of their preferred habitat type.

Slide 26 - And to kind of make things more complicated again we are we not only have to plan for conservation, now we have to plan for of conservation in the future so land use changes is kind of the biggest driver of extinction that we face today and so we're trying to protect these areas to tackle to tackle that to try and prevent land being transformed to agriculture and other economic uses, however, when this paired with climate change, it becomes more difficult because as climate changes. Species ranges and habitat types will shift into the future. As we can see here we have a kind of a prediction of the where different biomes in South Africa will exist in the future. And we can see that a lot of it is going to become undefined so we're not sure what's going to happen to it, but also this the Cape floristic region, which is the red area on the top map, and it is going to shift, like some of its going to appear bit further east, and it is now so if it's going to be converted to this succulent karoo which a different habitat type. And so, how do we plan protected areas for the future, this is a prediction, so this isn't definitely going to happen it's just our best guess. And so, if we see put a protected area right down on the coast to try and protect our fynbos at the moment and that becomes succulent karoo in the future, that protected area still has value because it's protecting something but it's not protecting the habitat type that we designed it for. So, whilst we can try and predict how this is going to change in the future, we can definitely say how it's going to change. So it adds another layer of complexity, to our planning and one of the ways around this is to try and not just create small, isolated protected areas, so if we fence off scenario and say, well, that nature can have that bit, those fences may prevent the migration of species in and out of that area may prevent dispersal so the species, there are a bit trapped. Especially if that is then surrounded by inhospitable farmland or a different land use type that those species can't exist there due to climate change, that causes that habitat type to change it becomes drier, say, for example. That habitat may become unsuitable for the species that were in it, and that the reserve is designed for, but because they can't migrate out of it, they can't then move to find more suitable habitat so it's likely that they'll just decline to extinction. So one of the ways around this is to try and design our conservation programs and our Protected Area networks with a much greater connectivity, so that the species that we are protecting can migrate and move much more easily than they could, and if we would just setting up small, isolated protected areas, but we'll talk about more of that in future lectures.

Slide 27 - So this is a quick summary so Protected Area extent is increasing, but extinction rates also continue to increase extinction rates also continue to increase, and this is largely due to anthropogenic impacts and the two most important of which are land use change and climate change. However, one of the reasons for the fact that that extinctions continue to increase, even though we have protected large parts of the world it's not only that we probably haven't protected enough to prevent these distinctions, but also that area based targets aren't enough for assessing how effective conservation is. The fact that we're biasing both are protected area placement and our research means that we're probably missing large parts of our biomes that are important for particular species because those species are adapted that particular habitat characteristics, we find there and by biasing our reserve placement we have these gaps species, and we also have missing large habitat types so that's why extinction continues to happen, even though we are protecting large parts of the planet. And so, along with this recorded lecture i'm going to put up an activity looking at Myanmar. So i've got a few different maps that look at which areas of Myanmar are currently protected, as well as human land use and also vegetation types. So have a look at the protected areas that currently exist, and what vegetation types and what ecosystems, they are protecting and have a think about why they might have been place where they are, and once you've done that i'd like you to design a new protected area or choose a place to create at least one protected area, but perhaps three or four. And I would like you to justify why you decided to put those protected areas in those places. Are there particular vegetation types, that the current Protected Area Network is missing? Are there particular habitat types that are very important for particular species or particular offer human benefits? For example, mangrove forests, which we have on the coast in Myanmar are very important for preventing coastal erosion and protecting against tsunamis and other things like that, so are there, particular places you'd like to place protected areas for human benefits as well as benefits or natural world? Would you like to place a protected area, you know vegetation part that has been very heavily transformed by humans in Myanmar so you'd like to protect what little we have left? Or would you like to place it in a scenario that has been transformed and you'd like to restore that the ecosystem that was in that place? When you're doing this, I would also want you to consider the conflict would arise from your protected area with the economic interests and the human one uses that we see in Myanmar. So, as we said earlier on the lecture the central, the country has been quite heavily transformed relative to the other places. For agriculture, if you place the protected area there, it might be very expensive to maintain because you're going to have to justify why you want to prevent farming to prevent farming occurring in that area where it's where it's very valuable for agriculture. So, have a think about all these different things and come up with the placement of a few protected areas that you would like to see in Myanmar and justify why you've placed and where you have.