Slide 1

Hi everyone and welcome to the second to last lecture in the series that i'm giving on conservation. So, in the last lecture we look at a species focus conservation and how you would go about carrying out conservation that focuses on a particular species. So how you would look at their abundance, how you would model their extinction risk and what interventions, you would put into place to try and protect that species. This week we're going to have a look at another very important aspect of conservation another very important way that we do conservation, because in the second three lectures so, four, five and six of my series we're looking at how conservation is done rather than why it's done.

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So what we're looking at today is conservation inside protected areas. Protected areas are one of the cornerstones of how conservation is carried out and how we protect the natural world. So the global area of protected areas, so the amount of land and see that has been protected. And in a national park or a wildlife reserve, or any of those other types of protected area that we get. And i'll talk a little bit more about the types of protected area in a second. It's grown massively over the 20th century and into the 21st century. So, as you can see here the green line is the size of the terrestrial Protected Area state, so the number of protected areas, we have at the top and the area in kilometers squared that we're protecting and the blue line is the number of marine reserves. So you can see that we're protecting more land than sea at the moment, which is something to consider when we think about how much more see there is then land on the planet. So we've been much more much faster off the mark protecting land. And also something to note is that there are a much fewer marine protected areas, but generally a marine protected area tend to be much bigger, which is why there aren't very many of them, but they do protect quite large area.

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So, even though we've been protecting lots of places using these protected areas. And we're still getting lots of extinctions and lots of biodiversity declines, so why is this still happening, even though we're moving towards our targets of the amount of land that we're trying to protect around the world. And so one of the reasons behind this is that we might be protecting areas that aren't ideal for biodiversity, they don't have the highest amounts of diversity, so this research looked at the placement of protected areas and where they are in relation to different factors, including altitude how steep the slope they are on, distance to urban areas and those kind of things. So these graphs are a little bit confusing, but on the X axis, you have the different factors that we were looking at so slope, elevation, distance, urban area. On the y axis there's this proportional difference doesn't really matter too much how that's been calculated and basically below zero means that we are protecting relatively few of those places and above zero, above the dotted lines were protecting relatively more of that kind of place. So we look at elevation the line is very, very low at areas of low elevation so between sea level like note meters and around just blow thousand meters were protecting much less of those places than we are higher elevation so two or 3000 meters were protecting much more of those. We are protecting fewer areas that are close to urban areas and we're protecting fewer areas that are on flat land so we're protecting more sloped places. So what they suggest to us is that we tend to protect places that are high, far from urban centers and also steep.

And we're probably doing this, because these are places that aren't particularly valuable for farming and other economic activities, so these places have a lower opportunity costs, which is what we

talked about in one of the other lectures. And so the opportunity cost again is just the potential profit, the potential income that you're missing out on by not farming or converting a particular area for an economic activity. So these high steep places have less value for farming so that's tend to be the place where we've set up protected areas, so these places might not protect very high amounts of diversity, compared to places that are lower and flatter.

So are protected area estate is biased towards these places which may be why we're still seeing extinctions because we're not capturing all the diversity around the world in our protected areas.

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So protected areas there's a whole range of different types, this is the categories that are set out by the IUCN by the International Union for the conservation of nature, no different categories depending on and different names of these places, depending on what they do and what they're aimed towards doing. So just as an example, we talked a little bit about wilderness in previous lectures, so a category one be IUCN protected area is a wilderness area, which is a place that tends to have little human influence. And where we put a protected area there to try and preserve that area, with little human influence for future generations, not just for the biodiversity, but for human recreational opportunities as well, so they can experience some solitude. A slightly different one here is a wildlife sanctuary which is set up to protect particular species. And in those places we can carry out some of the intensive interventions that we talked about in lecture four. So we can manage particular species to prevent them going extinct, and those are tend to be species that we think are important. And then there are some quirks some kind of differences between countries with these schemes, so the National Park here is a a representative example large enough to contain and tire relatively unmodified ecosystems. So these other kind of national parks, that you would get in the USA. So yellowstone National Park that we've been talking about with the wolves that is quite a large Protected Area with little human influence and that is quite close to being a self sustaining ecosystem. However, in the UK, our national parks are actually category five. Because a lot of people living in them, there are a lot of economic activities, including farming so whilst we value them for the landscape and they also do contain biodiversity they aren't a category two national park here they're actually a category five, which is a protected landscape. So they all aim to preserve biodiversity in some way and that they do so in different ways and different categories permits different activities to take place.

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So if we're going to design a protected area what's the most effective way of doing that for to protect biodiversity. So this ties into some of the things we talked about last week with the modeling of populations, so we want to Ideally, we want to set up an area that contains viable populations of the species within it that can be self sustaining they don't require human input to prevent them going extinct, and they also exist in a functioning ecosystem. So we've talked about ecosystem function, so that ecosystem can sustain itself into the future. Other considerations include the impact of humans and the provision of ecosystem services, so what benefits are humans going to get from these protected areas. Do we need to set up a protected area in an upland forest, so that the people down in the valley continue to get the benefits the services of water purification and some of those things that we talked about in the payments for ecosystem services schemes?

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So the basis of protected area design is biogeography which we've mentioned a few times now, which is the distribution of organisms and genetic diversity across the surface of the earth.

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And specifically the type of biogeography we think about in protected area design is island biogeography. So in this context, we are thinking of protected areas as islands of habitat in a sea of human altered landscapes. And so we can use the theories of island biogeography to explain the species richness and the ecosystem characteristics of these islands are protected area in this sea of unsuitable habitat. This theory was designed to explain this species richness of actual islands in actual ocean, but we can apply the concepts from this to protected area design. And when we're doing this we're looking at processes of immigration colonization and migration, so how animals are moving around how they get to these islands, whether or not they're made extinct from them, can they move to and from them.

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So this came from a book that was written in the 1960s which popularized the theory that insula biota so that's life and populations that live on an island, maintain a dynamic equilibrium. So this is a an equilibrium that can move between immigration and extinction rates. So this ties into the source and sink habitats dynamics that we talked about in the last lecture. So an island if it's small may be a sink habitat so because it's a small area it can't make the not be able to maintain the population of a particular species, but can that small population be maintained by immigration from the largest landmass.

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So when we're looking at this along the X axis, here we have increasing species richness. So, as you go to the right there are more species and the blue lines look at the probability of colonization so the probability that species will be able to get to that island or protected area. The Green lines are the probability of extinction. So the two main factors determining how many species can exist on an island are its size, so the larger an island and more species that can maintain because more resources, there are. And the other thing is its proximity how close it is to a bigger landmass so the closer that island is to a bigger landmass more likely is that organisms can migrate there. So even very distant islands can be colonized eventually by, especially by flying organisms, but ones that are closer can be colonized by by organisms that can't fly whether or not that's seeds that can wash across the cedar and even animals that swim, occasionally they may drift over on a floating log for floating detritus but the closer the island is the mainland is, the more likely it is that organisms will be able to colonize it.

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So there is a difference between a small island that is distant from a bigger landmass and a large island that is closer to a bigger landmass so as you can see, the large island that is closer to one, this will have more species than the small and distance and so when we are using this to try and design our protected areas, we want to be as far to the right hand side of this graph as possible. So we want to have as much species richness, as we can, therefore, we want to increase immigration and birth rates and we want to decrease emigration and death rates so how can we maintain as much species richness as possible.

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So these are just generally some of the rules of protected area design and we're going to cover a few of these today. And so, as we've talked about, we want larger reserves, you want ones that don't have fragmented habitat. And then we want to also increase immigration to these reserves, so

you want better linkages with other reserve, we want migration corridors. And then we'll also talk about edge effects we want round reserves rather than long thin ones. So I'll go through a few of these and i'll explain why we want to design reserves in these particular ways.

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And the four main things you're going to look at here are size edge effects random events and SLOSS, which stands for single large or several small which i'll explain later and migration and corridors.

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So the first one is size, so as far as i've already said. Generally the species richness of an area is greater, the larger that area is. So this study looked at the number extinctions that you get in areas of different sizes and focused on national parks in Northwest America. This found that the smaller area is, the more extinctions there are therefore less species richness/ So this just says that when we're designing protected areas, we want them to be as large as possible, so we can decrease these extinction rates.

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And these are just some of the reasons behind that so large reserves can support larger population sizes. So in the last lecture when we talked about the small population paradigm, you want to avoid that if we can and all the problems that come along with those small populations. So the larger area, the larger the population size, it can support this larger reserves also have more species. It's also partly due to the fact that they will likely more likely have a bigger diversity of habitats so they're likely be able to support a wider range of species that are adapted to different habitats. And there's also other things such as anthropogenic disturbance and edge effects which we'll talk about in a minute.

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So the second consideration is edge effects. So what is an edge effect? Basically, it means that the places close to the edge of protected area experience damaging impacts because of their proximity because of how close we are to the human dominated landscape outside of that protected area. And so, this can be things such as different weather conditions, so at the edge of a forest, so you say you have a forest, that is, next to a farm it might be windier it might be drier than the middle of that forest. You may be able to get more invasive species from that farmland, and you can also get lower habitat quality due to impacts of humans pollution and other things that are coming across from that human dominated landscape.

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So this again links into the sizes of the reserves that we want also their shape. So generally you want bigger reserves, because a bigger reserve has proportionally more cool habitat compared to edge habitat. You can see in this diagram and also if these reserves, with the same area but we're long and thin and proportionately have much less call habitat and edge habitat. So we just quickly flip back to here, the second from the bottom here, you can see that there's more green edge impacts edge affected area than you would get proportionally to the core area on the round one on the right there.

Slide 17 So these these graphs i'm going to show you now just show some of the edge effects that you get in forests. So this is biodiversity disturbance. And so don't worry too much about the curved

lines here just look at the bars. So each of these bars represents a different biodiversity disturbance and the size of the bar along the X axis shows the distance that that impact can take place into the forest reserve. So the very bottom one that is elevated pig abundance or weed invasion. Up to two kilometers meters into this forest reserve you get higher level of PICs and you also get more weeds so that's a long way into these reserves, and then there are a lot of other different impacts and different ones stretch different distances into these foreign reserves. So there's things such as different community composition so get different composition of species which are very important for different ecological functions. So this just shows some of the biodiversity disturbance edge effects that we get

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And, as well as these biodiversity and disturbance defects, we also get tree mortality edge effects. So these are things that contributes to the deaths of trees in our of the edges of our protected areas. And again, this graph just shows it's cut off the x axis label but it's just how far into the protected areas, these things happen in meters. So, as you can see, we get higher burning bigger higher loss of biomass and higher tree mortality higher tree damage so there's just a lot of things that damage trees that cause increased tree death closer to the edge of our protected areas.

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So we've looked at the size of protected areas and we've also looked at edge effect so we want big protected areas and want them to be as round as possible, rather than longer than so now we're going to look at random events and slots, which is single large or several small.

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So random events are catastrophes that can be caused by humans or by the environment. And so, this can be if it's caused by the environment, it can be extreme weather, it can be a hurricane or a cyclone or something like that. And then caused by humans, it could be an industrial accident or it could be intentional. Someone comes along and cuts down a lot of forest because they want to convert into a pasture and in Southeast Asia has some problems with the burning of peat rain forests, so it could be that someone comes along and does that to try and clear an area for farming. These random events can be a problem if you have if you've decided to set up one Protected Area. So say you want to try and protect a certain species. And you only have enough money to try and set at one protected area and so you're in protect that one if that then happens to be damaged by all of these catastrophes or destroyed and you feel that whole species you don't have an insurance population somewhere else. So an example of this is this fern that exists on Bermuda, an island in the Atlantic, called the governor Laffan's fern. This was extinct in the wild, but it was present in ex situ institutions in botanic gardens, so they breed plant in same way as zoos breed animals. And, and when they were introducing it to Bermuda this was quite difficult because this fern existed in caves so they would replant it into caves, however, hurricanes kept destroying the replanted individuals. Therefore it's better to in several caves at once, rather than just one because, if one of those caves is affected by Hurricane one of the ones might escape it.

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So, then, we get into this discussion about single large or several small. So if you are going to protect a certain area. Do you want to do it all in one go or do you want to do it in several do you want to protect one big area, or do you want to protect several small areas. There's a bit of a trade off here, because as we've said, the larger the areas are better it is for conservation, the more species

diversity they can maintain and the less of those places is affected by edge effects. However, maybe that one area is then more vulnerable to the random events than several small ones would be where you might get around them, and in one of them, but the other ones still exist. So, which one you pick here depends very much on the context and the species, So if it's quite easy to move between the reserves if species can migrate from reserve to reserve, maybe several smaller ones would be better. However if there is very inhospitable landscape between them, maybe a single reserve would be better, because you wouldn't have lots of or many smaller isolated populations. It also depends a bit on what threats are facing the species, so if there are lots of catastrophic events like those hurricanes on Bermuda again, maybe several small would be better, but if they are affected very strongly by edge effects and maybe a single one will be better, so you have to think about the particular species that you're looking at, there isn't a hard and fast rule here.

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So this is just the diagram for optimal design of protected areas. We will probably want a single large one but, again, this can depend on the species like we were just talking about in some cases, several small will be better. We want them to minimize the edge, we want them to be close to other protected areas so that things can more easily move between them, we want connectivity, but to be better and also, we would like to have buffer zones, if possible, these areas that are not strict protected areas, but there are some regulations as to what human activities can take place there, and this reduces some of those impacts on the protected areas from outside reduces some of those edge effects.

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So the fourth aspect of reserve design we're going to talk about our migration and corridors

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So what the landscape between reserves is often referred to as a matrix so we want to think about how easily species can move through it. This depends on the species again so if they can fly, then so birds and bats and some insects. So they can probably disperse across the landscapes much more easily than animals that have to walk through. And if we're thinking about animals have to walk how dangerous is it for animals to move through them are there, particular agricultural chemicals that are harmful will people try and kill those animals directly. We have to think about these kind of things that affect how easily animals can migrate between protected areas.

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And a population that is made up of several smaller populations is often referred to as a Meta population. This diagram here shows a conceptual idea of a metapopulation of frogs. So these frogs are maintained in four different populations and there is some migration between them, however, as you can see, between population A and population C there is a city in the way. A settlement of some kind, and that means that there's no migration between those two reserves. So when we have a situation like this, there are certain management considerations to think about we want to try and encourage as much as easy, we want to try and make movement between reserves as easy as possible so that we can maintain that connectivity, we can maintain gene flow and we can manage a larger overall population that if all of these populations were isolated.

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And so, providing corridors is difficult and you can't just plant lots of trees for forest species and then hope that those species will just move between those protected areas you can't just set up a fence between two protected areas, to create the corridor and hope the animals will move there. Animal behaviors tend to be a bit more complicated and animals rarely respects the lines that we draw on maps. So there's been some instances in India, where management authorities have tried to create corridors between protected areas for elephants and the offense don't use them. They go the way that they historically have done. So animal behaviors which I will get you on to a minute can be quite hard to change, therefore we need to work with the animals when we create these corridors need to look at the places that they have historically used for migration and try as much as possible to create our car doors in those places. So this diagram here shows Tanzania in East Africa and the green areas here are protected areas. And the purple lines, the solid pipeline show migration corridors, the dotted lines show corridors have potentially been severed so places that animals would have migrated previously, but now can no longer do so due to human habitation and all human effects so when we sever these migration corridors, we are reducing the amount of migration that can take place and we are effectively decreasing the protected areas state that we have we can't then continue to manage those populations as a Meta population and it becomes those populations become isolated and then they start to suffer from all the impacts of the small population paradigm.

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So, as I was saying, when we're thinking about designing corridors, we have to think about animal behavior which can be quite difficult to change.

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And this has been demonstrated on one of the reserves that I work on in Kenya, where even when a fence has been removed animals can continue to use the places where gaps used to be in those fences. This is an old fence line between two reserves in Kenya so on the right hand side we have Lewa, which was the reserve, where I did some of my fieldwork on the left, we have a place called Borana. And to try and maintain the movement of animals between these two reserves. They had these gaps in the fence, so this ties into I talked about in the last lecture with the protection of rhinos. Lewa had a population of black rhinos so in order for the rhinos to be protected from poaching, there is an electric fence between the two reserves, but they wanted to allow all animals, apart from rhinos to be able to move between the two. So in the they set up gaps in this fence where there wasn't an electric fence and instead there were these piles of stones and wouldn't post, I talked about in the last lecture that allow all other species through apart from rhinos. And so they had these gaps in the fences to try and promote this movement of animals between the two.

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Borana and Lewa were merged into one conservation landscape and black rhinos were allowed to move between the two so Borana increase its security so that it could also protect rhinos and they took down the fence line between the two reserves. So, whilst they were still two separate reserves, there could be managed as one big landscape and this provides an opportunity to study the impact that this had on animals behaviors. And what they found was that lots of animals continued to use the old fence gap, even when there was no fence in the other areas anymore. So on these pictures the yellow line here, is where the fence used to be. And then on the left and be our top down aerial photographs of that old fence gap, so you can just see the thin pile of stones and where that fence gap used to be. On these photos on the bottom, the Red dotted lines are the old migration routes,

so when there was only that gap available that's the those are the groups that all animals used to have to take to move between Lewa and Borana. The green lines are new migration routes.

So some animals did start to cross the fence, the old fence line in new places but lots and lots of animals, continue to use that old migration route because that was the behavior they had learned and the stuck to that behavior. And so, this just demonstrates that animal behavior can be quite difficult to change. So say that this wasn't a fence gap between two reserves. Say that it used to be the fence line between and a reserve and some farmland and then the reserve expanded it bought some that farmland and it took down the fence, so that he could expand into that farm. It may be that it will take a long time for animals to start to migrate into that new place because their behavior in the past has been to avoid up farmland because it's dangerous for them. And therefore, they might avoid that new land. If there is a reserve a bit further away, and instead of expanding into a farmland that reserve wanted to create a corridor between itself and that further away reserve and they bought some district of land between the two in a place that previously wasn't protected it might take animals a long time to realize that that corridor is available for them and it might not be as simple as just allowing the animals move to and fro. In this situation, with Lewa and Borana instead of just taking down the fence and allowing black rhino is to find their way over to Borana. That would have taken a long time, so instead they actually sedated a few rhinos and move them over there themselves which speeds up the process of the black rhinos colonizing that new reserve.

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So those are the four main aspects are protected area design i'm going to talk about today it's by no means all of the aspects that are important. The other things you have to think about our management so whether or not you're going to intervene in the conservation of particular species. As well as habitat suitability and a whole range of other things, but those are just the four that i'm going to talk about today. And finally i'm just going to have a quick talk about whether or not protected areas actually work. So, as we spoke about the start there's been a huge increase in the area that we protect around the world, and the number of protected areas that we have but biodiversity declines continue and so do extinctions. We might think that protected areas don't work, however, there is good evidence that they do work to a certain extent, so this is a quote from this paper here at the bottom and it showed that a large proportion of parks are successful at stopping habitat degradation so things such as land clearing logging deforestation and things like that. However, effectiveness of those parks to preventing biodiversity of cleansing extinctions correlated with basic management activities so putting up fences, which is what it talks about here with boundary demarcation as well as compensation of local communities. This means paying them for the damage that animals that come out of the protected area might be causing some analysis comes out of the practice area it damages the village are the locals being compensated for that. So protected areas can be efficient, but they need proper funding and they need proper management.

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And they are not always effective and the reference for this quote will be in the documents of lecture references, along with a task I have for this week. So this just shows that they're not always effective. Species of large mammals in African protected areas showed an average of 59% decline in population abundance between and that's a very, very big decline so even though even, in some of these very well known African protected areas, we are still seeing declines of very well known iconic species.

END

So that's the end of this lecture. Thank you very much for listening. Along with this lecture in this week's folder there will also be a task, I would like you to do in the in the document, along with the lecture references. The task of this week is to have a think about protected areas in Myanmar. So there are four maps of Myanmar in that folder to go along with the questions on the task sheet. And the first one is the shows the protected areas that already exist in my Myanmar i'd like to have a think about whether or not you think these are well designed, according to the rules of design that i've talked about in this lecture. And then want you to compare this with two maps showing key biodiversity areas which are places that have been designated as being very important for particular species or ecosystem services and also a map of vegetation types and I want you to think whether or not these protected areas are missing certain vegetation types and how well they cover these key biodiversity areas. Finally I want you to think about where you would place a new protected area in Myanmar but compare this your ideas with the map of economic land uses, do you think this new protected area would come into conflict with these economic activities. So do you think they would be a big opportunity cost of you, setting up this Protected Area. So that's the exercise that I'd like you to do for this week, and again I hope we can have a chat about it and talk about your ideas very soon, thank you very much.