Slide 1

Hi again everyone, so in my first three lectures and we've mostly looked at the whys in conservation. So what are the threats are facing the natural world that are causing biodiversity to decline and why that's important and why conservation was founded. And what aspects of the natural world people want to save. And so over those three lectures we've kind of had to think about why we try to protect the natural world and the justification for doing that. Going forward over the next three lectures we're going to more look at how we do conservation, so the methods that are generally used and how we translate our desire to protect natural world into actually doing it.This lecture we're going to look at the species level, so how we carry out conservation, that is focused on particular species like these African elephants that you can see here.

Slide 2

So what is species conservation? So this is conservation that attempts to prevent extinction of or increases the population size of particular species. And so, rather than focusing on an area of land instead we're focusing on one species within that area. So this is done all the time and the most often it's for those large charismatic species. I mentioned charisma,in the last lecture and so it's in Southeast Asia it's animals like orangutans and tigers, and then in Africa, where I work in East Africa, you have black rhinos white rhinos elephants. And then, in the UK, where I live, we have animals like red kites and sea eagles that have focused conservation efforts even reintroduction efforts, where animals are brought in from elsewhere into a place where they have gone extinct from. And it's so it's usually mammals and birds. It's not just mammals and birds there's lots of conservation efforts that are focused on amphibians, and fish and invertebrates as well and plants. But most often we think of birds and mammals as being these charismatic species that this kind of conservation is often focused on.

Slide 3

So an example of this is birds from Mauritius, so, if you remember way back in the first lecture I talked about the extinction of the dodo, which was a bird from this island in the Indian Ocean called Mauritius. So what this species demonstrate is that species can be brought back from the very brink of extinction, rom very, very low numbers back into functioning populations that, hopefully, in the future, we can get to a stage where they're self sustaining so they can continue to survive by themselves. So, as you see here on the slide there were only four birds in and through a range of intensive interventions by 2013 they were around 350 or 500. Now this species can't just survive by itself, yet this population is still quite small but it's not going to go extinct immediately it's been brought back from the very edge of extinction.

And these are just some examples of the interventions that were used to try and protect the species and to try and get it to breed more effectively. So there was guarding of nests from invasive predators which we've mentioned a few times so rats generally are the mammalian predators that were introduced to the island. And then there was some interventions that were aimed to try and get the animals to breed. This double clutching means that after a pair laid an egg that was removed it was given to a another pair that hadn't bread or it was raised in captivity, and that would cause the original pair to have another egg so, then you have to. And then, yes, so those some of those eggs were hatched in captivity and given two pairs that had not bread or lost their eggs and there was also some feeding of these animals to make sure that they had enough nutrition.

Slide 4

So why do species conservation, why do we focus on particular species, rather than focusing on areas of land. Generally it's because it's been decided as a particular species is valuable in some way, and so this can be charisma, which is exemplified by the Panda logo of the World Wildlife Fund or WWF and so these are animals that are cute or dangerous or charismatic in some other way, in that way that I talked about in lecture three. But it's not just this. As well there's ways of using these particular species to protect other species as well as larger areas of land. So we're not just focusing on one species at a time we're using these charismatic or these particular species to as tools almost to further the wider conservation efforts.

Slide 5

And i'm going to talk about these two examples here which our flagship species and umbrella species. So in naval terms a flagship is the most important ship in a navy. And so that's where this title comes from, so these animals are used as symbols to raise money, which can then be used to protect them, but also to protect other species. So as we just mentioned the giant Panda is an example of this. So lots of conservation charities and NGOs will have campaigns that focus on particular species, whether that's a Panda or a tiger or something else. And they use this to raise money but that money won't just be spent on that Panda or that tiger, it will be spent on the other projects as well that are potentially focusing on less charismatic species that might not raise as much money.

Slide 6

Umbrella species are similar but they tend to be animals that have a large range, so this so tigers are very good example of this. So, to protect a viable population of tigers, which means a population that can survive into the future that won't decline you have to protect very large areas of land, because they have very large ranges so to protect enough tigers, so that they can breed and continue to breed you have to protect very big areas of land. So this is called an umbrella species. So, if you think about an umbrella and they're kind of used to protect other species from the rain which, in this scenario is threats that would cause their declines. So by protecting that tiger habitat you're also protecting the other species that live there as well.

Well that's the theory, there are some criticisms of this concept, so if you just use some of those intensive interventions to protect the tiger, so if you're just feeding the Tigers, or something similar and you might not be protecting those other species, by default, especially if they're affected by different threats. So say there are there are amphibians, in these tigers ranges and they're affected by that chytrid fungus that disease that we talked about, then protecting this tiger might not protect those amphibians, because the tiger doesn't need protection from that fungal disease. So it can work but it just needs proper consideration that you're not just going to protect this one species.

Slide 7

So why is it important to consider the size of a population when we're looking at species conservation. So a lot of species conservation or lots of conservation in general is focused on minimum viable populations, which means what's the smallest size of a population that we can have our particular species, that means that I will continue to survive into the future.

Slide 8

But small populations are particularly vulnerable to particular threats so by setting up protected areas and protecting relatively small areas of land compared to human altered landscapes, we often get quite small populations these then become vulnerable due to a few different factors.

So the problems that these populations face are genetic and so this is some of the stuff that you're talking about with Cathy so I won't go into it too much. But when you have small populations you tend to lose variability in that in those populations which can mean the less able to adapt to future environments or changes, but can also cause problems in the present with inbreeding and other things. So an example here is the glanville flatillery which I think was the first organism that was proved to have gone extinct in a certain area due to inbreeding. So this is when deleterious aerials so that's alliums or genetic variants that are bad for the fitness of the animal become fixed in those populations, because related individuals are breeding with each other.

One of the other problems with small populations are is demographic issues so small populations are more vulnerable to going extinct just due to random events. So it might be one year that 10 females don't breed just by chance. In a big population that has very little impact, but if you only have 20 females in the population as a whole and that means that half of the individuals aren’t breeding so these chance events can have a bigger impact and you also can have chance differences in the sex ratio of young that are produced, which can mean in the future that aren't enough of each sex to breed and you also get alia effects which I will talk about in a minute.

And then environmental stochasticity, stochastic just means chance just means random events, and also affects more populations so like we talked about in the one of the other lectures if an organism has a small range. And if that range is affected by a damaging activity, whether it's land conversion or just an extreme weather event there's a bigger chance that that whole range will be destroyed. So these small populations are also vulnerable to environmental changes and environmental damage to their habitat.

Slide 9

So this is just a demonstration of the allee effect. So this is when populations experience a greater threat of extinction just because they are small. And so, these graphs the y axis is the rate of breeding generally here it's called the proliferation rates so how the population is changing and size over time. And the X axis is abundance, so the number of individuals in the population. So when there's an allee effect, you get negative population growth at very small population sizes. So if there's no effect, then K here is the carrying capacity so it's the number of individuals that and area of habitat can contain for that particular species. If there's no allele effect or there's a week allee effect the population will grow until it reaches K and then it will stay at about that level of abundance. It might go up and down a bit, but it gets pushed back towards K every time.

If there's a strong alia effect when the population becomes very small, the growth rate becomes negative and that pushes the organism towards extinction.

Slide 10

So an example of example of this is thought to be sumatran rhinos. And so these are declining very quickly and in 2019 the last one in Malaysia died. So it was thought a very low population sizes these animals were struggling to find mates were struggling to find individuals to breed with. So the population growth went negative and then they went extinct in Malaysia they're still present in other places, I think, in Sumatra witches are named after, on the Indonesian side of Sumatra.

Slide 12

So. that's some of the problems with the small population sizes and some of the justification for why we do species conservation. So now i'm going to run through a general sequence of events that you carry out when you're trying to protect a certain species. And these the four general steps. It will definitely vary, this is just a general overview of how these things often go how these projects, often take place and, but it does vary from project to project and species to species.

Slide 13

So the first thing to do is to estimate the population size of your species or your population and it's often quite difficult to do this and it's not just a case of counting the individuals, because lots of species don't like to be around humans, they're camouflaged or they're small or the hard to see. And so it's almost always impossible to conduct a complete census or population, which means that it's almost impossible to count all the individuals have a species or a population.

Slide 14

So one of the ways of doing this is by tracking, so using footprints or using done to try and estimate how many individuals that are in a certain space. So here we just have the footprints of the mammals, that you would find in East Africa who I work, so you can often use these tracks, to try and estimate how many individuals of a particular species have walked past a particular place.

Slide 15

Another method is to use camera traps So these are cameras that are automatic you tie them to a tree or something similar, and they are set off and they take a photograph when something walks past, so they have a motion sensor and when that motion sensor is triggered they take a photo. We can do this to try and census populations, try and estimate the size. But you see two cheetahs here. You might see two again the next day, but you probably can't be certain whether or not it's the same to or a different to so we use software and match particular patterns on individuals. So in case of cheetahs it spots so they'll all have a unique pattern of spots. We can use a special software to identify whether or not we've seen that individual in a previous photo and then we can get a number of unique individuals from our camera trapping project.

Slide 16

So. there's other ways of doing this, which is just by going out and counting animals from airplanes like we see with the elephant here when cause an example of this is the Grevy's zebra, which is a species of zebra in Ethiopia and northern Kenya. So how do you count these animals? Do you just go out once and you just count as many as you can and then that's your observation, or do you go out several times? So here, these examples are just examples of a single sample so you go with as many people as possible over a short period, say, a week and you try and count as many of these animals, as you can. In this situation, you have to think about whether or not you are missing certain habitats and whether or not there's an observation bias and how much of the actual population, are you actually recording. And you also have to think about the different habitats you're looking at So if you sample and undisturbed habitat and you get an estimate of the density of individuals there and then you use that to estimate the density in a disturbed habitat that might have a very different density. So you need to be careful when you extrapolate from your observations to cover larger areas

Slide 17

If we are going to carry out a project, where we sample several times, you can often use this capture mark recapture method. This requires several sampling sessions like I said and every time you catch an individual for the first time you mark it in a particular way. So on this snail here, you can see that it had written on its shell which doesn't harm the animal at all. And then, when you conduct your next sampling session you record how many of the same individuals you caught in this new sampling session so how many market individuals, did you sample and how many unmarked individuals that you didn't catch last time.

Slide 18

And once you've done that you can use these equations or the equation, the right to calculate how many individuals that are in your population, so the capital N, is the population size that you want to calculate. Capital M is the number of members of the population that were captured in your first round and marked. The small n is the numbers of the population that were captured in your second round just the total number of individuals. And the small m is the number of members in your second round that had that mark on them so you're trying to find out the proportion of mark to unmarked individuals in your second round of sampling.

Slide 19

So I know that can be a bit confusing to think about so i'm going to work through an example here. So this is an example where you capture and tortoises you're trying to figure out what is the population size of these tortoises. So when you go on your first day and you do something you mark all of the 10 individuals that you find with this red spot. On day two you capture 10 individuals again, but only five of them were marked so five of them had no mark on them, so when new individuals that you didn't catch in the first day.

Slide 20

And this is just a work through example. So you captured 10 individuals on the day one, which is capital M. You captured 10 individuals on day two, which is the small n. But only five of those individuals were tagged, which is the five there. So 10 times 10 is 100 divided by 5 so 20 is the population estimate that we have for these tortoises. So this is one way where you can try and make your population estimates more accurate.

Slide 21

So once we've estimated our population sizes The other thing we want to do is estimate the risk of extinction to those populations. So when we're doing this, the four main things we have to consider when we're thinking about the extinction risk of a particular population our birth and death rates and also immigration and immigration rates and together, these are called vital rates.

And these four vital rates, only these four can be used to try and estimate how the size of population will change into the future.

Slide 22

And so, this is just some kind of a mock up of some of the work that I do with black rhinos so it looks at how these vital rates change at different ages. So I used a historical data about how often the rhinos have bread and when they died over time to calculate their birth and death rates at different ages. So this is generally the shape of these vital rates that you get for long lived mammals at least. So you get peeks of death rates at very young ages and very old ages. So black rhinos can survive past 40 years old, but it is rare and you also get peaks of breeding rates in those middle ages around 20 years old. So this is generally the shape of these vital rates that you get. So young individuals are at risk of dying there's less lower death rates those middle ages and higher death rates for very old ages. But more individuals in the middle ages are breeding.

Slide 23

So this is just a quick equation, to show this. So r is the population growth rate into the future which is births and immigration minus deaths and an immigration, and this is expressed as a percentage. So, in a population of individuals say we had 10 births and five deaths and no immigration or emigration. We're estimating a % growth rate so we're estimating this population is going to grow at 5% over time.

Slide 24

Once we have estimated the vital rates and the population growth rate as a whole, we can use models to evaluate the risk or the probability of extinction for a population over time. And these are modeling so they require some assumptions, but they do provide surprisingly, robust evidence for management. Once you have these models, you can also modify your input into these models. So you can try and predict what would happen under different scenarios. So say we want to try and found a new population of black rhinos. And to do that, we want to remove a group from a population that currently exists. So we want to remove 20 individuals, we can take those 20 individuals out of our population model and see how that affects the future growth rate. To try and predict what would happen without having to actually do it and put that population at risk. And then, if it says that it won't have a long term impact on the extinction risk of that population, we can say to managers yeah that sounds like a good thing to do. If it will have a big impact, then we can advise against it. Some critiques are that we need a lot of data for this and it's rare that there is very good quality demographic data for wild populations. So I was very lucky with my work in that these rhinos are very heavily monitored due to poaching so there's very good demographic data but for other species, this is this often isn't the case. They also can be a bit pessimistic, which means that they predict declines more often than they will actually occur.

Slide 25

So this is what one of these population viability analyses looks like. I know it's a bit confusing, but basically what it's showing is that this population is likely to decline, over time, so when you do these population viability analyses you conduct the simulations so you project that population into the future many times. Because you often built in stochasticity so you've built in some chance. So if you are just looking at the vital rates every simulation would likely be the same, but if you build in some chance into models, if you say that you know every year there's a slightly different chance of breeding and dying and then every simulation will be slightly different. So there are lines on this graph that show. each different projection but, as we can see there's a kind of a faint black line in the purple there. And, and what that shows is that, on average, we predicted this population is going to decline and also lots of the simulations go extinct they reach a population size of zero. So if we came up with this result in our population modeling we want to be worried about our population, because we think it might go extinct. A good chance it will go extinct over the next hundred years.

Slide 26

Some uses of this is a said to predict the extinction risk of a particular population over a certain timeframe and also model how changing or management practices would impact on the population.

Slide 27

So number one we've estimated the size of our population, number two we've assessed the extinction risk of our population. The third thing we want to have a look at the habitat requirements and range determinants of yours, of the species, so what things do they need in a particular habitat to exist. What diet, what are they eating how much water, they need, what are the temperature what's the climate, they need how much rainfall things like that. Also are their interactions with other species that they need or that threaten them.

Slide 28

So also when we're looking at range determinants sometimes it's, not just because the habitat is suitable sometimes there will be suitable habitat somewhere else. But your species can't reach it, because it's an accessible to them, they can't disperse they can't migrate to that other place. So some examples of this are mountain ranges so lowland species will struggle to migrate over a mountain range. And also seas rivers and deserts. This is the case for terrestrial species. For species that live in the sea, land forms a barrier to this, so a good example of this is when the isthmus of Panama, which is the small bridge of land between North America and South America and when that became uplifted and became land. So before that there was a sea between those two continents. And when that happened previously the North American species and the South American terrestrial species were separated because they couldn't cross the sea. When that came up, they could then move from one to the other and there's this thing called the great American biotic interchange.

However, the marine species from the Pacific and the Caribbean sea they then became isolated. And then some interesting work looking at how populations of marine species on either side of that have started to diverge in evolutionary time, have started to change in their genetics and have started to diverge or already have diverged into separate species.

Slide 29

Human activity can also cause barriers to migration, whether or not that's a physical infrastructure, like a wall or whether or not its habitat destruction and fragmentation. So lots of species may not be able to traverse farmland. So say you have a large area of forest and you split it into two by lots of wheat fields lots of forest species might not then be able to get that all the area forest because they can't cross those wheat fields. Therefore you've blocked and those migration routes between the two.

So, once you so you start to assess the habitat requirements of your species, but you also need to look at what physical barriers prevent them from reaching suitable habitat.

Slide 30

So when we're looking at the range determinants of a certain species, we need to look at what they need from a habitat So how do we study animals diets. So one way is simply to watch and see what everything eats. So i'm sure you've all seen nature, documentaries with lions eating wildebeest and things like that. But that is a little bit anecdotal and we want to have a good idea of what these species are eating and in what quantities So yes, maybe we see lions eating wildebeest. But is that the most important aspect of their diet or other animals eating more of that and more important for them. So you can do systematic studies, where you follow species over a long period of time and record what they eat. You can look at animals dung. And in doing this, you can identify plant fragments. So these pictures on the rights are has taken under a microscope from a lion or predator dung, and you can identify those hairs. Different species have different hairs and you can identify them from how they look under microscope. And then you can get an idea of what these animals are eating and what proportions. You can also use DNA metaarcoding, and so this uses a particular aea of DNA that has been identified as being variable within the groups that you want to study. So say you want to look at plants you identify a particular area of DNA that is known to be useful for doing that, and you then take your dung sample you extract the DNA from it, you amplify that area of DNA and then you sequence it and you can see how many incidences of different sequences of DNA that are in your sample. You can match that to a database of known sequences that match to a particular species, and then you can see, which species are occurring in that dung.

Slide 31

So, as well as diets you also need to look at things like space so how many individuals that species are there in a particular place is there enough food for the all. And also look at water availability other species, including predators and competitors. The carrying capacity so that's what I was just talking about the, the number of individuals of your particular species, so they will compete with each other, you have that intra-specific competition and also whether or not they can disperse.

Slide 32

So as we talked about before whether or not there are certain barriers to dispersal. Once you have all this information you have a good idea of what that species needs from its habitat but that doesn't guarantee that the habitat that is currently suitable for the animal will be suitable in the future due to climate change or other changes. So we can use that information to predict how the range of a particular species will change in the future. So this is a study that looked at the habitat of the golden bowerbird in eastern Australia. And what they did is they looked at the climatic factors so temperature and rainfall that exist in places where that bird currently lives, and then we have an estimate of what kind of climate that they need. They then use climate models to predict where those climactic variables exist in the future, and so the big the map, on the very left here is their current range and then the other three are predictions of whether habitats will exist in the future on the different climate change scenarios. So our climate change models are uncertain so it's often done on a different scenarios to see where that habitat might exist in the future and, as you can see, we are predicting that this species will its range or the potential range will decrease very much into the future. So, then, we need to be a little bit worried about this species on the climate change because it's likely that its range will decline.

Slide 33

So these studies are often done using what are called bio climactic or bio climate envelopes so use the current range of species to decide what environmental what environmental variables determine that range so whether its temperature or rainfall or forest cover or anything like that. That gives you an estimate of the fundamental niche of that species. So a niche is the range of environmental variables that that species can live in, so a tropical species, a tropical forest species might need high temperature high rainfall and tree cover because it relies on being in a rain forest to survive. And so fundamental niche is those range of environmental variables that are needed for a species to survive. And then you take range of variables and you predict how they will shift what areas, those that type of habitat what existed in the future which is what we just talked about with the golden bowerbird. The limitation of this is it's purely correlative. So we are not saying that all they need this temperature, because it gives them, it encourages this particular plant and the plant it's just saying this temperature, we find that species in this range of temperatures. So we don't actually understand why that's happening in these models so it may be that, when we shift in the future it wasn't the temperature that they needed it was some other factor that correlates with the temperature, therefore it might not be our prediction for the future might not be correct. So the niche that we've actually modeled might be determined by other factors such as interactions with other species or physical barriers which we haven't accounted for in our model, therefore, our predictions might be wrong.

Slide 34

So there are ways around this you can start to put some mechanistic explanations into your models, you can start to put traits of your particular species into that model. And so you're looking at how particular traits of that individual of that species, make it able to survive in a particular place. So here the data we're looking at is rates of egg development at certain temperatures for a lizard in Australia. And as you can see the graph down the bottom here and the incubation time of lizards of the eggs of these lizards goes down as temperature increases, so the hotter the temperature up until degrees, the quicker these individuals, the quicker this species hatches from its eggs.

So it might be that it can't survive at low temperatures. So below 20 there, it might be that the eggs are completely unviable, but even at those temperatures like down towards 24 degrees. It takes them a long time to hatch so therefore the breeding rates are slower and the populations are less viable.

So on the right here, you can see a comparison between these two modeling approaches. The bio climactic correlative approach and the mechanistic approach so at the top and we record the presence or absence of this lizard and then we look at what climatic factors explain that presence or absence in a statistical model, and then we predict where they will occur in Australia what habitat is suitable for them. But in this mechanistic model, what we do. Is we look at the relationship between temperature and the hatching rate of these eggs, the incubation time. And we use that to show which areas of Australia are suitable for them so as we can see as it goes further north and it gets warmer the habitat is more suitable for this species. And so, this mechanistic model won't be affected by things like distribution barriers like we talked about before it can identify suitable habitat and that the organism might not be able to reach at the moment because of barriers to dispersal or other things like that.

Slide 35

So we've assessed the size of our species we've assessed extinction risk we've studied what habitat requirements, it has, and now we have all this data, we can start to actually conduct conservation, we can start to put in places interventions that will protect that species and prevent it going extinct. So there are two main things that conservation can do when it comes to reducing the risk of extinction, you can decrease mortality, you can try and prevent animals dying well, you can increase breeding, you can try and encourage them to breed.

And so, when we're doing this, we need to think about the areas that we are conserving species in so we're looking at the source sink dynamics so species do not just exist in optimal habitat the suitability of habitat for a species will vary spatially so will vary from place to place. And it will inhabit areas that are more and less suitable for it, so a source population or source area is very, very suitable habitat for that species, and it means that it mortality rates are low and reading rates are high. A sink habitat or a sink area are when mortality rates are higher their habitat is less suitable and breathing rates lower but a population may be maintained there by immigration from the source habitat. So we don't just want to conserve animals in just optimal habitat, we want to conserve them and maintain these source sync dynamics. So conservation isn't just about protecting an area of habitat and leaving alone, as we looked at with the Mauritian bird dimension kestrel at the start of this lecture and we can also protect species by intervening in a more intensive away.

Slide 36

So i'm just going to run through a few examples here of how we protect certain species, so we looked at why black rhinos are declining and threatened with extinction in East Africa and across Africa. At the moment, and it's mainly due to poaching. So how do we protect them. In lots of places they do it using security so they have ranges to try and prevent individuals poaching. On the left, here we have a photo of a fence. But this is a special kind of fence so lots of this reserve, which is all predator in Kenya is the very tall electric fence, you see, on the right. However, they want to keep the rhinos in, but they also want to allow other animals to be able to come in and out so as the lines drafts all those things, so what they do is they put this pile of stones and also these wooden posts next to each other, so in this gap there isn't any electric fencing. So all animals, apart from rhinos and can climb over that little pile of stones and can squeeze through these posts, however, because the rhinos are quite short legs and the quite wide rhinos cannot get through those posts. So therefore they're captive, so this is a way that in Kenya, they can protect their rhino populations, whilst allowing other animals to migrate in and outside of their reserves.

Slide 37

It's not always just about security and law enforcement and those kind of ways of protecting animals. You can also find ways to coexist So here we have an African wild dog or an African painted dog that has a GPS collar. So doing this, you can track the packs of these dogs, so you don't have to collar all the individuals you just have to collar a few from each Pack. You can see where they're going, and then, if they're going to be close to people's livestock, you can warn them and then they can protect the livestock without having to kill the wild dogs. On the right here we have a slightly different example, which is a project which puts up things, called bee fences. So elephants don't like bees. It's not entirely sure why it's probably because sometimes they sting them. So this charity puts up lines long lines of beehives. Along with some other infrastructure so sometimes you can burn chilies and other things like that, because elephants don't like chilli smoke. So you put up these lines of beehives and hopefully it keeps the elephants away because they don't like crossing that line of bees and it also gives local communities, a source of income from honey. So it's not just always about using security, you can find ways to coexist as well.

Slide 38

And so when we're thinking about what's the best way to protect a particular species that's threatened by intentional killing and human wildlife conflict do we want to just use law enforcement and those kind of security based approaches or can we provide ways of coexisting and provide economic alternatives to prevent intentional killing which can be just to protect your property protect your farm or it can be, because you want to sell a particular part of the animal for profit.

So it's been found that in particular cases providing economic alternatives, providing other ways of getting income can be more effective than enforcement. So in this case you want to try and prevent individuals poaching a rhino because they would get paid for it by giving them a different way to make money so, then they don't have to go out and kill that rhino to make money.

So in this example here in Bangladesh, they provided lots and lots of different economic alternatives different ways of making money that didn't require the people there to cut down trees or hunt animals from the forest. There was things such as raising plants raising fish and involving people in forest patrolling employing them as guides and security for our forest, so therefore they don't need to illegally cut down the forest or illegally hunt animals because they have other ways of making money.

Slide 39

And another conservation intervention, we often have to use is to especially on oceanic island is to control invasive species. And so like we talked about in one of the other lectures with the brown tree snake on guam the way of protecting the native species, which unfortunately is now too late, because a lot of them have gone extinct, we can kill the tree snakes that are causing those extinctions. This is often quite controversial and so people are very invested in animal welfare and animal rights don't like this a lot of the time.

But it can be a very effective way of preventing extinctions if invasive species are causing those extinctions. Sometimes eradication isn't possible there are too many rats there are too many cats to try and get rid of them all so to do that, we can clear, we can set up a fenced area that they can't get into you eradicate the invasive species from that area, and then you continue to protect it, as they can't get in. So a lot of this work has been done on islands are part of New Zealand so New Zealand is getting very good at eradicating rats from small islands and also on the Galapagos where goats were causing a big problem and they managed to I think eradicate a lot of goods from one of the Galapagos Islands.

Slide 40

And then there are a whole range of other interventions we can look at depending on the species we're trying to conserve and the threats, they face. So you can provide nest sites, which is especially important for lots of birds if they've been destroyed by habitat degradation, or something similar, you can provide food sources, which is what's happening here with these vultures. So if you have carcasses that aren't going to use for me to you can put them out from the sculptures you can provide water. You can move individuals or translate keep them from particular areas where they may go extinct to more suitable habitat or to habitat there's less threatened by humans, and you can also treat ill and diseased animals with veterinary care.

Slide 41

Finally, the last thing i'm going to talk about is captive breeding. So this is often seen as a last resort, but can be effective, so this is when it looks like a species is going to become extinct in the wild you can take some those individuals and you can put them into a zoo or a breeding and you can rear them there and they're protected from those threats that face them in wild.

So there are low lots and lots of zoos all around the world and some of them more focused on conservation and others and it's also the effectiveness of this depends on species that you're conserving. So when you think about a zoo a lot of them a lot of the species, you will think about are the big ones that many people go to see so elephants and lions and tigers. So, whilst it can be effective, to protect these species in these us it's often quite expensive and generally the larger animals range would be in the wild the less well they do in a zoo the less well they breed and the more problems they face. So the cost effectiveness of captive breeding tends to be highest for smallest species, so an example here are these partula snails which used to live on lots of oceanic. oceanic islands in Polynesia in the Pacific. And so, these animals because they're so small, and because feeding them is quite cheap I think they do it with lettuce they can maintain a lot of these species, at a very low cost. Because they are gastropods and they don't have big ranges and they're not particularly they're not intelligent like a mammal is they don't need lots of mental stimulation to stop them getting bored I think they just keep them in lots and lots of plastic boxes in a room in London zoo and they can keep them there very cheaply and prevent them going extinct, all together. And they have to do this because a predatory snail was introduce to Polynesia, which was eating them and causing lots of them to go extinct.

And finally i'm just going to quickly talk about the one plan approach and this is a an approach from the International Union for Conservation of Nature that tries to integrate in situ conservation, which is done in the wild and ex situ conservation, which is done in zoos. So lots and lots of places in the wild. are now starting to resemble the situation that we have in zoos, so we have small populations that are isolated from each other zoos have lots of expertise in managing that kind of population. Therefore the idea is that zoos can help people that conducts conservation in the wild maintain the small species into the future, so zoos don't just conduct conservation by captive breeding, they also have lots of expertise that can help conservation as a whole.

END

So, thank you very much for listening to this.The task this week is a little bit different what i've done is I have got some information on the banteng, which is an endangered cow and endangered bovid from Southeast Asia and lives in countries, including Myanmar. I've got the information from the IUCN read list, which is a database of how threatened different species are from all around the world and the information sets out the threats, they face and the current state of the species and it's conservation status. What i'd like to do is to read that information and then look at the task document on blackboard and what i'd like you to do is to design a research program and then a conservation program for that species. o this means that i'd like you to have a think about the current state of the species and the threats it faces, but also the gaps in our knowledge and if we're going to effectively conserve this species.

What do we need to know about it and looking back at the slides in this lecture what kind of studies do we need to do. Do we need to do dung analysis to look at what diet, it has and its habitat requirements? Do we need to conduct camera trapping studies to try and assess its population size? it lives in forest it's quite hard to find, so we need to employ some of those methods that I talked about. About how to study the size of shy populations. Once you have designed that research program i'd like to have a think about wat kind of conservation interventions you think would be most appropriate for this species. Do we need to move some individuals into zoos? Do we need to just protect particular areas of forest and then you think it will be fine if we just get rid of some of those human threats to the species? Do need to do other things? So that's the task i'd like to do to do for this week and then again once we can start to talk interactively over zoom we can have a think through some of your plans for the species, thank you very much and speak to you soon.