Conservation Geography
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Module - 8
Conservation of biodiversity
Lecture - 23
Ex-Situ and In-Situ Conservation

Namaste! We carry forward our discussion on the conservation of biodiversity and in this lecture, we should have a look at ex-situ and in-situ conservation.

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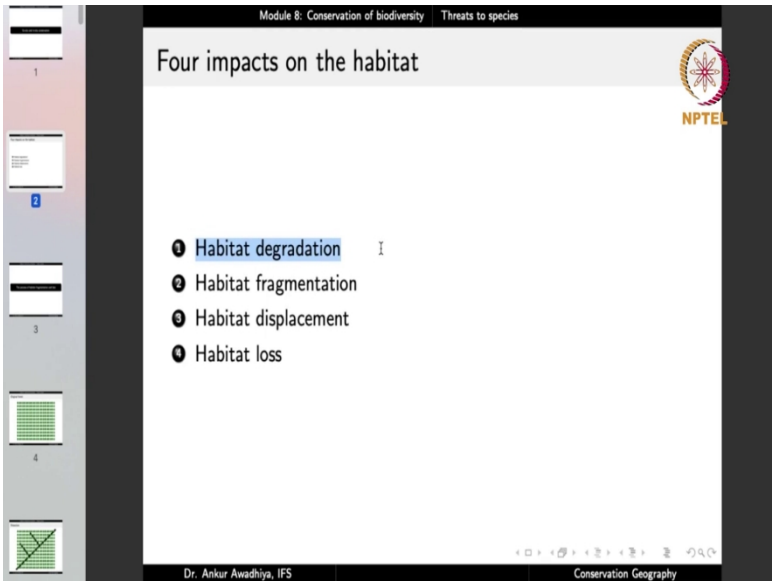

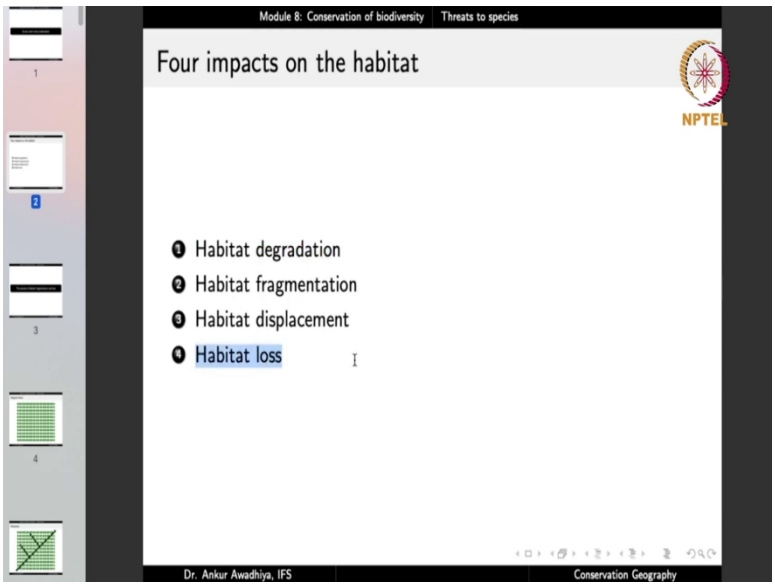

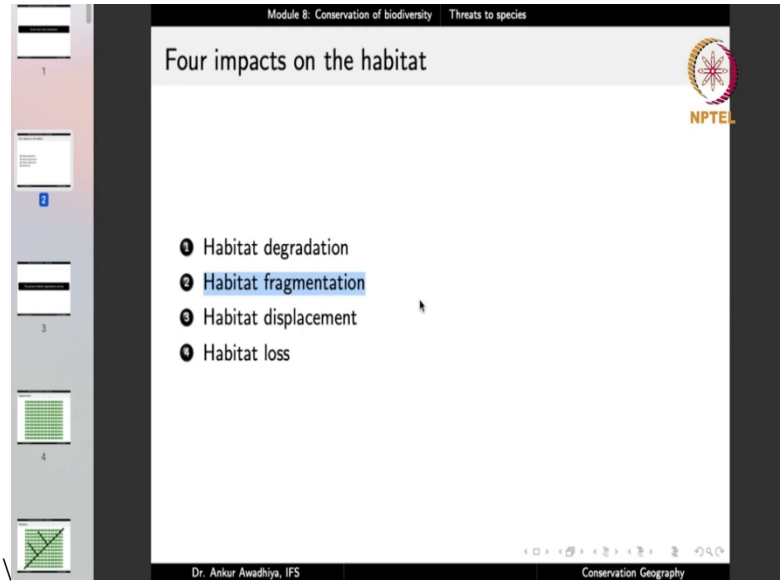

Now, in the last lecture we had observed that there are four major impacts that are happening on the habitat, there is habitat degradation or reduction of the quality of the habitat. Once the quality reduces so much that the animals cannot survive anymore, we say that there is habitat loss if the habitat is broken down into smaller fragments, we have habitat fragmentation and then there is also the habitat displacement. So, before moving forward let us have a look at habitat fragmentation in a bit more detail.

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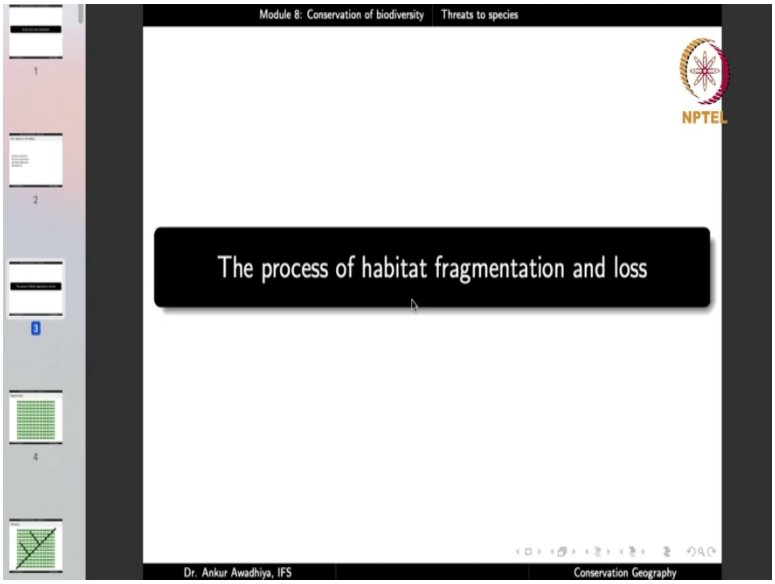

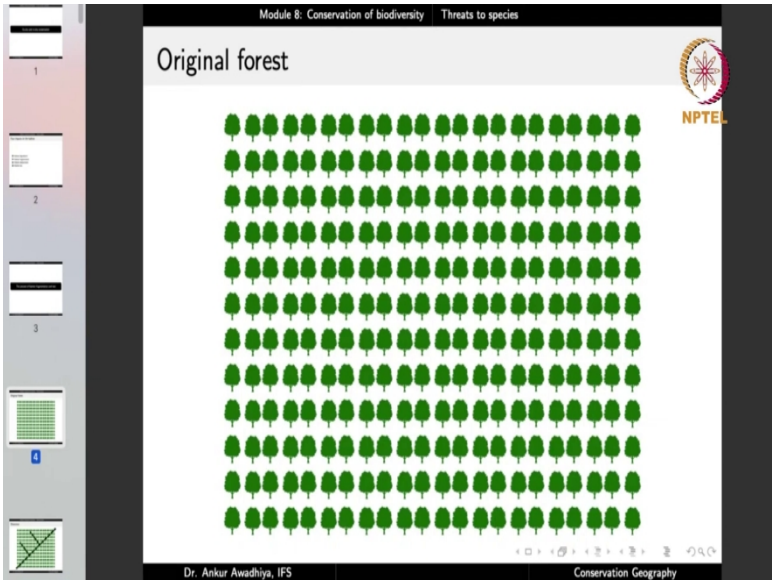

How does habitat fragmentation and loss actually occur? So, for this we considered an original forest that is untouched. So, we do not have any human influences and this is probably the most pristine natural habitat that is possible.

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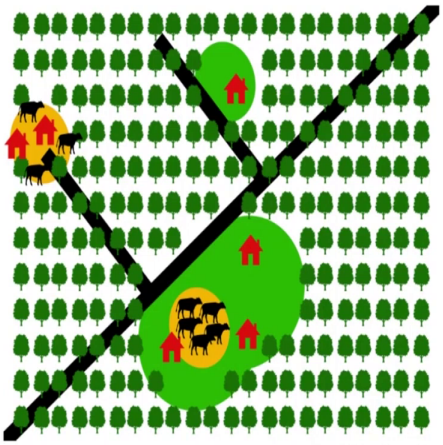
Perforation



Livestock in the forest

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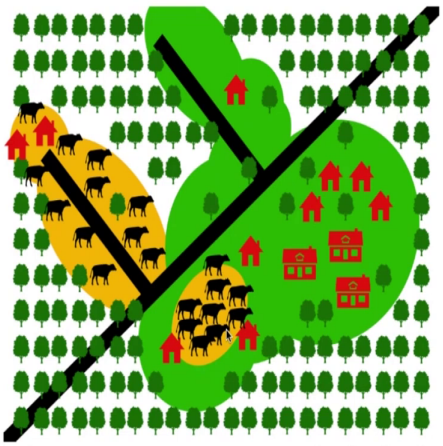
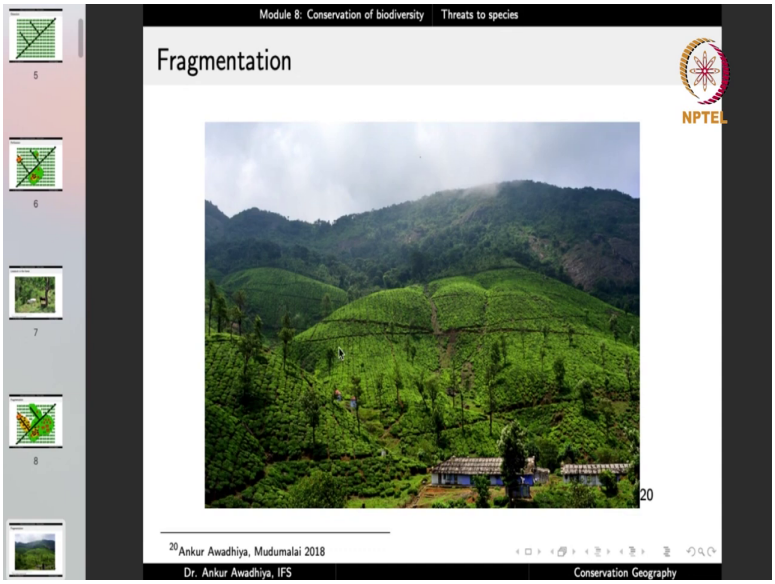
[19] Ankur Awadhiya, Mudumalai 2018

Fragmentation





Now, in this forest, suppose, a road comes up. Now, this process is known as dissection. Now, when the forest is deselected by this road, then typically, we are dividing the forest into smaller areas. Now, this would not be a very big influence in cases where the road comprises of a very small fraction of the total land surface of the forest and if the traffic density on the road is low enough that animals can move from one area to another area.

Now, typically, if the roads have a very high traffic density, then animals find it very difficult to cross the road. Because they feel a sense of fright when they when they observe very fast moving vehicles that are moving on the road. Typically, the drivers are also honking in the night times they are using the headlamps and all of that disturbs the animals.

And in certain cases, when they actually try to cross the road, they get hit and if they are hit by a fast moving vehicle, in a number of cases the animals die. So, roads become menace for the animals for several reasons. They have not just a physical barrier effect, but also a psychological barrier effect and at the same time, they also lead to heavy mortalities of the animals.

So, building a road in a forest area is mostly tantamount to fragmenting the habitat. But that is not the only influence of the road. Road also brings with it pollution roads also brings with it more human influence, because now people can access areas that were inaccessible before. Roads bring with them diseases and invasive species, because a large number of invasive species can move into the forest as seeds or spores that are stuck to the tires.

Roads enable people to hunt for animals. Because in the very dense forest, it is very difficult to get inside and hunt an animal and bring it out. But with a road, you provide an easy avenue

for poachers and especially in those areas where the roads do not have a very high density and a not routinely patrolled, you will often find that there would be a vehicle that has parked itself on the side of the road, people get into the forest for poaching or for illicit filling.

So, roads create n number of damages for the wildlife and their habitats. But that is not all. What further happens is that once you have dissection, people start to come into these areas and people start to settle in these areas. In a number of cases you will observe that on the side of the road, you will find us a person who has just set up a small stall, maybe a tea stall, maybe a stall to sell some vegetables and so on.

Now, there is nothing wrong if a person has set up a stall because after all the person also needs a livelihood. But typically what happens is that once you have a temporary setup after some time you will observe that people tend to make it into a permanent setup. So, you will start to see brick walls. Now, if there is a person who is living in that area, then this person also requires certain other facilities, this person would also require a certain level of safety.

So typically what will happen is that the areas that are near the stall they will be completely clear field. Because the person does not want to have a snake that slithers into the shop, he or she does not want a wolf or maybe other animals that come to near the stall and so, out of a factor of safety, the person would clear off the areas that are nearby.

Now, it is possible that the shop works well. Because, say after a very long journey, people stop there to have tea and if the customer base is substantial, then this person would also attract other people who would also want to set up a stall nearby. Now, once this process has been initiated, there is no going back.

Because after all, we cannot throw away people from the forest, they also need a livelihood. But in this process, you will start to observe that quite a large amount of plastic waste will start to get into the forest, because people would say demand for plastic cups, disposable cups, and because this area is not a town or a village, so there are no municipal facilities.

So where will all the used cups go? They will just be strewn around. So, now we are getting a system of getting plastic into the forest and if the stall is successful and more and more people start to come into this area, then we will start to observe perforation. Perforation means that the person who has set up the stall would probably also want to set up a small hut nearby because after all, who wants to go back into the village after every few hours, the person also needs to rest.

So, there has to be a cot there has to be hut nearby and if the person is living there, then probably he or she will also require some other facilities. Probably the person if he has set up say, a tea stall, the person would want to grow say gingers nearby to be used in the tea or perhaps the person would think that okay, I require milk for this tea stall why do not I bring say, a pair of cattle or say a few goats.

Now, what we are observing is that there is a stall there is a hut and slowly and steadily there will be a small pen that is set up for keeping the cattle and these processes will happen so subtly that they will be very difficult to discern and so in a very short period will observe that there will be a few huts that have been set up a few stalls that have been set up, probably a few cattle are being kept here.

Probably some area has been cleared, cleared off to grow certain vegetables or say ginger or say a few flower a flowering plants and this is perforation and wherever you find roads, you will find small perforations. So, now the forest which was erstwhile a completely covered forest is now getting perforated. Now, we are constructing holes in this forest and in a lot of forest areas, you will find certain livestock that are moving inside that are grazing inside and these are the earliest signs of perforation.

After perforation, we will have fragmentation. Now what is fragmentation? The people who started to live here, their business is going strong. So now they want to have more cattle. But then not everybody wants to set up a tea stall. Some members of the family may probably begin to cut the trees and say do a bit of agriculture in this area.

Because after all, they are also people they also need the livelihood. Now, because the tea business is going strong and there is a strong player. So, now you cannot have more and more number of competitors. So, there has to be another way out. So some people will start say agriculture some people will start to sell say cigarettes, some people will start to sell something else and in a short while you will observe that you have people that are using the forest primarily for cattle. There are people who are using the forest primarily for agriculture and to accommodate these people now you have a large number of hats that have been set up.

Now this is fragmentation because once this has been done, now there is so much amount of human dominated landscape that now animals cannot move from here to here without crossing the human dominated landscape. Now the habitat has already been fragmented, it has already been split into small parts. So this is an example of fragmentation. So in this picture, we can see that here we have lush green forests and here we have quite a lot of area

that is under agriculture. We can also observe a few huts and other buildings in the foreground.

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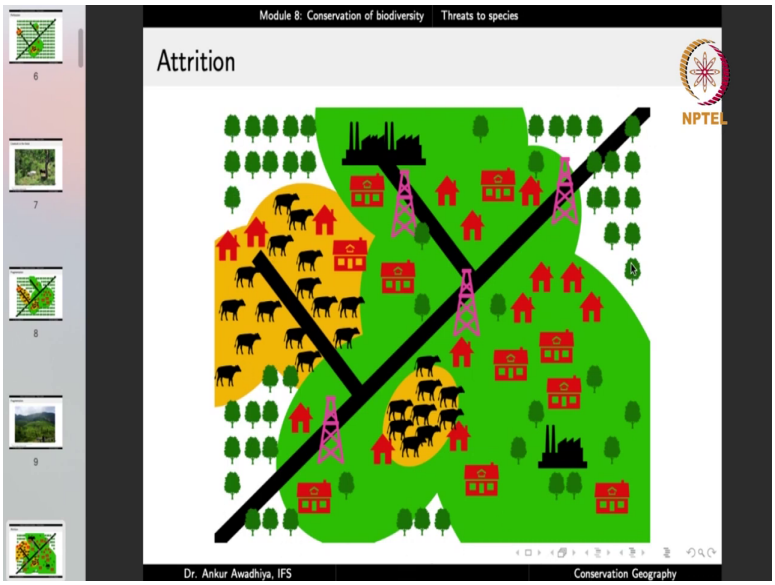

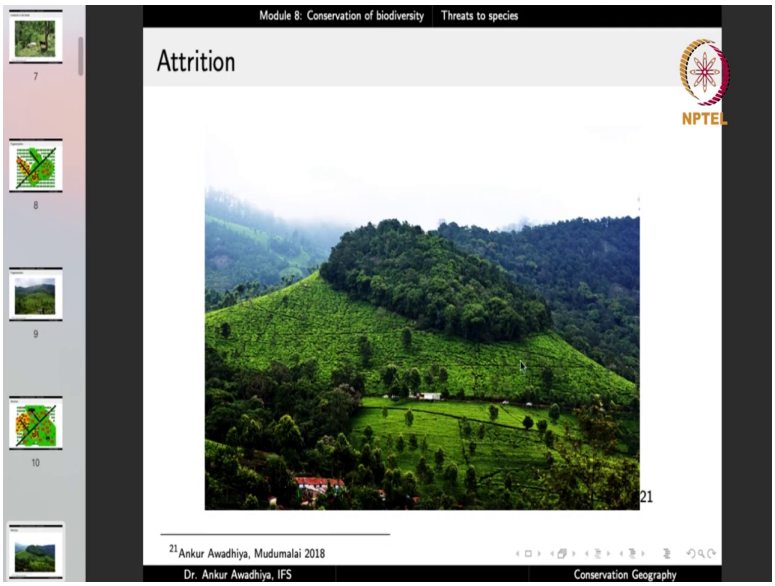

After fragmentation, the next step is attrition, attrition is making something smaller. So now the forest areas will start to become smaller and smaller. Why? Because the people who were raising cattle, they have now increased in number, the cattle have increased in number and the family size has also increased over time.

The people who are doing agriculture, they have also increased in numbers and so many huts and so many buildings have come up that now the government also feels pressurize that they should provide these people with, say, schools or hospitals, or other facilities. So we will start

to observe that government buildings have come up, electricity supply has come up maybe a few small industries have come up.

But all of these require space. So where is this space coming from this space has been taken away from the forest habitat and once this happens, we have very small patches of forests that are left. Now, you will remember that we always wanted to have large sized patches. Why? Because large size patches provide more number of habitats and because they can support a larger population size.

So the small factor dynamics do not play a role there. But now in this process of habitat fragmentation, by the attrition stage, the fragments are so small in size, that they can now not support a large population at all. As you now will start to observe a large amount of extinction that is happening and quite a lot of it will be undocumented.

Because, after all, if people are coming and living in an area, who is bothered to go into the forest and take a count of how many species are there, a lot of our forests are still highly undocumented, we still do not know what species live there. So this is the process of attrition and this is an image that shows attrition. In this hill, the agricultural fields have expanded so much that now only a small patch of forest remains. So, this is attrition.

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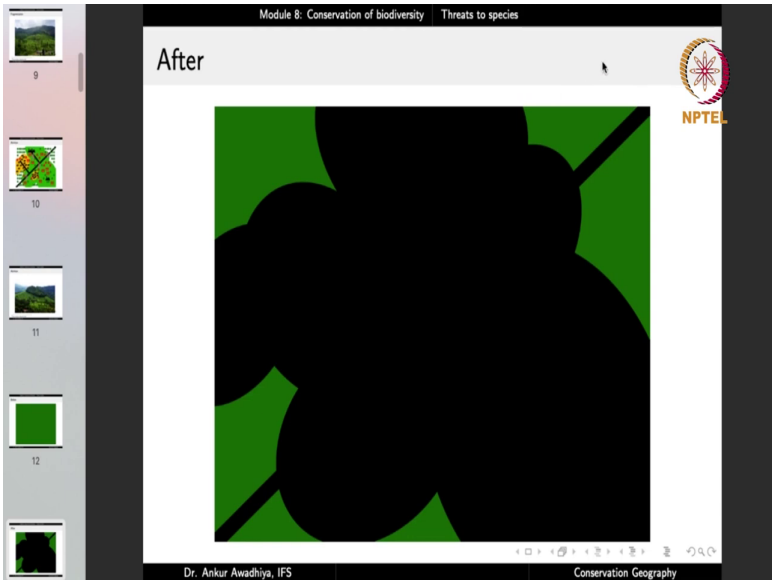

So, what is happening through all of these processes is that a large size habitat is being converted into very small patches of forests. So now very small parcels of the habitat remain.

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And this is an example of an extremely fragmented habitat. This is an area which is habitated by tigers and elephants, they use them as their natural routes to migrate from one place to another. And now we can observe that we do have forests here, but a large portion has been completely cleared off. We are observing, say lawns, we are observing agricultural fields, we are observing buildings we are observing resorts and whatnot.

And when this happens quite a number of times the animals do keep moving in their predetermined paths. And in this area, when elephants move and they encounter the human habitation, they just do not have an another option. Because elephants as we have seen, they

are mega herbivores they require large quantities of food and if they did not move the forest will be completely damaged.

So movement of animals is a mechanism that nature has evolved over the years to ensure that all parts of the forest are equally used and no part becomes overused. Now, in this case when an elephant tries to move from there to here, and when it encounters this area, the elephant does not have the option to go up the hill and then cross because an elephant weighs like 5 tonnes 5000 kilos and carrying a mass of 5000 kilos up the hill is very difficult. It is very energy consuming. Now the elephant began to move because in its original habitat, the part where it was living it, the amount of food available was less.

Now to carry the weight up the hill, it requires even more amount of food, where is it going to get this food from. So the elephant will cross through its natural route and when it crosses through the natural route, it will invariably enter the human habitations. And then we will say that elephants are creating havoc for people. Now it is not elephants that are moving into the human habitations. It is the human habitations that have moved into the elephant dominated landscapes.

And then we will start to observe things like setting up a fences followed by electric fences, followed by whatnot. Now, such a situation of conflict, a human wildlife conflict situation would very well have been avoided, if we from the very beginning demarcated areas as go and no go areas for human beings, if we could have said from the very beginning that this is an elephant dominated landscape and we are not going to permit any settlement in this area.

Only then can be reduced these conflict situations and these conflict situations are bad for humans, and they are bad for wildlife as well. Why humans? Because people lose their lives, people lose their property, people get hurt when they are confronted with elephants. But it is equally bad or even worse for the wild animals, because they have now a habitat that is completely fragmented and they have no other option but to get extinct.

So, these are the factors that are certainly leading to the extinction of several species without us even knowing about it. Now, in this case, it is important to understand that the people who set up their stalls on the roads in the very beginning they did not come up to this area thinking that okay, let us kill off the animals let us play a big role in the extinction of species, no, they were not thinking about that, they were only thinking about their own livelihood, nothing else. But in the process, they have started a process that ultimately leads to the extinction of a large number of species. So, this is the fragmentation of habitat.

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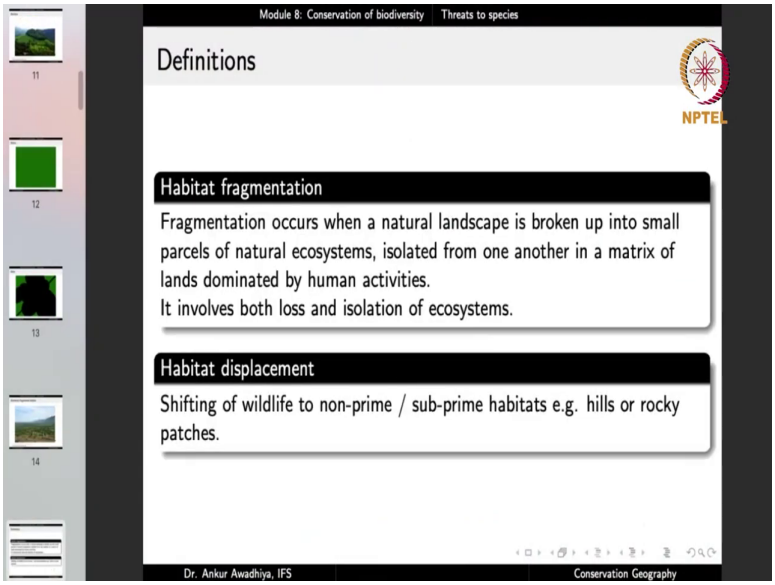

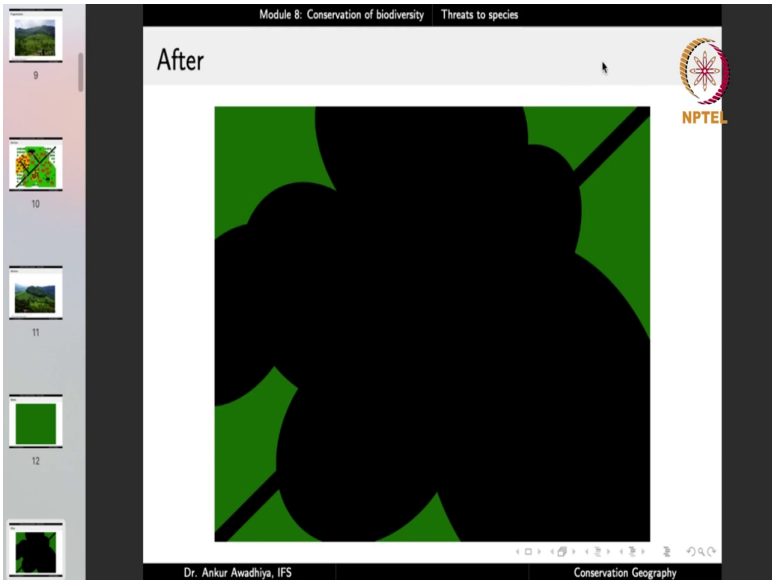

Fragmentation occurs when a natural habit landscape is broken up into small parcels of natural ecosystems isolated from one another in a matrix of lands dominated by human activities. So, this is a matrix of land dominated by human activities and this is fragmenting the habitat into smaller parcels. And it involves both the loss and isolation of ecosystems. Why? Because in this case, we can observe that so much area has been lost.

Now, there is no more habitat in this area for the wild animals. So this portion has been lost and these fragments are now isolated fragments. So it leads it involves both the loss and isolation of ecosystems. Another thing that plays a role is habitat displacement, which is shifting of wild life to non-prime or subprime habitats, such as hills or rocky patches.

In the case of habitat displacement, you will have a situation where the wildlife is moved out of its own area that is considered a grassland. Now, there will be a number of wild herbivores that will be frequenting these grasslands and using the grass for their food. Now, when we have humans coming to these areas with their cattle, the cattle will start to dominate because they are supported by humans, they are supported by dogs. They are supported by guns and sticks of humans.

So ultimately, whenever you find a situation that there are cattle grazing and an Nilgai comes into the area or say a Sambar comes into the area or a Bison comes into the area, what will happen, the humans will just freak out, they will start to make a noise, probably they will start to throw rocks to these wild animals or they will start to see fire at these wild animals or they will start to beat and chase away these wild animals or they use their dogs to chase these wild animals away.

And ultimately we will have a situation where in the whole of the grassland you will not find a single wild animal. The grassland will become reserved for the cattle only. But then where does the wildlife go? You will find wild life in say, the hilly areas in the surroundings.

So, in this picture, if this area does not have the wild life, where does the wildlife go? The wildlife has to go in this area. Now, these plain areas used to have lots of grasses probably a lots of trees. But these sloppy areas will probably not have that much amount of food. Because if these areas had ample amount of food, then probably humans would have moved into these areas.

But because of this competition, we have a situation where the humans have and there the cattle have occupied these areas, and the animals have only this area to go to. Now, this is

habitat displacement, the animals have been displaced from one habitat to another habitat and the second habitat to which they have been displaced to is probably not prime or subprime. That is, it does not have sufficient resources to sustain a large population of the wild animals, it does not have sufficient food, it does not have sufficient water, it does not have sufficient protective cover and so on.

And when you have less resources that are available for the animals, then their population will begin to collapse. Because there is no sufficient resources that are available the carrying capacity of the habitat is so low, that it cannot support a large population, the wild animals will start to die off probably through starvation or thirst and this will ultimately bring the population to such small levels that will start to observe the impacts of the small population dynamics.

And typically, in a large number of cases, if you ask the people who are living there, they would say O sir, there is nothing wrong. We are not occupying the animal habitats, because the animals live up the hills, they do not live on these plane areas. Whereas in actuality, the animals would have preferred to live in the plane areas, but they have been displaced out. So that is habitat displacement.

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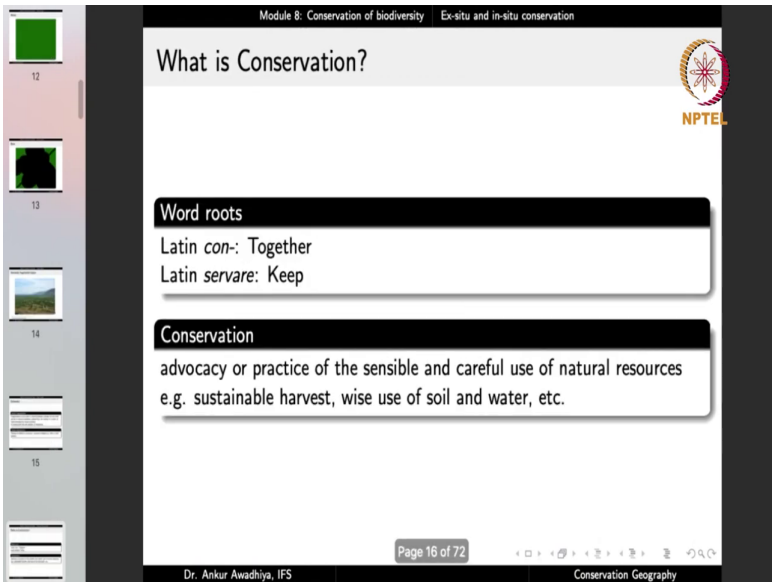

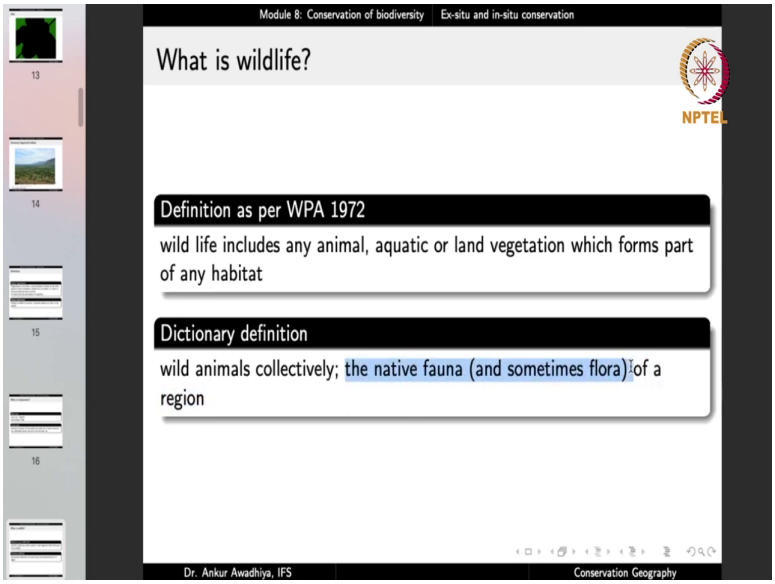

Now given that all of these are happening and we still want to conserve wildlife, how do we do that? So let us look at conservation. We have observed before that conservation means keeping things together and when we want to conserve wildlife, wildlife means it includes any animal aquatic or land vegetation, which forms part of any habitat, as per the Wildlife Protection Act 1972. And the dictionary definition says wild animals collectively and the native fauna and sometimes flora of a region.

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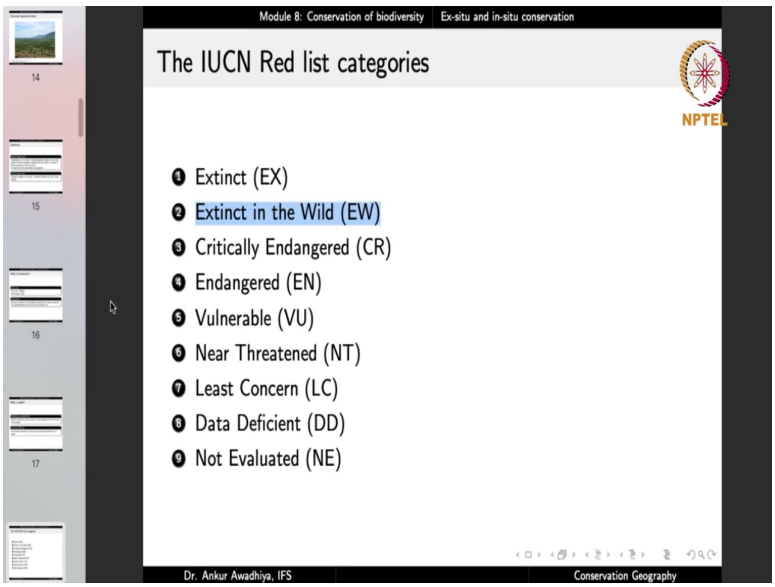

Now the forces of destruction have had different impacts on different wildlife and the international union for the conservation of nature has devised a red list category of different species. So from 1 to 7 we find different levels of threat. But then we also have two other

categories. Data deficient means that we still do not have sufficient data for keeping the species in one of the these 7 categories.

That is we still do not know for a few species how many individuals are left. Where do they live? What are their habitat conditions like? Are the habitats getting threatened or not? So, that is the data deficient category. We also have the not evaluated category for a large number of species that have not been evaluated. Now, how do we prioritize the species? Should we put all our priority on the extinct in the wild species? Or do we say that these are already a lost cause and so all our attention should be on the critically endangered species or probably on the endangered species. How do we decide?

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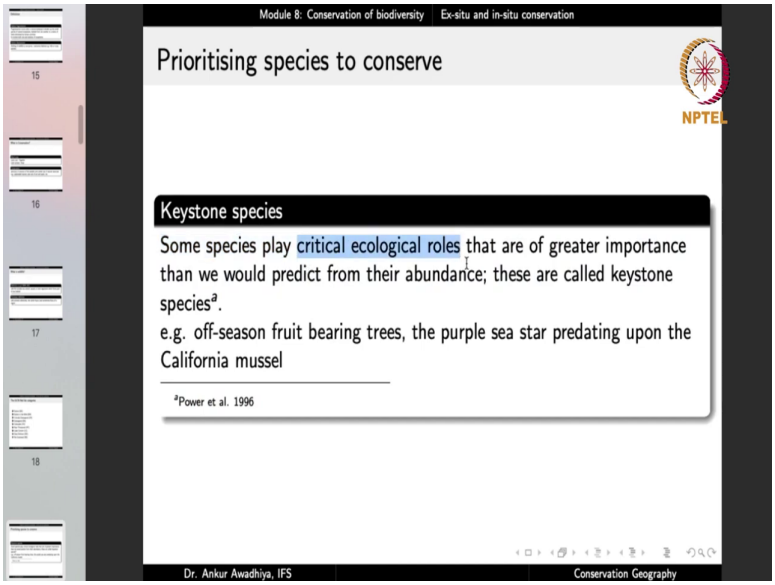

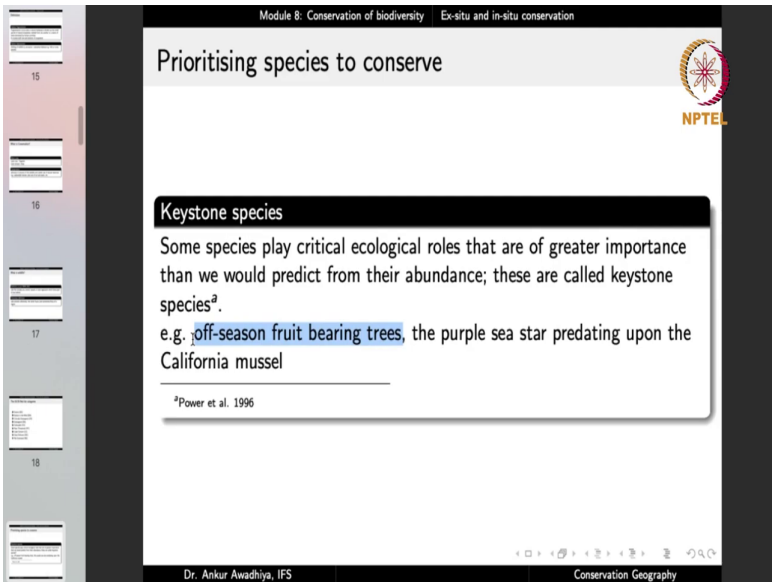

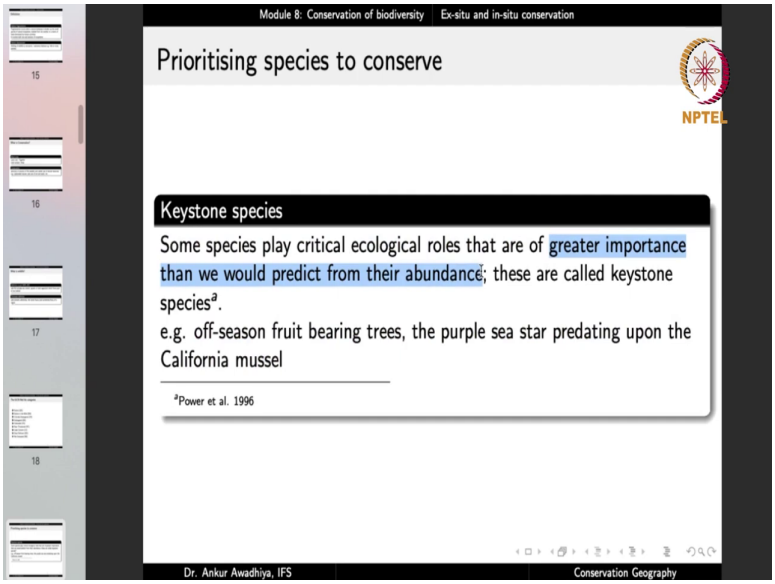

So we need to prioritize the species because we have lack of resources, we do not have sufficient money, we do not have sufficient manpower and most importantly, we do not have sufficient time to conserve each and every species. Because we have led so great amounts of destruction, that now time is severely limited.

So, if we do not prioritize the species to conserve, then probably will lose a major chunk of our species. So, now the question is how to prioritize the species to conserve and in this context, we just cannot leave it to subject matter experts. Because a person who is say working on Tigers would think that Tiger is the most important species and this is the species that should be given all attention.

A person working on elephants might say that no elephants require most attention. Whereas a person who is working on birds might say that we have spent so much amount of time, money and other resources on tiger and elephant conservation that now we should be conserving birds. So, you cannot leave it to just one set of scientific experts. It has to be a holistic view and for this we define certain categories of species.

The first are keystone species, they play critical ecological roles that are of greater importance than we would predict from their abundance and these are called keystone species. Species such as offseason fruit bearing trees. Now, if you have a single offseason fruit bearing tree, it means that in the offseason, when there is no other source of food in the forest, this tree provides food to a large number of organisms.

And so conserving this tree should be one of the most important priorities because this tree supports a large number of other species. Similarly, when we talk about tigers, the tigers are

keystone species because they keep the herbivore population in check, you remove the tigers and the herbivore population would increase so much that they would eat away all the young plants and when the older trees become older and they die, we will have a stage where the forest no longer have any younger regeneration to replace them and whole forest will be gone.

So tigers are required to keep a check on the herbivore population. So tigers are also keystone species. Now in this context, it is important to note that we still need herbivore populations, we cannot say that okay, we need the forest for their ecosystem benefits and so we should kill off all the herbivores because if you try to do that, then who will say perform the seed dispersal.

So herbivores also have their own importance in the system. But the key here is that tigers are keystone species because they keep the herbivore numbers in check, they ensure that the herbivore numbers do not increase so much as to cause destruction of the habitat and at the same time, they also ensured that it does not go so down that we do not have any herbivores left.

So there is a dynamic equilibrium between tiger and the herbivore populations that is governed by things that are known as Lotka Volterra dynamics. So, these are keystone species, those that play critical ecological roles that are of greater importance than their numerical abundance, so they have to be protected.

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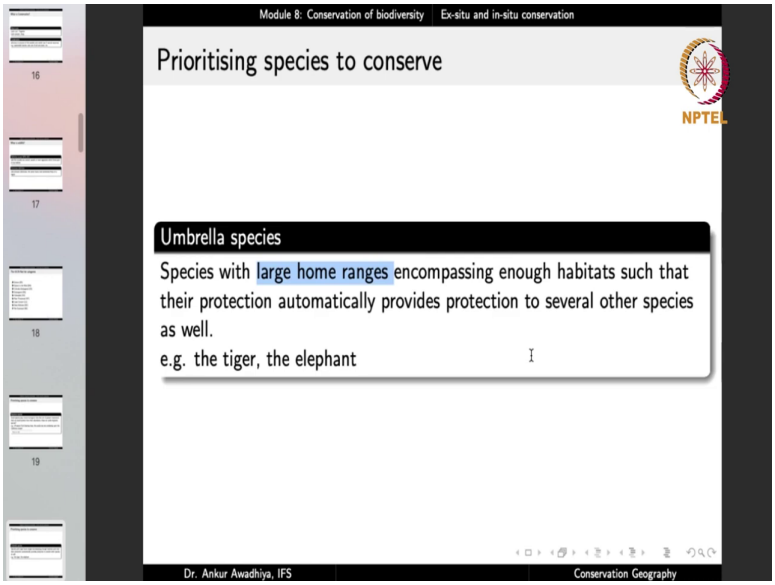

Second is umbrella species. Species with large whole home areas, large home ranges, encompassing enough habitats, such that their protection automatically provides protection to several other species as well. Things like tiger and the elephant. Now, elephant, as we have observed is a mega herbivore, it has a huge home range.

Now, if you focused on conserving the elephant, you would have to conserve the huge home range of the elephant as well and when you protect and conserve this huge home range of the elephant, then quite a large number of species automatically get protected and this is very important, because we still do not know everything about every species quite a large number of species are still undocumented.

And so we have to work on these large habitat level interventions to protect those species that we have still not documented. Probably a few of them could even be a keystone species. But we do not know. Similarly, tigers required large home ranges and so if we conserve tigers, large home ranges automatically get protected.

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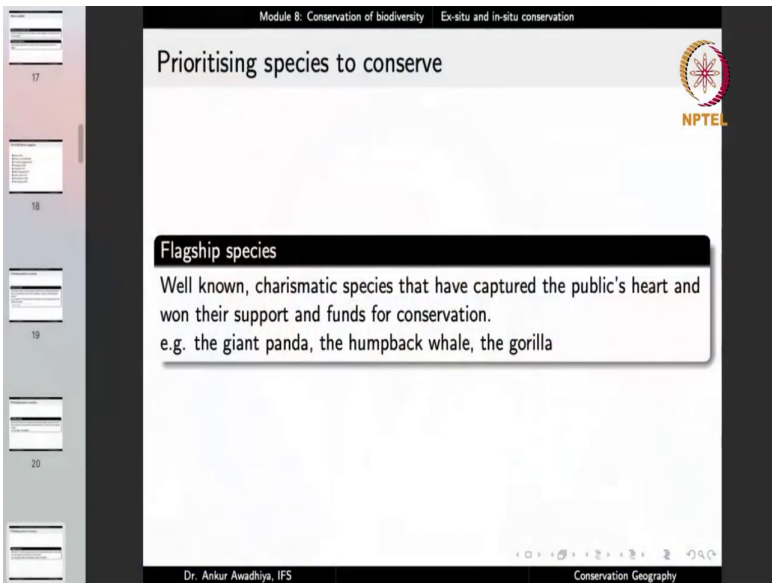

And the third category of prioritization is the flagship species, the well-known charismatic species that have captured public's heart and win their support and funds for conservation. These are the species that people relate to the giant Panda, the Humpback Whale, the Gorilla the Polar Bear, even species that have religious importance, such as the elephant, because of its association with Lord Ganesh or species such as the tiger.

Now, these are species that have cultural religious significance or those a species that people relate themselves to because they find them cute or they find the majestic are also those

species that need to be given a priority. Why? Because they move public opinion and public opinion is important so, that we have people that are working for conservation, we cannot do conservation without people.

So we need people to work for conservation to protect these animals and the animals that they relate to should be given a high priority. So these are also the priority animals. Now the thing is, if we had infinite amount of resources infinite amount of time, infinite amount of money, we would have preferred to save each and every species conserve each and every species. But if we do not have sufficient resources, then for prioritization we should at least select those species that are keystone species or umbrella species or flagship species.

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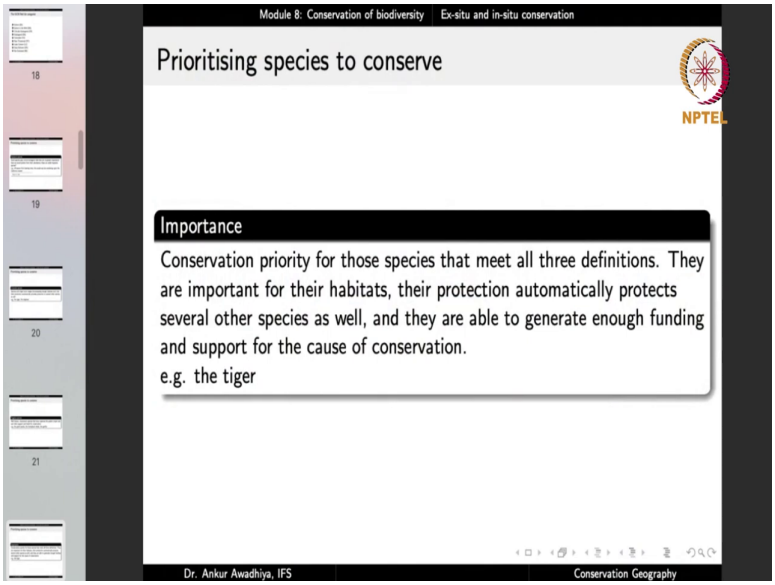

But nothing like if you have a species that meets all these three criteria species that are important for their habitats meaning that they are a keystone species with large home ranges meaning that they are umbrella species and species that are able to generate enough funding and support meaning that they are flagship species. They should be the number one priority.

So species like the tiger, it is a keystone species because it regulates herbivore population, it has a large home range and plus people can relate to it, it has religious significance, it has cultural significance people want to see tigers. So, species such as tigers that meet all the three criteria should be the species to be given the highest amount of priority. So, this is the benefit of categorizing species on these three scales.

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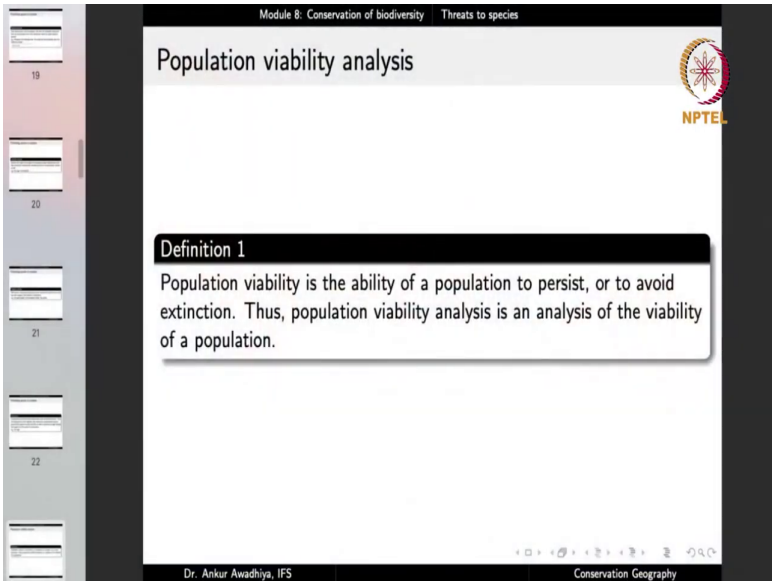

And for these species, we can even do population viability analysis. Population viability is the ability of a population to persist or to avoid extinction. And so, population viability analysis is an analysis of the viability of a population that is we are trying to understand if a population can survive to a certain time span or not. That is in the next 100 years, what is the extinction probability of a particular population, that is population viability analysis.

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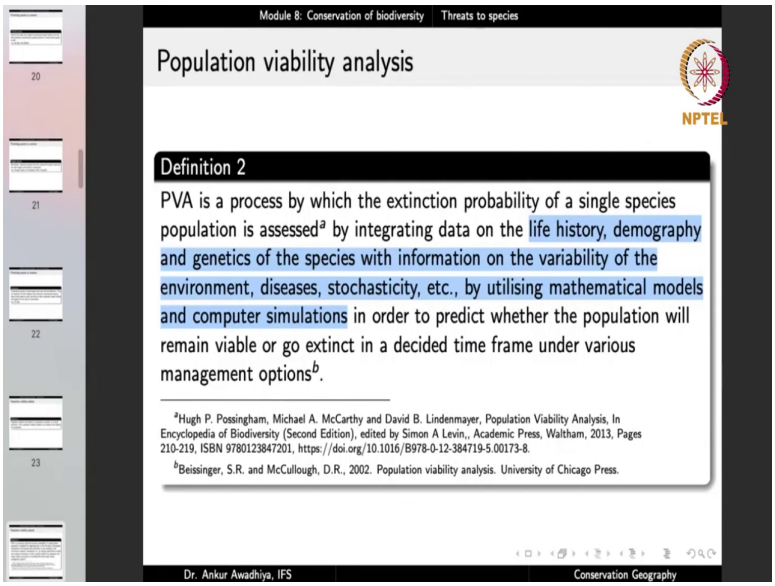

It can also be defined as a process by which the extinction probability of a single species population is assessed by integrating data on the life history, demography and genetics of the species with information on the variability of the environment diseases stochasticity et cetera. By utilizing mathematical models and computer simulations. In order to predict whether the

population will remain viable or to go extinct in a decided timeframe under various management options.

That is, we integrate all sorts of data that we have about the species data about how large is the litter size? What is the sex ratio at birth? What is the age at which different individuals die? So, what is the life expectancy for males? What is the life expectancy for females? What is the home range? How frequently do they move from one population to another population?

And we combine this with data about the threats, what is the frequency of drought in a forest? What is the frequency of floods in a forest? What is the frequency of major diseases spreading in the forest? What is the frequency of a forest fire? So, when we integrate all of these data together now, because we have a large amount of data, so we typically make use of mathematical models or computer simulations.

So, for instance, we can use a computer simulation and say in the first year, we say that there is a flood with such and such probability, what will be the and we know the current population size, what is the expected population size after the first year, then in the second year, suppose we get to drought what happens to the population then? In the third year, suppose we get a forest fire, what happens to the population then and so on.

So, basically, we do a computer simulation, taking into account the probabilities of various threats and we put in data about the current population numbers and the population characteristics to understand what are the factors that will play the most dominant role in the extinction of the population and how long will the population be able to persist and with this information, we can make management interventions.

So, suppose we figured out that the population will die because of inbreeding depression, because animals are very much related to each other. So, in that case, we will probably try to bring an individuals from outside. If he learned that the population has the highest threat for from poaching probably will work on the protection measures. So that is population viability analysis or an analysis of the viability of the population. Now, once we know the extinction probability of a population, what can we do about the population?

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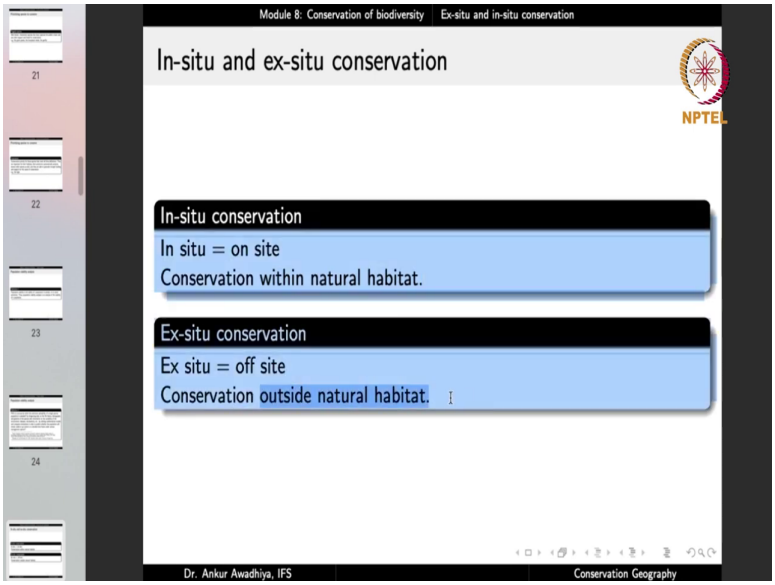

Now in this context, there are two modes of conservation in situ conservation and ex situ conservation. In-situ conservation is conservation on the site that is within the natural habitat and ex situ conservation is conservation off site that is outside the natural habitat. So, in the case of in situ conservation, we try to protect the habitat where the animal is naturally living.

So, it is conservation on site on the site where the animal is actually found. In the case of ex situ conservation, we take a few animals out of their natural surroundings, keep them in a facility where they are completely protected, give them food, give them water, give them maternity care and so on to ensure that these animals survive and preferably also breed. So that is ex situ conservation.

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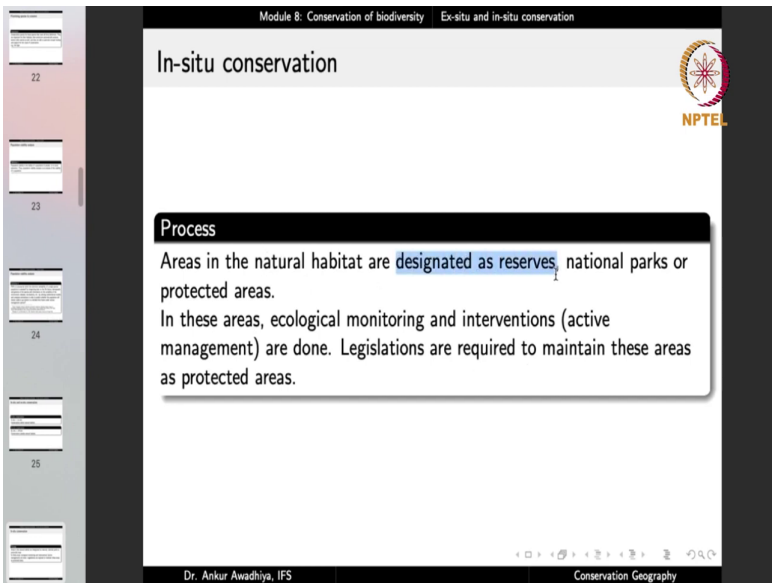
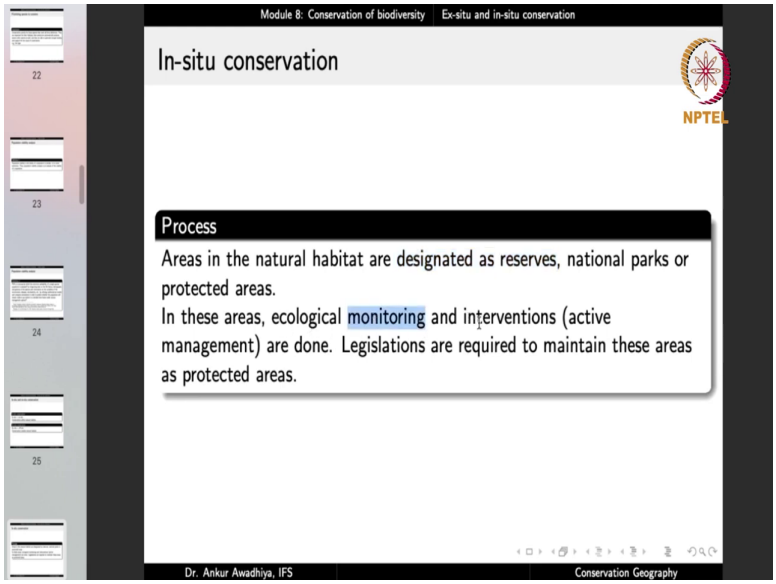
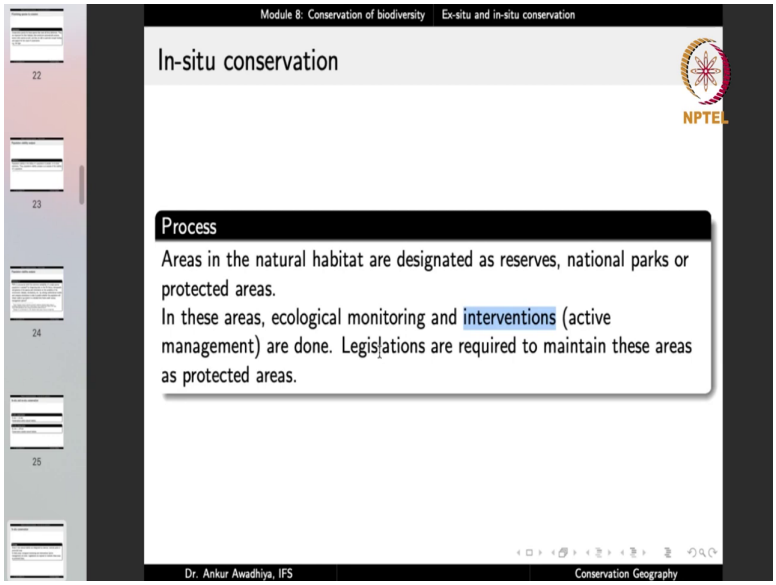



Module 8: Conservation of biodiversity
Ex-situ and in-situ conservation
In-situ conservation
NPTEL
Process
Areas in the natural habitat are designated as reserves, national parks or protected areas.
In these areas, ecological monitoring and interventions (active management) are done. Legislations are required to maintain these areas as protected areas.
Dr. Ankur Awadhiya, IFS
Conservation Geography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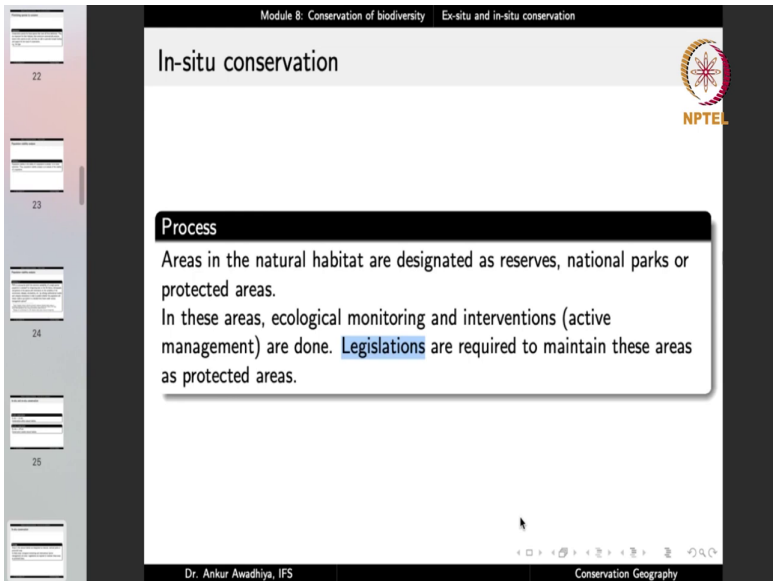
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Now, in situ conservation the process is that the areas in the natural habitat are designated as reserves national parks or protected areas. In these areas, ecological monitoring and interventions are done. Legislation are required to maintain these areas as protected areas. That is we designate areas as protected areas, do monitoring and do interventions. And typically, these also require legislation to ensure that these areas remain as protected areas in the long term. So, this is in situ conservation.

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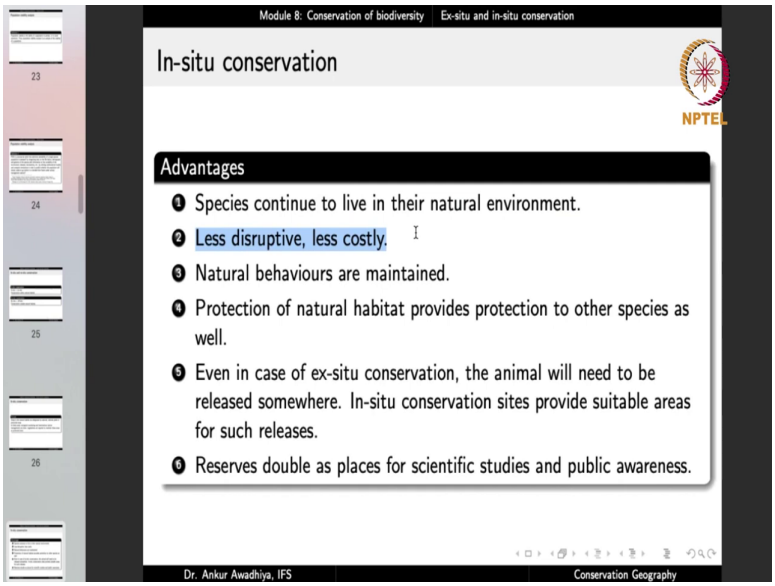

Advantages, the species continue to live in their natural environment, because these reserves are being made in areas where animals naturally live, it is less disruptive, less costly, because there is very little amount of intervention that you need to do. You are not capturing animals, you are not transporting animals, you are not setting up a big infrastructure rich facility you are not giving them food and water from outside you are not giving them veterinary treatment and so it is mostly less costly, then ex situ to conservation.

The natural behaviours are maintained because the animals are living in natural conditions. Protection of natural habitat provides protection to other species as well and even in the case of ex situ conservation, the animal will need to be released somewhere so in the case of ex situ conservation such as zoos, once you have done captive breeding the animal population has increased then you will preferably want to release it back into the natural environment.

Now, if you do not have in situ conservation sites, such as wildlife sanctuaries or national parks or reserves, where would you release these animals back to? If you do not have in situ conservation areas, it is possible that all of the habitat of the animal becomes completely lost and so we require in situ conservation to work together with ex situ conservation. Now, in

situ conservation sites provides suitable areas for such releases and they also double as spaces for scientific studies, public awareness, tourism et cetera.

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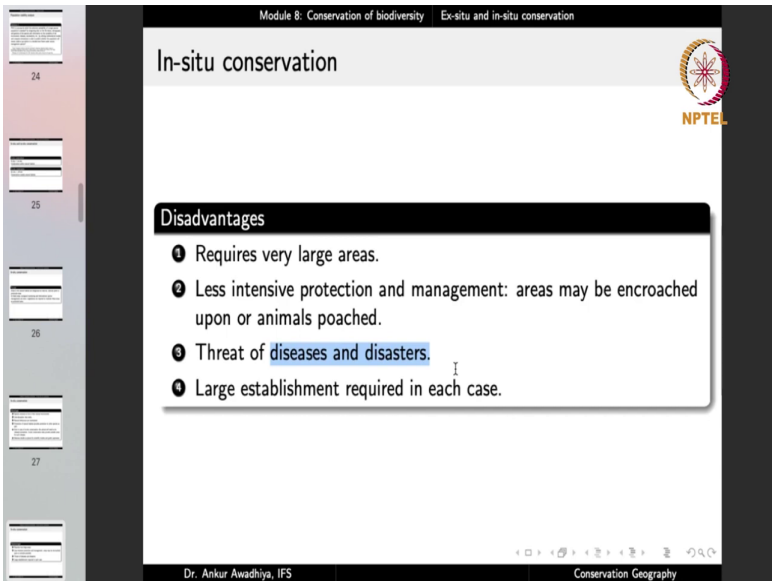

Disadvantages typically, these are very large areas and the land is becoming costlier by the day because people want to use land for various other activities for agriculture, for mining, for industries for habitations. And so when the government says that okay, this area is a wildlife sanctuary, you will always find that people want to find out some other loophole to convert this area to a non-protected area or at least to divert certain areas from the protected area to be used for other uses.

Typically uses such as laying of roads, laying of railway lines or doing mining. So, the first disadvantage is that it requires very large areas, the protection and management are less intensive and so the areas may get encroached upon, or the animals will get pushed, we regularly hear of poachers being able to make their way into protected areas and killing off a few animals because these areas are large areas.

So you cannot have a full proof safety mechanism. You cannot cover this area completely with a fence because in any case, you want to maintain connectivity between different areas. And so, the interventions, the protection the management they become less intensive, which has their own side effects. There are constantly threats of diseases and disasters typically, because these areas are large and it is difficult to provide instant veterinary care to all the animals and because the areas are large, so you require large establishment, large number of people to run these areas.

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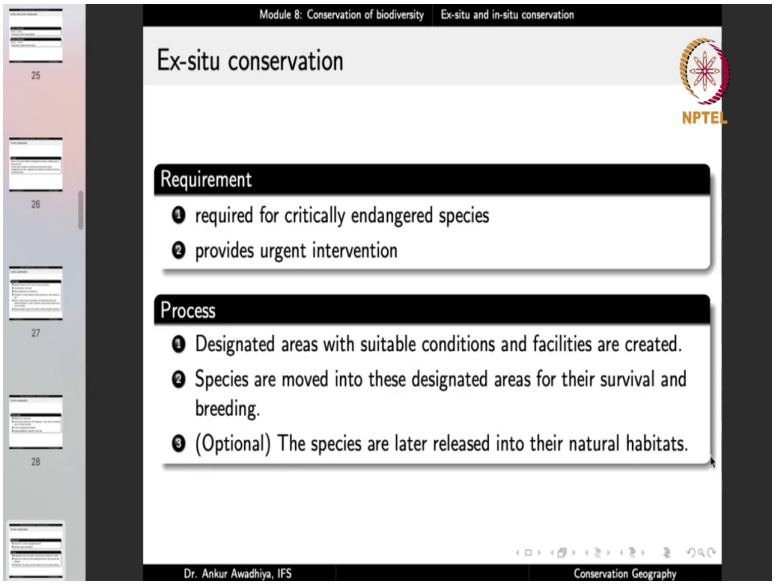

Ex situ conservation on the other hand is conservation off sight. It is typically required for critically endangered species. So there are certain species that are now so less in numbers that if you do not give them intensive coverage, intensive protection, then they will very soon become extinct and to give them an intensive care, we take them out of the natural habitat and we rear them in artificial facilities.

So, that is ex situ conservation it provides urgent intervention when it is needed. Process we designate areas with suitable conditions create facilities. Now, suitable conditions means, that we can have a requirement that it should be a plain area or when we are doing conservation of plants then it should be say a hilly area or it should be a shady area or it should be a sun exposed area with such and such rocks or such and such soil.

So, there can be n number of suitable conditions. So, we select these areas and then we create facilities, facilities such as a perimeter fencing around this area so that nobody else is able to enter into this area. We need enclosures and cages for the animals we need food processing facilities, and so on.

So once these facilities have been created species are moved into these designated areas for their survival and breeding and we give them ample amount of care, food and support and the third optional step is that the animals are later released back into their natural habitats once the numbers have gone up. So that is ex situ conservation

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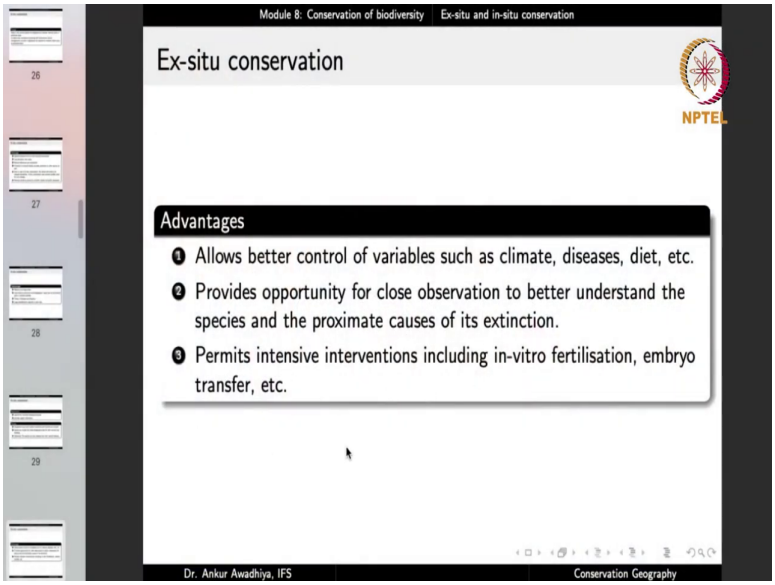

Advantages; it allows better control of variables such as climate, disease, diet, et cetera. Because you are keeping the animals in a separate facility, you can control the climate, if it becomes too hot, you can put on a cooler you can put on an AC, if it becomes too cold, you can run a heater, you can keep a very good control over diseases because you can provide them with instant veterinary care as and when required.

We have a very good control over diet, we can control the amounts of nutrients that these animals are getting, probably even give them multivitamin supplements. It provides opportunity for close observation to better understand the species and the proximate causes of its extinction.

So for example, we can understand about the breeding behaviours of these animals to understand why the animal populations in the natural habitats are not going up. Then it permits intensive interventions including in-vitro fertilization, embryo transfer and so on, which may be very urgently needed for those species that are right on the brink of extinction. If you do not store their sperms, their ova, their embryos, then probably it would be a lost cause very soon. So ex situ conservation permits intensive interventions.

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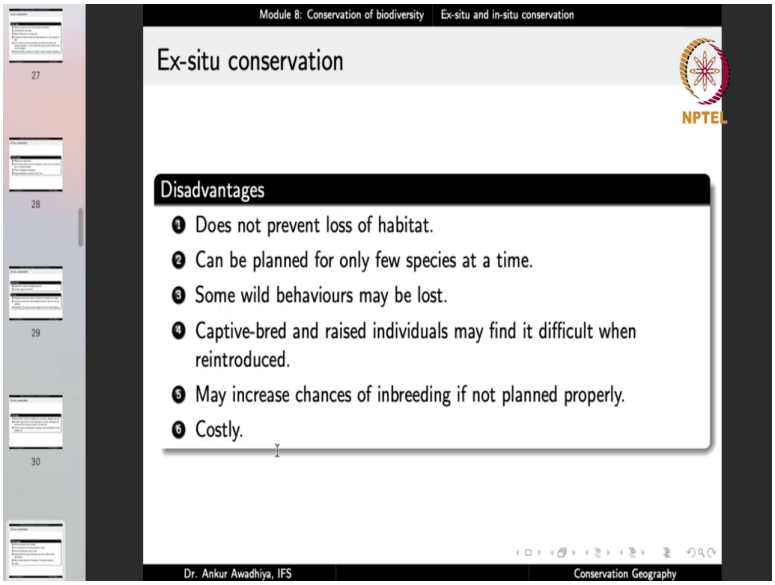

But it also has its own disadvantages, it does not prevent the loss of habitat. It is possible that the specimens that are kept in the zoos, they survive and they breed. But in the meantime, all of their habitat is lost. So once the populations increase in size, where do you release them. So it has to be accompanied by in situ conservation.

It can be planned for only a few species at a time because it is very resource intensive. It is very costly. Some wild behaviours may be lost because you are keeping the animal in an artificial environment. So it is not getting a natural habitat, it will lose its behaviours. Captive breeding and captive bred and raised individuals may find it difficult when they are reintroduced.

Because they have never lived in the natural habitats. They do not know how to survive in the natural habitat. They have not learned how to hunt, for instance, because they have always been provided with food. So once you release them into the natural habitat, they would still expect that humans would come around and give them food.

It may increase chances of inbreeding if it is not planned properly. Because you are keeping a few animals in a facility and so if you do not take care, then it is possible that there are large amounts of inbreeding that occur in these small populations and it is costly, not just in terms of money, but also in terms of other resources, like time and manpower.

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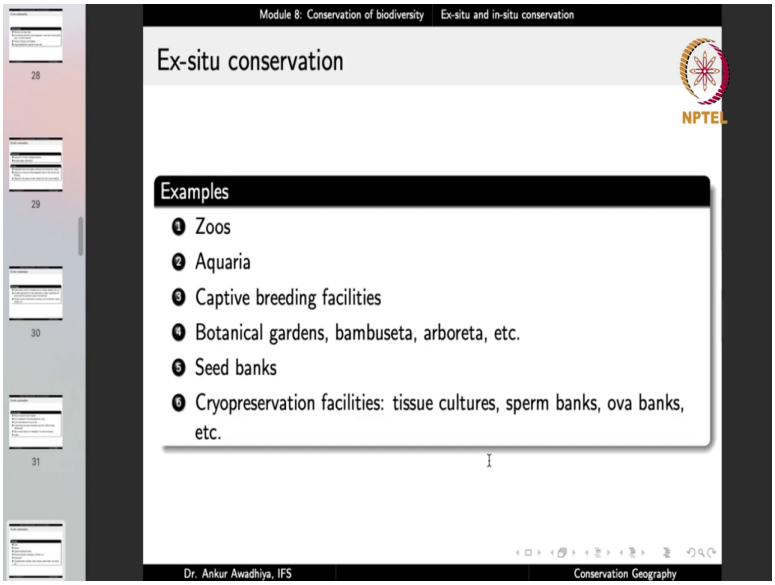

Examples of ex situ conservation include things like zoos, aquaria, captive breeding facilities, botanical gardens, bambuseta where we keep different species of bamboos; arboreta, where we keep different species of trees, seed banks, cryopreservation facilities like tissue cultures, sperm banks, ova banks and so on. So these are all ex situ conservation facilities, because in these cases, you are keeping the animals away from their natural habitats.

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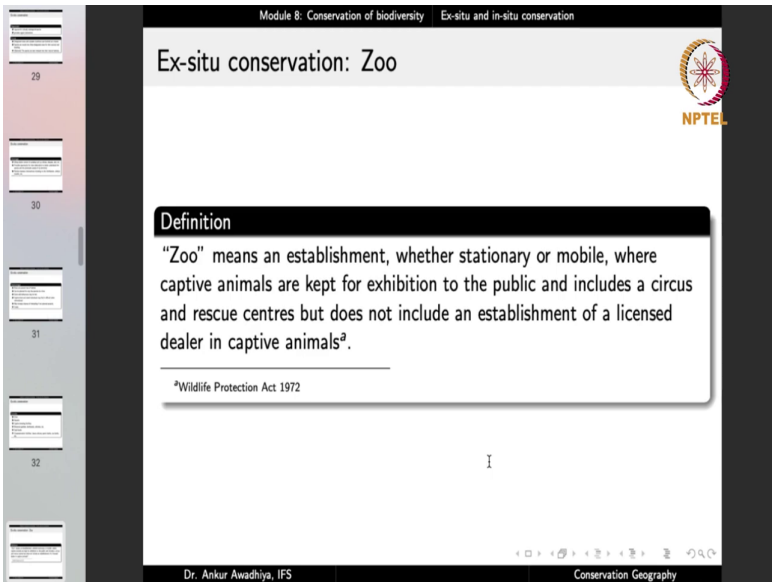

So, let us now look at one example in detail and this example is zoo. Zoo is defined as an establishment, whether stationary or mobile, where captive animals are kept for exhibition to the public, and it includes a circus and rescue centers, but it does not include an establishment

of a licensed dealer in captive animals. So this is how the Wildlife Protection Act defines a zoo.

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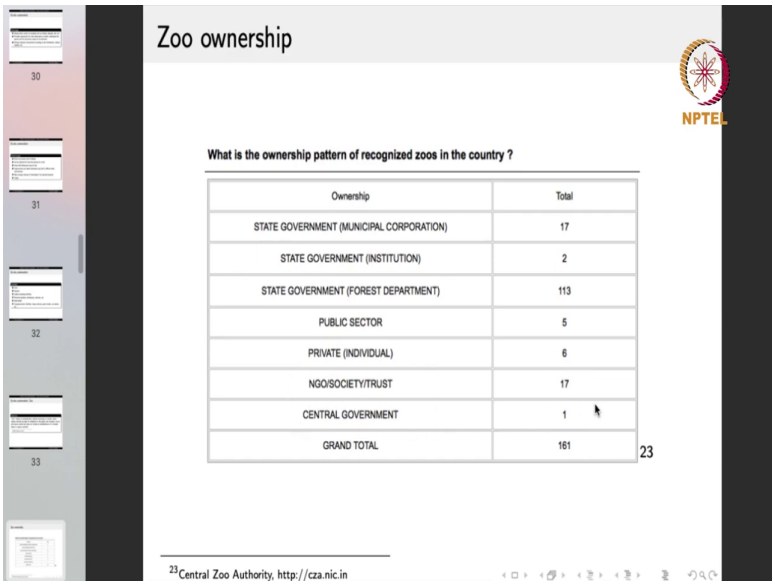

In our country, the majority of zoos belong to the state government or the forest department. Then we have zoos that belong to the municipal corporations to state government institutions, public sectors. We also have private zoos, zoos that belong to NGOs or societies and we also have one zoo that belongs to the central government.

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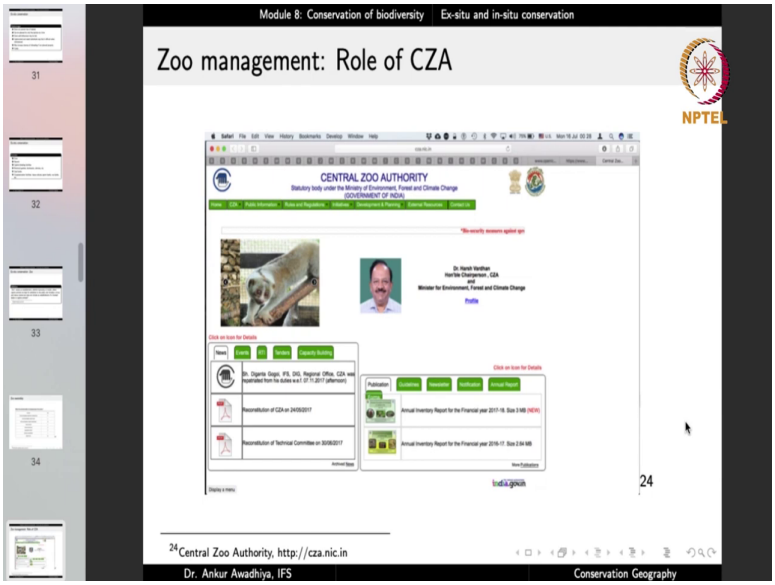

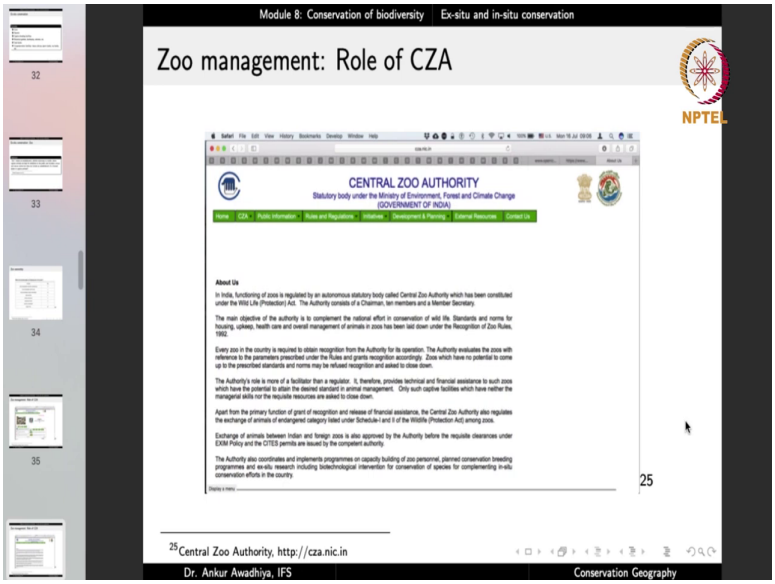

And in our country, the zoo is overseen and managed under the umbrella of the central zoo authority. The central zoo authority sets guidelines about things like the enclosure size, or things like how the animals should be kept, what they should be fed, and so on.

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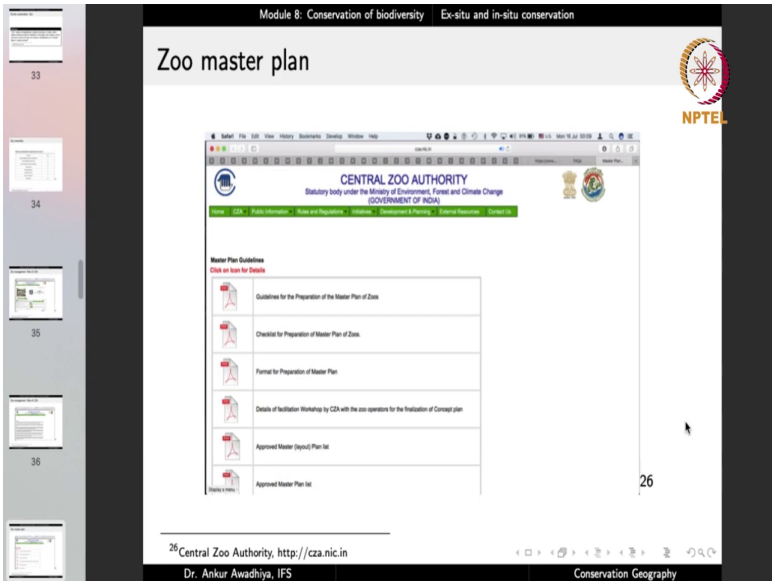

And for the zoos, we have master plans that tell us about how the animals are going to be brought in how they are going to be managed, what kinds of care are we going to give to these animals.

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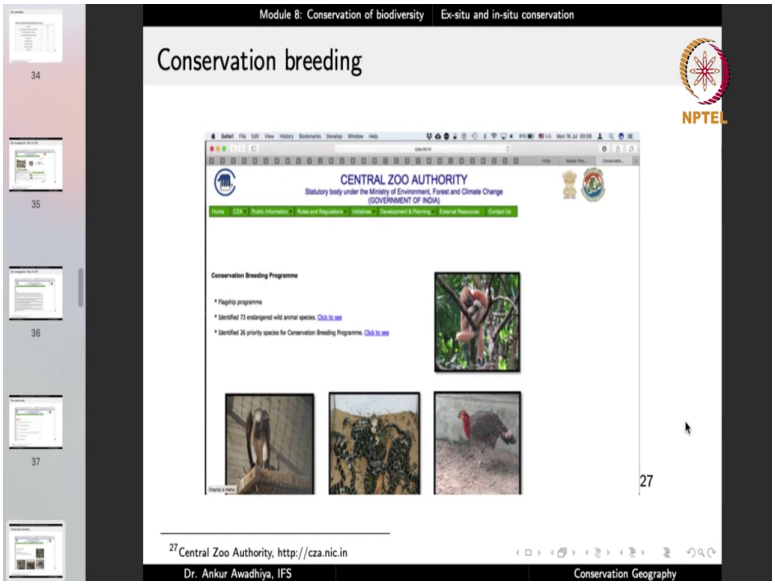

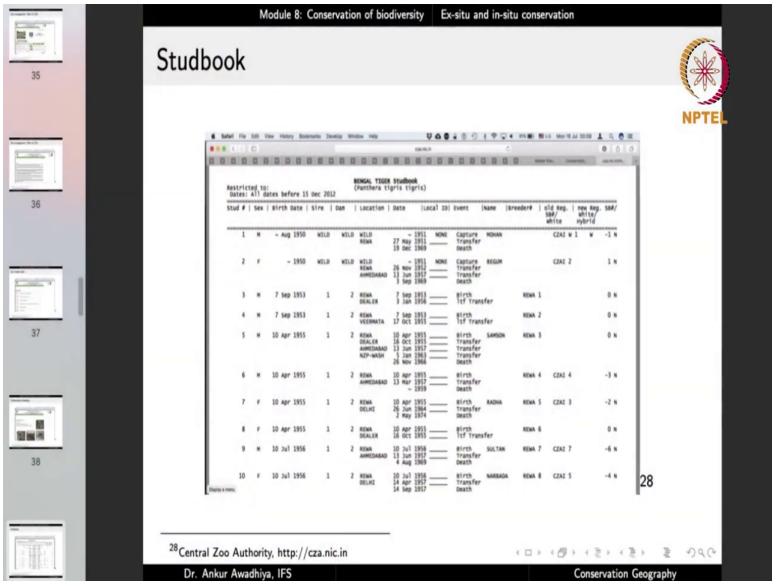

And in a large number of zoos, we also do conservation breeding, in which case, we perform captive breeding probably for later release back into the habitat. For this, we also maintain stud books, which tell us about the origin and the pedigree of different animals. So, who is the father of whom who is the mother of whom, so these stud books are kept, so that inbreeding depression is avoided in the zoo facilities.

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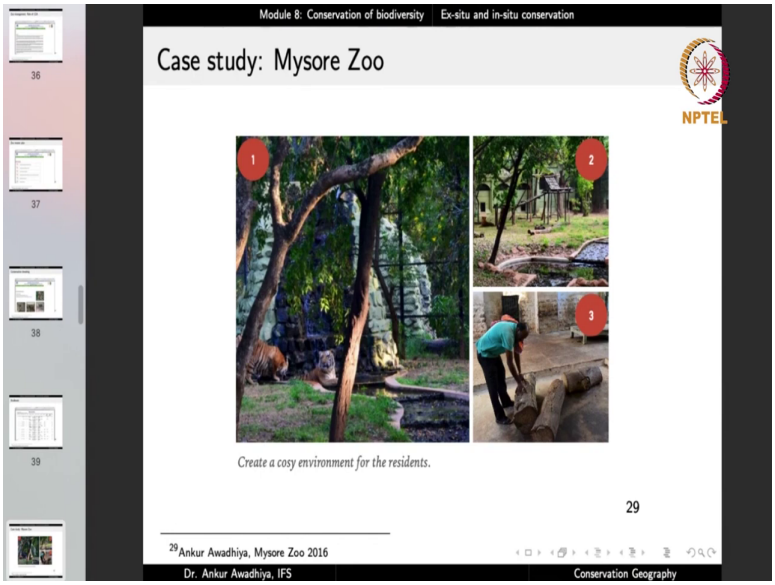

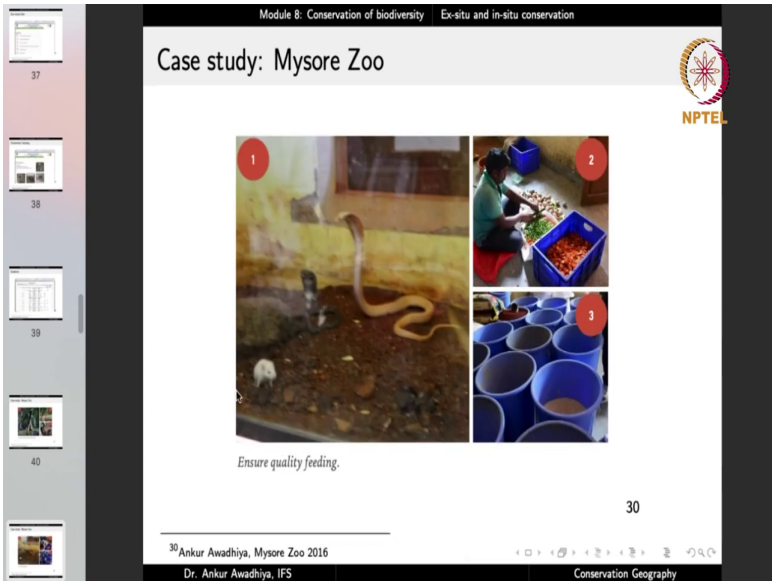

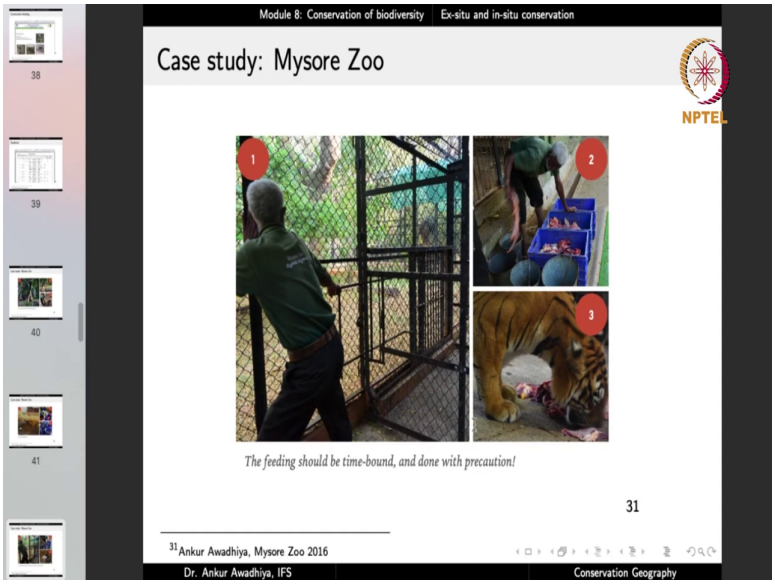

Let us now look at a case study and this is of Mysore zoo. So if you look at the tiger an enclosure, you will find that it is given a waterfall in artificial waterfall. So that there is a cozy environment it feels at home, there is a large and enclosure. It even has things like these logs that are kept for maintaining its scratching behaviour.

In the zoo, the diet is the most important and certain animals are captive bred such as these white mice to be fed to snakes and in other cases, the food is brought from outside it is prepared and it is fed to the animals. So this is a tiger that is feeding in the zoo.

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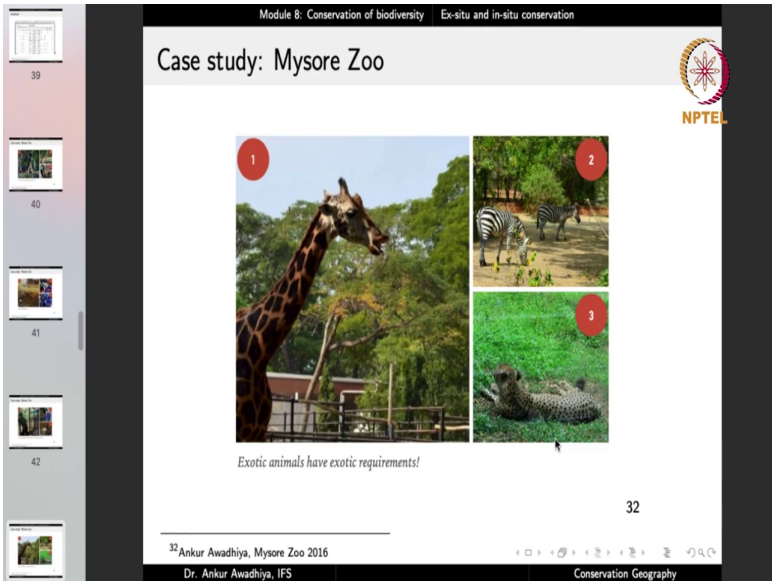

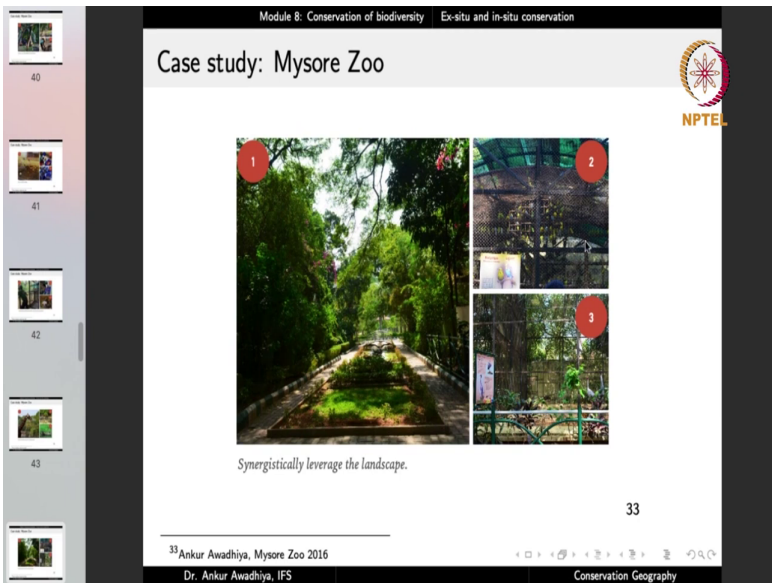

Then we have exotic animals as well. So we have giraffes, we have zebras, we have cheetahs, and they have their specific requirements. So whenever you keep any animal in the zoo, you

have to be very particular about where this animal has come from, what does it eat, what are its behaviours like and so on.

Then, the landscape is strategically leveraged. For example, if you look at the bird enclosure, the, those birds that feed on insects, then it is kept in such a way that natural breeze also brings in certain insects to these birds.

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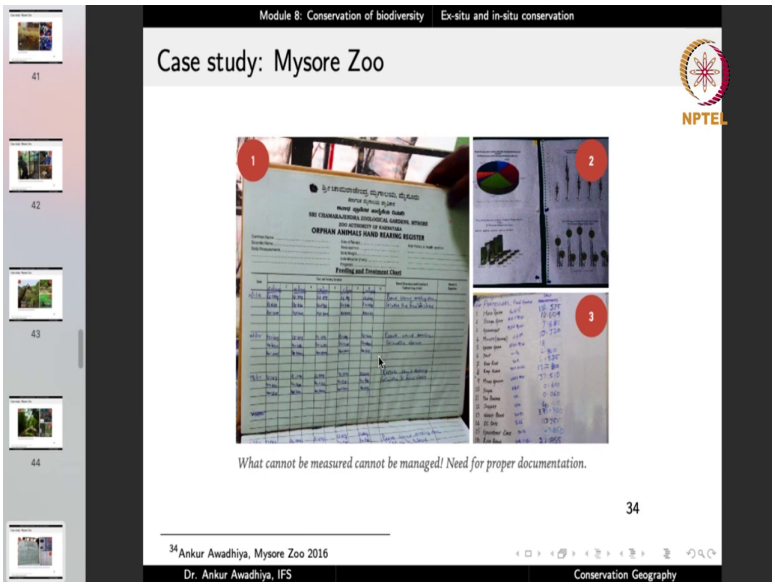

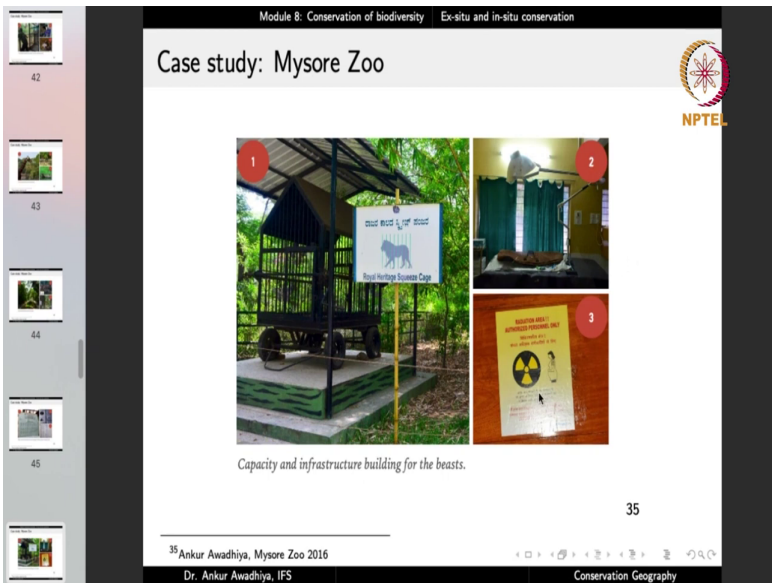

Then the data are kept about various activities that are going on, then we have a very good amount of veterinary care that gets provided. So we have cages such as the squeeze cages that are used to give medicines to animals. We have very good veterinary facilities in terms of X rays, operating theatres, and so on.

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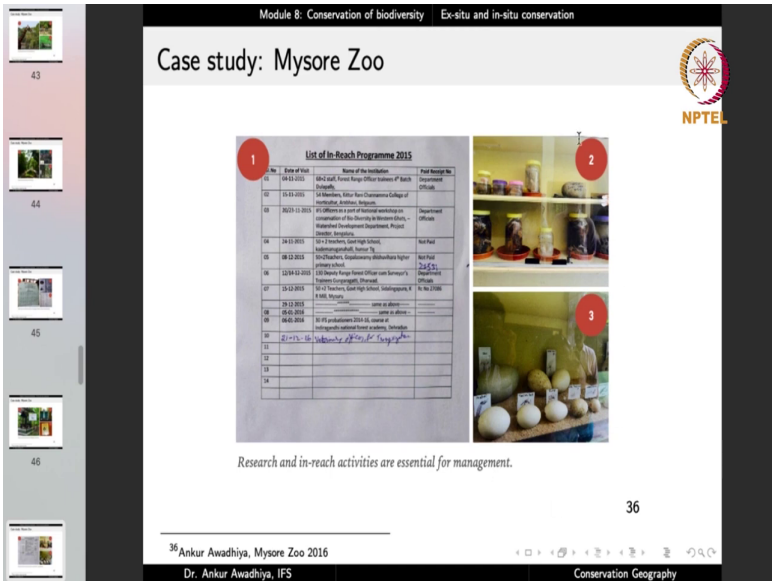

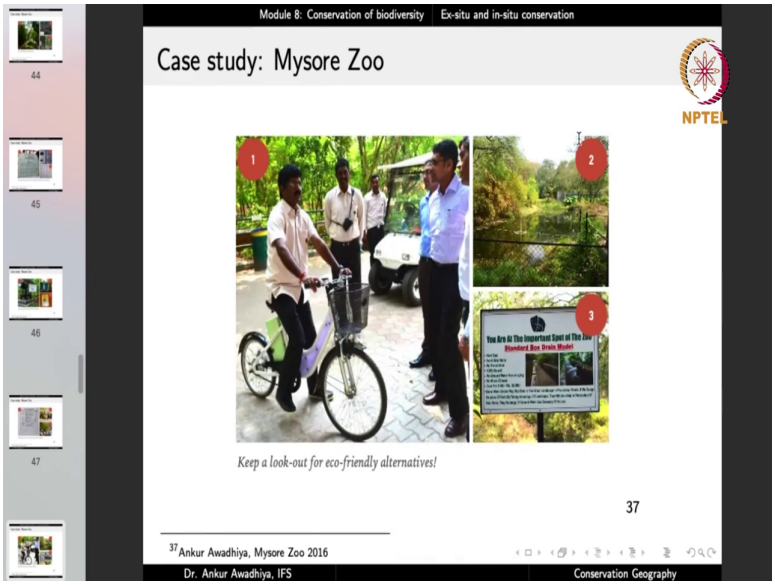

Then, zoos also play a big role in doing research, and in reach. So it allows people to come and observe animals, it allows researchers to take samples from animals, things like blood samples, or things like tissue samples. And quite a lot of eco-friendly activities are being used these days.

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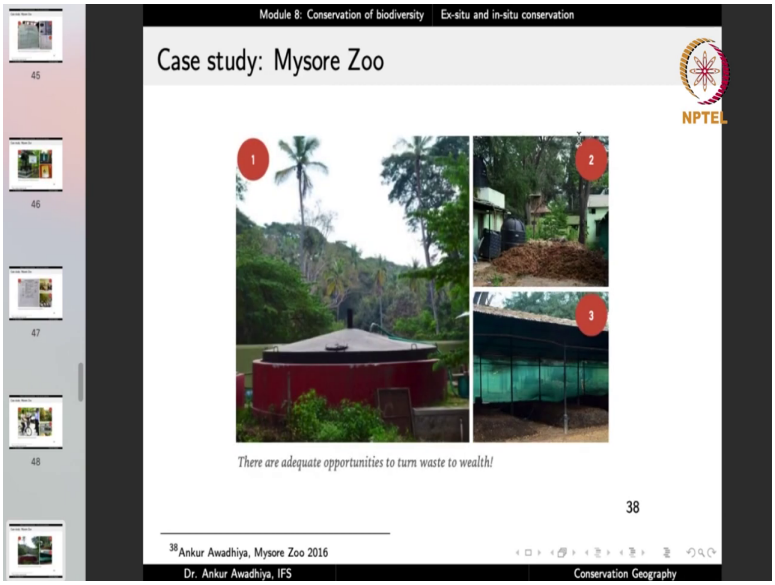

The zoo also makes use of its waste. So it tries to minimize the impact on the environment. It maintains very good amount of visitor facilities. Because as we have seen a zoo is a facility that also intends to display animals to the public and this is very important to generate a public opinion towards conservation.

So we want people to come to zoos to see these animals, to become attached to animals so that they can later on play a role whenever there is a conservation challenge. Now if people are coming into the zoos, we need to have facilities; facilities for ticketing, facilities for their movement, public amenities, toilets cafeteria and so on. So it requires a very big infrastructure.

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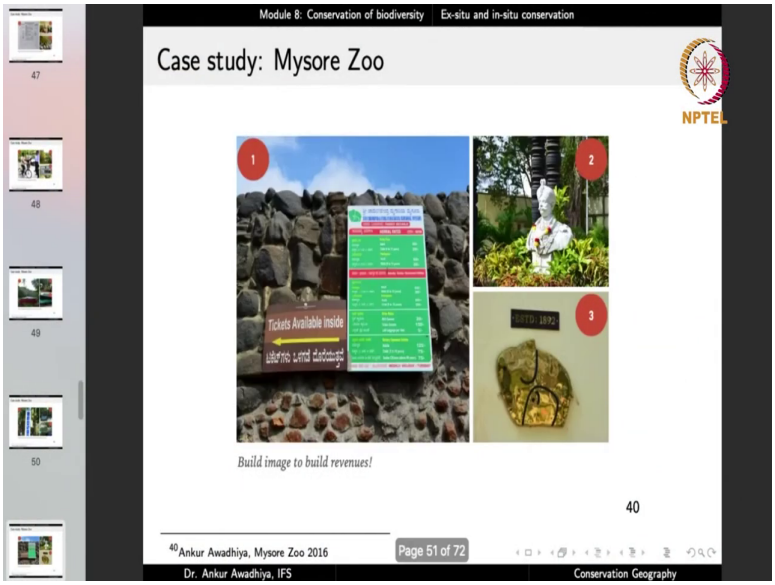

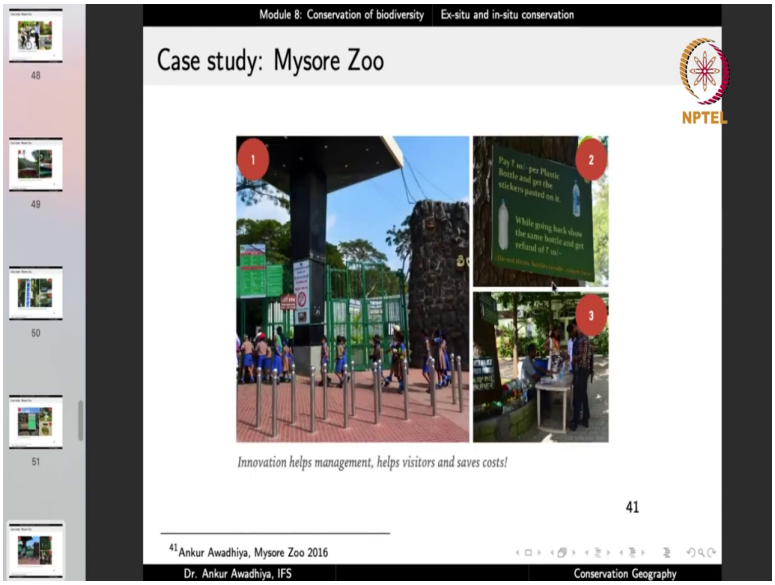

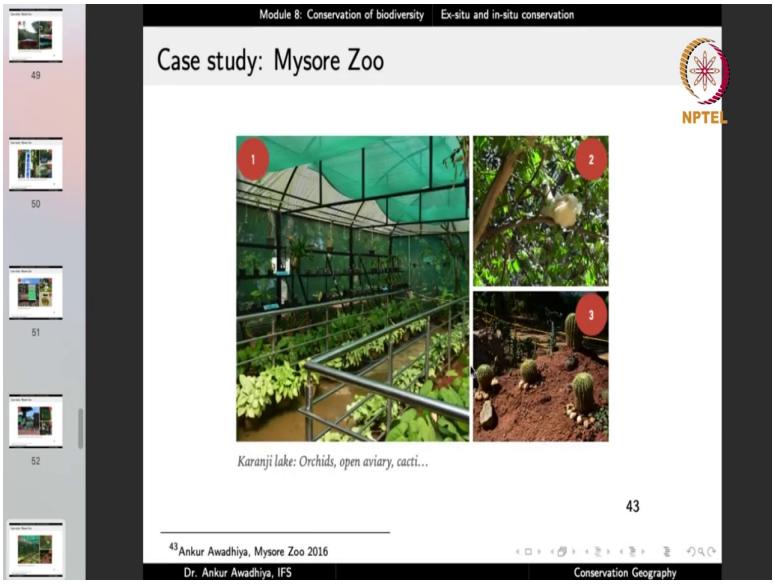

There is also image building exercise, lots of innovations such as to reduce the use of plastics, lots of specific facilities for specific organisms such as orchids or cacti or birds.

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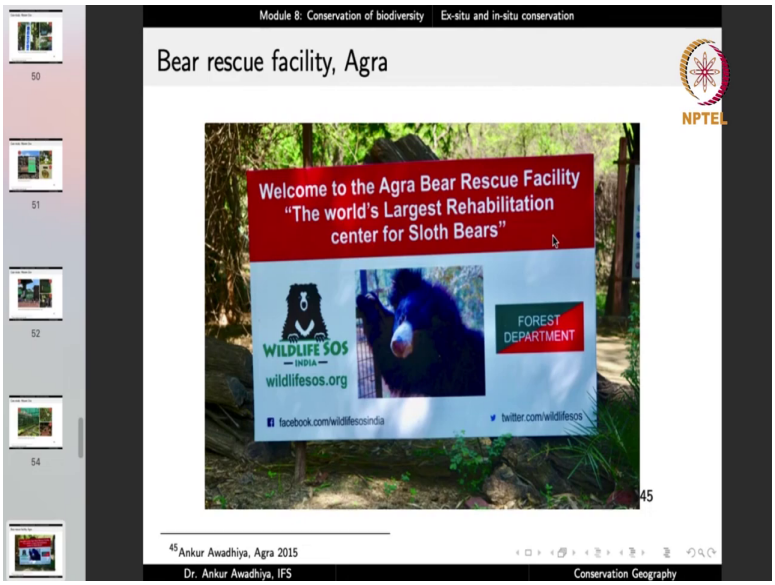

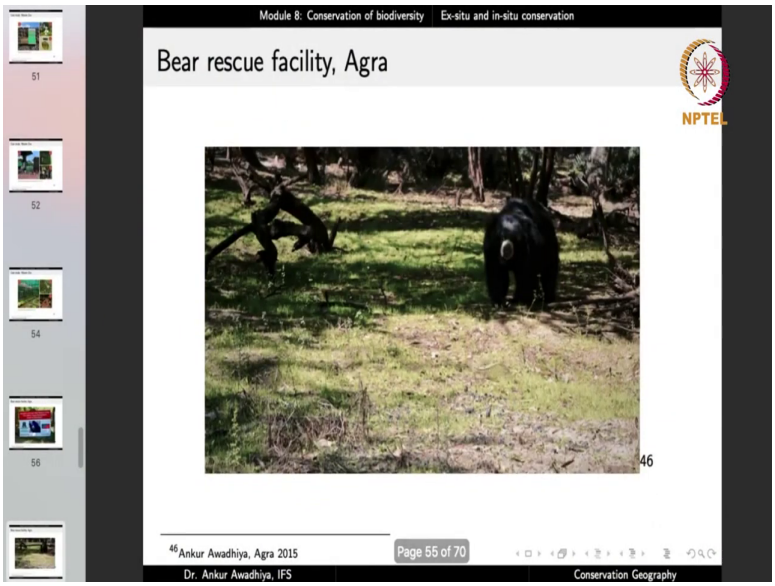

And we also have a large number of rescue facilities in our country. Now rescue facilities as you remember come under the ambit of zoos. So we have things like bear rescue facilities where bears are kept.

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We have lion rescue facility we have turtle rescue facility, in which case the eggs are brought in and they are kept they are hatched and then once they hatched, the young ones have come out then they are safely released back into the seas.

Now this has become especially important because the nest of turtles are often poached upon by dogs and also by human beings, they are also trampled upon. So these rescue facilities are not playing a big role in conservation. These are all ex situ facilities.

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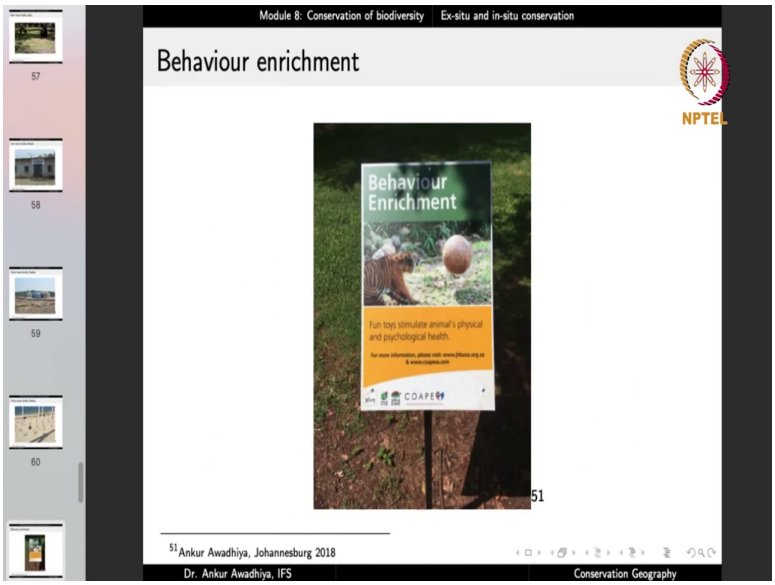

In the zoos, we have to take care of behaviour enrichment, the animals should not feel bored. So this is about the ex situ conservation.

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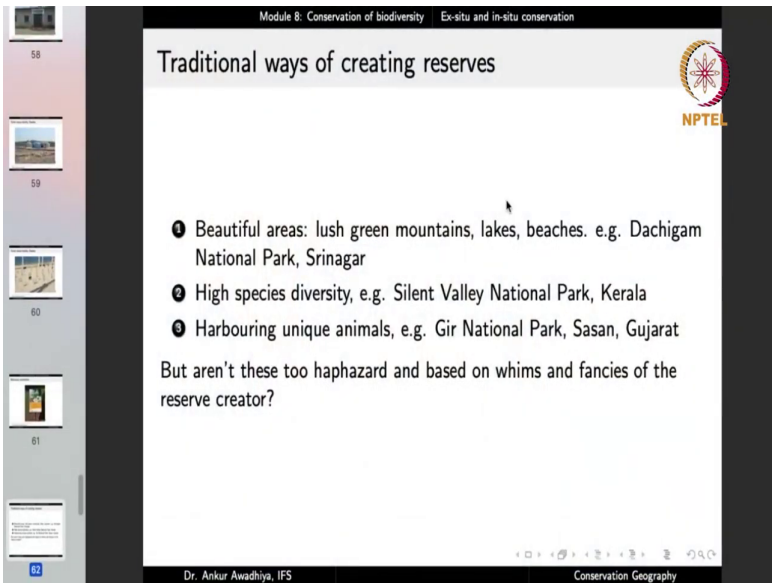

Now, coming in situ two conservation, in the case of in situ conservation or conservation on site, we try to create a reserve a protected area such as a national park or a wildlife sanctuary in the natural habitat. Now the question is, where should we create the reserve? So traditionally, the reserves were created in areas that were beautiful areas, lush green mountains, lakes, beaches, such as the Dachigam national park in Srinagar.

So the ruler went to an area saw that okay, this area is a very beautiful area and decided on this part that okay, I am going to make this area into a wildlife reserve. Often these were the old Shikar Gaahs of the kings, or in certain cases, areas that had high species diversity, they were made into reserves, areas such as the Silent Valley National Park, in Kerala, or in certain cases, animals that were harbouring unique animals that are not found anywhere else, such as the Gir National Park in Sasan, Gujarat, which is the only place where we find Asiatic lions. So these were the areas that were traditionally made into reserves.

But these are often very haphazard and based on the whims and fancies of the reserve creator. Now that we have a big conservation challenge, and we have a shortage of resources, we need to optimize even in the case of reserve selection, we need to choose such areas where we can have the maximum benefit maximum conservation with minimum amount of resources.

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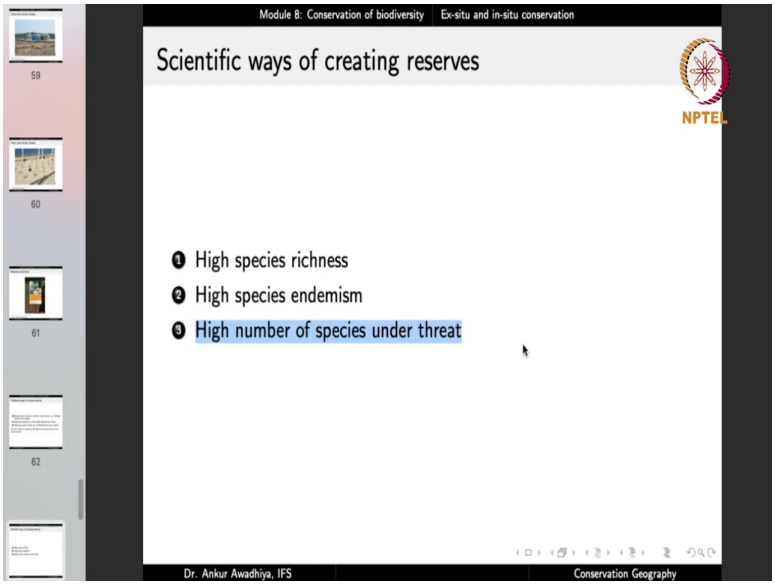

So, if you wanted to do that, how will you go about selecting the area, one way to begin is by selecting criteria. So, the scientific way of creating reserves should have a way of selecting those areas that have maximum species richness. So that a large number of species get

protected particularly those species that are not found anywhere else, that is the endemic species.

So, if they are found in one area, they that particular area should be a conservation priority else that particular species will be lost and it should have a high number of species under threat. So that we are able to save a large number of species from extinction.

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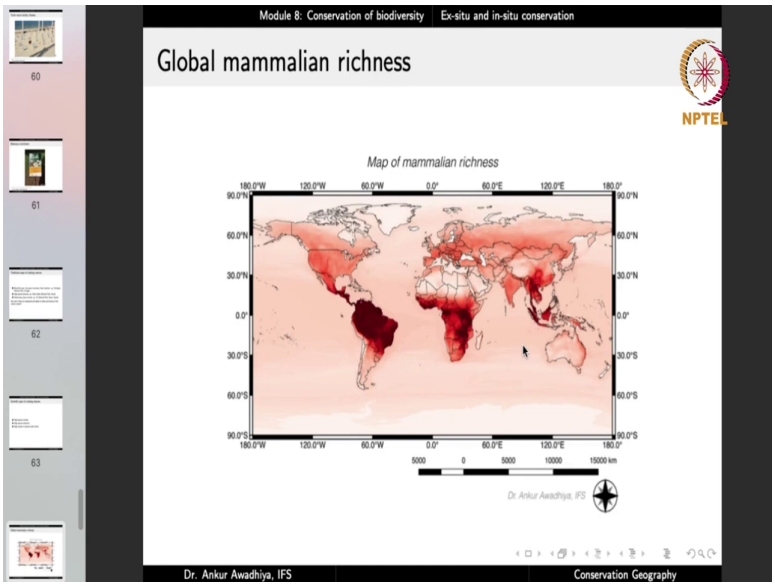

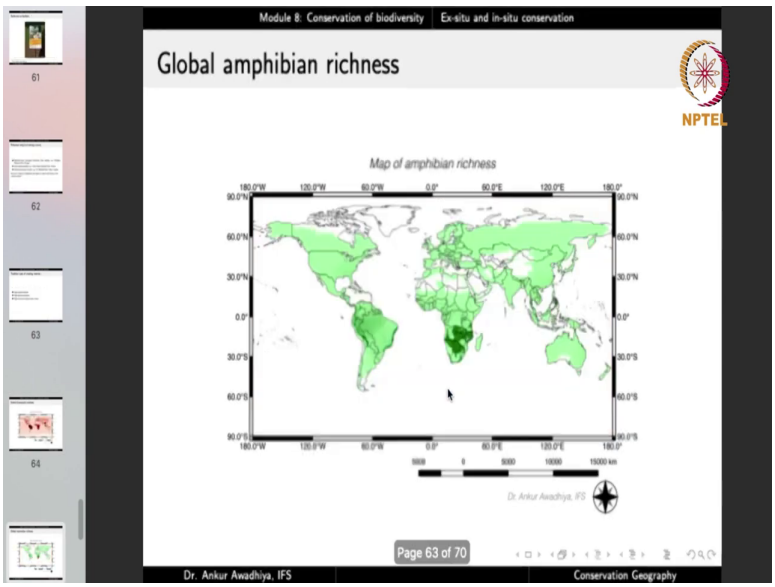

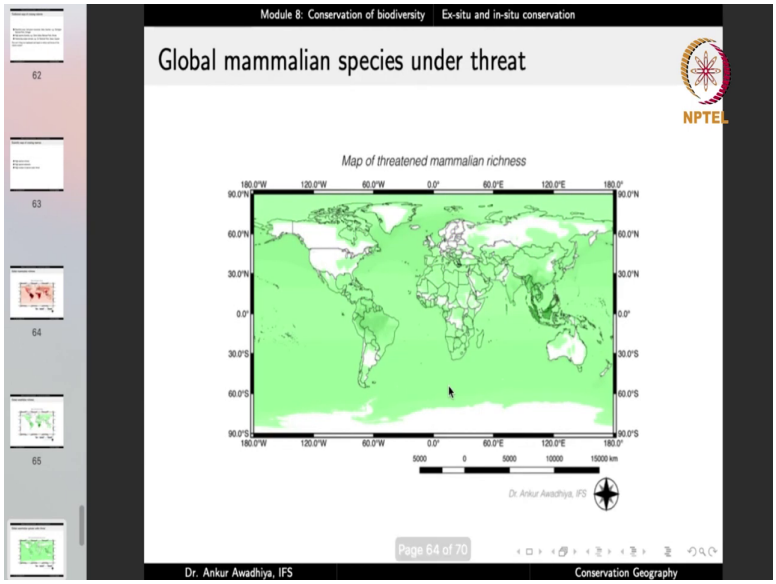

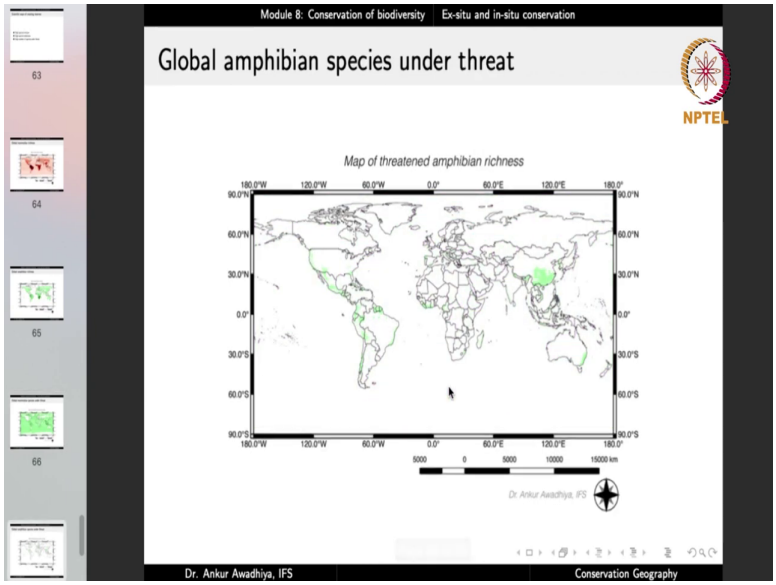

So, how will we go about looking for these to look at richness endemism and threat we make use of maps. So, we can create a map of global mammalian richness or global amphibian richness or species under threat and these can be say, mammalian species, amphibian species, or all the species.

Now with these maps, we can look for those areas where we have a large species diversity, we have a large number of species under threat and on that we can overlay a map of those areas that harbour endemic species. Now, the areas which come under all of these three categories are the prime areas where we should be creating the reserves.

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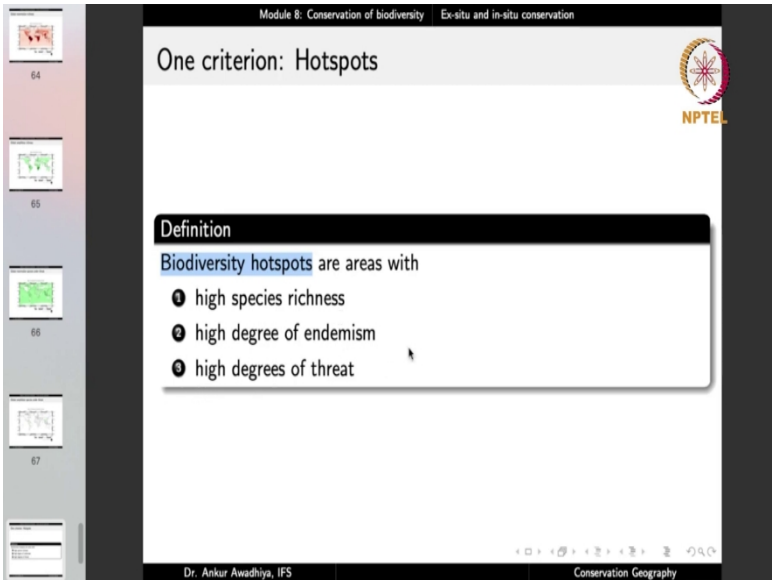

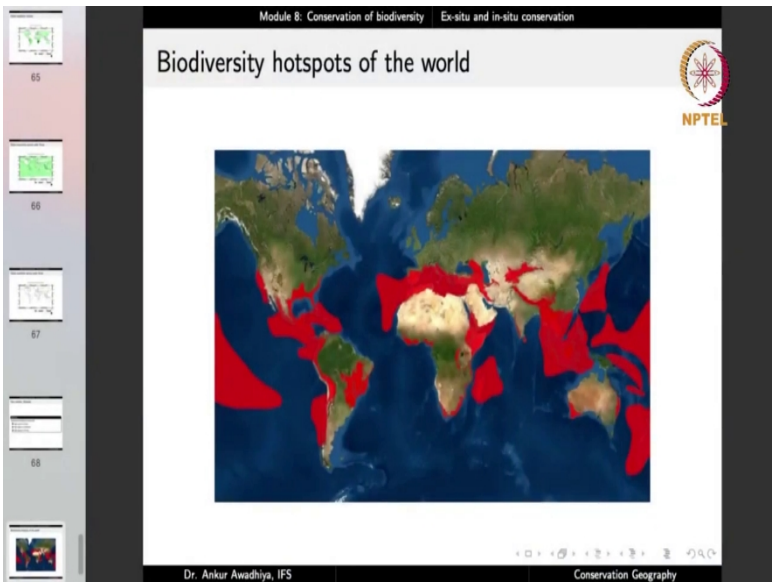

And one criterion that mixes all of these together is the criterion of biodiversity hotspot, biodiversity hotspots are defined as areas with high species richness, high degree of endemism and high degree of threat and these areas have already been marked on the map. So, in India, we can find that the Western Ghats and the Himalayas, they form biodiversity hotspots.

It means that these areas have a large number of species and many of those species are threatened and some of those species are found nowhere else and so, if these areas are not conserved, we will lose these species very soon. So that is the criterion of biodiversity hotspots.

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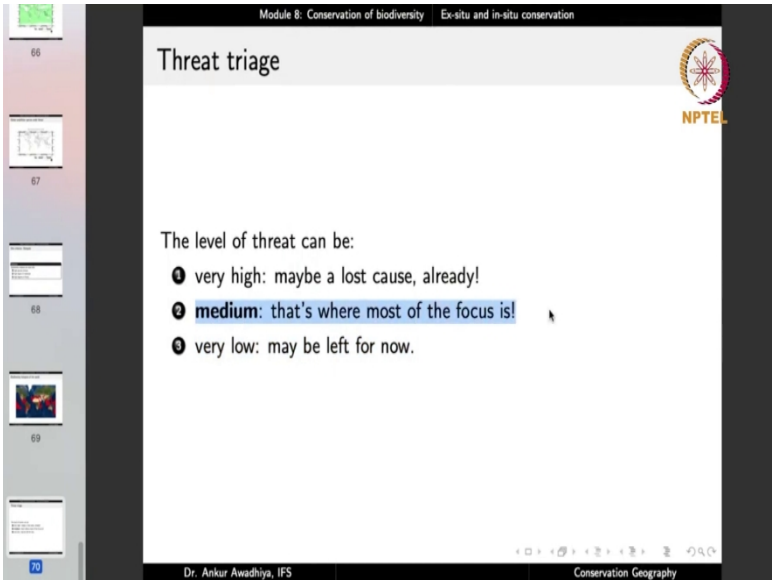

We can also look at the threat triage. Now threat triage means that we can look at the levels of threat. If an area is falling under a very high threat in a region then probably it is already a lost cause, an area will fall in a very high threat region when there is already a huge amount of habitat loss, or habitat degradation or habitat fragmentation or habitat displacement. So, now very little areas remain and by the time that we are able to move forward with the legislation and declaration of these areas, as a result, probably people will encroach upon these areas, and they will be a lost cause.

So it does not help very much to focus our attention on the very high threat areas. Similarly, those areas where we have a very low level of threat, they should not be a priority, they can wait for now, Examples include islands that are so far off that people just do not go there. Now, whether you designate those islands as protected areas or not, it will hardly make any difference, because there is already very little human intervention in those areas.

And so they should not be a conservation priority. Because time, money and resources that are already limited, they should be prioritized to do the areas where we can make maximum impact. And these are the areas that have a medium level of threat. So basically, these areas can be protected, we still have time left to protect these areas and if we do not protect them, we will lose them. So these should be the maximum focus areas.

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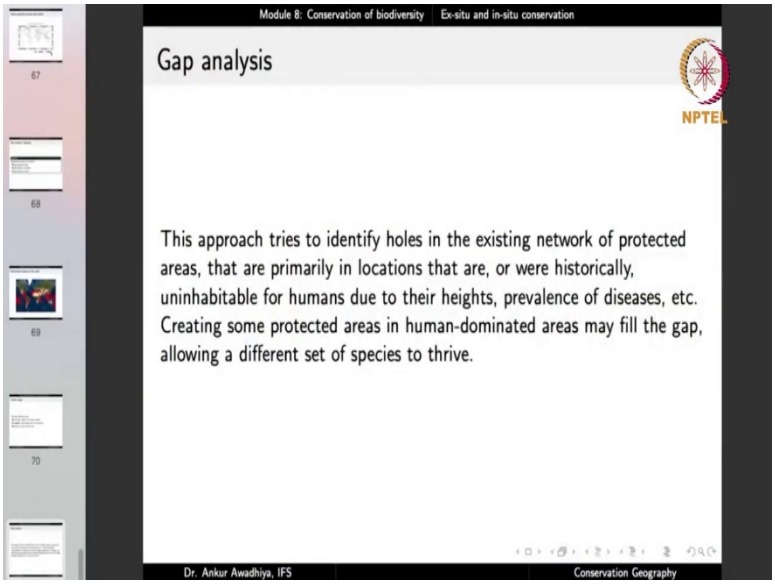

Now together with threat, we can also look at gap analysis. This is an approach that tries to identify holes in the existing network of protected areas. So essentially, what we do is that we make a map of the protected areas and we look at those locations where we can set up a protected area to fill the gap.

Now, traditionally protected areas were are located in those regions, which are or were historically uninhabitable for humans, because of their heights, prevalence of diseases and so on. So they were either very hot areas, very cold areas, very far off areas, areas with lots of malaria, and so on. So we left them for wildlife that is good. But then we also need areas that are habitable areas that are plane areas, grassland areas for wildlife. Because there are a large number of species that thrive in those areas and because we have converted most of them for agriculture, so now those species are at a very great risk.

So we need to at least set up a few reserves in these cozy areas. So that is done through gap analysis. So creating some protected areas in human dominated areas, say by purchasing agricultural land, may fill the gap and allow a different set of species to thrive. So we can look at all of these criteria.

So our reserves should be areas that are primarily areas with high species richness, high degree of endemism, a large number of species that are threatened, but the level of threat should be a medium threat, so that we still have time to protect the areas, preferably those that can fill the gaps, preferably those that permit animals to move and so on. So we will build up on this in the next lecture by looking at the principles of reserve design. So that is all for today. Thank you for your attention. Jai Hind!