Wildlife Ecology
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Lecture - 23
In-situ conservation

[FL] Now, that we know that there are species that are under the threat of extinction, what can we do to conserve them? What are the ecological processes that we can use, or what are the conservation strategies that we can use to protect those species to save them from the brink of extinction.

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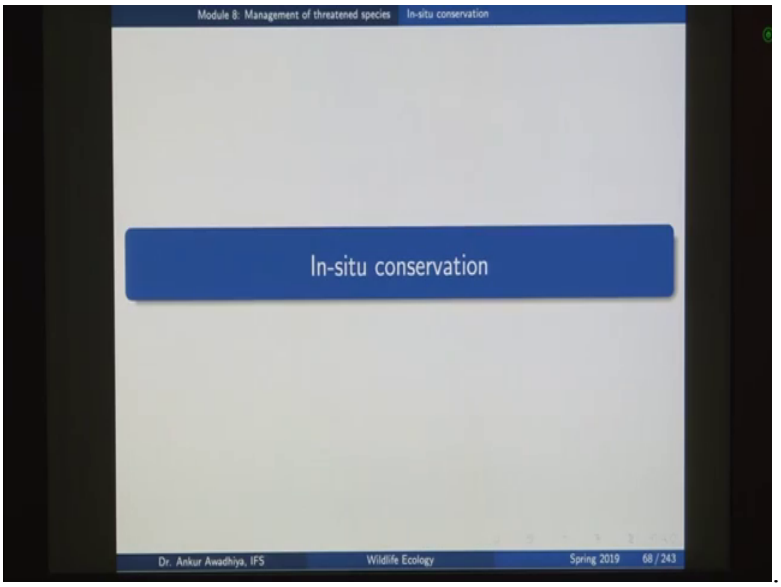

So, in this context we have two different kinds of strategies which are In-situ conservation and Ex-situ conservation. And, in today's lecture we will have a look at In-situ conservation.

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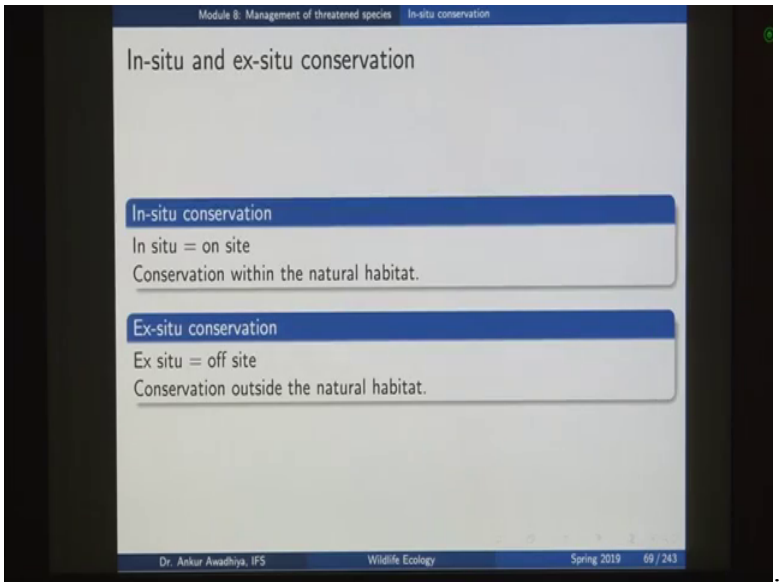

As, always we begin with the word roots in situ means on site. So, this is conservation that is done within the natural habitat. On the other hand ex situ conservation, ex situ means off site, which is conservation that is done outside the natural habitat. So, in situ conservation would be conservation that you are doing within the natural habitat. So, things such as national parks violate sanctuaries commander in situ conservation, because you already have organisms that are living in those areas and so, you are conserving the organisms on the site.

Ex situ conservation is when you are trying to conserve the organisms outside their natural habitat. So, if you are setting up a seed bank, and taking out seeds from the natural habitat, and storing them there in the seed bank. So, that if something happens to the natural habitat you can use the seeds bring them to the natural habitat and you can regrow the plants back. So, that would be an example of an ex situ conservation or things such as zoos.

So, you have a zoo in Delhi. So, those animals are not are not naturally living in Delhi, but they have been brought from different areas of India, in different areas of the world, and then they are kept in the Delhi zoo. So, zoos are an example of ex situ conservation.

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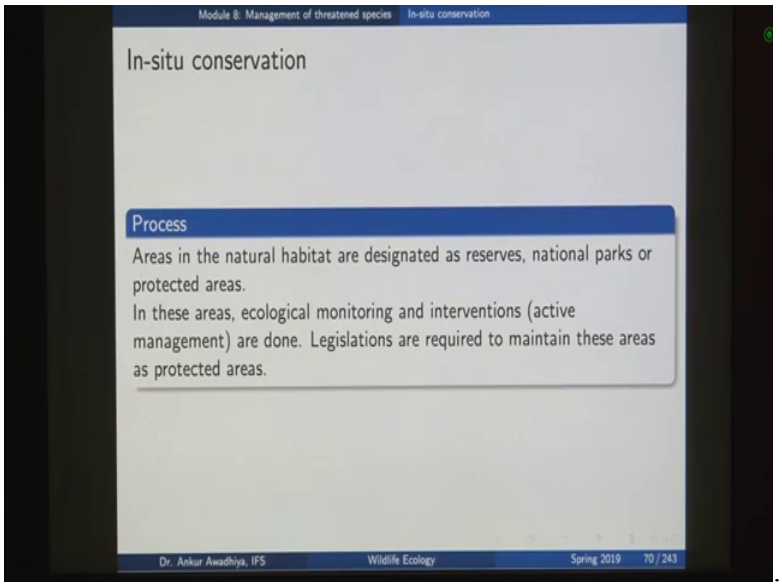

So, the process of in situ conservation would be that areas in the national habitat are designated at as reserves national parks or protected areas. So, you classify the natural habitats or you look for those areas in the national habitat, that you can classify as reserves national parks or protected areas. And, then in these areas ecological monitoring and interventions that is active management are done and legislations are required to maintain these areas as protected areas.

So, what you are doing is you are taking out some areas of the natural habitat. And, you are saying that these areas will be protected areas, you are putting up some legislation. So, that people are not able to intervene into these areas, or people are not able to divert these areas for some other applications. And, once you have done that you do habitat monitoring and some amount of interventions.

Now, these interventions could be say if you are observing that the wild dog population in your area in that actual habitat is going down. So, then you would ask the question what is the reason. Probably your wild dogs are not getting enough amount of food or probably they are suffering from some disease. So, the intervention in this case would be to intervene at the level of food or at the level of disease.

So, suppose they have some disease. So, you might give them some antibiotics or maybe you could try to vaccinate them if that diseases leading to a high amount of death rate and so on. So, that is the process of in situ conservation.

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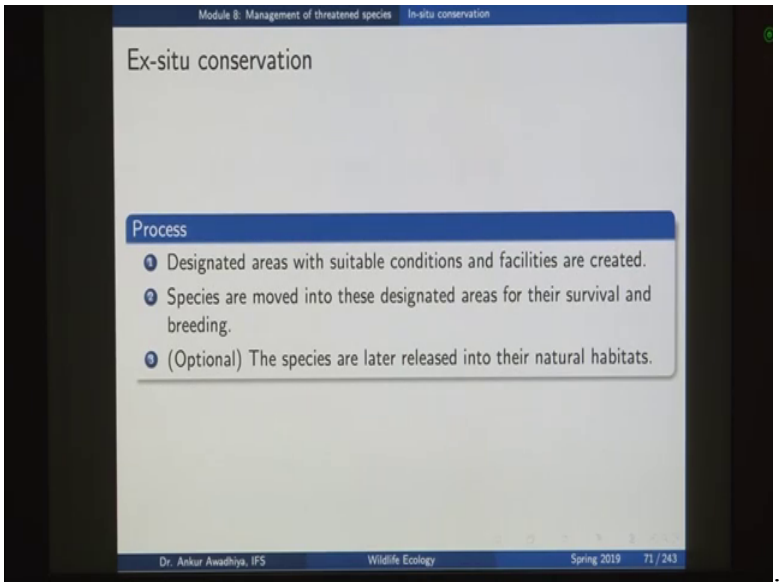

Whereas, in the case of ex situ conservation you designate areas with suitable conditions and facilities are created in those areas. So, when you are setting up a zoo you designate certain area in your city or outside your city and you say that ok, we are going to construct this zoo here, then you create facilities in those areas. So, you create enclosures, you create pathways.

So, that people can come visit these areas. You create pathways through which feed will be brought for these animals; you create pathways so, that the where you can bring in more animals from outside or maybe take some animals outside. You create facilities in terms of veterinary care what are those designated areas in your zoo where if an animal is suffering from a disease, you can take it out and give it some amount of veterinary treatment.

So, all these facilities are created and once you have these facilities the species are moved into this there is designated areas for their survival in breeding. In a number of areas you also do captive breeding of these animals. And, then the third stage is optional when the species are later released into their natural habitats. So, that is the ex situ conservation.

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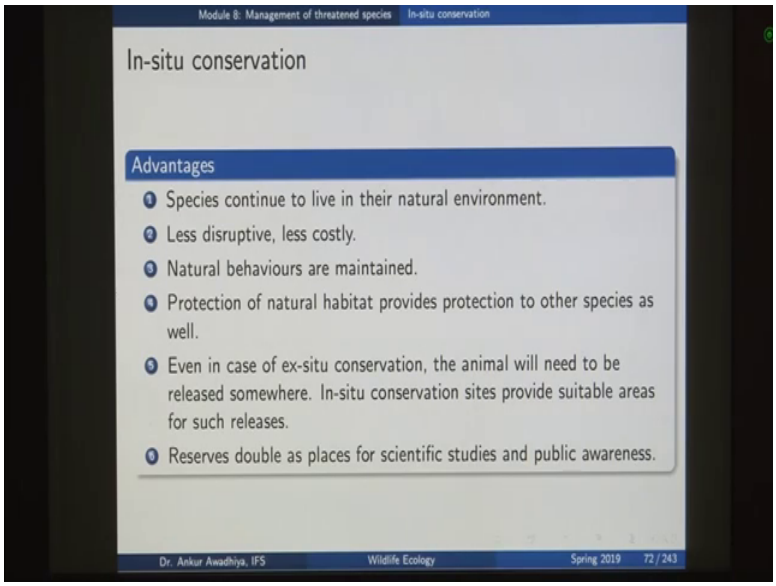

Now, in situ conservation gives a certain amount of advantages over the ex situ conservation. And, at the same time it also suffers from certain disadvantages as compared to the ex situ conservation. So, when we are talking about in situ conservation you can think about say a tiger reserve. Should you keep a tiger in a tiger reserve or you should you keep a tiger in a zoo? In both the instances we are trying to conserve the tiger. Now, in the if you are keeping it in a tiger reserve it would give you certain advantages.

Species continue to live in their natural environment a zoo is an artificial environment whereas, a tiger reserve is a natural environment, it is less disruptive and less costly. So, you are not required to take the animal away. So, if you are taking a tiger out of a forest area and to keep it into a zoo, you need to engage a number of people, this tiger will have to be immobilized and then put into a cage, and then transport it to another location, and then once it has been moved into a zoo then, it will have to be fed. And, all these feeding arrangements will also require quite a lot of cost whereas, if you are keeping it in the natural environment the tiger is going to hunt by itself, you do not have to go there and feed this tiger everyday.

So, it is less disruptive and less costly also natural behaviors are maintained. If, you have tigers that are living in the wild conditions, in those situations the cubs that are born will be trained by their mothers on how to hunt? They will remember and they learn these processes of hunting whereas, if you are keeping a tiger in a zoo so, a tiger will variously

forget how to hunt and because it is getting a food in a premade format. So, the animals all is already killed and probably already cleaned before giving it with the tiger. So, it will lose out it is natural behaviors very easily.

Protection of natural habitat provides protection to other species as well. So, in the case of a tiger reserve, when you are protecting the tigers you are at the same time also protecting the Chitals, the Sambars and a number of other species leopards and so on by protecting the tigers. Whereas, in the case of ex situ conservation, if you are keeping it in the zoo. So, if you are only keeping a tiger in the zoo, then in that case you are not protecting the other organisms.

Now, even in the case of ex situ conservation, the animal will need to be released somewhere. Because, if you are keeping tigers in a zoo you are doing captive breeding and from say 5 tigers, now you have 50 tigers. Now, if you have 50 tigers what do you do with these 50 tigers, they will have to be released somewhere, because keeping a tiger is extremely costly.

And, if you have in situ conservation sites, then these sites will provide suitable areas for such releases later on; so which is also why you need to maintain in situ conservation areas as well. And, also reserves SS places for scientific studies and public awareness, which is also why we keep in situ conservation methods.

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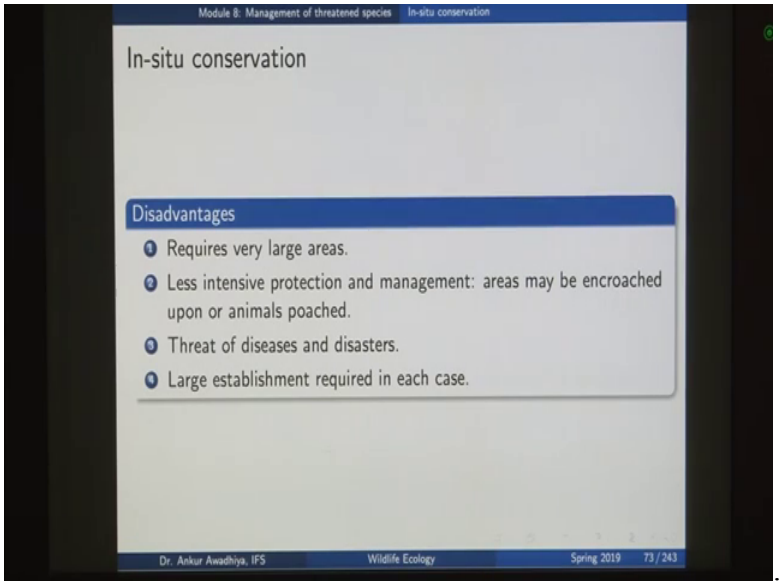

However, it also suffers from certain disadvantages. It requires very large areas. So, in the case of tiger reserves, it will have tens or even hundreds of square kilometers of area. Whereas, to have a zoo you might set up set up a zoo in a very small area say a few square kilometers. So, in situ conservation has this disadvantage that it requires the very large area. Also less intensive protection and management, because the areas may be enclosed upon all the animals posed.

So, here we have the classic example should you keep all your eggs in one basket or should you keep your eggs in different baskets. In the case of a zoo when you have all the animals in a very small area you can give a very good amount of protection to those few number of animals.

Whereas if you are keeping the animals in very large size forests. So, you cannot be there in the forest at all places at all times. So, it is possible that we have that some poachers might get inside and poach some of the animals, or maybe some people would try to encroached upon some areas of the forest, but that is a possibility. So, which is there in the in situ conservation, then there is a threat of diseases and disasters.

Because your level of intervention in the case of in situ conservation will not be very high whereas, in the case of a zoo a diseases much easily controlled because you have access to all the different animals. So, you can give medicines to all different animals on all diseases whereas, in the case of in situ conservation that is not possible. And, also large establishment is required in each case, if you want to maintain a tiger reserve. So, you will require a large number of forest cards a large number of rangers some SDOS, some DFOS and so on whereas, in the case of a zoo the level of establishment is not that high, because it is a smaller facility.

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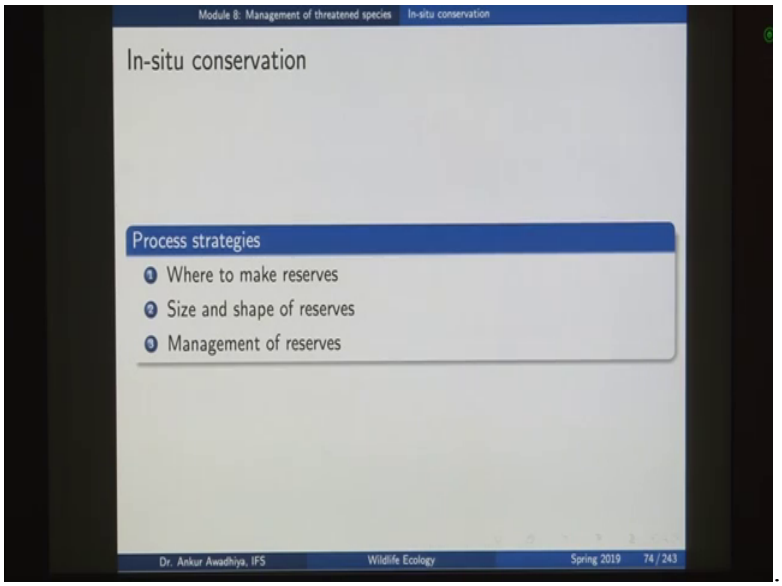

Now, if we are trying to go with in situ conservation. So, in this lecture we will concentrate on in situ conservation. So, if you are going with in situ conservation, what should be our strategies? So, basically we are asking the question, where should we make these results? We said that we wanted to create these in situ conservation reserve we want to make a tiger reserve they should we have this tiger reserve.

Second, what should be the size and shape of these reserves is there any ecological concept through, which we can determine what should be the shape and size of this reserve? Should we have large reserves, should we have smaller reserves, or should we have reserves that are say linear, or reserves that are circular, or reserves that are square in size, or square in shape, what should be the size and shape of the reserves?

What are the ecological principles through which these would be guided? And, third question is how are we going to manage these reserves? So, we begin with where to make the reserves.

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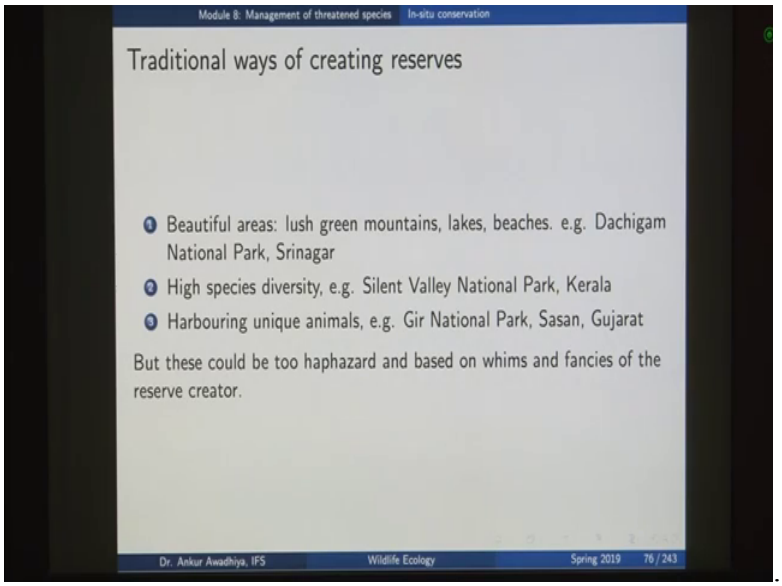

So, traditionally reserves have been created in areas that are beautiful areas. So, areas that have lush green mountains, lakes, beaches, example the Dachigam National Park in Srinagar, it is a very beautiful area.

So, earlier when kings wanted to make a reserve they would choose a very beautiful serene environment and create a reserve or we could create reserves in those areas that have a high species diversity. So, we can use our knowledge of ecology or our understanding of ecology to say, that we should create a reserve in an area that has a high species diversity. So, that we can conserve a large number of species if you create a reserve an example is the Silent Valley National Park in Kerala. So, this area has a very high species diversity or another way of creating a reserve is those areas that harbor unique animals.

So, for instance we have this Gir National Park in Sasan Gujarat, because we have lions there. The only reason we have this natural park there is that we have this unique animal lion that has not found anywhere else. So, these were three ways in which traditionally we have been creating reserves, but then these could become very haphazard and based on the whims and fancies of the reserve creator.

For instance if I am not interested in lions and probably I had to set up this reserve, I could even say that lions are not important for us. Let us create a reserve for say gorillas. Now, gorillas are also important species lions are also important species, but then I can

make a decision that I should have a reserve where we have gorillas. And, not lions and somebody else may say that we should have a reserve where we have lions and not gorillas.

Now, is there a way can we use our ecological understanding to reduce this amount of whims and fanciness. So, that everybody can come to a common platform. And, so, the process of reserve creation becomes more and more systematized.

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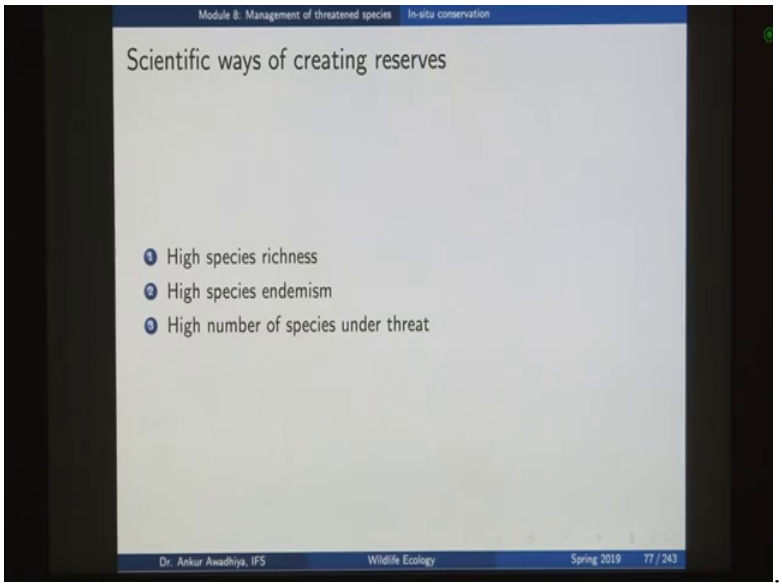

So, now we look at the scientific ways of creating reserves. Now, scientifically or logically we can say that we should have reserve in those areas that have high species richness, because in that case when you construct a reserve you will be conserving a large number of species automatically. We also require reserves that have a high degree of a in areas that have a high degree of endemism.

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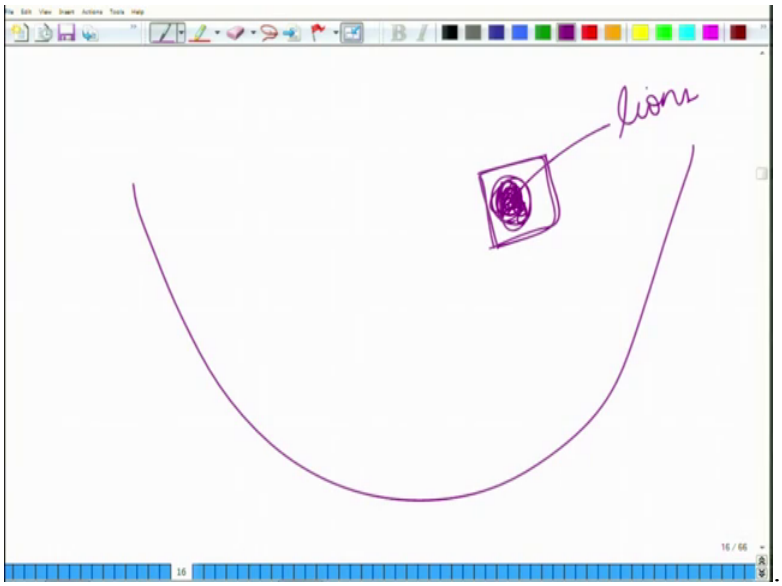

Because, if we have an area in which you have a particular species say lions. So, if lions are only found in this area and not found anywhere else if we construct a reserve in this area will be conserving this population of lions, because if we lose our population of lions in this particular area will lose the lions completely forever.

So, we also require need to have reserves in those areas that have a high degree of species endemism. And, also we require reserves in those areas that have a high number of species that are under threat. So, threat richness and endemism are three things that should guide our process of selecting areas where the reserve should be set up.

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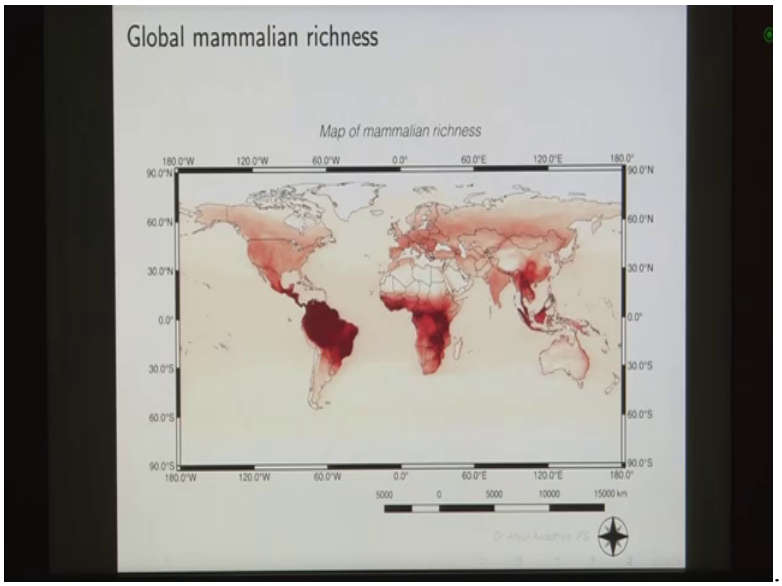

So, how do we begin with that? We will begin by plotting where different species are found. So, things such as global mammalian richness can be plotted to see, what are the areas where we have a larger richness of mammalian species.

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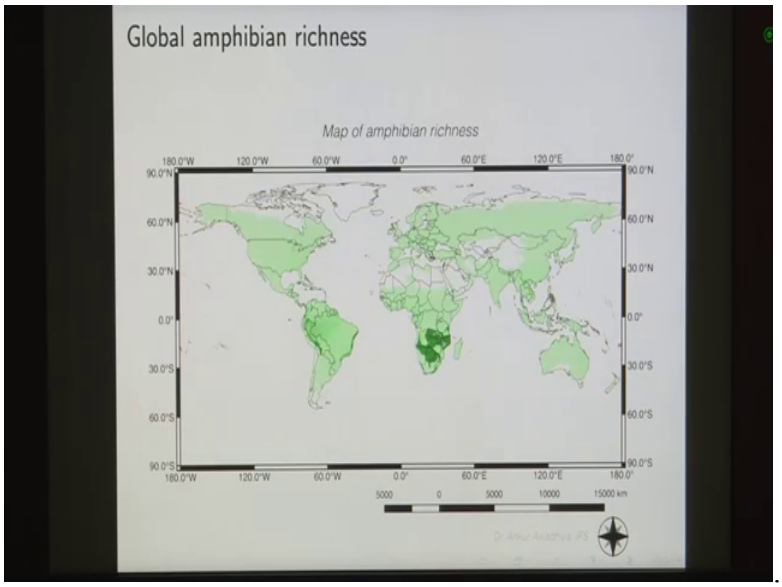

Or we could do it for amphibians species, or we could look at the IUCN lists of which different species are under threat.

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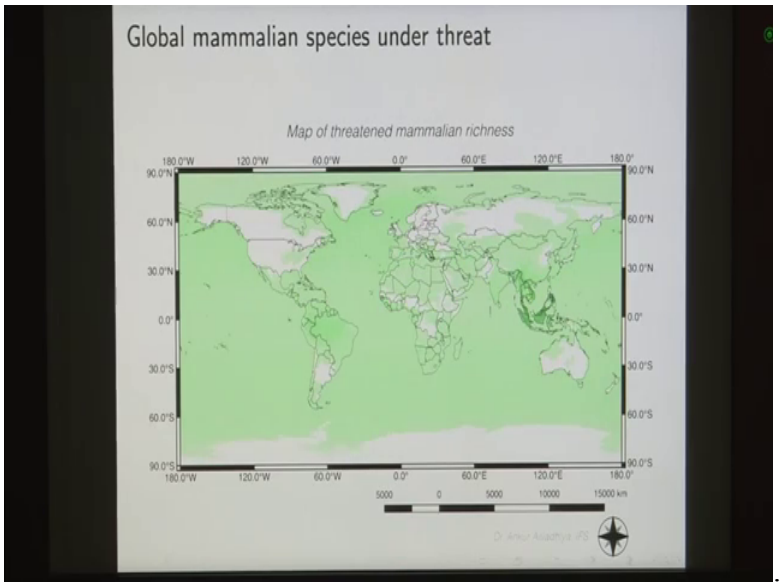

And, we can plot those species. So, global mammalian species that are under threat. So, here again we can see for instance that the areas in Southeast Asia have a larger amount of threat or a larger number of species that are under threat.

So, probably we require more amount of conservation in that area or amphibian species under threat.

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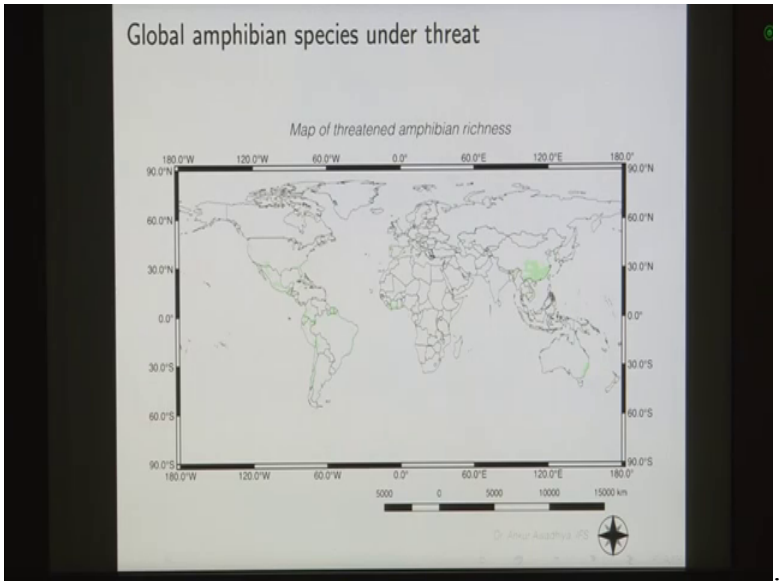

So, we can use our knowledge of the concepts of biogeography to state that, because different species are found in different areas, because different areas have different habitats, and because the species under threat are found in different areas. So, which are the areas in which we need to set up our reserves.

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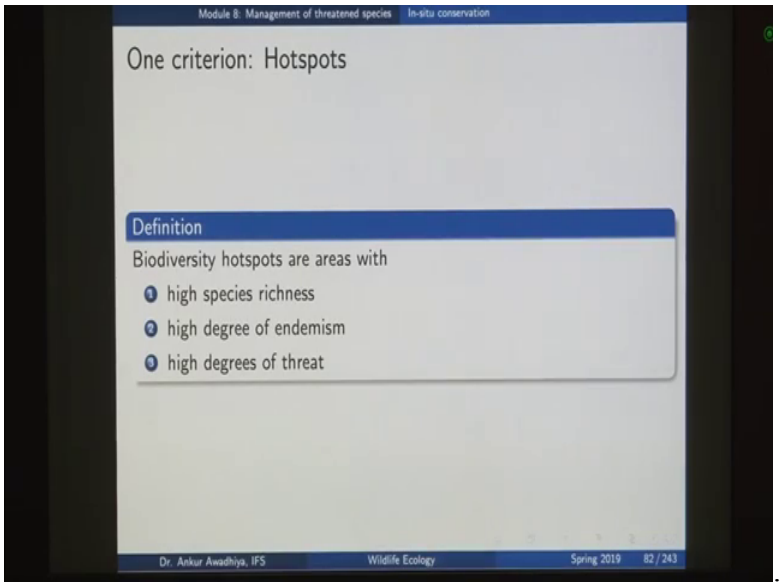

And, one way in which we can collate all of this different information is by looking at biodiversity hotspots. So, as we have defined before biodiversity hotspots are areas that have high species richness, high degree of endemism and high degree of threat.

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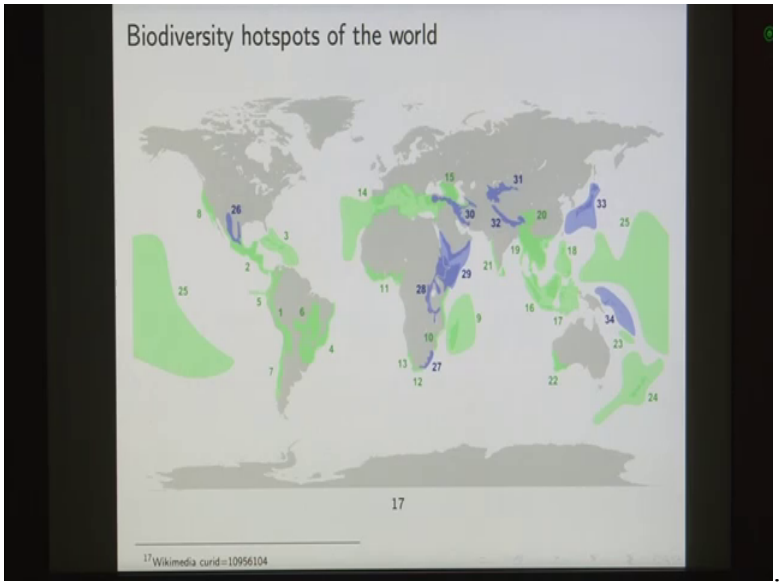

So, we have quantified all three of these we have plotted these things together to look at the areas that have theta Biodiversity hotspots. So, even in our country we have this Dhari region we have the western guts and we need more amount of conservation in these areas.

So, now everybody can come to this platform and say that yes we need to conserve more and we need to construct more and more reserves in these particular areas.

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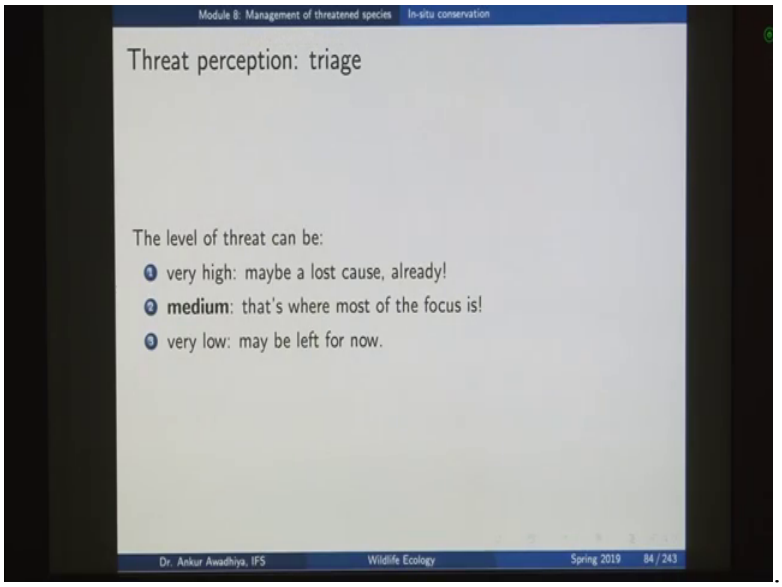

When we are talking about threat, there is this other concept of setting up a triage. Now, triage try S 3. So, triage says that we need to look at the level of threat that can be perceived by us.

So, if there is an area that has a very high degree of threat. So, there is a very small piece of forest.

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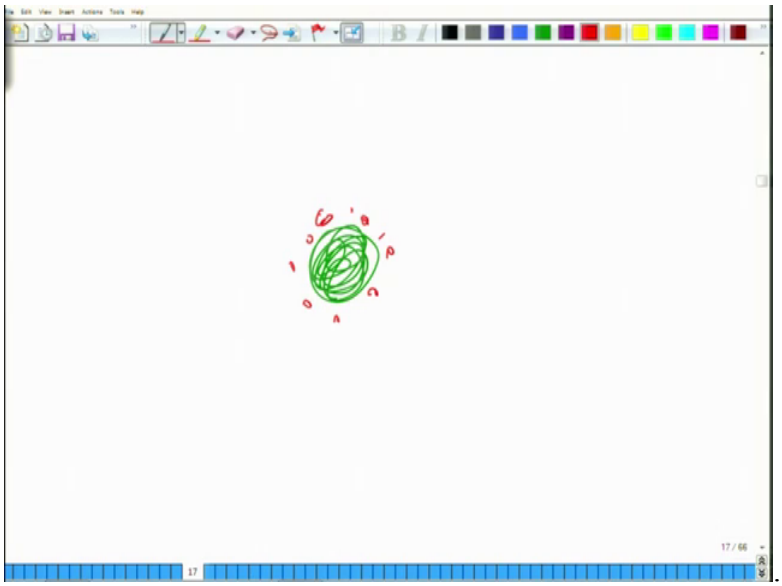

Suppose, this is a very small piece of forest and this forest is surrounded on all sides by different villages, and all of these villages are putting a very high amount of influence on to the small piece of forest. So, there is a very high degree of threat that this forest is perceiving.

So, should we set up a reserve here? Well the answer would be yes and no, yes if this area has some endemic species that we need to protect at all cost, but then we could even go for the answer of no, because we already have such a huge amount of human influences then probably it is already a lost cause. Because, we even if we set up this reserve, we cannot remove all of these humans from these surrounding areas. So, this is already a lost cause.

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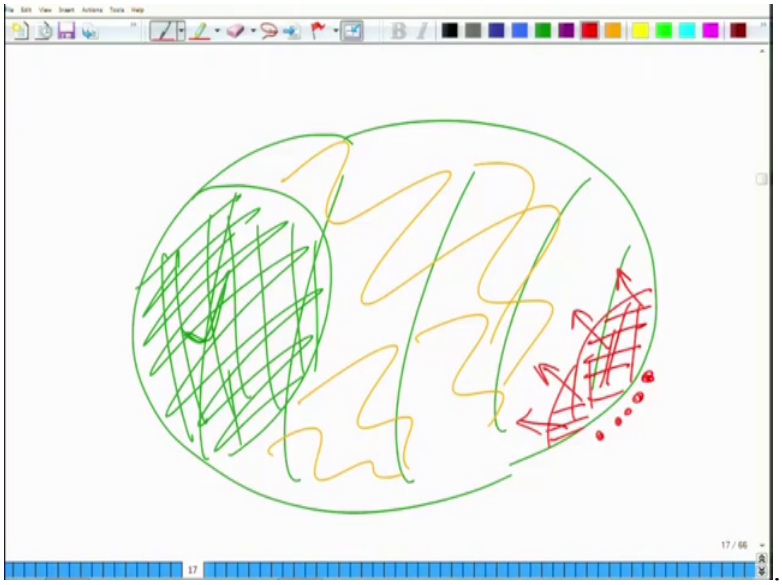

Now, secondly, if the level of threat is very less so, why can we have situations say do we have the level of threat that is very less, we have a very large size forest. And, in this forest there are only these areas that have the villages. So, there the amount of threat that is in this forest is very less and especially in these areas, it is extremely less. There is practically no amount of human influence in these areas. Should this area be a priority area for us, should we set up a reserve in this area?

So, the principle of triage would say that no we should not set up a reserve in this area, because this particular area can wait for a while. Even, if we do not set up a reserve in this area the species in this area are already protected, because there is a very less amount of threat that we have in this area. So, which areas should be should be prefer for making a reserve, that should be the areas that have a medium level of threat that is where most of the focus is or should be.

So, essentially if you in this particular forest if you need to set up a reserve, it should not be in this area, because this area already has a very high amount of human influence, it should not be in this area. Because, here is well we have a very less amount of threat, but a reserve should preferentially be constructed in these yellow areas, which have a medium level of threat. Because, if you do not set up a reserve in this area, then probably with time the human influence that is now concentrated in this area would then move into this area.

Now, if we are setting up a reserve in this area, because currently the these areas are not being used by human beings. So, it becomes much more easy to conserve to convince the policy makers or the administrators, that we need to set up these areas as it reserves. And, probably there would be a very little amount of opposition from humans that are living in these areas, because they are already not using the these areas. And, if we are setting up a reserve in this area because these are already a very high human use area then there would be a moment opposition.

So, the principle of triage tells us created in those areas that have a medium level of threat in the highest preference. On the other hand if you have some area that has a high level of threat or a very low level of threat and there is some other factor. There is some amount of endemism or there is some policy issue, that after a while we might lose these areas as well, then it would make sense to create a reserve in those areas as well because they would also move into the medium threat category in that respect.

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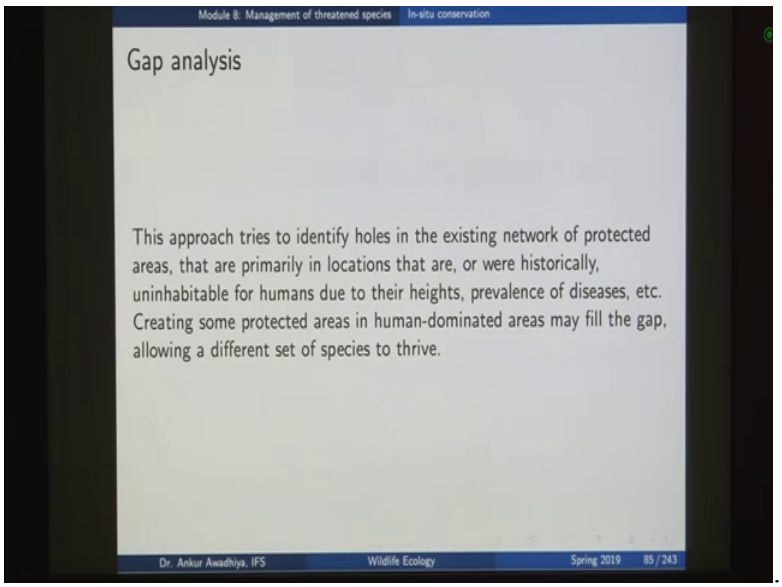

Another way in which we can look for areas we have to set up a reserve is through the process of gap analysis. Now, this approach tries to identify holes in the existing network of protected areas that are primarily in locations that are or were historically uninhabitable for humans due to their height prevalence of diseases etcetera.

Now, creating some protected areas in human dominated areas may fill the gap allowing a different set of species to thrive. Now, what it says is that consider a hill?

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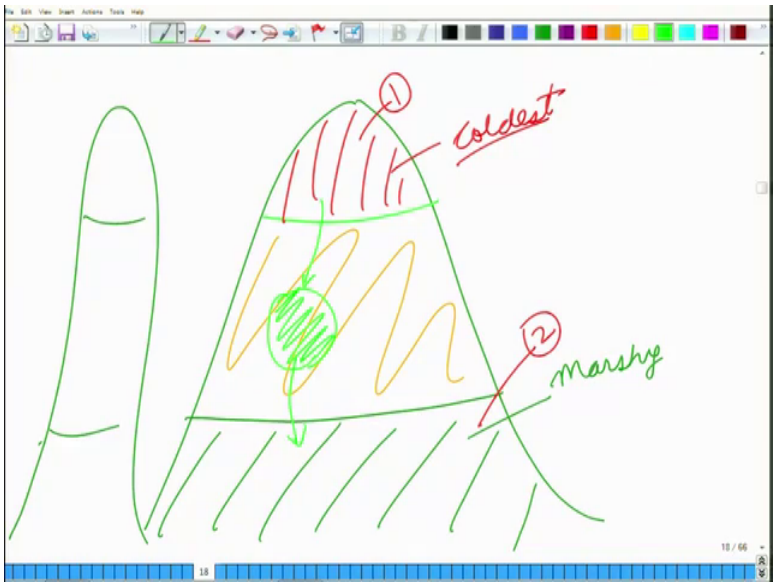

Now, in this particular hill, those areas that were say on the very top and were very cold. So, these are the coldest areas. So, these were not used by human beings. And so, probably there was a reserve that was set up in these areas. Then, on though low lying areas suppose there were a number of marshes so, this was a marshy area. So, it had a very high amount of infestation because of mosquitoes and so, because this area was not being used by humans there was also a reserve that was historically set up in this area.

So, we have 2 reserves one is this reserve and the second one is this reserve that already exists. Now, if we have another hill nearby should we also construct a reserve in this area and in these areas? Now, gap analysis would say that no, because we have seen in the case of biogeography that different species have different requirements. So, by constructing these 2 reserves, we are conserving those species that live in cold areas and that live in marshy areas, but what about those species, that are living in these areas they have not been given any amount of protection so far, because these areas are extremely human dominated.

Now, if we could take some area out of here and probably convert that into a reserve, then a there is one line of one school of understanding that says, that this would be the most preferred location where we should be setting up a reserve. Because, if we do that we would not only be providing a continuity between both of these existing reserves, but

at the same time this would be an area whose habitat has not been afforded any amount of protection so far.

So, gap analysis says that we should identify the gaps in the existing network of protected areas. And, set up a reserve in those areas where we can see a gap.

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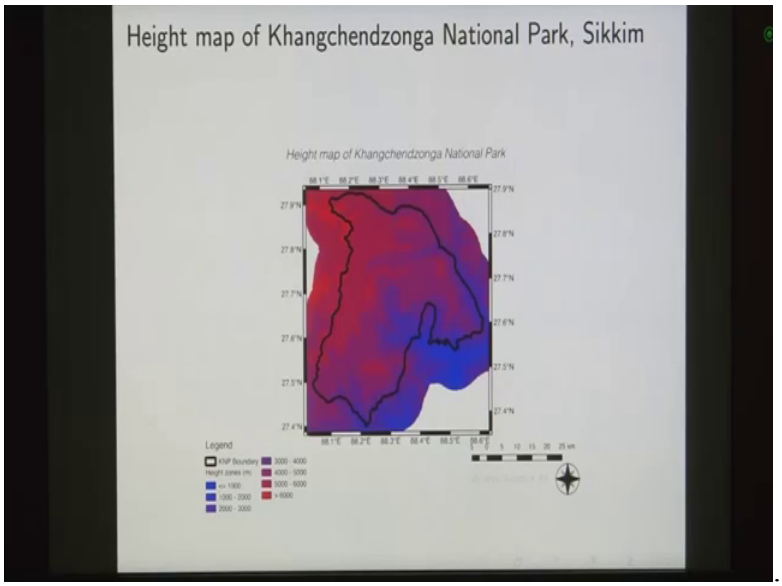

Now, an example is the Khangchendzonga National Park, in Sikkim.

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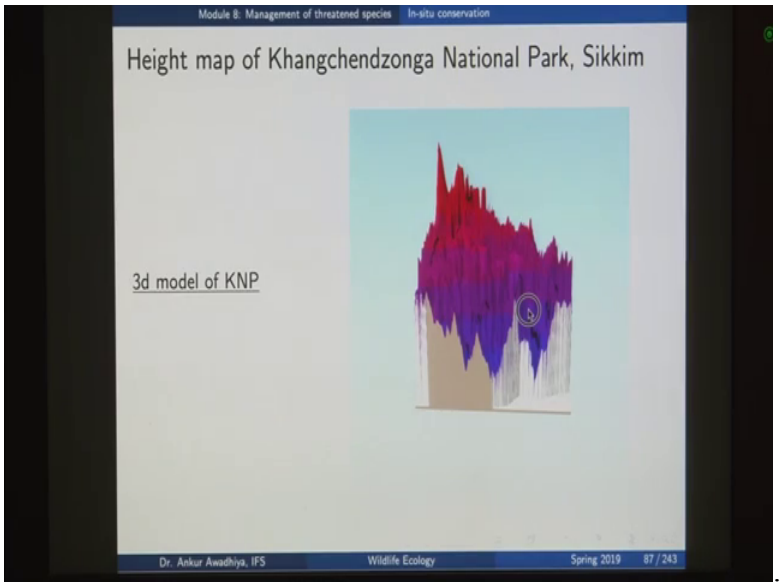

Now, if you look at the area and if you look at this area in 3 dimension we will see that most of the area is very at a very great height and so is very cold and so, this area has been set up as a national park. But, then those areas that are not at that great height and are not set up as a national park, probably those are the areas where we should also devote some amount of our attention.

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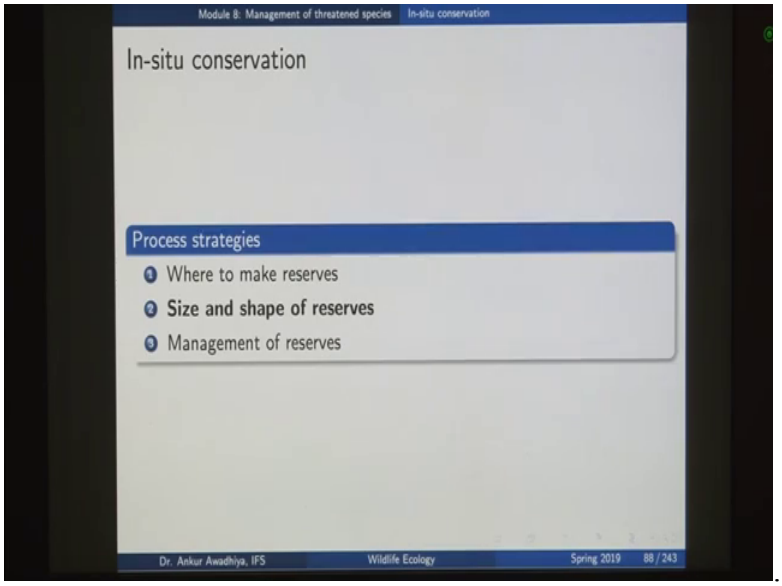

Now, once we have decided what are the areas where we should have the reserves? The next question is what should be the shape and size of those reserves? Are there any ecological principles that should guide the shape and size of those reserves. So, now, we look at the principles of reserve design.

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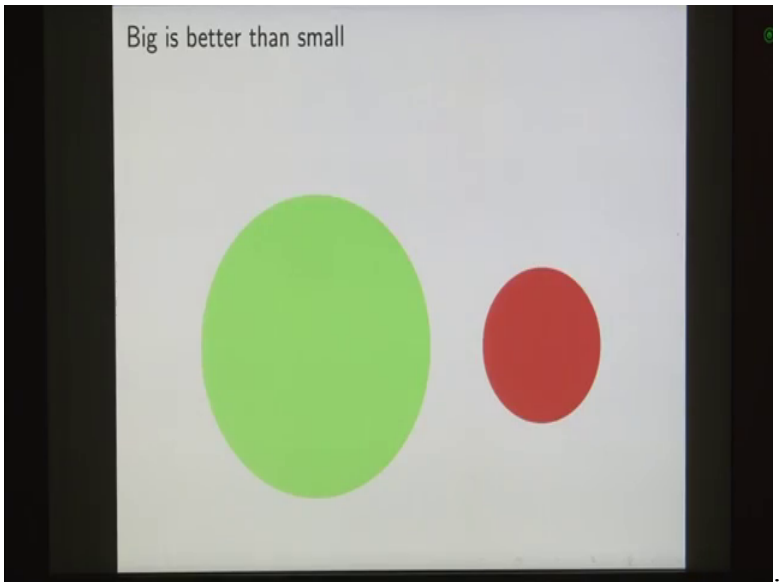

The first principle is that big is better than small. If, you have a larger size reserve, then probably that is better as compared to a smaller size reserved; now why again, because if you have a larger sized reserve then probably you will have a greater amount of habitat diversity.

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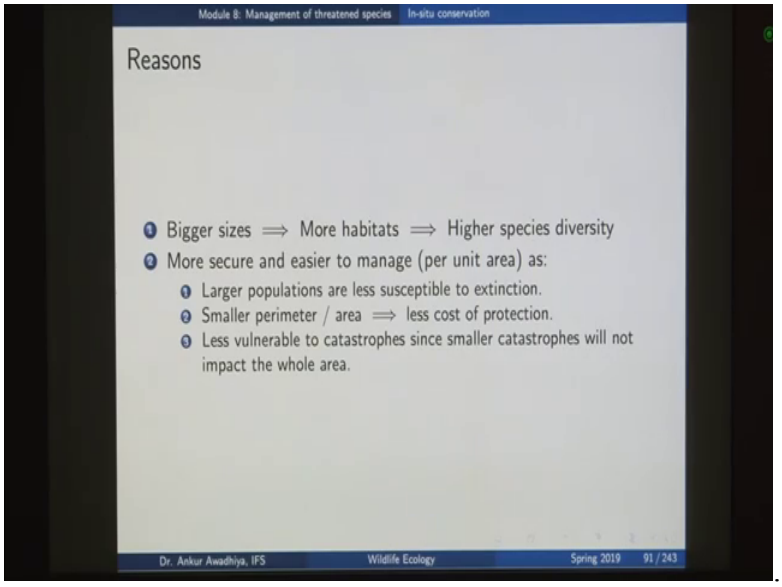

Because, if you have a smaller size reserve that will have say N number of habitats, if you have a larger sized reserve, you will have more number of habitats. More number of habitats would then support more number of another more amount of species diversity,

which is why we should have larger size reserves. Also, in the case of larger size reserves you can even protect those species that have a large homes home range requirement, which is not possible in the case of smaller sized reserves.

And, also administratively it is more secure and easier to manage per unit area, because one larger populations are less susceptible to extinction. Because, in the case of larger reserves, if we have larger populations, you only have deterministic factors that are playing a role, but stochastic factors will not be playing a role, but in the case of a smaller reserve, if you have a smaller population, then a stochastic factors will also be playing a role.

Second, when you go for a higher for a larger sized reserve, you have a small parameter per unit area, which means that you have a less cost of production of protection what does that mean?.

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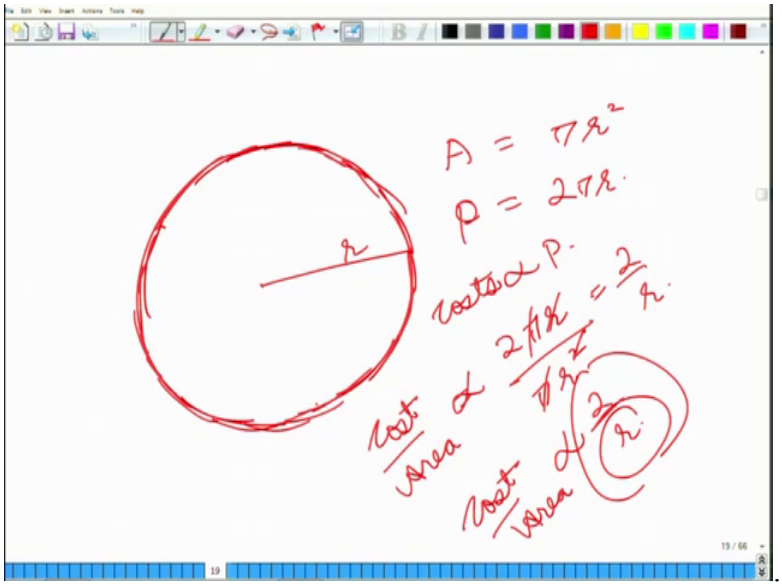

Let us consider a circular reserve of say radius r. Now, the area of this reserve will be given by pi r square and the circumference of this reserve or the perimeter of this reserve will be given by 2 pi r.

Now, the most amount of protection that we need to do is on the circumference, because it is on this circumference that people will come and get into the reserve. So, if there is some person who wants to come into the reserve for poaching he or she will have to

cross this perimeter. So, all of this perimeter needs to here a high degree of protection. So, our costs are proportional to the perimeter of this area.

Now, if we look at cost per unit area will find that is given by that is proportional to 2 pi r which is the perimeter divided by pi r square. So, pi if pi get cancelled out. And so, this is equal to 2 by r. So, your cost per unit area is proportional to 2 by r. Now, if you increase r this value of 2 by r reduces. So, if you have more r. So, 2 by r is less, which means that you will have a lesser cost per unit area, if you have a larger amount of r.

So, more so, larger the reserve S, it means that you have less cost of protection per unit area. And, third is that it is less vulnerable to catastrophes since smaller catastrophe will not impact the whole area.

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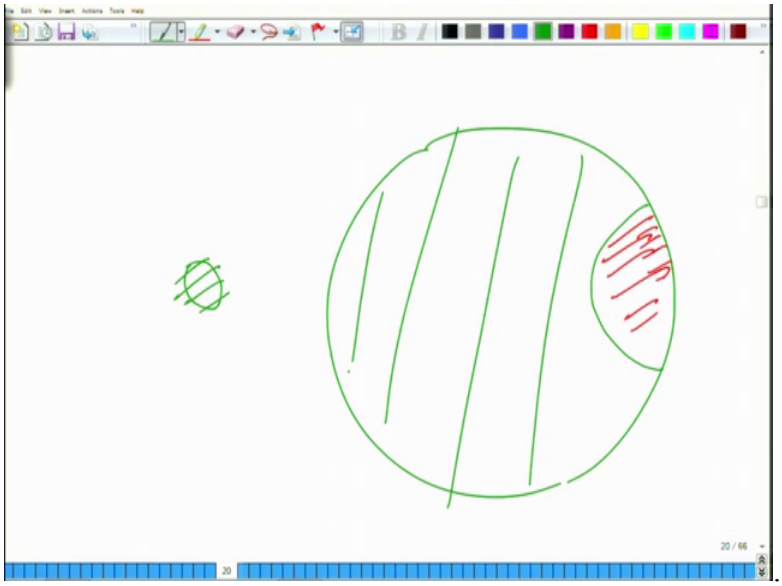

So, if you have a very small size reserve this is the reserve and if you have a fire the whole of the reserve might be lost to fire, but then if you have a large size reserve, and then you have a fire here a probably a larger sized fire, then you might be able to save the other areas. So, there was a fire that destroyed this much of portion, but then these areas would still be saved.

So, in that case we say that the larger size reserve is less vulnerable to catastrophes, because you will not lose the complete population. The population that is left or that you were able to protect in the case of a larger size reserve might be sufficient in most cases

to restock the whole reserve later on. So, smaller catastrophe do not impact the whole area. So, this is also another reason why we prefer to have large size reserves.

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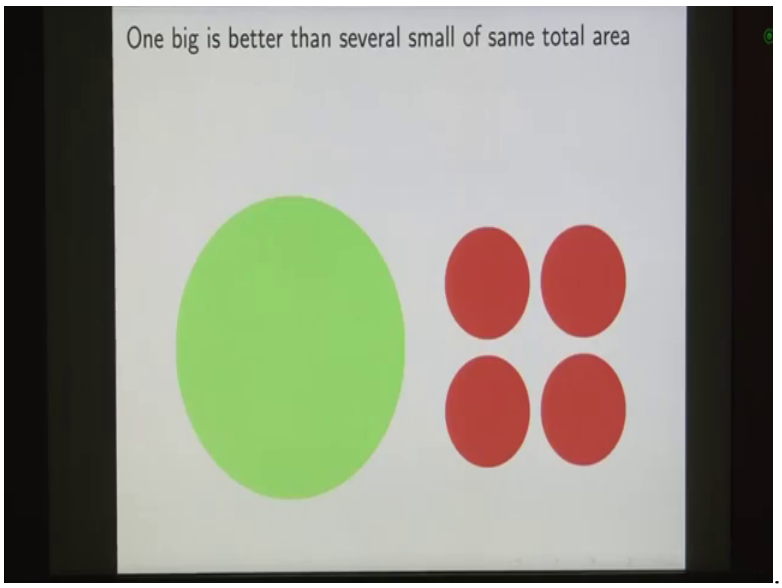

Now, it is not just a area, but also the connectedness one big reserve is better than then several smaller reserves of the same total area. So, here you have one big reserve here you have 4 smaller reserves. And, the total area of these 4 smaller reserves is equal to the area of the large of the big green size reserve green colored reserve.

So, in this case also we will see that this reserve is better than having these 4 smaller size reserves.

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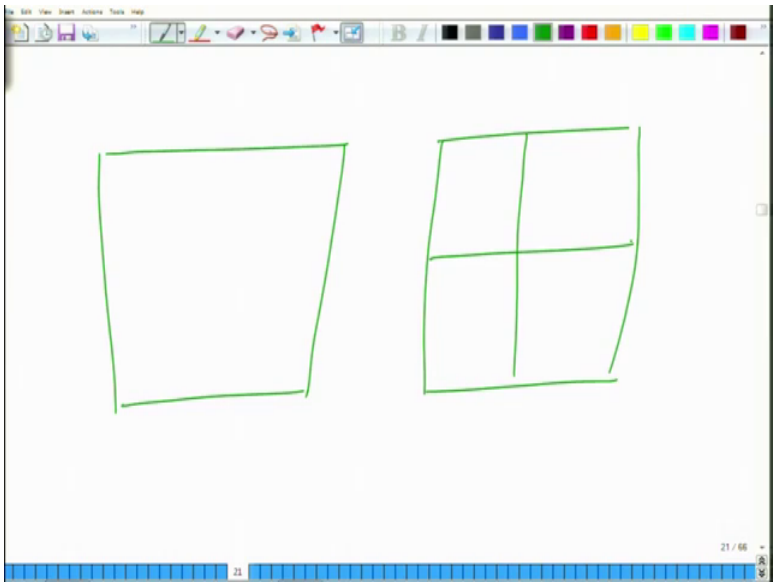

Why, because here we are saying that you have this one big reserve and then you have these 4 smaller sized reserves. Now, in the case of smaller sized reserves because the populations are not connected with each other. So, the animals that I hear will not be able to move to this other area. So, they will behave as small populations. And, again in the case of small populations will have more amount of stochasticity.

So, in the case of the a one large reserve in this reserve will only have deterministic factors that will play a role in extinction, but in the case of these reserves will have the stochastic phenomena, that will also play a role alongside the deterministic phenomena. So, the chances of all these four getting suffering from local population extinctions is very high.

And, at the same time if you have these 4 smaller reserves the total cost of maintaining these results will also be very high, because here again if you have a smaller size. So, the parameter per unit area is very high.

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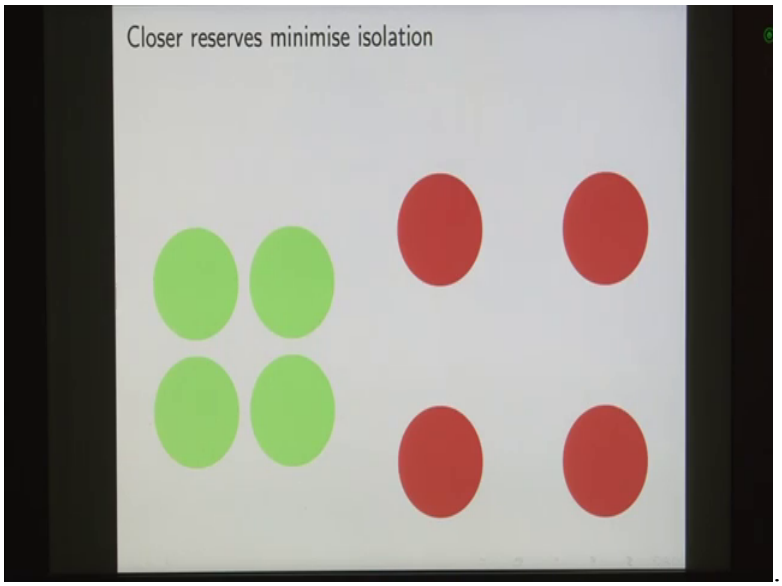

Next, if you cannot have a situation where you have a large sized reserve you have to go with smaller size reserves. So, in that case we say that closer reserves are better because they minimize isolation. So, here this left side green colored four reserves, this configuration is better than having this reserve why, because if you have these reserves that are close by. So, there the animals will be able to move from one area to the other area. Because, there is a very small amount of patch that has anthropogenic influences whereas, if you have this population and this probably needs to move to this area, then it will find it very much difficult.

So, if these populations are able to mix with each other. So, in that case these reserve effects of a some local extinction you will have animals that are coming from this small reserve this reserve and this reserve that will restock this population. So, the amount of stochastic population loss that you will observe when the reserves are close by will be less.

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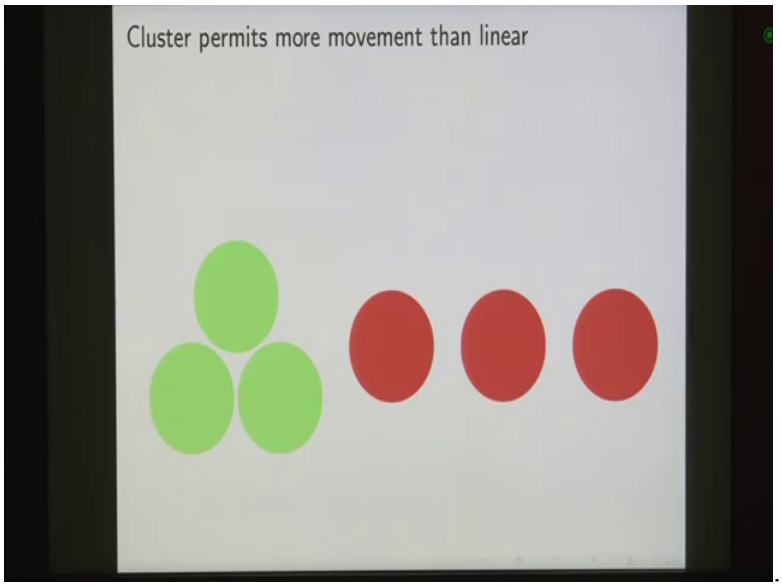

And, similarly not only should these reserves be close together, but then we in place of having them in a linear fashion, we should have them in the form of a cluster. Because, in the case of a linear fashion, if this portion suffers from an extinction a local extinction only animals from here will be able to come here, but animals from here will find it very difficult route to reach this reserve.

Whereas, if you have it in the form of a cluster, if you have local extinction here the animals from here will be able to repopulate the animals from here will be able to repopulate. So, cluster is always better than having a linear arrangement. So, this is also another learning that we are having from ecology.

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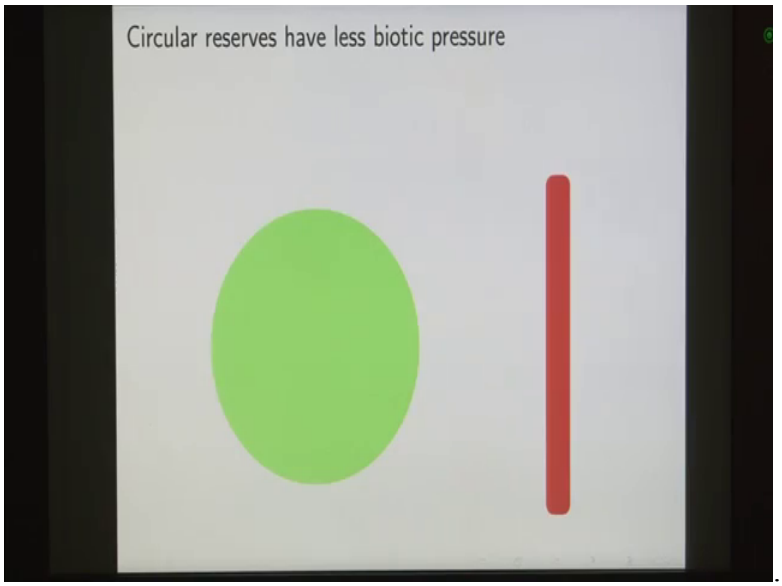

Also circular reserves are preferred as compared to linear reserves, because they have less amount of biotic pressure.

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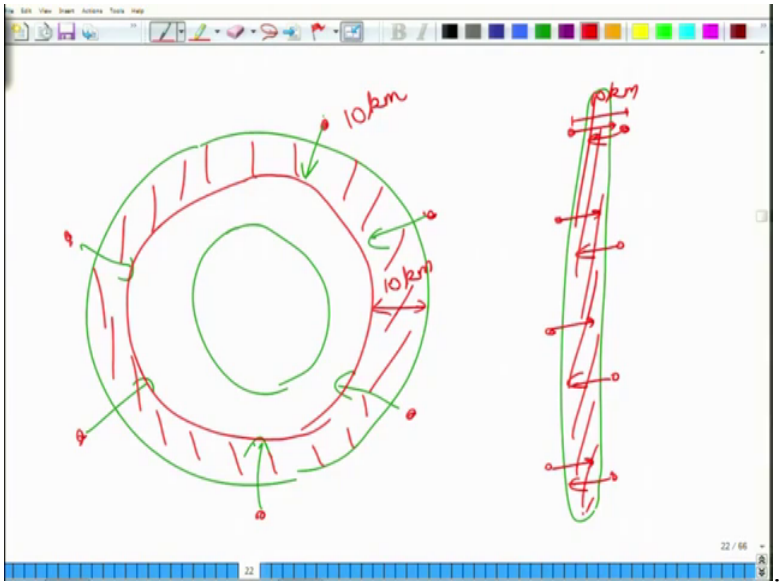

What do we mean by that, if you have this reserve. So, in this case and you have say villages in the periphery. So, in this case the central portion of this reserve will have a very less amount of biotic influence, because it will be protected from all of these using all of these buffer areas. Whereas, if you have a reserve that is linear in shape and suppose you have the villages here like this. So, in this case the village the influence of

these villages would be much higher as compared to when it was a circular reserve, or to put it in other words suppose in a from any village the cattle are able to go say 10 kilometres inside.

Now, if you have a reserve that is in a circular fashion. So, in that case you will have a 10 kilometer. So, this much is your 10 kilometers. So, this much area will suffer a heavy amount of influence, because of the biotech pressure whereas, in this case because this area itself is 10 kilometers. So, the whole of the reserve will face biotech influences.

So, in that case to reduce the amount of biotech influences to reduce the amount of anthropogenic influences, it is preferred to have a reserves that are served to have results that are circular as compared to the reserves that are linear.

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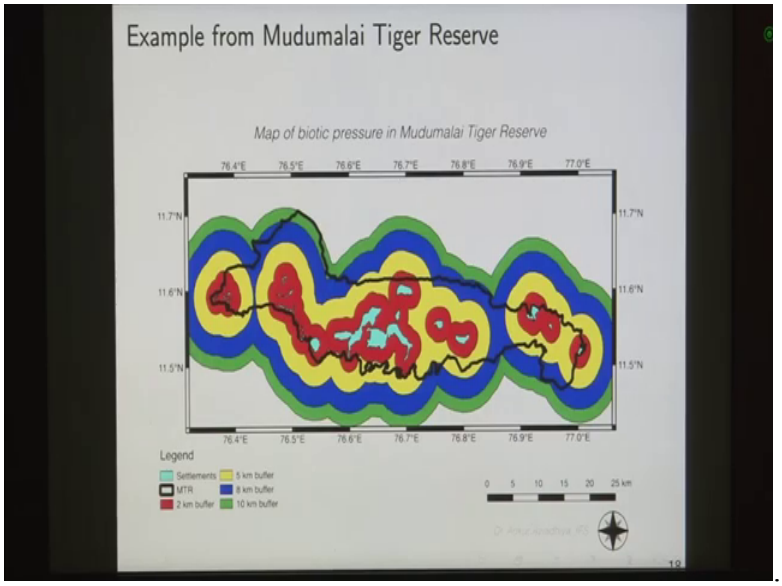

And, a good example in this case is are a Mudumalai tiger reserve in Tamilnadu. So, in this case this black line is showing us the reserve. So, as you can see this is more or less a linear reserve.

Now, in the case of this linear reserve and these blue areas are the settlements that are there in inside the reserve. And, if you look at the biotic pressure, we see that this 10 kilometer buffer completely covers the reserve. So, in that case just because this reserve is a linear in shape the amount of biotic pressure is too high.

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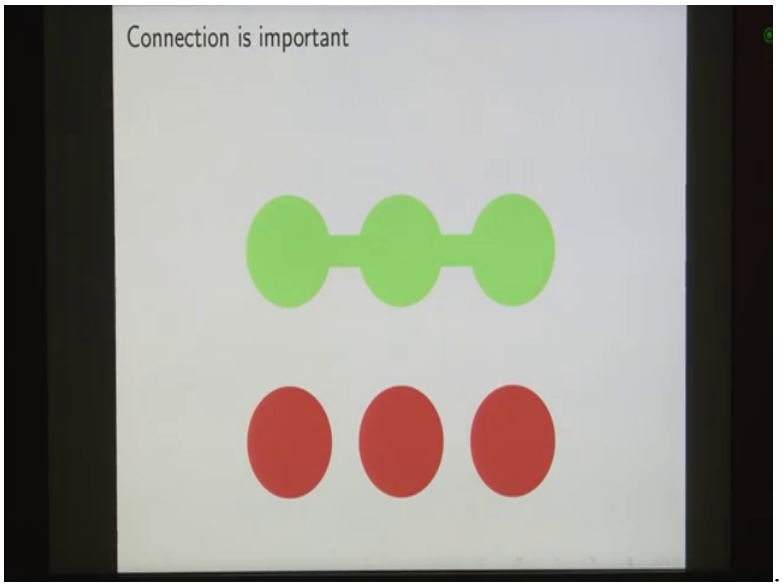

Another thing is the level of connection that we have, if you have reserves that are connected with each other. So, you have these three smaller populations, but then because they are connected with each other they will behave like a larger population. And so, the only deterministic factors will play a role in population dynamics that could lead them towards extinction, but a stochastic factors will not play that bigger role.

Because, even if you have a local extinction here you will have animals, that will migrate from this reserve and from this reserve to restock this area. And, so, the chances that you will lose out your population and all 3 of these reserves together will become very less.

Whereas, if you have reserves that are not connected with each other, you can have a local extinction here and then there is no animal that will come and restock this area. After a while you can have a local extinction here, again you would not have any animals that will restock this idea. And, if you have a local extinction here as well you will lose out your species in all three of these results. And, if these three are the only reserves where you have your species so, you will lose your species completely because of this process.

So, these are the factors that we need to keep in mind, when we are designing a reserve. So, we looked at where a reserve should be located and we looked at what should be the shape and size of the reserve, it should be large in size, it should be as close as possible

to the other reserves there has to be some amount of connectivity, it should be as circular as possible and so on.

Now, if nothing else works, if we are not able to have a large size reserve and you have to go with the smaller size reserve at least try to maintain connectivity between the reserves.

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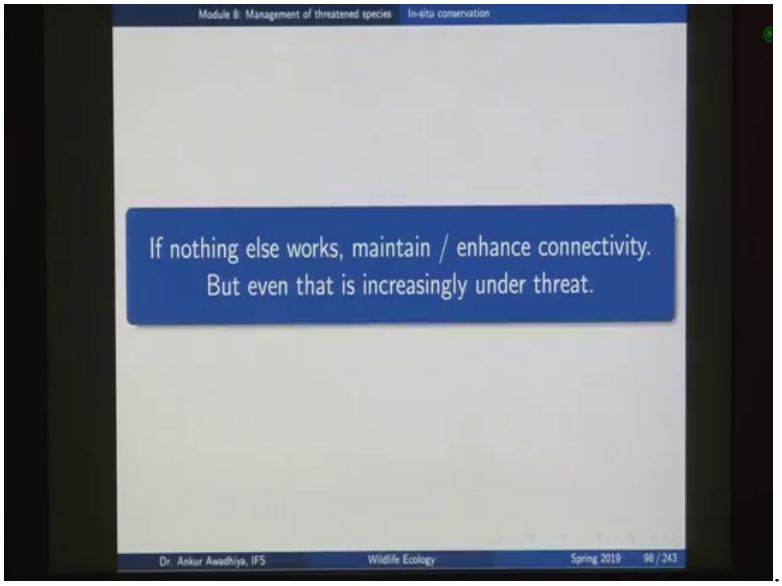

Because, in that case your animal will be able to move from one area to the next area and prevent the local extinction restock the populations. And, avoid the stochastical depths in the smaller populations.

But, then we are observing that even that is increasingly getting more and more under threat as can be seen from this example from Manas.

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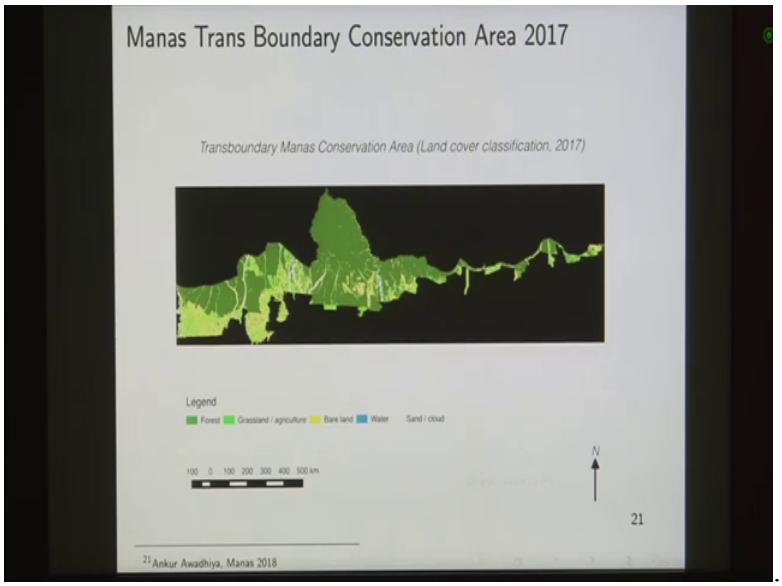

Now, here we have a satellite image of the Manas Trans Boundary Conservation Area in the year 1985. Now, in this image we have classified this image. So, that this dark green areas are forest areas the light green areas are grasslands or agriculture, the yellow areas are bare land so, there is hardly any yellow area in this case, the blue areas are water, and the white areas are sand or clouds. So, like this area is sand area.

Now, I would want you to focus your attention in this area. So, here we observe that we have a forest that is coming now like this and then going up and it is surrounded by the grassland so, the agricultural fields. And this is the image from 1985. Now, let us look at this area in 2003, 1985 2003, 85 2003.

So, here we can observe that this small portion, that we had here is lost when we move from 1985 to 2003. And, now further look at this area from 2003 to 2070, we have further lost it. So, all these forests are now getting lost, but then more importantly, if you look at these portions, if you look at this portion, if you have an animal and this area also has a number of elephants. So, if you have an elephant that wants to move from this area to this area.

So, here you have these small patches that are probably habitations. And, if you had an animal that wanted to move from this area to this area you have this small corridor and you have this small corridor.

Now, if we look at this area from 2003 to 2017 we observe that we are losing out these corridors as well. So, now, there is complete disconnect between both of these areas. So, even the corridor connectivity that is so, important for the animals there is now getting more and more lost with time.

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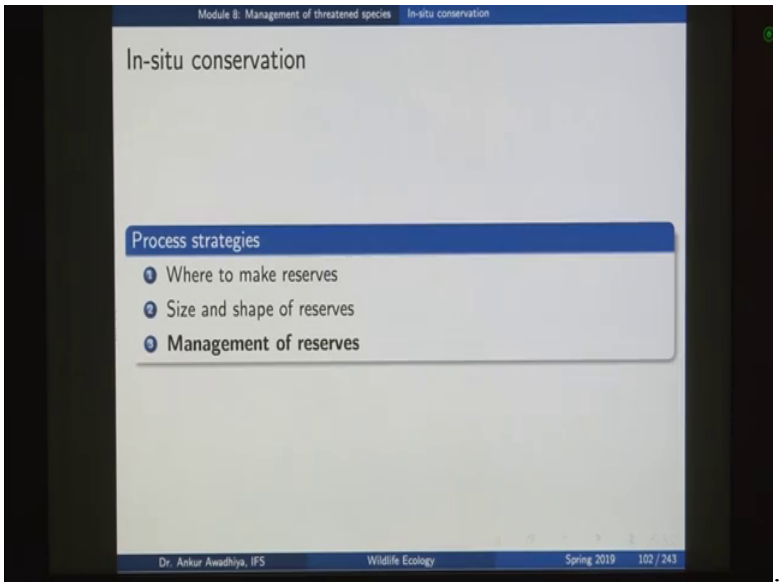

So, we looked at way to make the reserves, we looked at shape and size of the reserve the third question in the case of in situ conservation is how do you manage your reserves. Once you have created your reserves what next do you need to do?

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So, in this case we look at the 5 tools of habitat management that are used in the case of reserves. And, these tools come from the works of Aldo Leopold and he said that we have 5 tools of habitat management, we have the axe. So, axe can be used to cut a tree that is not required in your area or it can be used to cut climbers that are not required in your area the second tool is cattle.

So, you can use cattle to graze up any area, if you want to reduce the amount of grasses that you have in an area. The third tool is the plow. So, the plow can be used to remove weeds from an area or it can be used to add more and more grasses to an area by seeding them with the grass seeds.

The fourth tool of habitat management is the gun that you can use to keep certain populations under check. If, there is some population probably of an invasive species that is growing up very fast in your area probably you can call it down using a gun and the fifth tool of habitat management is fire.

Now, fire can again be used if you have an area that is extensively covered with weeds. So, you can burn that area down so, that your native vegetation can come up again. Now, if you look at all these 5 tools of habitat management that, classically we have been using, the axe, the cattle, plow, the gun enter fire, these also incidentally turn out to be the tools of habitat destruction.

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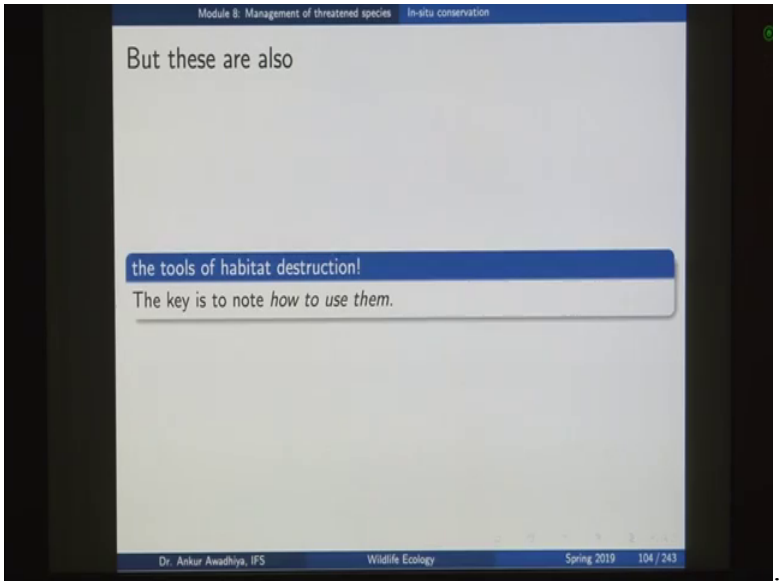

Because, gun is used for poaching forest fire is used to destroy forest, plow is used in the case of encroachment when people want to convert a forest into agricultural land, cattle is used again as a competitor against are wild animals and so on. And, also axe is used for deforestation. So, all of these are also tools of habitat destruction.

Now, the key is how to use these tools, we can use them for habitat destruction or we can use them for habitat conservation.

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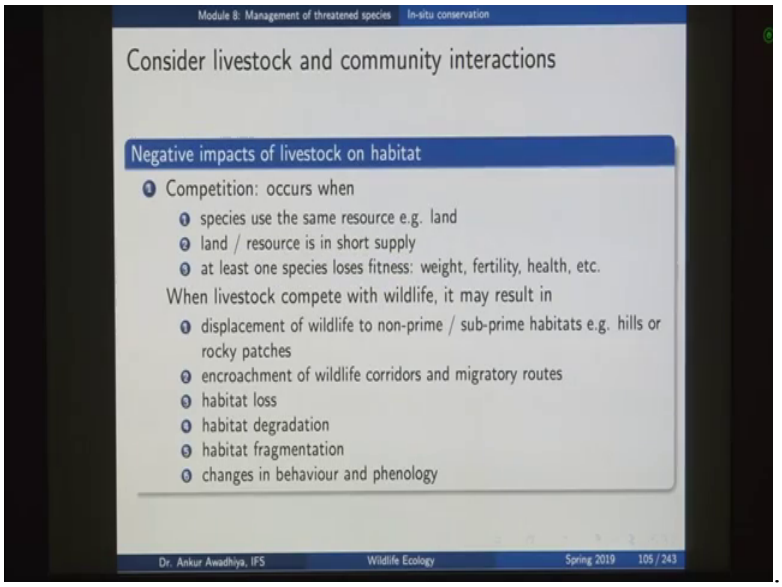

Now, we will consider one example and this is the example of livestock and community interactions. So, if you have cattle that are coming into your forest that can have a positive role or that can have a negative role.

The negative role that we all know is things such as competition. So, competition when species are using the same resource that is land so, all these animals are rising in the same area. So, you will observe situation of habitat displacement or you can have a competition when the land is in short supply, or at least one of the species loses the fitness.

So, this is what we have seen in the case of ecology a competition, which is an interspecies interaction will occur when both the species are using the same resource, that resource is available in a quantity that is not plenty for both these species to live together at the same time. And, so, there would be a loss to at least one of these species,

because of which we call it a negative or an inharmonious interspecific or interspecies interaction.

Now, in the case of livestock competing with wild life in an in most cases the livestock wins and the wildlife is the organism that has to suffer the brunt or the negative impact. And, those negative impacts can be in terms of displacement. So, we looked at habitat displacement in the last lecture as well. So, displacement of wildlife to non-prime or subprime habitats like hills or rocky patches, or it could lead to encroachment of wildlife corridors and migratory routes, or even degradation and loss of habitats, or fragmentation of habitat, or changes in behavior of the wild animals, or in the phonology of some plants.

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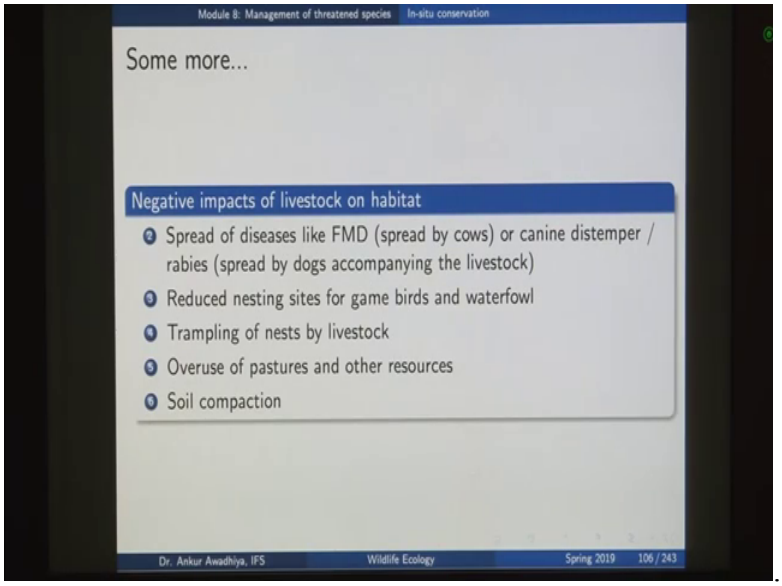

Or it can even lead to spread of diseases. So, if you have cattle that are bringing in foot in mouth disease from outside. So, they can spread it to the wild animals as well, or if you have dogs that are bringing in canine distemper or rabies then that can also get straight to the wild animals.

Other negative impacts are reduced nesting sites for game birds and waterfowl, because there is a lot of trampling of these nest by the livestock. And, also because these by the action of these livestock's a number of small bushes get lost. Also, this might lead to overuse of pastures and other resources soil compaction and so on.

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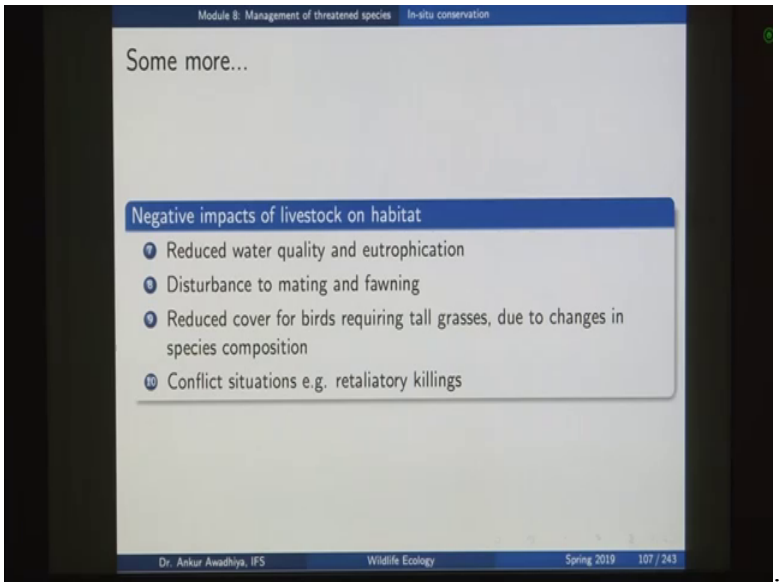

It could even lead to reduce water quality and eutrophication in the water bodies, disturbance to meeting in fawning behaviors of animals reduced covers for birds, that require tall grasses because of changes in species composition or situations of conflict such as retaliatory killing.

Now, retaliatory killing is something that happens when there is a farmer or a herdsmen, that is bringing his or her cattle into the forest areas and because we have predators in the forest areas. So, there is a chance that a tiger might go and kill a cattle for food. And, once that happens the villager would think that the tiger is killing my animal. So, we should kill the tiger. And so, in retaliation he or she might go and kill the tiger. So, retaliatory killing is also a negative influence of the livestock.

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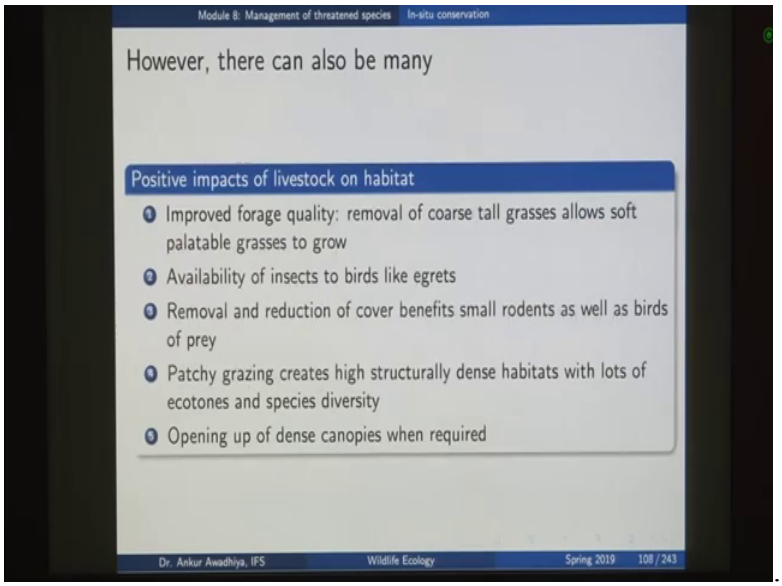

So, we all know all these negative influences, but then the livestock can also have some positive influences. So, positive influences such as you can have an improved forage quality, because removal of course, tall grasses allows soft and palatable grasses to grow.

So, if you have coarse grasses if you have tall grasses and if those grasses are eaten up by the livestock. So, after they are eaten up new leaves would come in and those new leaves might then be used by the by life. So, it leads to an improvement in the forage quality or availability of insects to birds like egrets.

Now, we saw this in one of our earlier lectures in which there are birds like egrets that come and set and wait for these livestock and when these livestock come. So, by their feeding by the grazing moment the insects get disturbed, and when these insects are disturbed the egrets are able to feed on these insects. So, the livestock can support birds such as egrets that are present in the wild areas.

Also removal and reduction of cover benefits small rodents as well as birds of prey, if you have less number of shrubs in an area. So, the birds such as eagles or hawks will be able to spot mice and rabbits in that area and that will benefit these birds. Also you can have patchy grazing that creates structurally dense habitats with lots of ecotones and species diversity. Now, this is also something that we have seen earlier in the case of ecology.

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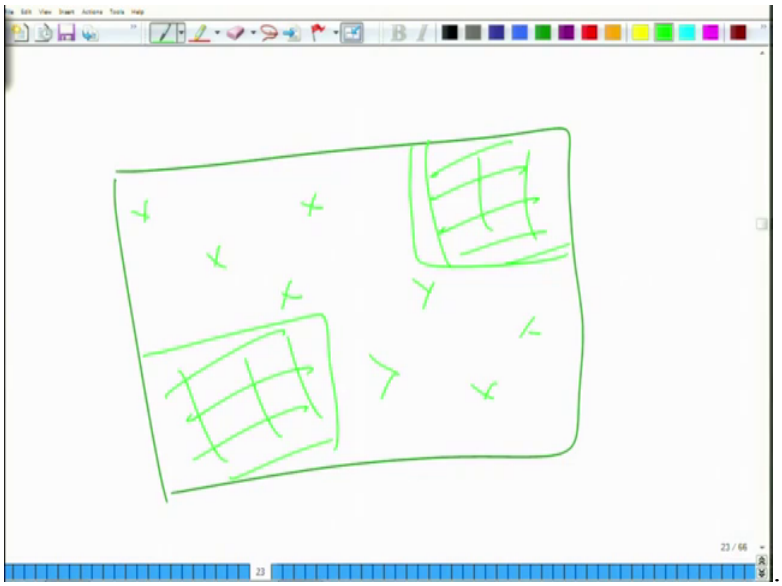

So, if you have this area that was grassland and all of this area was one and the same, if you can make your cattle graze in say these two areas. So, in that case the habitat of these 2 areas will become very different from the habitat of the surrounding areas.

So, it will lead to more number of habitat small amount of eco tones, which would also support a greater amount of biodiversity, but again if you can make them to graze in this patchy manner, other positive impacts are opening up of den of dense canopies when required. So, if you have a very dense canopy if you have a number of trees in an area. So, light is not able to reach to the ground.

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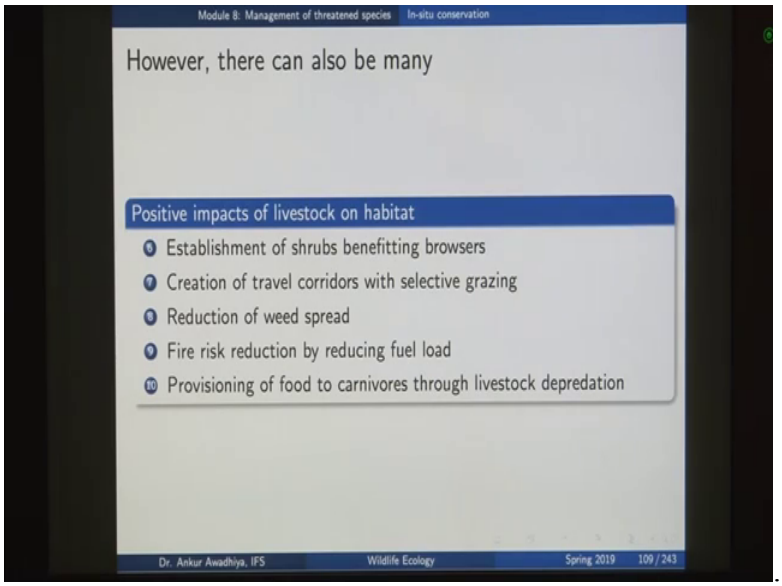

But, if you remove these canopy; if you reduce the amount of canopy load that is there in an area so, sunlight will reach to the bottom, that might reduce say some pathogens or that might even lead to the growth of some other species. Establishment of stubs that benefit browsers, creation of travel corridors with selective grazing, reduction of weed spread, fire risk reduction by reducing fuel load, provisioning of food to carnivores through livestock depredation. So, there are a number of positive impacts that we have because of the livestock that are grazing in the area.

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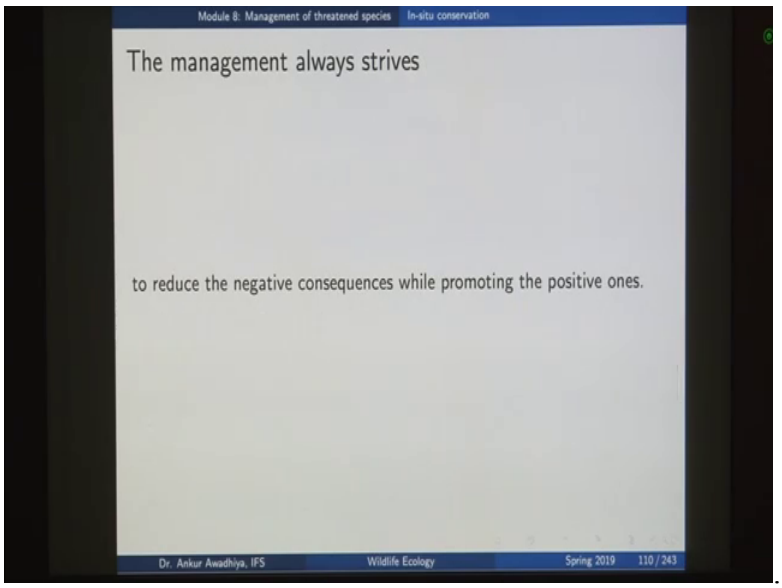

Now, the role of the management is to reduce the negative consequences and to promote the positive consequences. So, if we can do that using proper management. So, in that case we can use all these 5 tools of management for the conservation of wildlife. So, even in the case of the livestock we can convert them from competitors, from negative influences to the wildlife habitats to cooperators and to positive influences to the wildlife habitat. The only trick is to see that the negative influences are reduced and the positive ones are improved.

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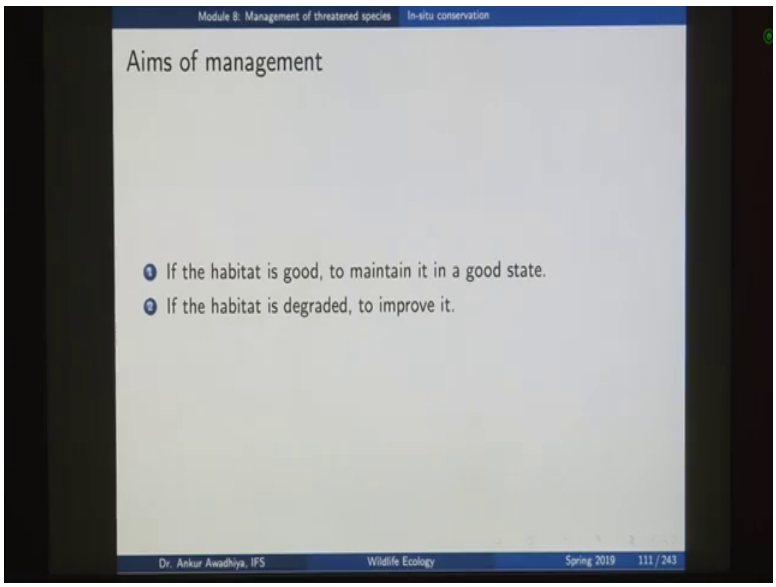

So, essentially the aim of management is that if there is a habitat that is good to maintain it in a good state and if there is a habitat that is degraded to improve it. And to improve these habitats that are degraded we can make use of all these 5 tools of management. So, when we see improvement what does that mean?

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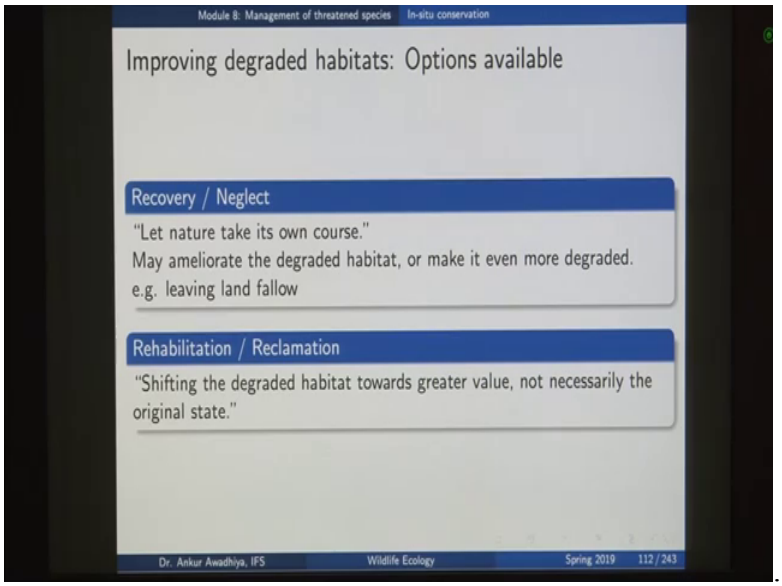

So, if there is a degraded habitat what are the options that we have with us. The first option is recovery or neglect. So, essentially you leave that area as such and let nature take it is own course. And so, it is possible that with time some species would come up into that area, there will be some amount of succession. And, nature would be able to bring this area back to the prime conditions, but then in a number of cases this is more of a wishful thinking then what actually happens.

Because, if you leave a degraded habitat as such and if you are not removing the causes of degradation then this area might become even more and more degraded. So, as we saw in the case of areas that are becoming more and more decertified. So, you have a lot of over grazing in those areas say in the case of goats that we saw. So, these goats are eating up the herbs and shrubs in that area and converting these areas into more and more degraded areas.

Now, if you do nothing with to these goats then probably this area will completely convert into a desert. So, recovery might lead to or a neglect might lead to some amount of recovery or it might degrade the habitat completely and only to habitat loss. The other option is that of rehabilitation or reclamation, which is shifting the degraded habitat towards a greater value, which might not be the original state, but which would be something that is better than the than the existing situation.

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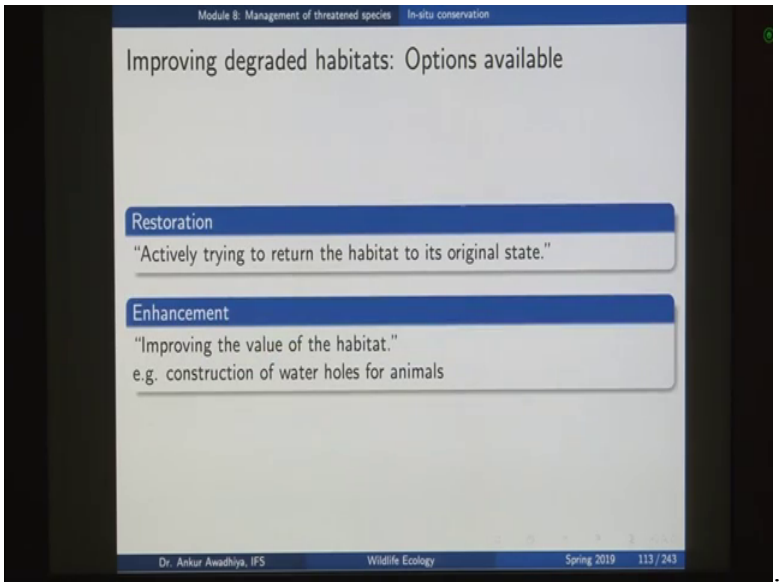

The next one is restoration. In the case of restoration you are trying to bring the habitat back to the original state. And, enhancement is improving the value of the habitat example construction of water holes for animals. So, in the case of rehabilitation or reclamation, you are trying to bring it towards the original, but you are not completely reaching the original state. In the case of restoration you are completely able to reach the original state. And, in the case of enhancement you are trying to improve the value of this habitat which may or may not be towards the original state.

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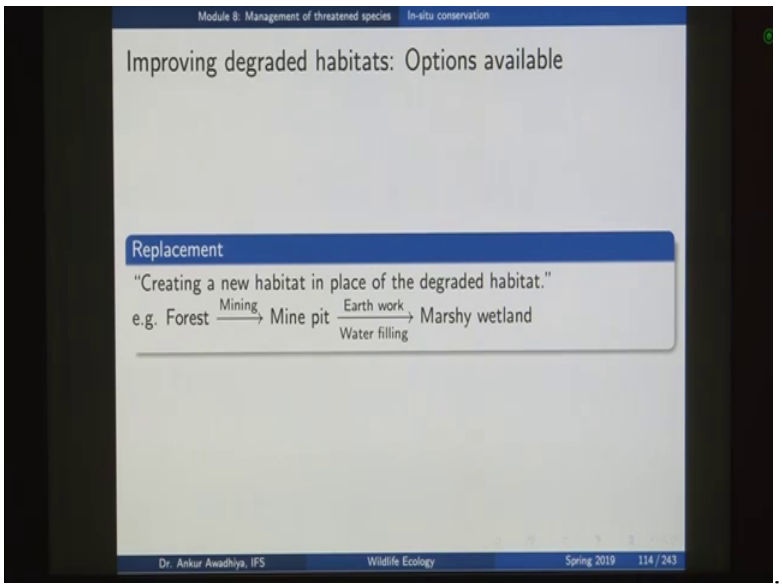

And, one other option that is available is that of replacement, so, in place of converting it towards the original habitat you convert it into a completely new habitat. So, for instance there was a forest this forest was cut down for mining purposes. So, you have these mine pits. And, in place of converting these mine pits back to the forest you fill them with water and you convert these into water bodies. So, that would be an example of replacement.

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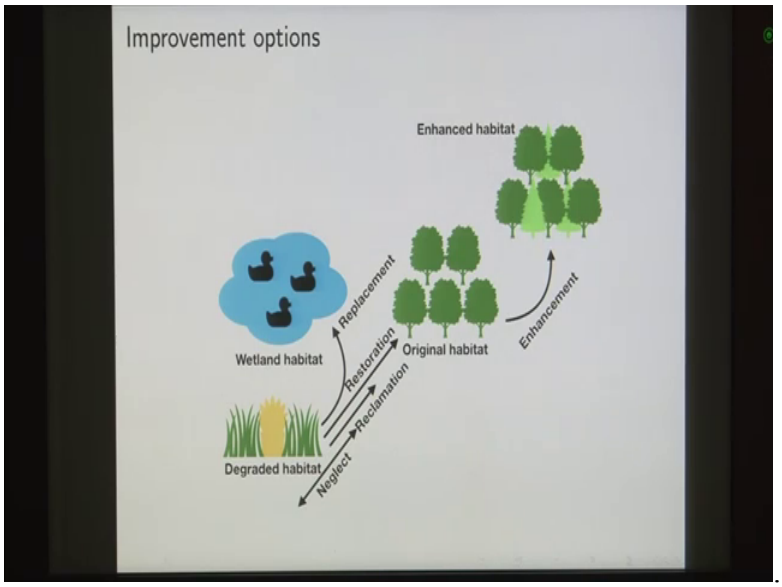

So, this figure tells us what are the improvement options that are available with us? So, you have a degraded habitat you can neglect it you can do nothing to it. So, in that case it might restore to some extent or it might become completely degraded or you could go for a reclamation. So, in the case of reclamation you are trying to convert it towards the original habitat and you reach somewhere in between. You have not reached to the original habitat, you have reached to somewhere in between, that is reclamation.

The third one is restoration in which case you convert this degraded habitat completely to the original forest. And, then if you move it even further it would be an example of an enhanced habitat.

So, in place of having just these trees you are now having even more amount of biodiversity or other option is that of replacement. So, in place of this degraded habitat you have converted it into a wetland habitat. So, these are the improvement options that we have with us when we are talking about the in situ conservation.

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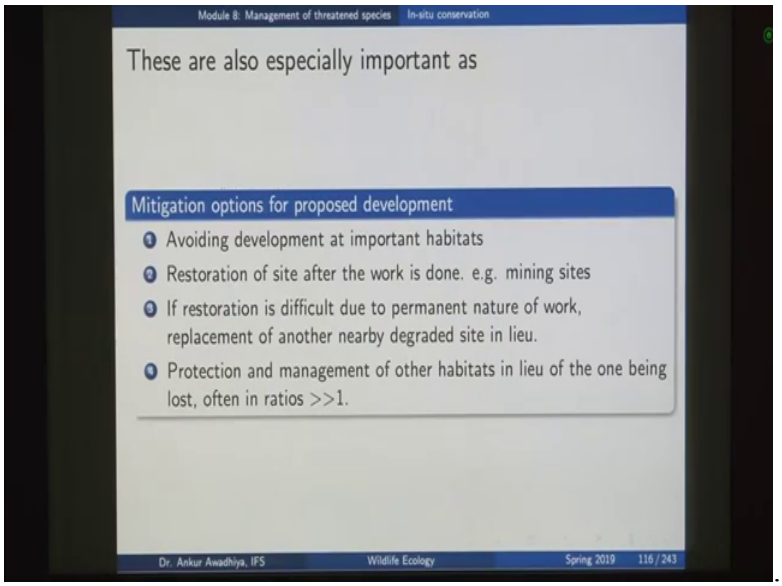

Now, knowing all of these options is also important, because these are also mitigation options for proposed development. So, suppose you have an area where you are doing in situ conservation.

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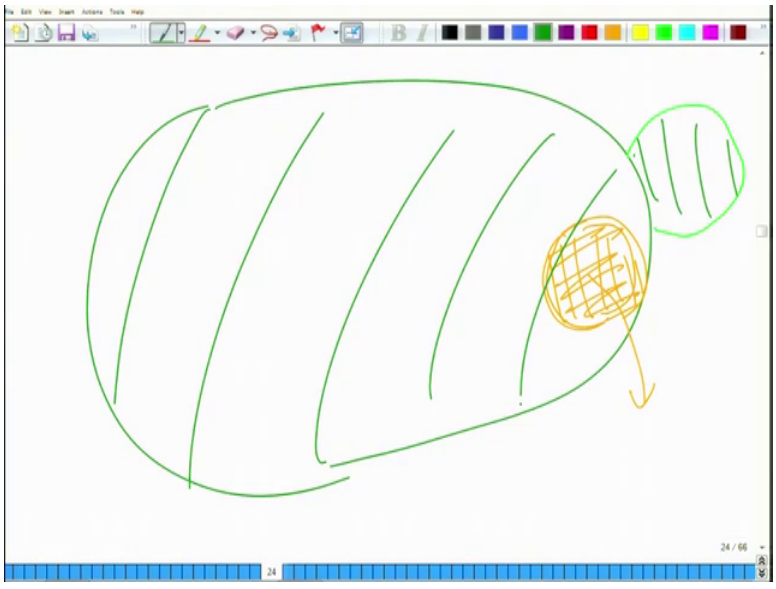

So, there is this big sized forest that is available with you and the society also has it is own needs and wants. So, because of that this area needs to be converted into a mining site.

Now, the question is if this area needs to be converted into a mining site, how can you best use this area. So, that you have maximum amount of conservation for maximum number of organisms. What are the options that are available with us? So, these options go by the name of the mitigation options.

So, there is something bad to then to the biodiversity that is happening and what are the ways through which we can mitigate the level of harm that could be there.

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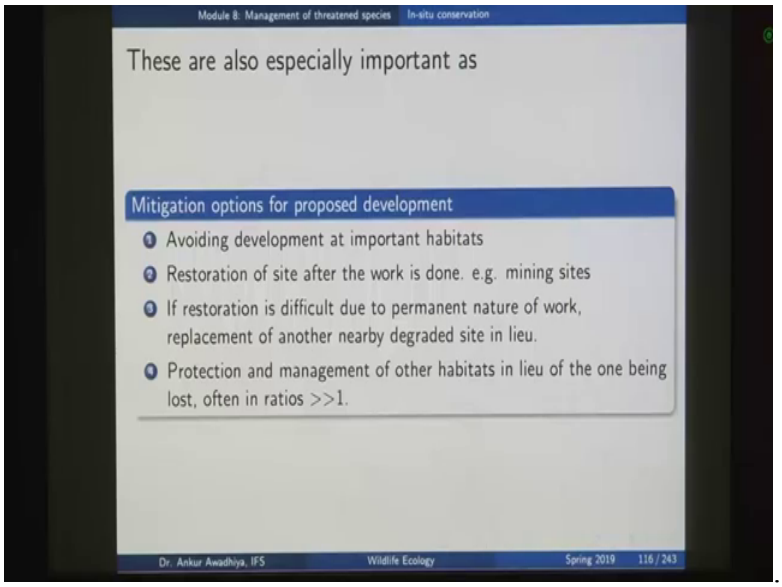

So, these mitigation options could include things like avoiding development at important habitats. So, if we have designated an area as a tiger reserve. So, we say that these are the areas where there will be no development as at all. An, other areas we can say that we should go for restoration of the site after the work is done. So, example is mining sites you did this mining, but then later on you have to fill these holes and you need to plant trees.

If restoration is difficult due to the permanent nature of work replacement of another nearby degraded site in lieu. So, for instance in this case you were not able to restore this particular mining site, it became completely degraded. So, then another option would be to take another area that is nearby and then convert that into a forest.

So, that is also another option that is available. And, other option is protection and management of other habitats in lieu of the one being lost. So, in this case what we say is

that, this is the area that you are converting into mining. And, to if you are converting this into mining, you should give sufficient amount of resources that would lead to protection of this big area or maybe habitat improvement in this big area. So, even by losing a small area in totality we can work for the conservation of this species

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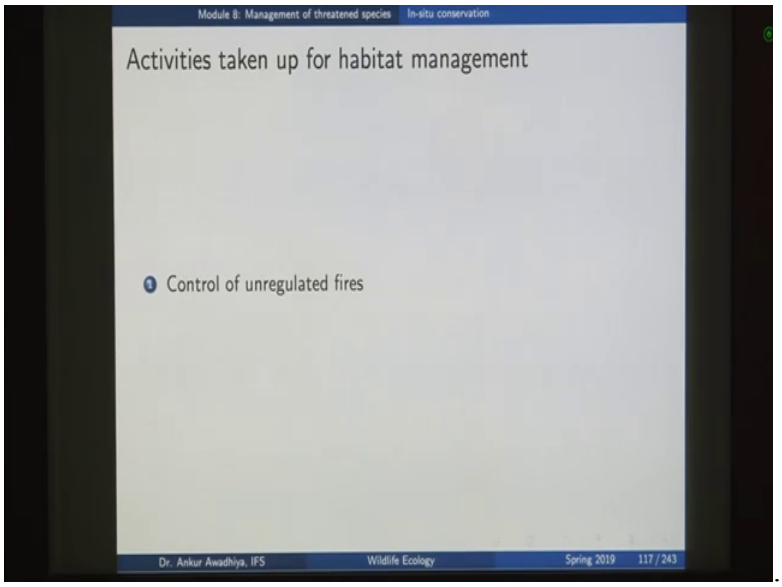

Now, what are the activities that are actually taken of for habitat management out there in the field. So, we looked at what different things need to be done, we looked at how habitats need to be improved, but then what are we actually doing out there in the field for habitat management.

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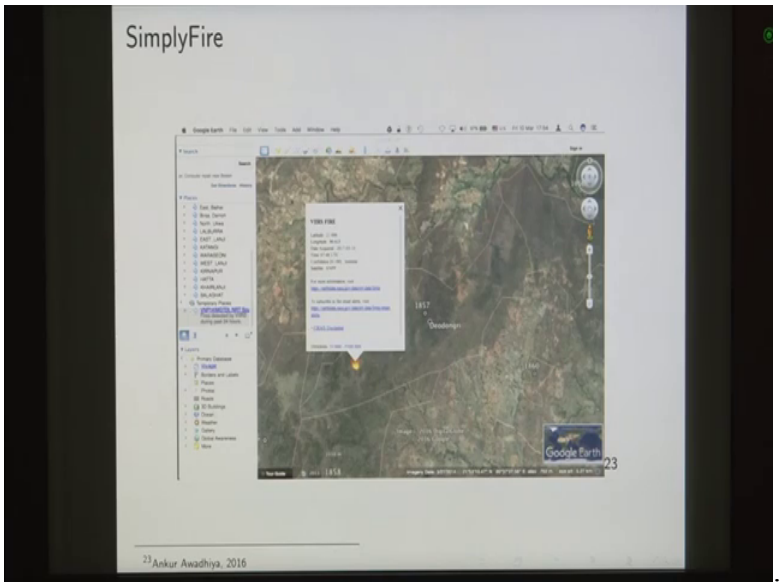

So, one thing is control of unregulated fires. So, we have this application known as simplified through which we get to know where we are having a forest fire in real time. And, once we know that there is a fire here, we can we go to those areas and we extinguish the fire. We also work with things such as fire lines.

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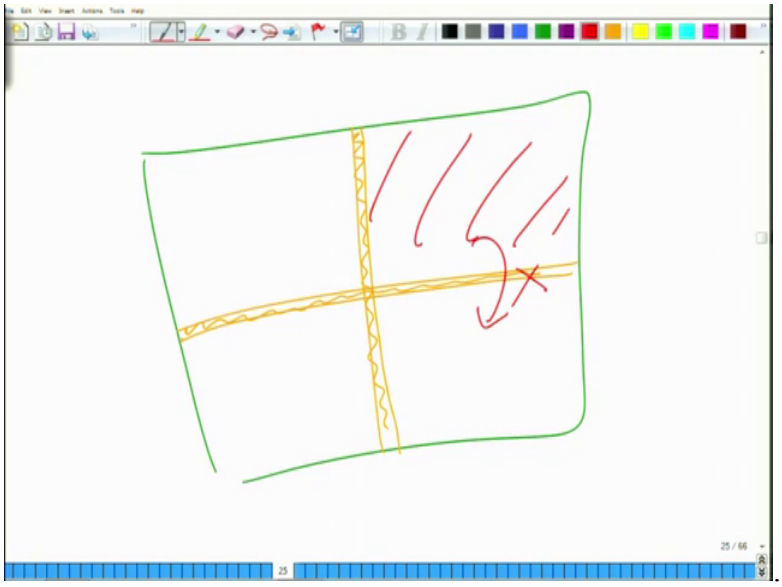

So, in the case of a fire line if you have this big sized forest you will convert it into smaller areas by just clearing of very small strips. So, in this case we are not fragmenting the habitat, but we are still converting a very small section to a non-tree section. So, that

if there is a fire in any area, this fire will not be able to jump to the surrounding forests and will be contained to that area.

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We also make use of equipment's such as instaalert it which give us a real time notification there is a fire in our forest areas.

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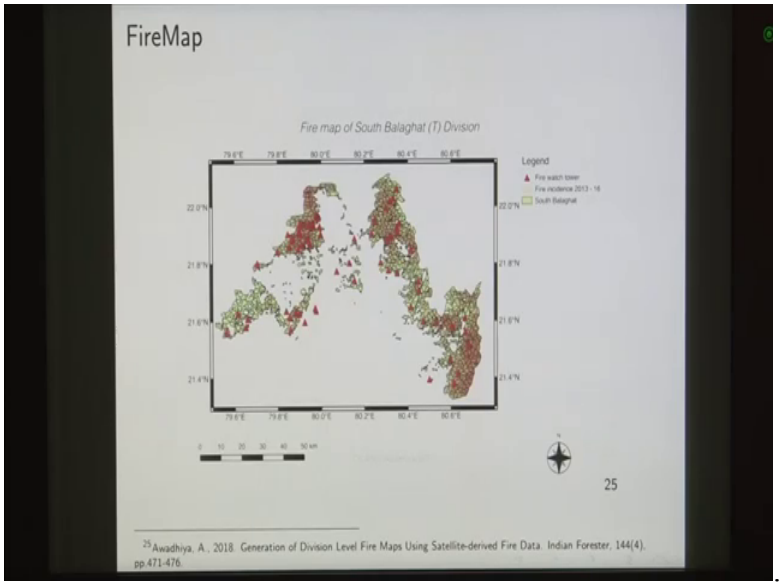

As, also we make use of fire maps. So, fire map is a way in which we are able to concentrate our efforts. So, for instance in the case of these are the reserve forest in

Balaghat and here we can see that we have more fires in these three areas. So, we deploy our resources preferentially into these areas by using this these technologies.

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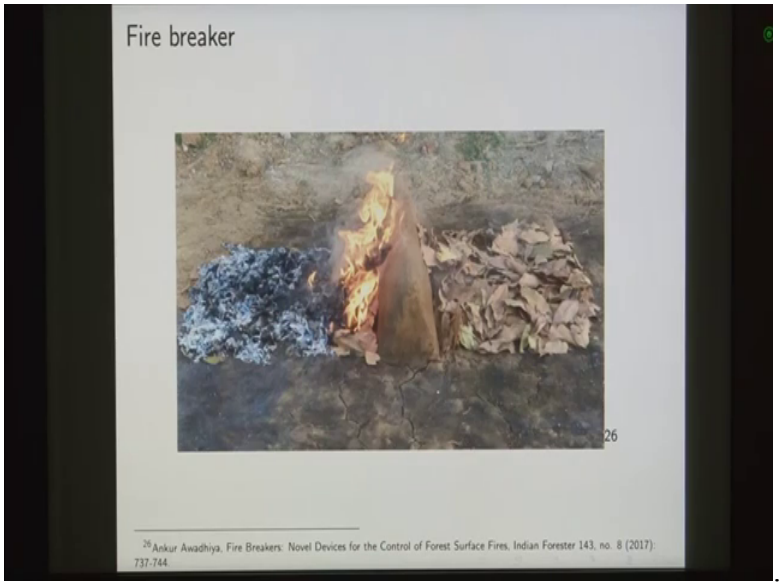

We also make use of fire breakers to substantiate the fire lines.

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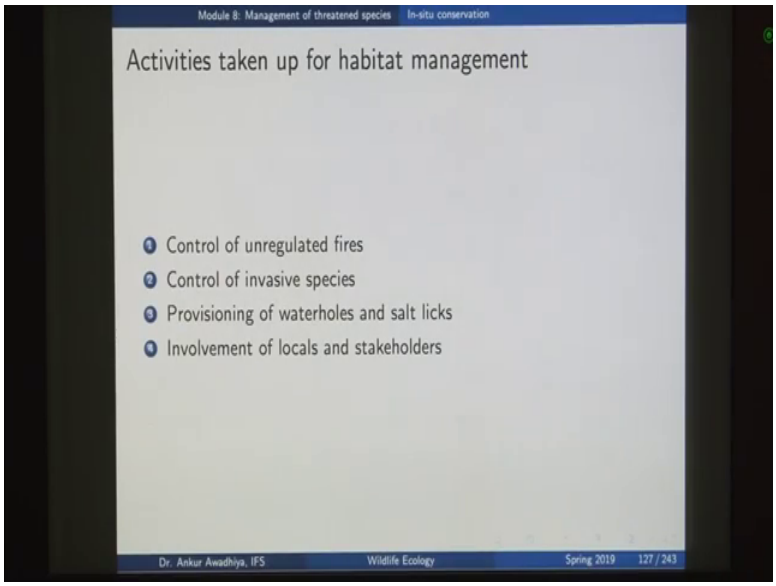

Also other activities are control of invasive species.

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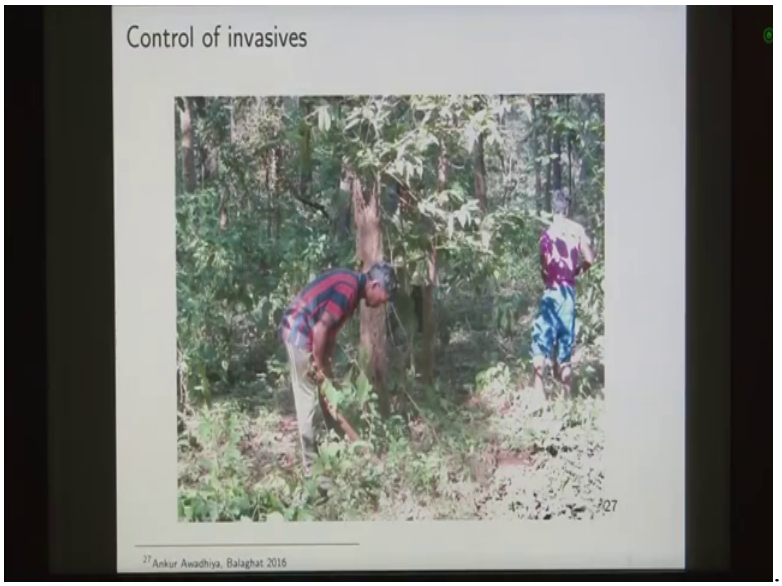

So, we make use of local people. And, in this case these people are removing the weed species that have in the invasive species that have come up into our forested areas. Because of these weed species the grasses are not able to grow and so, the amount of further availability to the wild animals less. So, we approved these species we remove these species from these areas. So, that the habitat becomes much more improve for the wildlife.

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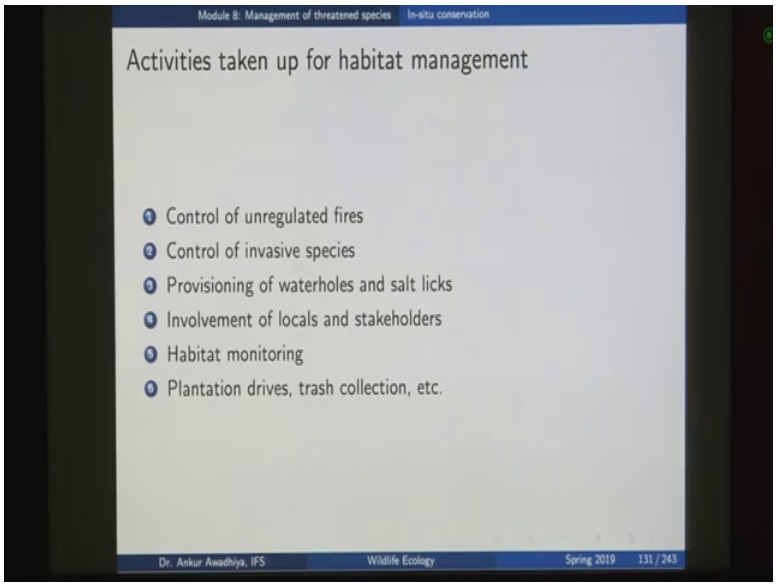

Other is provisioning of water holes in salt lakes.

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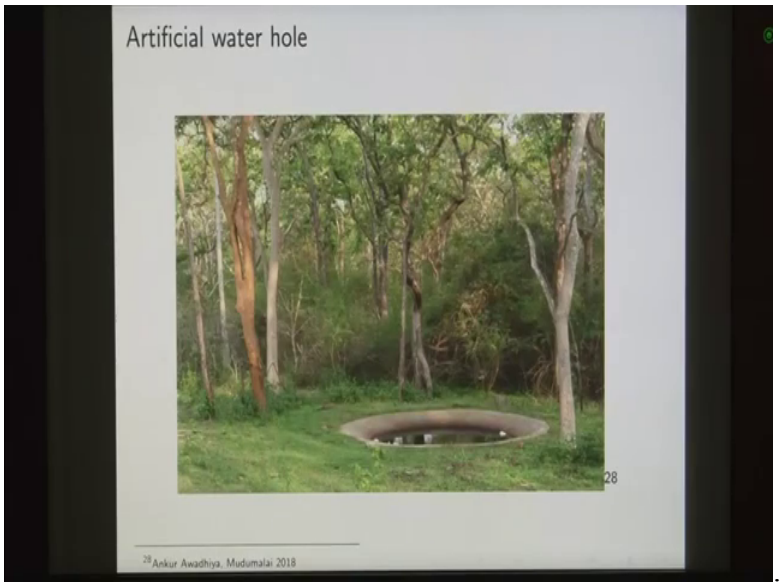

So, in those areas where we have a scarcity of water, we could even go for construction of a small waterhole, and in this water hole people would come and bring water in tankers and would fill these water holes. So, that even in the case of the peak summers the animals are having some access to water or we could go for salt licks.

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Now, salt licks are areas in which we are putting some salts and we are also adding some mineral nutrients. So, that if there is an area where we observe some amount of mineral deficiency in the in the wild animals, we could construct some salt licks. So, in this case

we will have some salt and we will mix it with some other minerals. So, that the animal will come licked these salt lick and will get the minerals. So, that their health improves. Otherwise improvement of is involvement of locals and stakeholders.

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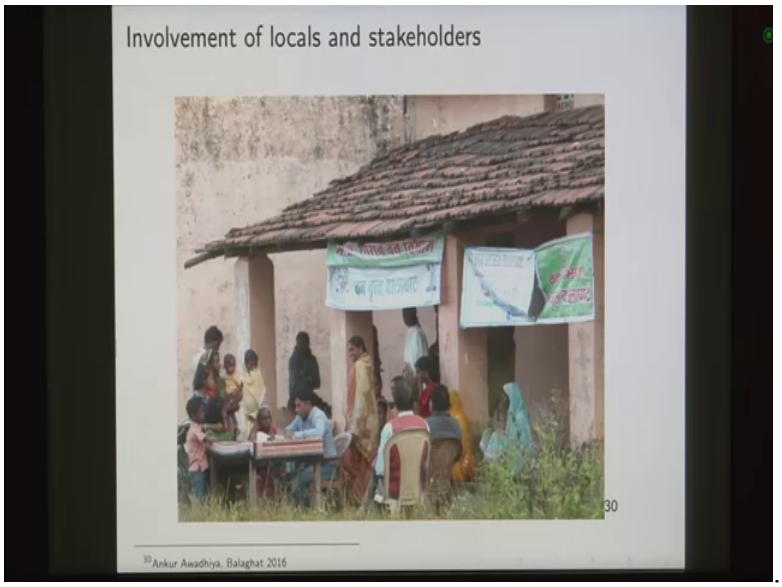

So, we work with the locals we give them different facilities we set up health camps for them. So, that they also work for the cause of conservation. So, that if we the idea here is that if we are working for a common cause if we are friends for this common cause. So, in that case people also want to protect the forest, because only because of the forest they are getting these benefits. So, they would try to prevent poachers that are say coming into these areas.

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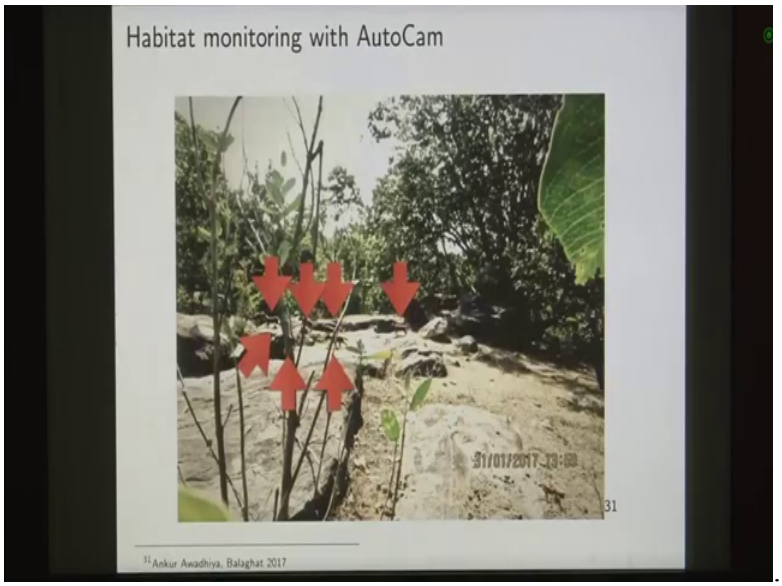

We also do a lot of habitat monitoring. So, in the case of habitat monitoring, we also make use of technologies such as auto camps. So, in this example we are observing wild dogs and there are 7 puppies in this wild dog den. So, in this example by habitat monitoring what we are doing is we are trying to get a grasp of the population dynamics of different of different species.

So, for instance here if we see that there are 7 puppies. So, there is a good amount of natality that is there in this population. So, it is not that much suffering from the stochastic phenomena that could lead to it is extinction. So, such kind of habitat monitoring is also done. And so, is plantation, drives, trash collection and so on.

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So, plantation drives are done to convert certain areas that are devoid of vegetation to have some amount of foliage cover in those areas. So, that the animals have access to shade they also have access to certain fruits and so on.

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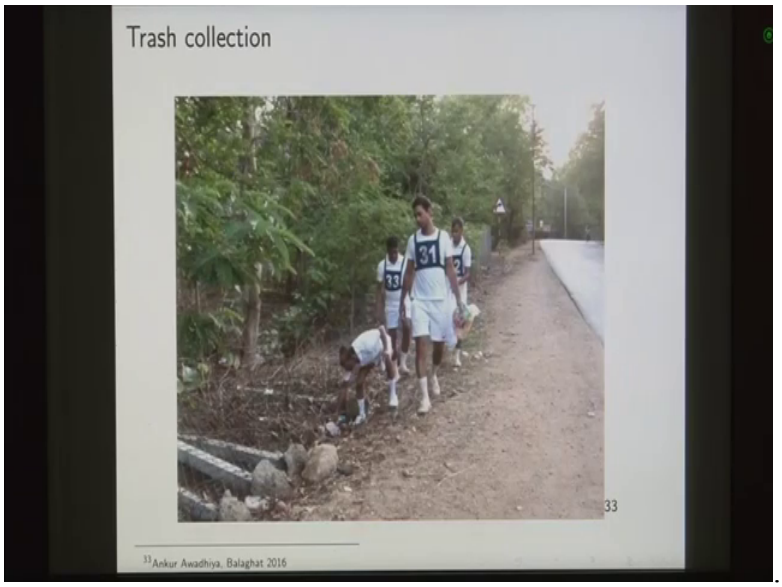

And, also trash collection so, that the amount of habitat degradation that is there, because of the influence of humans is also reduced.

So, in this lecture we looked at in situ conservation. So, in situ conservation we began with the definition by saying that in situ conservation is it is conservation on the site itself. So, on site means you could create reserves you could create say, national parks, or wild life sanctuaries and so on. So, that your animals remain there and they are able to live in their natural habitat they are able to retain all of their cultural characteristics, they are able to retain their natural behavior.

Now, this is contrasted with ex situ conservation in which you have conservation that is off the side. For example, construction of zoo, or construction of aquaria, or construction of a seed bank and so on. Now, in a number of situations we have found that the ex situ conservation is more costly as compared to the in situ conservation, but then in situ conservation also has it is own pros and cons. Like animals are able to retain their behaviors and even protection of certain species also conserves a number of other species, but then the minus point is that it requires a very huge area, very huge establishment, and you do not have that amount of control over things such as diseases, because you have a very extensive area.

So, we began by looking at in situ conservation. Now, in the case of in situ conservation we have these 3 basic questions, where should you have the reserves, what should be the shape and size of these results and what should be the management interventions that we need to do for in situ conservation. So, we began with where should the reserve be.

So, reserve should be in areas that have a high species richness, high species endemism and a high amount of threat, or probably a moderate amount of threat if you go by the triage principle. We also looked at gap analysis, which tells us that we should construct reserves in those areas that have so, far mean left out.

Then, in the case of shape and size of reserves, we looked at principles of reserve design, you should have a large size reserve, you should have reserves that are close together, reserves that are connected to each other, reserves that are in a cluster format, reserves that are more circular as compared to a linear reserve and so on.

And, in the case of management interventions, we looked at different options that are available with us we looked at neglect, we looked at restoration, we looked at replacement and so on. And, we looked at different mitigation options, what should we do to prevent the harm that is there to the species that are residing in the in those areas.

And, finally, we looked at various different interventions that we are already doing in the field in the case of in situ conservation. So, we should remember this point, that conservation biology is the practical application of the knowledge of ecology for the benefit of certain species.

And, this is what we are doing in this particular module and in situ conservation is a very important part of our conservation strategies. So, that is all for today in the next lecture we will look at ex situ conservation which is conservation off the site; so that is all for today.

Thank you for your attention [FL].