Wildlife Conservation
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Lecture – 13
Reserve Selection and design

[FL]. We know what a habitat is, and we have seen how we are losing out our habitats for the wild animals. So, how do we protect our wild animals? One way is through creation of reserves for the wild animals which are protected areas also which are protected habitats. So, in today's lecture will look at habitat will look at reserve selection and design. So, let us begin.

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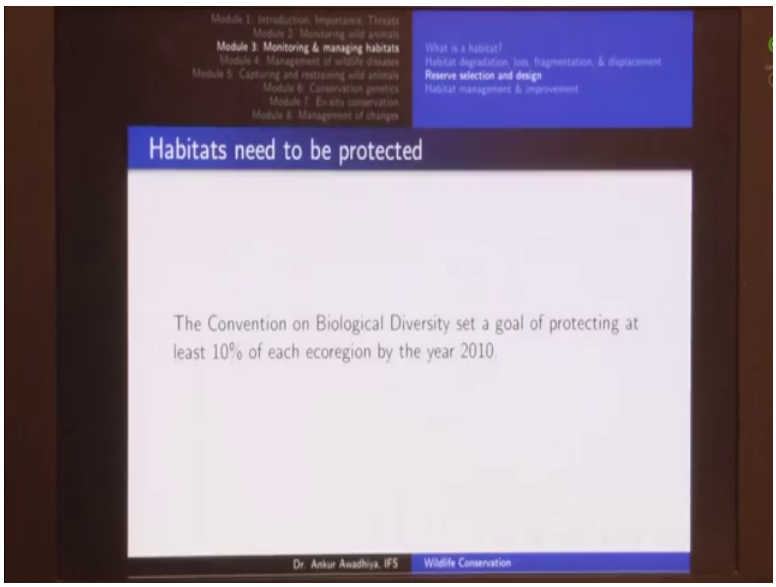

We know that habitats need to be protected the convention on biological diversity set a goal of protecting at least 10 percent of each ecoregion by the year 2010.

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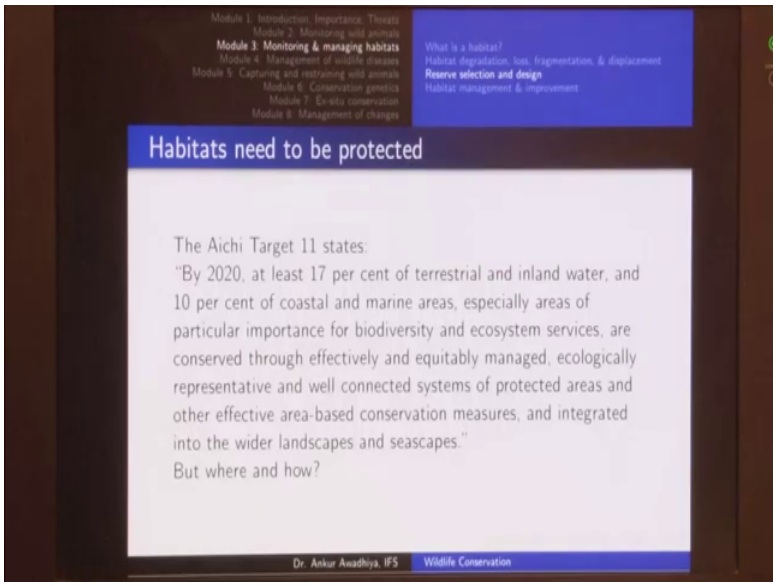

Then we had the IT biodiversity targets, and these increased that level of 10 percent by stating that: “By 2020, at least 17 percent of terrestrial and inland water and 10 percent of coastal and marine areas especially areas of particular importance for biodiversity and ecosystem services are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area based conservation measures and integrated into the wider landscapes in seascapes.”

So, this is one of our targets. But then the next question is we know that we want to create a reserve, but then where should we create our reserve and how should we create our reserve.

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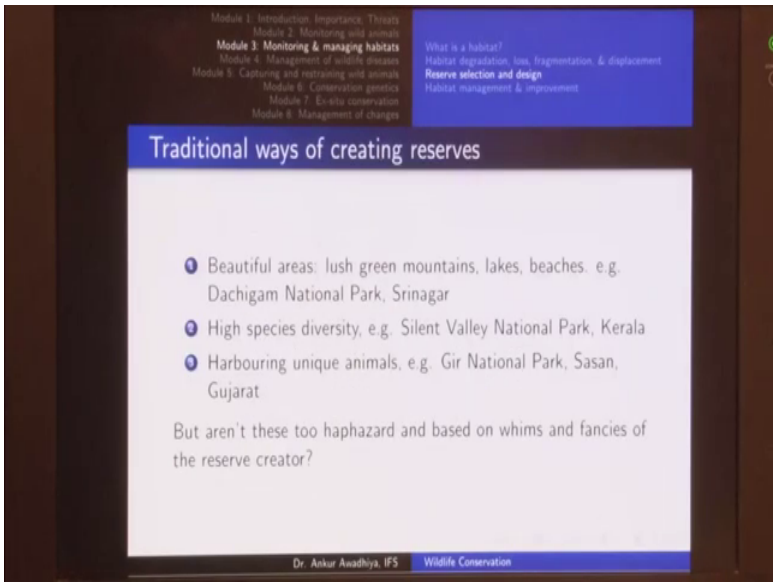

So, we look at how the early reserves have been created so far. So, the traditional ways of creating reserves were consisting of beautiful areas. So, you have lush green mountains, you have lakes, you have beaches, like in the Dachigam National Park in Srinagar. So, because this is a beautiful area let us make a reserves out of it otherwise we had areas with high species diversity. So, like the Silent Valley National Park in Kerala. So, this area has high diversity of species. So, somebody thought let us a reserve out of it, otherwise harbouring unique animals such as the Gir National Park Dasan Gujarat which has the Asiatic lions. So, this is the only population left of the Asiatic lions. So, because it has this population let us make a reserve out of it.

In certain situations people also use the criteria that any area that does not have any use for humans, let us convert them into a reserve. So, most of are very high mountain areas that are not being used by the human beings are have been declared as reserves. But then all of these are ad hoc measures of creating a reserve all of these are very haphazard, and depend on the whims and fancies of the reserve creator. So, is there any scientific way in which we could construct a reserve? What is the theory of construction of a reserve?

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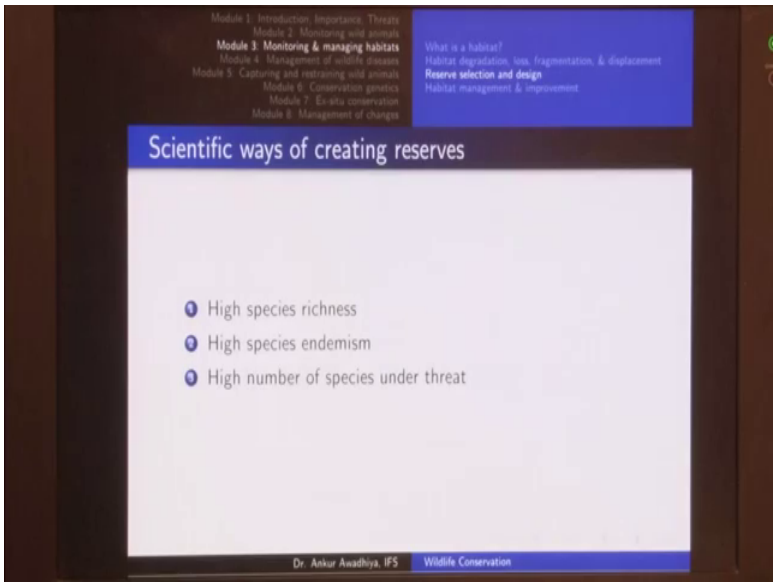

So, the scientific way of creating reserves should dwell at least at these 3 points. It should have areas with high species richness, a high species endemism and a high number of species under threat. Why? Because we want reserves to be able to protect our species; so, if there are areas which have high species richness. So, and we create a reserve there then we would be able to conserve quite a large number of species. It is even better if the areas have a high level of species endemism, and endemic species as any species that is only found in this area and this not found anywhere else.

Now, if your area has some such species then it makes all the more sense to create a reserve there. So, that your species that only found in these areas are even more protected also the third criteria is that of threat. If you have a high number of species under threat then it makes sense to create reserve there to protect those species, because if you have an area that has very high species richness of a very high species endemism and there is absolutely no threat there. So, in those situations it does not make any difference whether you create a reserve or not. So, examples could include some of our island some of the are very small islands which are not inhabited by human beings which are not even visited by human beings and they also have a very high species richness and by very high species endemism.

So, whether we create a reserve there or not would hardly make a difference. But then when we talk about species richness and species endemism is there any way in which we

could categorically say that these are the areas where we have a high species richness and a high species endemism.

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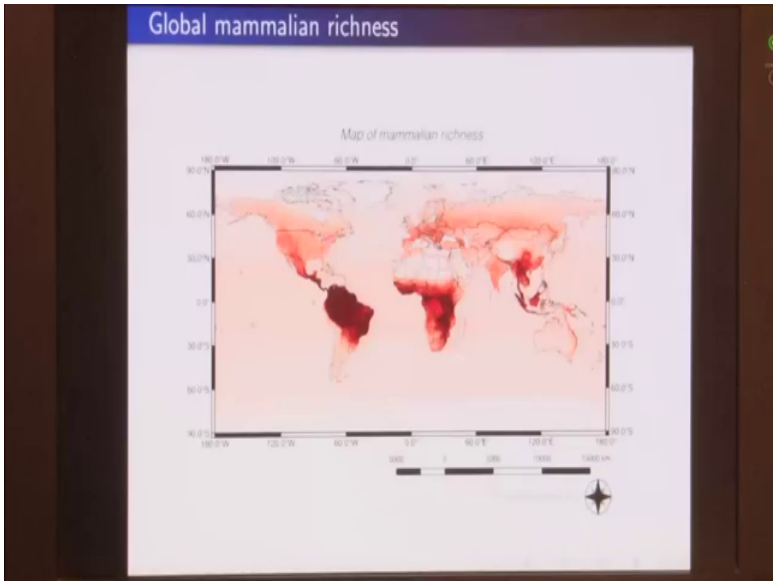

So, to answer that question we have created some maps. So, this is a map of mammalian richness. So, richness again as we remember is the number of species per unit area. So, here we can see that our equatorial rainforests have a very high level of mammalian richness, and in the case of India we can see that this these Terai areas which are the conference of our Indo-Gangetic plains and the Himalayas have a higher level of species richness for mammals.

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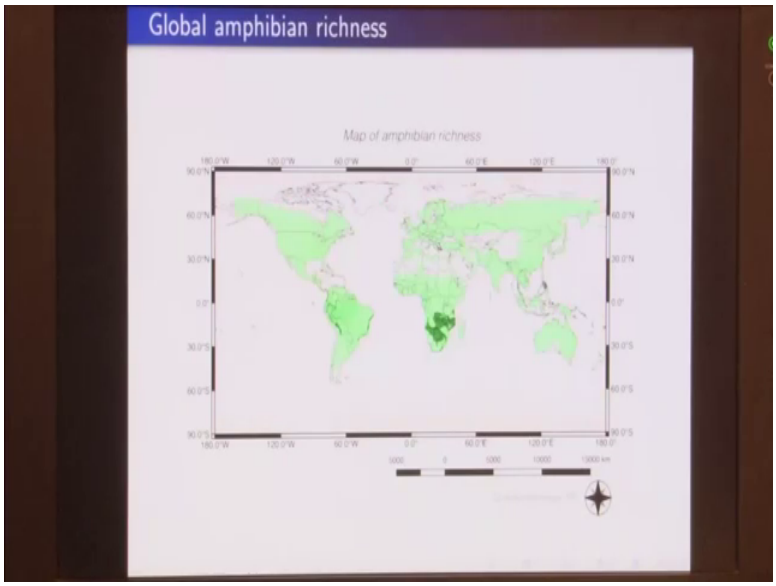

Now, not only for mammals we can construct similar maps for other species such as the that are the amphibian species. Now, this map shows the amphibian richness in different areas.

Now, because all these areas are oceans so we do not have any amphibian richness in these areas, similarly in the case of ice caps here and in the case of Antarctica we do not find any amphibians. Also in the very drier very dry areas of Sahara we will not find much of amphibian density. But then amphibian richness is high here. So, maybe these are good areas for the construction of the reserves if we wanted to preserve amphibians.

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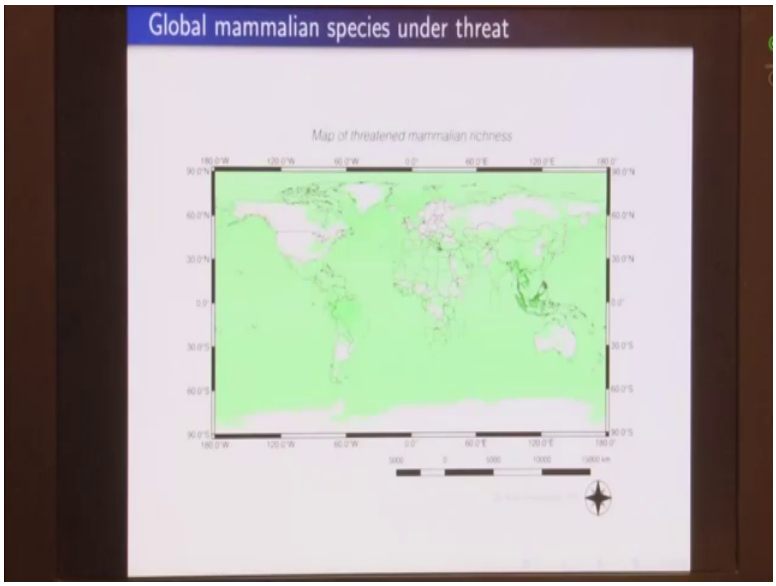

Now, we can even modify these maps that we do not just need how many mammals are there we want to see how many threatened mammals are there in each area. So, essentially in this map we have converted our mammalian richness by adding another concept and that is the level of threat that is there.

So, whether the mammals that are found in these areas, whether they are vulnerable, whether they are critically, endangered, whether they are endangered, whether they are extinct in the wild, and so on. So, when we modulate our maps in this way we see that these areas in the southeast of Asia they have a very high level of threatened species of mammals.

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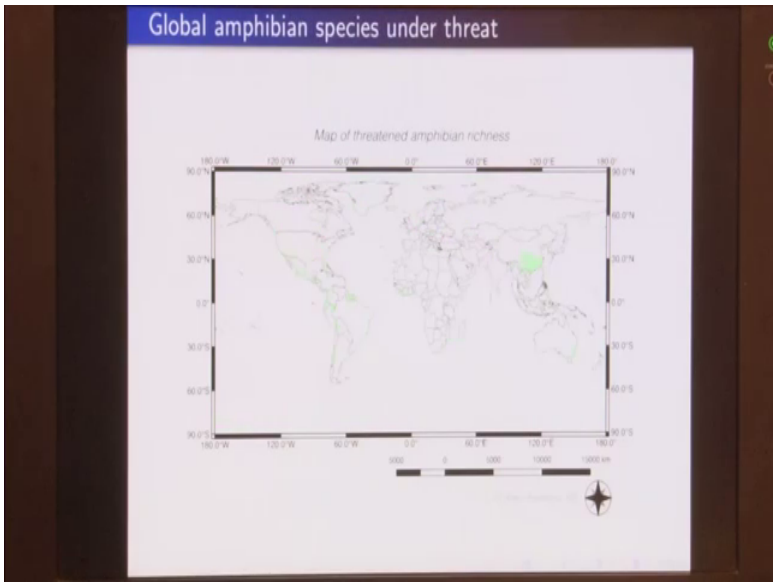

And similarly we can construct these maps again for the amphibian species which are under threat and now, in this case we can very clearly see that most of our western guards also have a number of threatened amphibian species. And so, these could be areas where we wanted to where we should create more of the reserves.

Now, here we have talked about species richness. Next we can create similar maps for endemism and we have also seen the maps for the threatened species, but then is there any criteria in which we can include all of these. So, we have discussed one such criteria in an earlier lecture and that is about the hotspots.

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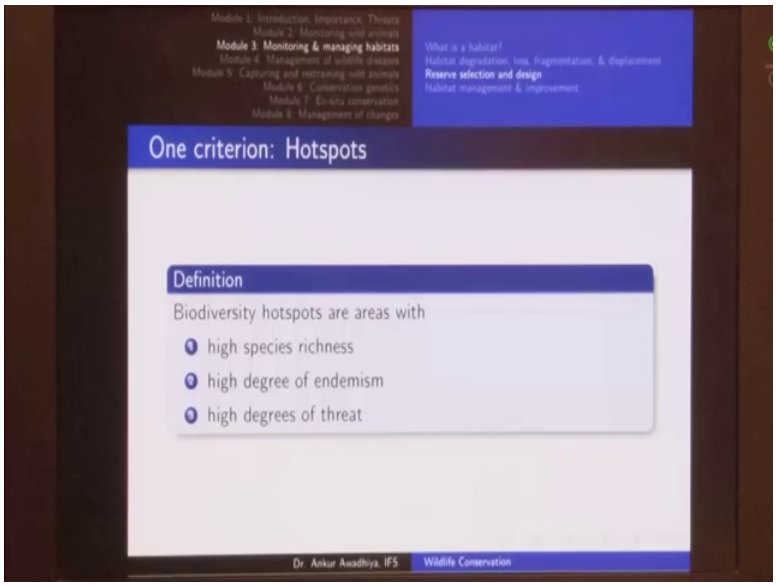

So, hotspots or biodiversity hotspots are those areas which have a high species richness, a high degree of endemism, and a high degree of threat. So, basically if we have a biodiversity hotspot in the area it makes a very great amount of sense to create a reserve in those areas to protect those species.

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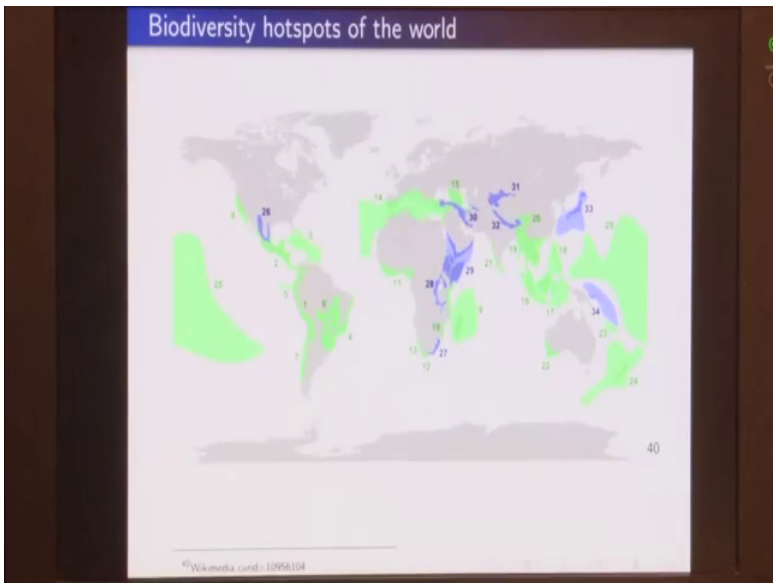

So, if you look at the map of the biodiversity hotspots of the world here again we find that our western guards, the North Eastern part of the country and the Terai arc

landscape, and most of our islands come under the biodiversity hotspots. So, it makes very large (Refer Time: 08:04) to creates reserves for the protection of specie.

Now, when we talk about threat how large should be the level of threat for us to create a reserve? If there is an area that has a very minimal level of threat then we have seen that it does not make much sense to create a reserve or to not create a reserve, right now. Maybe in the future we could take that decision, but because whenever we are constructing a reserve we are always bound by the amount of time and the amount of funding that we have so we need to prioritize those areas where we should construct our reserves.

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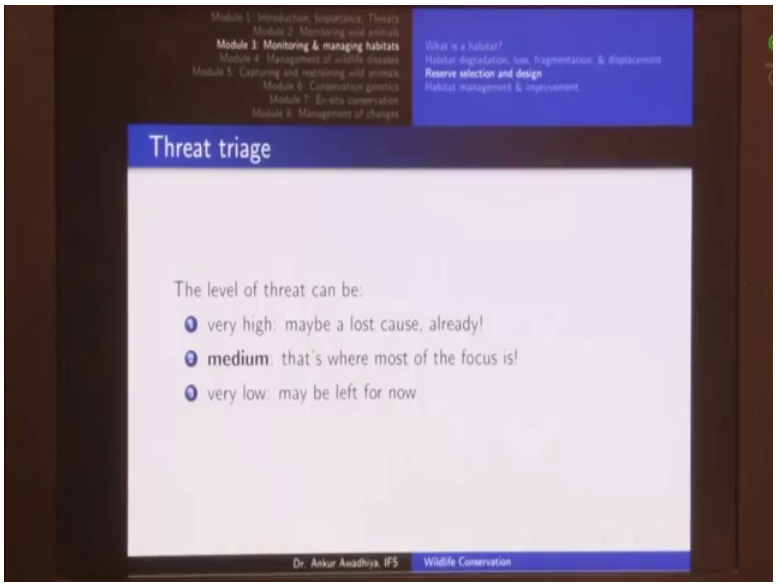

And one way of prioritizing it is a threat triage. Now, triage is a concept that comes from the French. So, whenever we have a situation of battle or a war in some area and there we have doctors and there we have a number of soldiers, that are wounded. Now, those wounded soldiers could be having say just some scratches on their body and there could be some people who are extremely severely wounded and there would be some people who are who lie in the middle. So, now as a doctor if somebody goes there; what should be the priority of treating all of these people.

So, to answer that question we came up with the concept of the triage. Now, triage says that if there are people who have a very small amount of scratches on their body, then whether we pay them any attention or whether we allow them to heal by themselves it

does not make much of a difference. So, they could be given a lesser priority when we have a large number of people who need to be treated and a very small number of doctors.

On the other hand if we have those people who are extremely severely wounded; so, every person would require a tremendous amount of attention by this very small team of medical practitioners. So, while we are saving one of those people it is quite possible that those people who had a moderate level of injury would also die in the in the process because they would not get any medical attention because all that engine has been diverted to those people who are extremely severely wounded. So, then the concept of triage says that whenever we come into any such situation the first priority should be those people who would benefit a lot by our medical attention, which would be most of the people in the middle who do who have wounds, but those wont are neither very severe nor very minimal.

So, in those situations we would be able to make much of a difference by diverting most of our medical attention preferentially to them. Once we have treated that group and if there is time and resources available then we could go to the more severely wounded group and then followed by people who have a very little amount of injury.

Now, in the case of reserves here also we can say that the level of threat can be very high medium or very low. Now, in areas that have a very low level of threat then they may be left for now, because we can cater to these regions maybe in the future. In the areas that have a very high level of threat. So, essentially we are talking about areas in which we have a huge human influence a huge anthropogenic pressure and we have a very small area that is left. So, there is a huge pressure in the very small forested areas. So, maybe those areas are already a lost cause because by the time we are through with the legislations with the executive procedures to construct that reserve maybe people would have already taken off that forest area from the map.

Whereas, those areas that country have a medium level of threat that is where most of the focus should lie because in those areas by the time that we have, that we are done with our legislative and executive administrative formalities we would still be having quite a lot of forest left and. So, we would be able to make an impact in those areas.

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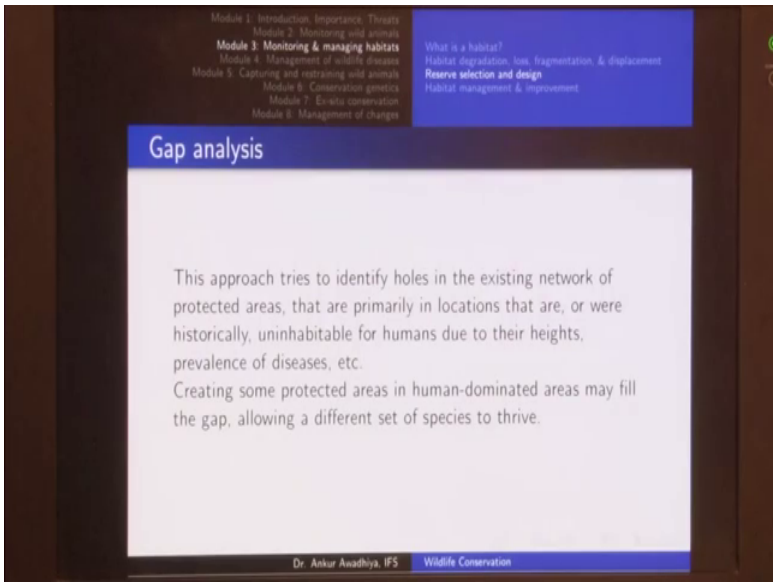

Another way of deciding where to have our reserves is gap analysis. Now, gap analysis is an approach and this approach tries to identify holes in the existing network of protected areas that are primarily in locations that are over historically uninhabitable for humans due to their heights prevalence of diseases etcetera. What it says is that historically we have constructed our reserves in those areas which were not suitable for humans.

So, for instance most of our reserves in the Terai hotels of the Himalayas are there because when we did not have any insecticides these areas were heavily infested with mosquitoes people died in large numbers because of malaria. So, people did not want to live there. So, because they were hardly any people there, so these areas were converted into reserves.

Similarly, in the mountain areas which are at a very great height people do not want to go there or recite there. So, so those areas are converted into reserves. But now that we know that most of our reserves are in those areas and very little reserves in those areas which are being inhabited by humans it makes a great amount of sense to have some reserves at least in those areas which already have a human population. So, we might have to displace those human populations but then by displacing those we would create situations in which we would have a very large amount of species richness and species biodiversity.

So, creating some protected areas in the human dominated areas will fill the gap, the gap that exists between these two extremes of areas where we do not have any human populations and this would allow a different set of species to thrive.

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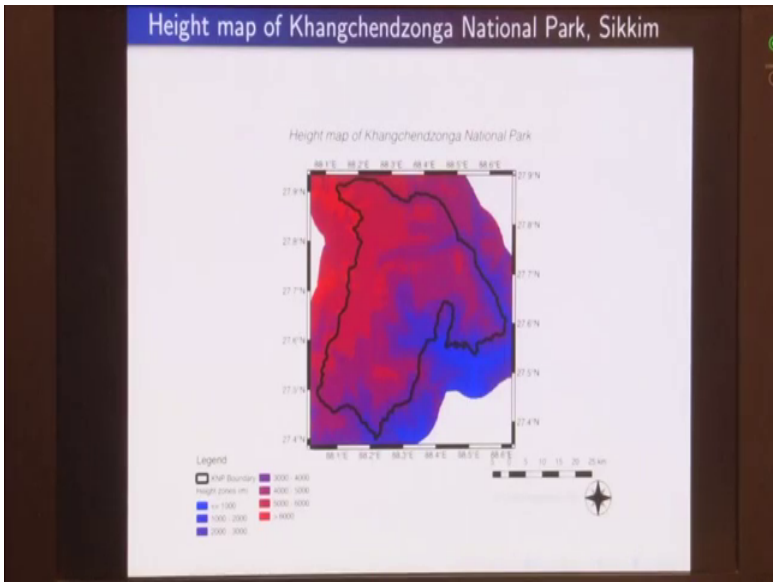

Now, to give an example let us talk about the Khangchendzonga National Park. So, this black line demarcates the boundary of the Khangchendzonga National Park, and the colors represent the heights of these different areas. Now, as we can observe most of these areas are in different shades of red. Now, this shade of red goes from 6000 meters up to greater than 4000 meters. So, these areas have a height of more than 4000 meters. So, above a height of 4000 meters there are very few number of people who would live there.

There are very small patches like this patch that has been left out which has a lesser height, but most of the areas when we considered outside of the national park they are more of a flatter area at lower elevations and these are the areas where human beings live.

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Now, to look at it in another way, let us look at a 3 dimensional model of the Khangchendzonga National Park. So, here again we see that most of these areas are very they are very high and at this the same time there are having very steep slopes. Now, these steep slopes cannot be maneuvered by most of the animals and so, even if we have constructed a national park using most of these areas these are primarily because human beings are not using these areas and not because we have high species richness in these in these areas. So, probably it would make much sense to divert at least some of these areas which are outside of the national park at present, but at lower elevations so that we could have a greater density of animals and more animals that have conserved in these areas.

So, moving from here let us look at the principles of reserve design. So, we have seen that historically we have constructed reserves in those areas where humans were not very (Refer Time: 16:02) to use those areas. But now, if we get a chance to design a reserve how should our reserve be are there any basic fundamental rules that need to be followed and we are designing a reserve or say for instance there is a patch of forest that needs to be to be converted into a reserve, and we know that once we have we have converted that forest into a protected area for animals it becomes very difficult later on to divert any of those areas into other human uses. So, once we have constructed our reserve it becomes a sanctuary for the animals for a very long period of time.

So, given that we have to convert a forest into a reserve area what are the principles according to which we would demarcate a boundary for our reserve?

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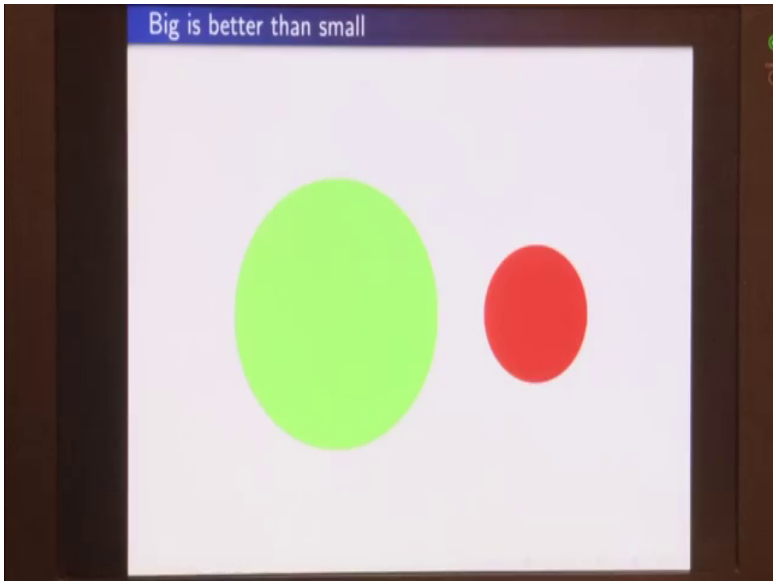

So, the first principle is that big is better than small. So, when you are constructing a reserve we should have as large an area as is possible. So, a larger area is always better than a smaller area.

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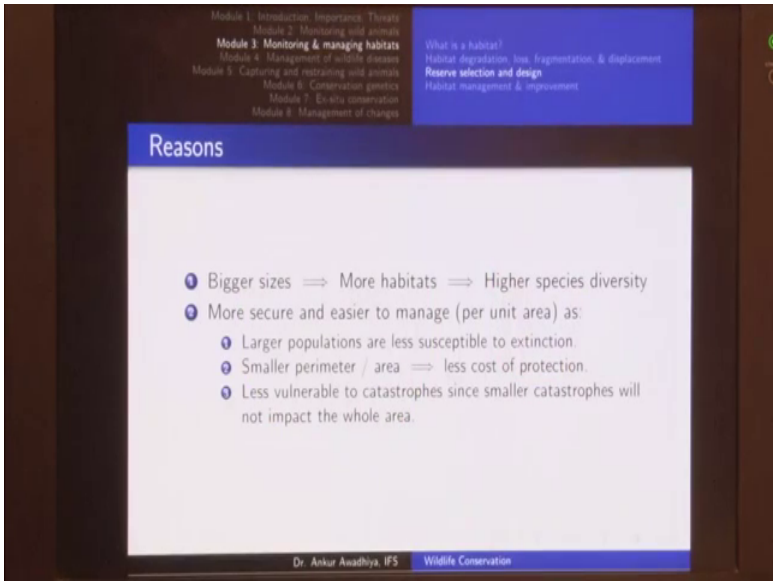

Why is that so? This is so because a bigger size means that we have a more diversity of habitats. So, and a more diversity of habitat also translates into higher species diversity

in that area. So, when we have a larger area we would be having hills we would be having some grassland some patches of water some marshy lands and so all of these together would provide a much greater species diversity than would be possible with a smaller area.

Secondly, it is more secure and easier to manage per unit area because the larger populations that are present in these larger areas are less susceptible to extension just because of their size. Also these areas have a smaller perimeter per unit area which translates into a less cost of protection so to understand how that works.

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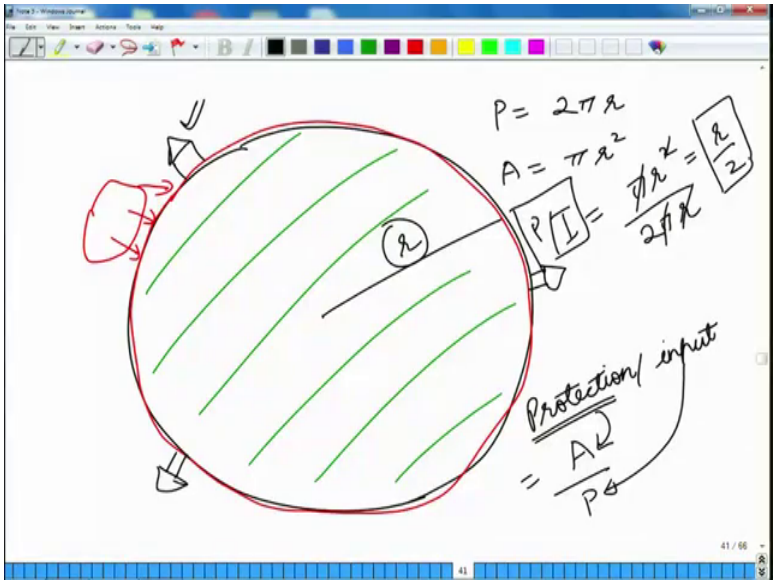

Let us see let us make a reserve and this reserve let us consider a circular reserve with a radius of r. Now, the perimeter of the reserve is given by 2 phi r which is the circumference of the circle. The area of the reserve is given by phi r square. Now, when we talk about protecting a reserve so we might be having a human settlement here and so humans might want to get in into the reserve say for poaching or say for extraction of timber or for extraction of fuel wood. So, in that case when we need to protect all of these areas the strategy normally is that we protect the boundary because if the boundary is secured then people from outside will not be able to enter into the park.

Now, the protection of the boundary would mean putting up of say some chalkies somewhere, some chalkies maybe some patrolling camps maybe deployment of more and more people. Now, this deployment of people would depend on the perimeter of the

area. Now, per unit of perimeter how much area can we protect? So, the level of protection per unit of input would be given by the area that we are protecting divided by the perimeter that we are using because the level of protection depends on the total area that we are protecting. So, a larger area that is being protected is better and input depends on the perimeter because in the case of this national park if the perimeter is larger they would require more number of chalkies more number of people.

Now, this protection per unit input we have area which is given by phi r square, and we have perimeter that is given by 2 phi r. So, phi and phi cancel out r and r cancel out, so this is equal to r by 2. So, essentially when we increase r, so when this r increases r level of protection or the amount of protection per unit of input also increases which means that with very less number of people with very less amount of budget we are able to protect a larger area. And this is only possible if we have a larger area from the beginning itself. So, that it has a smaller perimeter compared to the area or a larger area compared to the perimeter. Next point is that with a larger reserve they are less vulnerable to catastrophes since a smaller catastrophes will not impact the whole area.

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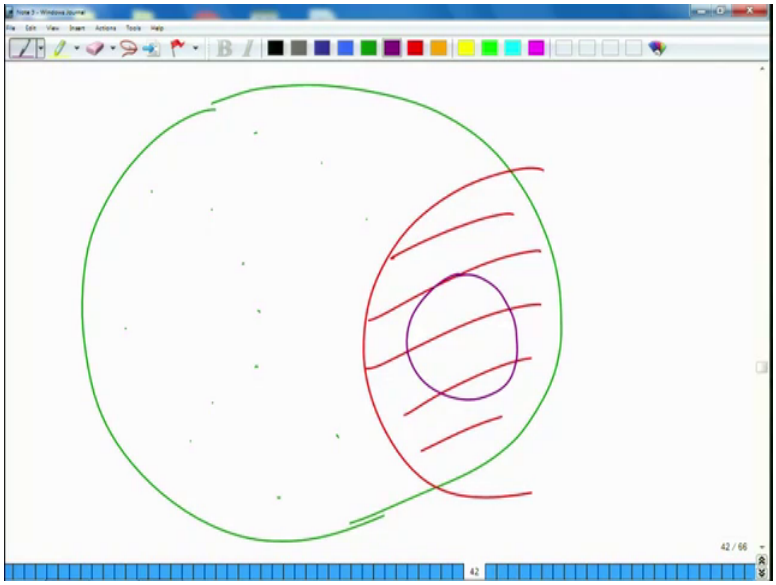

What this means is that if you have a large size reserve and say there was a fire that influenced this much size of the reserve, so this much amount of area was gone. So, even then the animals and trees that are there in the rest of the reserve would be able to very populate this area in no time. However, if otherwise we had a smaller reserve and we had

this fire. So, the whole of the reserve is now gone all the trees all the plants all the animals are gone and so there is nothing that would be able to repopulate this area. So, a larger reserve is less vulnerable to catastrophes since smaller catastrophes will not impact the whole area.

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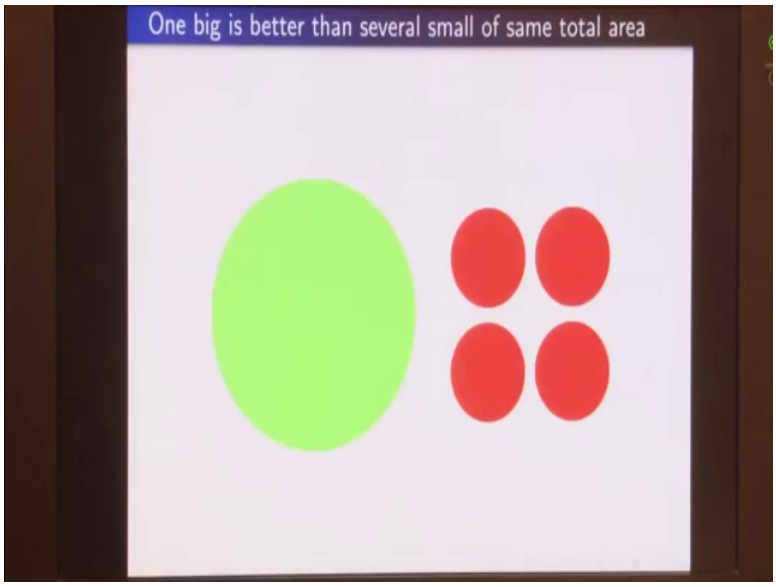

Another concept is that one big is better than several small of the same total area. So, essentially if we have an option to have a large size reserve and another option is to have 4 smaller reserves and the total area of these 4 smaller reserves is equal to that of the larger reserve then it is always better to have this larger size reserve. Now, why is that so?

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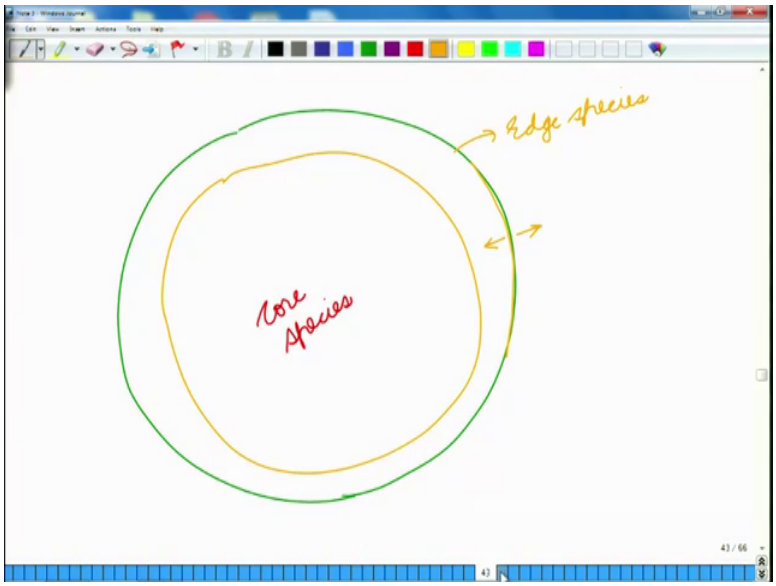

So again coming back to the drawing board; in the case of any forest we would be having some a species that we call as core a species and there are species that we called as the edge species. Now, for instance in the case of a Tiger Reserve a tiger is a core species, so a tiger would prefer those areas in which there is hardly any of human disturbance with there is hardly any amount of edge, so it would remain in the center. Whereas, leopard is edge species it would move in these areas. So, that it can utilize the forest areas and it can also go out into the human habitated areas to say catch a dog to catch a stray dog.

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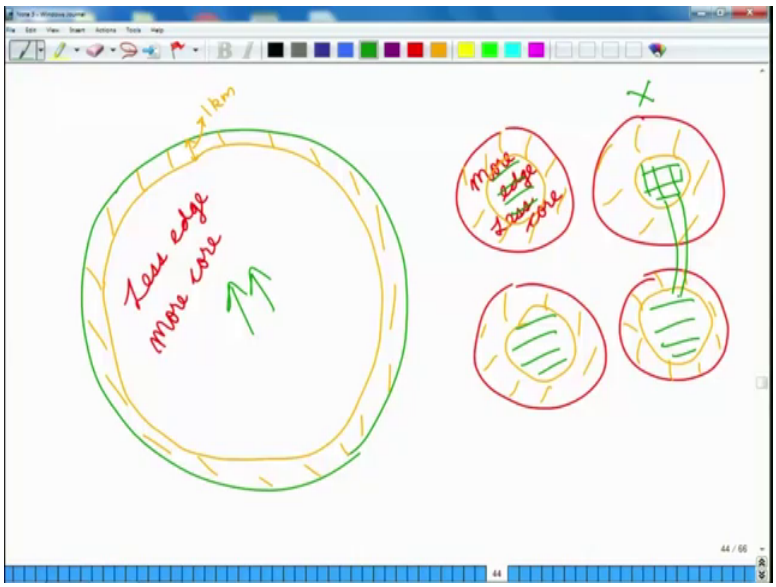

So, when we talk about a reserve and suppose we have large size reserve, versus we have 4 smaller size reserves. Now, in the last size reserve we have less edge that is available and more core that is available, and in these reserves we have more of edge when we add all the 4 perimeters and we have less amount of core available. Now, when we are making a reserve it makes much more sense to have more amount of core so that the core species are also represented here because in the case of edge species because they can they can tolerate a certain level of human disturbance.

So, they are much less susceptible to extinction as compared to the core species. So, whenever we are making a new reserve we try to maximize on the core area, and maximization of the core area is only possible when we have one big reserve as compared to several smaller reserves or to represent it more graphically suppose our edge consists of one kilometer. So, in this area we would be having this much area that is the edge and the rest of the area is the core. Now, in these areas we have this much portion that is the edge and this much area which is the core.

So, the total amount of core that is available here is much more than the amount of core that is available in these smaller areas. Also when we are considering species such as elephants which require a huge amount of core area, if we have these smaller reserves they will not be able to sustain any populations of the elephants, because these core areas by themselves are so small and because we do not have any connectivity to the other cores that the elephant populations will not be able to survive in these areas. So, the second principle of a of reserve design is that one big is better than several small of the same total area.

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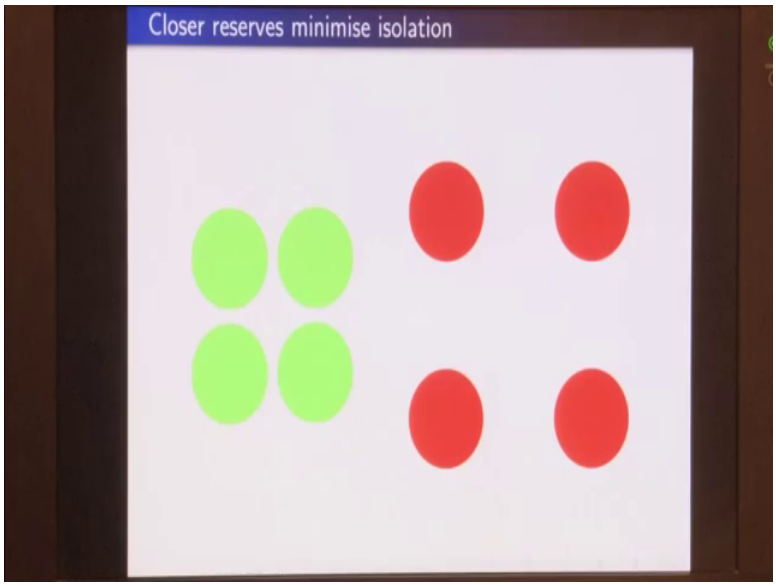

The next principle is that closer reserves are better because the minimize isolation. So, basically if we have these two situations this situation is better, because if you have a small corridor here. So, the animals will be able to move from this point to this point. Even when we do not have a corridor there is a small patch of human dominated areas and there would be some animals would which would be able to cross from this side to this side. However, because these reserves are very far from each other; so, if any animal has to move from this circle to the circle it would have to negotiate a large area that has that has human dominated influences. So, basically the reserves on the left are much better because they are less isolated from each other.

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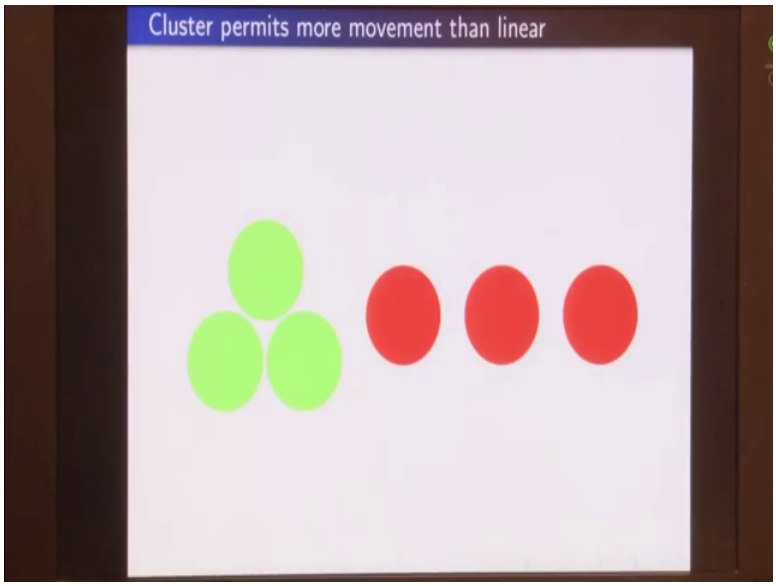

The next concept is that cluster permits more movement than linear. So, essentially if you have these 3 reserves if we have these in the form of a triangle. So, basically if an animal has to move from this circle to this circle there is a very small human dominated area that the animal would have to negotiate. So, movement from a to b, a to c and b to c are all equally easy.

However, if we have reserves that are linear and let us call this as a, b and c. So, a to b moment is easy b to c moment is easy, but if any animal has to move from a to c it would have to traverse a large distance either outside or through these reserves in the case of the left side reserves the movement is easier and so these reserves are always more preferred.

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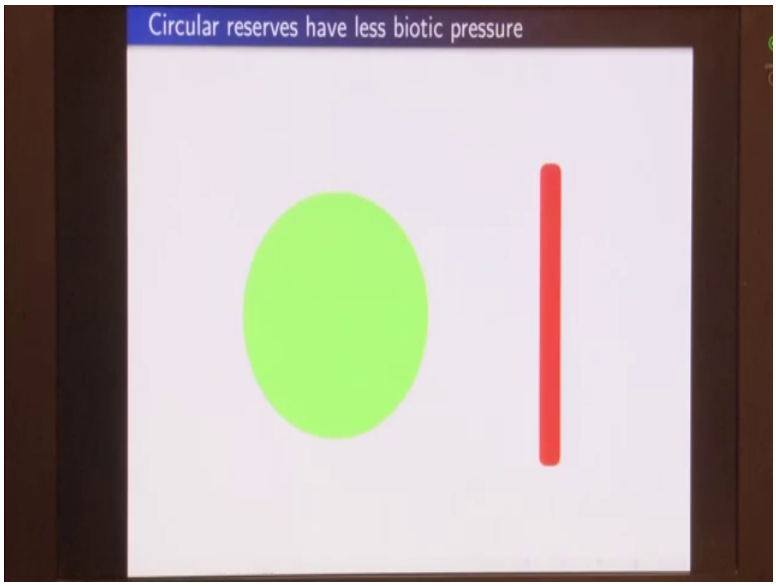

The next concept is that circular reserves are always preferred than linear reserves because they have less amount of biotic pressure.

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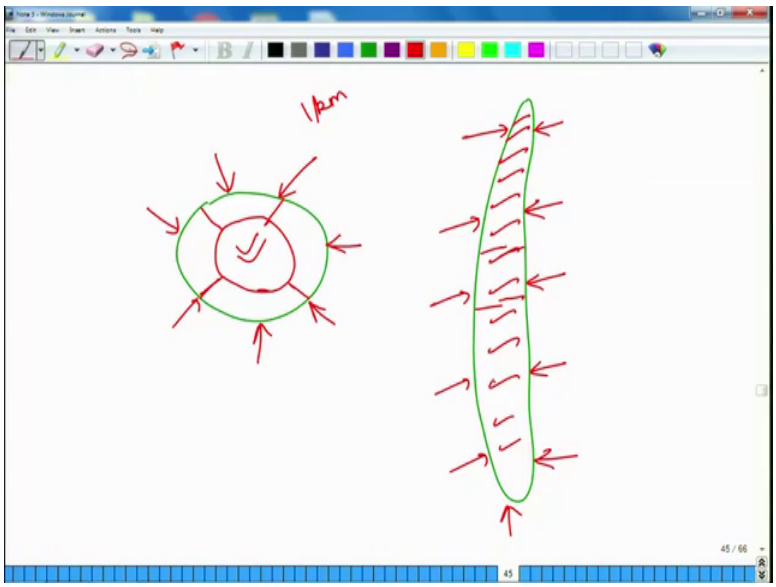

Now, what we mean by this is that, so we have one reserve like this and the second reserve which is like this. Now, in the case of the left side reserve it is having human pressures from all sides and in the case of the right hand reserve this is also having human pressures from all sides.

Now, let us say that in 1 year these people are able to move say 1 kilometer inside and let us say that this much is 1 kilometer. So, from this side they are moving 1 kilometer, this side also 1 kilometer, this side also 1 kilometer, this side also 1 kilometer. So, essentially after the passage of 1 year we would be having a smaller size reserve and this much amount is left.

In this reserve, if we say one kilometer here and one kilometer here then essentially we have lost all the area. So, all the areas gone now because, 1 kilometer here and 1 kilometer here would mean that people have eaten away into the whole of the reserve. So, essentially when we says that a circular reserve is better it is because it has effectively less amount of biotic pressure from human beings and cattle.

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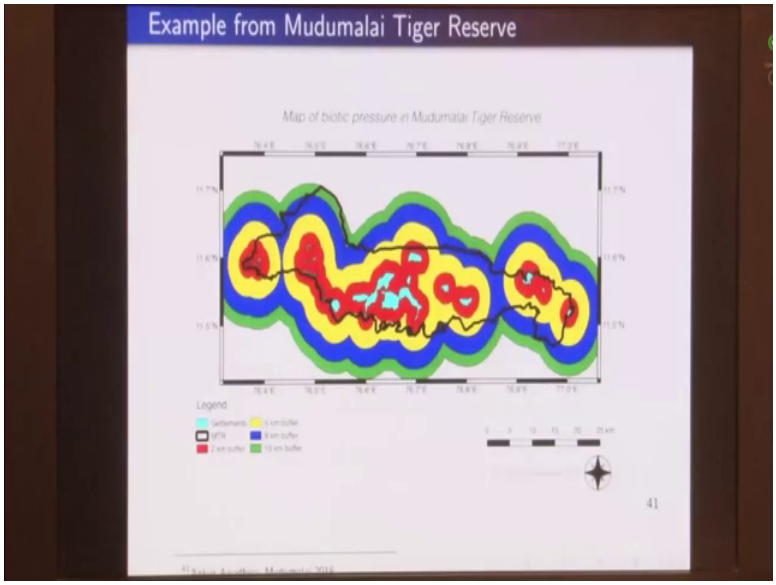

To look at it in another way this is a map of the Mudumalai Tiger Reserve. So, these black lines demarcate the boundary of the Mudumalai Tiger Reserve the blue areas are the settlements which are left inside the Mudumalai Tiger Reserve. Now, we went there and we talked to the villagers and we asked them that when they go out for grazing what is the distance roughly that they travels inside, and they said that they roughly go from 8 to 10 kilometers every day. So, they would go 10 kilometers inside the forest have their cattle graze all throughout the way and then they would come back in the evening.

Now, we created buffers around these settlements. So, the red color buffer is 2 kilometer buffer, then we have a 5 kilometer buffer which is blue then an 8 kilometer buffer that is

red and then a 10 kilometer buffer that is in green. So, these represent distances from the settlements.

So, as we can observe here if we take a 10 kilometer buffer the whole of the Tiger Reservers is taken up by the biotic pressure. So, this is there because this reserve is mostly linear in its formation. So, we have this reserve that has this much of length and only this much of the bred. So, this is essentially a linear reserve. On the other hand if all of this area was converted into a circle and then probably much more of the area would have been spared from the biotic pressure.

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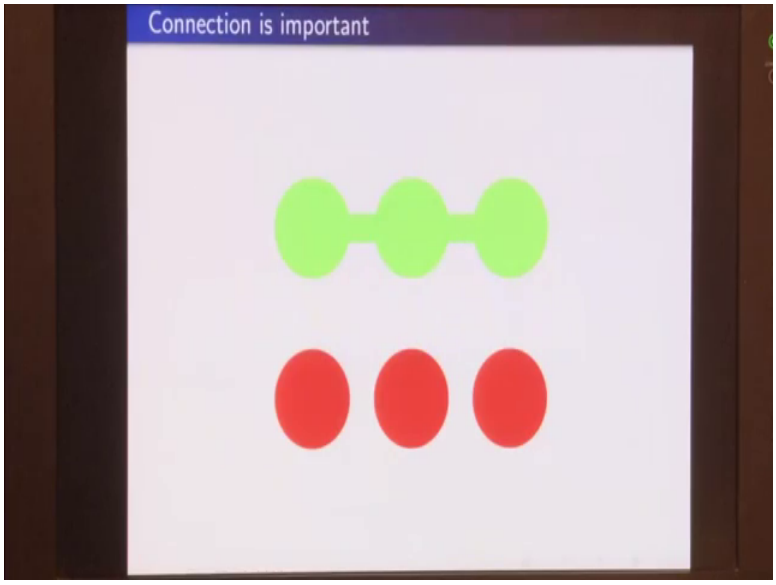

Another concept is that connection is important. So, if we have these two scenarios. So, in the bottom side we have these 3 results which are not connected. So, essentially any animal from this point will not be able to go to this point. How this matters? On the top side we have the reserves that are connected. Now, why is this important? If we consider this reserve it would have some population of animals. So, we have these two scenarios these are connected and these are not connected.

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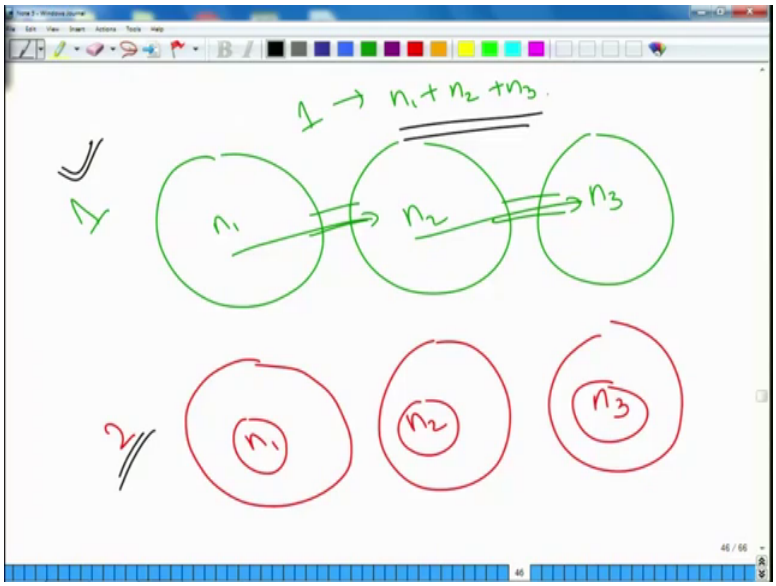

Now, suppose we have n 1 animals here, n 2 animals here, n 3 animals here for any particular species and the same numbers here n 1, n 2 and n 3. Now, because in first scenario the animals are able to move from one reserve to another reserve, so in this case this when we talk about populations this consists of only one population whose size is n 1 plus n 2 plus n 3, whereas, in the second scenario we have 3 populations of sizes n 1, n 2 and n 3.

Now, as we have seen before a larger population is less susceptible to extinction, probably because one there is less amount of inbreeding because you have a larger choice of mates to mate with, to because these animals are less susceptible to any of the catastrophes. Because if you have a fire in any of in any small population then the whole population might get decimated whereas, if you have a fire in a larger population there is a much greater possibility that some of the animals would be spared and would be able to repopulate the area. So, now, in that scenario, the scenario 1 because it has a larger population it is safer as compared to the second scenario, so which is why we see that connection is important.

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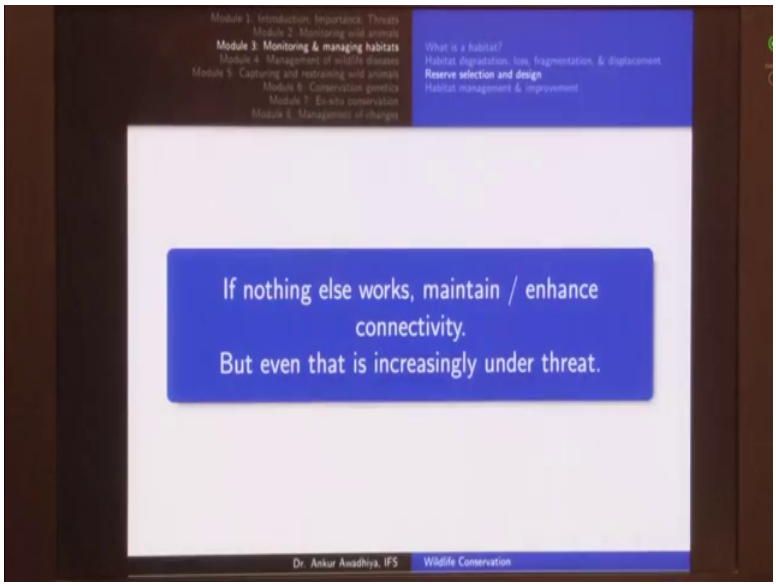

Now, of all the factors that we have discussed this factor of connection should be the easiest factor. So, basically if nothing else works if we do not have much of an option of were deciding where to have our reserve we can at least maintain or enhance the connectivity between different reserves and between different parts of the same reserve. However, the sad situation is that even that is increasingly coming under threat.

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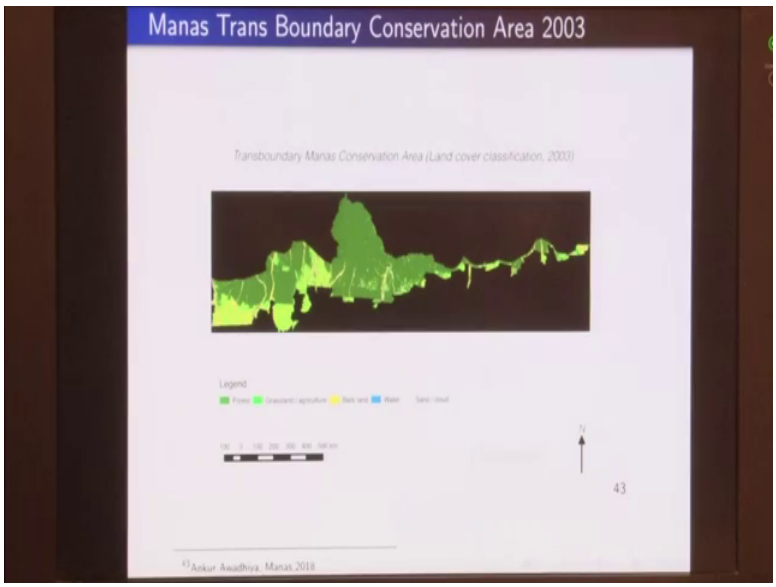

So, we did this study in the Manas Tiger Reserve. So, Manas Tiger Reserve is there in the state of Assam and here we have taken the trans boundary conservation area which

also includes the Royal Manas Reserve of the country Bhutan. And this image shows us a satellite depiction, so we have we took satellite images and then we converted that information into different kinds of land covers. So, the dark green cover is forest, the light green is either grassland or agriculture, yellow portion is bare land, blue is water, and white color represents either sand or cloud that came into the image. So, now this image is showing us how this Tiger Reserve looked in the year 2003.

I would want you to concentrate at this point. So, we have the straight line here and we have this roughly rectangular patch of forest that was there in the year 2003. Now, let us look at the same area in the year 2017. So, here we can observe that all of these areas were eaten up they were either enclosed or they were diverted, so essentially we have lost this much amount of habitat. So, here we are talking about a habitat loss. Looking at the images back again, so we see how this area was lost in the ensuing period.

Now, next I would want you to concentrate on this region. So, this region had some amount of grasslands in the year 2003. Now, in the year 2017 we can see that all of these areas which earlier had some grassland and major cover of forest are now, all cleared up. Now, this clearing up happens either because there is some invasive species or because these areas have been taken up for agriculture or for grazing. So, what people do is that the chop of all of these trees and then these areas are converted into grazing lands or these areas are converted into farmlands.

So, to look at these images again, so we see that all of these area are areas are. Now, gone next I would want you to concentrate at this region. So, here we observe that we had this large patch of forest we had another patch of forest here and we had some areas which were grasslands, but then we had these dark areas which were acting as connectivity corridors. So, this was in 2003, this is in 2017.

So, what we observe here is that those green patches dark green patches of forest that were there between this big patch and this big patch are now all gone. So, what is happening here is that we are having some human settlements some villages that have come up here and they are encroaching into these areas and they are cutting away the trees. So, once this tree cover is lost then the animals will not be able to move from this point to this point. So, to look at these images again, so this was in 2003, then in 2017 so not only are we losing the habitat at quite a fast pace. So, this is just a span of 14 years,

but at the same time the connectivity between these patches is also getting lost at a very fast pace.

Even if we consider this area so the animals from this point were able to reach into this larger patch earlier, but now that area again is lost because we are having this linear portion in which the habitat has been lost. So, have very concrete evidences of habitat loss habitat degradation and habitat fragmentation even in areas that are as crucial as the Manas Tiger Reserve.

So, in this lecture we looked at the principles of reserve design and how we are losing out our areas because of habitat loss, degradation and fragmentation, and why reserves are extremely crucial to conserve at least these small patches of biodiversity. So, that is all for today.

Thank you for your attention, [FL].