Wildlife Conservation
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Lecture – 02
A Closer look at Biodiversity

[FL] In this class, we will have A Closer look at Biodiversity. Now just think of a situation, you are getting inside a jungle or a forest.

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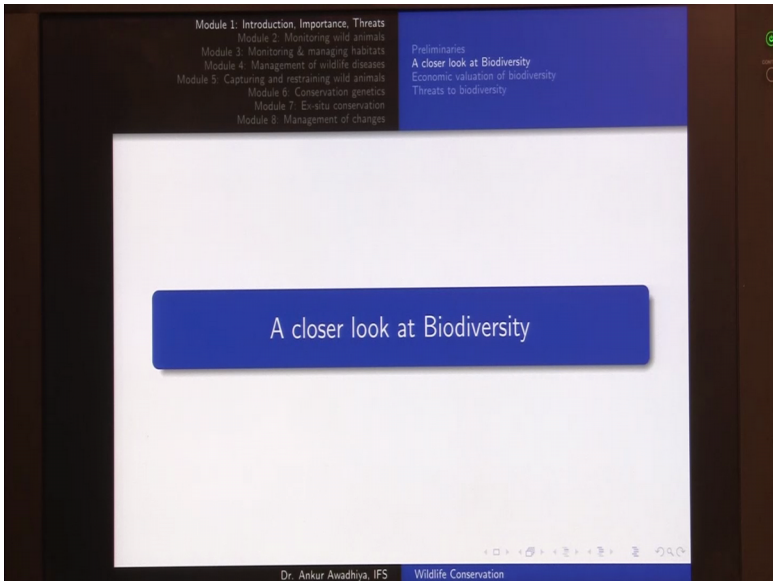

So, what do you see, inside the jungle? So, invariably most of you would say that when we get into a forest we will see a number of trees; yes we will see a number of trees and we will also see some undergrowth may be even some climbers that are on those trees.

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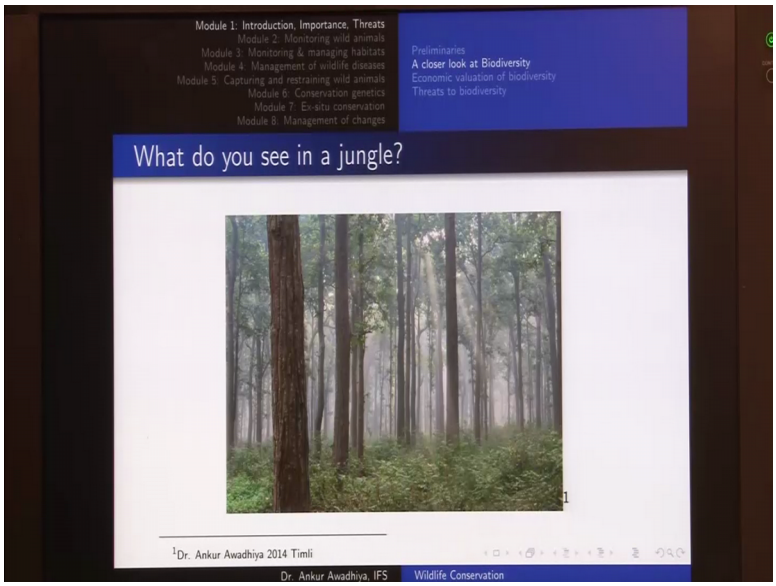

So, we will see a quite a lot of plant diversity. We will also see some animals. So, we will see some herbivores animals such as this chital, so this chital is grazer it feeds some grasses.

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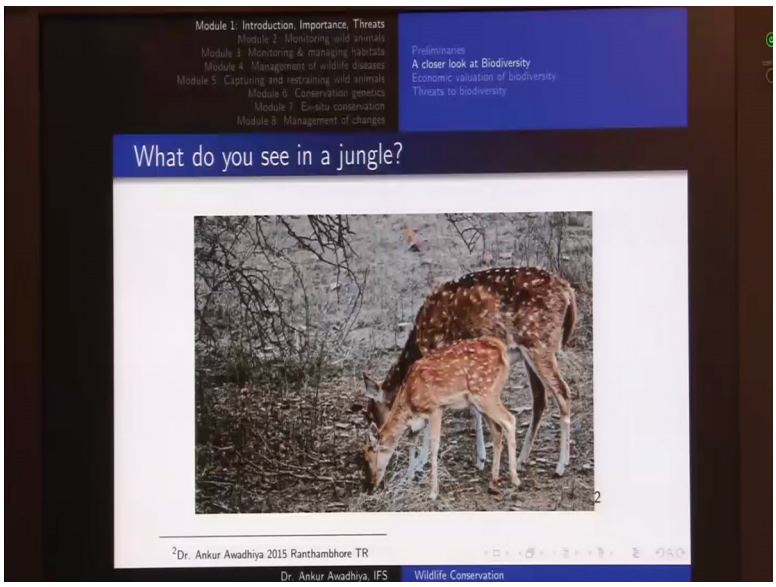

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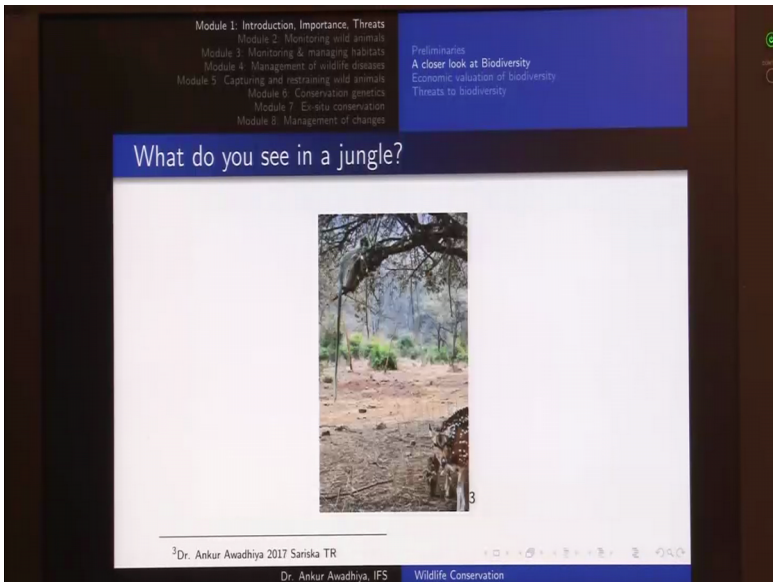

We could also see some combinations of animals. So, like here we are observing, a langur and chital association. So, what we see in this case is that this langur is sitting on a tree and then it is eating some leaves from this tree, it is also dropping some leaves and some twigs and may be some fruits downwards. And then we are having some chital here, that are taking advantage of the situation and they are feeding on these fallen leaves or these fallen fruits because, this langur is may looking all these resources available to these animal which they otherwise would not have had accessed to.

Now, we are also seeing this association because, this langur is sitting on top of this tree. So, it has a very good vantage position. So, it can look around from to a very large distance and if any tiger approaches, it would make a call and this chital would also benefit from that. So, not only we will be see some animals; we will also see some association of animals.

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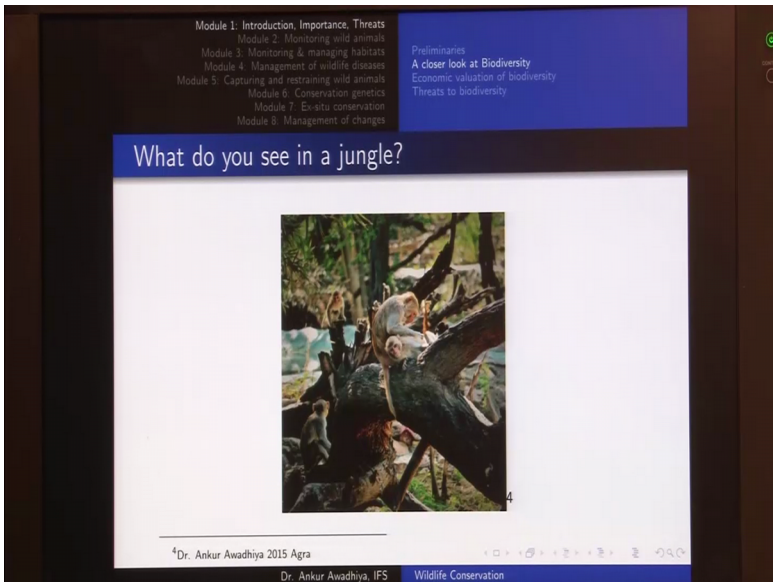

Then we might even see some populations of animals, now population is a group of animals of the same species.

Now, in this example; we are seeing that there is this monkey; that is taking out say insects or lies that are there in the bodies of the second monkey and essentially cleaning the other monkey. So, now, this is a process that goes by the name of yellow grooming. So, this monkey is grooming somebody else, if this monkey was grooming itself we would have called it auto grooming, but in this process we are saying an yellow grooming.

So, will see quite a number of populations of different animals that are interacting amongst themselves, then if you look up we might see some birds.

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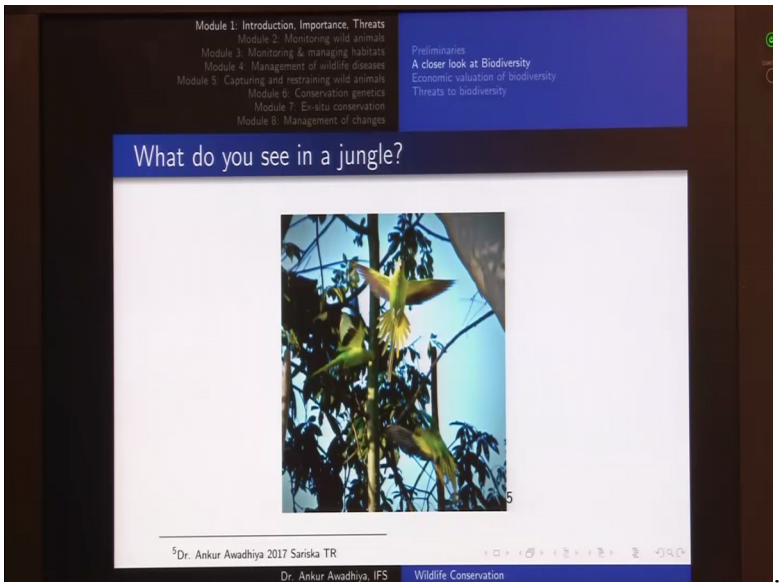

So, we might have a look at parakeets, parakeets will also be mostly in a group or we may see some mynas in the forest or we may see some peacocks in the area.

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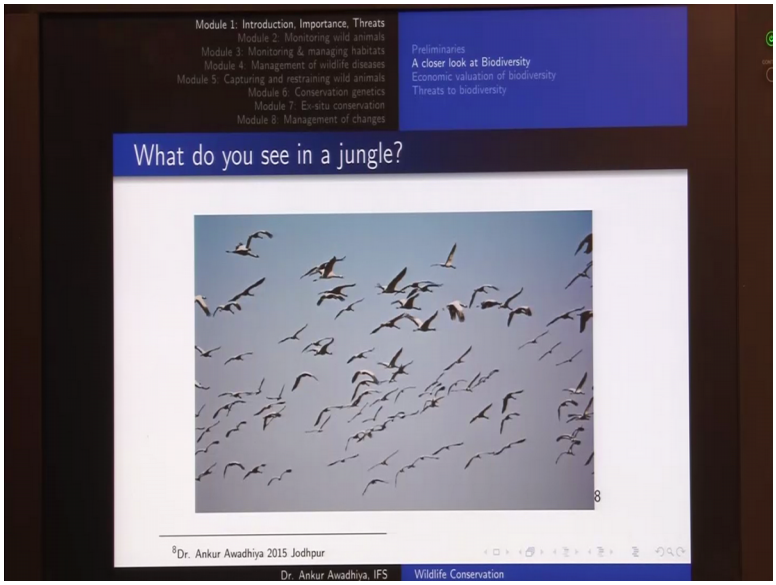

We might even observe some birds or some other species; that are coming into and going out of this area; a process that goes by the term of migration. So, we will see some migrating species or let us say we will have a possibility of seeing some migrating species.

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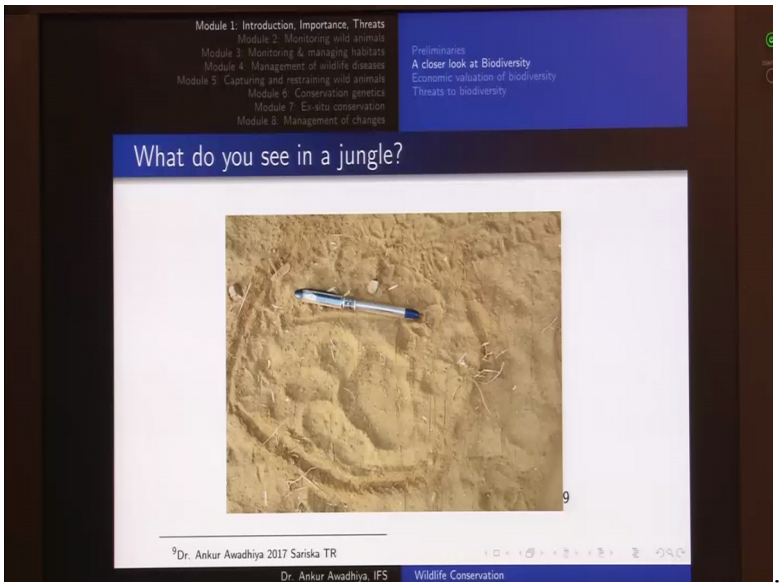

Now, if we look down, then we might be able to see some signs on the ground. So, like this thing is a pug mark of a tiger. So, essentially, a tiger went through this way and on the dust or on the soil that was there it put its paw mark. So, it was walking like this and so, we are seeing the impression then in the ground, this pen has been kept for sizing purposes. So, it is a reference for the size.

So, when we look down, even if we are not able to see an animal we will be able to see some signs of the animals. Even on the trees we might observe that, if we are going in an elephant infested area then on the trees we might see that this elephant has taken out some bark. So, debarking is an indication of the presence of elephants or for example, if we are moving in an area that has sambar deer, so we might get some smell, that comes out because it has marked a tree.

So, things such as these signs will also be same in the forest to give us an indication of the species, also signs such as these.

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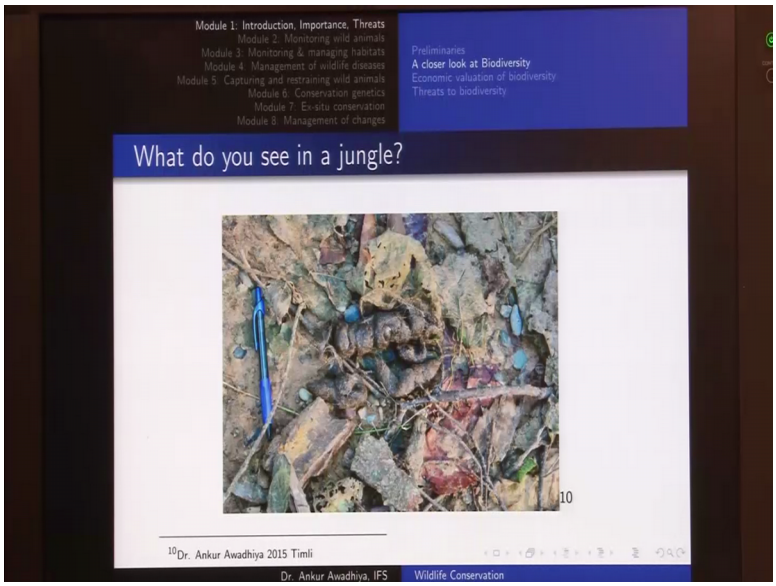

So, this is the excreta of a tiger and. So, this is also giving us an indication of what is there in the forest.

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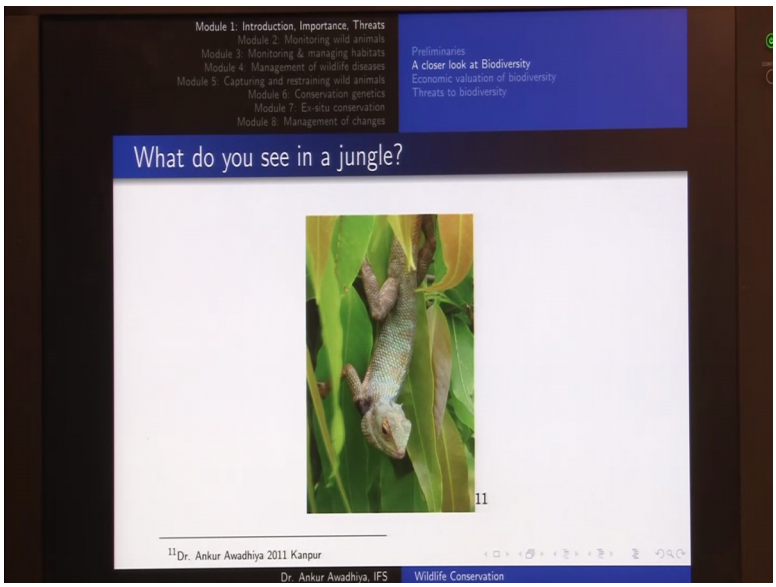

If we look at the trees and the shrubs; we might even see some reptiles. So, we might get a chameleon somewhere or we might get some insects that are pollinating or we might have a look at this termite mounds. So, we were ever there is a termite mound there are a number of termites inside.

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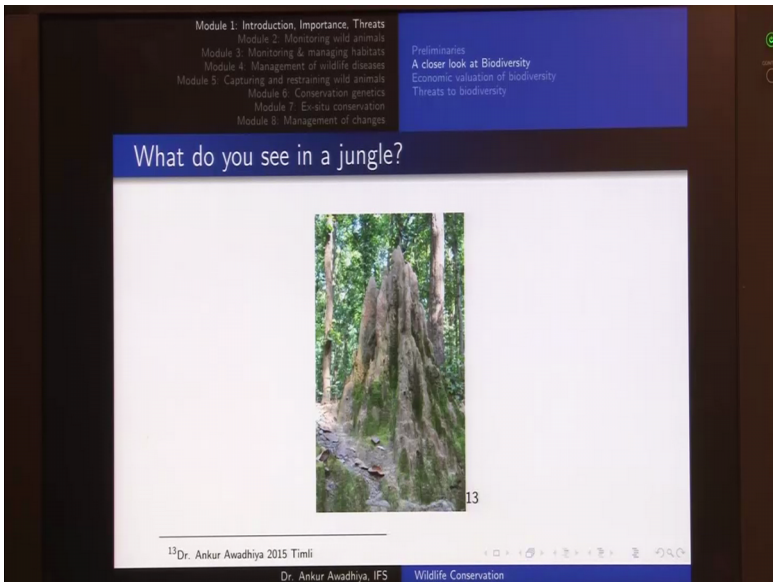

Or we may see things such as fungi.

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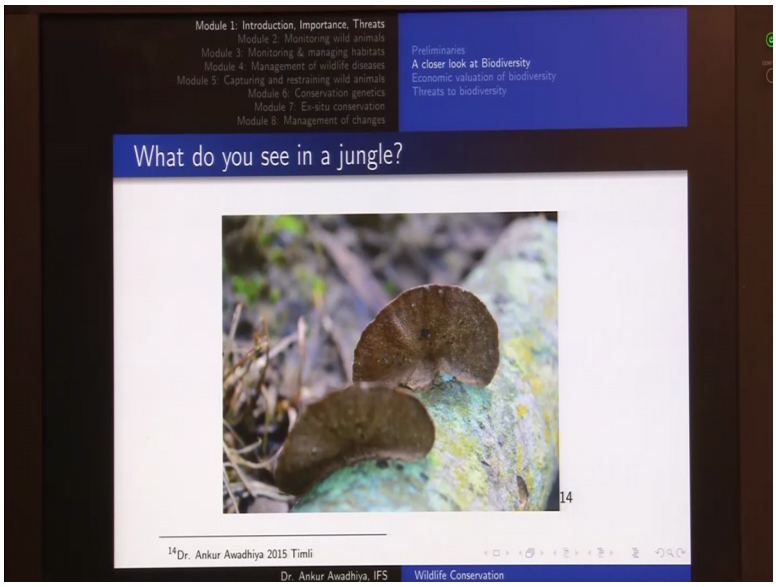

So, this is a fungus that is growing on a dead and decaying log of food. So, this is also another organisms that we could see.

Now, if we are lucky and if there is if we go to a water body and we are able to see some organisms, we might be able to see some water birds or some birds that reside near water.

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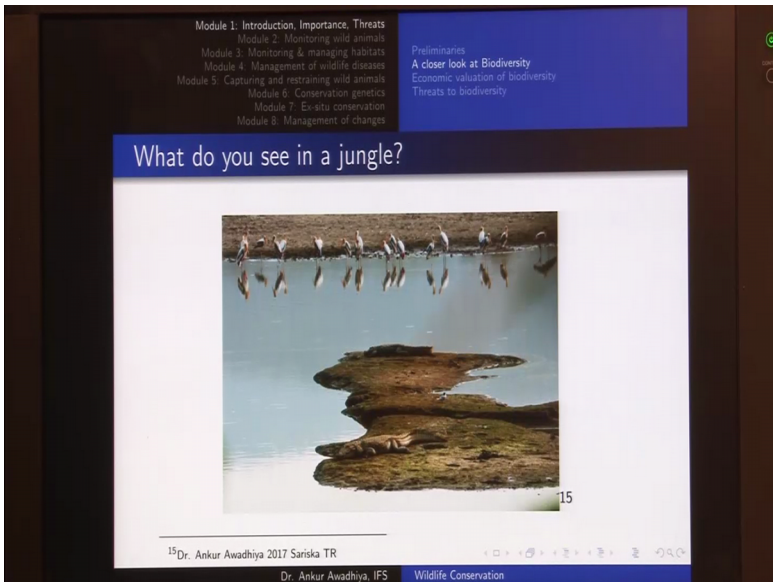

We might even be able to see some crocodiles in the area or some turtles in the area. So, these turtles are basking. So, they are coming out in the light yeah they are trying to absorb as much of the heat as possible, because, these are cold blooded animals.

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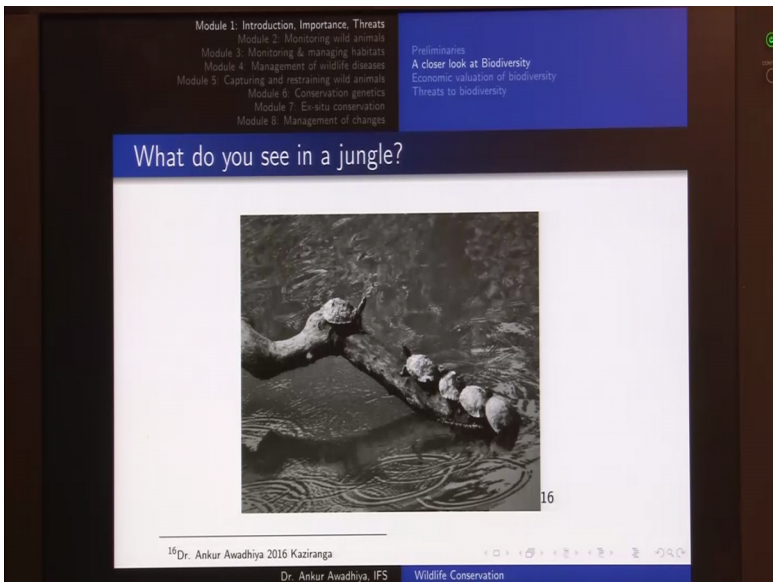

So, we are observing animals and their behaviors.

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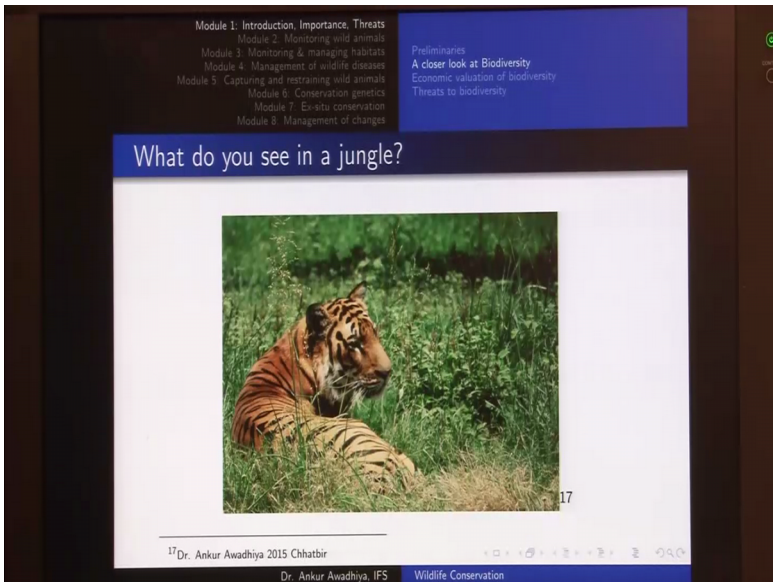

Or if we are extremely, lucky we could even observe a tiger in the area or say a bear in the area or maybe even an elephant in the area.

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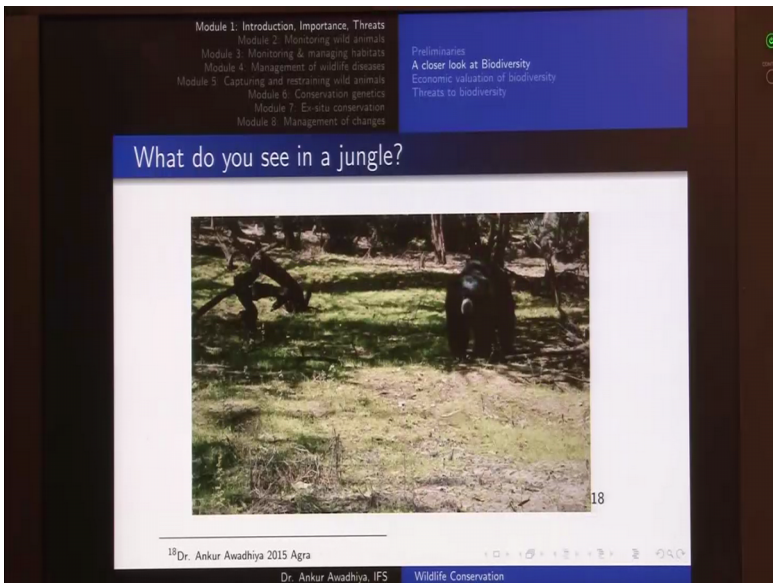

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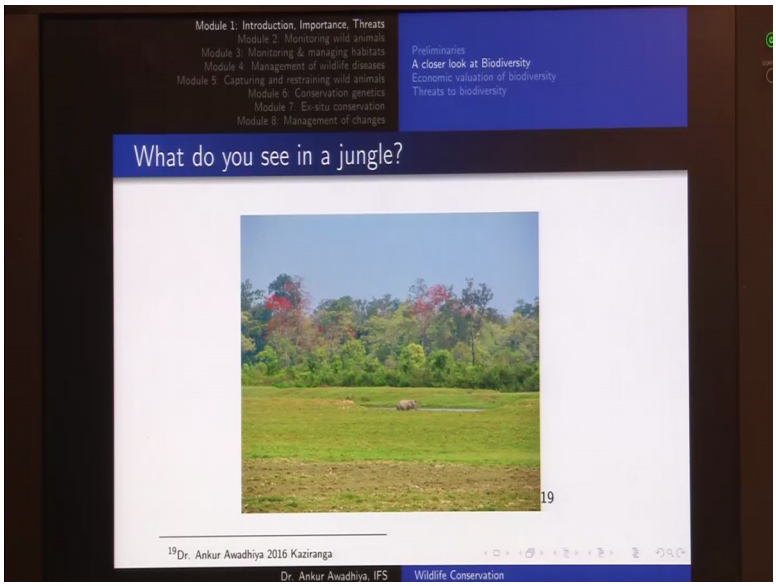

So, this is a picture from Assam and here we have this elephant at a distance. So, there are quite so many organisms that we may see in a forest and all of these are signatures of biodiversity.

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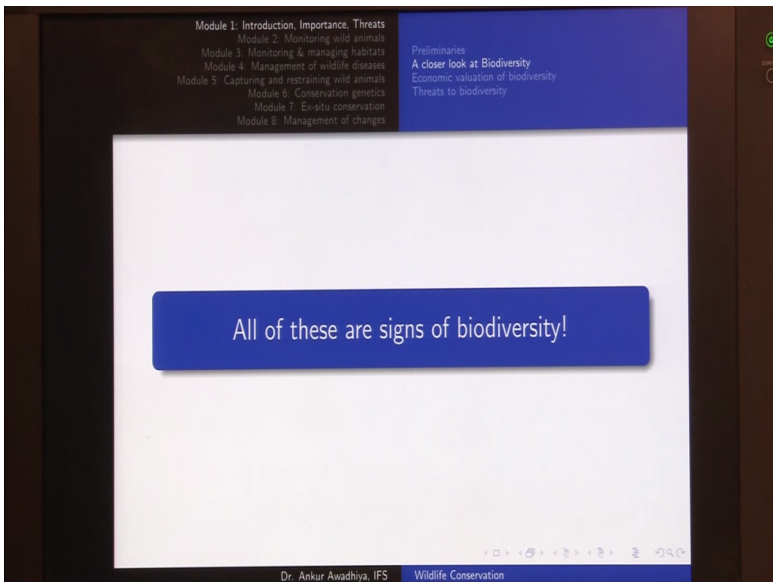

So, next question is; what is biodiversity?

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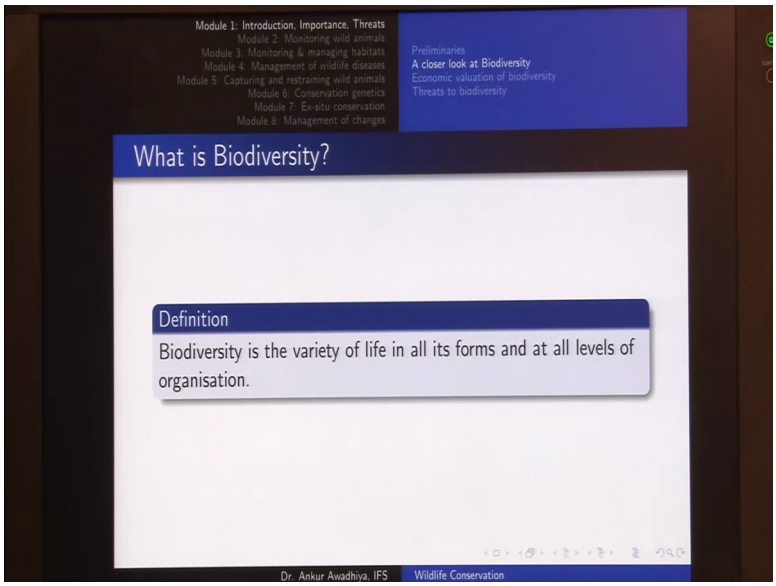

Biodiversity is defined as the variety of life in all its forms and at all levels of organization. So, there are different forms of life; that we observe in a forest and these are in different levels of organizations. So, what do we mean by different forms and what do we mean by different levels of organizations?

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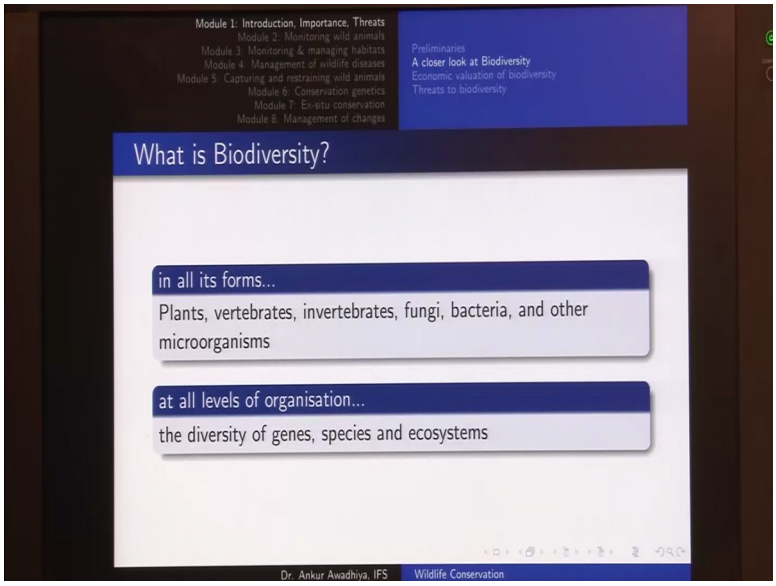

So, when we see in all its forms; we have seen a number of plants, vertebrates, invertebrates, fungi, bacteria and other microorganisms, that could be found in this area and all of these are signatures of biodiversity. What do we mean by different levels of

organization? We may have organization at the level of genes; which are inside any individual; we may have organization at the level of species.

So, all these different species that we have observed in the forest and also different kinds of eco systems that are there. So, for instance is this forest only having patches of wood or does it also have a pound or say it does it also have a grassland? So, all these different levels of organizations we are also comprise the biodiversity. So, now, let us look at all of these in greater detail.

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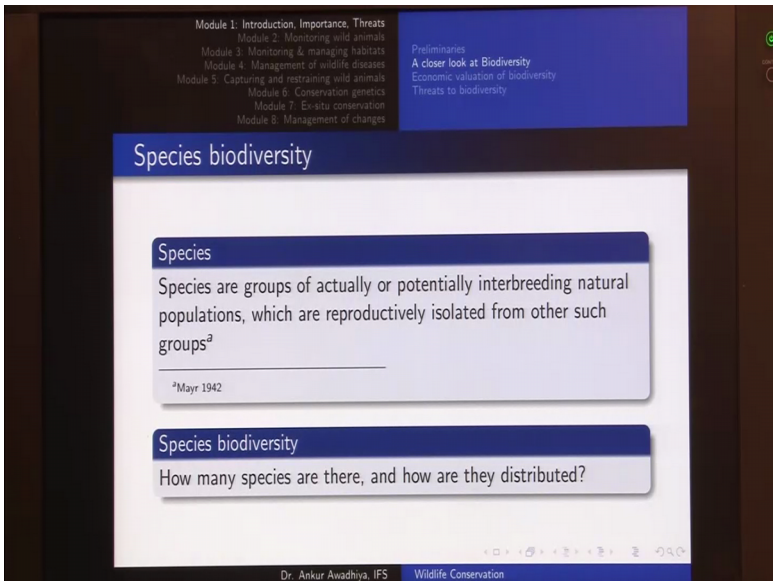

When we talk about, species biodiversity; species are groups of actually a potentially interbreeding natural populations, which are reproductively isolated from other such groups.

Now, what do we mean by that? They are actually interbreeding or potentially interbreeding. So, actually interbreeding an example; would be the tigers of one particular tiger reserve say the tigers of Kanha tiger reserve. So, these tigers are actually, interbreeding amongst themselves. So, in this population we have n number of tigers and these tigers are breeding amongst themselves.

So, they form one species or potentially interbreeding; potentially interbreeding because, say consider the tigers of Sundarbans and the tigers of Kanha. Now the tigers of Sundarbans in West Bengal do not come to Madhya Pradesh to breed with the tigers of

Kanha, but, they are potentially interbreeding because, if you bring both of these populations together or individuals from both of these populations together then they will be able to breed.

So, these are potentially interbreeding. So, groups of actually or potentially interbreeding natural population; which are reproductively isolated from other such groups, what do we mean by reproductively isolated? So, for instance, if you take a tiger and if you take a wild dog if you place both of these together, they will not be able to breed. So, they are reproductively isolated. So, even if you bring them physically together they will not be able to reproduce amongst themselves.

Now, when we say a reproductively isolated, it means that either they will not be able to reproduce or even, when they do and result in a hybrid; this hybrid would being infertile. So, this hybrid will not be able to continue forward. So, species are groups of animals of actually or potentially, interbreeding natural populations which are reproductively isolated from other such groups.

Now, species by biodiversity ask the question; how many species are there and how are they distributed? So, for instance, in our forest; if we have 10 species or if we have 1000 species. So, if we have 1000 species we will say that we have more amount of biodiversity; as compared to a forest that has only 10 species. So, that is how many species are there, how are they distributed? So, when we talk about the distribution of this species what we are asking is suppose we have 10 species of trees in a forest.

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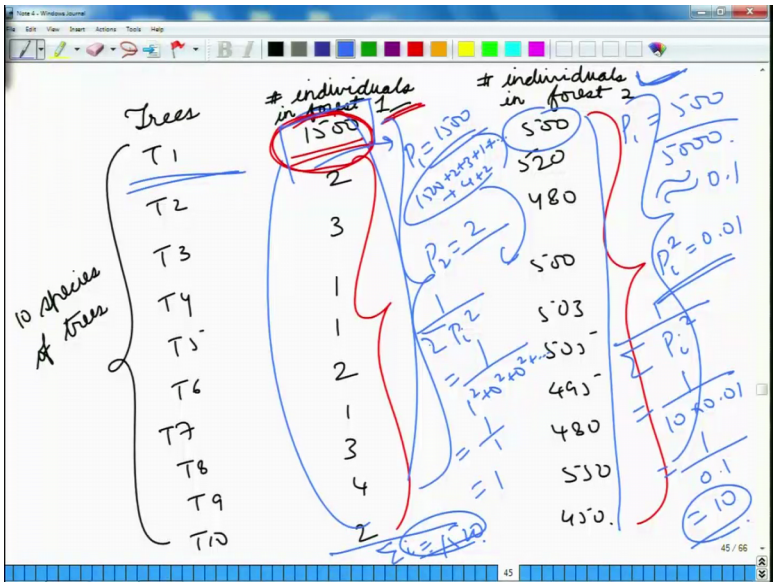

So, we have trees we have T 1, T 2, T 3, T 4, T 5, T 6, T 7, T 8, T 9 and T 10. So, these are 10 species of trees.

Now, we are having a look at the number of individuals that are there. Now suppose in the first case, we have say 1500 individuals of species T 1, say 2 of T 2, 3, 1, 1, 2, 1, 3, 4, 2. Now this is one scenario. So, these are the number of individuals in say forest 1. Now we have a look at number of individuals in forest 2 and let us say we have say 500, 520,480, 500, 503, 505, say 495, 480, 550 and 450.

Now, in this example we can see that in the case of forest 1 there is 1 species that is predominant in this area. So, this species is found everywhere, whereas, the other species, the other 9 species that we have in this area are only found in the some small patches. On the other hand in the case of forest 2, all of these species have nearly equal numbers. So, when we say how are they distributed we are asking the question is there any 1 species that is found predominantly.

Now, in the case of our forest 1, what we will have is that there is a mono culture of a species 1. So, everywhere there is only 1 species and the other species that are found in this area, are found in such a small proportion; that we would say that the level of biodiversity in forest 1 is very less because, it is predominately a mono culture there is just 1 species that is found everywhere. In the case of forest 2 we will say that this forest has more amount of biodiversity because, this is not a mono culture; there is not just 1

species that is found everywhere. But everywhere in every patch will find a different combination of species. So, the amount of diversity here is more.

So, species diversity ask the question; how many species are there and how are they distributed? Next we have genetic biodiversity.

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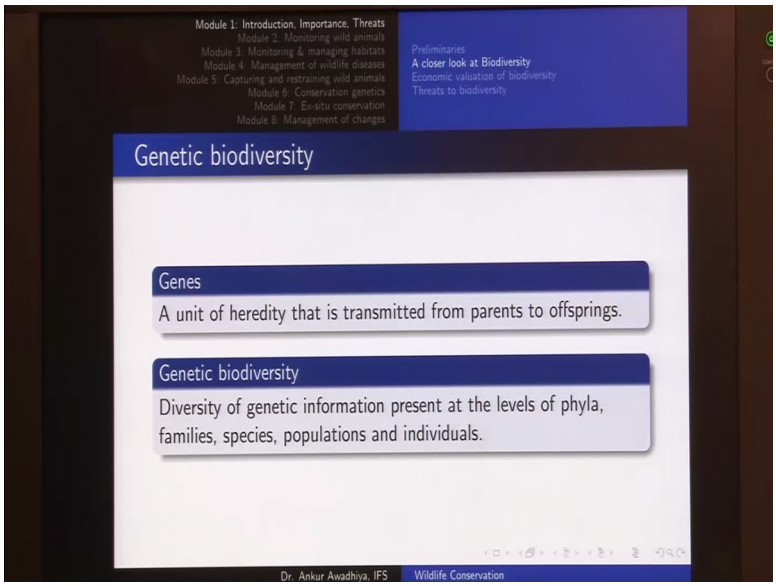

So, let us begin with genes, what is gene? A gene is a unit of heredity; that is transmitted from parents to offspring's. So, for instance, if there are parents that are very tall, there is a good chance; that their off spring will be also be very tall because, this is one characteristic that goes on through heredity. So, it is transmitted through heredity, it comes from parents to off springs. So, we will say that, there is a gene for tallness; similarly, we can have a gene for say hair color, a gene for skin color, a gene for eye color, a gene for whether the hair is straight or curly and so on.

So, any individual will have in number of genes in the case of human beings we say that we have close to around 30000 genes in our bodies. Now genetic biodiversity would ask, about the diversity of genetic information present at the level of phyla, families, species, populations and individuals. So, what we are asking here is that; let us say talk about human beings. So, human beings have 30000 genes, but if we consider a smaller species, say a let us consider a microorganism that has say only 20 genes. So, 30000 genes versus 20, so we would say that humans have more amount of genetic biodiversity as compared to that particular microorganism. So, that would be at the level of individuals.

Next, at the level of populations so for instance, consider a plantation of eucalyptus, now these eucalyptus trees could be clones of each other. So, basically you take 1 eucalyptus plant and while it is growing you divide it into 2 and then you grow them in different pots; that you get 2 plants similarly, you can continue this process again and again. So, it goes by the name of vegetative propagation and all of these plants could come from just 1 plant.

So, all of these plants would have the same gene. So, plant A and plant B will not be different; as in the case of twins in the case of human beings. So, when we talk about twins both of them have the exactly the same genetic makeup, if they are if they are mono zygotic twins. So, if they are coming from the same zygote.

Now, there is 1 population of a of a eucalyptus plants, that have all come from 1 plant. So, they have all this same genes, there is say another plantation; that has come out of seeds. Now when it has come out of seeds each and every eucalyptus plant will have a different set of genes inside the plant. So, we will say, that live that looking at the population level the plantation that is come out of seeds is having more amount of genetic biodiversity as compared to first plantation that is a clone in which all the plants are clone of each other.

So, we can look at genetic diversity at the level of individuals or at the level of populations or even at the level of this species. So, for instance, if there is a species such as the human beings. Now human beings have a very wide diversity of genes available with them, because, they have lived as different populations over a very warts landscape throughout the earth, but consider another species that has say in the case of German rhinoceros that we observed in the last class.

Now, German rhinoceros has only 100 individuals left. So, even at the level of the species; the genetic diversity that is there in human beings will be much greater than that in the German rhinoceros off air for instance, the amount of genetic diversity; that is there in a species of deer in our forest say chital will be much greater than the amount of genetic diversity that is there at the level of species in the case of German rhinoceros or we can have a look at the level of families or at different other levels. So, in the case of genetic biodiversity, we are looking at the diversity of genetic information that is present at the level of phyla, families, species, populations and individuals.

So, how do we look at this genetic diversity?

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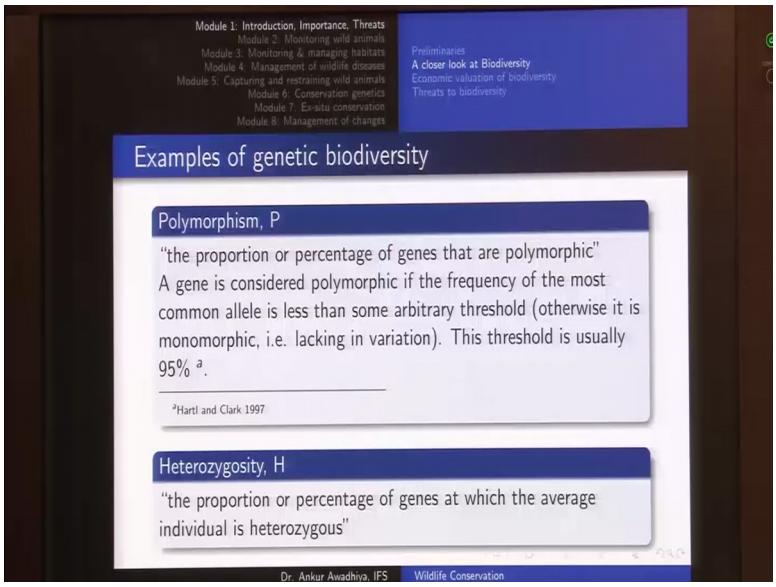

There are two very easy indicators of looking at genetic biodiversity. One is polymorphism and the second is heterozygosity, the polymorphism is the proportion or percentage of genes that are polymorphic. Now a gene is considered polymorphic, if the frequency of the most common allele is less than some arbitrary threshold otherwise, it is monomorphic or lacking in variation; this threshold is usually 95. Now, for instance, consider a gene for say Tallness.

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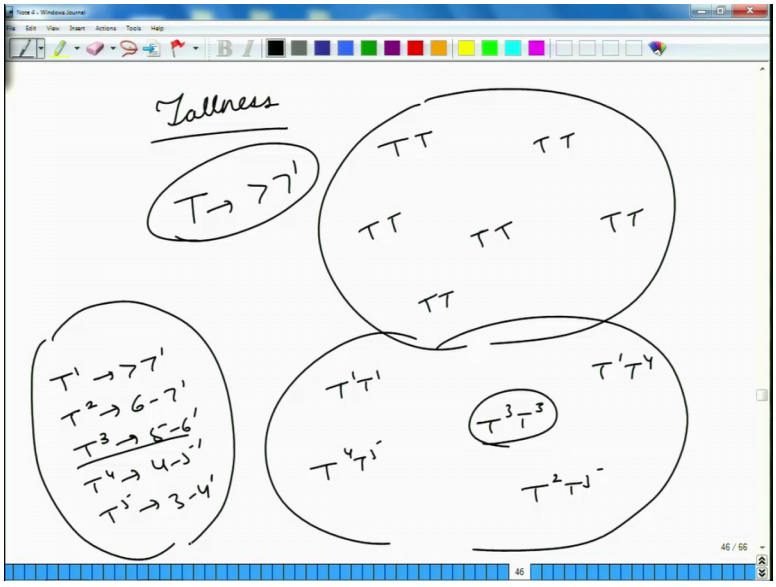

Now, this gene let us represent it by capital T, if you have a population, in which every individual is having and we are considering here that every individual is a diploid individual. So, every gene is present in two copies.

So, we have all the individuals that are T T, T T, T T, T T, T T and T T. So, in this case, we would say that this population is monomorphic because, there is only one allele available here which is, capital T. So, all of this individuals are very tall say this capital T quote for a height of greater than 7 feet.

On the other hand, let us consider another population, in which we have different alleles of T. So, we have T 1 which coats for greater than 7 feet height, we have T 2 that coats for say 6-7 feet height, we have T 3 that coats for 5-6 feet, we have T 4 that coats for 4-5 feet, we have T 5 that coats for 3-4 feet.

Now, in this case in the population will be having individuals; which are say T 1, T 1 or T 3, T 3. So, in this case, this individual is having both the alleles that are T 3 or we could have some individuals that are say, T 4 T 5 or say T 1 T 4 or say T 2 T 5 and things like that.

So, in this particular case, we are having 5 different alleles for the same chain; which are, T 1, T 2, T 3, T 4 and T 5.

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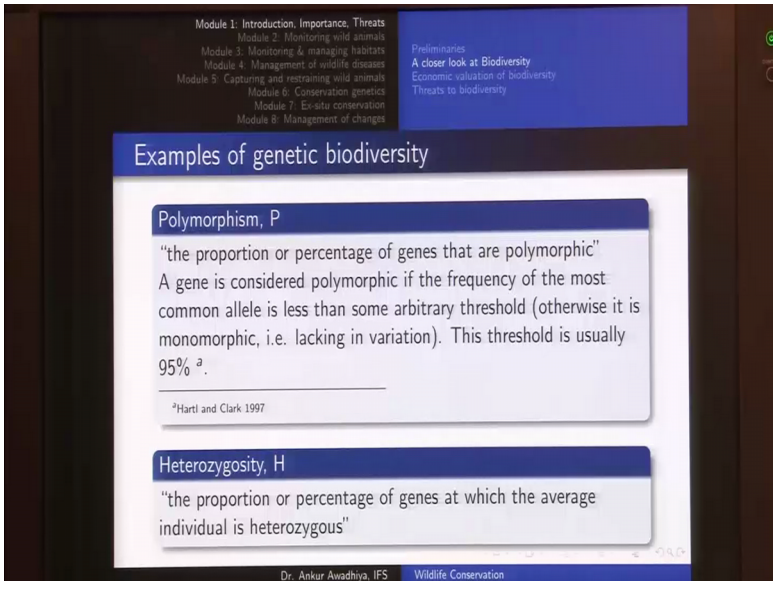

So, when we talk about polymorphism, then we would be having different alleles of the same gene it cannot a single gene and the second criteria is that, the frequency of the most common allele is less than some arbitrary threshold; which means that when we talk about all of these different alleles and we look at their frequencies. So, for instance, in this population P 2 we are having 5 individuals.

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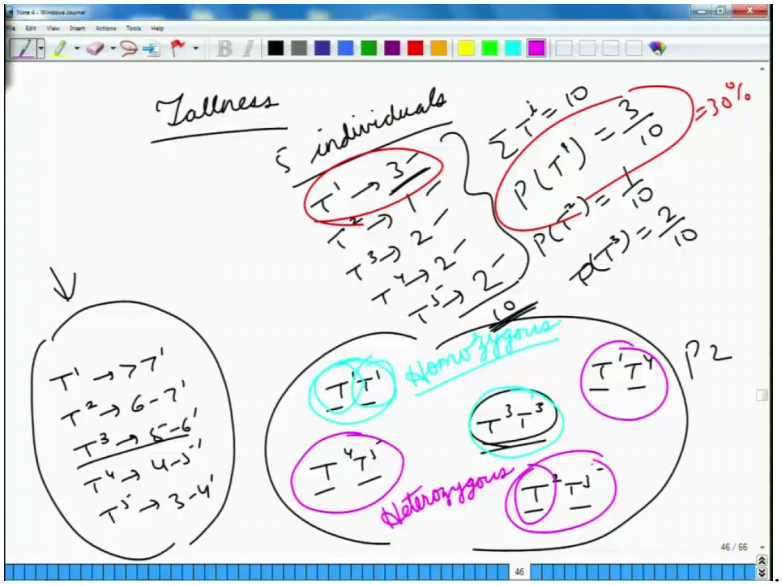

So, let us, now get rid of the first population. Now, in P 2 we are having 5 individuals. Now how many number of T 1 are there? So we have 1, 2, 3, it is there in 3. How many T 2s are there? So, T 2 is there only in 1.How many T 3 are there? So, T 3 is there in 2 copies. How many T 4 are there? So, there is 1 and 1 2 and how many T 5 are there? So, we have T 5 and T 5 so, it is 2; so, 2 4 6 and 4 10. So, these are the number of alleles of T 1, T 2, T 3, T 4 and T 5 that are found in this population.

Now, total number of alleles so, the sum of T I is 10. So, we have 3, 4, 5,6, 7, 8, 9,10. So, it is total number is 10, now the proportion of any particular 1. So, you have proportion of T 1, this will be given by 3 by 10. So, you have 3 divided by total number of alleles, proportion of T 2 is given by 1 by 10, proportion of T 3 is given by 2 by 10 and so on. Now in this particular case, what we are saying is that the frequency of the most common allele is less than some arbitrary threshold.

So, let us look at the most common allele here, so the most common allele here is T 1 and the frequency of T 1 is 3 by 10, which is 30 percent. Now, because 30 percent is less

than 95 percent, so, we would say that this population is polymorphic or this particular gene is polymorphic in this population.

On the other hand, when we had all the individuals in the first population, so, let us write the first population again.

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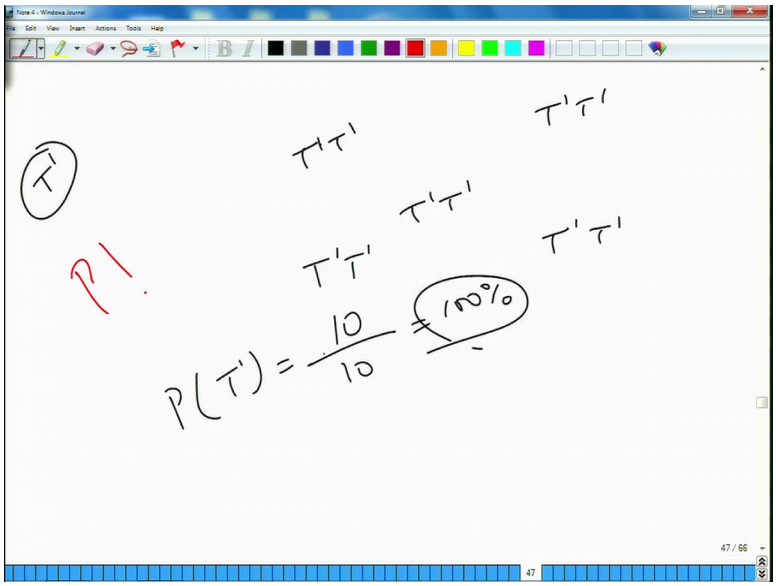

So it only had one single allele. So, it let us call it as T 1, so the first individual was T 1 T 1, the second one was T 1 T 1, the third one was T 1 T 1, the fourth one was T 1 T 1 and the fifth one was T 1 T 1. So, in this case what is the proportion of T 1? So we have 10 alleles of T 1 divided by total of 10, which is 100 percent.

So, because this is greater than 95 percent, we would say that this population P 1 is monomorphic or the gene for tallness T is monomorphic in this particular population. In the case of the second population it is polymorphic. Now this arbitrary threshold is taken as 95 percent. Now, what does this mean? That if the most common early available allele is found in a proportion of more than 95 percent then essentially, it is the same as that of a mono culture. So, basically, all the individuals that are there in this population, then more than 95 percent of the cases they are having this allele of T 1.

So, in that case we would call it a monomorphic. The second thing is heterozygosity, now, heterozygosity is the proportion of percentage of genes at which, the average individual is heterozygous. Now coming back to the drawing board in the case of the

second population, what do you mean by homozygous and what do we mean by heterozygous? So, consider this individual T 1 T 1.

So, this individual has 2 copies of T 1 this individual has 2 copies of T 3, but this individual has 1 copy of T 1 and 1 copy of T 4, this individual has 1 copy of T 2 and 1 copy of T 5, this individual has 1 copy of T 4 and 1copy of T 5. So, essentially, the individuals, the blue ones are homozygous, homo means same. So, in this case both the alleles are the same, the pink individuals are heterozygous because, they have different alleles present in them. Now here we are talking about only one gene that was T.

Now, similarly we can compute whether any particular gene X is present in a homozygous situation or in a heterozygous situation. Now heterozygosity says the proportion of percentage of genes at which the average individual is heterozygous. So, we can compute how many genes are in a homozygous state and how many genes are in a heterozygous state in different individuals and then we can take an average, to figure out the percentage of genes that are heterozygous in an average individual.

So, this also a measure of the genetic biodiversity, next we have ecosystem biodiversity.

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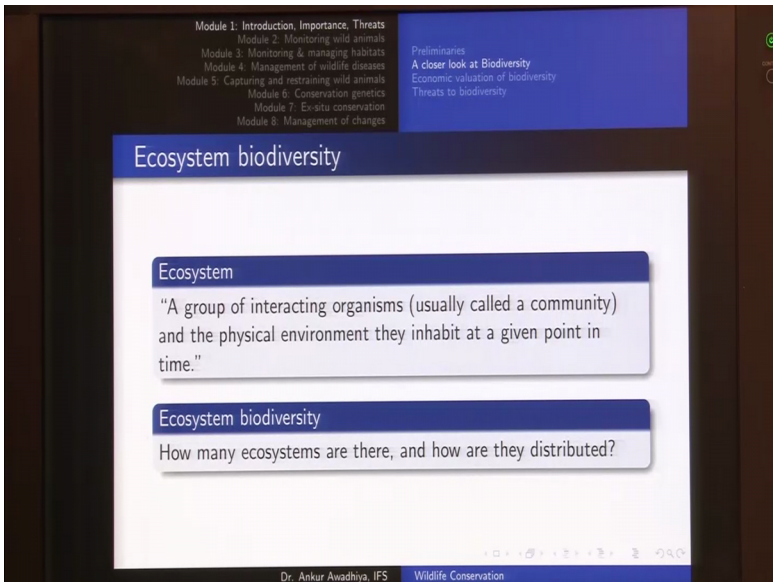

Now, ecosystem is a group of interacting organisms, usually called a community and the physical environment; they inhabit at a given point in time. So, a good example could be a lake; so, in the lake we have water we have some amount of light that is coming in,

there are some chemicals that are dissolved inside, there is dissolved oxygen, there is dissolved carbon dioxide, there also some salts, some nutrients. So, these are the physical environment; that are present in the lake also there would be number of interacting organisms inside. So, we will be having say some fishes, some frogs, may be some species of insects, may be some species of annelids inside. .

So, all of these together that are found in the lake will from a lake ecosystem, similarly we can talk about a grassland ecosystem. In which we will be having some species of grasses, some species of plants, may be some dear species, so these are the interacting organisms and the physical environment would include the air that is coming inside the amount of moisture that is, there the amount of sunlight that we are getting there, so that will form a grassland ecosystem, similarly, we can have a forest ecosystem.

Now, ecosystem biodiversity would ask; that in your forest how many ecosystems are there and how are they distributed?

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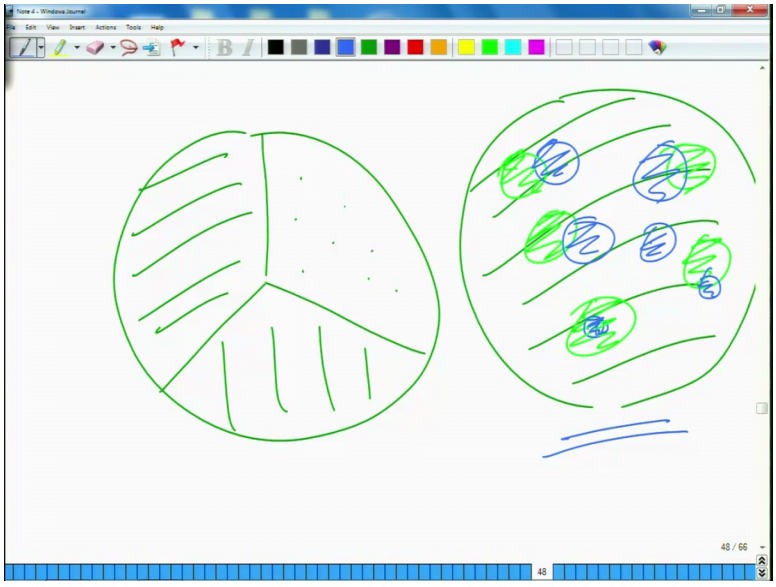

Now in the case of distribution, what we are asking is that in our forest, do we have all the forest together, all the grasslands together and all the lakes together? Or do we have a situation in which, in our forest we have say forest everywhere, but then there are some patches of grass lands; that are randomly distributed and then some patches of lakes that are randomly distributed. So, they are coming close to the forest, they are coming close to the grasslands, some are within a grassland and soon.

So, in this case we would say that, this forest is having a greater amount of ecosystem biodiversity as compared to the first forest.

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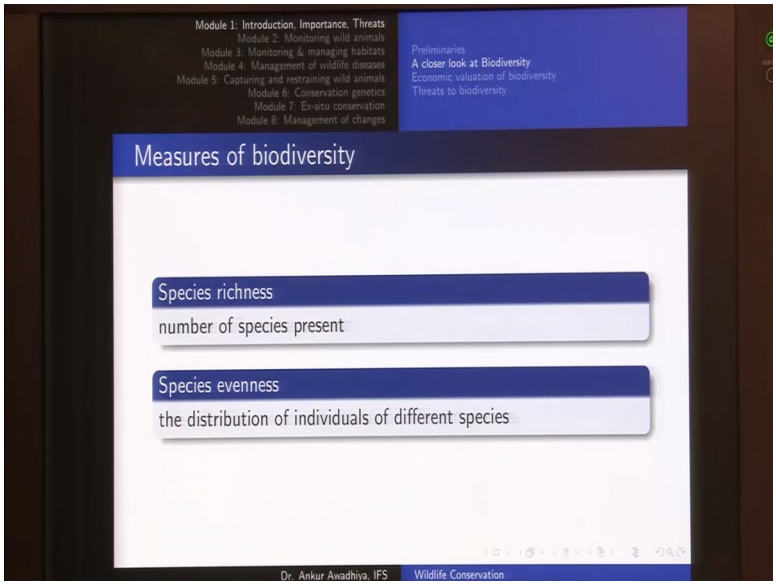

So, how many ecosystems are there and how are they distributed? When we talk about biodiversity and when we want to put a numerical figure to this biodiversity, then we can make use of species richness and species evenness.

Now, species richness, ask how many species are present the number of species that are there and species evenness ask about, the distribution of individuals of different species. So, what we are asking here in this example? We saw that in this particular forest, we are having individuals of this species T 1 that are predominant and everything else is subjugated, whereas, in the forest T 2, we have all these different species that are evenly distributed.

So, we had said that our forest 2 is having a greater amount of species biodiversity as compared to forest 1, even though both of these are having equal number of species.

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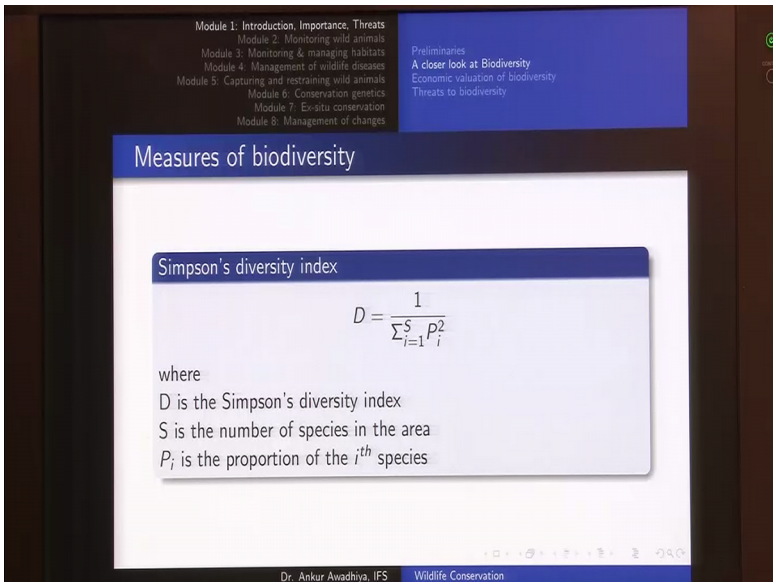

Now to put it mathematically, we make use of two indices; the Simpsons index and the Shannon index. Now in the case of Simpson index it is defined by D is equal to 1 by sum of P i square. Now, P i is the proportion of the ith species. So, for instance in this particular case, we will count the number of individuals. So, this will be your sum of individuals here say this will be very close to say 1520.

Now, the proportion of the first species P 1, will be given by 1500 divided by this sum. So, this sum is 1500 plus 2 plus 3 plus 1 plus so on till 4 plus 2. So, you have counted all of these and you have divided 1500 by that number; P 2 similarly, is given by 2 divided by this thumb P 3 and P 4 and so on.

Now, in this course this formula is not that important, but just to get a glimpse of it, here we are saying its 1 divided by P i square. So, basically in the case of the first population will be having 1 number that is close to 1 because, this is 1500 divided by say 1520 or 1530, which will come very close to 1 and everything else is 0 or very close to 0 it is like, 1 by 1500 or 3 divided by 1500 they are very close to 0.

So, when we talk about this number, we will be having a number that is very close to 1 because, P i square so for the forest 1, it will be 1 square is 1 for the other 1 it will be 0 square is 0. So, the sum of all of those will be equal to 1. Whereas, in the second case, in the case of the forest 2 here we will be having P 1 is given by 500 divided by all of these,

now this thumb would come to be close to around 5000. So, it will be a approximately equal to 0.1. So, when we say P 1 square, it low be 0.01.

Now, in the formula, on the denominator side we have P1 square plus P 2 square plus P 3 square plus so on. Now in the case of the second forest, all of the P i squares will be close to 0.01. So, essentially when we say 1 divided by sum of P i square it will be 1 divided by 10 into 0.01 is 1 divided by 0.1 is equal to 10.

When, in the case of the first one we had 1 divided by sum of P i square is equal to 1 divided by 1 square plus 0 square plus 0 square plus so on; which is 1 by 1, which is equal to 1. So, numerically, we can get an idea, that the first forest is having a Simpson index of 1 the second forest is having a Simpson index of 10. So, we will say that the second forest is having more amount of diversity, as compared to the first forest. Along with this we can also take about the equitability or the evenness which is given by D divided by the maximum value of D or D max that is there in the population.

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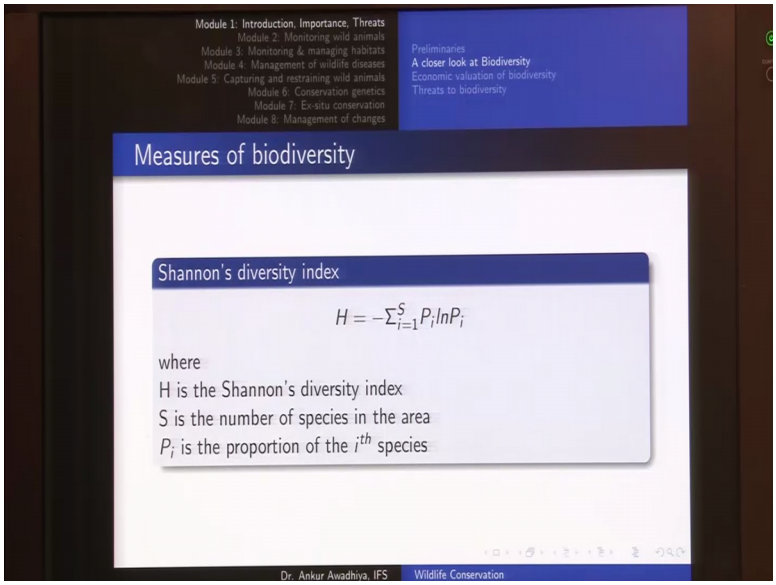

Similarly, the other measure of biodiversity is the Shannon index, which is given by minus sum of P i log P i, where P i is calculated in the same fashion and here, also we can have the equitability or the evenness value that is given by H divided by the maximum value of H that is possible.

Now, for this course you only need to remember, that there are these two measures of biodiversity, Simpson index and Shannon index that we can use, but then this formula is not very much useful for this particular course, maybe we will use it in some other course.

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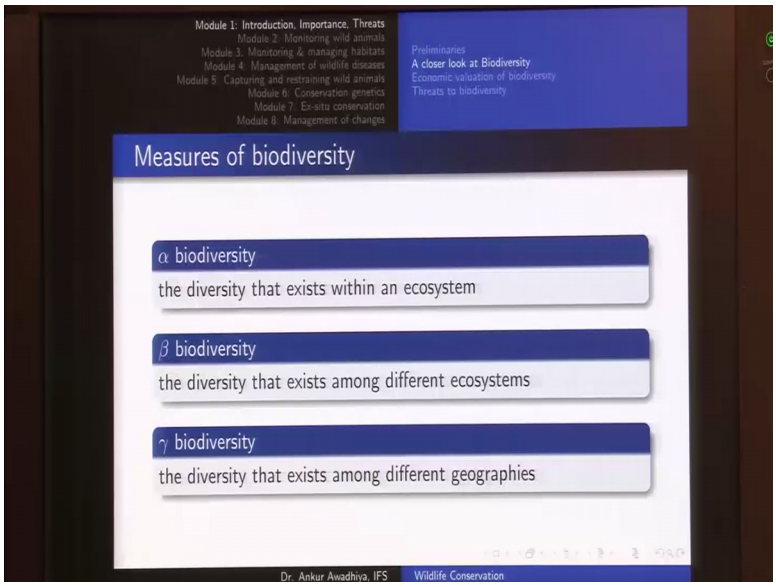

Now there are three measures of biodiversity that we use. So, these are alpha, beta and gamma biodiversity. Alpha biodiversity is the diversity that exists within an ecosystem. So, with in a lake; what is the biodiversity that would be the alpha biodiversity, gamma biodiversity on the other hand is the diversity that exists among different geographies.

So, in the first case, we are talking about 1 ecosystem that is only in 1 place, in the third case, we are talking about a very large scale. So, very large scale, so, there are a number of ecosystem and then we are asking; what is the biodiversity that is existing amongst these different geographies and the beta diversity, is the diversity that exist among different ecosystems. So, here we are comparing ecosystem say, a lake with the forest.

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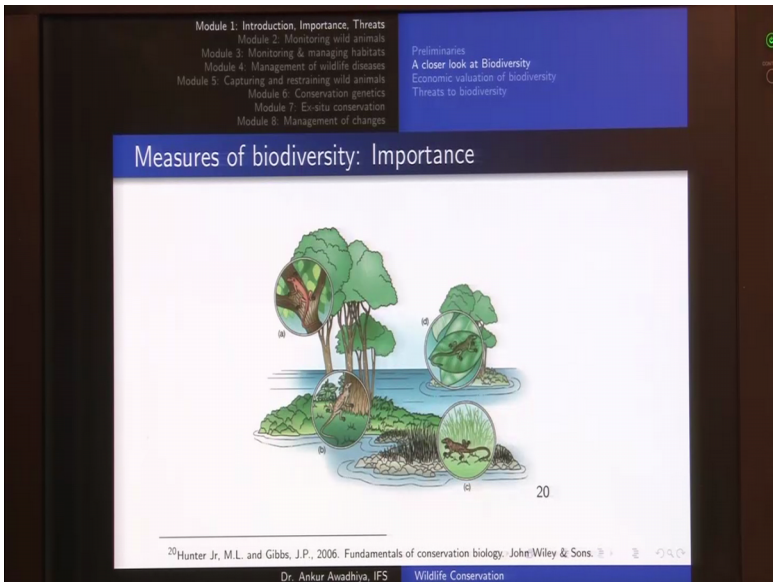

Now the importance here is that, we will use this example; to exemplify. So, in this area we have this Iceland this is the first Iceland and this is the second Iceland and let us consider that we are only considering the species of these lizards that are found here.

Now, in the first Iceland, we have two ecosystems one ecosystem is that of a forest that has trees and grasses and the second ecosystem, is a marshy swamp. So, we have one species of lizard that is found in the trees, one species that is found in these grasses and one species of lizard; that is found in the swamps and then there is this Iceland, that is far off and that is having a fourth species of the lizards.

Now, when we talk about the gamma biodiversity, so, we are talking about all of these together. So, in gamma biodiversity we will be considering all the four species. In the case of the alpha biodiversity, will be considering only one ecosystem. So, in this case we have this ecosystem of the swamps that has only one species. In the case of this ecosystem of forest, we are having two species and in the case of this third ecosystem of forest we have only one species so that is the alpha biodiversity. When we ask about the beta biodiversity we are comparing two ecosystems.

So, in these two ecosystems, how many species are there, that are unique between both of these for example, if we had a third species that was found in here, as well as here. So, we would not count that species in the beta biodiversity, but we would only count those

species that are different between both of these ecosystems together. So, we will count 1, 2 and 3 because, these 2 are not found here and this 1 is not found here.

So, this is the relation between; alpha beta and gamma biodiversity, but then why is this important? Because, at times when we are conserving an area. So, probably, we are having a tiger reserve that has these swamps and then somebody could come and say ok, this swamp only has one species of lizards whereas, if you have forest you will have two species of lizards. So, why not convert this swamp into a forest. So, that in place of hiring one species you will be having more species so more amount of biodiversity.

So, the answer, whenever you get such a proposition should be to look at the alpha beta and gamma biodiversities. So, no doubt, if you replace this swamp with the forest; your alpha biodiversity will increase from one species to two species, but then let us have a look at the gamma biodiversity. Now in the gamma biodiversity in the present scenario you are having four species 1 2, 3 and 4.

Now, if you replace this swamp and you replace it with another forest so you will have one species that is here and here one species that is here and here. So, essentially in this Iceland we will have only two species, because this species will be exterminated. Now this species exist. So, here we will have two species and here we will have one species. So, the gamma biodiversity will go down from 4-3.

So, even though your alpha biodiversity will increase, if you replace this swamp with the forest your gamma biodiversity for the whole of this region will go down. And which is why it is important even to conserve those areas that do not have a very strong a very large amount of biodiversity, because these are areas in which we find those species that are not found anywhere else.

So, they have a large degree of endemism or species that are found only in one area. Now, the biodiversity and spatial scale tells us about the hotspots. So, essentially like in the previous example; when we asked, what are what are these different species and how are they distributed? They can also give us an indication of which areas require the most amount of protection by us. So hotspots are defined as areas, which have high species richness high degree of endemism and also high degree of threat.

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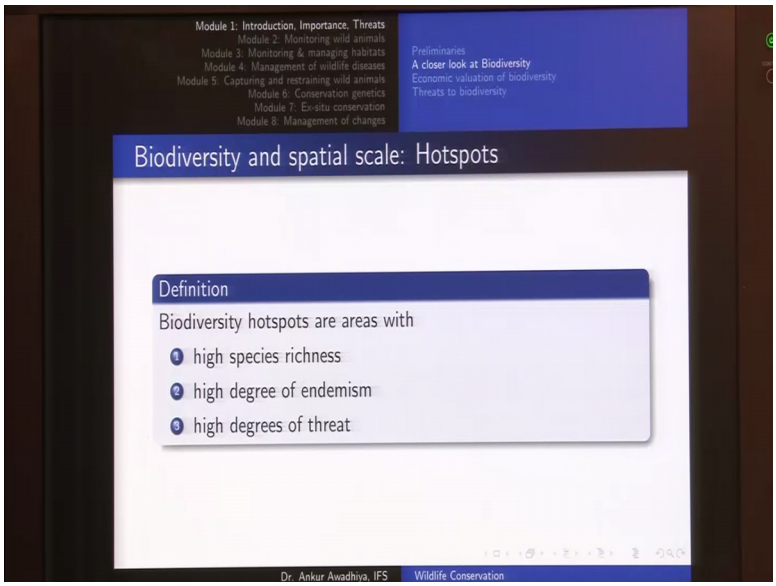

So, essentially these areas have a large number of species there are some species or a number of species that are only found in these areas not found anywhere else and also these areas are under a large amount of threat. So, if you have any of such areas, then you need to give it more amount of protection.

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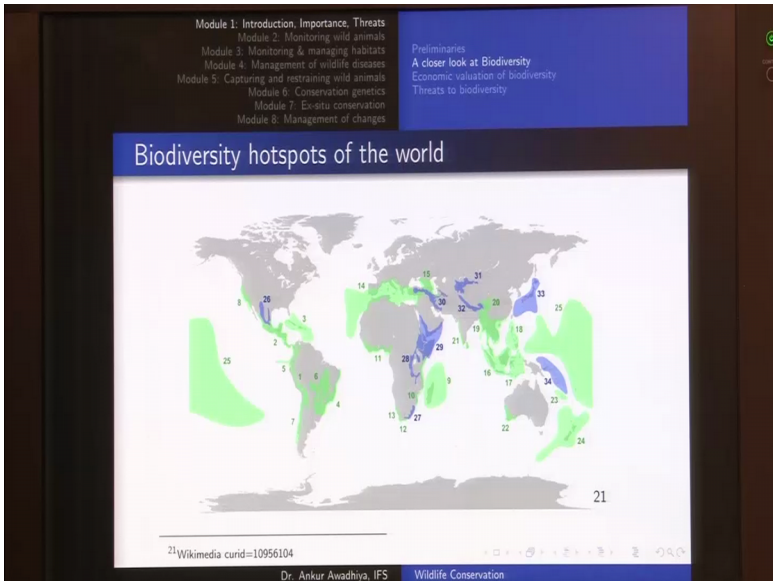

So, for a instance, if you look at the biodiversity hotspots of the world we will find that our Western Ghats come under a biodiversity hot spot. Why? Because, the Western Ghats being are rainforest or the tropical forest, they have a huge number of species; especially,

those species that are not found anywhere else. So, they also have a huge degree of endemism.

So, high species richness, high amount of endemism because, for instance a frog that is found in Kerala, will not be found anywhere else in the world. So, this has high degree endemism, also the number of frog species there is much larger, then is in found in say a grassland, because these are very dense forest and these get a huge amount of rain. So, high species diversity, high amount of endemism and also high amount of threat, because people want to convert these forest to say to say grow a plantation of say coffee or say rubber.

So, these areas, which have high species richness, high level of endemism and high level of threat, would be called as a biodiversity hotspot. Now, in this lecture we had a closer look at biodiversity, we started by saying; what all different kinds of organisms do we see in a forest within moved up to say what is the difference between; species biodiversity, genetic biodiversity and ecosystem biodiversity.

Then we looked at special scales of biodiversity, alpha, beta and gamma biodiversity. We also looked at numerical methods of finding out the biodiversity of an area, that is the Shannon index and the Simpson index and we also had a look at which areas require most amount of protection, which you call as biodiversity hotspots that have three criteria; large number of species, species that are found only in this area nowhere else and the areas that are having a great amount of threat, because people want to divert these areas into something else. So, these are biodiversity hotspots. So, that is all for today.

Thank you for your attention. [FL]