Wildlife Ecology
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Lecture – 05
Species abundance and composition: Biodiversity

[FL] Moving on in our Ecological Structure module, we now move to the second lecture, which Species abundance and composition or Biodiversity. Now, the ecological structure is comprised of a number of species. And so, it becomes very important to understand how many species are there how are they distributed, and what is the composition in a particular ecosystem. So, how many individuals are there of each species and which is the study of biodiversity.

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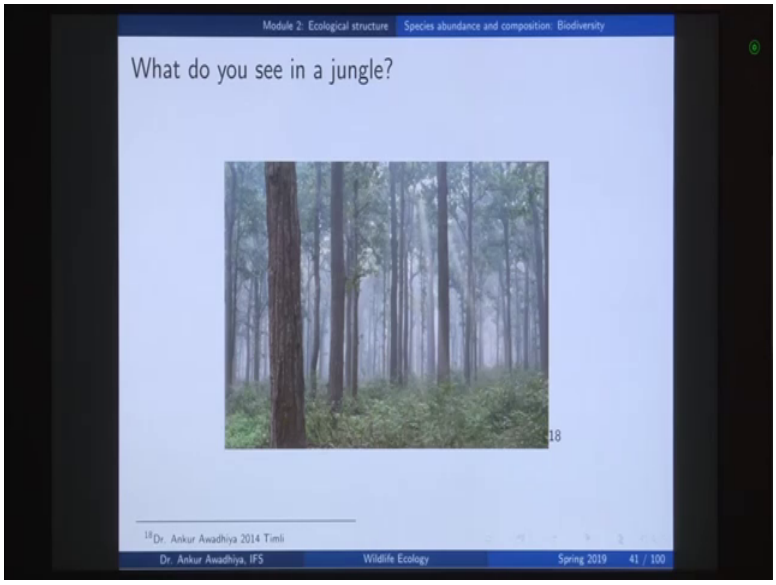

Now, a number of ecological studies have been done in the forest, because forest provide an avenue in which you can understand nature units most drop form because they are untouched by humans. So, we are able to see how nature operates without any anthropogenic influence.

So, if you enter into a forest what do you observe the first thing you will observe is a lot of serenity you would not have any loud noises of vehicles you would not have any smoke and so on. And, you will also observe a number of trees probably if you are moving into forest that is safe a deciduous forest or it or a coniferous forest. So, you will

also observe a number trees. Now, these trees will also be divided into a number of canopies. So, you will have a top canopy which is comprised of the of these tall trees, you will have a middle canopy you will also have some ground cover that is comprised of these herbs and shrubs and so on.

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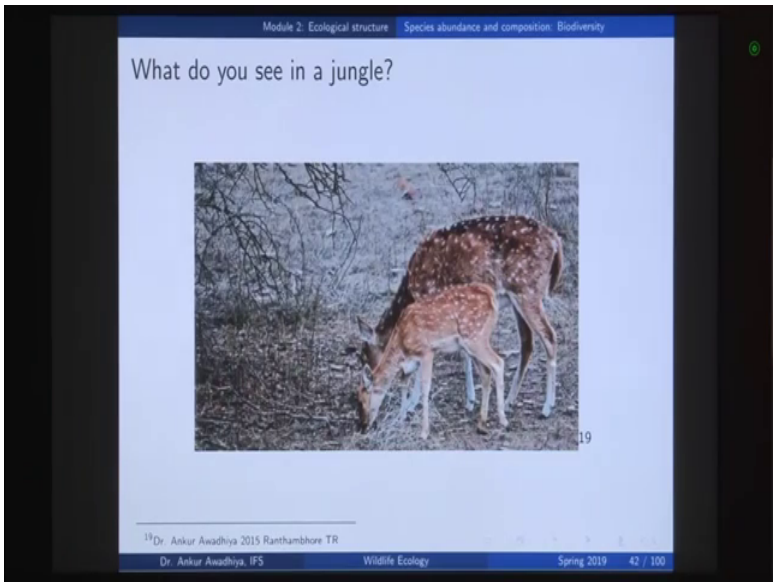

If you look around and if you are lucky you will also observe a number of animals in the forest. So, these are Chitals which are feeding on the grasses that are found in the forest. So, you will observe some animals.

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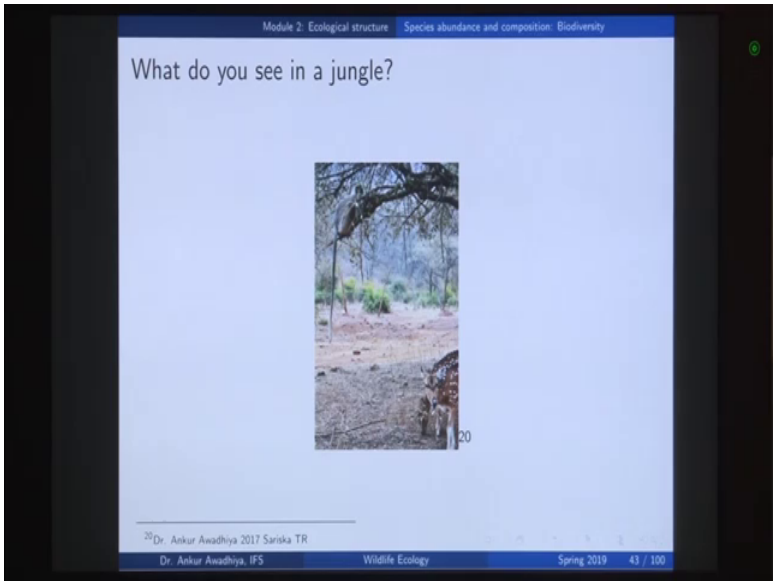

You will also observe some interactions between these animals. So, like we talked before about the langur chital association. So, this is an example of a langur chital association. So, we have this tree on which we have this langur and this langur is feeding and it is throwing of some pieces of the leafs down into the forest floor. And so, there are a number of chitals that have come to this area to feed on this leafs.

Now, these chitals would not have had access to the leafs, because they cannot climb the trees evidently. And, by coming in close contact with another species now they are able to getting access to this food resource. And, they are also benefitted, because the langurs can look very far because they are at a higher vantage position. And, so, if there is any predator nearby if there is a tiger nearby they would give of alarm calls and they the chitals would run away.

Similarly, the chitals are having another more ground view of the situation and so, if a tiger is nearby and if the langurs are not able to see it, because of say tall grasses the chitals might be able to sense the presence of the tiger because of the smell of the tiger. If that happens the chitals would give off alarm calls and then they would start running of and that would also alarm the langurs. So, we observe a number of interactions that are taking place between different species, when we move inside a forest area.

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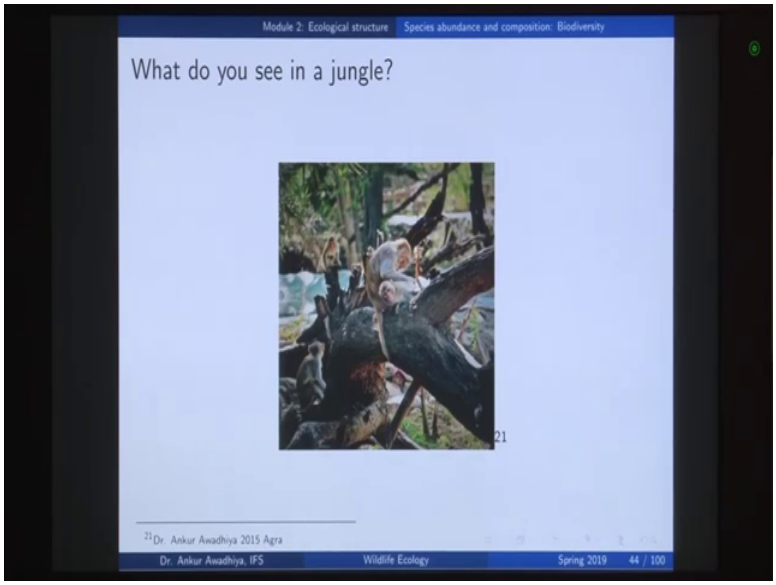

We will also observe a number of population level interactions amongst a number of animals. So, in this case you are observing a troupe of monkeys that are doing

allogrooming allogrooming is grooming of someone else. So, we will observe monkeys and their behaviours.

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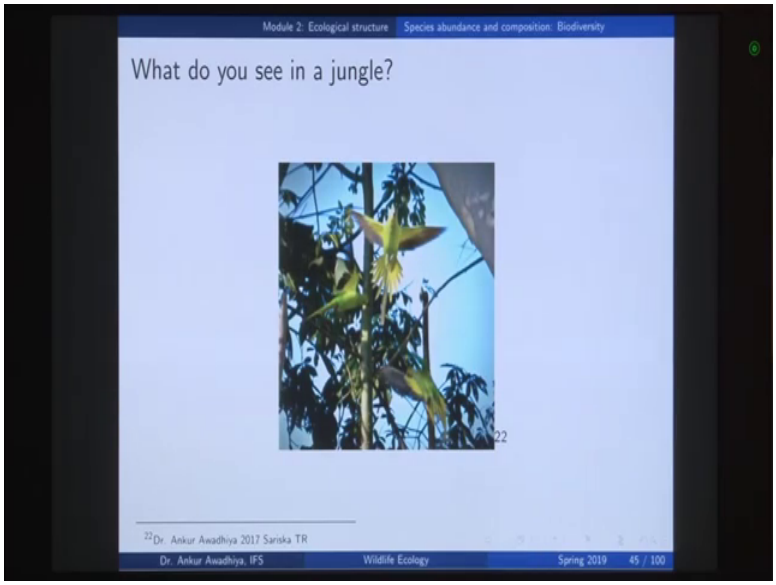

If, we look up we will observe some birds we will see parakeets most probably.

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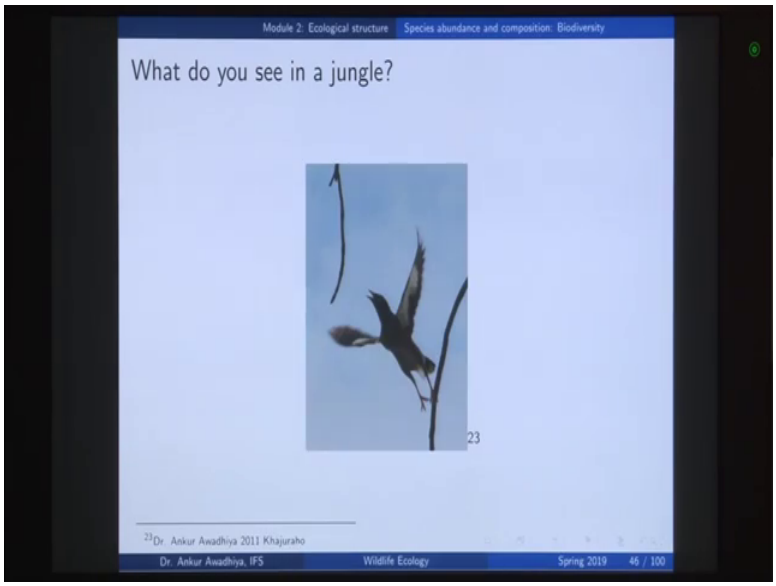

Or may be even things like Mynas.

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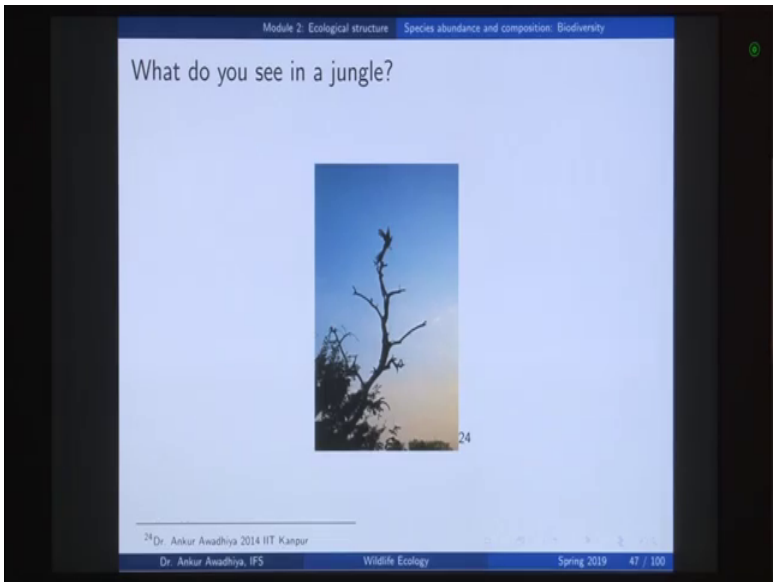

Peacocks if, you are lucky or we will also observe some animals and birds that are migratory.

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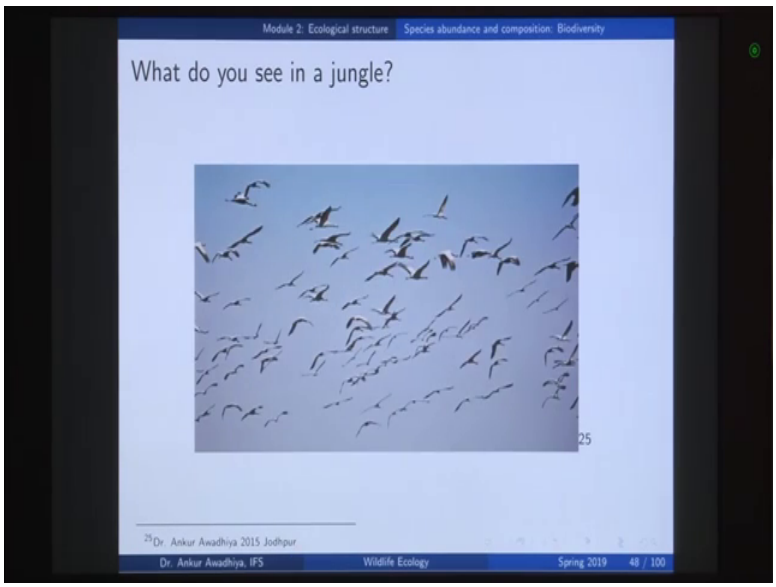

So, this is an example of Democil Crain's which are migratory species that visit our country for a while and then they move off.

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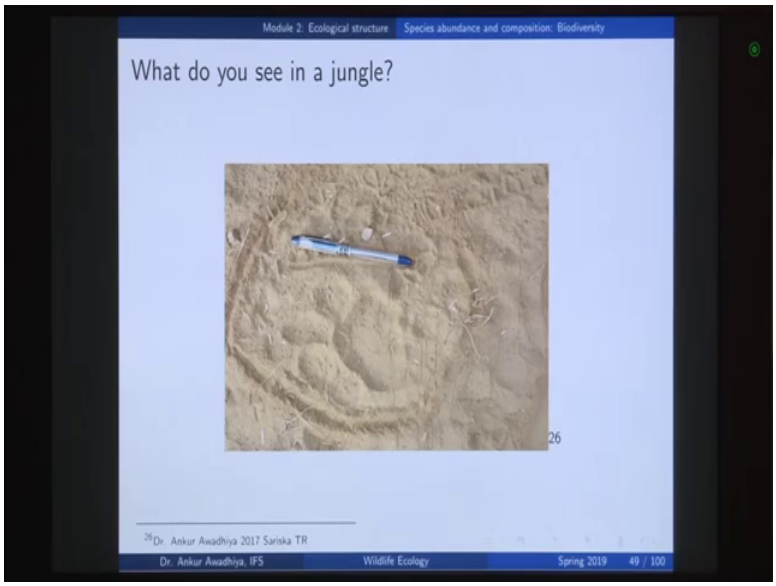

We might observe some signs of some animals. So, for instance this is an image of a pug mark of a tiger. A pug mark is a mark that is left on the ground when the animal is walking. So, for instance in this case we have this loose soil. So, when the tiger was walking here so, it will left an imprint on the ground which is the pug mark. And, we have kept this pen to give you a sense of scale of how large this pug mark is. So, even though we are not able to see some animals we might be able to infer their presence in our forest by using these indirect signs.

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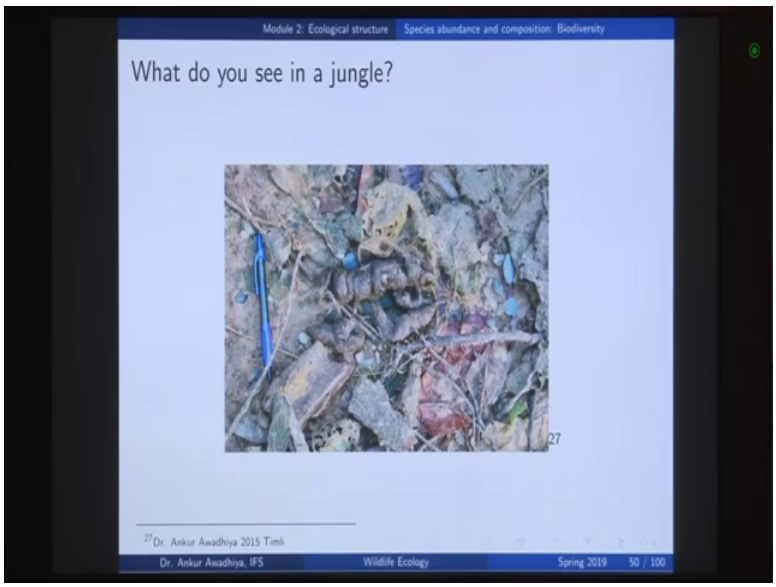

Another indirect sign is the scat of animals. So, scat is basically the Fecal matter that is left behind by the animal. And, every animal has a scat of different size and they also have different behaviours when it comes to living there fecal matter. So, for instance members of the cat family would typically by after they are done disposing of their fecal matter they would just move like this. So, they will scratch the ground.

So, we will see some scratch marks near these cats and we can make a correlation about the size of the scat the number of by scats or fecal samples that have been deposited by the animal. And, some other sign such as scratching marks on the ground to infer which animal give off this scat. So, we can also get a sense of what animals are nearby by looking at this ground?

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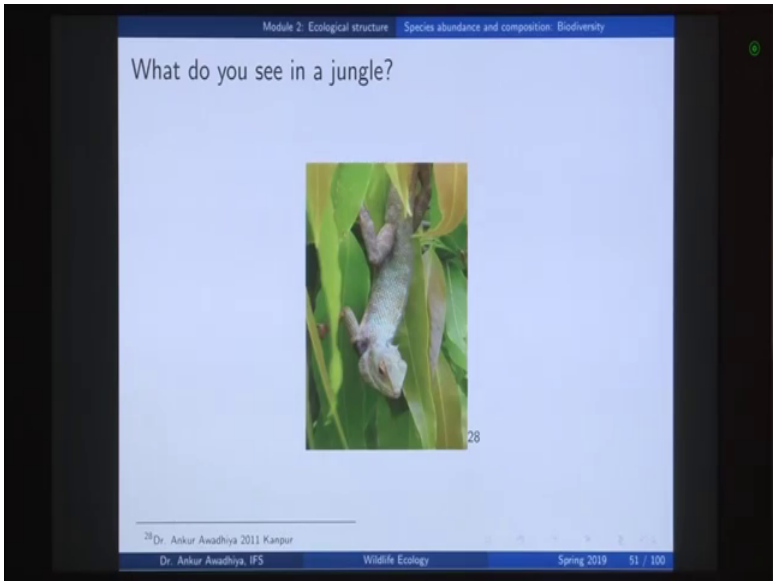

Then, if we look closely into the vegetation we might also observe some reptiles such as chameleons or some other members of the lizard family.

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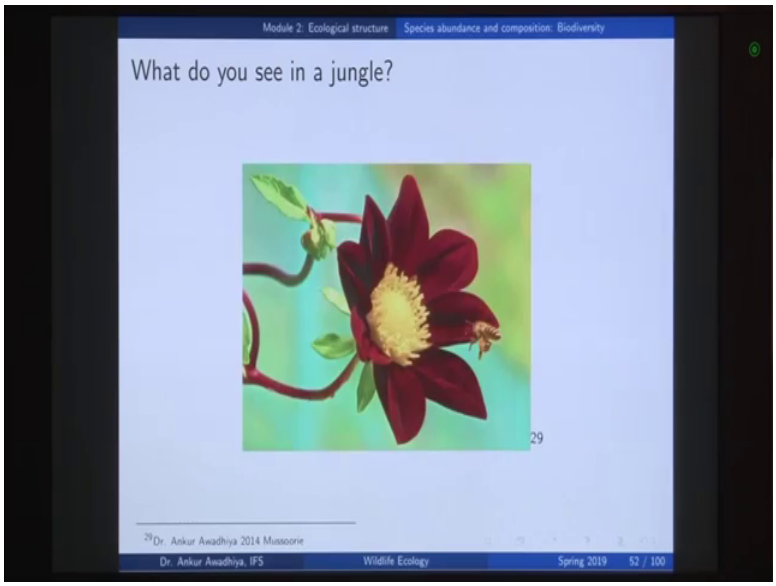

This area might also have some flowers and may be some insects that are pollinating in this area. So, for instance here we have a bee that is pollinating and if you look closely we will also observe some other body parts of the bee. So, in this case these are the pollens sacs in which it stores the pollen.

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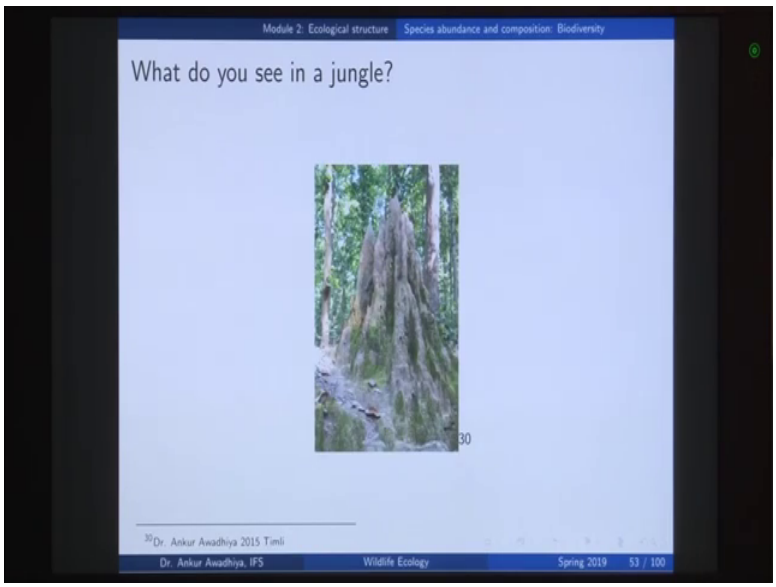

Then, we might observe some other inferences such as termite mounds. So, if there is a termite mounds. So, you also have termites in this area or things like fungi.

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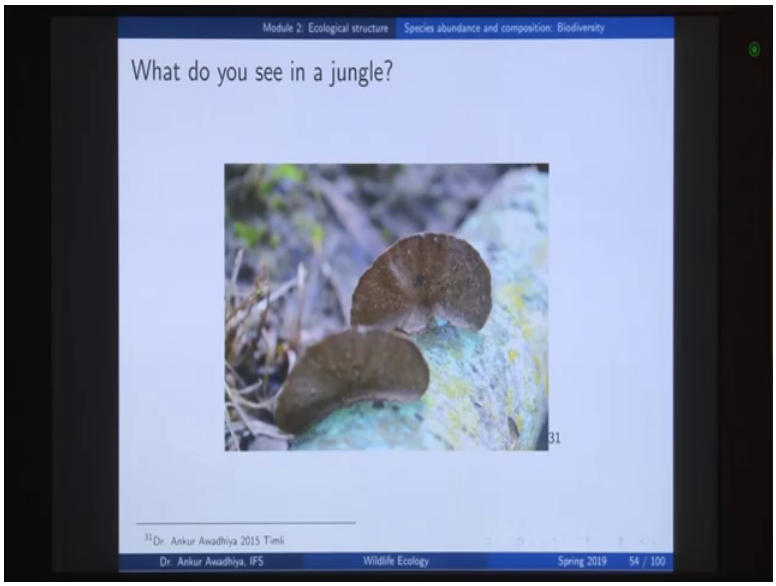

Now, fungi play a very important role in the forest ecosystem, because when there is any dead wood or there are dead leaves that are lying on the ground. So, they are also storing a number of nutrients inside. So, this dead log has a nitrogen inside, it has some phosphorous inside, it has some potassium inside may be some amounts of magnesium or iron is well and by decomposing these logs the fungi are able to release this nutrients back into the ecosystem. So, that, they can be made use of by some other organism. So, we will also observe some saprophytic organisms such as the fungi. They could be also be a number of bacteria in this a area or may be some other fungi that we are not able to look directly from (Refer Time: 07:26) I just what we can make an inference.

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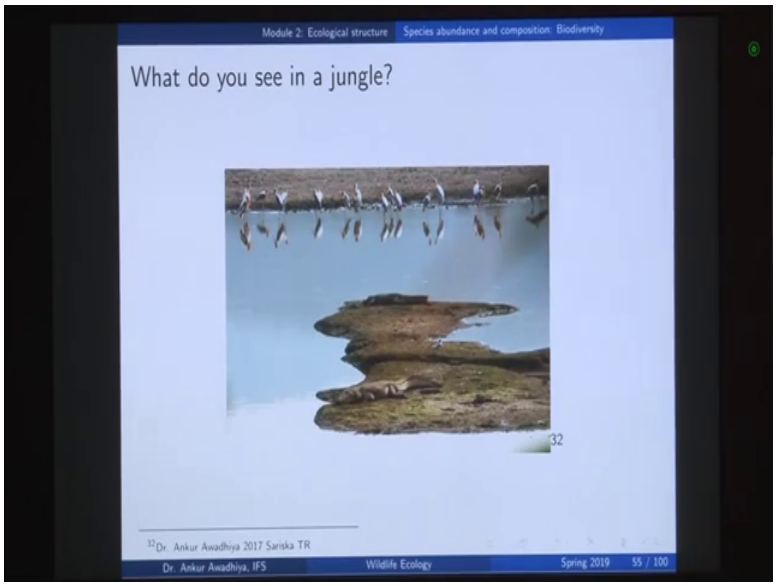

If, we go near a water body we might observe some reptiles such as [FL] or some birds that a will be seen near this area. In these water bodies there will be some fishes may be some frogs, may be some turtles.

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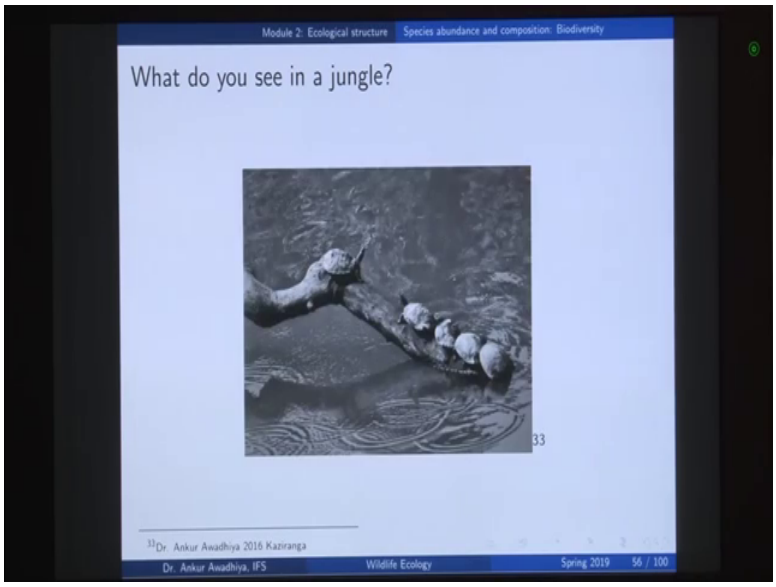

So, we might be able to see some Turtles or maybe we might not be able to see some turtle and they will also be a number of plant like forms that are found in this area.

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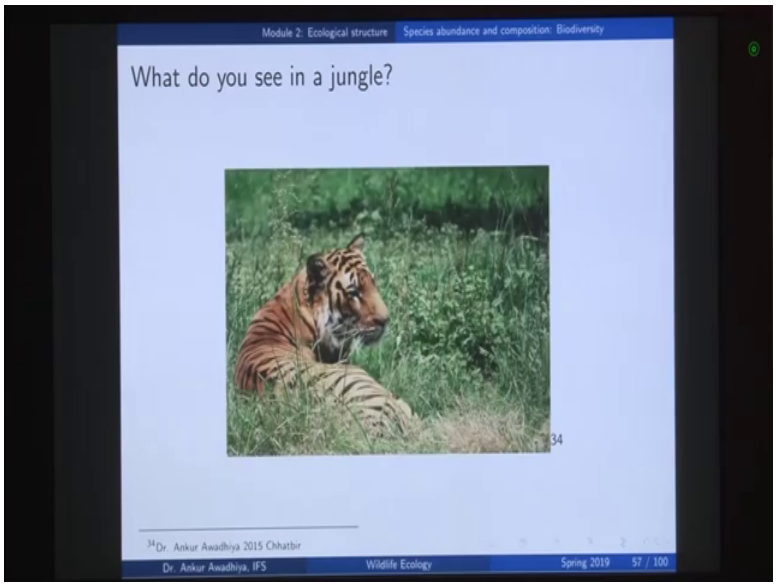

And, if we are lucky we will even see a Tiger somewhere.

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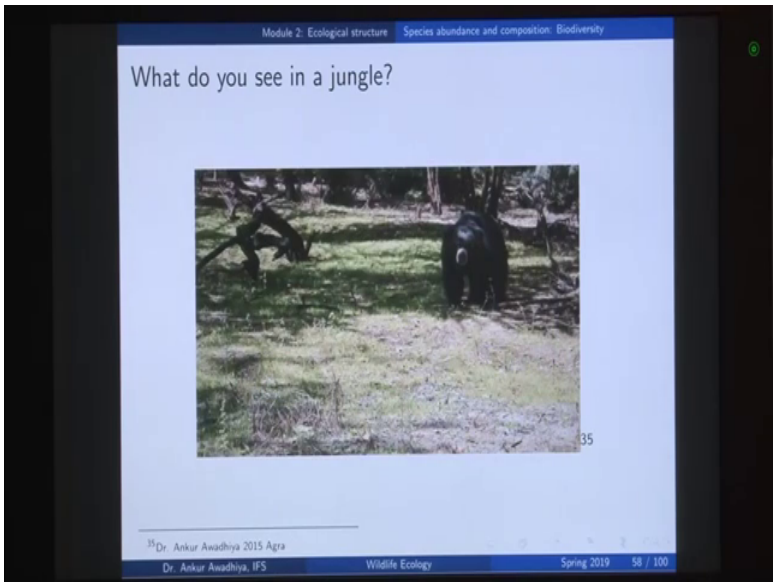

Or some Bears, or even may be some Elephants.

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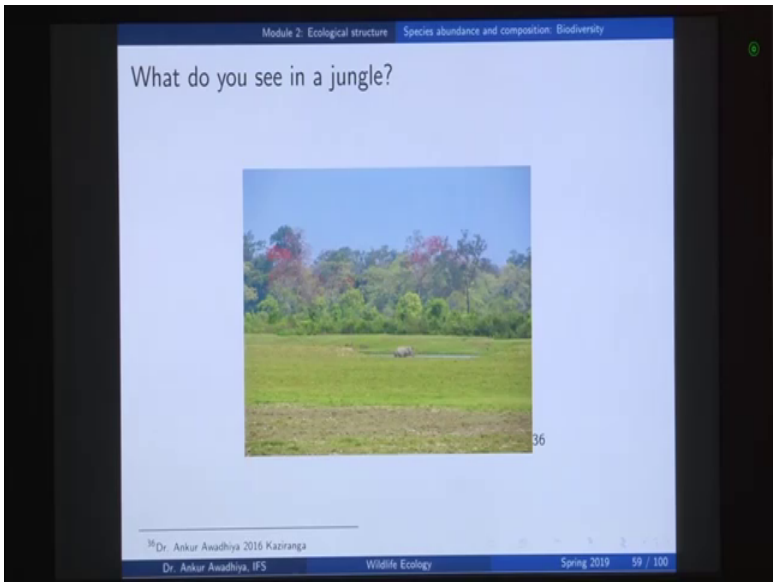

Now, the point is all of these are signs of biodiversity in this area, whether it is the Tiger, whether it is the Elephant, the plants, the trees, the bacteria, the fungi all of these are signs of biodiversity.

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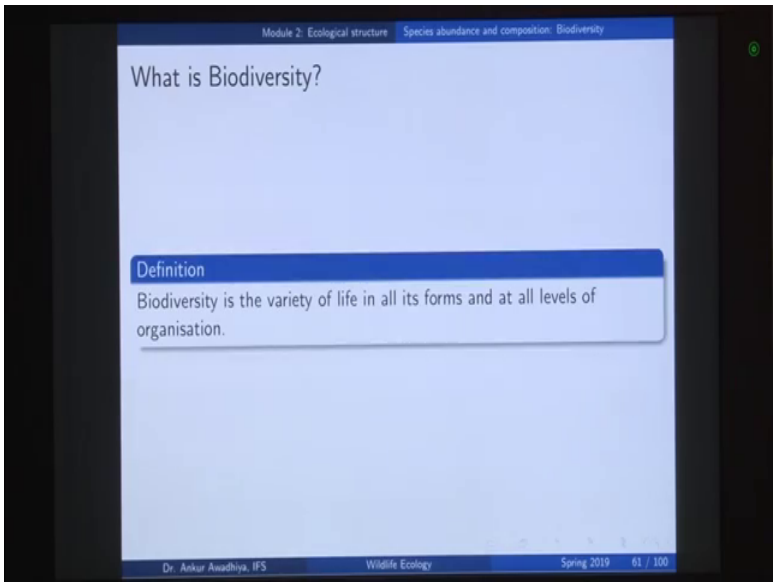

So, how do we define biodiversity? Biodiversity is the variety of life in all it is forms and at all levels of organisation. Now, in the last lecture we looked at the different levels of organisation that are found in the nature and biodiversity refers to the variety of life. So,

variety of life is different kinds of life forms that have that we are seeing in all it is forms and at different levels of organisation.

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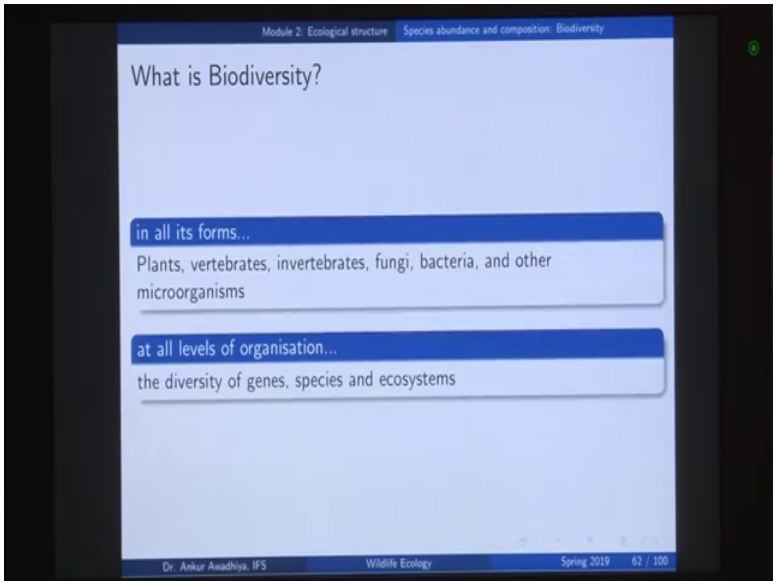

So, when we say in all it is forms it includes plants, vertebrates, invertebrates, fungi, bacteria, and other microorganisms. And, when we say at all levels of organisation, we can say diversity at the levels of genes, diversity at the levels of species, diversity at the level of ecosystems, or we might even look at diversity at some other level of organisation. Now of these 3 are the most are considered to be the most important. The genetic level biodiversity the species level biodiversity and the ecosystem level biodiversity and we will have a look at it in greater detail.

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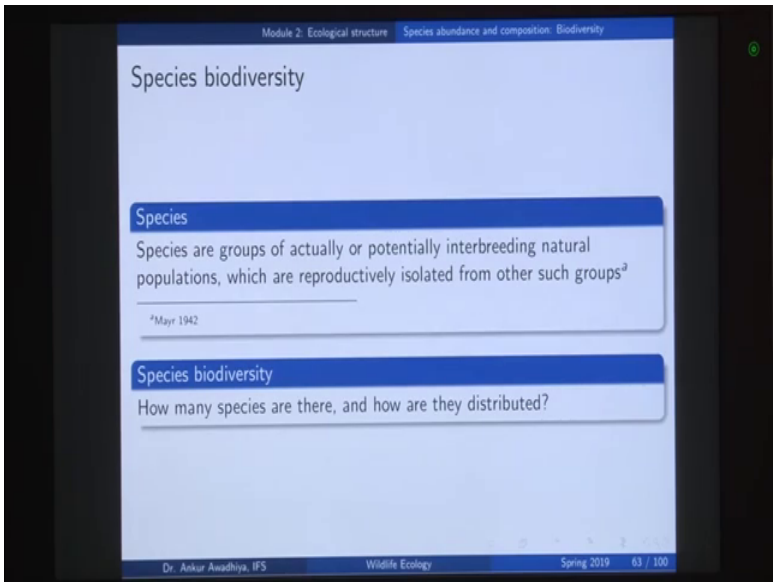

So, what do we mean by now species as we know a groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups. Now, when we say actually interbreeding. So, for instance if we consider the chitals of kanha they will be interbreeding amongst each other.

So, they are actually interbreeding a natural population. But, if we consider the chitals of kanha and the chitals of Rajaji so, both of these are not interbreeding with each other. Why, because one is there in Madhya Pradesh and the other population is there in Uttarakhand, but they are potentially interbreeding natural populations. Why potentially interbreeding? Because, say if you take a chital from rajaji and take it to kanha and try to mate it with the chitals of kanha, they will result in fertile offspring's. So, they are potentially interbreeding and they are natural populations. So, species are groups of actually or potentially interbreeding natural populations and these groups are reproductively isolated from other such groups.

What do we mean by reproductive isolation? So, for instance you have a species that is called chital, you have another species that is called say tiger. If, you try to mate a chital with a tiger they would not be able to mate, or even if in extreme situations if we are able to (Refer Time: 10:55) them to mate they might not result in offspring, or they might even result in an offspring that is itself in fertile. So, this is meant by reproductive isolation.

So, they are reproductively isolated from other such groups. So, species are groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups. Now, species biodiversity asks how many species are there and how are they distributed?

So, the number and the distribution.

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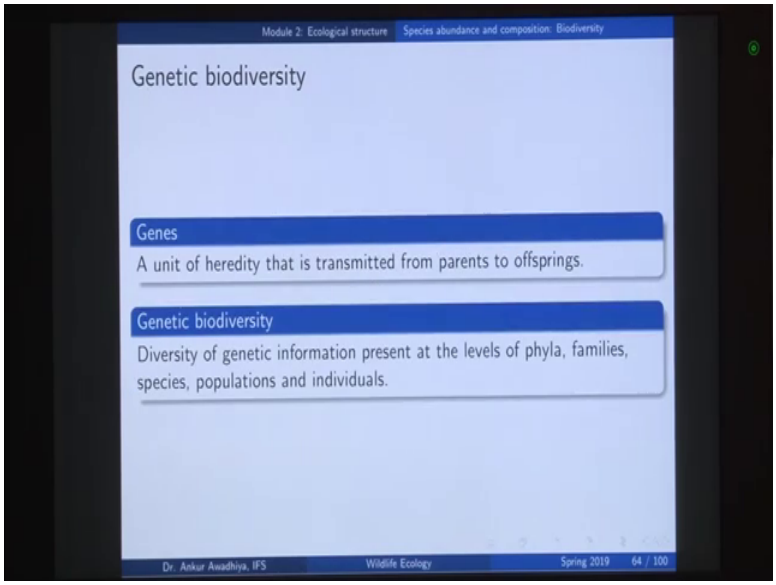

The genetic biodiversity on the other hand ask the diversity of genetic information that is present at the level of phyla, families, species, populations, and individuals. Now, genes as we know are units of heredity that are transmitted from parents to offspring's. So, we might have a gene for say eye colour, a gene for hair colour, a gene for skin colour, a gene for tallness and so on.

So, when we consider all these different genes genetic biodiversity ask what is the diversity of genetic information? So, for instance if you consider the diversity of genetic information at the level of a population. So, for instance consider a population of chitals in kanha. So, how different are these chitals from each other genetically, are all these chitals having the same gene for height or are they having different genes for heights. Are they having or different a leads for the height or are they having the same coat colour or are they having the same eye colour and so on.

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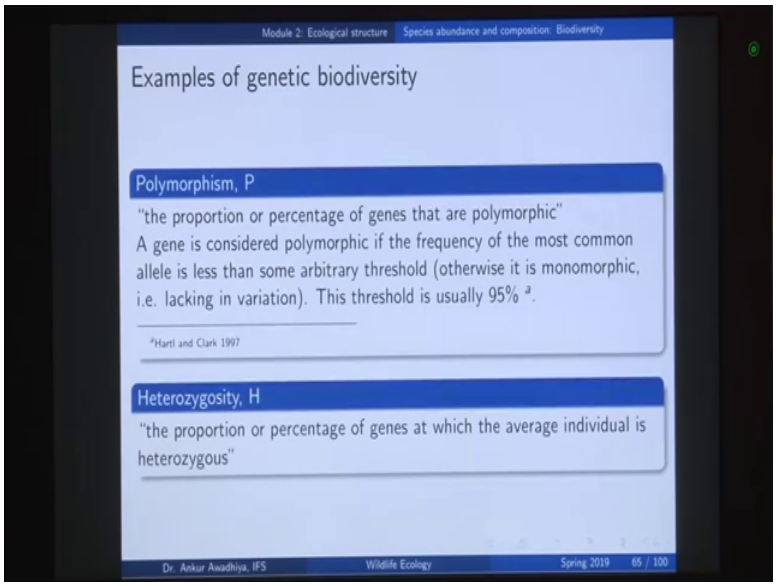

Now, examples of genetic biodiversity include Polymorphism and Heterozygosity. Now, polymorphism is the proportion or percentage of genes that are polymorphic. Now a gene is considered polymorphic if the frequency of the most common allele is less than some arbitrary threshold and this threshold is generally taken to be 95 percent.

Now, what do we mean by this?

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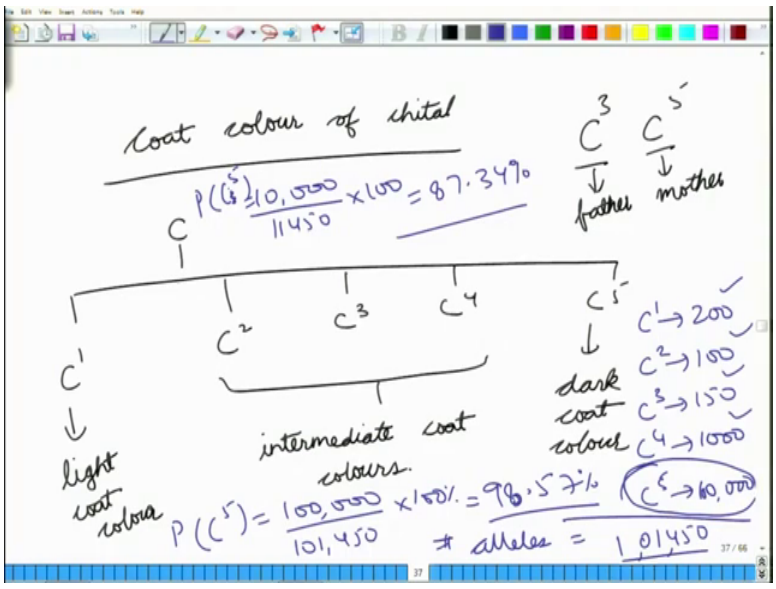

Now, let us consider the coat colour; the coat colour of chital. So, let us say that it is coded by a gene called C. Now, this gene C might be available in a number of forms. So,

we might have a C 1 allele that codes for a very light coat colour. And, we might be having say C 2 C 3 C 4 and C 5 and C 5 coats for a very dark coat colour. And, these 3 are coating for some intermediate coat colours.

Now, any particular organism or any particular individual of chital in this population will be having 2 alleles for the same gene C. So, basically it will be having 2 Cs one is coming from it is father and the second one is coming from it is mother. Now, it is possible that you have C 1 and C 1, C 1 coming from father and C 1 coming from mother or you could have C 1 and C 5 or say C, C 3 and C 5 and so on.

So, if you consider all the individuals in this population and you figure out what alleles are there. And, then you do a counting of these alleles. So, it is possible that we might see that C 1 is present 200 times, C 2 is present 100 times, C 3 is present 150 times, C 4 is present 1000 times, and C 5 is present say 10,000 times. Now, in the case of polymorphism we will ask the question is this gene the gene for coat colour that is represented by C, it is polymorphic if the frequency of the most common allele is less than 95 percent.

Now, in this particular example how many alleles do we have number of alleles is 200 plus 1 300, 450, 1450, 11450. So, these are the total number of alleles that we have.

Now, what is the frequency of the most common allele? Here the most common allele is C 5, which is present in 10000 copies. So, the frequency is given by 10000 divided by 11450 into 100. Now, this is the frequency of the most common allele. Now, the question is it more than 95 percent or is it less than 95 percent?

So, if we do this calculation 10 000 divided by 11450 multiplied by 100, it comes to 87.34 percent. Now is this less than 95 percent the answer is yes. So, in this case we would say that this particular gene is polymorphic for this particular population. Now, suppose we had say in place of 10,000 genes we had it in 100000 genes. Now, what would be the total in this case?

So, we have 1450 101450. And, in this second example what should be the proportion of C 5. So, here the proportion of C 5 would be given by 100,000 divided by 101,450 into 100 percent. Now, if we do this calculation. So, we have 100,000 divided by 101450 into

100 we will get to a figure of 998.57 percent, which then would be greater than 95 percent.

So, in such a scenario we would say that this particular gene of coat colour represented by C is monomorphic for this particular population. So, essentially what we are asking is that if there is a gene that has only one allele. So, for instance if all these individuals for one and the same with regard to coat colour everybody just had C 1 C 1.

So, in that case this particular gene would be called monomorphic mono is one morpho is form. So, it has only one form which is C 1, but if we have more than one forms we then put a threshold is this threshold. So, when we have this threshold of 95 percent, we ask if the frequency of the most common allele is greater than this or less than this. Because for instance, if you have a population in which you have 1 lakh copies of say C 1 and say only 2 copies of C 2.

So, in that particular case we would say that even though we have 2 different alleles for this gene, but it is still monomorphic because more or less we can say that all the individuals are similar when it comes to the coat colour.

Now, the second thing that we ask in the case of genetic biodiversity is the level of heterozygocity. Now, heterozygocity is the proportion or percentage of genes at which the average individual is heterozygous.

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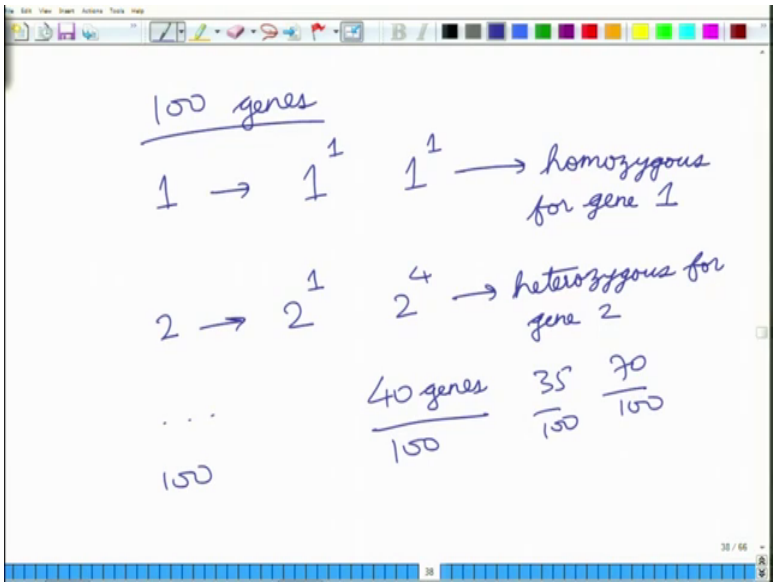

So, what we ask in this case is suppose in the case of chital we have 100 genes actually this number of genes is very large it say between 20,000 to 100,000. But, for an example it stick 100 genes. Now, heterozygocity ask the question what is the percentage of genes at which the average individual is heterozygous.

So, heterozygous means that suppose for gene 1 this gene was present in 2 every gene is present in 2 copies. So, suppose this was present as 1 1 and 1 1. So, in this case we would call it homozygous for gene 1. Now, in the case of gene 2 suppose it was present as 2 1 and 2 4. So, here we will say that it is heterozygous for gene 2. And, similarly we will move on till the gene till the last gene which is the 100 gene.

Now, in this case suppose out of these 100 genes there were 40 genes for which this individual was heterozygous. So, in this case 40 out of 100 genes it was heterozygous. Now, we take another individual for this individual it was say 35 out of 100, may be for another individual it was 70 out of 100 for which it was heterozygous. Now, heterozygocity would ask what is the proportion or percentage of genes for which the average individual is heterozygous.

So, we can average all of these values to get an idea of the level of heterozygocity that is present in this population. So, genetic biodiversity can be looked at (Refer Time: 21:07) these 2 examples polymorphism and heterozygocity.

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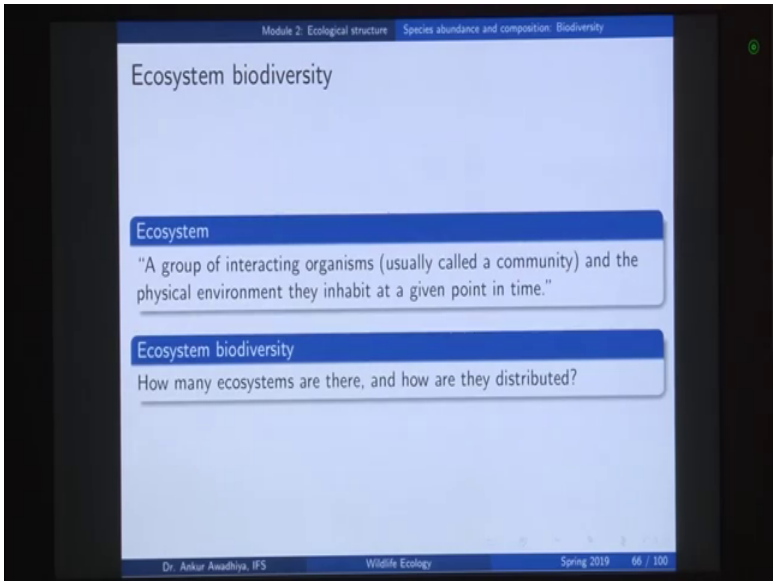

Next is ecosystem biodiversity. Now, ecosystem as we saw before is a group of interaction organisms or population or community and the physical environment they inhabit at a given point in time. So, you we have a group of different populations, that forms a community and to this community you add the abiotic element. So, the physical environment and you get the ecosystem. Now, ecosystem biodiversity ask the question how many ecosystems are there and how are they distributed?

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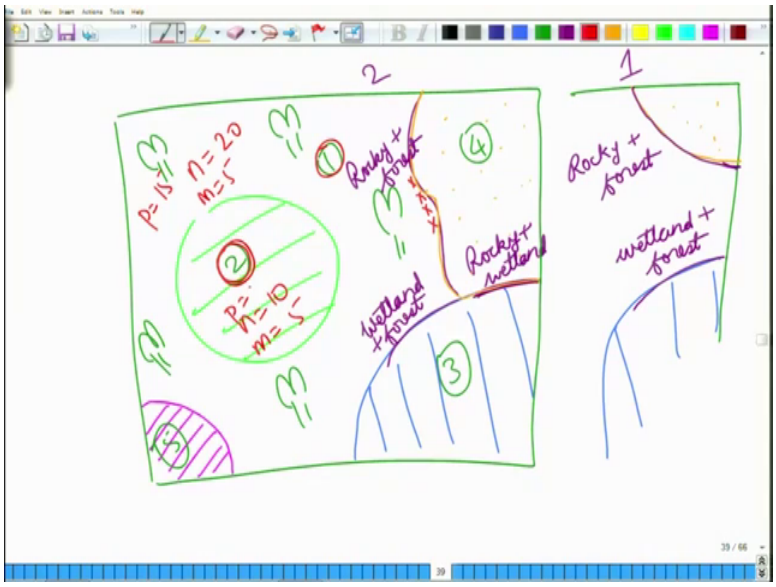

Now, what are the different kinds of ecosystems that we have that we can have in a forest? So, suppose this is our forest. Now, it is possible that the whole of this forest is comprised of trees. So, in which case we will say that it has only one kind of an ecosystem, but then it is also possible that this forest has this area that is a wetland, then it has this area which is a grassland, then this has this area which is a rocky outcrop; then probably you have this area which is very close to a reverend. So, it gives you a different kind of an ecosystem and rest of the area is comprised of trees.

Now, in this case we would say that this area is comprising of a forest ecosystem, a grassland ecosystem, a wetland ecosystem, a rocky outcrop ecosystem, and a river and ecosystem. So, in this case we have 5 different ecosystems. Now, ecosystem biodiversity is asking the question how many ecosystems are there. In the first example we had only one ecosystem.

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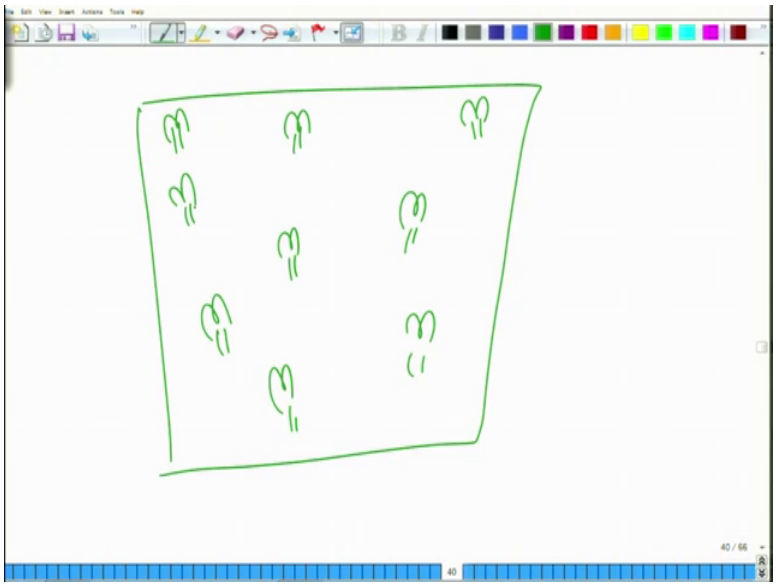

So, in the first example we only had this forest and the whole of the forest was comprised of trees. So, this is one ecosystem and this is another ecosystem. So, we can see very clearly that this ecosystem with 5 different smaller ecosystems is much more diverse as compared to the first case in which we have only one ecosystem in this area.

The second thing that it asks is how are they distributed? Now, why is distribution important? Distribution is important, because say in this particular example in place of having a scenario like this we had a rocky outcrop that moved like this. Now so, this is a rocky outcrop. Now, what is the difference that we get? Now, in the first example we had this rocky outcrop and here we had the water body.

Now, in this case let us look at the number of edges that we have in this is small portion only. So, we have this edge that is comprised of rocky plus forest and we have this edge that is comprised of wetland plus forest, but so, so let us call the situation 1 and let us call the situation 2. In this situation we have an edge which is rocky plus forest, we have this edge which is wetland plus forest, but now we have another edge which is this one, which is rocky plus wet land.

Now, by having such a distribution by having more number of edges we also increase the amount of biodiversity in this area why, because there might be some species that prefer living on the edges. So, for instance they could be a species that prefers living here. So, that it is able to venture into the forest. So, that it can get it is food, but when the

predators come it should be able to run into the rocky outcrop to save itself. So, edges have their own significance in the ecosystem.

Now, by having a distribution in which maximizes the edges that are possible we can maximize the biodiversity, which is why the ecosystem biodiversity ask this question not only how many ecosystems are there, but also how are they distributed?

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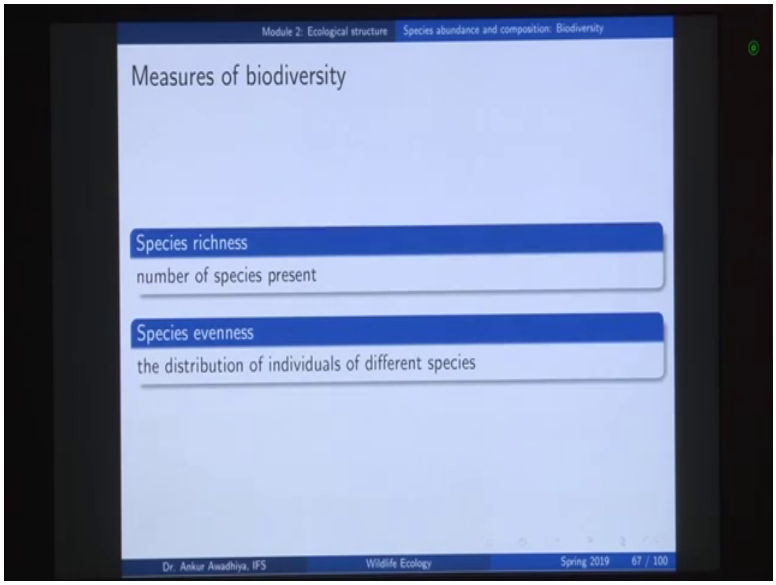

Now, out of these different up approaches of measure in biodiversity. The simplest one is the is looking at the species richness and the species evenness which is the species biodiversity. Why, because in the case of genetic biodiversity you have to look at individual genes that are present in the population, which is not only way technology intensive, but also very much cost intensive, but if you just went into the forest and looked at the number of species that are there.

So, they can just be looked with your naked eyes or may be with using a binocular or some microscope. So, it is the most easiest way of measuring biodiversity and so, this is the most widely used measurement of biodiversity. Now, species biodiversity also ask 2 questions; one what is the number of species that are present in your area and 2, what is the distribution of individuals of different species? Now, what do we mean by that? The first one is simple species richness is the number of species present in an area.

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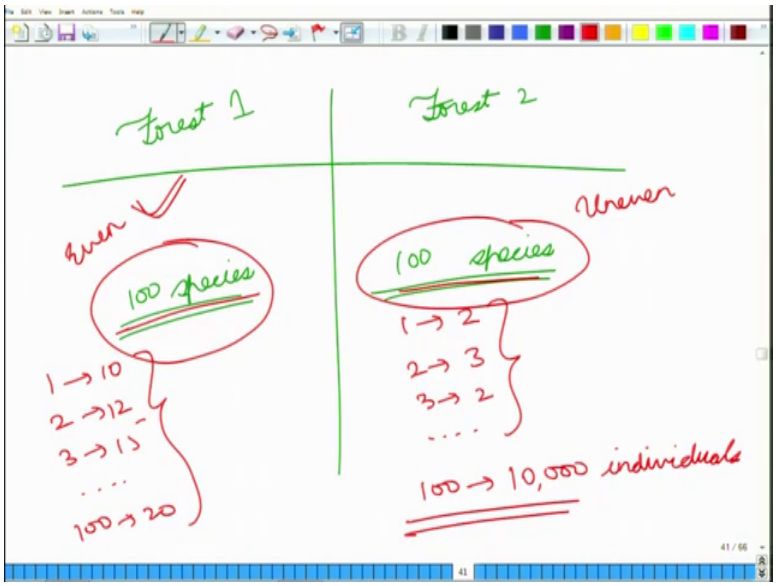

So, consider 2 forests. So, you have this forest 1 and you have forest 2. Now, say forest one has a total of 100 species and forest 2 has say 1000 species. Now, species richness ask the question how many species are present. So, in this case you have 1000 species here you have 100 species. So, we will say that forest 2 is much more biodiverse as compared to forest 1.

So, that is species richness the second thing is species evenness or the distribution of individuals of different species. So, for instance in this case suppose both the forest had equal number of species. So, let us have 100 species in forest 1 and 100 species in forest 2.

Now, the distribution of individuals of different species ask the question, how many individuals do we have of each species in both of these forests? So, in this case suppose species 1 has 10 individuals, species 2 has 12 individuals, species 3 has say 15 individuals, and so on till species hundred that also has say 20 individuals.

So, this is the level of distribution of individuals of different species that we have in forest 1. In the case of forest 2 suppose we have species 1 that has 2 individuals, species 2 has 3 individuals, species 3 has 2 individuals and so on, but there is one species that has say 10,000 individuals.

Now, in this case we would say that even though both the forest have the same number of species both have 100 species, but if we look at forest 1. So, in this case all these species have roughly equal number of individual. So, when you move out into the forest if you take any snapshot you might be able to see all 100 of these species. So, all these hundred species are distributed everywhere.

Whereas, in the case of forest 2 we have 99 species with very few number of individuals and one particular species that has 10,000 individuals. Now, if you move into this forest you would observe only species number 100, because rest of the species are so, few that that your system is overwhelmed with species number 100. So, in this case we would say that the species are not equally distributed or the in or the individuals are not equally distributed amongst different species.

So, when we ask this question what is the level of species evenness distribution of individuals of different species, we would say that even though this species richness is same in both these forest 100 species each, but this forest is much more even and this forest is very much uneven when it comes to evenness. So, when we have the same level of species richness we prefer an even forest. So, we will say that; the amount of biodiversity in forest one is much greater than the amount of biodiversity in forest 2.

Now, how do we know how many individuals are there in the forest?

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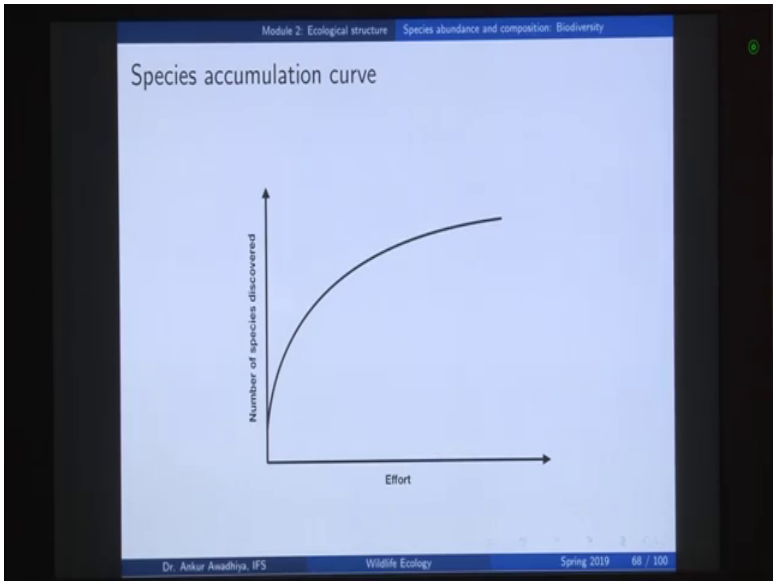

So, that brings us to a concept of species accumulation curve. So, how do you get to know how many species are there in a forest? Let us consider that we are considering the number of mammals that are found in a forest.

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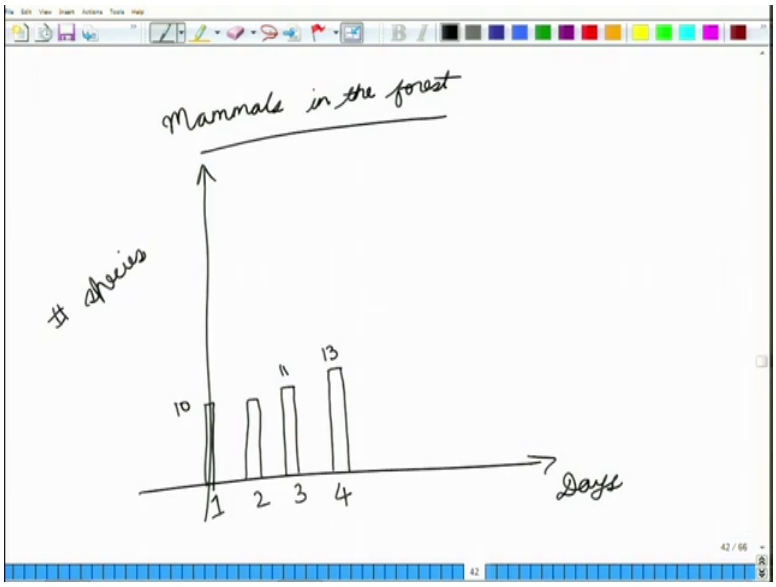

So, we are saying the number of mammals in the forest. So, you go into the forest and on the very first day suppose you saw 10 species, this is 10 species. So, you have the number of species and you have days. And, on everyday suppose you are venturing out into the forest and you are spending say 6 hours in the forest, and you are looking at different mammals that you can see in this forest.

So, on the very first day you will be able to see the maximum number of animals, because these are the most common animals. So, you venture out into the forest and you saw say chital or sambar or langur or maybe some macaques. So, these are the animals that are very easily seen probably on day 2 you did not find any new animal. So, the number of species remains the same. So, this is day 1, this is day 2, on day 3 you got a bit more lucky and you saw a tiger.

So, on day 3 your number of species increased from 10 to 11, because you saw a tiger, on day 4 it is possible that you also saw 2 other animals. So, it increased from 11 to 13 may be because you saw a leopard and you also saw an Elephant, but then with time as you are observing more and more number of species it will reach to a point of saturation.

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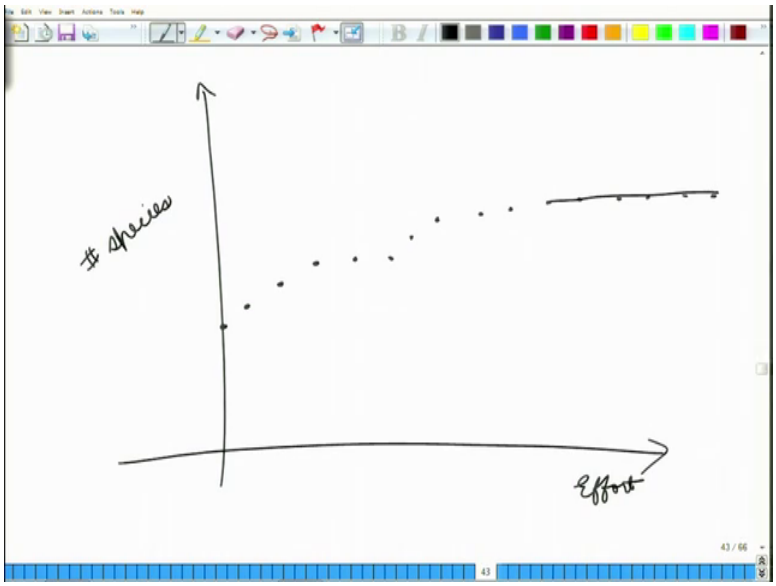

So, when we draw and the number of days and the number of hours that are spent goes by the name of effort. So, we are drawing the number of species verses the effort. So, on the very first day you will see the largest number of species, then this curve would increase with time it might also remain constant for some days, but then it will again increase as you are going to see more and more number of individuals, but then after a while it will become flat. Because for so, many days you are not seeing any new individual.

So, here we see that on the first day we saw so, many individual then every day we are seeing some new individuals, but then after a while it is reaching to this level of flatness. And, once we reach this stage we say that this is the number of species that are found in this area. So, we draw a straight line and we see that this is the number of species that we have in this area. Of course, the number of species may be a bit more or a bit less, but more or less this is the number of species that we have.

So, this is a way in which we get to this species richness of an area. Now, after richness the next thing is to compute the species evenness. So, for all of these species we will keep a note of how many individuals did you observe for this particular effort, and then we would compute it in this way.

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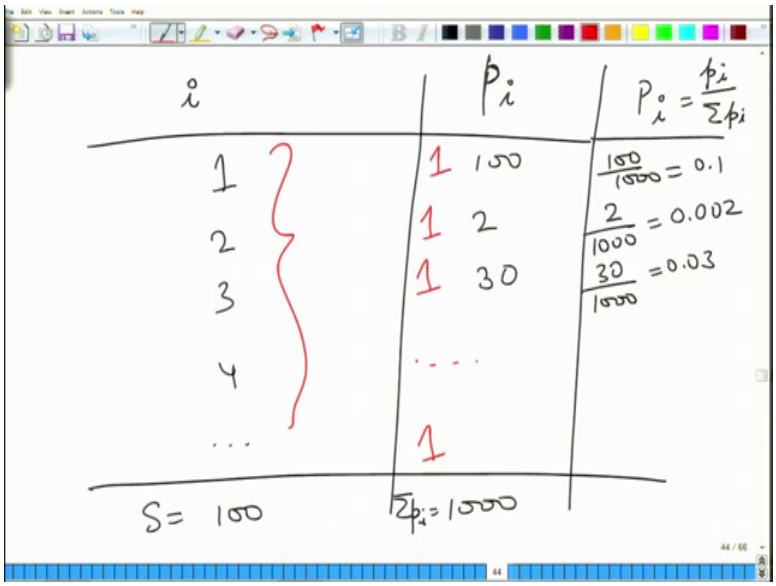

So, say you have the ith species and you have the population of the ith species so, 1 2 3 4 and so on. So, suppose for the first species you saw 100 animals for 2 the second species you only saw 2 animals, for species 3 you saw 30 animals and so on. So, you will make the stable and once that is made we measure biodiversity using different indices.

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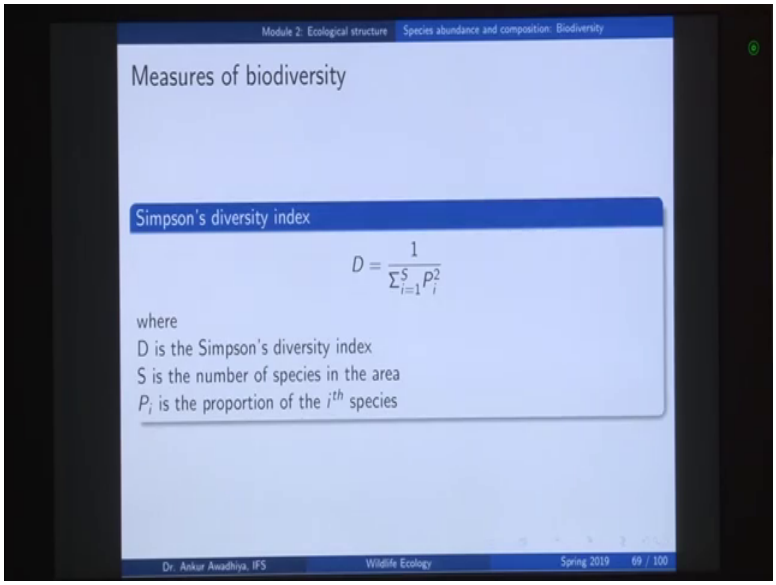

Now, the first index goes by the name of Simpsons diversity index and is given by the symbol D, which is equal to 1 over sum i is equal to 1 to S and P i square. Now, this it is call it as small p i and from this we will compute a capital P i. Now, here we have total

number of species. So, S is the last species that we have let us say we have 100 species that are found in this area. And, the total number of individuals that we found in this area is 1000. So, this is the sum of all the p i's is 1000.

Now, capital P i is computed as small p i divided by the sum of small p i's. So, in this case because this is 100 so, you will have 100 divided by 1000 is equal to 0.1. In this case you will have 2 divided by 1000 is 0.002 here you will have thirty divided by 1000 is 0.03 and so on.

So, here we are computing the p i's. Now, in the case of the Simpson diversity index you have one divided by the sum of P i square. So, in this case you will have P i square. So, let us draw it again.

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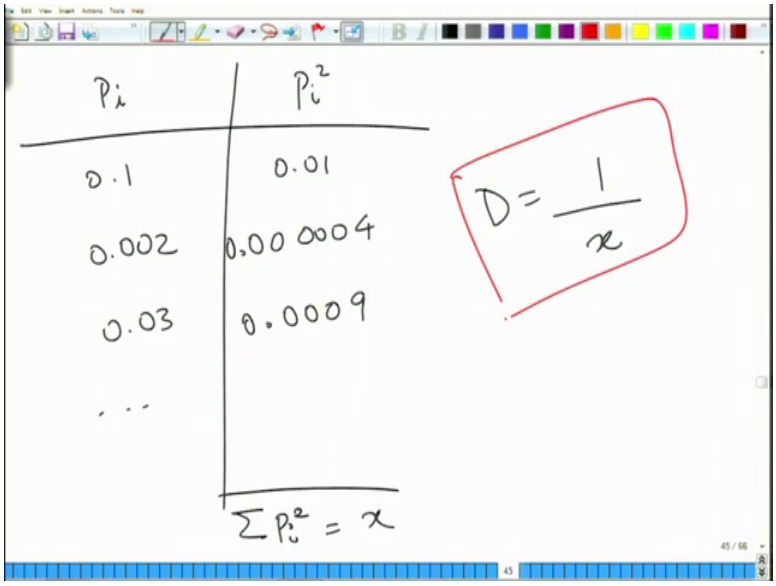

So, here you had P i. So, P i was 0.1, 0.002, and 0.03 and so on. So, you do a P i square and you get 0.01 and then this will be 412345 this will be 9 and so on. So, here you are having the P i squares. Now, you do a sum of all the P i squares and you will reach to a value of x and then D is given by 1 divided by the sum of all the P i square or the sum of or this value of x.

So, this is the measure of biodiversity that is given by the Simpsons diversity index. Now, D is the Simpsons diversity index, S is the total number of species in the area and P i is the proportion of the i th species in this area.

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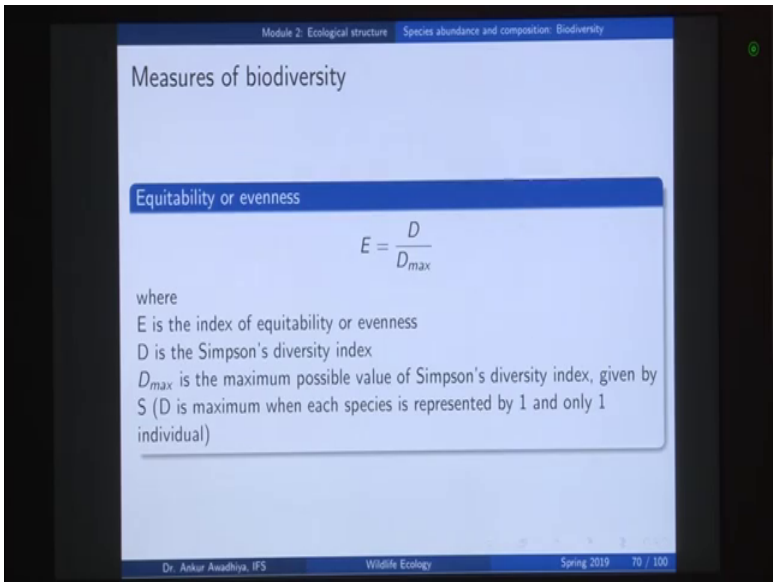

Now, from this D we get to a value of evenness. Now, evenness or E is given by D divided by the maximum value of D or D max.

Now, evenness is maximum if for all of these species for all of these species, you had the same number of individuals or best if you had only one individual of all the species. So, for instance in this case species 1 had only one individuals, species 2 had only 1 individual, species 3 had only 1 individual and so on till species number 100. If, that is the situation so, mathematically the value of D will become maximum and when you divide D by the maximum value of D you get the equitability or evenness value of the Simpsons diversity index.

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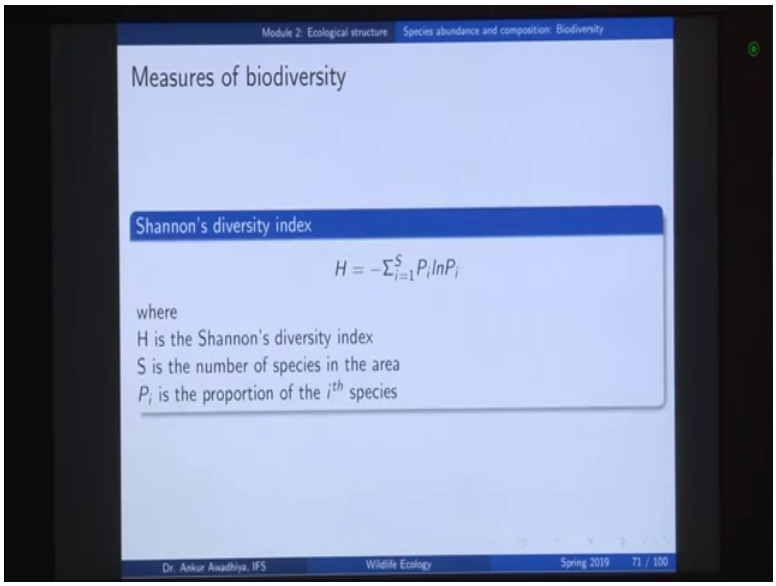

Another, index that is used is the Shannon diversity index. Now, in the case of Shannon diversity index you have it is minus sum over I from one to the last number of species that is i is equal to 1 to S. And, here you have P i log of P i in this log is the natural logarithm which is log to base E. So, once you compute this value this is the (Refer Time: 39:30) diversity index.

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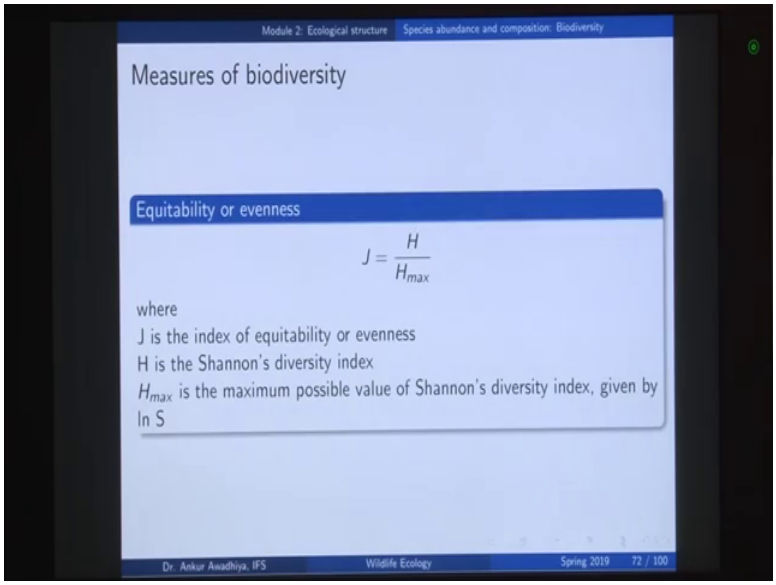

And, here also you can get to an evenness value by H divided by H max. Now, these formulae do not have to be remembered for the purpose of this course, this is just to give you an indication of how this biodiversity is actually measured in the field.

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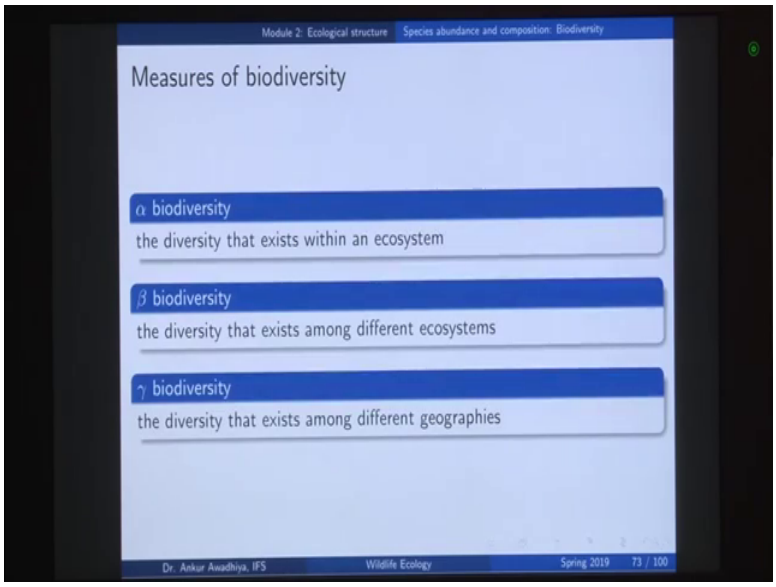

Now, from here we move to the next concepts of biodiversity. We have geographically we can have 3 values of biodiversity alpha beta and gamma. Now, alpha biodiversity is the biodiversity that exists within an ecosystem. So, in our forest so, this is our forest and in this forest we are having 5 different ecosystems. So, the first ecosystem is the forest, the second is the rocks, the second is the grasslands, the third is the wetland, fourth is the rocks and fifth one is the reverend ecosystem.

Now, alpha biodiversity will ask the diversity that exists within an ecosystem or for instance if you are looking at alpha biodiversity in terms of species the richness, how many number of species do we have in the forest ecosystem, or the trees ecosystem. How many number of species do we have in the grassland ecosystem? So, suppose here you have the number of species is 20 here you have the number of species is 10.

So, alpha biodiversity is asking the question what is the biodiversity that exist within each and every ecosystem. Beta dive diversity on the other hand ask what is the diversity that exist among different ecosystems. So, for instance it is possible that out of these 10 and 20 species, there are say m number of species say 5 species that are common between both of these. So, there are only P number of species that is here you have 15

and here you have 5 species that are different between both of these ecosystems. So, beta diversity ask the question what is the diversity that exists among different ecosystems? And, gamma biodiversity takes it even further to ask; what is the diversity that exists among different geographies which are very far from each other.

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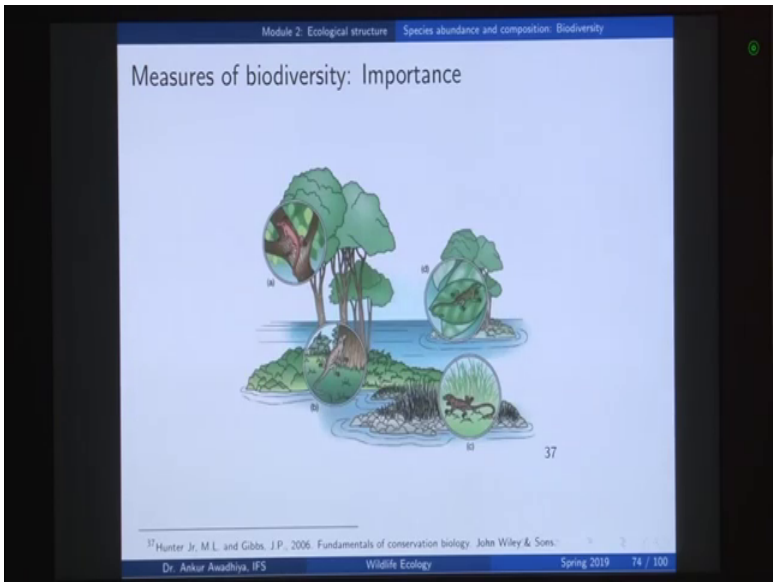

Now, to given example of alpha beta and gamma biodiversity here is a field situation. So, you have 2 islands; on the first island you have a patch of trees and a swampy area and on the second island you have a patch of trees. Now, here we are looking only at the lizard population that is there. So, this swampy area has one species of lizard this patch of trees has got 2 species of lizards one lives on the grasses and the second one lives on the trees, and on this island we have another species of lizard that is found.

Now, when we ask about the alpha biodiversity here we have 2 species of lizards, here we have one species of lizard and here we have one species of lizard which is the alpha biodiversity. Now, if for instance we try to increase the alpha biodiversity of this particular ecosystem or this particular island by draining of this swamp and generating a a piece of woodland in this area. So, in that case this species would be lost, but we would be getting 2 species in the same area.

So, in this case the alpha biodiversity would increase from 1 to 2, because now we only have one species and if you drain out this swamp and do a a copy paste of this area you will get 2 species, but if you look at the beta biodiversity. So, currently between these 2

ecosystems we are having 3 species 2 here and one here, but when we replace this swamp with this forest land we will only be left with 2 species or to put it as in image.

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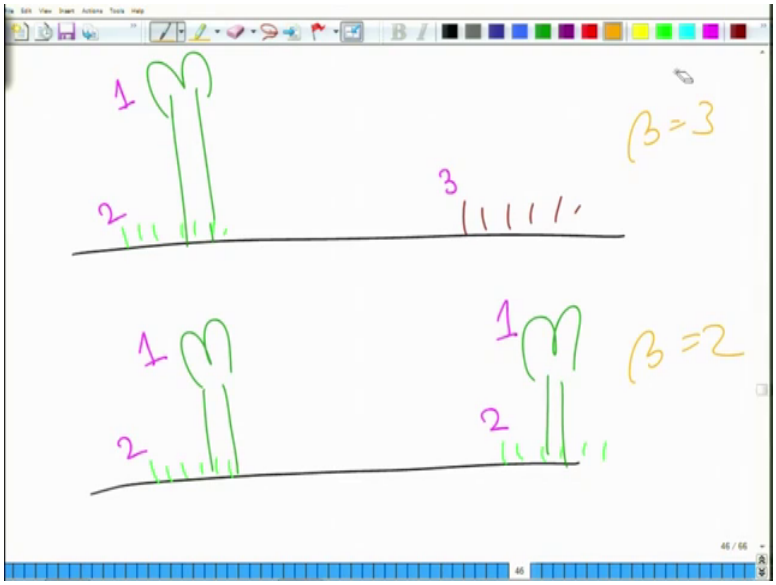

In the first case we have these trees and we have the grasses, and on the other hand, we have some swamps. In the second case we would drain off the swamp and we would have trees here and trees here and we would have grasses here and we would have grasses here, but in the first case we had a species 1 here, a species 2 here, and a species 3 here. In this case we would have species 1 here and species 1 here, species 2 here and species 2 here.

So, if we look at the alpha biodiversity. So, here alpha is 1 here alpha is 2, because for this particular region the swampy region you have shifted from one species to 2 species, but if we look at the beta biodiversity here beta is 3 whereas, here beta is only 2 because here you only have 2 species that are there on this island when we are looking at the beta biodiversity. So, it is important to look at biodiversity at different levels of organisation.

Now, we make use of all this information to decide where to concentrate our conservation efforts.

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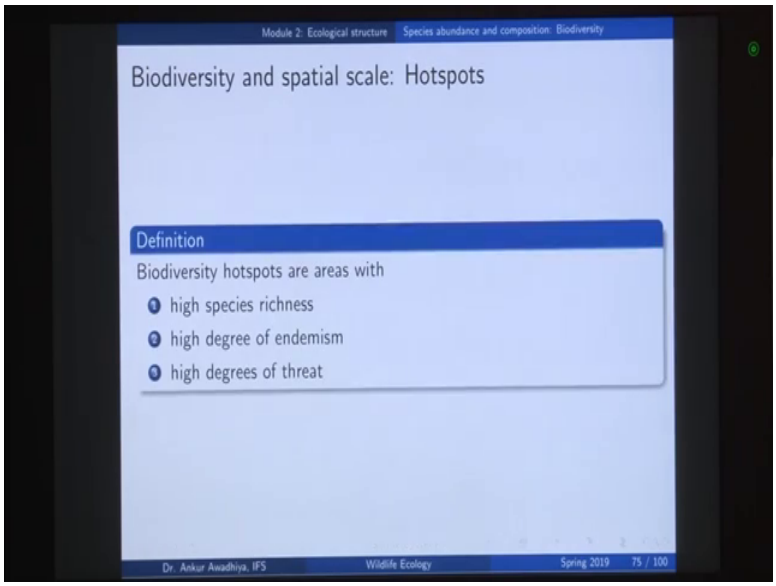

So, we look we define some areas as biodiversity hotspots. Now, biodiversity hotspots are areas with high species richness. So, they have a line number of species a high degree of endemism. So, endemism means that these species that are found in this area are not found anywhere else. So, these areas are very are providing a very typical ecosystem or a distinctive ecosystem for these species that are found here.

So, because just distinctive ecosystem is not found anywhere else so, this area has a high degree of endemism and also a very high degree of threat. So, a high degree of threat would mean for instance if we have a new disease that is taking over the individuals of these areas. So, for instance in the case of South America we have a fungal disease called the (Refer Time: 46:07) disease that is exterminating the populations of frogs.

So, a number of species of frogs from they from that area are getting extinct. So, we will see that that do's spots in South America have a very high degree of threat or for instance let us consider the equatorial rain forest. Now, a number of equatorial rain forest have been cut off to gather timber, or may be to create some settlements, or may be to construct some roads, or to have mendles to by converting those areas into mining areas. So, there again because these ecosystems are getting destroyed we will say that they have a high degree of threat.

Now, biodiversity hotspots will be areas that have all 3 of these. So, they have a large number of species these areas are providing such ecosystems that these species thrive

only in these areas they are not found anywhere else. So, they have a high degree of endemism and they also have a high degree of threat.

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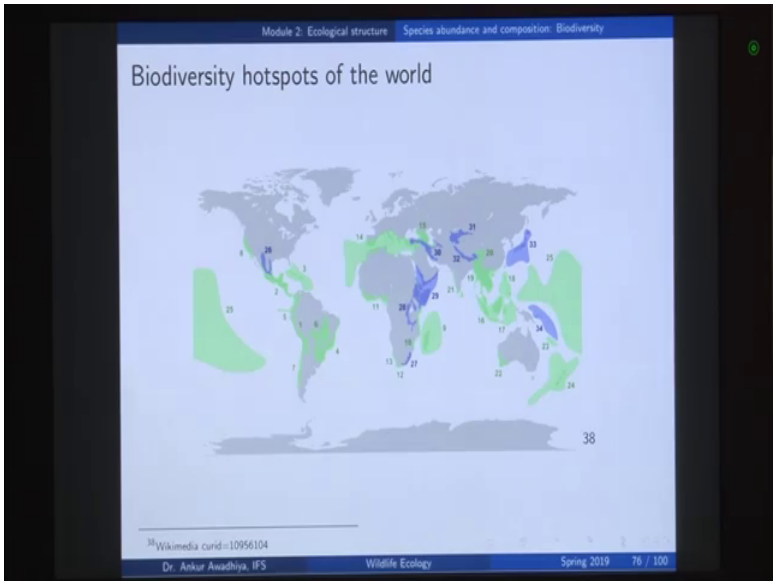

So, once we do that we will observe that there are certain areas that require a larger degree of protection as compared to some other areas. So, for instance in the case of India, if you look at the Western Ghats. So, Western Ghats are a biodiversity hotspot why, because they have a very large number of species. These species are not found anywhere else for instance some frog species that have been discovered in the silent valley national park of Kerala are not found anywhere else in the world.

So, those species would be sent to be extremely endemic to those areas. And, these areas are also having a large amount of threat, because people want to chop of the trees here and convert these areas into plantations. Because, these areas are also very good areas for say coffee plantations or for say rubber plantations. So, in this case these areas would be classified as biodiversity hotspots and we would need to a focus more attention into these areas.

Now, in this lecture we had a look at the ecological structure in terms of biodiversity. So, we looked at species abundance and species distribution and species composition of different areas. So, we define biodiversity as the amount of variety that exists in different life forms in different forms and in different levels of organisation.

We defined genetic biodiversity, we looked at species biodiversity, we looked at ecosystem level biodiversity, and we also looked at alpha beta and gamma biodiversity, which is biodiversity within an ecosystem biodiversity between 2 ecosystems and biodiversity between 2 different geographies. And, we also had a look at how to determine this species richness and this species evenness of an area, by looking at the species accumulation curve and also by looking at the number of individuals that are present for every species.

And, to concentrate all this information into one index, we can develop the we can make use of the Shannon index or the Simpson index, which gives us a snapshot view of the amount of biodiversity that is present in an area, in terms of the species richness and in terms of the species evenness.

And, from that we moved on to the biodiversity hotspots which are areas which have a very large number of species or a large species richness. They have a high amount of endemism which is which means that those species are only found in those areas they are not found anywhere else. So, if we lose those areas we will lose those species forever. And, 3 these areas also have a high degree of threat because people want to divert these areas for some other applications, or probably because these areas are suffering from diseases or maybe they are suffering from heavy floods or maybe forest fires and so on.

Now, these areas which are defined to be biodiversity hotspots are those areas whose ecosystems require a larger degree of protection. If we wanted to conserve the wildlife in this area. So, that is all for today.

Thank you for your attention [FL].