Conservation Geography
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Module - 8
Conservation of biodiversity
Lecture - 22
Threats to species

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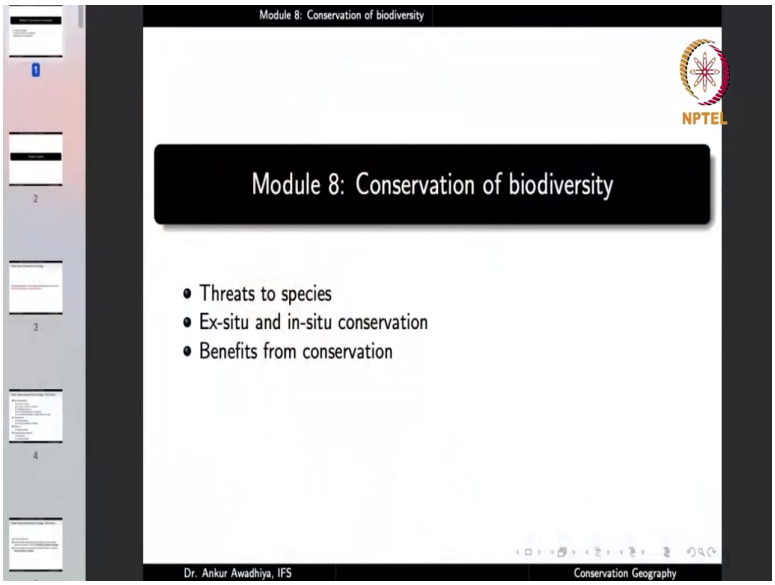

Namaste! In the last lecture we looked at biodiversity, which is the variety of life in all its forms and at different levels of organization. Today we begin a new module, which is conservation of biodiversity. In this module, we will have three lectures, threats to species in which we shall discuss the kinds of challenges that different biodiversity are facing on this planet.

Now, a large fraction of these threats are because of the impacts of human beings, the anthropogenic influences. So, for instance if we remove forests, if we divert forests, for say agriculture or for setting up of buildings or industries, then the habitats of the species are lost that is a major threat.

So, in this lecture, we should look at the different threads that are there to different species. In the second lecture, we shall have ex-situ and in-situ conservation, ex-situ refers to conservation that is off site, in-situ refers to conservation that is on site. So, you can perform conservation of species conservation of biodiversity either in the habitat where they are being found.

For instance, if you preserve or conserve a forest, where animals are found, if you convert that into say a national park or a wildlife sanctuary and manage it in such a manner, that the species are protected and conserved, then we will call it an in-situ conservation, conservation on the site where the species are found. On the other hand, if you take out certain species from the natural habitats, place them in zoos and conserve them that is protect them and see to it that they are able to increase in their numbers through reproduction.

In such cases, we will say that this is an ex-situ conservation, conservation off site not in the place where the animals are naturally found. So, in this lecture, we shall look at ex-situ and in-situ conservation, the different forms of ex-situ and in-situ conservation. And why are we doing this conservation because it provides us with certain benefits. So, in the third lecture, we shall look at benefits from conservation.

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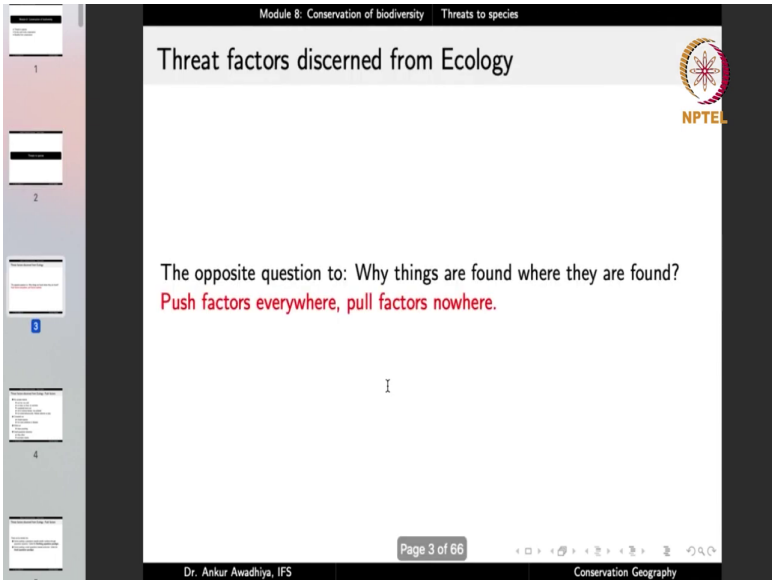

So, let us now begin with threats to species. What are the threats to species? Now, threats to species are the opposite question to why things are found where they are formed. That is when we talked about biodiversity. And when we discussed that camels are only found in deserts. Because through the process of evolution, they have now developed those traits, those characteristics that make them best suited for a desert habitat. So, they have a good amount of storage of food and water in their bodies.

They have padded feet that permit them to walk on the deserts, they have long eyelashes that protect their eyes, from the sand, and so on. Now, when you have an animal that has these characteristics, and if the deserts are lost, there is no desert that remains then where will this animal go? This animal cannot live in polar areas because it does not have the characteristics that would permit it to live in polar areas. In the case of polar areas, we require a complete different set of adaptations, something that is found in the polar bear.

So, you will require long fur a camel does not have long fur, you would require ability to blend with the surroundings that is white in colour. But a camel is yellow in colour yellowish brown. So, the camel will be very easily spotted by the predators that are found there. It would require adaptations to gather food that grows in the polar areas that is ability to feed on things like algae or lichens whereas the camel is adapted to feed on thorny bushes.

Now, it does not have the thorny bushes in the polar areas. Whereas it does not have the adaptations to feed on those organisms that are found in the polar areas. So, in that case, the ability of camel to survive would depend on the availability of the habitat to which it is adapted. So, the camel lives in the desert areas because it has pull factors from the desert,

because it has those adaptations that permitted to live without any major competition in the desert areas.

If the camel move to say, an evergreen forest or say a deciduous forest, then though it will be able to get its food. But it will not be that efficient in getting that food, it will not be that efficient in running away from the predators that are found in the forests. And so, in no time it will get hunted out. So, it does not live in the forest areas because it is getting pushed from the forest areas because there are certain species that are living in the forest areas that are either more competitive than camels.

So, they are able to displace it out or that are predatory species that are going to hunt it out. So, it will not be found in the forest areas because it is getting pushed from there. Whereas it gets a pull factor from the deserts because in the desert, it does not have any competition. So, the major threat that organisms face today is that they are having push factors everywhere and pull factors nowhere.

Why? Because we are reducing, we are removing those habitats where different organisms are found. In the case of deserts, we are doing a lot of mining in the deserts, mining for sandstone, mining for marble, mining for sand, mining for petroleum, and a lot of other things. In a large number of cases, we are also converting deserts into farmlands by bringing in water from outside.

So, we have developed an extensive canal system. And once you have the canals you have a good availability of water. And so now the habitat changes. Now, you have lush green grasses there, you have the agricultural crops and the camel is not able to compete in those situations it was very well able to compete in a desert but it is less able to compete in more equitable conditions.

Then, if we talk about the species that are living in the forests, we are diverting forests like anything, we are diverting them for agriculture industry for making habitations, for mining purposes, for setting up of roads, so on. If we talk about the coastal areas, there are a large number of species that live on the coasts. But then we are converting coasts into beaches. We are setting up huge concrete sea walls.

Now, these sea walls are to protect the coastal areas, the buildings that have been built in the coastal areas. But once you have a sea wall, how will animals come to this area to say lay eggs. In the case of river habitats, we have already observed that in a large number of cases

we are over exploiting the water resources, we are pumping out water and taking it to other places so that now less and less amount of water is available for the animals that live there.

We are mining away the sand that is there on the beaches. So, in these situations how will animals such as gharial or crocodiles or turtles lay their eggs, we are doing an over exploitation of fishes by doing extensive fishing. Now, if you take out all the fishes from the water, what will the predatory animals that live in water feed on. We are converting the rivers into ponds by making dams.

So, we are converting a flowing system of water into a stagnant system of water and both have very different characteristics. So, the animals that live in the free-flowing rivers, now they have got nowhere else to go. So, essentially, we are creating situations through large scale habitat modifications such that now there are a large number of species that are getting a push factor from everywhere and they do not have any place that attracts them that pulls them and if they are getting pushed from everywhere, where will the animals go. In such situations, the only option is the extinction of the animals. So, this is the major threat that the animals are facing today, push factors everywhere and pull factors nowhere.

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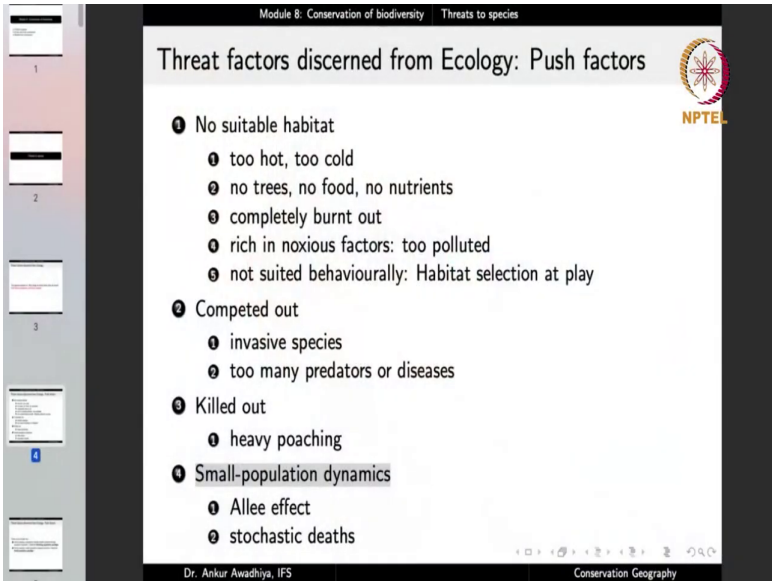

Now. what are these push factors? No suitable habitat. That is the habitats that remain are either too hot or too cold, or they do not have trees, they do not have food. There is no availability of nutrients. They are completely burned. out. In a large number of cases, people deliberately set fire to forests in to grasslands. So, that once the cover is gone, once the trees have been burned, the minerals that are present in their bodies, they are now available in the form of ashes.

And this ash on the erstwhile forest floor will now support grasses. And so, in a large number of cases, we find that people that rear cattle, they set fire to the forest to convert it into grasslands so that their animals can feed their, but in such a situation where will the animals that live in forest go, you have completely removed their habitats. Or the habitats that remain are rich in noxious factors, they are too polluted. We have polluted our rivers, our water bodies, to such a large extent that in a large number of cases.

Now, they do not support the biodiversity that they were supporting before. Even in the case of air pollution when we talk about species, such as lichens, now lichens live in those areas that have unpolluted it, you increase the level of pollution and you will find an extermination of the lichens or habitats that are not suited behaviourally because there is habitat selection.

Now, habitat selection means that through behaviour, certain organisms prefer certain habitats. So, for instance, there can be a species of bird that lives in say, mango trees. Now, this bird can also make a nest in say a Jamun tree, but it will never make a nest in the Jamun tree it just prefers to make a nest in the mango trees. Now, if the mango trees are gone, then there will be no place where this bird would feel comfortable. And if the bird is not comfortable, it will not make a nest it will not give rise to young ones.

And slowly the population will move towards decline. Or we can have situations where there is a lot of competition. We have a large number of invasive species. So, we have looked at Lantana camara, a species that was brought to India for horticultural purposes, but that has now spread to our forests. Now, this is a species that makes toxins it stores toxins in its body.

And so, a large number of animals are unable to feed on this species. But at the same time, it produces a very large number of seeds and the seeds are very hardy. So, the seeds are going to remain in the forest to give rise to more and more lantana plants. And so, this species is now replacing the indigenous flora of the forests. So, the indigenous vegetation is getting out competed, the indigenous vegetation dies and the places taken up by Lantana camara. Now, if you have such a situation, then where would the native species go?

Competition is also being observed in the case of animals. So, in the case of Bharatpur Bird Sanctuary, we observe that there are species of catfish that were brought to this area to increase the protein consumption of the locals. So, catfish is a very hardy species, it can grow even in very polluted waters. And it can feed on roughly anything. So, you can even feed it waste and it will eat waste and it will happily survive there.

But then, the catfish was able to move out of the ponds because it can survive even out of water for a very long period of time. And so, in the rainy season, it was able to move out and now it entered into the Bharatpur Bird Sanctuary. And now, this is a major threat, because it can live in very extreme conditions, it can feed on roughly anything and so it is now feeding on birds and their young ones.

So, you have a situation where there is a large amount of competition especially because of invasive species that also pushes the native species out or the presence of too many predators or diseases. In a large number of situations, we have observed that people are now moving into the forest in a very large way. And when people go into the forest, they also take their dogs with them. Now, if the dogs have rabies, then rabies will also move into the forest ecosystem.

When people take their cattle into the forest areas, then the diseases that are found in the cattle, things like tuberculosis, things like mastitis, things like foot and mouth disease, things like ringworm, they also make an entry into the forest areas. So, we are not just reducing the amount of space that is available for the wild animals, we are also making them more and more diseased by taking these pathogens into the forest areas.

And if there are too many predators, too many diseases, too many invasive species, then that acts as a push factor because the indigenous native vegetation or the animals will be unable to thrive in such conditions. In certain cases, we are directly killing out animals through poaching, poaching, for fur, poaching for ivory, poaching for skin, poaching for bones, poaching for gallbladder, poaching for meat, you name it and you have those poaching that are going on.

That is another major threat to a large number of species, a big threat to our biodiversity. And then we also have certain small population dynamics. So, if because of all of these factors, the population has reduced then we will start to see Allee effect is a condition in which once the population size has reduced the efficiency goes down. So, for instance, in the case of predators, such as wolves, or wild dogs, that hunt in packs, these animals are able to run fast, but they are not able to run long.

So, when they are chasing a prey, so, for instance, if you have a population of wild dogs that is chasing a sambar then the wild dogs will run fast, but they will not be able to bring the sambar down. So, what they do is that they set up a relay race. So, as soon as the first dog is getting tired, another dog replaces it once this dog gets tired, a third dog replaces it and so on.

So, there will be a time at which the sambar will get tired and then the whole pack will be able to bring it down.

Now, if the pack size is so less that they are unable to set up a relay race or if the pack size is so less that they cannot all attack the sambar to bring it down then the whole pack will go hungry. Another example is that once you have population sizes that are very less the animal density is so low that the animals are now unable to find their mates, they have to travel very long distances in search of mates and in a number of cases they just do not find their mates and so, the efficiency of reproduction goes down.

So, these effects occur when you have smaller populations. Another small population dynamics is the stochastic deaths that is random deaths. Now, if you have a population of 500 animals and if 5 animals die, nothing will go wrong, because 5 animals is just 1 percent of the population. But if you have a population of, say 6 animals and 5 of them die, then there is only a single lone survivor and the population will be completely extinct with this animal dies. So, the stochastic effects also start to play a big role in the case of smaller populations.

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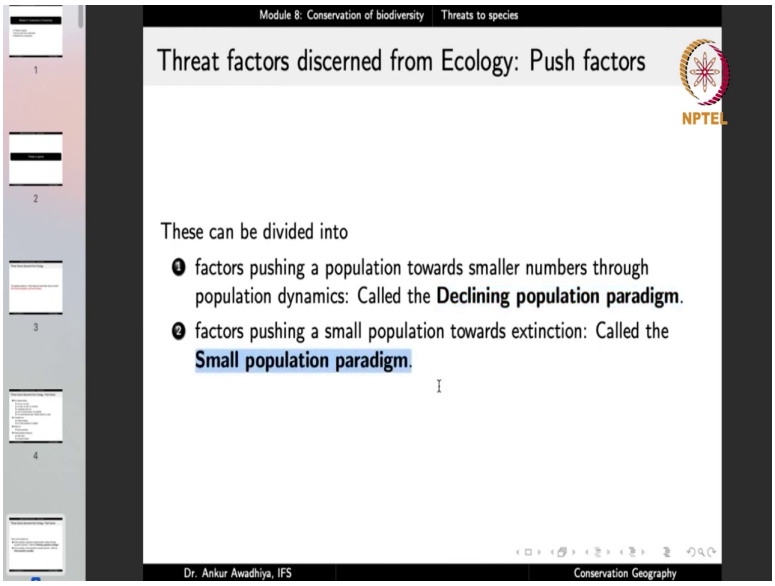

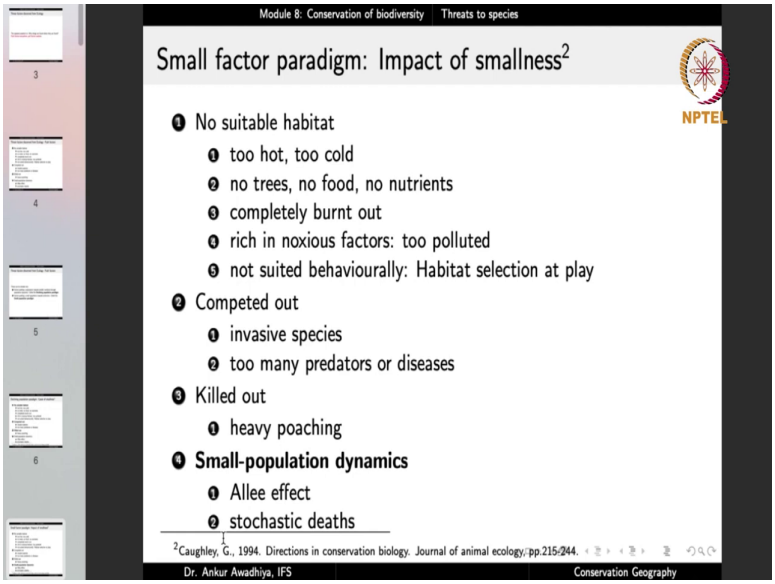

Now, the factors or the push factors can be divided into those factors that push the population towards smaller numbers through population dynamics and these are called the declining population paradigm. So, in the case of declining population paradigm, the population size is declining it is reducing, or factors that push a small population towards extinction called the small population paradigm.

So, once we talk about these factors 1, 2, and 3, then these are the declining population paradigm the push a population towards smaller numbers. And once you have a small population, then we have this small factor paradigm which will push the small population towards extinction.

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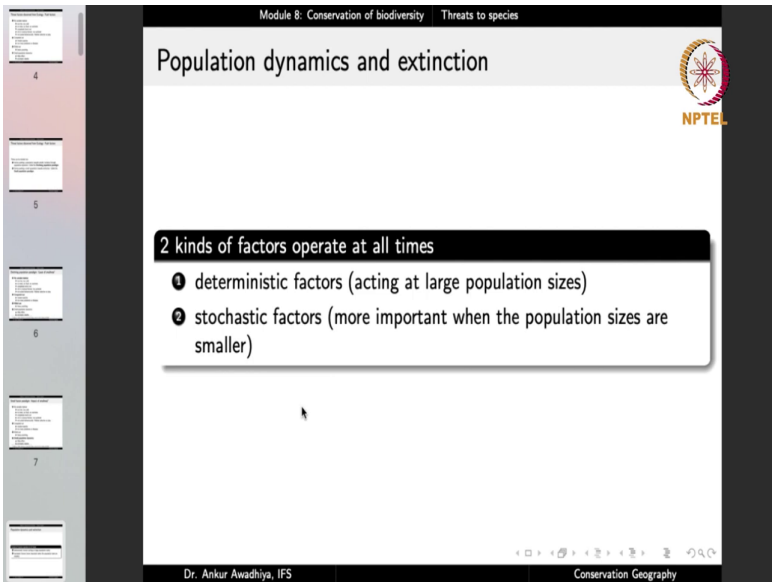

So, when we talk about extinction, there are two kinds of factors that are operating in any population. You have deterministic factors which act at large population sizes and stochastic factors which become more important when the population sizes are smaller.

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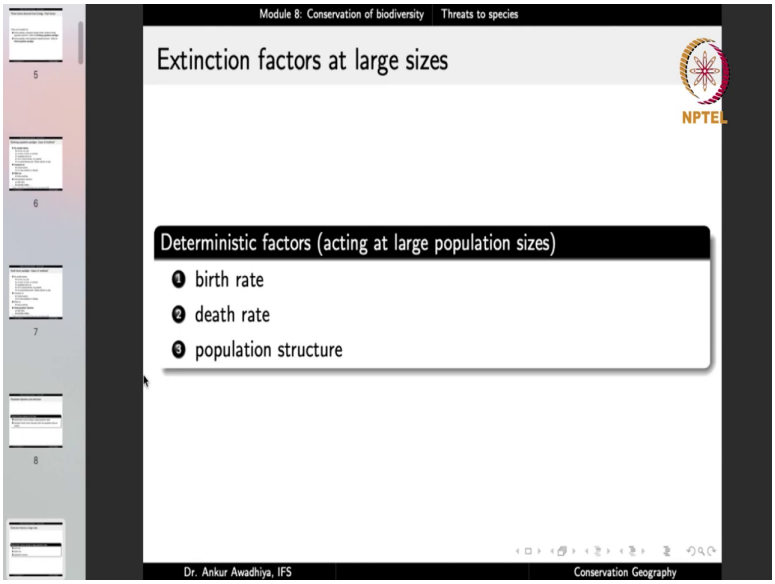

So, what are these; deterministic factors are things like birth rate, death rate, and the population structure. So, if in a population the birth rate is less and the death rate is more, so in this case less number of animals are getting born in the population and more number of animals are dying out. So, slowly the population size will reduce.

So, this is a deterministic factor it plays a role even in the case of large size populations, things like population structure which means, the proportion of animals that are in the reproductive age versus those animals that are very young or very old or the proportion of animals in the population that are females because the females will give rise to the next generation.

Now, if the population structure is disturbed and how can it be disturbed, it can be disturbed even in the case of large size population. So, for instance in the case of a large number of species such as crocodiles or turtles, the sex of the young one is determined by the ambient temperature. Now, because of global warming we can have a situation where all the young ones that are getting born they turn out to be males.

So, in this population we will have in excess of males and a very less number of females, when these females give rise to young ones, again the young ones turn out to be males. And so, slowly and steadily the population will be composed of all animals that are males and

there will be no females left in the population. In such a situation there will be no more mating and the population will become extinct. So, population structure is also something that acts even in the case of large populations and this is a deterministic factor.

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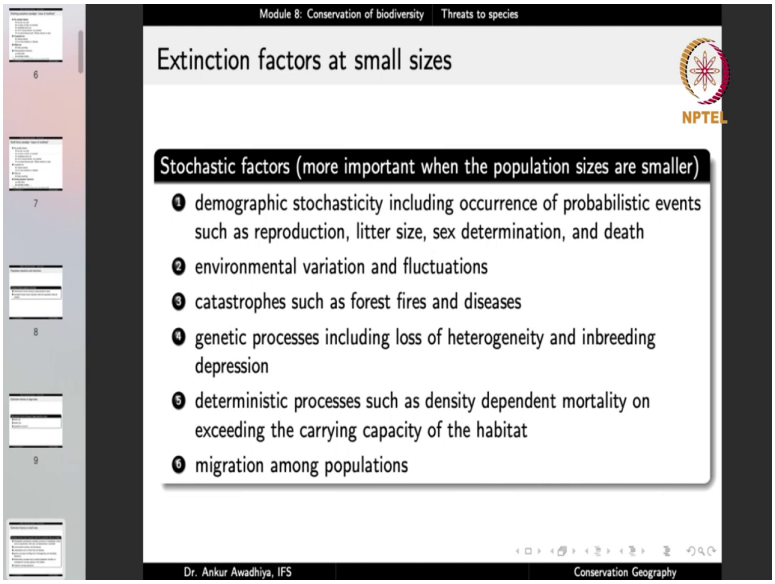

Stochastic factors are chance factors, they are important when the population sizes are smaller things like demographic stochasticity including occurrence of probabilistic events such as reproduction, litter size, sex determination, and death. So, for instance, if the litter size is less meaning that the next generation has lesser number of individuals, it will not play a big role in the case of a large size population, because just by chance, it is possible that this year the litter sizes are less.

Now, they will be compensated by a larger litter size probably in the next generation. So, that is not a very big cause of concern, but it becomes a bit cause of concern in the case of smaller populations, because in the case of very small populations, once you have a small litter size, then the next generation has so few number of individuals that it is now being pushed towards extinction.

So, these demographic stochasticity factors they occur even in the case of large size populations, but they are not that important in large size populations, because they get averaged out over several years. Then we have environmental variation and fluctuations. So, you can have things like an extreme flood or in extreme drought or you can have extremes of temperatures.

Now, they will play a role even in the case of large populations, but for large populations so many individuals will survive, these environmental fluctuations that the population will not be pushed towards extinction. But in the case of a small population, if you have a population of say only 10 individuals, and of these 10 individuals, 7 individuals die in the case of a drought, then the population has a very bleak future. We have things like catastrophes such as forest fires in diseases. Genetic processes, including loss of heterogeneity and inbreeding depression.

Now, if you have a small population, then inbreeding depression becomes much more prominent, because so few number of individuals remain in the population, that the only option to breed is to breed amongst close relatives. So, you will have breeding between parents and children or grandparents and grandchildren, or between uncles and nephews, and so on.

Now, once you have matings that are between very close relatives, there is a very quick loss of heterogeneity in the population. They will be inbreeding depression, meaning that a large number of individuals will be born with many genetic disorders or with reduced efficiency or with things like a reduced sperm count or with large number of abortions. And so, this will be pushing the population towards extinction.

Then we have deterministic processes such as density dependent mortality on exceeding the carrying capacity of the habitat. Now, in this case, when the population sizes are very large, then there is a density dependent mortality because the density increases and once you have a high density then diseases can spread very quickly among the population. Now, in the case of a large sized habitat, once you have a large size population, then you will start to see the density dependent mortality.

Now, this is a mechanism that nature uses to control populations of different organisms. So, once you when the population size is very large, then if a single animal becomes sick then so many animals are getting in contact with the sick animals that they will also fall sick and ultimately the population, so many individuals would die that the population size will be reduced and that is fine in the case of large size habitats and large number of individuals. But now, when the habitats are getting lost, so now, you have a very small sized habitat that is left.

And so, even with a very small population, you have a high density of population. Now, density dependent mortality will still play in the case of this small population and it will wipe

out a large number of individuals that are there in the small population pushing it towards any an even smaller population or pushing it towards complete extinction. So, density dependent mortality occurs in the case of large populations and small populations, whenever the densities increase, but in the case of large size populations, they are just a regulatory mechanism.

In the case of small populations, they become an extinction mechanism then we have migration amongst populations. In the case of a large population, if a few animals migrate out, nothing big is going to happen. But in the case of a small population, if a few animals move out, then the population will may become extinct, especially when animals of a particular sex move out.

If all the males move out or if all the females move out, then the remaining animals that are there in the population, they will be unable to breed and carry on the population forward. So, these are the stochastic factors, which are very important when the population sizes are smaller. They even occur in the case of large populations. But for smaller populations, they are especially tragic.

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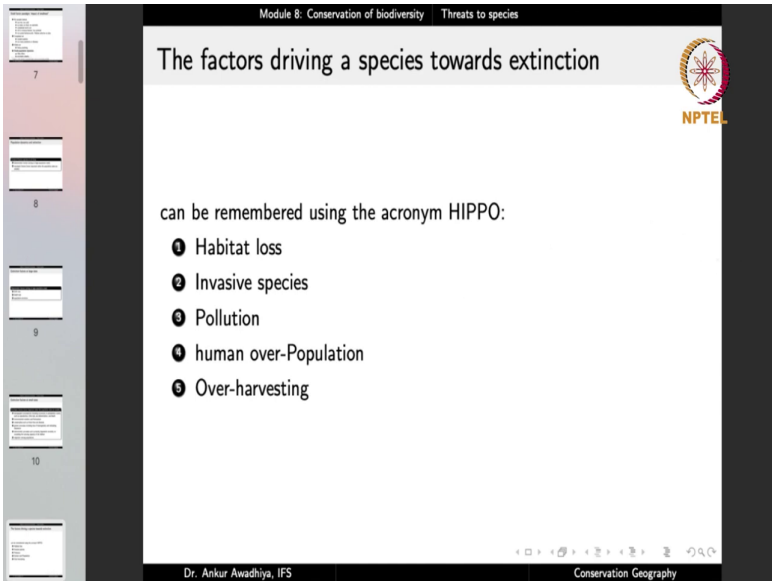

And the factors that drive species towards extinction can be remembered using the acronym HIPPO, H is habitat loss, I is invasive species, P is pollution. P is human overpopulation, and O is overharvesting. So, human overpopulation is playing a big role in or doing habitat loss and doing pollution and doing overharvesting and in a large number of cases also, in bringing invasive species to other areas. So, of all the factors in HIPPO, the human overpopulation is the most important factor these days.

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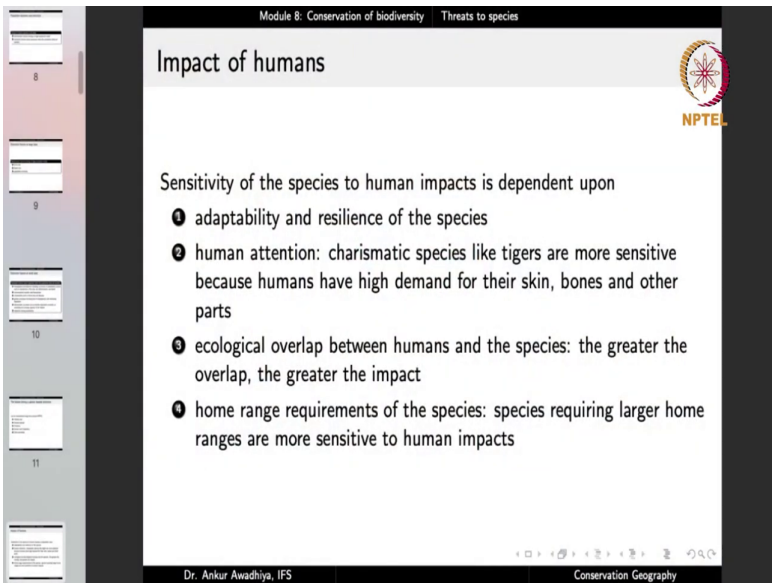

Now, the impact of humans is not the same on every species, it depends on a number of factors. So, sensitivity of the species to human impact is dependent upon the adaptability and the resilience of the species, is the species are able to adapt to the changing situations. And if

the population goes down, is it able to come back to the original state. A very good example in this case is the difference between tigers and leopards. Now, tigers are mostly found in those areas where the impact of humans is very less.

They prefer living in the core areas of the jungles, they do not prefer human interactions. And so, if humans degrade their habitat or destroy their habitat, the tigers will not have anywhere else to go. They are large size animals, and they find it very difficult to live in human dominated areas. Whereas in the case of a leopard, even if humans move into the forest, the leopard will be able to survive.

Why? Because it will start hunting on things like chicken, things like dogs, things like goats, or even smaller children. So, this species, the leopard is able to adapt very well, even to human presence. It has a very resilient population. So, even if humans kill a large number of leopards, the population will be able to come back and it is also aided by the fact that the leopard is able to climb trees.

So, there will be a leopard sitting on a tree and you will be unable to spot it. And so, it is difficult to exterminate the species. But in the case of tigers, because they cannot climb trees they will be found on the land and you can very easily wipe them out. So, the impact of humans will depend on the adaptability and resilience of the species. It will depend on human attention.

Charismatic species, like tigers are more sensitive, because humans have high demand for their skin, for their bones, for their other body parts. So, if you go to old palaces, you can find that there will be a large number of bodies of tigers that have been that have been shot and the bodies have been stuffed and they have been kept just as a display. Or you will find the skins of tigers that are hanging on the walls or that are being used as rugs.

Now, you will hardly find the body of say a nilgai or a sambar that has been stabbed and kept for display. Why? Because a tiger is a beautiful looking animal. It is a charismatic animal; it is a majestic animal. And so, humans have traditionally paid a lot of attention to the species. And because of that, a large number of tigers were hunted and their body parts were used for display.

Even today, there is a high demand for the skins, bones and other body parts of tigers, especially in the case of traditional medicine, and especially in the case of people who are superstitious. So, you still have a large demand for tiger body parts because of which tigers

are continually in at threat. Another factor is the ecological impact between humans and the species. The greater the overlap, the greater the impact.

So, for instance, the species that lived in the grasslands have been particularly hard hit because of the impacts of humans, when the grasslands were converted into farmlands. So, there is a great amount of ecological overlap between human activity and animal activity. People use grasslands either to rear animals, or later on to grow crops. Similarly, the forests that are found in plain areas, they were heavily cut down, chopped for timber and converted into agricultural fields.

So, the animals that were living in the forest in plain locations, they were particularly hard hit, much more than those animals that were say living in the peaks of different mountains. Because humans have hardly any use of the peaks they are difficult to go to. So, the amount of ecological overlap also plays a role in the amount of impacts that humans have.

And the home range requirements of species, species that require larger home ranges are more sensitive to human impacts, because when there is even a small amount of impact the home range reduces once the home range goes below a certain size then the animals are unable to survive there.

This is particularly important in the case of animals that are say mega herbivores, animals like elephants. Now, elephants require so much amount of food that they cannot be kept in a small area, because if you keep them in a small patch of forest, they will eat up everything and the whole forest will collapse. So, they typically require last size forests so that once they have eaten in one area, they will move to another area, then they will move to yet another area and by the time they come back to the first area this area has already regenerated it has been given sufficient time for the new plants to thrive.

But if you have a small sized forest, these animals cannot live there. Or animals like tigers, if you keep tigers in very small patches of forests, they will eat up all the herbivores and very soon there will be no food left. So, tigers also required large areas. Now, if humans reduce the areas, then these species are particularly hit.

Whereas those species that have very small home ranges species like rabbits or hares, or say rats and mice, they will not be that much harmed, because even if there is a small patch of forest then there is plenty of space plenty of resources for these animals to live. So, the impact also depends on the home range requirements of the species.

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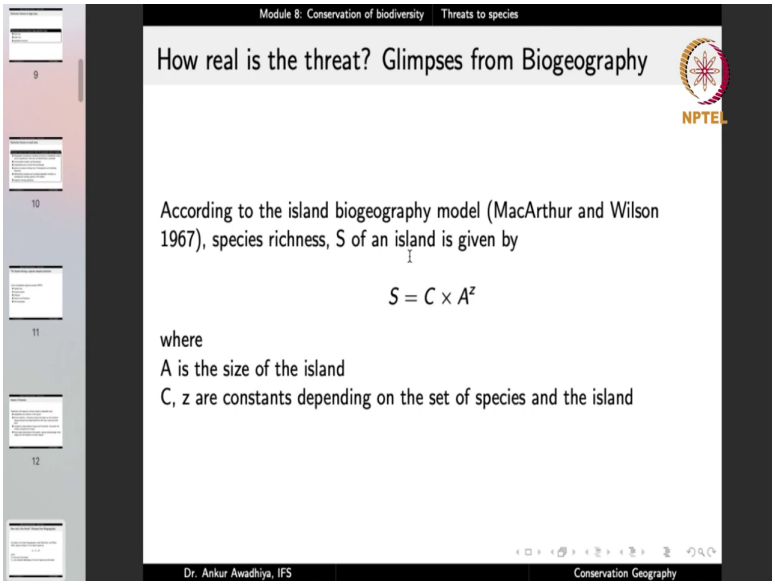

So, how real is this threat? What is the rate at which we are losing the species? Is it just a theoretical thing? Or are we looking at destruction of species? And how many species are we losing? Now, according to the island biogeography model, the species richness of an island is given by S is equal to C into A to the power z, where S is the species richness that is how many number of species are there in this area or the amount of biodiversity of the island. It is equal to C which is a constant into A which is the size of the island to the power of z which is where z is another constant.

So, essentially what we are saying here is that if A increases, that is the size of the island is more then the number of species will also be more which is quite expected because a larger sized island will typically have more number of habitats which will support more number of species. But if you increase the size of the island by say double the species richness will not double because it is related by a factor of z and it is controlled by the factor C.

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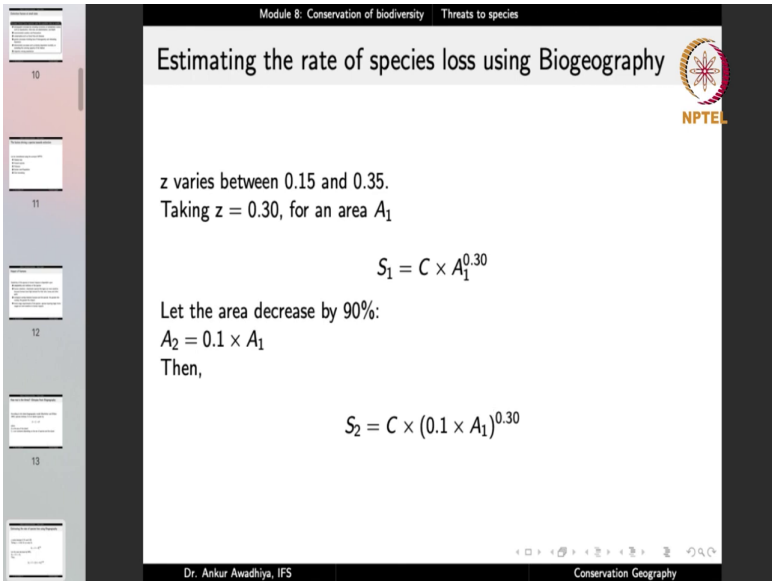

Now, when we use this model and in the case of forests, forests can also very easily fit into this model, because if you consider a forest that is surrounded by human dominated landscape that is you have a small patch of forests where and it is surrounded by say agricultural fields or by human habitations. So, this forest is acting like an island. So, we can very easily use the island biogeography model in the case of patches of forests.

And for various patches we have found that z is between 0.15 and 0.35. So, taking the value of z is equal to something in between 0.3, when an area A1 we will have S1 is equal to C into A1 to the power 0.3 and if you reduce the area by as much as 90 percent. So, if you take A2 is equal to only 0.1 or A1 then we can write S2 is equal to C into A2 to the power of z and it was 0.1 A1 into to the power of 0.3.

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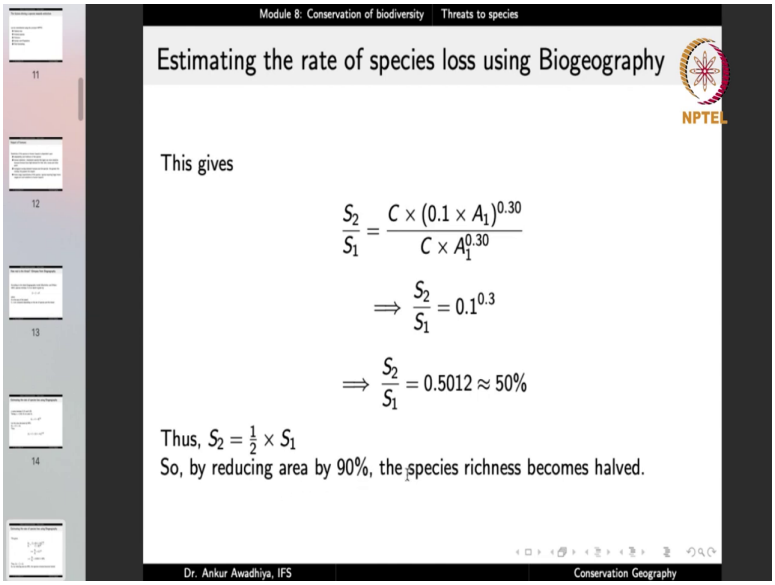

And in this case, if you take out the ratio you will find that it is roughly 50 percent. So, by reducing the area by as much as 90 percent the species richness becomes harmed which is a good thing in some aspects because, even when a large amount of habitat is destroyed, you still have a sufficient amount of biodiversity that is left. The problem is that those species that required larger habitats, larger home range species, they are preferentially targeted. So, they will be lost but a large number of species will still remain. So, that is a good thing.

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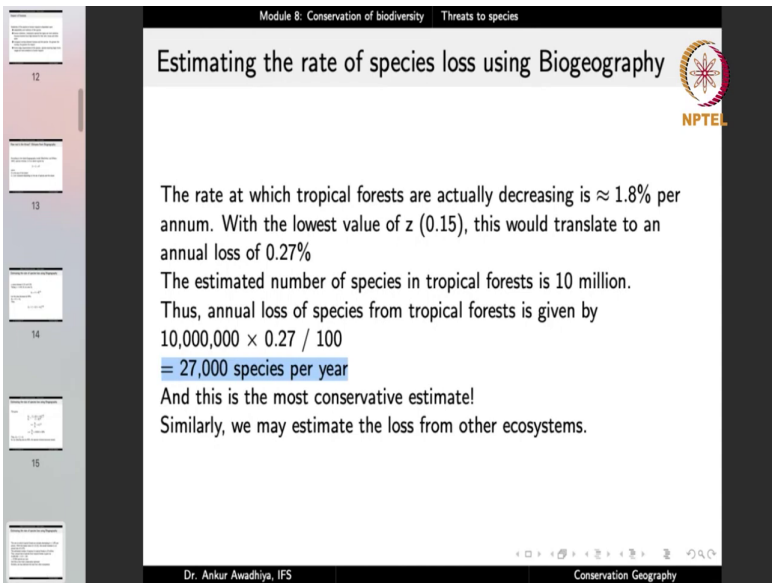

But then, if we look at the rate at which we are losing the tropical forests, it is 1.8 percent per year. And if we take the lowest value of z that is 0.15 it would mean an annual loss of 0.25 percent, a very small fraction. But then if we look at the estimated number of species it is 10

million, multiply 10 million with 0.27 percent and you get 27,000 species being lost every year with the most conservative estimate because we are taking the smallest value of z. And this is only in the case of the tropical forests we have so many ecosystems that we are destroying.

And so, the number of species that we are losing every year is very high. Now, in a large number of cases, we do not even know which are the species that are getting lost, because even before we have had a chance to observe the species document them even name them, they have become extinct. So, the island biogeography model gives us an estimate and in a very conservative estimate, we are losing 10s of 1000s of species every year with the current rate of destruction. So, this is an important finding that the threat is very real.

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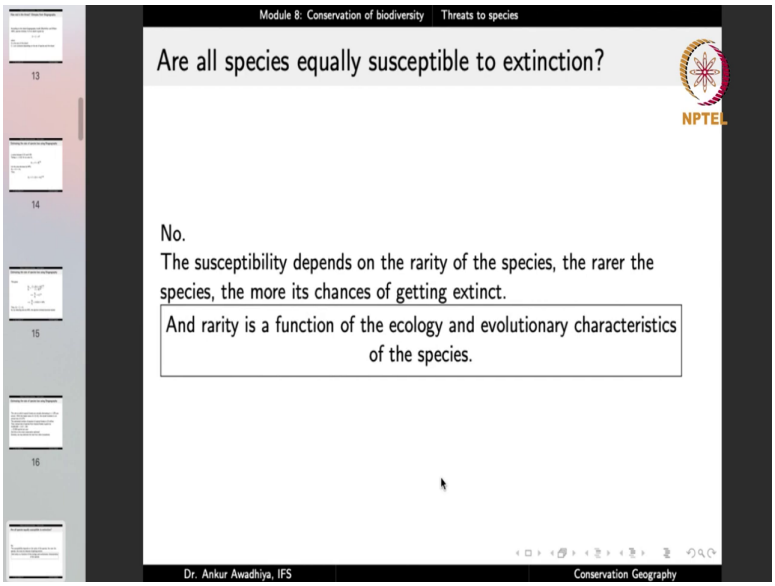

Now, all the species are not equally susceptible to extinction as we have seen that certain species will be lost preferentially. And the susceptibility also depends on the rarity of the species that rarer the species the more are its chances of getting extinct. And rarity is the function of ecology and evolutionary characteristics of this species.

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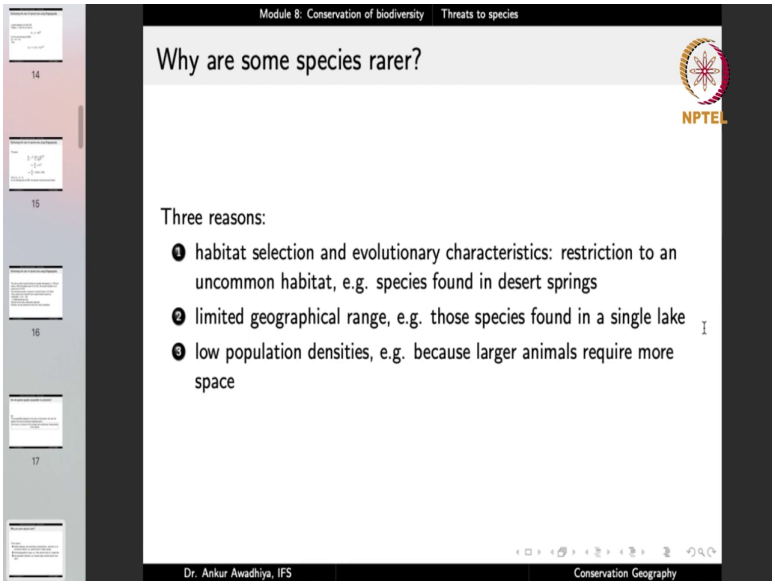

So, why are certain species rare? So, if a species is rare, then there are less number of individuals, the smaller factor dynamics are already playing a role. So, if there is a little amount of impact of humans, these species will be very easily lost, they will become extinct. But then the next question is why are certain species rare? Certain species are rare because of their habitat selection and evolutionary characteristics, such as restriction to an uncommon habitat. Example is species that are found in desert springs.

Now because springs in the desert areas are by nature, very less in numbers. If we had too many springs, then probably the area would not have been a desert. So, the springs in a desert are very less. So, the species that have made the desert springs as their homes, they will automatically be very rare because they habitats themselves are very rare. In other cases, there are species with limited geographical range, those species that are found in a single lake.

Now, these species are unable to move to other areas and so they have a very limited geographical range. If this lake is destroyed, if this lake is over polluted, if this lake is drained out, all the species that are found in this lake they will become extinct. And certain species typically have low population densities. And in a large number of cases, the larger sized animals have low population densities, because they require more space.

So, for instance, if we look at elephants, they will give rise to only one calf in each gestation and this calf will be produced after this a span of several years. This is a natural mechanism to keep the population in check, because if the population of elephants increased beyond a limit, then they will wreak havoc to the habitat and the whole habitat will be lost.

So, through evolution, it has been selected that these animals will have very less number of offspring. Similarly, tigers in the case of tigers, one litter will typically have 2 to 3 cubs and these cubs will remain with the mother for 2 to 3 years. So, that the tiger population does not increase so much that it becomes beyond the carrying capacity of the habitat. So, this is another factor why certain species are rare, because they have low population densities. Now, the destruction of habitats of these species that are already there will have a much greater impact.

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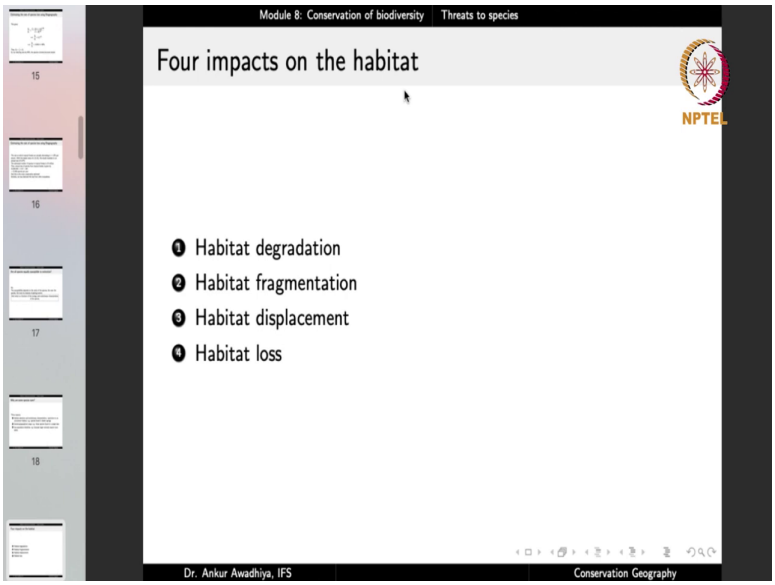

So, what are these impacts on the habitat? We have habitat degradation, habitat fragmentation, habitat displacement and habitat loss. So, let us now look at all of these.

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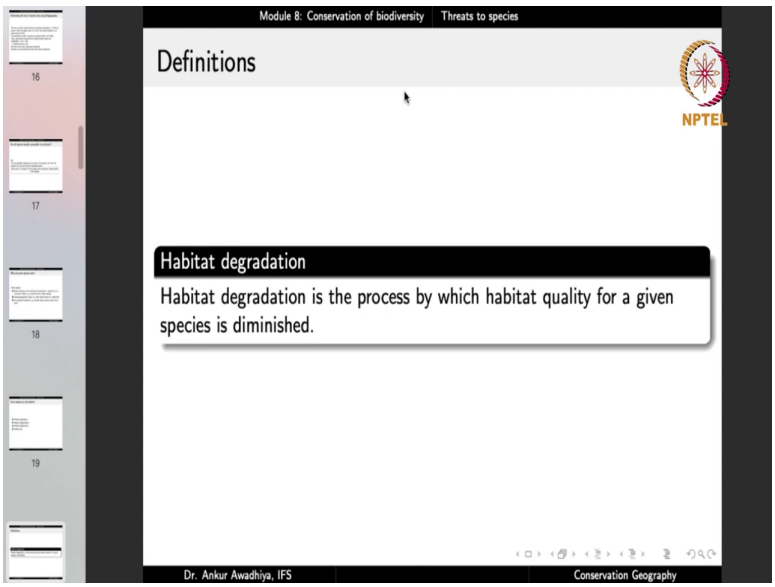

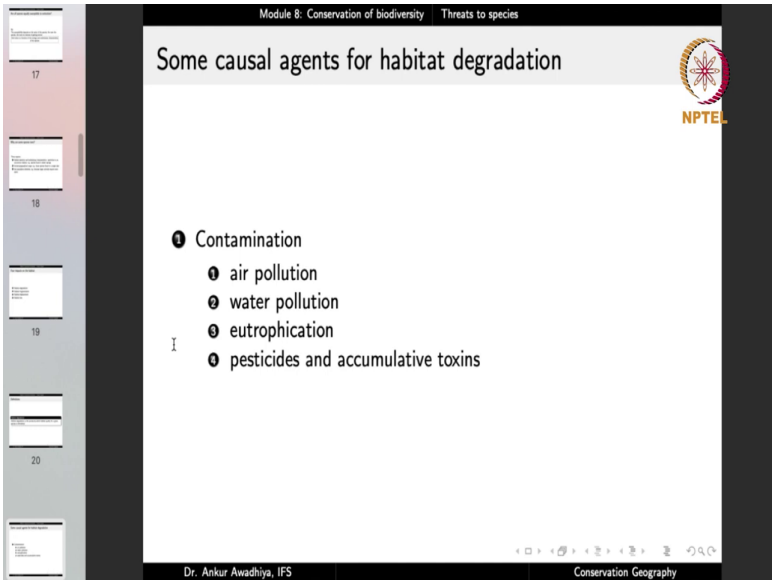

Habitat degradation is defined as the process by which the habitat quality for a given species is diminished. And this quality is diminished, because of several reasons. The quality may go down because of contamination. So, here we are talking about pollution. We can have air pollution, water pollution, eutrophication, in which case, the fertilizers that are being used in our farmlands, they make their ways into the water bodies through the rain.

And once they have reached the water bodies, they increase the algae population and the water plants population to such a high level that there is no space left for other species. And once these large algal blooms die, then all of the oxygen in the lake is used up by the decomposition of their bodies, the lake becomes anoxic and no longer able to support any plant life. So, this is habitat degradation, contamination by air pollution, water pollution, eutrophication, pesticides and accumulative toxins and all of these reduce the quality of the habitat.

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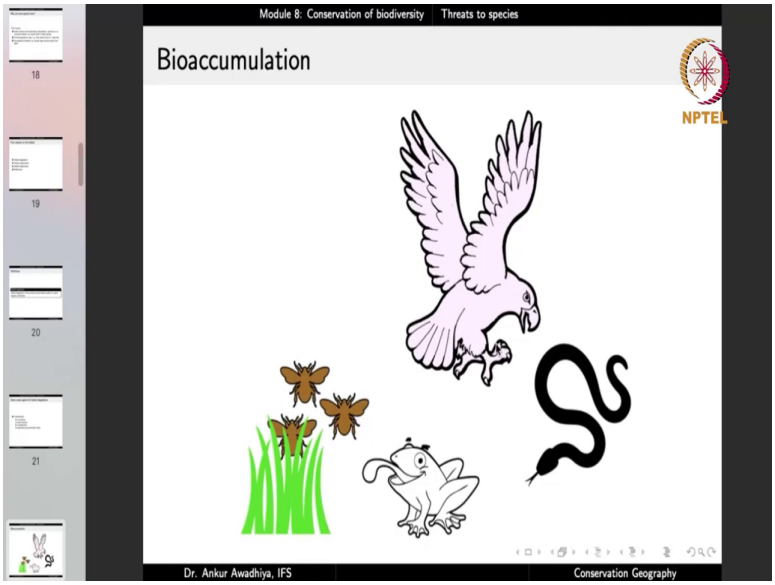

In the case of bioaccumulation, what happens is that if there is pesticides that are sprayed on, say grasses or on say, species of the poaceae family, such as rice or wheat, then the insects that were feeding on these grasses, either they would die, or certain insects would still remain alive, but they will have certain amount of these pesticides in their bodies. These pesticides become stored in their bodies they become accumulated in their bodies.

Now, if you look at the food chain, if you have a frog, and the frog is eating these insects, so a frog will typically eat 10s or 100s or 1000s of insects, and the pesticides in the bodies of all of these insects will get accumulated in the body of the frog. Moving up the food chain, a snake will eat several frogs, and the pesticides in the bodies of all of these frogs will become accumulated in the body of this snake. later on, once a hawk eats this snake, then all of these toxins are moved into the body of the hawk.

And a hawk will typically eat several snakes and so the pesticides in the bodies of all of these organisms, it is getting increased in concentration and it is getting deposited in the bodies on different organisms. And so, as we move up the food chain, the concentration of pesticides increases, and so does their negative impacts. So, the birds will face a very great amount of negative impact of these pesticides, things like DDT.

Now, when DDT was sprayed, it was found that the birds laid eggs with very weak shells. Because of the impact of this DDT. And before the chicks could hack, or could hatch, the eggs broke down, resulting in a very great amount of destruction of different birds. There was a book published by the name of Silent Spring, because it turned out that when DDT was sprayed into several habitats, say for the control of mosquitoes, so many birds died that in the

spring season, it became very difficult to hear the chirping of birds. So, that is a habitat degradation that occurs because of contamination.

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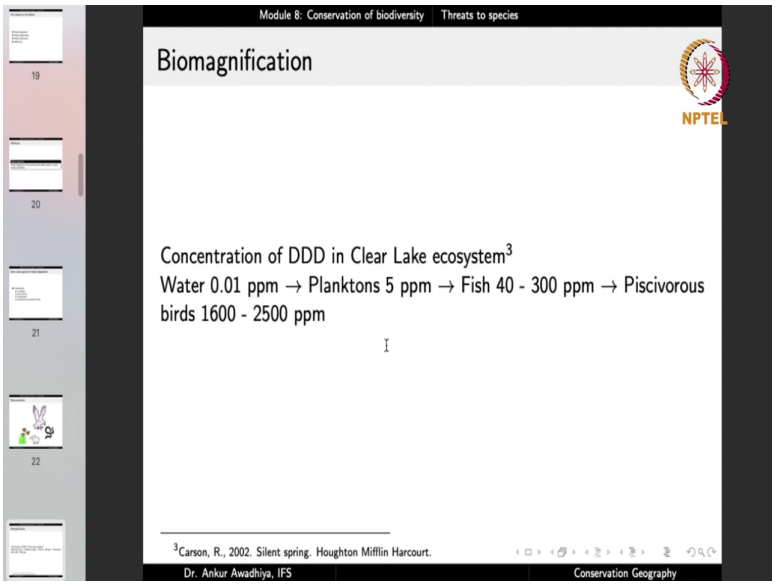

So, this is an example of biomagnification in the Clear Lake ecosystem. So, this is a lake and the scientists were looking at the concentration of DDD, and in the water, it was 0.01 ppm parts per million. In planktons, it was 5 ppm, in fishes, it was 40 to 300 ppm. And in fish eating birds or piscivorous birds, it was 1600 to 2500 ppm, the concentration increases as we move up the food chain. And this impacts a large number of species that are specially on the upper echelons of the food chains.

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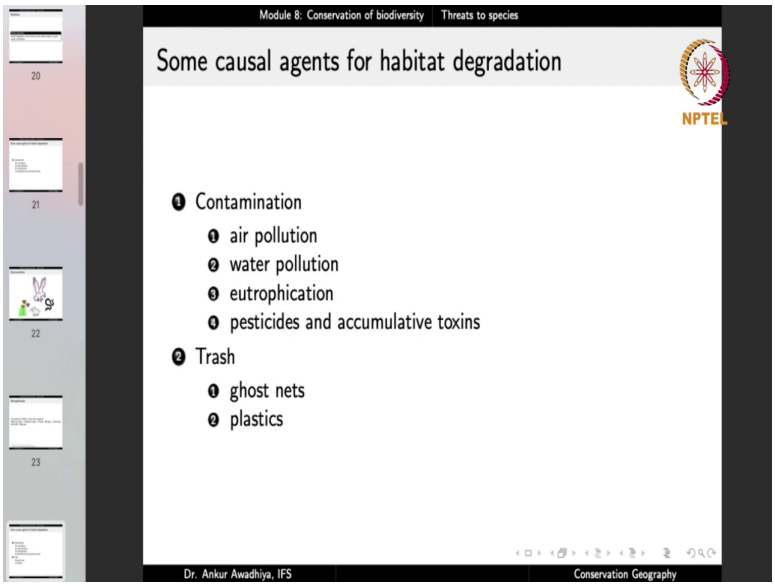

Another habitat degradation is trash, the waste that we throw. Ghost nets. Now, ghost nets are those nets that have lived past their useful life. And a large number of fishermen just throw them out in the water bodies. Now, the thing with ghost nets is that they are very efficient mechanisms to trap animals.

So, even though these nets are say broken, or they are torn out, they will still be able to catch a large number of animals, and they will drown these animals, they will not permit these animals to move away. And so, they become very efficient mechanisms for Habitat degradation. Things like plastics, we use so much amount of plastics and a large portion of those plastics is just dumped into the environment.

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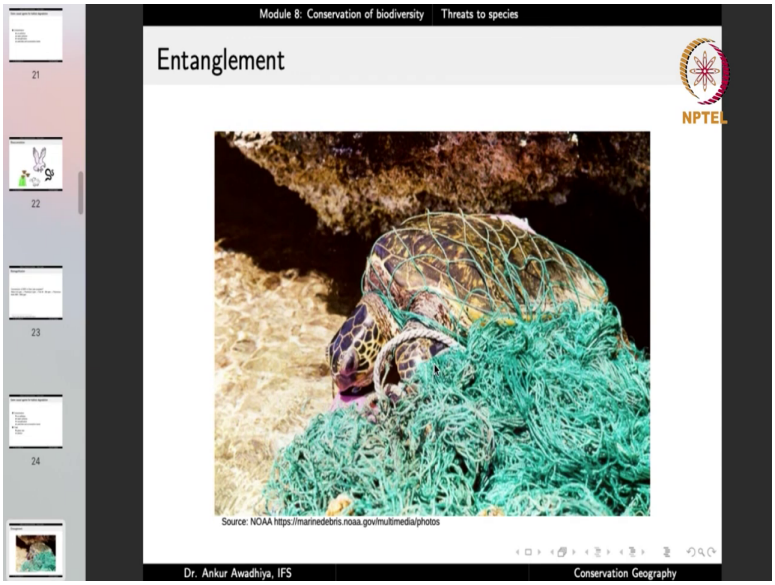

So, this is the impact of a ghost net, the animals get entangled. This turtle is entangled in this net. And once it is entangled, it cannot move to the surface to breathe, it cannot dive down, it cannot get its food. And if it is not rescued, the animal will slowly perish.

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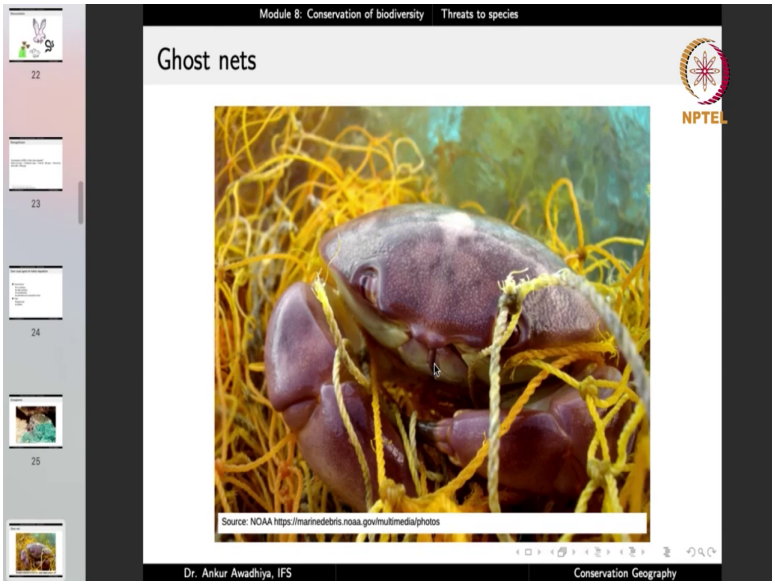

A crab that is there in a ghost net.

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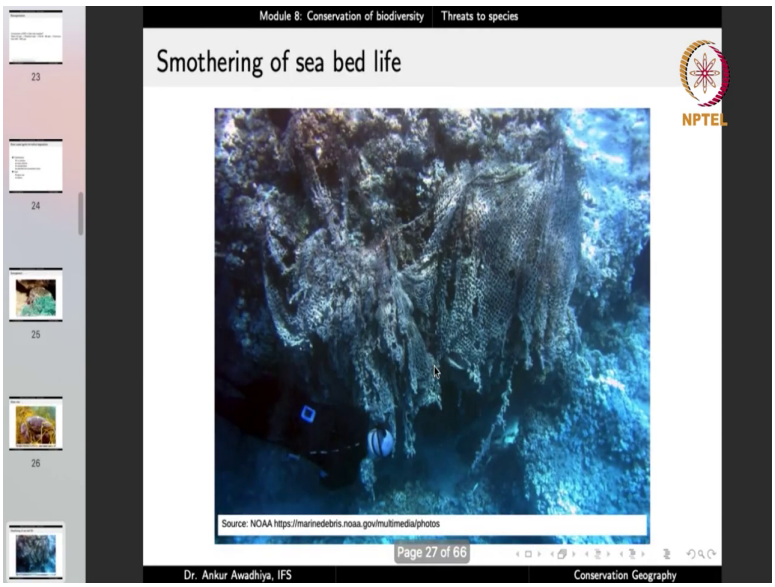

Large number of corals. Now, this is a ghost net that is there on top of this coral. And these animals will now no longer be able to get the food.

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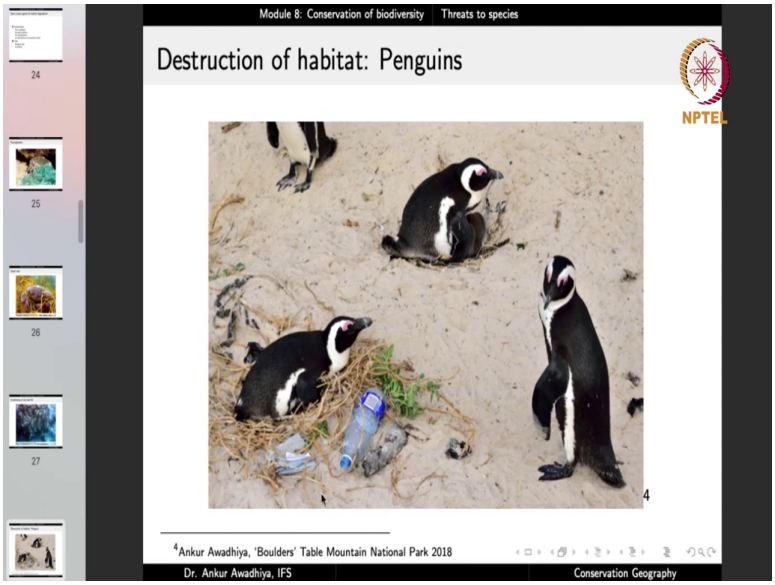

Penguins, so in the case of penguin habitats, this is from Table Mountain National Park and you will find that so much amount of plastic is strewn around that it is degrading the habitat.

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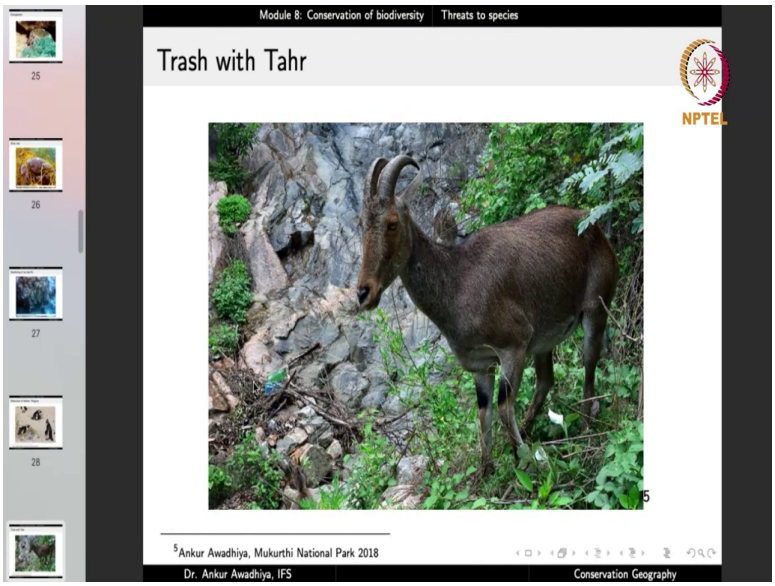

In our country in Mukurthi National Park, we saw this nilgiri tar and there are these plastics in its habitat.

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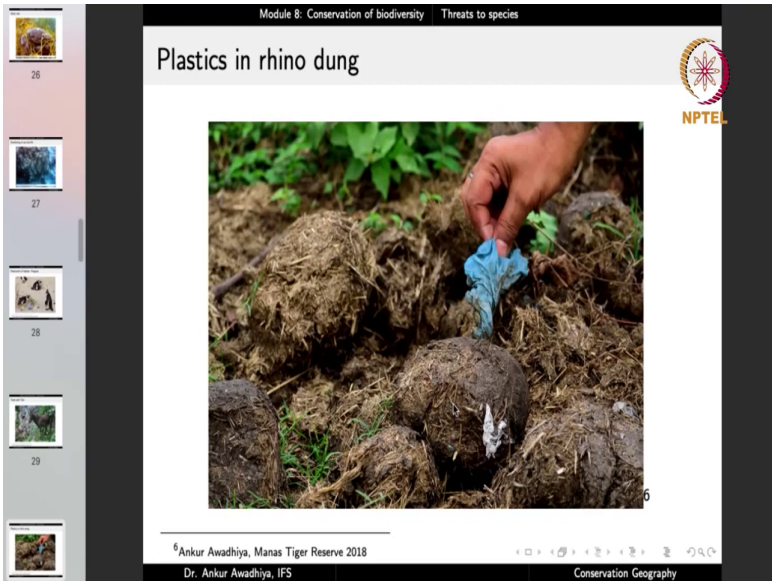

Again, habitat degradation. When we went to Manas Tiger Reserve, we saw rhinoceros dung and inside the dung, we found plastics.

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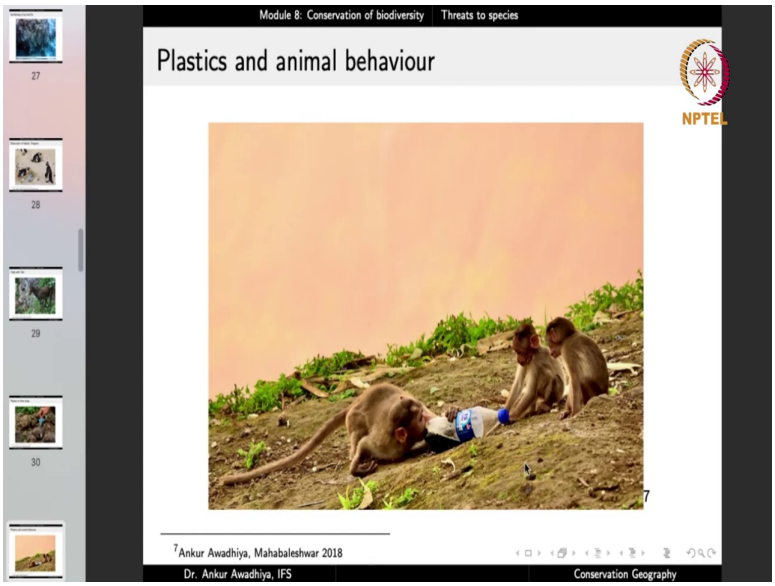

Plastics are now everywhere. We went to Mahabaleshwar and here you find these macaques that are trying to drink cola from this bottle. Again trash.

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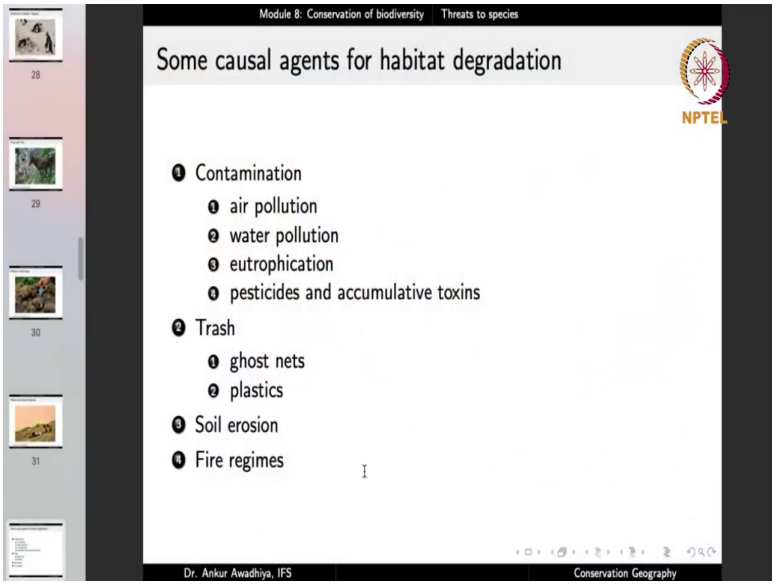

So, these are habitat degradation mechanisms, we have soil erosion, if soil gets eroded, again the habitat is degraded, the quality is reduced, not just the quality of the land, but also the quality of water. So, the water will have so much amount of sediments that it will not be suitable for drinking or suitable for swimming of different animals and so on. Then fire regimes.

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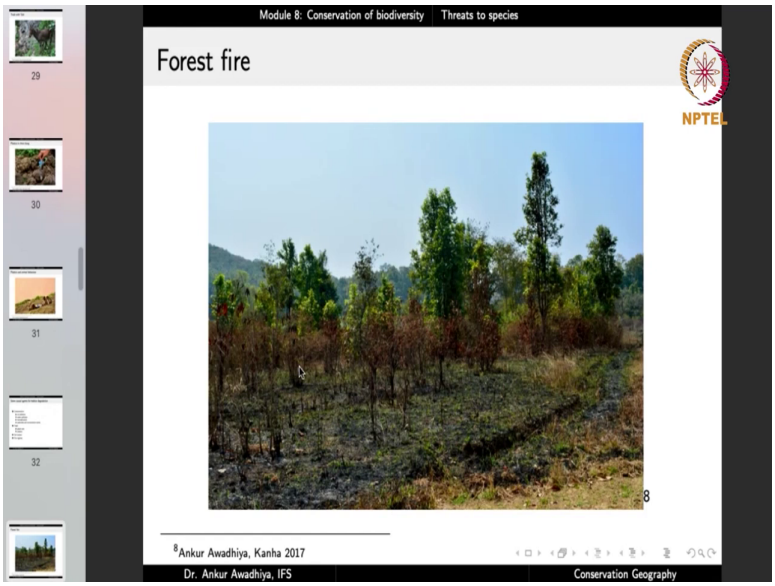

When the forests get burned, this is again habitat degradation. Because the quality of the habitat has gone down.

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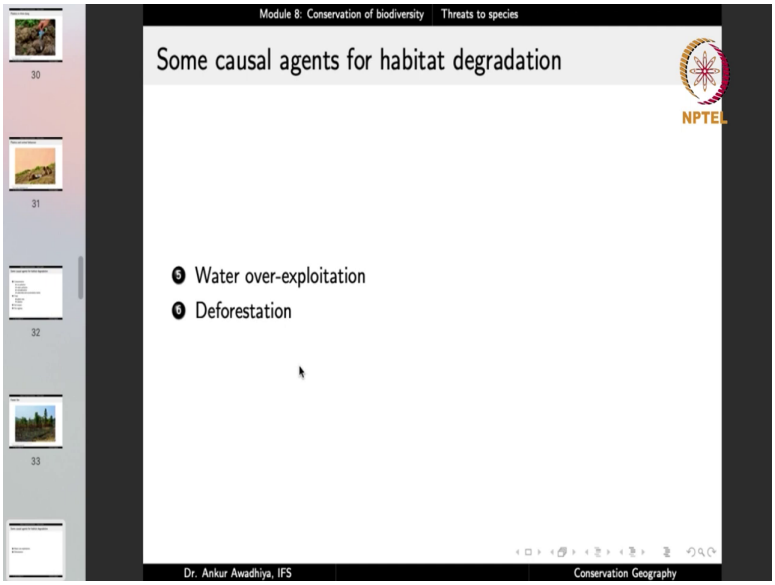

Over exploitation of water. If water itself is not present in large quantities, and a number of cases what we have observed is that when waters in the rivers are overexploited, then the depth of the river water reduces and once the depth reduces quite a large number of animals are unable to move from one place to another place, because they require a certain depth of water to swim, you reduce the depth and these animals will slowly be pushed towards extinction.

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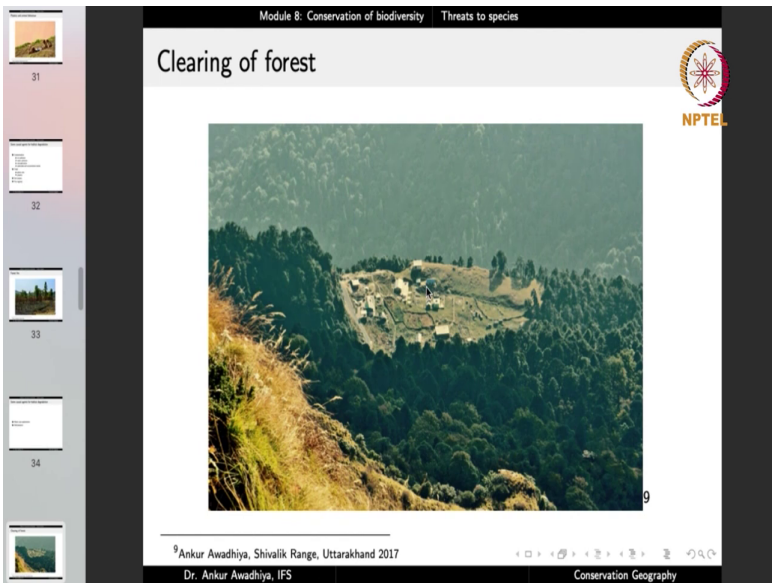

Deforestation. So, when the forests are cleared, So, earlier we had all of these forests. So, there was a large size habitat. Now, this portion has been cleared. So, the habitat has reduced in its quality.

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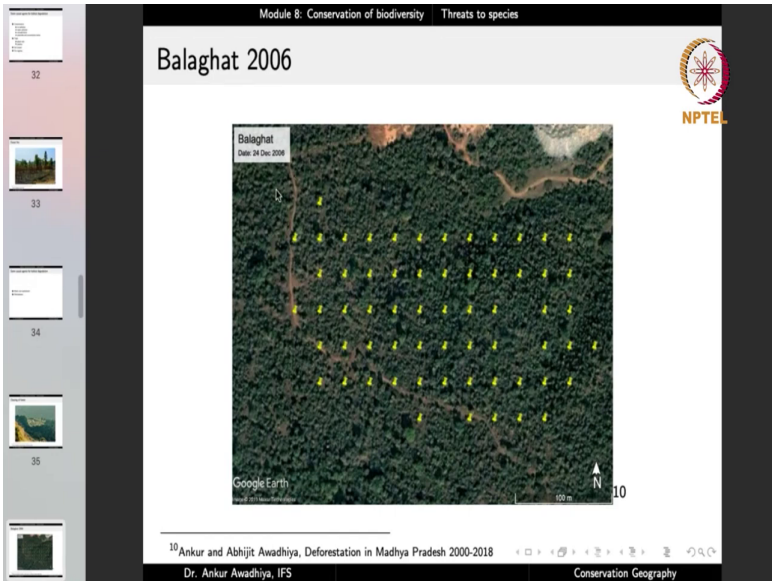

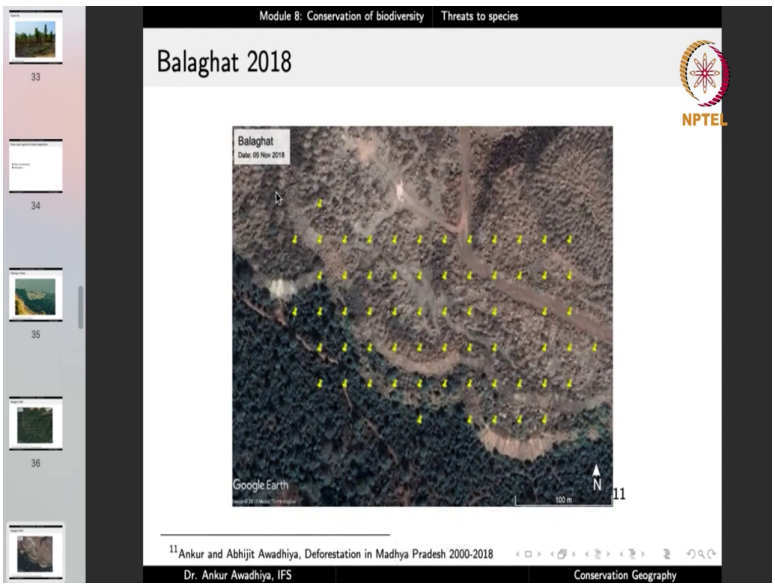

And we are finding deforestation in a large number of areas for n number of reasons. This is an example from Balaghat district in Madhya Pradesh. This is the satellite imagery from 2006. This is the satellite imagery from 2018, the same area. So, essentially, we use an algorithm to find out the areas where there is deforestation. So, these are the points that show where deforestation was detected, we look back through satellite images and this is the difference, this is habitat, this is deforestation for mining.

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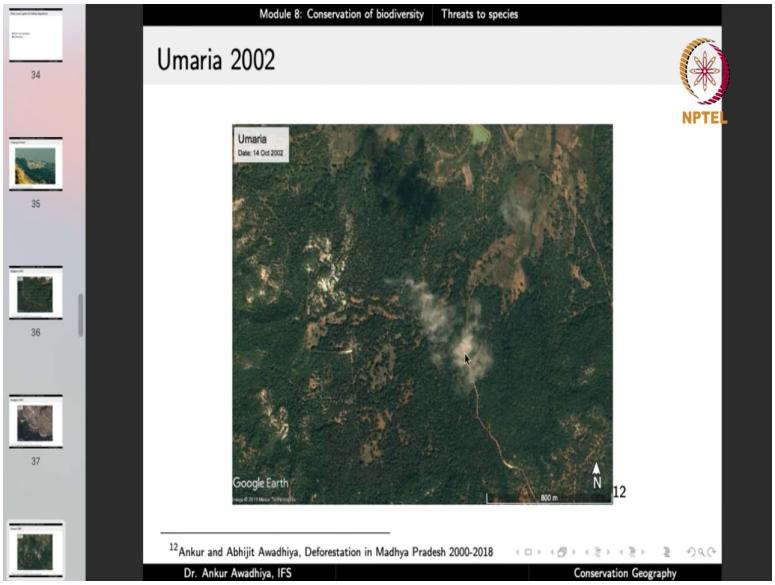

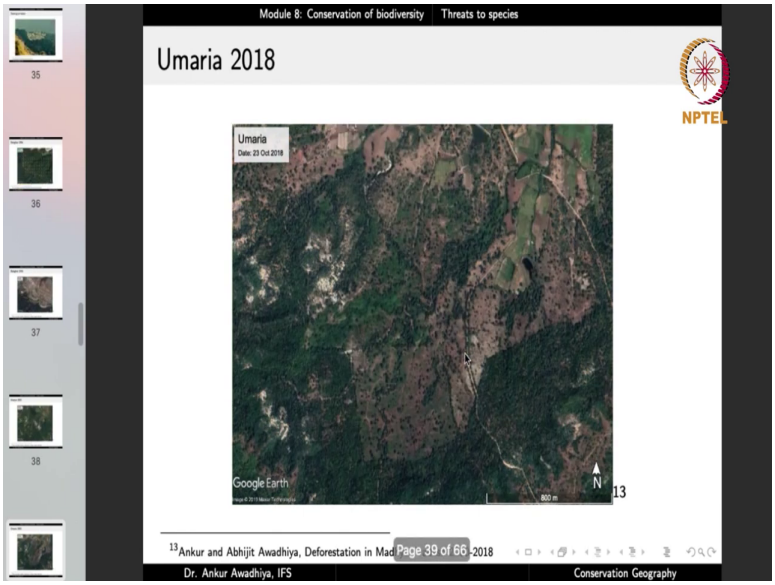

This is an Umaria district. So, here again you can keep a track of this road. So, this is a common point. And if you look at all of these forests, this is in 2002. This is 2018, the forests have been cut down and converted into agricultural fields.

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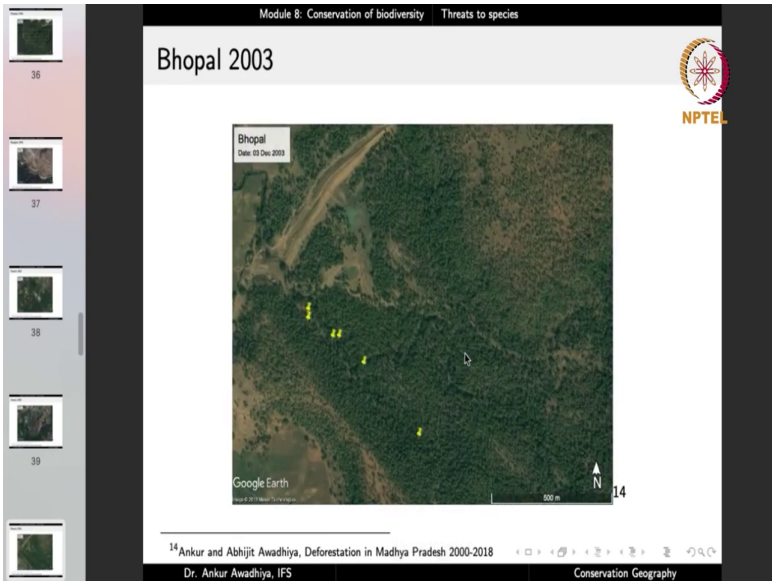

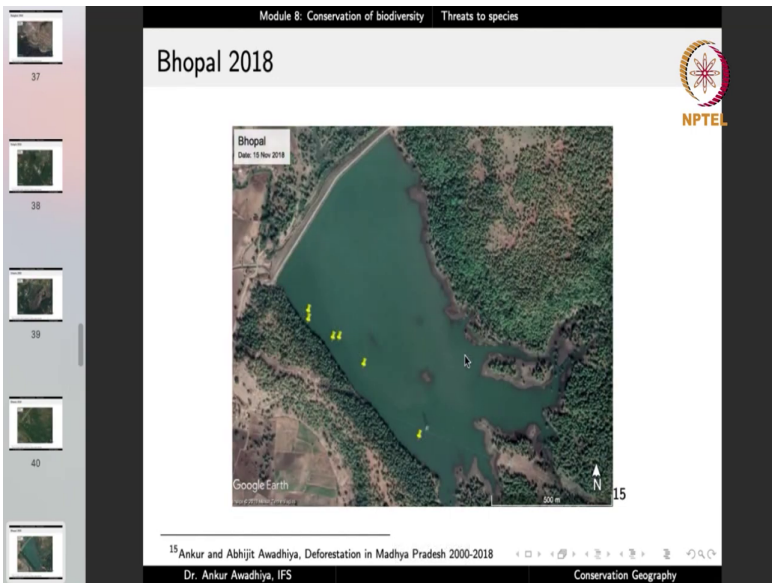

This is from Bhopal district. So, Bhopal in 2003, Bhopal in 2018. So, all of these trees are now lost because this area was converted into a small dam.

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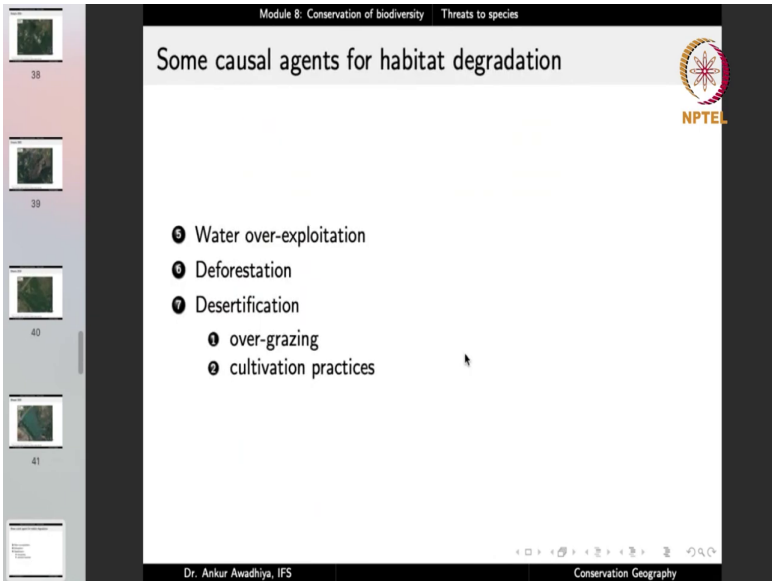

So, these are all different examples of habitat degradation. Another thing is desertification, conversion of habitats into deserts primarily because of over grazing or because of faulty cultivation practices, overuse of water in the case of cultivation practices and over grazing which reduces or completely removes the cover of vegetation from the soil. And once the cover of vegetation is removed, then the soil becomes drier and drier because it is now fully exposed soil and slowly it will convert into a desert.

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So, over grazing, if you look at this area, you are witnessing the conversion of a habitat into a desert because so few plants remain. But then there is a huge goat and sheep population that

is being reared here. So, they will eat up all of these plants and slowly and steadily you will have a situation where there is no more vegetation cover that is left in this area.

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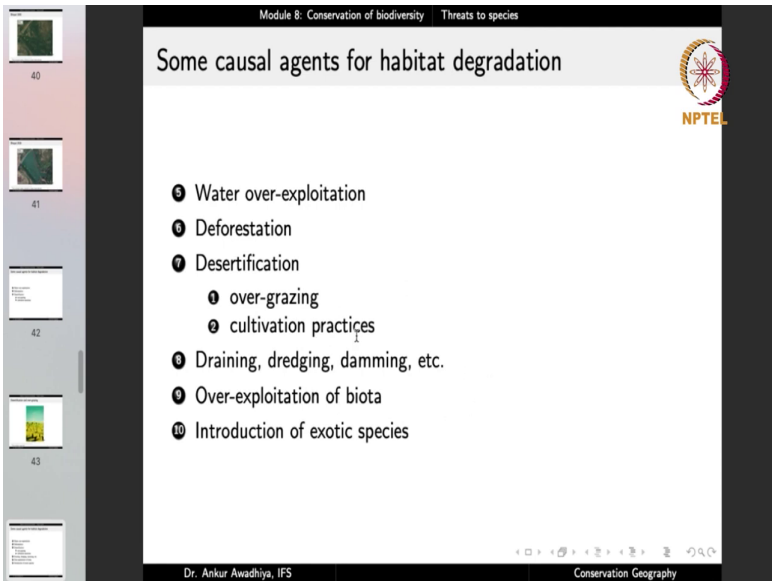

Or draining, dredging, damming. So, when a lake is being drained, when a water body is being grazed if there is a dam that is being created, all of these degrade the habitat. Over exploitation of biota, overfishing, over harvesting. Once that happens, less amount of food is available for the predators, quality has gone down. Introduction of exotic species, species invasive species.

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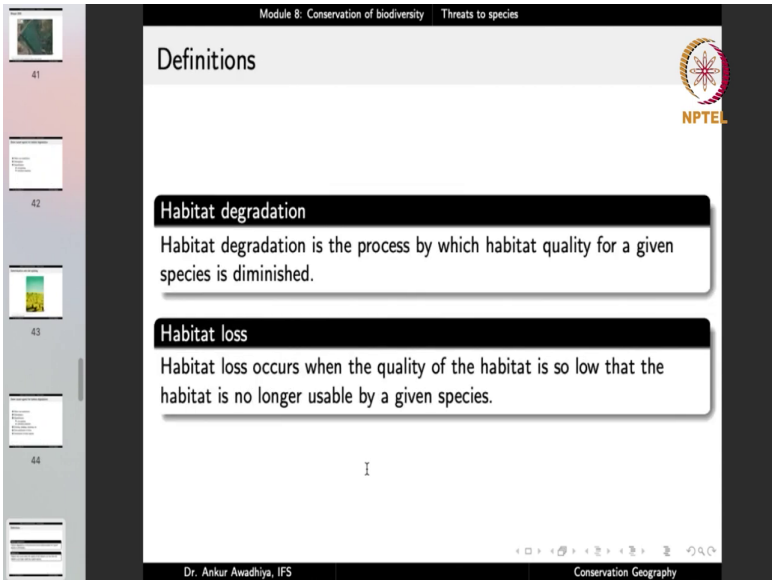

So, this is habitat degradation, reduction of habitat quality. Now, if the quality reduces to such an extent that no more animals are able to live, then we will call it habitat loss. So,

habitat loss occurs when the quality of the habitat is so low, that the habitat is no longer usable by a given species. So, then we will say that the habitat has been lost.

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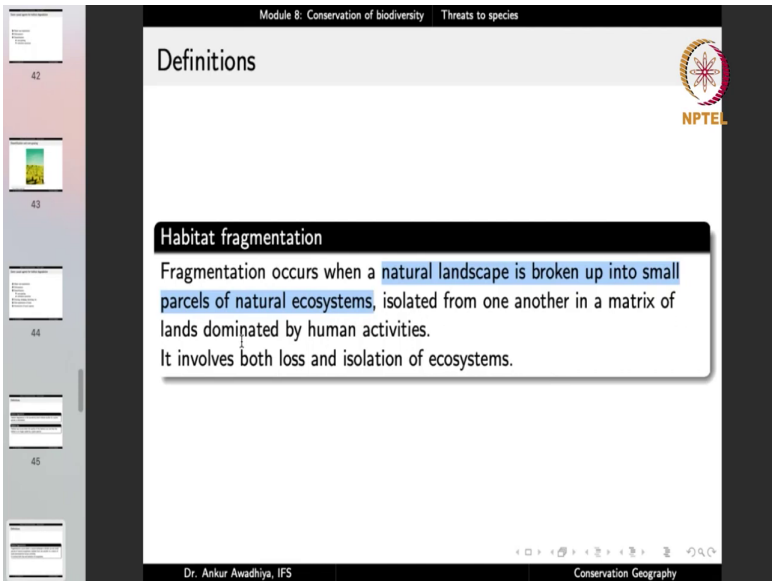

Another thing is habitat fragmentation. Fragmentation occurs when a natural landscape is broken up into small parcels of natural ecosystems isolated from one another in a matrix of lands dominated by human activities. And it involves both loss and isolation of ecosystems. So, when there is habitat fragmentation, then natural landscape is broken up into small parcels.

So, what is happening is that earlier we have a large size forest. And now we have divided these forests into say 2 or 4 parts. Once that happens, it becomes a very tragic consequence for those animals that have large home ranges. Because they consider there is a forest that is supporting, say 10 elephants. Now, these 10 elephants because elephants live in a herd, so essentially, it is supporting one herd of elephants.

Now, this herd moves through different places in the forest in different times of the year to get their food and elephants being mega herbivores, they require lots of food. So, they are moving in different areas of the forest. They are eating up trees, and they are also playing a big role for the ecosystem because they make food available for other animals as well.

But then if you convert this forest into two parcels, so there is a road that has come up through the center of the forest and now you have two small portions and there is so much amount of traffic that now the elephants are unable to cross from one side to another side. So,

in that case, we still have 99 percent of the forest that is remaining, because only 1 percent of the area has been converted into a road.

But now, because you have two smaller parcels, you cannot support one herd in either the first parcel or either in the second parcel. And so, now the habitat has become fragmented and this herd will very soon be lost it will become extinct because it will overuse the parcel where it is existing, it will overuse all the resources and then so less amount of food will remain that the fecundity will go down the herd will stop producing more elephants, there will be density dependent mortality and very soon the animals will become extinct, there will be local extinction.

Whereas on the second parcel, there are no elephants to take care of the ecosystem and slowly that ecosystem will also move towards degradation. So, that has habitat fragmentation conversion of natural landscape into smaller parcels.

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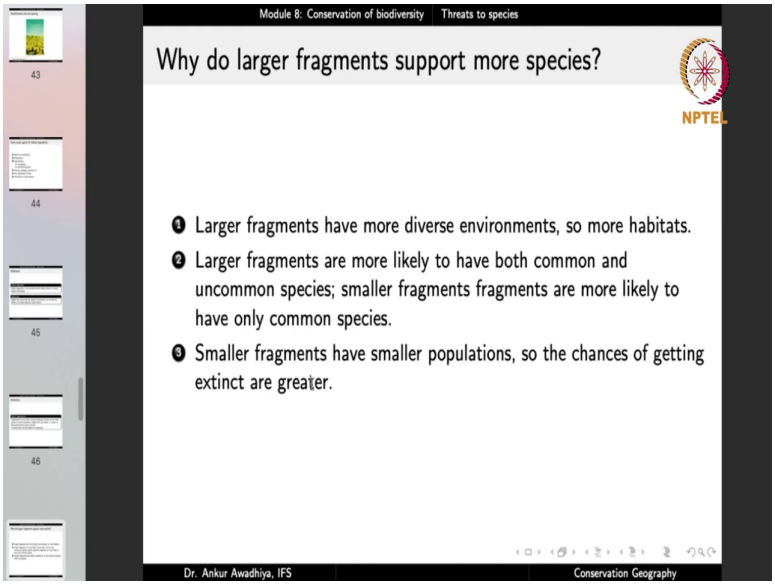

Now, larger fragments support more species because of three reasons. One, they have more diverse environments, more number of habitats so more number of species, they are more likely to have both common and uncommon species whereas smaller fragments are more likely to have only the common species.

Now, uncommon species are typically those that have the larger home ranges. And also, the smaller fragments have smaller populations and so the small population dynamics also plays a big role. So, the chances of getting extinct are greater. So, typically, larger size fragments are vastly more important, vastly more useful for the survival of a species. Once we break

them into smaller fragments, they are of very little utility, even though a large portion of the habitat remains.

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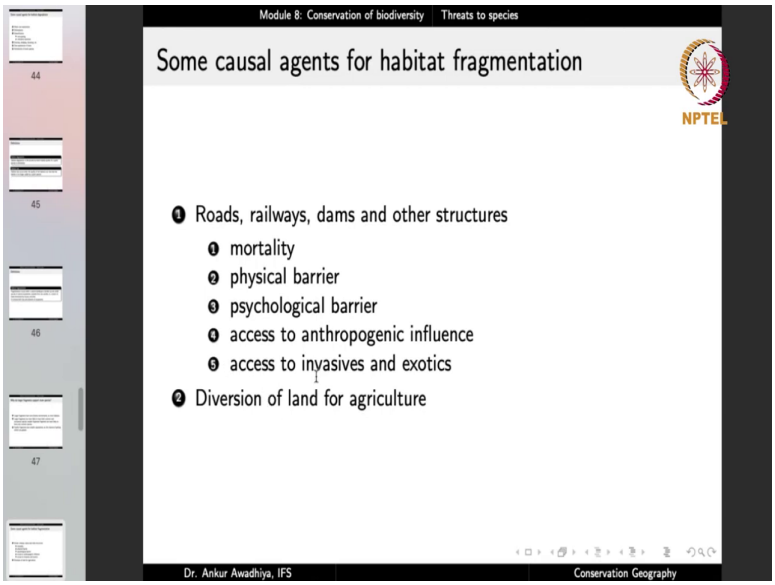

So, what causes habitat fragmentation, we have things like roads, railways, dams, and other structures. So, typically the linear infrastructures, the infrastructures that are in the form of a straight-line things like roads and railways. So, they very easily fragment habitat into smaller parcels. Now, they can result in mortality, when animals get into accidents with fast moving vehicles, the animals will die or there is a physical barrier.

So, in a large number of cases, what we observe is that if there is a road that is moving through the forest, then to prevent the accidents the route department will set up fences on both the sides. Now, once you have fences on both the sides, the animals have no way to move from one parcel to another parcel because there is a physical barrier.

Or a large number of cases the traffic density is so high that so many vehicles are moving, there is so much amount of sound that the animals find it difficult to move from one place to another place, there is a physical as well as a psychological barrier.

Plus, it increases access to anthropogenic influences. Once you have a road then people can get into the forest and once people are getting into the forest, you will find it very difficult to stop poaching and to stop illicit felling of trees. In the case of forests that do not have roads, people do not have access to the interior portions.

So, even though you will find certain amount of poaching on the fringes, the core is more or less safe. But with roads, the even the core areas become accessible to humans. And with

them, we also have access to invasives and exotics. Another agent is the diversion of land for agriculture. So, that also fragments the habitats.

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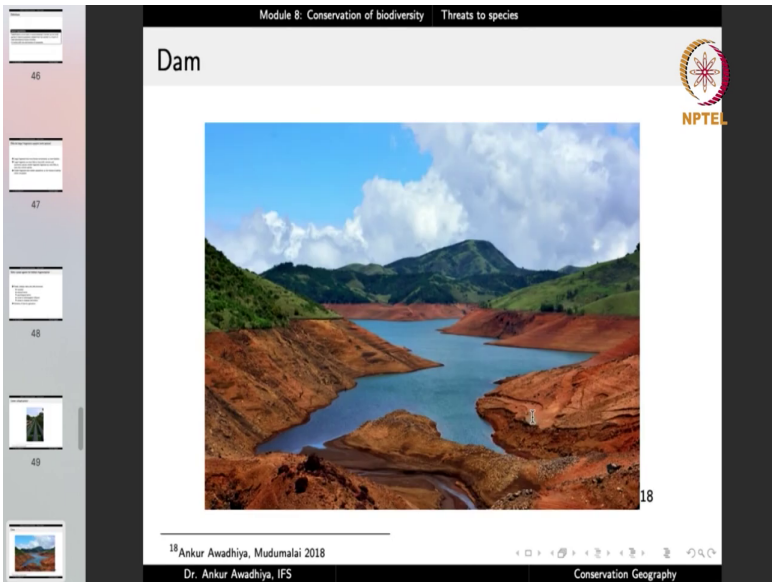

So, we have habitat fragmentation because of infrastructures and agriculture and they can be both linear infrastructures and things such as dams or other infrastructures. So, essentially, habitat fragmentation is playing a very big role. When we are doing development, we are making infrastructures in the name of development.

So, we find that we are putting species through a large amount of threat because of habitat degradation, habitat loss, habitat fragmentation, and we also have habitat displacement that we will consider in the next lecture. So, that is all for today. Thank you for your attention. Jai Hind!