Forests and Their Management
Dr. Ankur Awadhiya
Department of Biotechnology
Indian Institute of Technology, Kanpur

Module - 11
Newer Trends in Forestry
Lecture – 33
Conservation of Wild Animals

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[FL]. In today's lecture, will have a look at Conservation of Wild Animals. Now, forests are not just places where trees are; they are also the places where we have wild animals. And, when we are doing a management of forest, then we also need to take care of the wild animals in that area.

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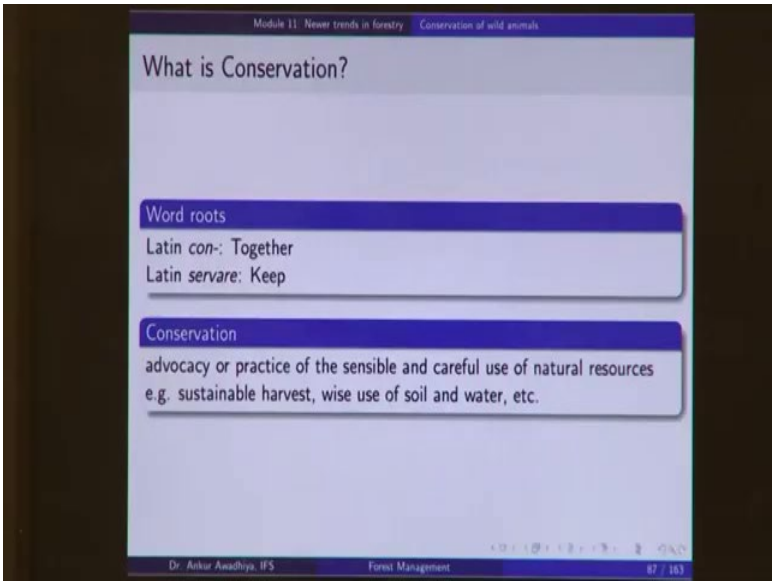

So, let us begin by looking at what conservation is? The word conservation is derived from two words "con", which is; a Latin word which means "together," and "servare" which is another Latin word; which means "keep." So, when we say that we want to conserve; we want to keep together the wild animals; we want to manage the forest in such a manner that we do not lose the wild animals.

So, we want to keep these wild animals together there in the forest without losing them out,; without putting them on a risk to extinction; that is conservation. So, conservation

can be defined as “advocacy or practice of the sensible and careful use of natural resources.” So, it is advocacy; that is you are trying to advocate that people should do this, or people should do that; so, it is advocacy or the practice. In the case of practice, you are actually implementing things yourself.

Advocacy or practice of the sensible and careful use of natural resources. So, you want to use your natural resources in a way that is sensible and which is careful, such as sustainable harvest, wise use of soil, water, and so on.

So, when you have a forest, you have wild animals. If you are saying that we want to conserve these wild animals, it means that you are going to do your forestry operations in a manner which is sensible ,and which is careful to ensure that the animals are not getting wiped off. This in certain cases would even mean that you should refrain from doing any forestry operation in certain areas; these are the areas that we call as the wildlife reserves.

In our country, we have things like; a wildlife sanctuary, a national park, a conservation reserve, a community reserve, and so on. So, these are places where we do our management in such a manner that we prioritize the animals. So, this is conservation.

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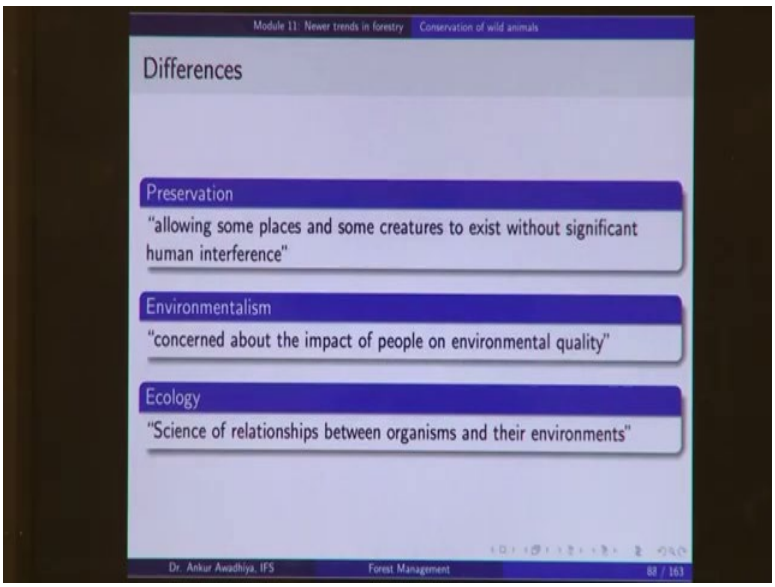

Now, conservation is different from other related terms such as preservation. Now, when we say preservation, it means allowing some places and some creatures to exist without

significant human interference. So, if you say that we are trying to preserve a certain forest, it would mean that you let the forest as it is; you do not do any management intervention in that area. You let nature prevail; so, in that case, we will say that we are preserving a forest.

Similarly, environmentalism is different from conservation. Environmentalism is concerned about the impact of people on the environmental quality; it is not talking about the sustainable use of resources; it is not talking about wise use of resources; it is only talking about environment and its quality. And, it is also different from the field of ecology which is the science of relationships between organisms and their environments. Now, what we are emphasizing is not preservation; is not environmentalism, or ecology in this lecture, but conservation.

So, when we say that we want to conserve the forest and the wildlife, it does not mean that we are not going to do any intervention in that area. It merely means that we are going to do interventions; we are even going to harvest certain resources from that area, but we are going to do it in a manner which is sensible; which is mindful; which is careful to ensure that the plants and the animals are also allowed to live and thrive in that area so that is conservation.

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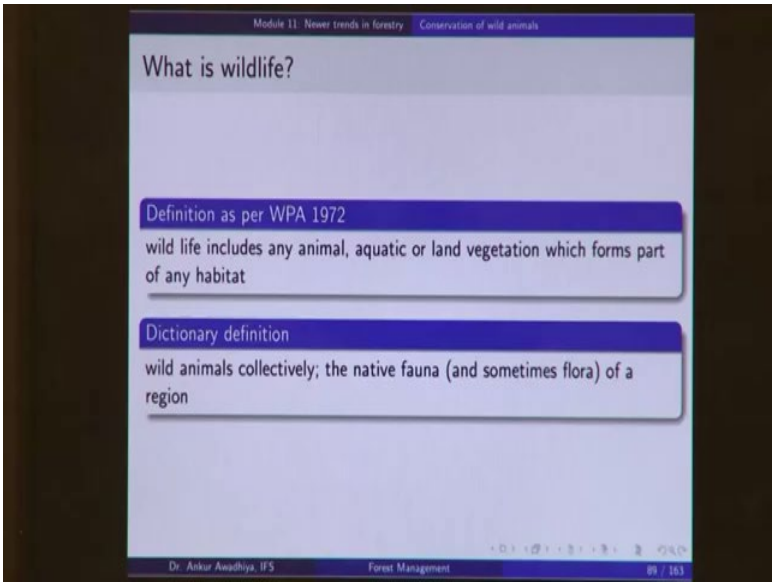

Now, when we say wildlife conservation, what is wildlife? As per the Wildlife Protection Act, wildlife includes any animal, aquatic, or land vegetation which forms part of any

habitat. So, all the plants, all the animals. that are forming parts of any habitat comprise wildlife. And, wildlife is different from wild animal; wild animal is legally only those animals that are listed in the schedules in the Wildlife Protection Act. Now, as per a dictionary; the dictionary definition of wildlife would be, wild animals - collectively the native fauna and sometimes flora of a region.

So, when we say that we are trying to do a conservation of wildlife, it would mean that we are trying to use the wildlife in such a manner, which is sustainable; which is sensible; which is careful. And, why do you have to or why do you need to conserve wildlife? It is mostly because the wildlife serves certain purposes for us.

So, for instance, consider a forest that you are managing for say the purpose of water, or say for the purpose of preventing or avoiding soil erosion. Now, if you want to manage a forest for soil erosion, you would want to ensure that your forest always has certain vegetation; it is never completely denuded. Because, if you have a land that is devoid of the forest cover, then typically the action of rain, water, sunlight etcetera, will be much more greater compared to another piece of land that is covered with the forest.

So, you want your land to be covered with forests indefinitely; but then each and every individual tree that is there on this land has a finite lifespan. So, all these, these trees that you see on a piece of land, they will grow and at certain point of time; they will grow old and they will die off.

So, when that happens; you, and because you wanted to maintain a cover of trees on your land at all times, how do you ensure that? One way out is to ensure that there is always a regeneration. So, whenever an old tree dies out, there are some young trees that are out there to take its place.

But then these young trees; because they are so close to the ground, they are also susceptible to the impacts of certain other animals such as the herbivores. So, if you consider any forest, you will find that there are cows that are getting inside; or there are deer that are living inside; or there are other herbivores such as say Nilgai or Sambar that are living inside; and these herbivores may or will browse or graze upon these young plants.

And, if we do not do anything about that, then probably there could be a situation in which all the young plants die off. And, if that happens, then what will happen? When your old trees die, then you will have a forest where you do not have anything. So, when we say that we want to conserve wildlife, we want to do it because we want to have a forest, and these and we will conserve these wildlife, so that they are able to protect these forest, and how will that happen?

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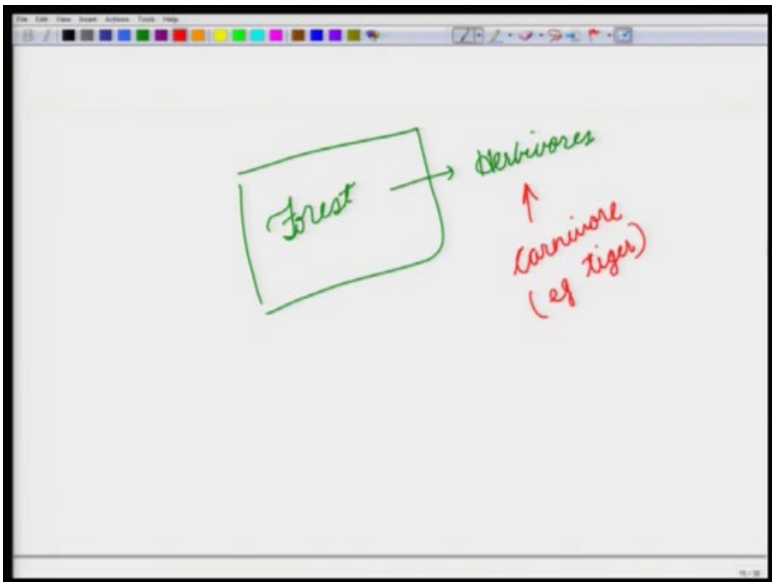

So, suppose you have a forest; and in this forest, you have herbivores, but you do not have any carnivore. What will happen? So, the herbivores are getting plenty of food in the form of these young plants. So, they are thriving well; their population increases. So, earlier, if you were having only 100 animals in this forest; now, you have 500 animals.

Now, as the population size grows, it will need more and more amount of resources; it will need more and more amount of food. So, when the population grows, your young plants are being put to a much greater danger. So, how do you control the population of a herbivore? A simple way out is to introduce a carnivore, Why? Because you do not have an option to kill all the herbivores, because the herbivores are also playing some other role for your forest.

For instance, many of these herbivores are eating up the fruits of the trees. When they eat these fruits, the seeds that are inside are able to reach other areas where they will come out with their dung, and they will start to germinate. Now, if you remove these

herbivores, then probably there will be certain tree species whose seeds are not able to move to other areas, because plants as we know they do not have legs; they do not have wings.

But, because we have these animals, so this, so the seeds or the fruits can move together with these animals. So, we need these herbivores, but we also need to control the population. To do that, we can introduce a carnivore, such as a tiger. So, basically when we say that we are conserving tiger; we are not conserving tiger, because we are very fond of tiger; we are conserving tiger because we have our own selfish needs.

Because we need these forests for meeting certain of our needs; our needs for timber; our needs for water; our needs for controlling soil erosion; our needs for biodiversity different - different medicinal plants; different non-timber forest produce. All of these are being met by certain forest; and for the management of these forests, we require tigers to be there because of which we are conserving the tigers.

So, conservation of wild animals or conservation of wildlife is primarily important, because of the purpose is that the wildlife serve for us. They maintain our forests. They generate revenue out of tourism. They provide jobs to people. They provide water to people by conserving the forest. They keep our dams working for longer by avoiding soil erosion.

So, because of all these purposes, we need to conserve these wild animals. But then, not everybody is aware of or is able to appreciate the utility of these wild animals, because of which certain people go out, and do hunting or poaching of these animals; even though, it is not permitted by law.

Now, because these people have existed for a very long period in our societies; because of such people over time, we have had certain animals that have been put to extinction or to the brink of extinction.

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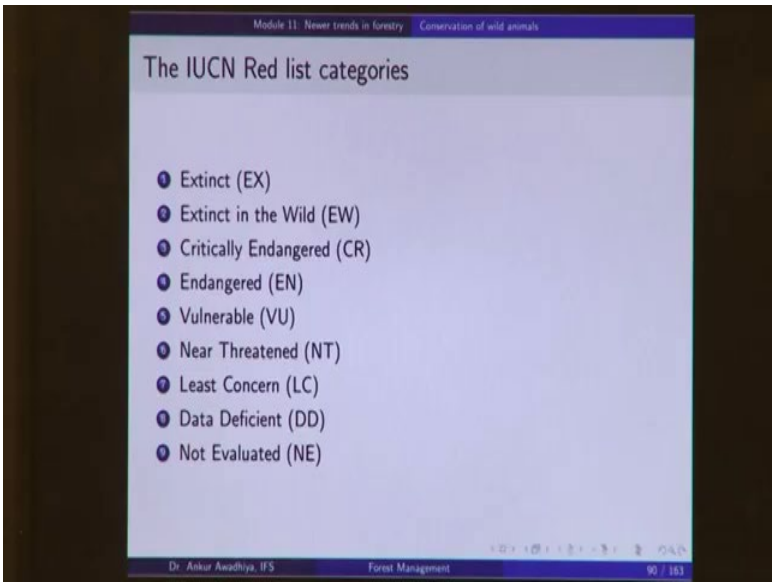

So, we can classify different species as per the IUCN red list categories. There are certain species that are already extinct, such as the dodo (bird). So, this species no longer exists anywhere neither in the wild nor in captivity.

So, this is a species that is now completely gone. And, with the dodo, there are certain trees that are also gone; because they were certain trees that were dependent on a dodo to feed on their fruits and to spread the seeds. They were certain trees, it needed to move through the dodos intestines or to its digestive system, to be able to germinate. So, with the dodo, one the that particular species of tree is also gone.

Then, we have the category of extinct in the wild. So, there are certain animals that are, now, no longer available in the wild. But we have a few animals that are there in captivity, and there is a chance that we can do a captive breeding, and probably release them out in the wild. Or, there is a chance that our captive breeding experiments will not succeed, and say and, those species will become extinct.

So, these are species on the brink of extinction; extinct in the wild. Then, we have critically endangered species, which are slightly less threatened than extinct in the wild. Then, we have endangered species; then we have vulnerable species; then we have near threatened species, and then we have the least concerned species.

Now, least concerned species are those that are found in such large numbers that it is not a concern from the conservation point of view. A good example is cows or buffaloes that are domesticated animals and so, people already care for them. So, they are not of any more concern from the point of view of conservation. Animals like dogs and cats that are cared for as pet animals. Then, there are certain species for which we do not have data and there are certain species that have not yet been evaluated.

So, these are the nine IUCN categories. And, when we say that we are trying to conserve wild animals, then we also need to know which animal belongs to which category. So, for instance, if there is certain species that is say critically endangered or extinct in the wild, then probably we will have to put much more attention to that species, if we want to conserve that species.

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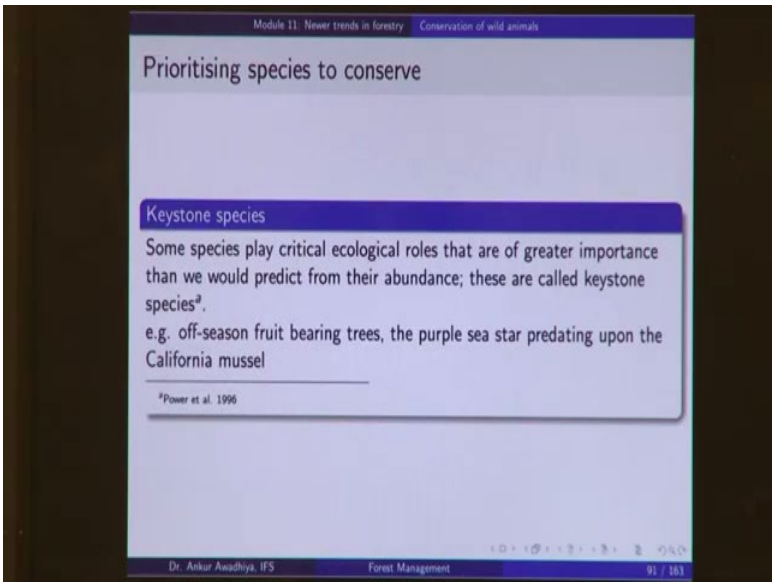

Now, when we talk about prioritizing species, there are three other concepts that we need to keep in mind. The first concept is that of a keystone species. So, some species play critical ecological roles that are of greater importance; then, we would predict from their abundance, these are called keystone species, such as offseason fruit bearing trees, the purple sea star predating upon the California mussel, or a very good example is a Ficus tree.

Now, a Ficus tree, such as banyan or a pipal tree, is a tree that is very highly edible. So, it has fruits that birds can eat; it has leaves that animals can eat; it has flowers that the

animals can eat, and so on. Now, even in a very pinch season; even in a very dry season, you will find that the ficus tree has leaves; it is green in color; it has water; it has food.

So, a single ficus tree is able to support a very large number of organisms. Typically a very large number of birds are able to use this tree, as their source of food. So, conserving a single ficus tree would mean conserving such a huge diversity or such a huge number of birds as well. So, these are the species that we need to be careful about.

So, when you are doing the silviculture operation, and if you see that on your enumeration register, you have certain ficus trees, and then probably you should paint them with a blue color; you should not cut those trees. Now, those trees could also have been cut for timber, but then their utility as wildlife trees is much greater than their utility as say timber trees.

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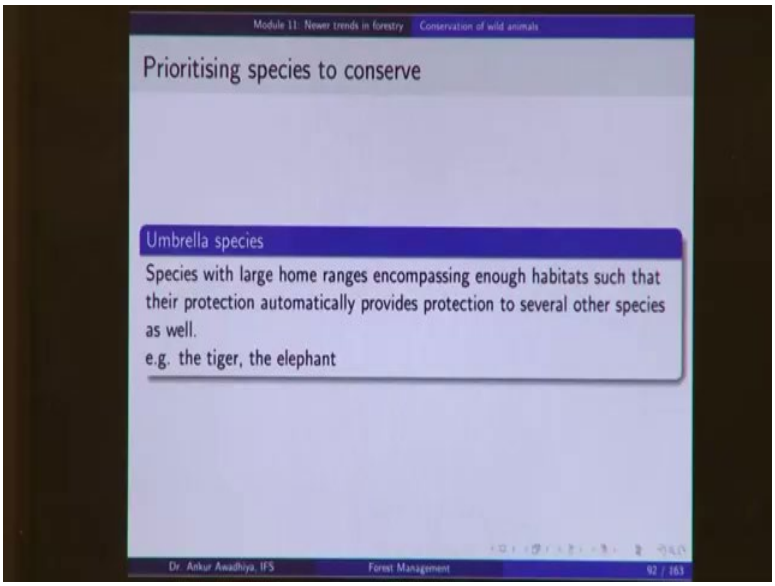

So, this is a viewpoint that you need to keep in mind. Another category is that of umbrella species. Now, umbrella species are, “species which large home ranges encompassing enough habitat such that their protection automatically provides protection to several other species as well,” such as the tiger and elephant.

Now, in our country, a single tiger requires roughly 60 to 80 square kilometers of area to be able to get sufficient amount of food. So, if we say that we are going to conserve tigers, it would mean that for every tiger that we are conserving we are also protecting 60

to 80 square kilometers of land. And, in that 60 to 80 square kilometers of land, there will be so many other birds that lie; that live on that area; there will be so many other animals that live on that area; there will be so many other plants that live on that area.

So, by saying that we are conserving this particular species of tiger, we are able to conserve large parcels of land; we are able to conserve large number of animals; large diversity of animals.

So, these species that go by the name of umbrella species, they just like an umbrella is able to protect a large number of people, because of its large size; similarly because these species the umbrella species have, they have large home range requirements; so, protecting them or conserving them also conserves a large number of other species.

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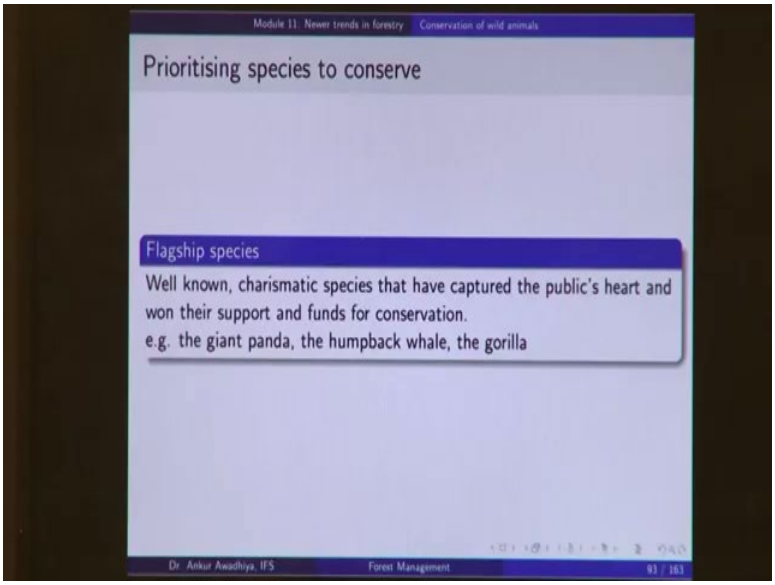

The third category is that of the flagship species. They are well known charismatic species that have captured the public's heart and won their support and funds, for conservation. Such as the giant panda, the humpback whale and the gorilla. So, these are animals that we find to be very cute or to be very powerful or very majestic. So, for some reason, we get emotionally attached to these animals.

So, because public wants to protect these animals; so, it makes much more sense. It is much more prudent to conserve these animals, just because people love them. Now,

when you are planning a conservation strategy for wild animals, you need to look for options in which you are able to combine all these three categories together.

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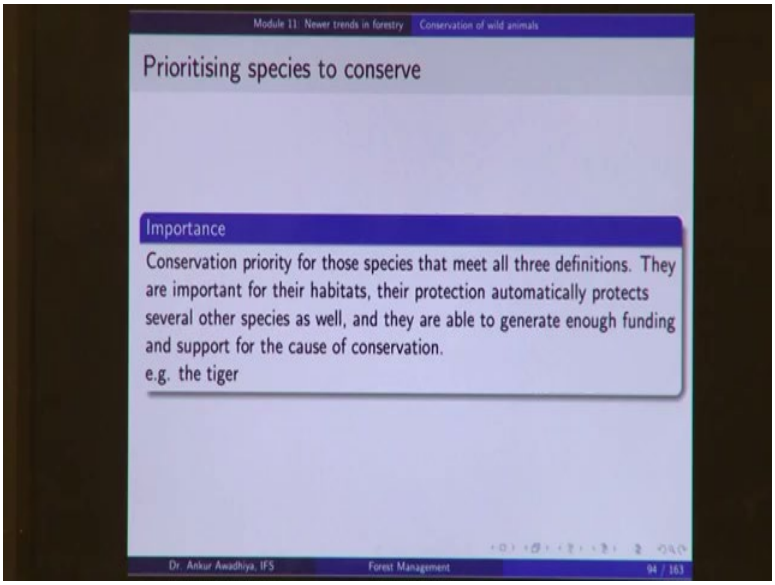

So, if there is a species that is a keystone species; the species is also an umbrella species and is also a flagship species. If you make a plan to conserve that species, then probably it is a very good plan because, because it is a flagship species; so, you will get funds. You will get support for its preservation because it is an umbrella species. So, a large number of a large parcel of land will get protected; large number of species will get protected. And, because it is a keystone species; so, it will probably help in the proper running of the ecosystem which will then conserve a number of other species as well.

So, good species, in this case, are things like the tiger. So, a tiger is a flagship species; we have tiger reserves; people want to protect tigers; tigers have religious importance and tigers are also able to get huge amounts of funds, because people want to see tigers. So, they are flagship species; they are umbrella species; they require large areas.

So, if you conserve tigers, you will also conserve a number of other species that live on that area. And, they are keystone species, because they regulate the size of the herbivore population. So, if you conserve tiger, you will be controlling or regulating the herbivore population in the jungle, which in turn will also regulate the regeneration of plants in that area.

So, this will have a much greater impact than say conserving a herbivore or say conserving a plant species. So, tiger is a very good species to conserve, because it meets all the three criteria; it has a flagship species, its a keystone species, it and it's an umbrella species. So, if we know these classifications, it helps us to choose which species to prioritize, because our aim is to conserve the whole area our aim is to conserve the wildlife. And, by choosing these species, we will be much easily able to accomplish our goal.

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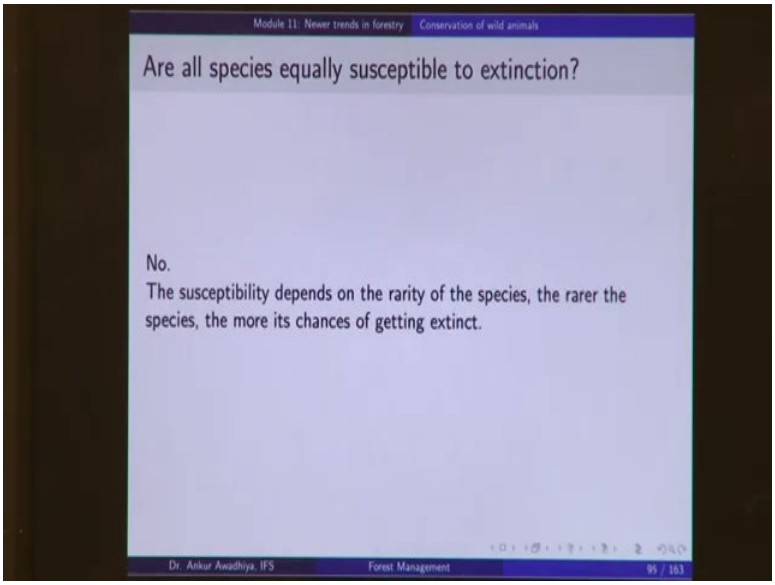

Now, when we talk about conservation, all species as we saw before are not equally susceptible to extinction. The susceptibility depends on the rarity of the species. And, if there is a species that is rarer, there is a greater chance that it will get extinct.

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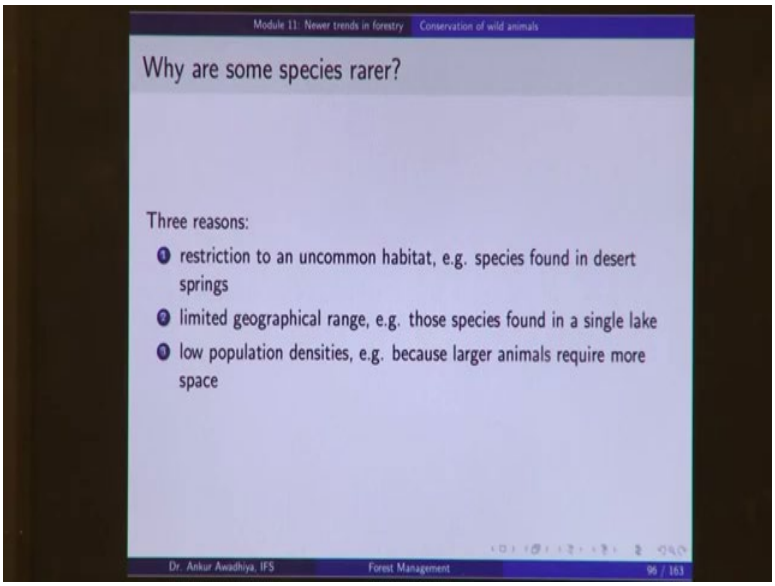

And, what sorts of species will be rarer? If there is a species that is restricted to an uncommon habitat; a species that has a limited geographical range; a species that has low population densities. So, these species are rare species and so, there is a greater chance that they will very easily get extinct. And, if there is a chance, then there is also an opportunity to prioritize conservation in such a manner that we are able to save these species.

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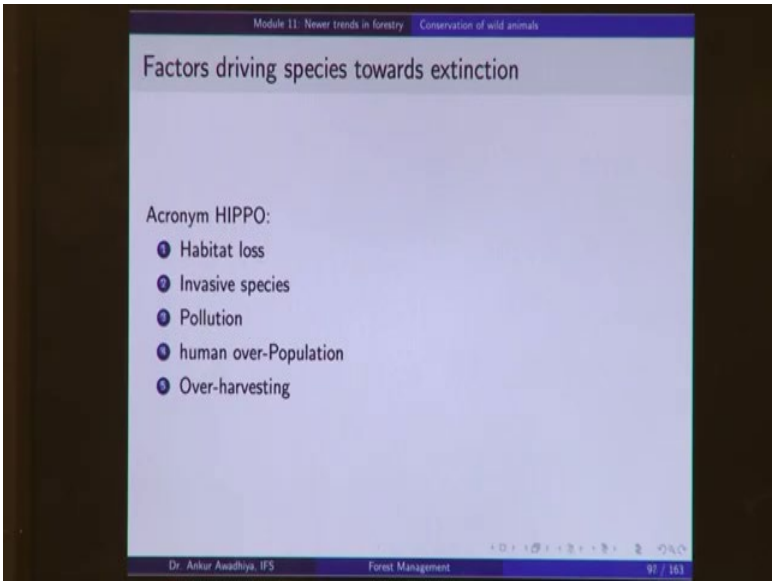

Now, when we want to do conservation, we need to know the factors that drive species towards extinction, and as we saw before these are the HIPPO factors. Habitat loss, invasive species, pollution human, overpopulation and overharvesting. So, if you know the causes of extinction, you can work on those causes and you can ensure that the species do not get extinct.

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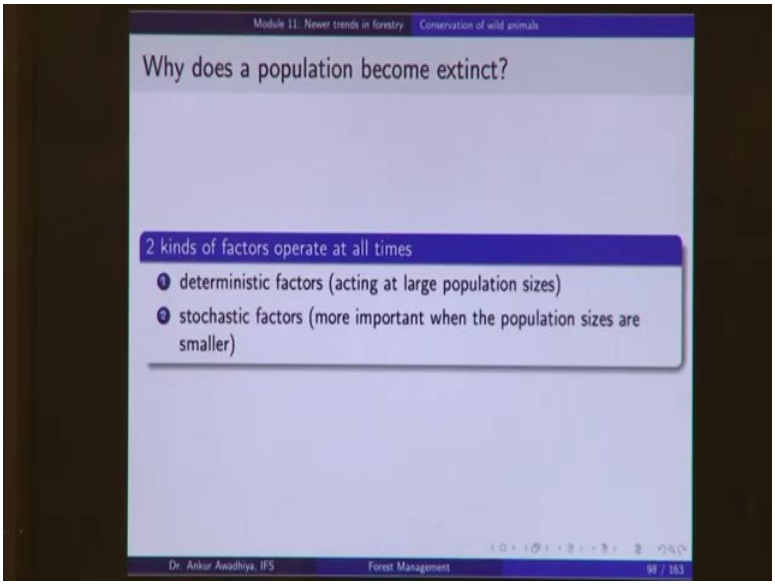

Then, we saw before that a population becomes extinct, because there are two kinds of factors that are operating at all times; the deterministic factors and the stochastic factors.

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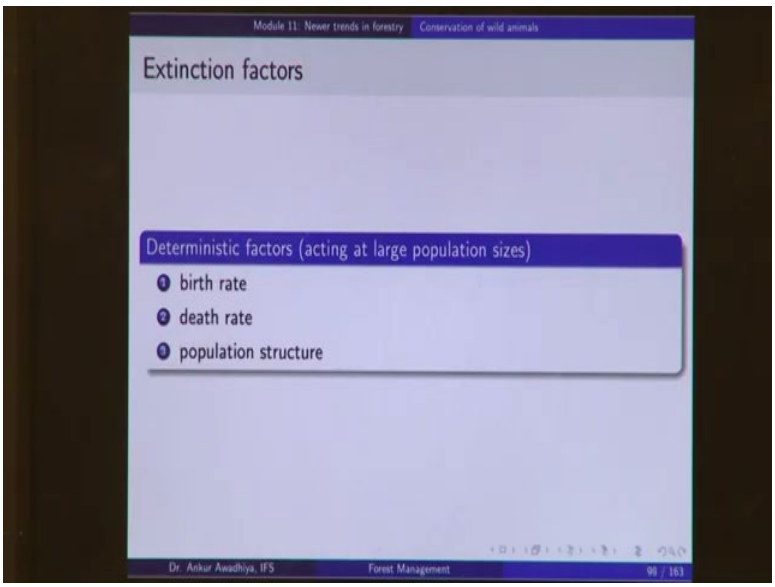

We have seen the deterministic and the stochastic factors, and the impacts of humans.

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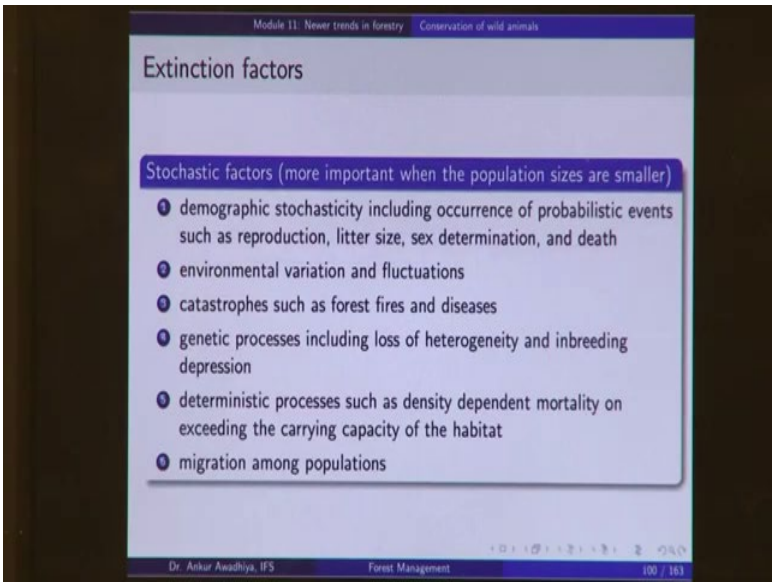

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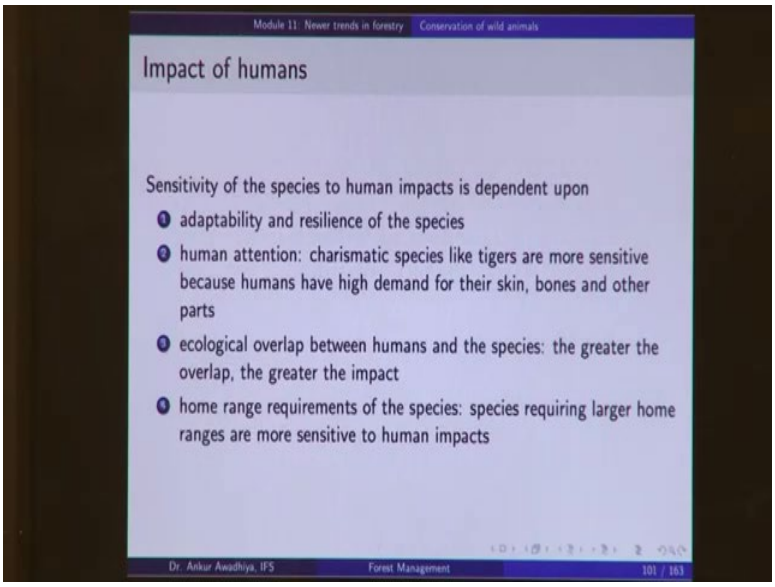

So, for instance, if there is a species that is less adaptable, then it will be more susceptible to extinction. If it is less resilient, it will be more susceptible; if you have human attention on species such as tigers, then those species will have a much more precarious condition for extinction. If there is an ecological overlap between humans and the species, then there will be a greater chance of the species getting extinct.

A good example is those species that use the same grasslands that are being used by our mulch animals. And, if there is a species that has a very large home range requirement then, it and, then there is a greater chance of this species getting extinct, because it is difficult to provide large uninterrupted areas to these animals.

Now, we have seen these factors; we have seen these impacts. Now, the question is what can we do about then? So, if we want to do conservation, what are the options that are available with us? Now, the biggest thing to keep in mind, is to be mindful of the conservation of animals. So, for instance, we saw before that when we are doing the silvicultural prescriptions, we first of all remove the dead, dying and diseased trees.

Now, the dead, dying and diseased trees are not useful from a silvicultural point of view, but what from the point of view of animals? So, if you have a tree that is dead; so, probably, it is infested with termites; probably it has a large number of holes on its body, and these holes are also being used as nesting regions or roosting regions by different birds.

Now, if you remove this tree, then those birds will also lose their homes. So, these trees, which are known as snag trees, need to be preserved; need to be conserved, if you want to conserve wildlife. So, it is just a matter of knowing what to do and what not to do. The other options are the options of *in situ* conservation and *ex situ* conservation.

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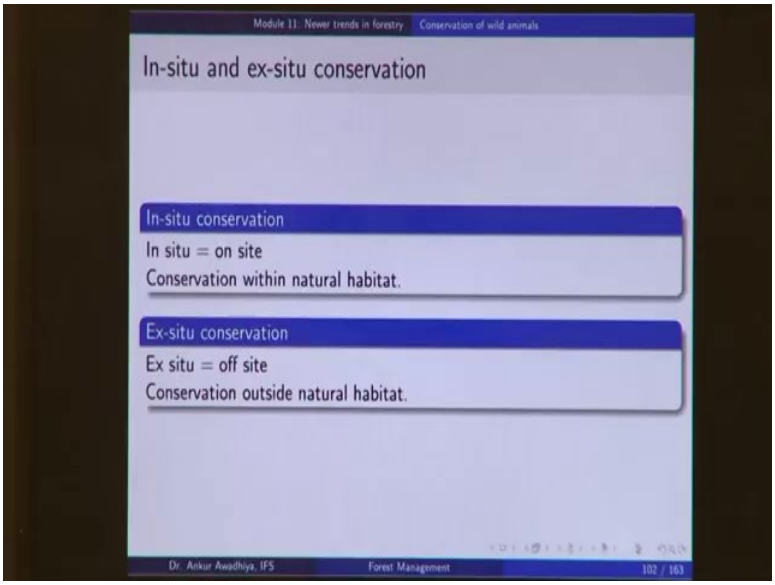

Now, in situ; it means ‘on site.’ So, in situ conservation is conservation on the site or conservation within a natural habitat. So, for instance, tiger lives in a forest; if you conserve a tiger in the forest, then you are doing in situ conservation. On the other hand is the ex situ conservation, which is ‘out of site or off site.’ So, it is conservation outside the natural habitat.

So, a tiger lives in the jungle; but you take this tiger out, because you think that there is a great poaching pressure on this animal; so, you bring it out. You keep it in a zoo and you are caring for this animals. So, this sort of a conservation is known as ex situ conservation, because you are not caring for or you are not conserving the tiger inside the forest; you are conserving it outside the forest.

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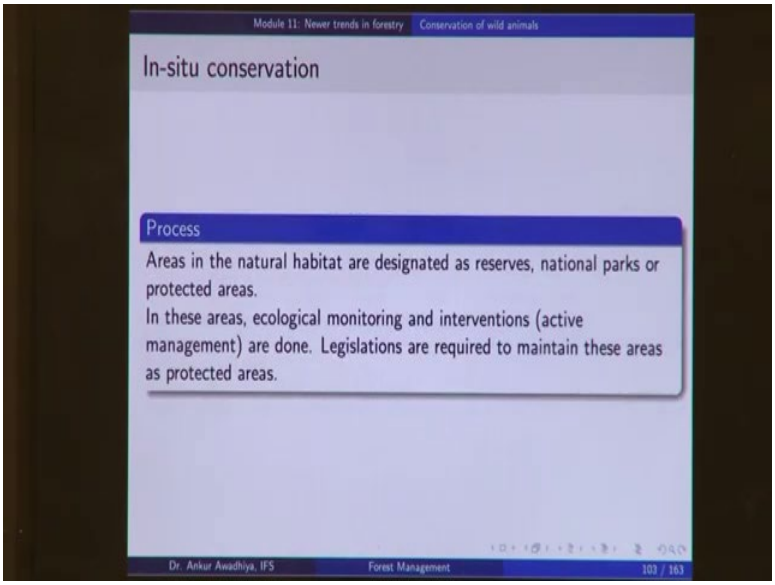

So, these are the two options in general that we have. And, how do we do these in situ conservation? Areas in the natural habitat are designated as reserves, national parks or protected areas. In these areas, ecological monitoring and interventions active management are done, and legislations are required to maintain these areas as protected areas.

To give an example, if we talk about the Kanha national park is tiger reserve. In that case, the forest that were having a large biodiversity, they were designated legally as national park and tiger reserve, and the interventions that we do in this area are primarily focused towards the wildlife.

So, for instance, we will not be doing enumeration and marking of trees in this area because we are not interested in removing the timber; we are more interested in conserving wildlife in this area. So, our interventions would be the enumeration of wild animals; our interventions would be provisioning of water to wild animals, maintenance of grassland, since such a manner that the herbivores are able to get sufficient quantity of food.

So, here again, we are doing the management operations, but in such a manner that our objective is more inclined towards the conservation of animals.

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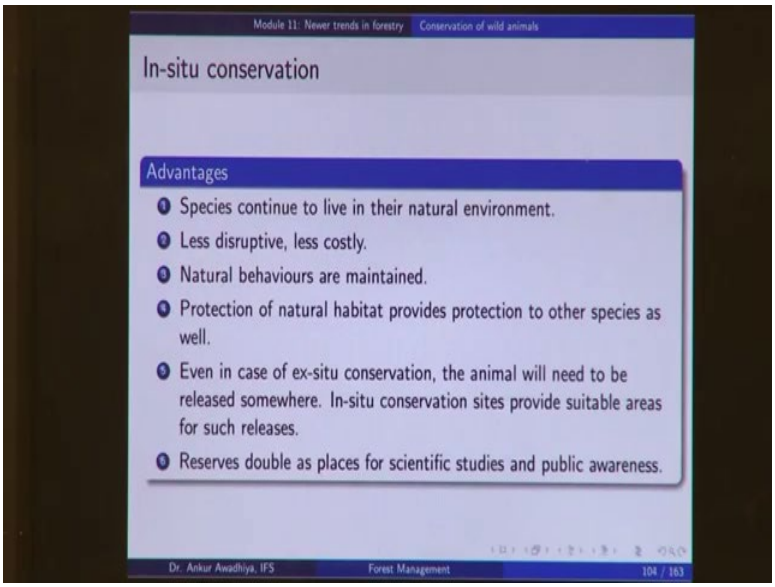

In situ conservation has several advantages; the species continue to live in their natural environment. It is less disruptive, less costly; there is hardly anything that you need to do. You just need to delineate this area; say that this area is a sanctuary or a national park or a tiger reserve, and nature will take care of itself. There is hardly any intervention that you need; the only intervention is that of monitoring. And, if something goes wrong; if there is a disease that has spread in this area, probably you will control that; otherwise, you will just protect this area. So, it is less costly.

Then, natural behaviors of animals are maintained. Protection of natural habitat provides protection to other species as well, which was primarily why we wanted to conserve the tigers, because their conservation also conserves other species. Even, in the case of *ex situ* conservation, the animal will need to be released somewhere; *in situ* conservation

sites provide suitable areas for such release. And, this reserves double as places for scientific studies and public awareness.

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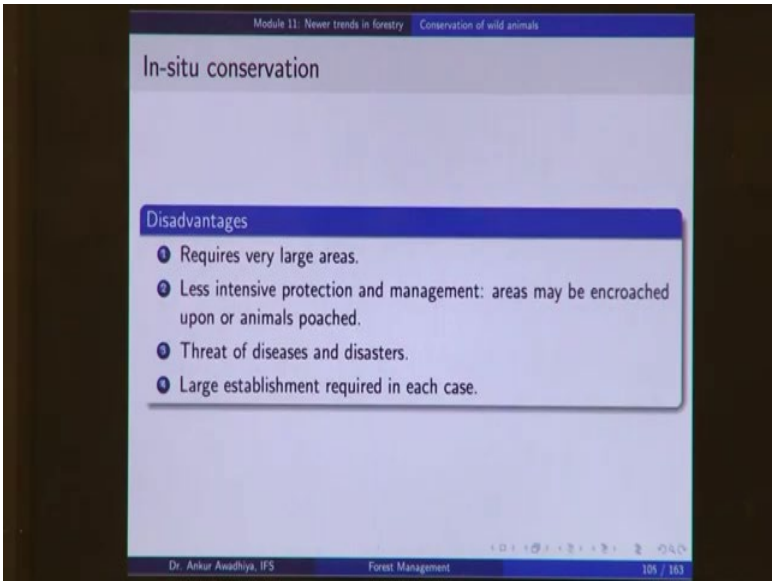

But then, they also have disadvantages. They typically require larger areas. There is less intensive protection and management; the areas may be encroached upon, or the animals may be poached, there is a threat of disease and disasters. And, a large establishment is required; typically, because the area is large.

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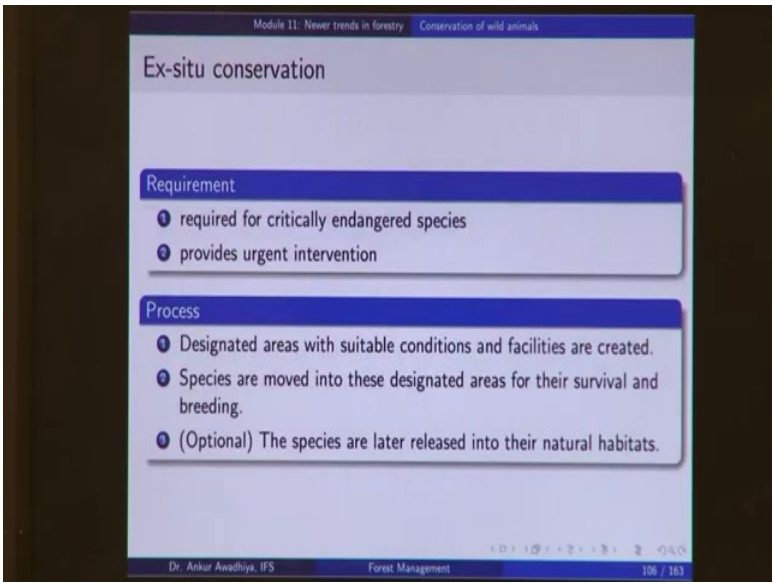

On the other hand, in the case of ex situ conservation, that is typically required for critically endangered species. Because, if there is a species in which say only 20 individuals are left ,then you cannot let them remain in a jungle. Because there is a good chance that some poacher may come and poach up on these animals, it is much better to take them out of the natural environment, keep them in an area where they are monitored 24 by 7, in a more intensive manner.

They are given the best food; they are given the best veterinary here to ensure that these animals survive. So, in the case of critically endangered species, ex situ conservation is at times the only option that is left with us, and it provides urgent intervention. The process is to designate areas with suitable conditions, and to create facilities such as zoos. Species are moved into these designated areas for their survival and breeding, and optionally, when the numbers have increased, the species are then released back into the natural habitats.

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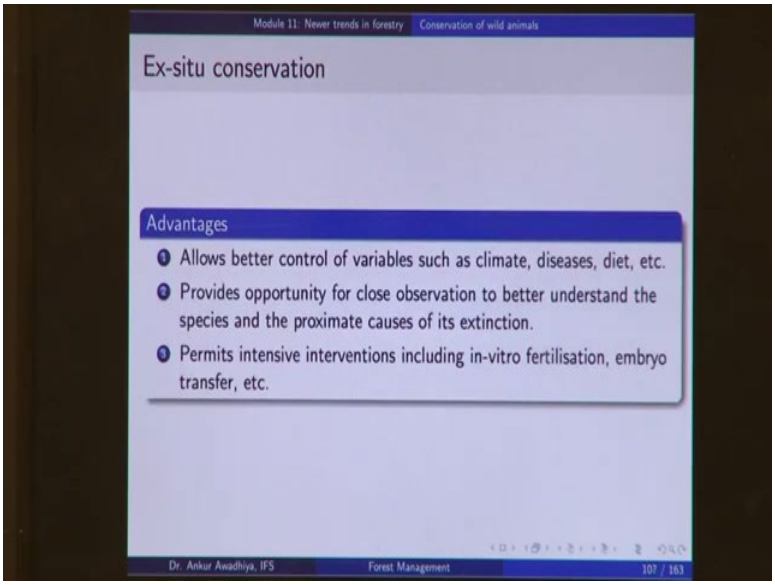

Advantages. It provides much better control of variables such as climate, disease, diet and so on. Provides opportunity for close observation and permits intensive interventions including in vitro fertilization, embryo transfer, and so on.

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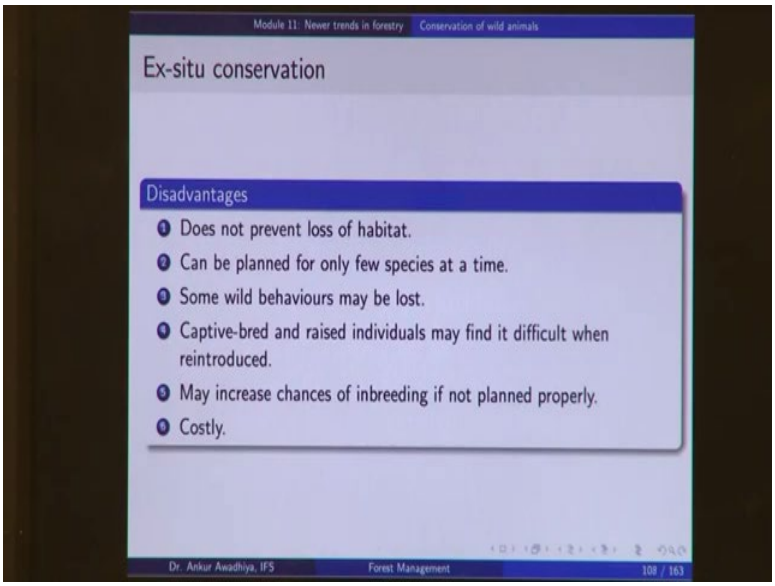

The disadvantages are that, it does not prevent the loss of habitat. So, you are conserving a certain species, but then all its home is lost. Then, it can be planned for only a few species at a time; the wild behaviors may be lost, because a tiger that is hand reared in a zoo, probably, does not know how to kill an animal for its food. Because the only thing that it knows is that, every day say at 5 o'clock in the evening, a door opens and the food comes in.

So, in that case, it may lose its natural behavior; its natural instincts of hunting. Then, captive bred animals and raised individuals may find it difficult when reintroduced because they have lost the wild behaviors; it may increase chances of inbreeding, if not planned properly, and it is costly.

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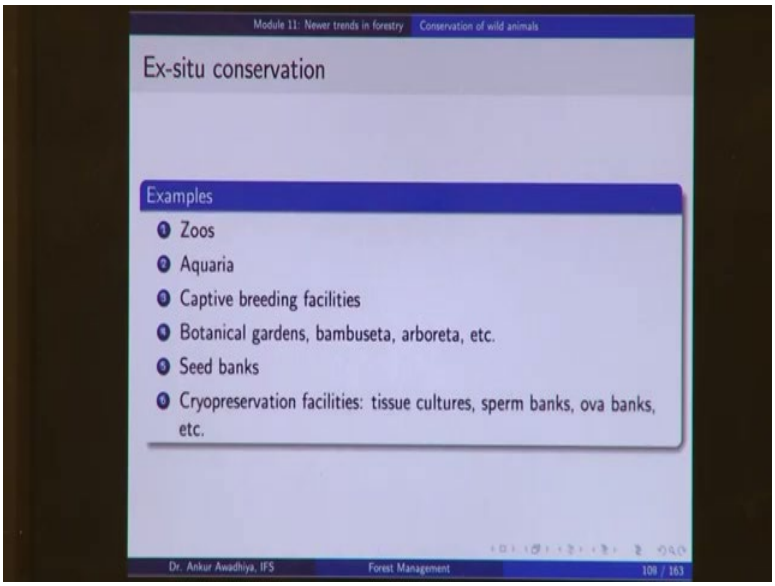

Examples include zoo, aquarium, captive breeding facilities, botanical gardens, bambuseta, arboreta, seed banks, cryopreservation facilities and so on.

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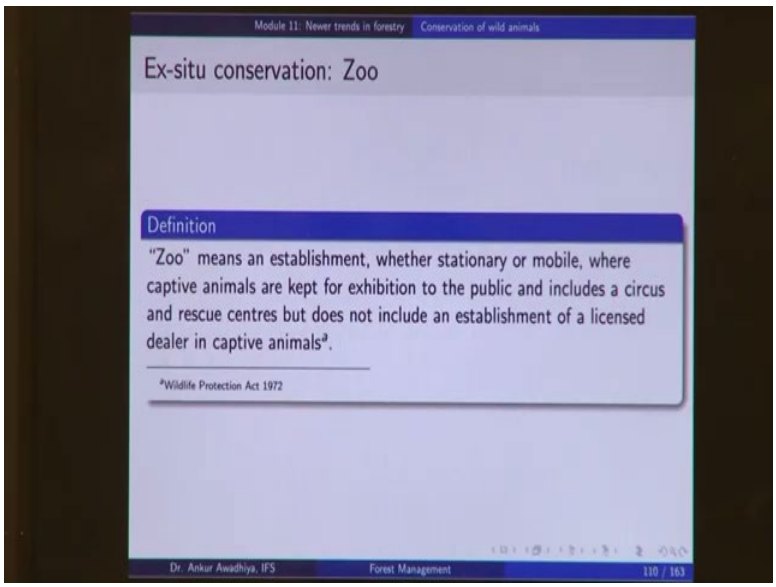

So, let us now have a look at one ex situ conservation methodology, which is a zoo. Now, as per the wildlife protection act, a zoo is defined as, "an establishment whether stationary or mobile, where captive animals are kept for exhibition to the public and includes a circus and rescue centers, but does not include an establishment of a licensed dealer in captive animals."

So, basically, you can have a stationary zoo or you can have a mobile zoo; animals are kept here typically for exhibition, and it includes circus and rescue centers.

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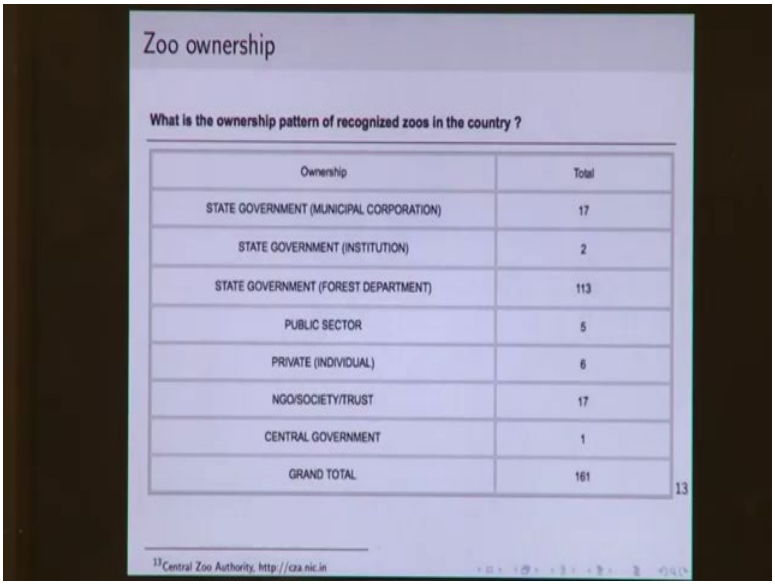

In our country, the zoos are owned by either the state government, as Municipal Corporation, or as institution, or as forest department. There are also some public sector zoos; there are also some private or individual zoos; then there zoos under NGOs or societies or trusts; there is one zoo under the Central Government, and this brings our total to 161 zoos.

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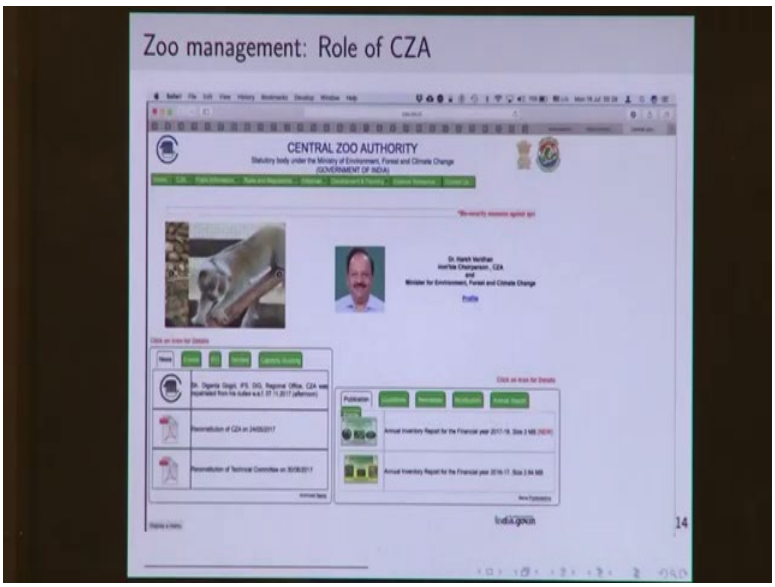

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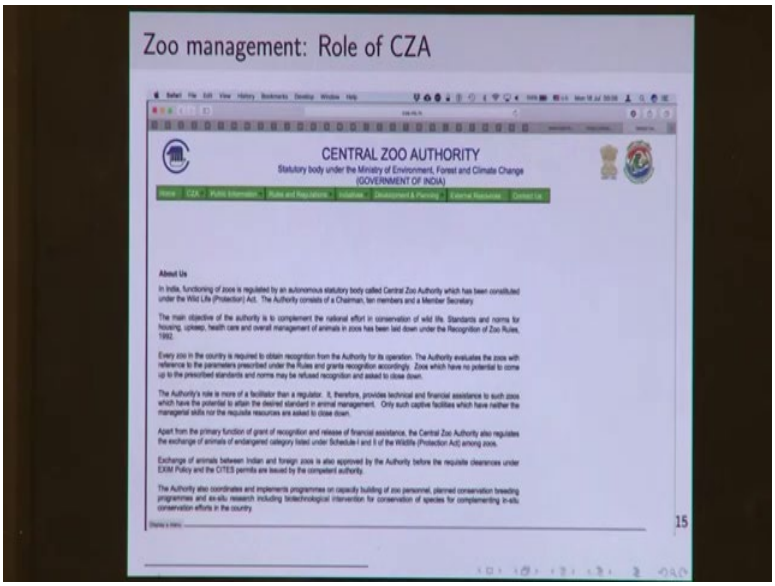

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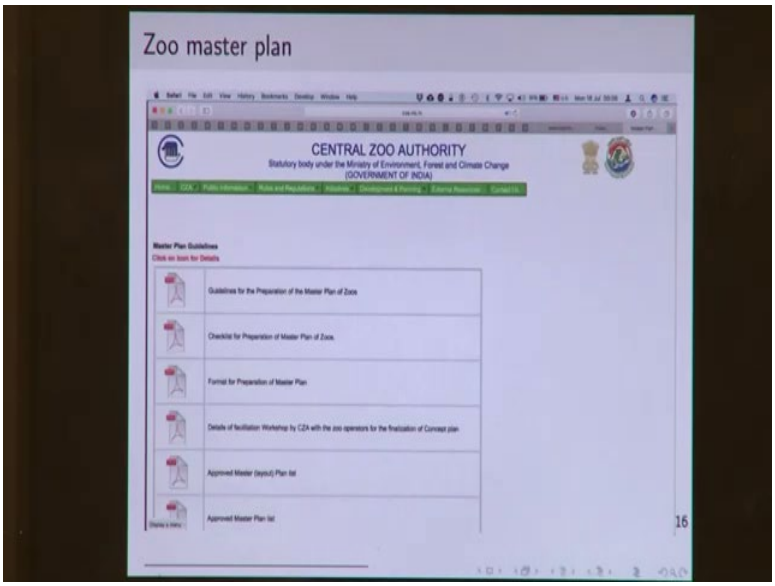

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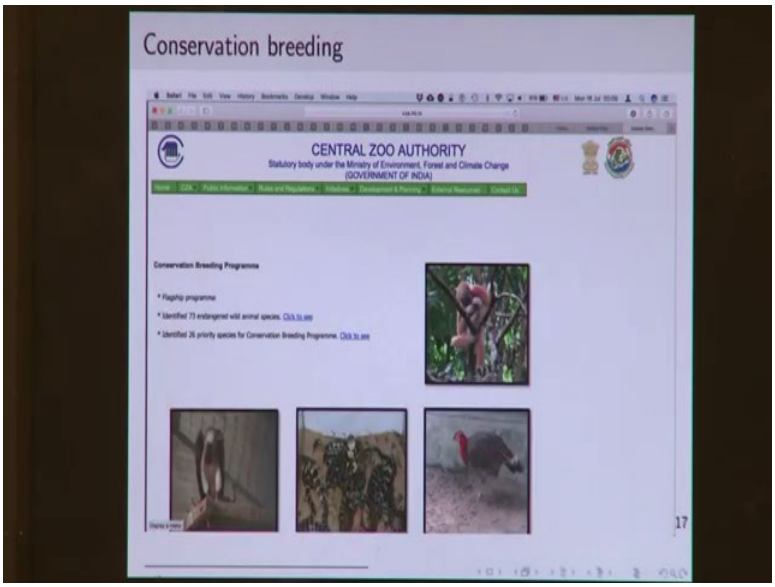

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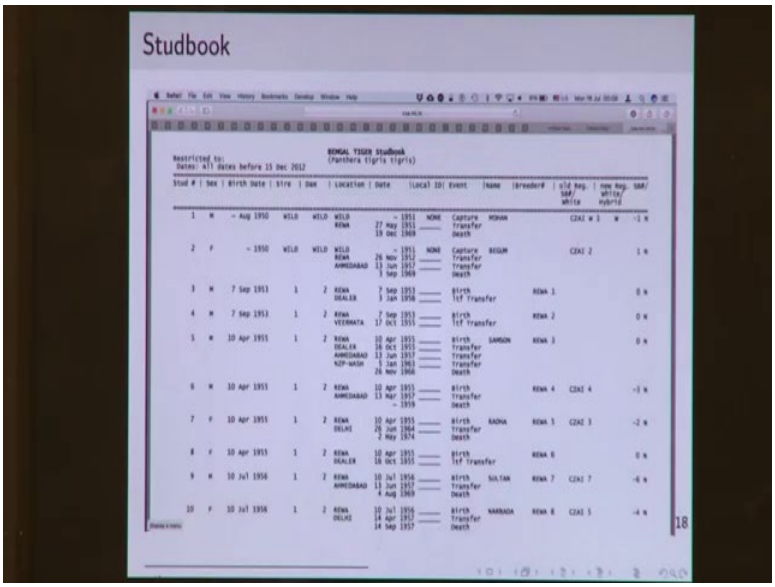

Zoos are governed by the Central Zoo Authority, which helps create a master plan; which helps in conservation breeding of animals; which maintains the or which defines the standards in which the studybooks are to be maintained.

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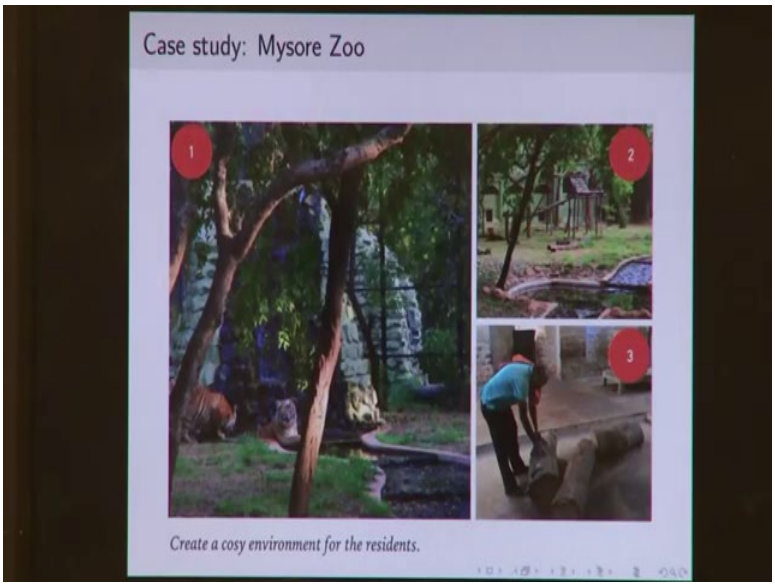

So, what is there in a zoo? Typically, in a zoo, there is a good environment where the animals are kept. So, there will be enclosures here; you can see that we have these tigers; there is this enclosure; there is this waterfall; there is some grass, so that this animal feels comfortable. Then, even when these they are provided with these logs, so that they can maintain their natural behaviors of scratching.

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There is quality feeding material that is provided to these zoos; to the animals in these zoos. So, typically, we have very good kitchens; there are also some animals that are

captive bred to be used as food for different animals. So, for example, this white mouse is being captive bred inside the zoo, so that it can be fed to these snakes.

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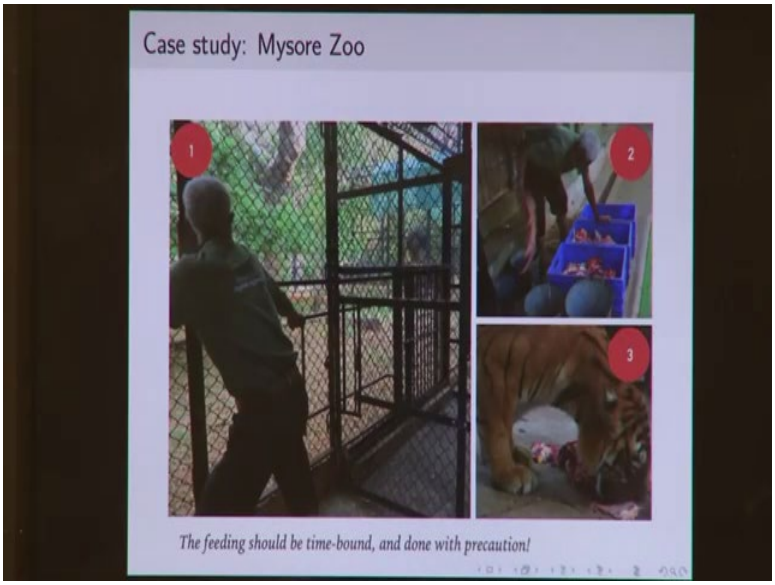

Then, the feeding is done in a time-bound manner.

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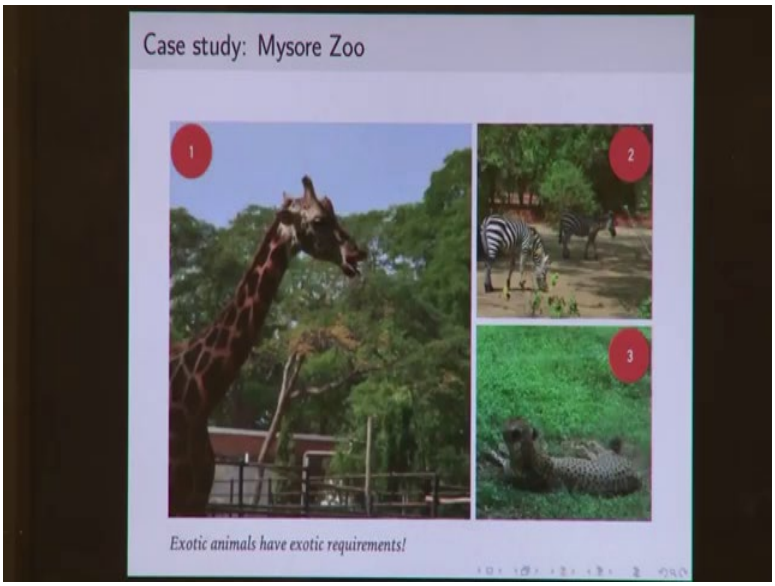

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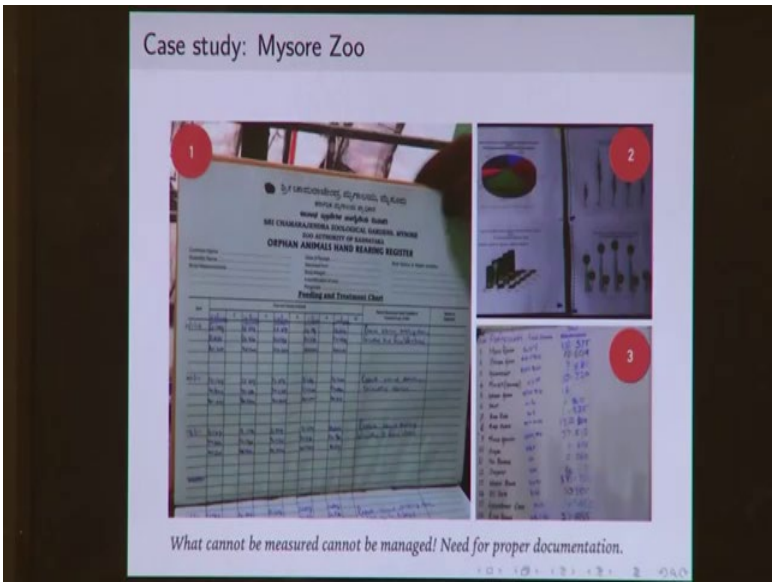

Even in the case of exotic animals, we have exotic requirements, so they have to be maintained; landscaping is done; records are being maintained. Now, this is very important, record such as studbooks, record such as visitor books, records such as such as captive breeding books, records such as records of veterinary treatments that are provided to different animals, records of what food is given to which animal on which day.

So, if there is an animal that is now not eating properly, then probably it that animal is having certain diseases. You will not know about the condition of the animal, if you do not have a record of how much amount of food this animal eat on every day. So, there is a good amount of documentation that is also needed in a zoo.

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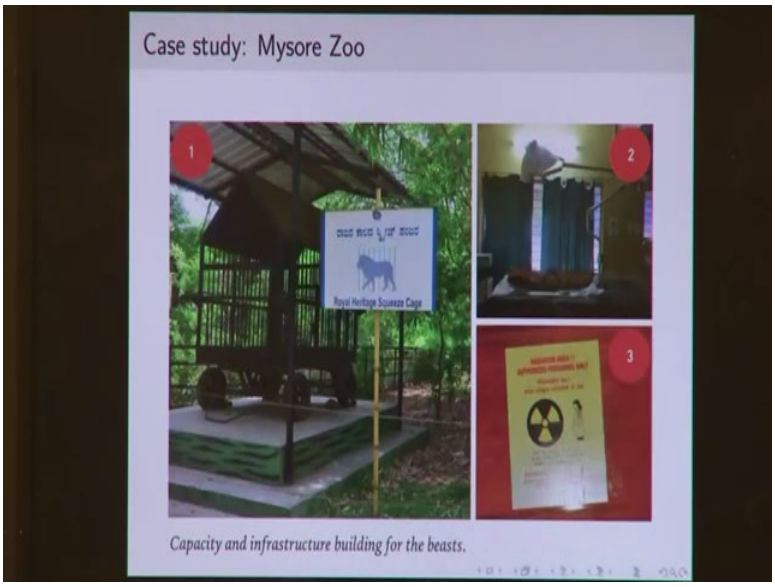

Then, there is capacity and infrastructure building, research, and in reach activities are essential.

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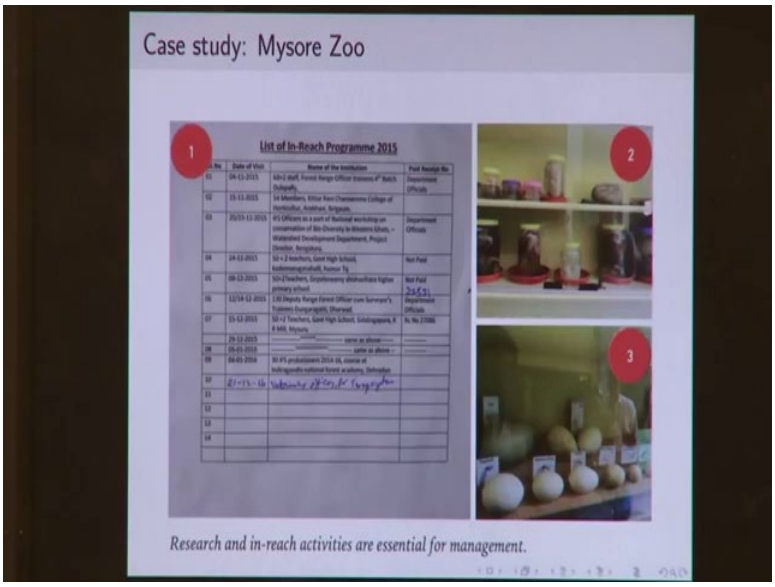

So, at all times of one major reason, why we create a zoo is that we are able to observe the animals more closely and this provides an opportunity for research. This provides an opportunity to understand their behaviors, which later on can be used for conserving these animals. For instance, if we know what sorts of breeding partners are being favored by a particular species, then probably we can do some amount of matchmaking to ensure that more and more number of individuals get born.

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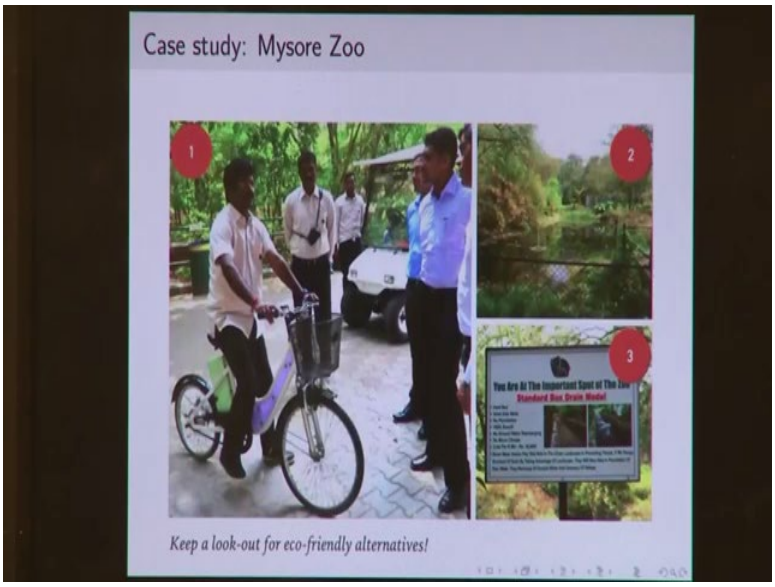

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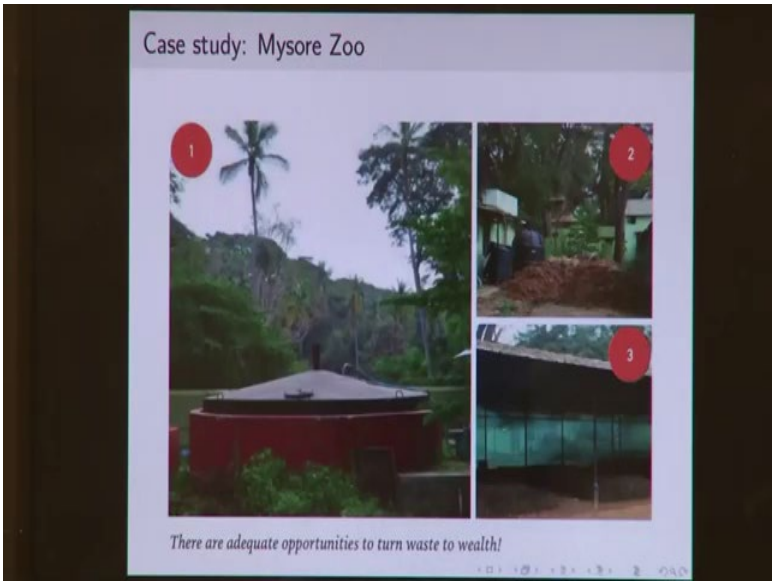

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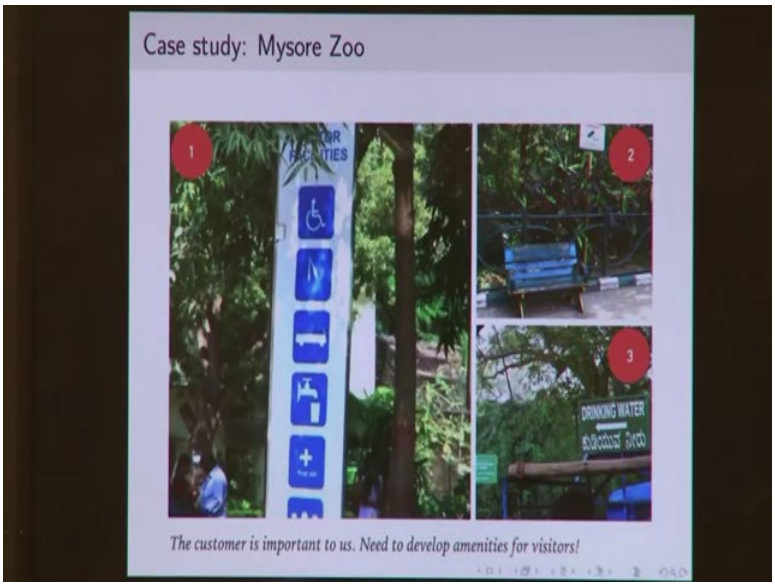

Typically, we these days; we emphasize ecofriendly activities and we have amenities for visitors, because remember that a zoo is typically a place where the animals are exhibited. So, when there is an exhibition, people will be coming into that area and if people are coming, then a zoo will also be having public amenities.

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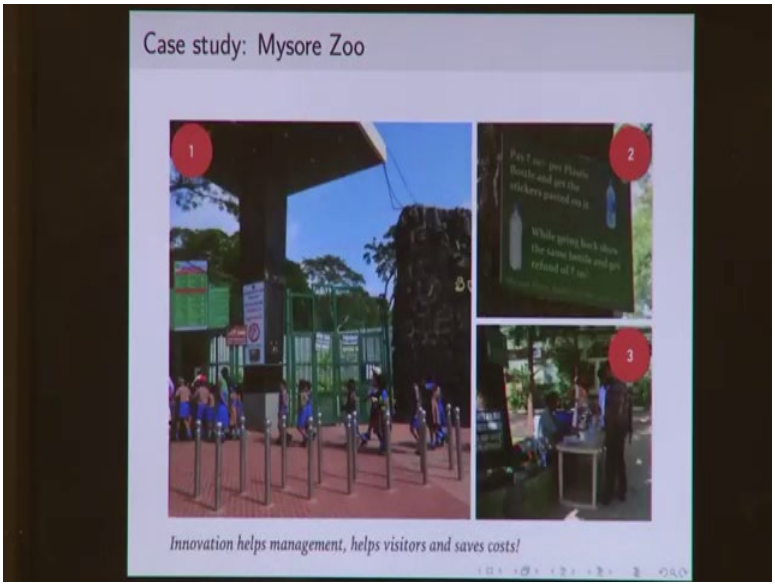

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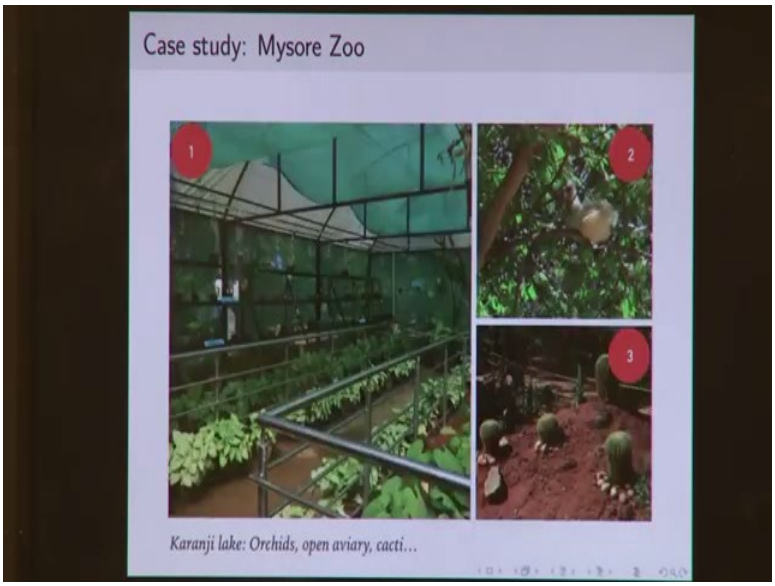

Then, we have innovations, then typically in a zoo we also conserve other organisms such as orchids; we typically, we have open aviary, cacti and so on.

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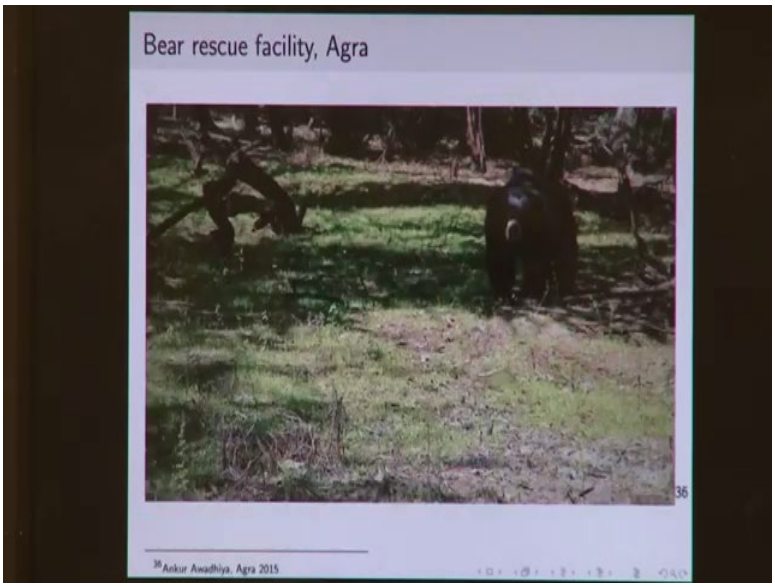

Now, there are certain zoos, such as this zoo in Agra, which is for the rehabilitation of the bears; the sloth bears. Now, this zoo in particular focuses on those animals that have been rescued from the Madharis or from different circuses.

Now, if there is an animal that was raised by a Madhari, and is trained to show some sort of dancing patterns, then if you just leave this animal out into the jungle, it will probably die out of starvation, because it does not know how to search for food; it does not know how to search for water; it does not know how to protect itself. But, then these animals can at times be used for captive breeding purposes.

So, if you have a facility where these animals are kept, then probably they will be useful say in the next generation, or at least in this generation. They can be used to observe the behaviors and to facilitate the understanding of general public about the need of conservation. So, in this zoo or in this rescue centre, the animals are kept in a very natural environment and they are left in peace.

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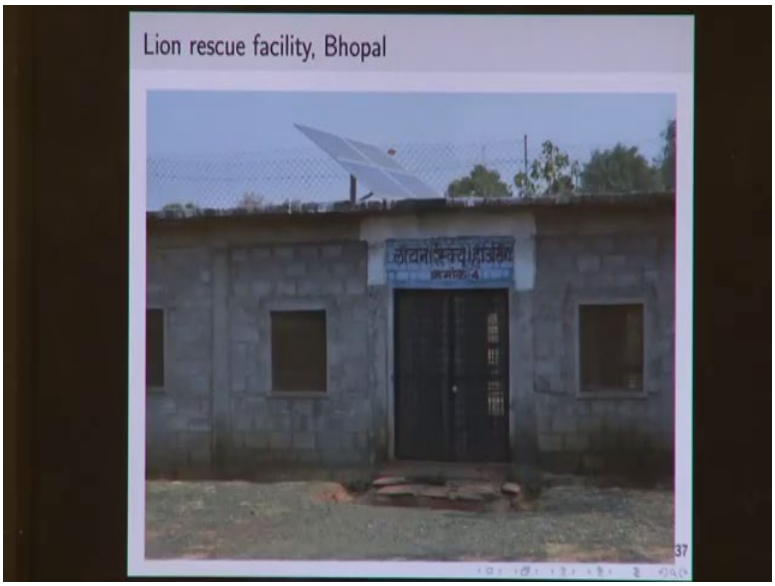

Then, we have a lion rescue facility in Bhopal.

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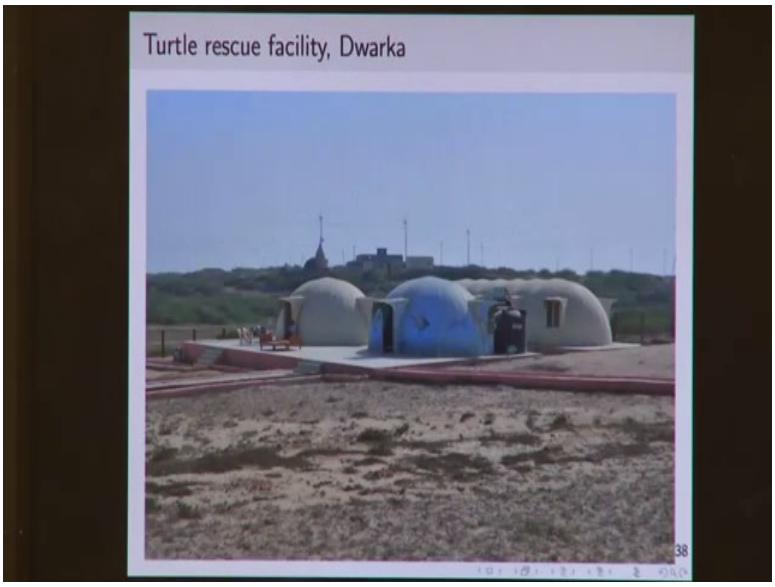

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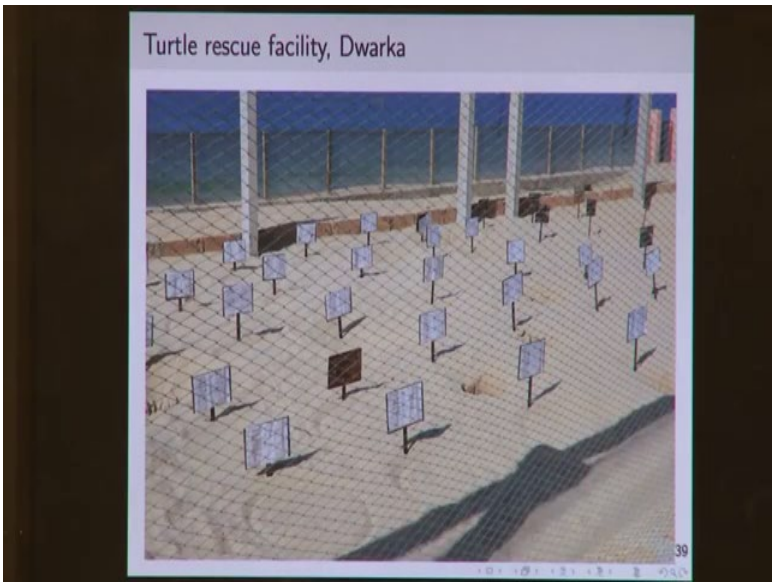

We have a turtle rescue facility in Dwarka. Now, all these rescue centers are zoos as per the definition of a zoo.

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But then, in certain times; certain animals are not cared for in a zoo, and they might start showing stereotypical behaviors. So, this is an animal that is showing at us stereotypical behavior; it is just moving right and left without any purpose, because it is feeling bored; because it has got nothing else to do.

Because, unlike in this picture where you saw that this animal is in a very natural condition,; if you look at this animal, it is lying there on a concrete floor without any natural reinforcements; and so, it is feeling very bored.

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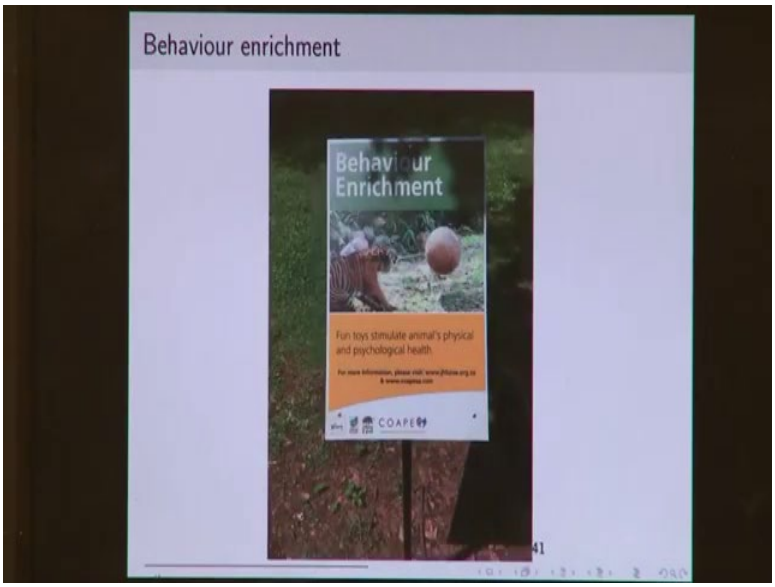

So, typically, in zoos we also need to take care of the behavior enrichment for different animals. We need to provide them with certain toys, with certain activities, to keep them busy.

Now, this is one good example of an ex situ conservation facility. So, in the case of a zoo, you create a facility; you create enclosures; you create resources in the form of manpower; in the form of funding, so that the animals are able to get good quality food, good quality care, good quality attention.

And, to get funds and to raise awareness, you also invite public to this area. And, when you are keeping animals in good cozy environments, they will start to breed and once their numbers have reached to a substantial number, then you can also start to release these animals back into the wild. So, this is one mode of conservation ex situ conservation.

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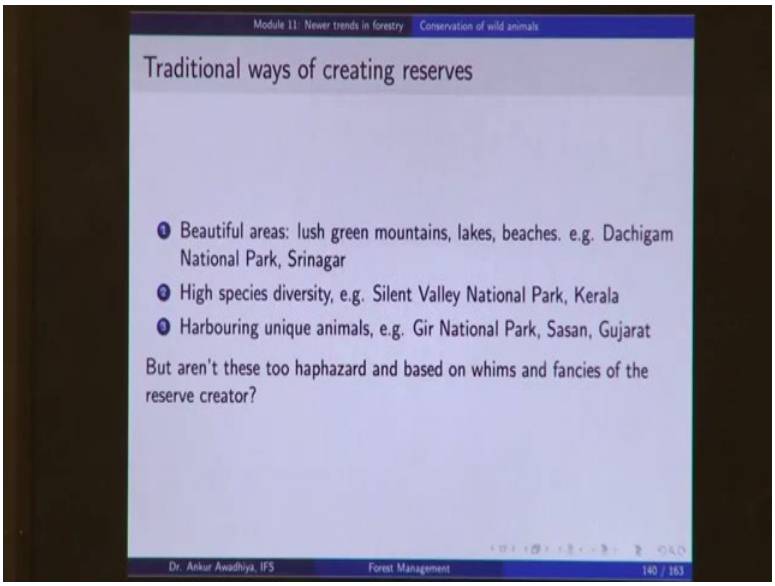

Another mode is that of the in situ conservation by creating of reserves. Now, typically when we talked about national parks and wildlife sanctuaries; there were three typical ways of creating reserves, beautiful areas. So, somebody went to Srinagar, saw that there is very good mountain, very beautiful mountain and said let us have a national park in this area or let us have a sanctuary in this area.

So, this is one way in which certain reserves were made. So, if you visit these reserves, you will find that you will have very breathtaking sceneries in that area; they are beautiful areas. Typically, the older kings used to make reserves in this manner. Then, there are certain reserves that are made because they have high species diversity such as the silent valley national park in Kerala; or there are certain reserves that were made, because they have some unique animals, such as the Gir national park in Gujarat which has the only population of Asiatic lions.

But these days, if you want to do conservation in a more scientific manner, then you need to employ a scientific procedure.

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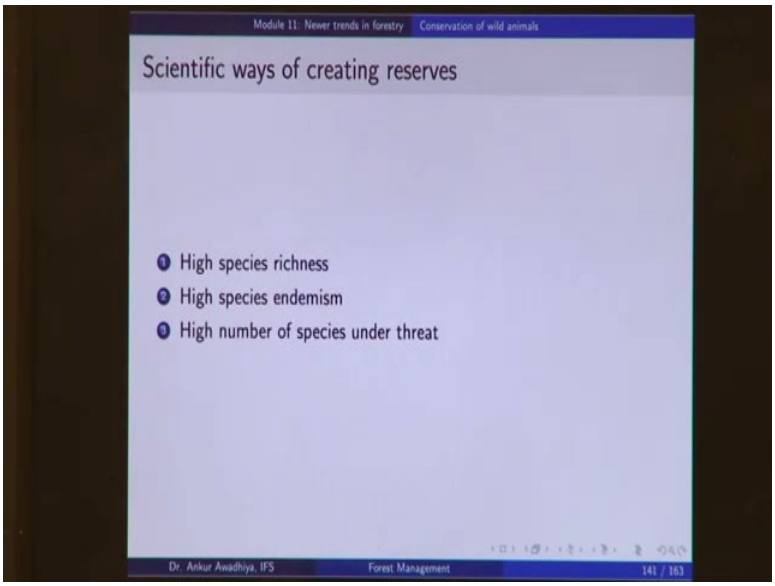

So, the scientific way of creating reserves looks at three things; richness, endemism and threat. Now, richness means how many number of species do you have in an area. So, if you have one area with 100 species and another equally sized area with 1000 species, then the then the equal sized area which is harboring 1000 species is probably better to be converted into a reserve, because in that case 1000 species of animals will get conserved.

The second thing is endemism. So, if there is an animal that is only found in one area, then you have got no other option, but to create an in situ conservation reserve for that animal, in that area itself. A good example is the Asiatic lion, because it is found only in Gujarat only in the Gir national park. So, you had to create a national park in that area.

Now, typically now, because the lion population has increased; so, it is moving to other areas and so now more number of areas can be converted into lion nation parks or lion sanctuaries. But earlier when we had a very small population; the number was down to less than 100 individuals. So, one when you had that condition, then you had no other option, but to create a national park or a sanctuary in that area.

The third thing is the high number of species under threat. So, as we saw before in the IUCN red list categories, you have certain species that are highly endangered and there are certain species that are not of that much concern.

So, if you are creating a reserve and then probably you should go with those areas that have larger number of species that are under threat. So, in this case, there are three things that we need to keep in mind the richness, the endemism and the threat. Now how do we look at all three of these?

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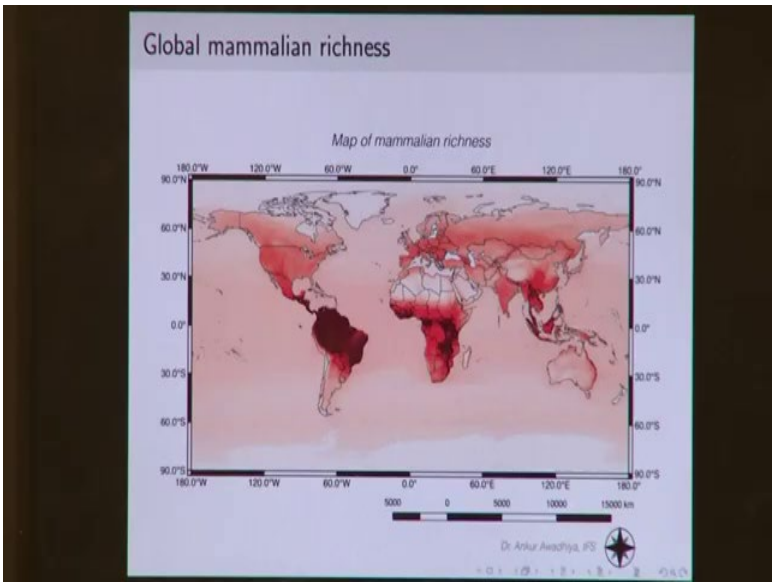

So, a richness or the number of species per unit area is known it has been surveyed a number of times and so, now, we can make create a map of say mammalian richness, amphibian richness and so on.

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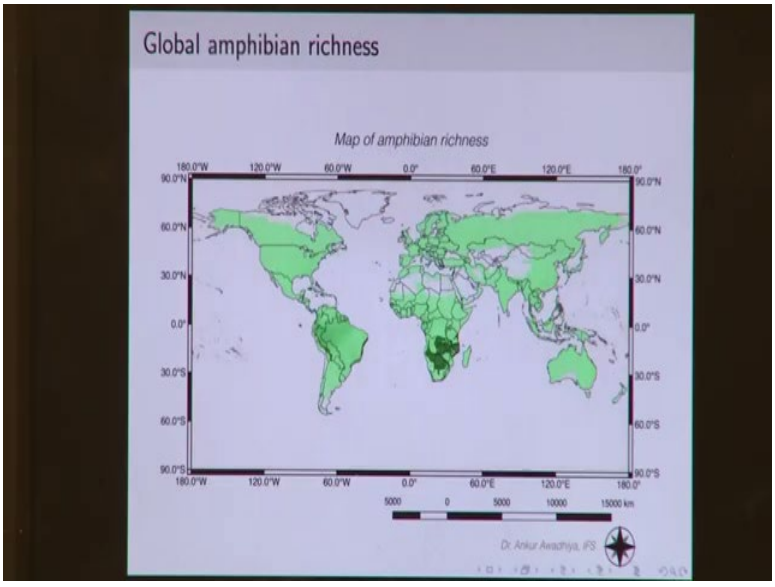

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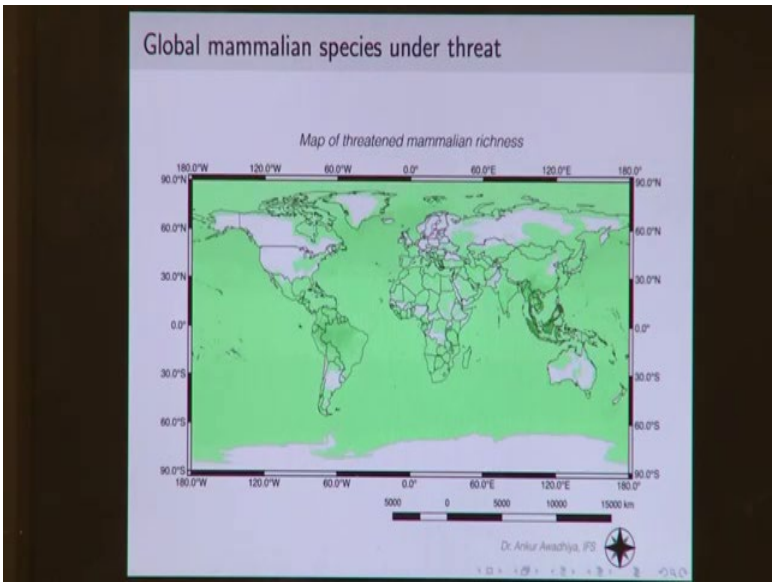

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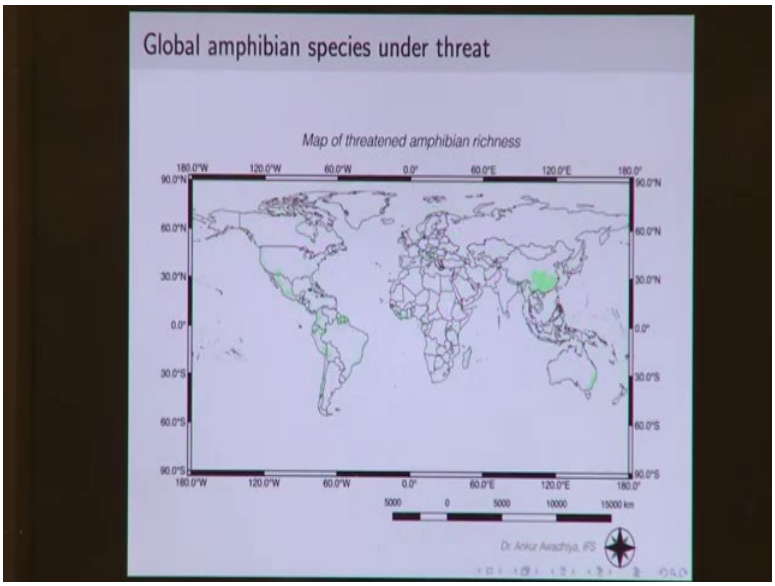

The threat status of different species is known so we can also construct maps for that and the endemism is also known.

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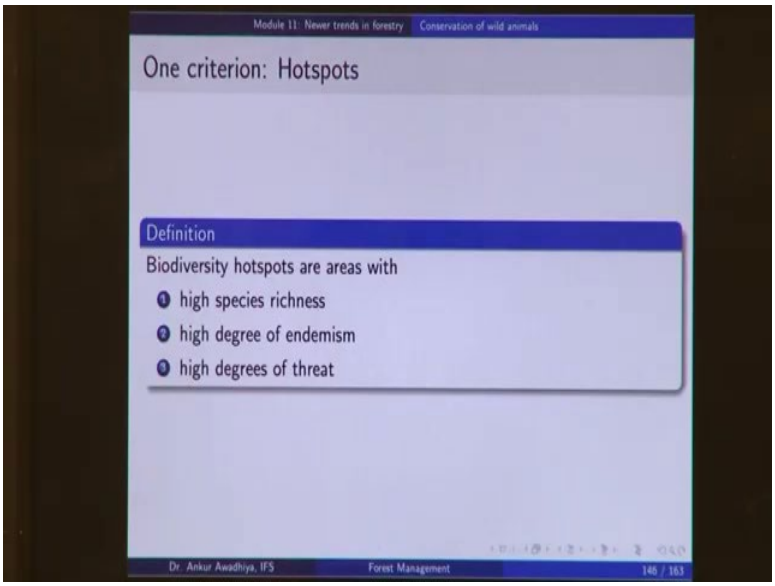

So, when we combine all of these; three together; high richness, high endemism and a high degree of threat, we construct a map of the biodiversity hotspots of the world.

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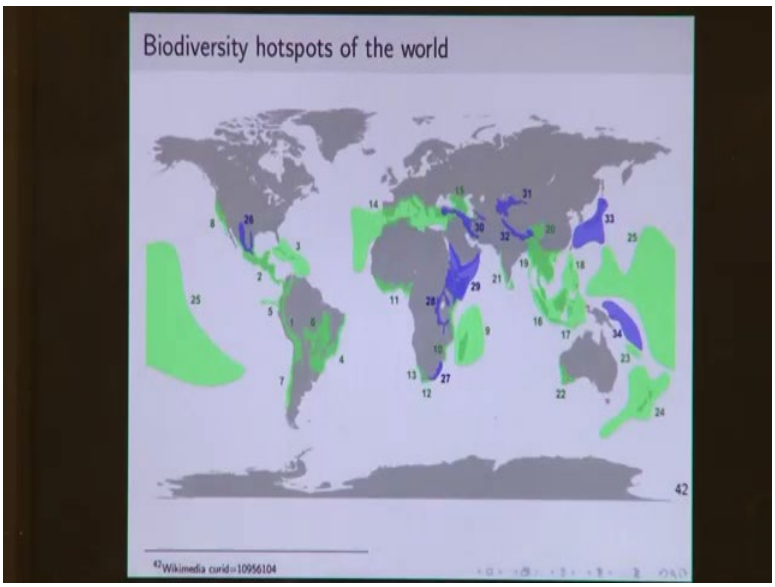

So, biodiversity hotspots are those areas that have a large number of species that are threatened. And, many of those species are only found in these areas; they are not found anywhere else. So, it makes much more sense to create reserves in these areas.

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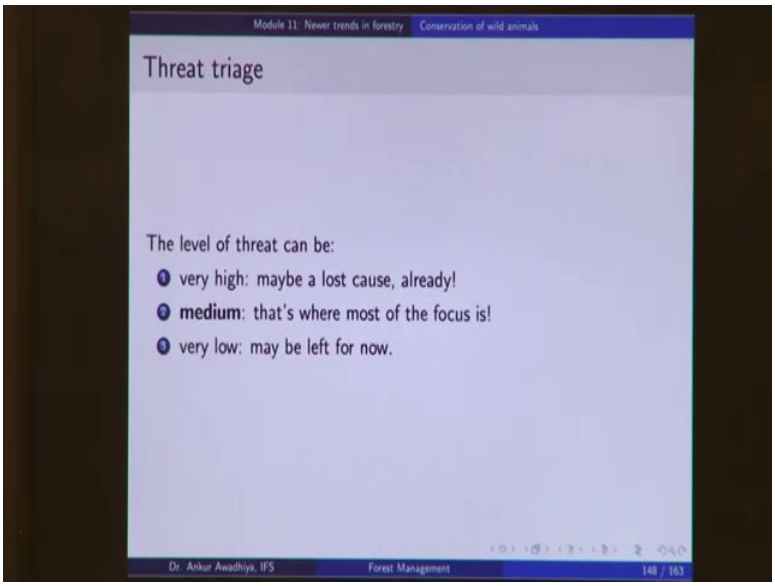

Another factor to keep in mind is the level of threat. So, if you have an area that is facing a very high degree of threat; so, say in the next 3 years, this area will be completely destroyed. So, by the time you will move people; so, you will legally convert this area into a reserve, this area will be gone.

So, probably it is not that prudent to invest your time in resource into that area, especially if that area is a small area. On the other hand, if there are certain areas which have practically no threat, considered certain islands where nobody goes. So, whether you convert them into a reserve or not and it is immaterial.

But then, there are certain other areas that have a medium level of threat. So, you can do something about it; you have time, and if you do not do anything, then probably you lose those areas. So, these are the areas that we need to concentrate more and more. So, typically in the case of a threat triage, we go with those areas that have a medium level of threat, and we also go with a gap analysis.

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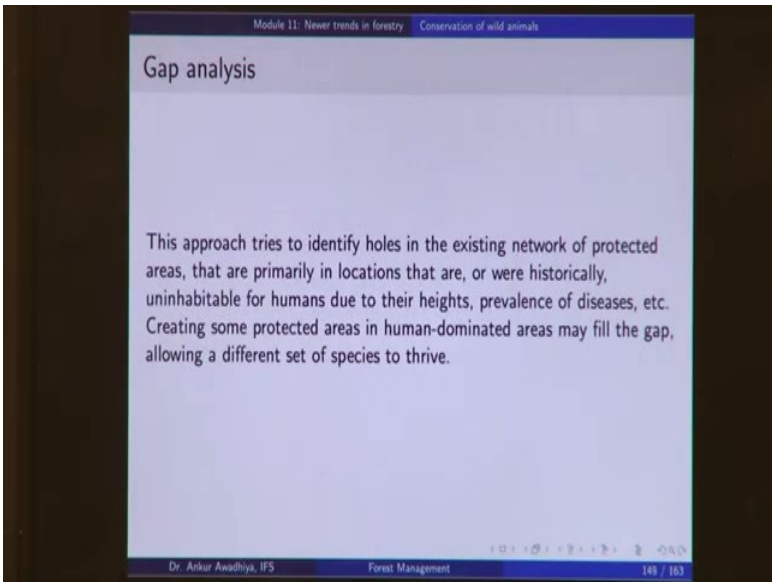

A gap analysis approach tries to "identify holes in the existing network of protected areas, that are primarily in locations that are, or were historically uninhabitable for humans due to their heights, prevalence of diseases, etcetera. Creating some protected areas in human-dominated areas; may fill the gap and allow a different set of species to thrive."

So, a gap analysis typically makes a map of different protected areas in your area, and then you start to look for gaps. What are the kinds of ecosystems that have been completely wiped off, and are now completely inhabited by humans.

So, probably, if you would construct a sanctuary in such an area, then it will help a certain group of animals; or if you have a sanctuary that is created between say two sanctuaries, then it could be used as a stepping stone corridor for certain species that is a gap analysis. You try to look at the gaps that are there in your existing system of protected areas, and you try to fill up those gaps.

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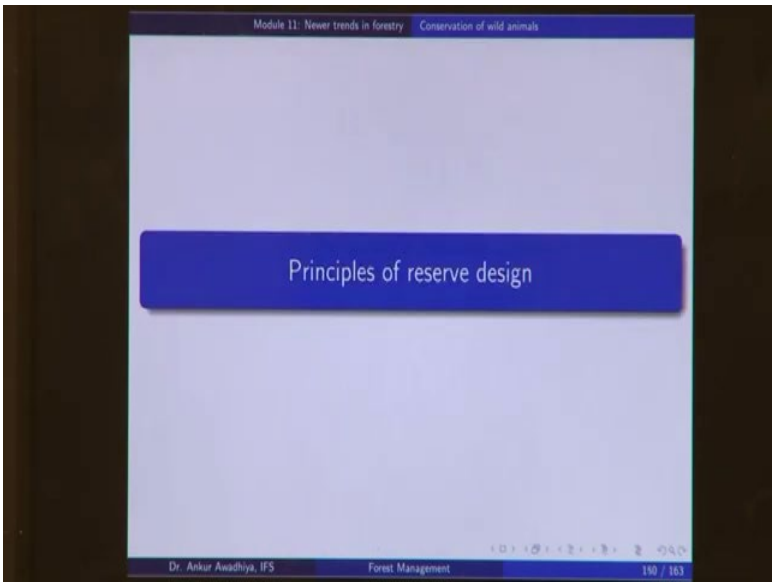

And, you fill your gaps by keeping in mind, the principles of reserve design.

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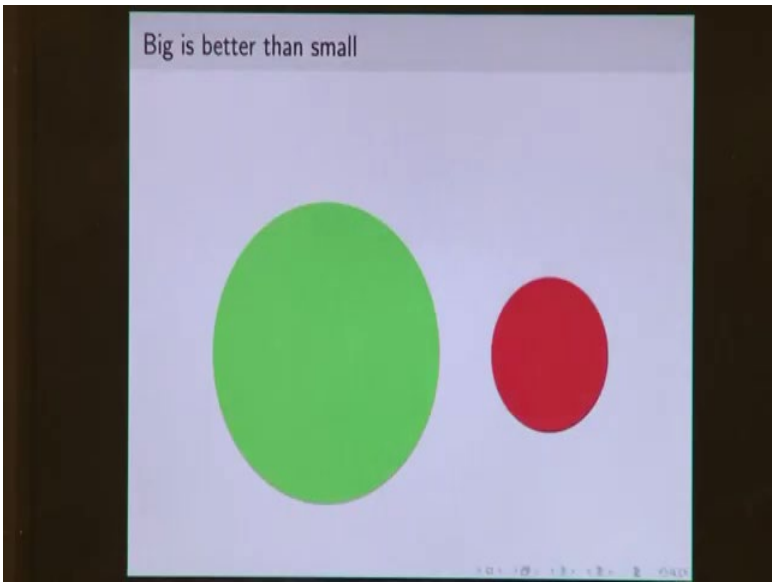

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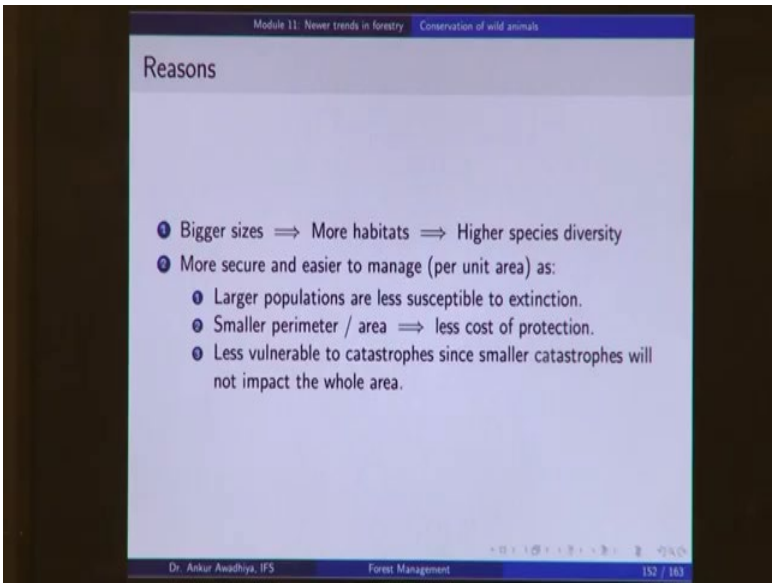

What are these principles? Go with a larger size reserve. Why a larger size reserve? Because of two reasons; one the larger the size more the number of habitats; more the number of species that you will be able to conserve in this area.

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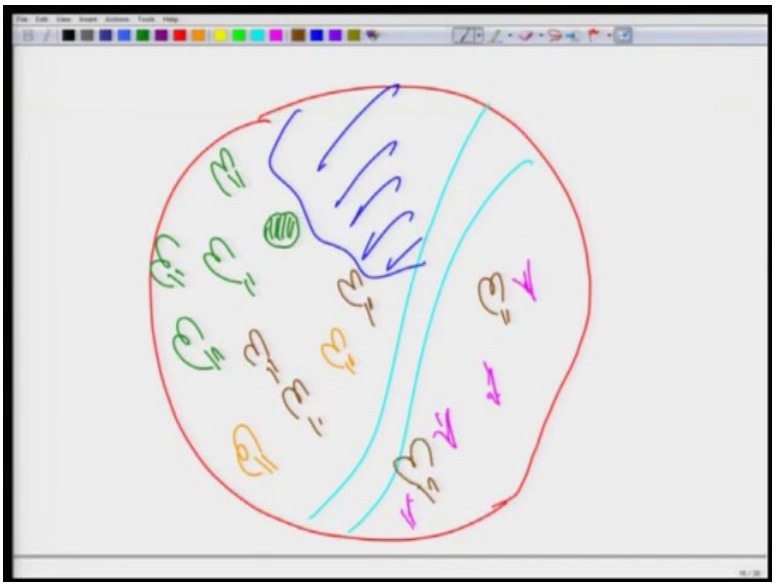

So, to give an example, suppose you have a small area that is grasslands, but then if you in place of this small area; if you go with a larger sized area, then it not only has these grasslands, but typically it will also have certain rivers; it will also have certain forested patches; probably pond somewhere; probably some shrub vegetation somewhere; probably a mixed forest, in some other area. So, the larger the area is able to have more

number of habitats; more number of habitats means that you will also be having more number of species.

So, because your aim, in this case, is to conserve wild life, go with larger areas; with more number of habitats; go with areas with more number of ecosystems; and more number of eco tones which are the boundaries between different ecosystems.

So, more the diversity, more than number of species you will be able to conserve. Secondly, more secure and easier to manage per unit area, because the larger populations are less susceptible to extinction. If you have a small population, that then you have the stochastic factors that are acting on it. But, if you have a larger area; with a larger population, then only deterministic factors will be acting on it.

So, if you have larger areas, then your animals typically are more protected against the stochastic factors. Then, smaller perimeter per unit area means that there is a less cost of protection, what it means here is that; If you consider any reserve; so, for simplicity let us say that your reserve is a circle with radius R.

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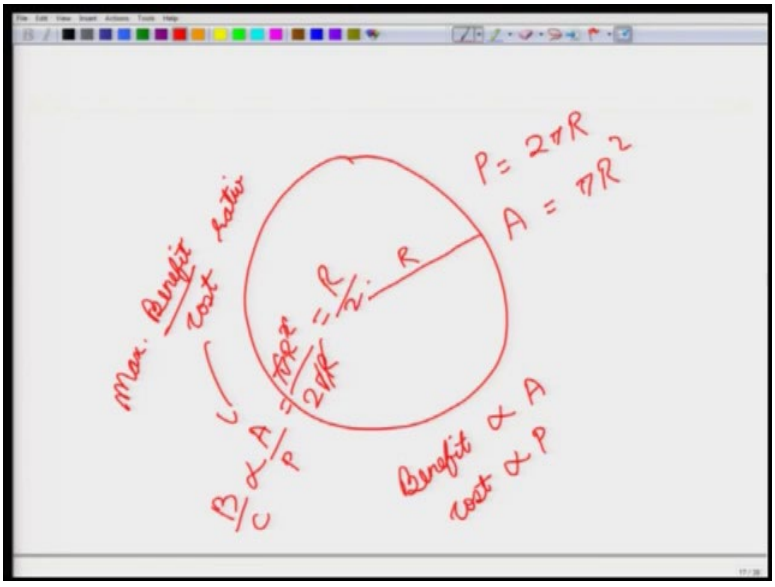

Now, the perimeter of the reserve is 2 pi R and the area of the reserve is the is pi R square. Now, the benefit of making this reserve is proportional to the area because the larger the area the more number of species that you will be able to conserve.

On the other hand, the cost is proportional to the perimeter, because the perimeter is where probably you will have to go with a fencing mechanism, or you will have to deploy certain staff to protect the perimeter, so that other animals especially the mulch animals or poachers are not able to infiltrate into your area. So, all your cost are basically focused or primarily focused to the perimeter.

So, if you want to have the maximum benefit to cost ratio; so, in that case, the B by C will be proportional to A by P. Now A is pi R square P is 2 pi R pi and pi get cancelled R and get cancelled; so, this is equal to R by 2, which means that your benefit to cost ratio is proportional to R.

So, more the value of R the larger the radius more is the benefit of your area. So, in this case, from a purely economics point of view, you should go with a larger area because it will have a smaller perimeter per unit area; so, you will have a lesser cost of protection for the same benefit. And also, it is less vulnerable to catastrophes since the smaller catastrophes will not impact the whole area.

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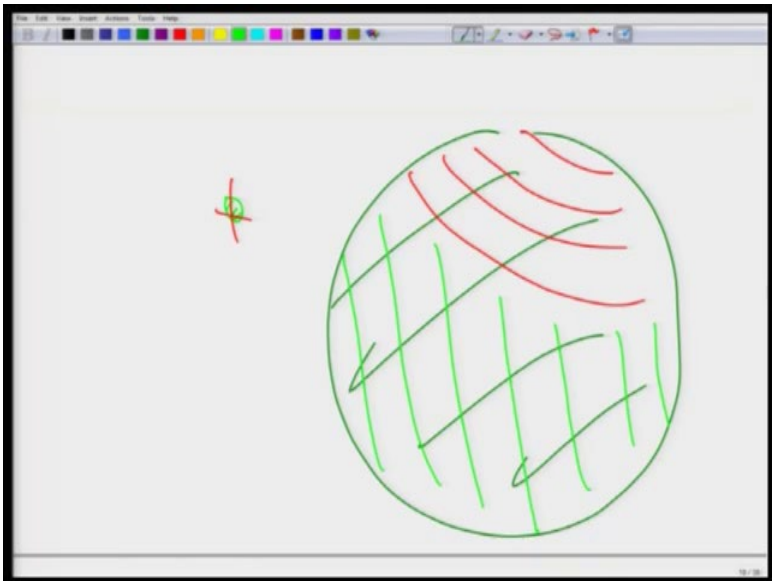

So, if you have a small forest and there is a fire in this forest, the whole forest is gone. But if you have a larger sized forest and there is a fire in this forest, and this fire was able to engulf this much amount of forest; which is much greater than the amount that was engulfed in this in the smaller forest. But even after that, there is so much of area that is

left and the animals that were able to survive; will then be able to repopulate the area that got destroyed. So, the larger areas will also give you the sort of a protection.

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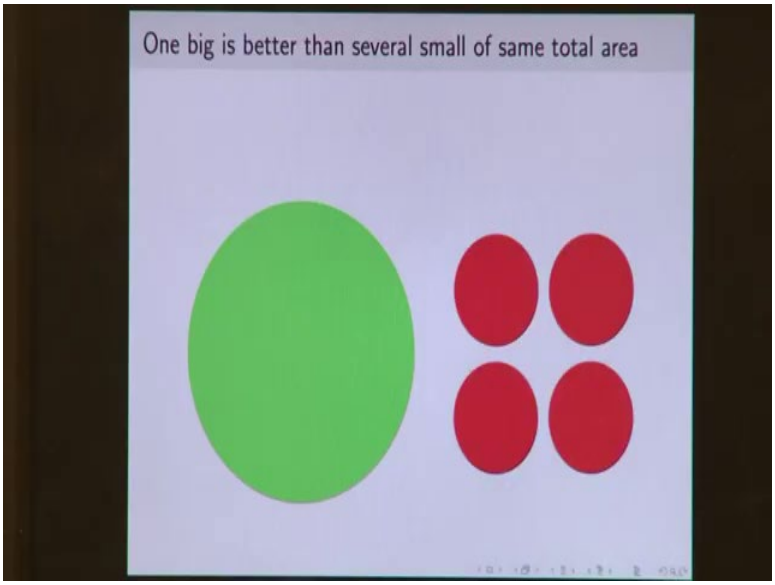

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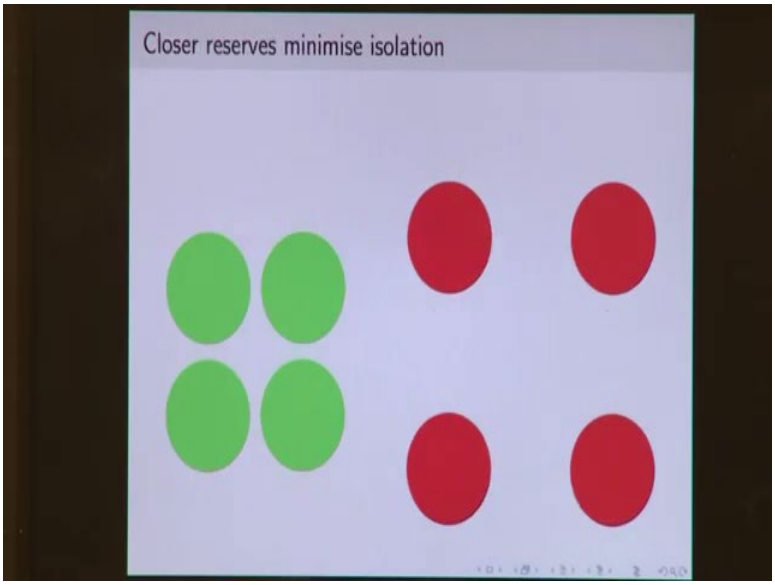

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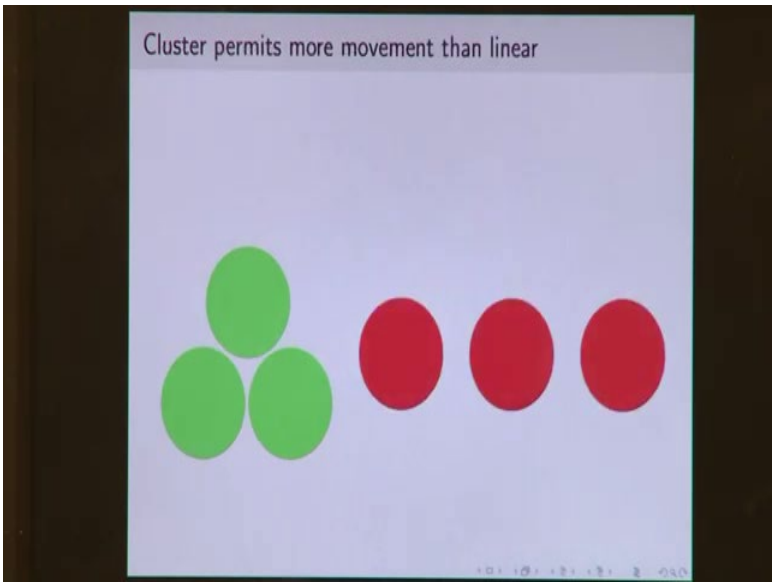

Other criteria are that one big reserve is better than smaller than several small of that same total area. Have reserves that are close together, so that the animals do not feel isolated; convert them in the form of a cluster so that there is more movement of animals between these different reserves; have reserves that are more circular in size, because they will be having less biotic pressure.

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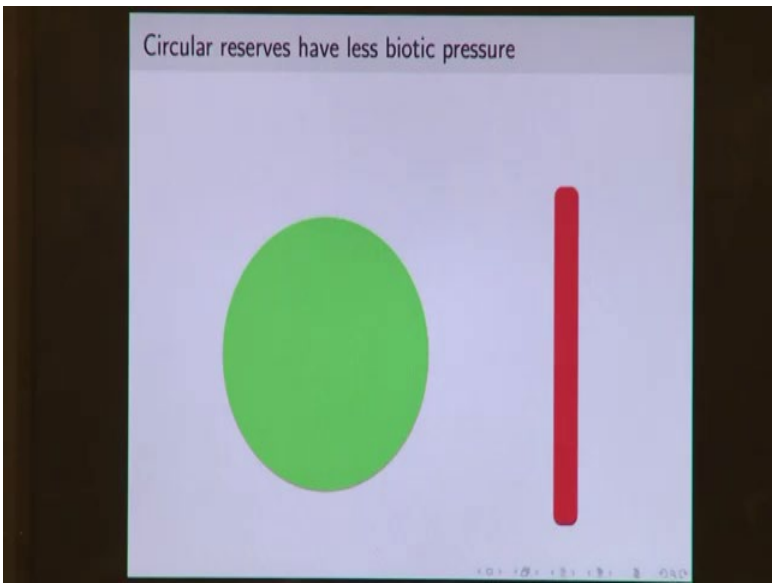

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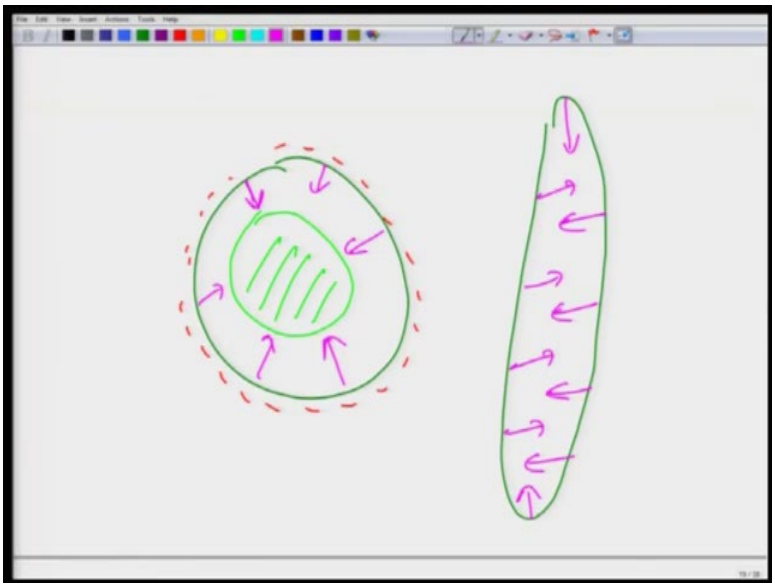

Because, in this case, if you have a reserve like this versus the reserve like this; and if people are able to influence; now, this influence could be not just because people are getting inside, but also because people use, people burn things, people cook food on using biofuels which also gives out a huge amount of smoke; people also do things that pollutes the nearby areas; for instance, the use of pesticides or inorganic fertilizers.

Now, there will be some impact of all these activities even inside your reserves, because all around the periphery you have people. Now, suppose this impact is able to reach till this distance; so even after all of these impacts, you will be having a certain amount of core area that will be free from all the impacts. But, if your reserve was more elongated in shape; so, in that case, they there is an impact of human beings in all the area of the reserve and there is no place that is left out. So, you typically want to go with circular reserves because you have lesser biotic pressure.

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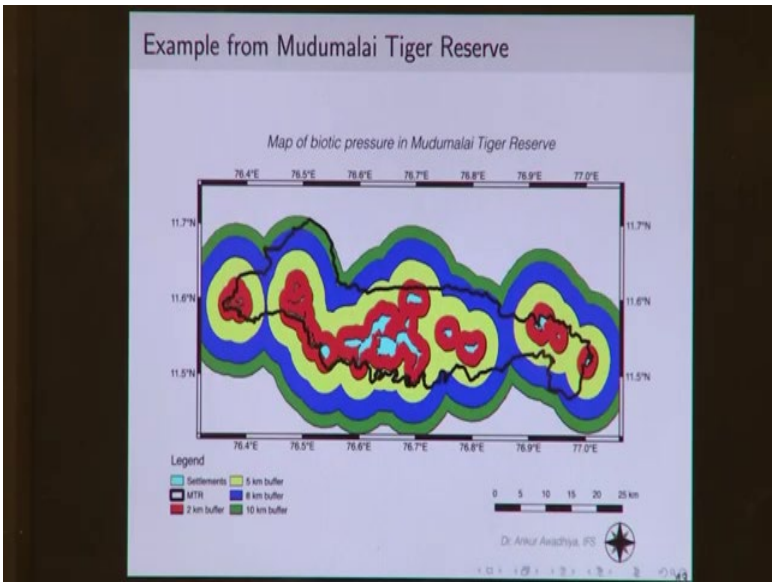

So, for instance, this is Mudumalai tiger reserve, and we plotted the influence of different villages. And, if you look at this plot, then if you draw a 10 kilometer buffer; then there is no area of the park that is completely left untouched.

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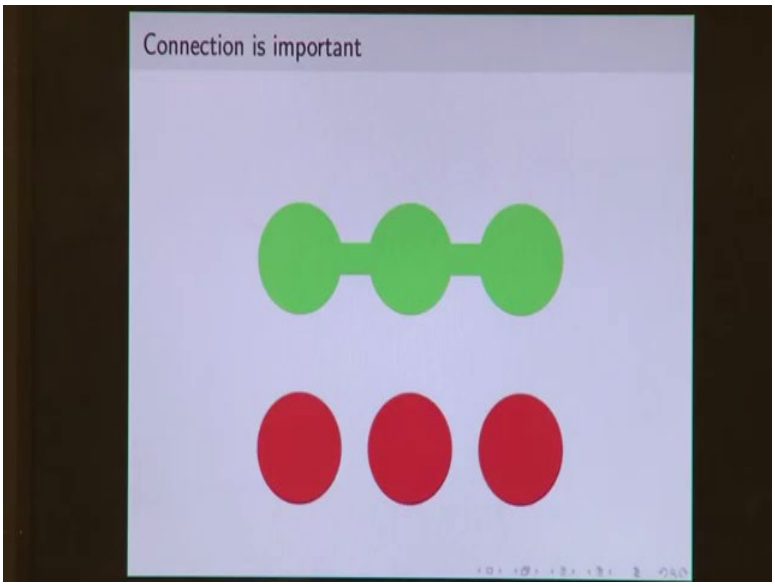

If nothing else happens, at least maintain a connection so that the animals are able to move from one place to another place. Now, these are the theoretical underpinnings of how to design a reserve, but then how do you do it practically. So, we need to ensure that

there is a good amount of biodiversity in that area; we need to ensure that we are able to fill up the gaps; and, we need to ensure that we are able to maintain the connectedness.

While also preserving those species that are the flagship species; so, we did one such exercise in Madhya Pradesh. So, the government of Madhya Pradesh wants to have more number of protected areas, typically because Madhya Pradesh is one of the very few states that is now moving towards the right to water to all the citizens.

Now, if you want water, you would want to have a good amount of groundwater recharge. And, for a good groundwater recharge, you will want to have areas that are well forested. Now, if you want to maintain these forests for water, you will want to control the herbivore population. And, to control the herbivore population, you will have to maintain a a good amount of carnivore population.

Now, similarly, when we talk about things like tourism or things like employment, though these protected areas; especially the sanctuaries, national parks, and tiger reserves; they are able to give a good amount of employment to the locals, and they are also able to bring in much more amount of resources to the state.

So, recently, there was a study that was done. And, it told us that, if we invest say 1 rupee in into Panna tiger reserve, the amount of benefits that we get are close to 1900 rupees; that looks like a very big figure. Because typically the banks, if you put 1 rupee into a bank, they will only give you back 6 paisa in return; so, 1 rupee and 6 paisa. But, in the case of tiger reserves, you put in 1 rupee and you are getting roughly 2000 rupees; why? because the amount of groundwater recharge that this area will do.

Even though, you are putting in a very less amount of investment, so the amount of groundwater recharge will be tremendous; the amount of biodiversity services will be tremendous; the amount of pollution controls through bioremediation will be tremendous.

So, because of these reasons the government of Madhya Pradesh wants to have more sanctuaries. But then, where do we plan these sanctuaries?

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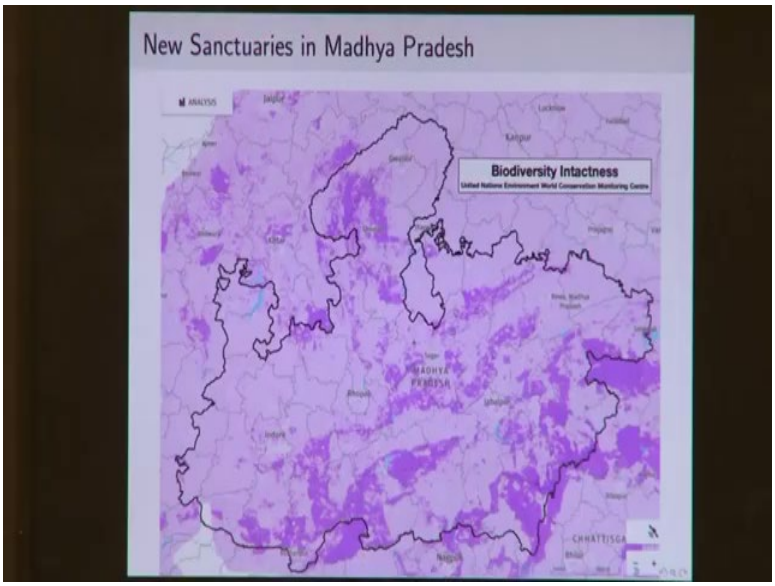

So, we started with the biodiversity intactness index map. So, this is a map from the United Nations environment wild world conservation monitoring centre. Now, what this map typically tells you is that, say in the year 1700, if you had 100 percent biodiversity, what is the amount of biodiversity that is left today?

Now, if you look at this map, most of the areas in western Madhya Pradesh are now devoid of biodiversity. Now, why is that so? Because these areas in western Madhya Pradesh, they are the more industrialized area; they are the more urbanized areas; so, there is less amount of forest cuts that is available in these areas. But then, if we look at these patches, these patches are still those areas that are left.

So, in eastern Madhya Pradesh, we have larger number of such areas. In southern Madhya Pradesh, we have good amount of biodiversity; northern Madhya Pradesh, we have good biodiversity, and even in the case of western Madhya Pradesh, we have certain spots where we have biodiversity left.

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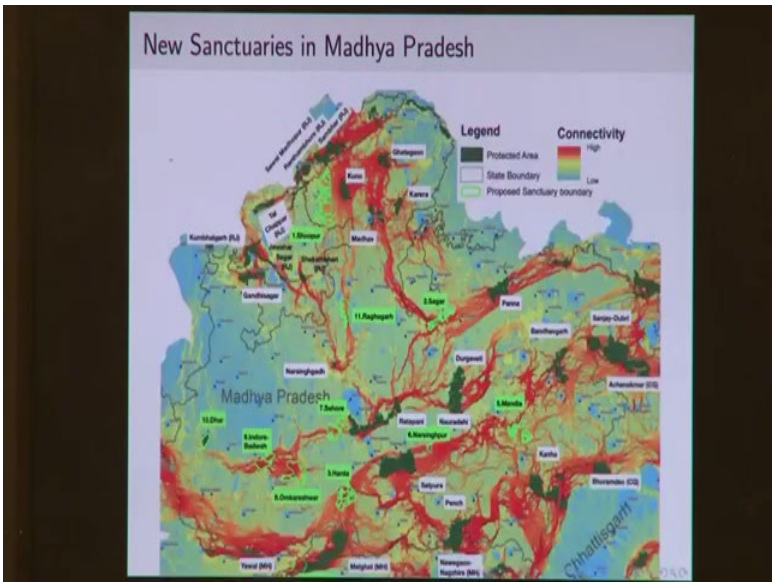

This is richness, and also an indication of the threat in this area. We also make use of the gap analysis. So, this is a map of where the existing sanctuaries and national parks lie, these are in these dark green colors. So, these are the locations, on this map we also have the movement regions of tigers.

Now, tiger; as we have seen before is a flagship species; it is an umbrella species; and it is a keystone species; and, if you call here a tiger and if you call here certain tigers, and if you let them move from one area to another area, these are the routes that they typically take.

So, the government decided that, if we want to construct sanctuaries, why not construct them on these routes, so that we are able to reinforce these movements; we are able to reinforce these natural tendencies; so that we are able to get the benefits of tourism; we are able to get the benefits of water; but at the same time, we are also able to prioritize our flagship, umbrella, and keystone species.

So, these are the new reserves that are now under consideration by the government. So, this is a way in which we can scientifically pinpoint the areas where we should be making the reserves, and then we can look at those areas. The other things that were kept in mind are that there should not be any displacement of locals, because of the construction of these reserves. They should not be the hampering of rights of any person,

and typically reserves should be constructed in those areas where we have less employment and scarcity of water.

But we can quantify all of these different parameters, and now, it is possible especially through the use of GIS to pinpoint those locations, where we will get the biggest bank for the buck. So, that is all for today.

Thank you for your attention [FL].