Wildlife Conservation

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Lecture - 30
Fundamentals

Today we move into a new module which is on ex-situ conservation. Now, this module is going to have 4 lectures, the first one will deal with the fundamentals of ex-situ conservation. So, we look at what is ex-situ conservation? How is it different from in-situ conservation? How are both of these things done? What do we actually mean by it? And what are the precautions that we need to take when we are planning an ex-situ conservation facility? Then in the 2nd lecture we look at zoos and their management.

So, zoos are one of the most common ways of ex-situ conservation. So, we will look at their legal aspects and also what kinds of facilities are provided and what are the precautions to be taken. Next we will move to botanical gardens which are ex-situ conservation sites for plants and also include things such as collection of bamboos like bambusetum or collection of trees in the name of arboretums and so on. And then in the 4th lecture we will move into the more newer techniques such as cryopreservation and seed banks. So, let us now begin with the fundamentals.

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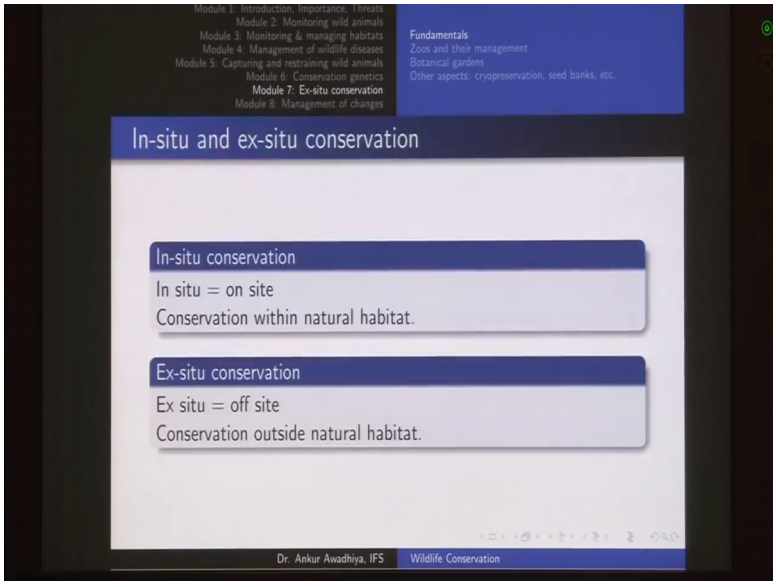

So, what is ex-situ conservation? And what is in-situ conservation? Now, in-situ means on the site. So, this is a conservation that is done within a natural habitat. So, basically what all things we have been discussing so, far when we talk about reserves, when we talk about protected areas, when we talk about our forests and if we are doing any conservation activities there then it goes by the name of in-situ conservation because, there we are doing conservation within the natural habitat.

Ex-situ means of the site so, ex-situ conservation is conservation outside of the national habitat. So, things like our zoos, botanical gardens, cryopreservation, seed banks and so, on come under the category of ex-situ conservation.

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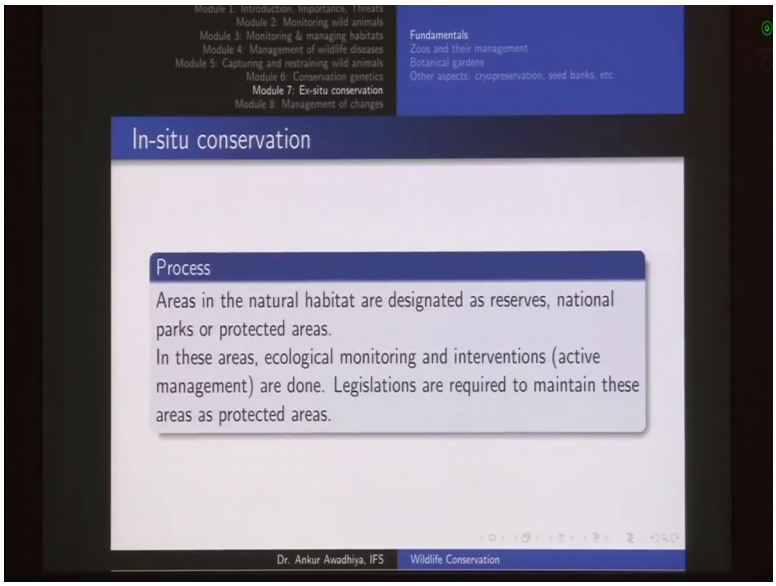

So, when we talk about in-situ conservation so, we will now look at both of these in greater detail. So, when we talk about in-situ conservation the processes that areas in the national habitat are designated as reserves, national parks or protected areas. And in these areas ecological monitoring and interventions in the form of active management are done and legislations are required to maintain these areas as protected areas.

So, what we are doing here is that we select some areas in the national habitat. So, we will select some forested areas for instance and then will designate them as either a wild life reserve, a national park, a protected area or wild life sanctuary or by whatever name is common in the legislation of that particular country. In our case we normally talk about national parks and wildlife sanctuaries and also these days we are talking about

biosphere reserves. So, all of these would form parts of the national habitat. So, these are all in-situ conservation so, most of all that we dealt beforehand.

So, like monitoring of animals, monitoring and managing of habitats and all those things have more relevance with the in-situ conservation. Now, in these areas what do we do? We do ecological monitoring and we perform some interventions. So, we talked about some interventions or active management in the form of disease control or in the form of immobilization of animals, capture of animals, translocation of animals and all those things are done even in the case of in-situ conservation. And legislations are required to maintain these areas as protected areas and in our country the primary legislation is the wildlife protection act of 1972.

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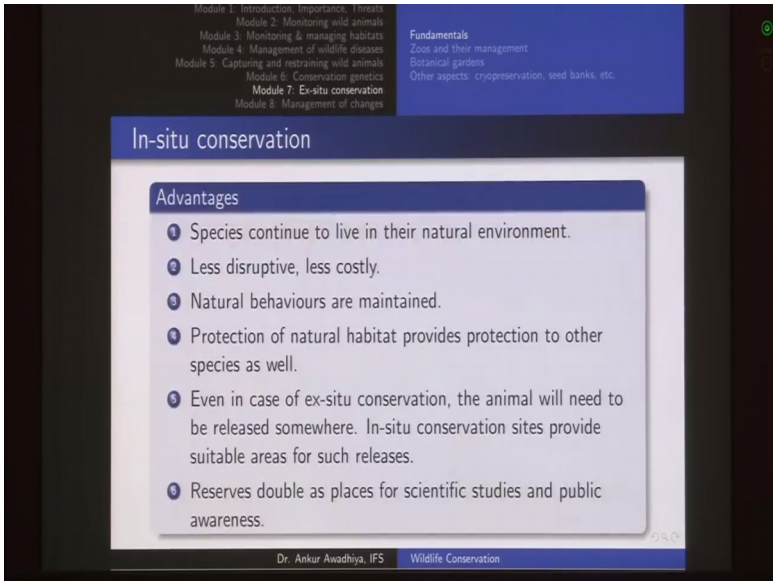

Now, in-situ conservation is the more common way of conserving the species why? Because, of the advantages that it provides one the species continue to live in their natural environment. So, there is hardly anything that needs to be done there is a national environment species are living there, you just designate that area as a reserve and the species will continue to live there in their natural environment is not much of an intervention that is required.

So, less intervention means that it is also less disruptive and less costly because, we are not tinkering with the system a lot. Next, natural behaviors are maintained so, these

natural behaviors that have been handed over through generations and through evolution these are maintained because you are not tampering with the system a lot.

Next, prediction of national habitat provides protection to other species as well. So, for instance, when we talk about ex-situ conservation facility for say rhinoceros. So, in that case we will be talking only about the conservation of rhinoceros, but then if we are doing an in-situ conservation of rhinoceros then a number of other species that live in the same habitat will also get protection at the same time. So, protection of the national habitat provides protection to other species as well.

Now, even in the case of ex-situ conservation the animal will need to be released somewhere and in-situ conservation sites provide suitable areas for such releases. So, for instance when we are talking about the in-situ conservation for rhinoceros we created a captive breeding facility for them. So, the number of rhinoceros went up, now what do we do with those rhinoceros? So, they will need to be released somewhere. Now, if there is no forest left then where are we going to release them. So, in-situ conservation needs to be done at the same time along with the ex-situ conservation.

So, that we have some natural areas in which we can release our animals from the ex-situ conservation facilities as well. Also reserves double as places for scientific studies in public awareness. So, for instance when people get into our tiger reserve so, tiger reserve is in in-situ conservation and when people go there then they get acquainted with the pause of conservation they come within the conservation fold. So, it leads to public awareness, people get to know how nature works, how ecology works. And also these reserves also act as places for scientific studies.

So, for instance what is the natural behavior of a tiger? Or what is the natural behavior of say a deer? And then what are the interactions between deer in different of the species? So, in one of our earlier lectures we looked at the interaction between Ethel and the languor. Now, this languor and Ethel association could only be observed in one of the In-situ conservation facilities such as a tiger reserve.

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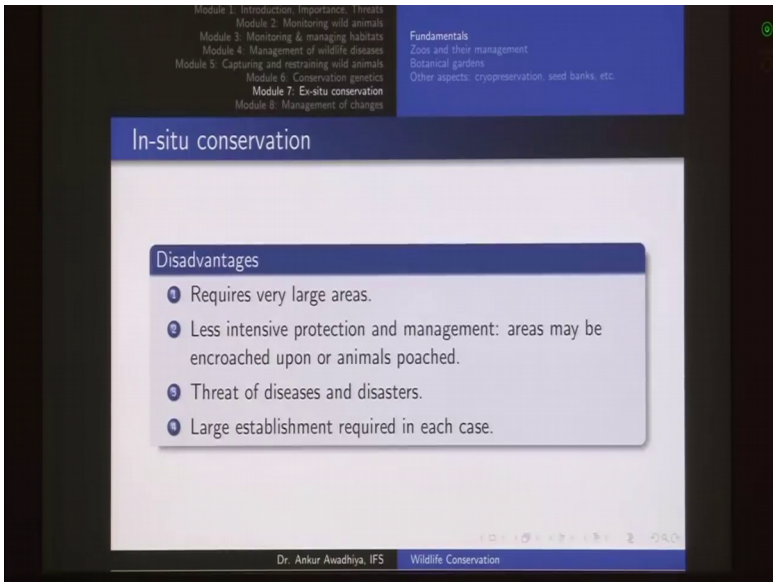

But, then in-situ conservation also has some disadvantages. One it requires very large areas why? Because, our management is not that intensive, our management is not tinkering with the system in a very big way. So, typically we require larger areas to face it to accommodate a larger number of animals, then because here these areas are very large. So, the protection would be less intensive and also the management will be less intensive as compared to a very small area which is the case in the case of an ex-situ conservation facility.

Now, if our protection is less intensive then there is always a chance that some areas may get encroached upon or some animals may get post. Next, we have a threat of diseases and disasters, again because our management is not very intensive and then because these areas are very large. So, we also require larger sized establishment for most of these in-situ conservation areas.

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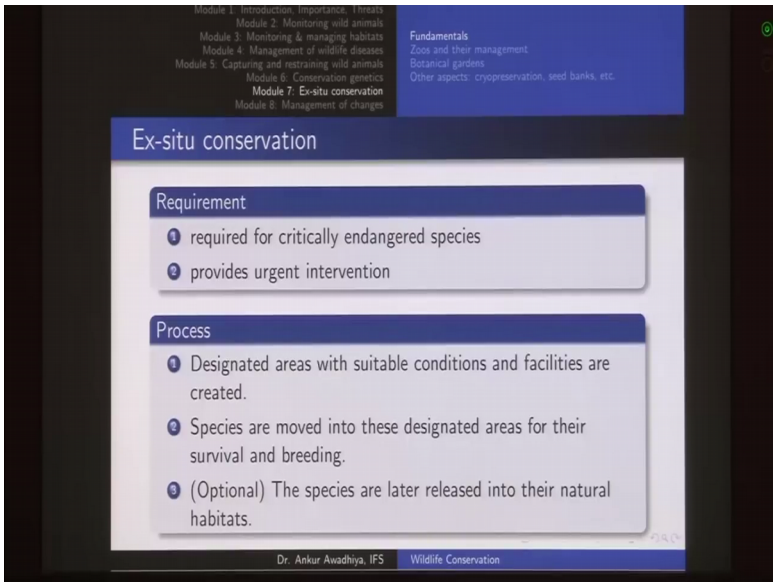

So, to overcome these requirements primarily and also for some specific cases we look at the other option that is available and that is the ex-situ conservation. The requirement these are required for critically endangered species. So, for instance in the case of a species such as the Javan rhinoceros. We have say around 100 individuals that are left in the national environment.

Now, if those 100 individuals are left in the forest and people are because, in the case of our in-situ conservation methods the level of protection is not that great. So, people would still go inside and try to poach this rhinoceros besides, if you have a very large sized forest.

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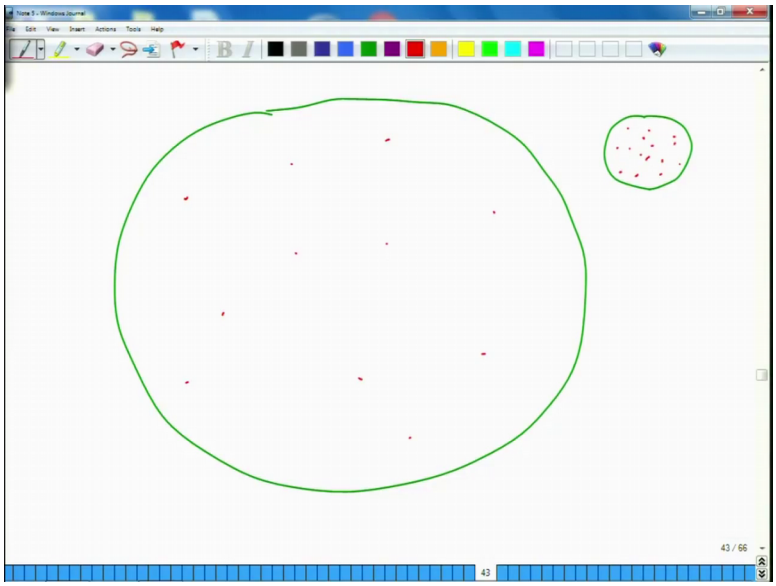

So, for instance if this is our in-situ conservation facility and we are talking about say 100 individuals. So, these individuals will remain very largely dispersed from each other. So, the amount of meeting that is going to be there would be less whereas, if we bring all of these individuals in a smaller facility then the density of animals goes up.

So, basically when we have increasing the densities so, the animals are able to get into more contact with each other so, the chances of meeting also go up. So, it is required for critically endangered species and secondly, it also provides urgent intervention. So, for things that require urgency if there is a huge disease that is there in the system then we would have to go for an ex-situ conservation. So, that at least some individuals are given an added protection.

Now, here the process is we designate areas with suitable conditions and facilities. So, these facilities are created and then species are moved into these designated areas for their survival in breeding. So, essentially we are talking about the translocation of animals from their natural habitat into our facilities and then our aim is twofold we want more and more survival and more and more breeding.

So, that the number of individuals goes up. Once that happens, once we have a sufficient number of animals then the species may later be released into their natural habitats. Now, that is the aim, but then in certain situations it is not possible right now to transfer feed these animals back into the natural habitats. Primarily because, they could be situations

in which there is no natural habitat left or for instance the natural habitats that are there are extremely under great threat.

So, in those cases we would talk about introduction of species into some other areas that are not part of their native or the historical range. So, that is also an option so, they can be released into their natural habitats or in some cases they may be released into some other areas as an introduction or in certain other situations we might just have to wait.

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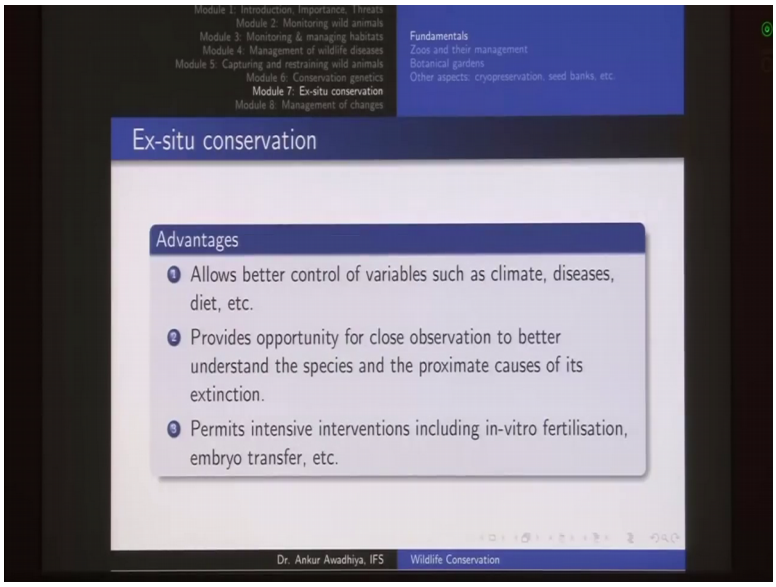

So, what are the advantages of ex-situ conservation? So, essentially what we are doing in ex-situ conservation is that we are creating a facility and in that facility we are shifting some animals and we are doing an intensive management of animals. So, when that happens then we have a better control over the variables such as climate, diseases, diet and so on.

So, for instance, if you get to know that the giant panda beats say at a temperature of between 15 and 20 degrees Celsius. Now, when this giant panda is out there in the forest we will not be able to regulate the temperatures because that will be under the control of nature. But, if you are creating a very specialized facility for the giant panda you can install air conditioners, you can install heaters to ensure that the temperature is always between 15 and 20 degrees.

So, climate can be controlled, diseases can be controlled because you are not allowing any other animals to come into contact with your animals that are there in the facility. The diet can be very strictly controlled so, that your animals get a very nutritious diet which may not be possible in the in-situ conservation areas. Now, it also provides an opportunity for close observation to better understand the species and the proximate causes of it is extinction.

So, primarily when we talk about in-situ conservation we get to know more about their natural behaviors, but then those natural behaviors are also more difficult to observe because in-situ conservation areas like reserves are last sized areas and your animals are there in a less density.

In the case of ex-situ conservation your facility is small there are more number of animals. So, you can do a more intense observation, a more closer observation to understand the species and the proximate causes of it is extinction. So, for instance you could get to a point where you understand that this species is getting extinct it because of a number of stillbirths that are there.

Now, if there is a stillbirths you cannot understand this in the case of a large size reserve where you do not get to see a number of samples, but when you are there in an ex-situ conservation facility. So, you will get to see that the number of stillbirths are very high, which would tell you that this could be due to say inbreeding. Now, if there is inbreeding then you can do a more intense management so, this is in the case of the third point.

It permits more intensive interventions including modern facility technologies such as in vitro fertilization or in simpler terms it is creation of a test tube baby, embryo transfer and so on. So, because you have a smaller facility, more number of animals, more control so, you can do a more intense observation and also a more intense management intervention.

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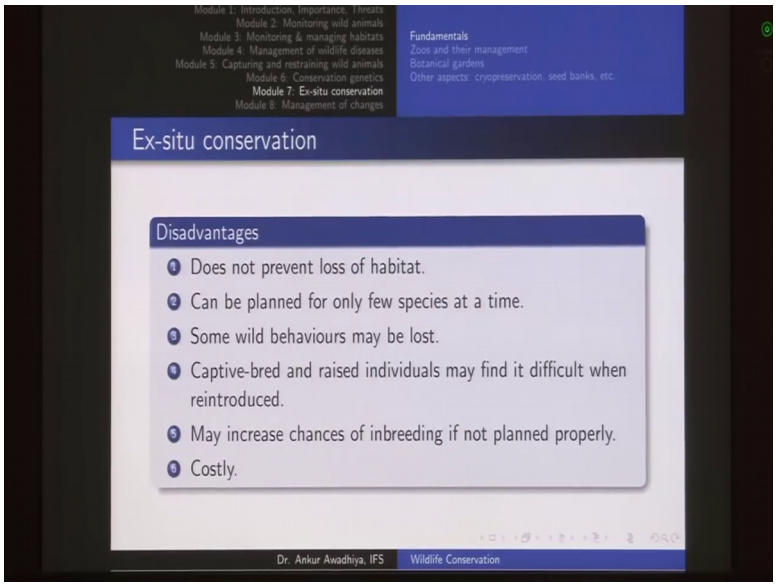

But, then ex-situ conservation facilities also have their own share of disadvantages. One, it does not prevent the loss of habitat because you have created a specialized facility for some of your who you are low monitoring your animals; you are giving them all the intervention. But, then when your concentration is only at ex-situ conservation it is possible that the forest will continue to be lost, will continue to get degraded. So, it does not prevent the loss of the original natural habitat. Second it can be planned only for a few species at a time.

So, for instance, if you go into any of our forests you may find say 500 plus species, but then when you are talking about ex-situ conservation you will create a facility for say 1 species or say 2 species, but not more than that. So, this can only be planned for a few species at a time.

Now, there are some exceptions in the form of zoos, but then in the case of zoos also you can have a maximum of say around 50 or 100 species, beyond that it becomes very difficult. Third, some wild behaviors may be lost because you are placing your animals in a completely artificial environment. So, they might lose out some of their wild behaviors.

So, for instance, in the case of tigers when we if there are any tigers that become orphans because their mother gets killed or the mother runs away. So, in those cases we try to hand rear the cubs, but then when we are trying to handle other cubs they might not learn

the wild behavior. So, they might not learn hunting as efficiently as their mother would have taught them. So, in the case of ex-situ conservation some wild behaviors continue to get lost.

Then captive bred and raised individuals may find it difficult when reintroduced because, they do not have their wild behaviors, they do not have their wild instincts. So, later on when you have increased their numbers and you are trying to bring them back into their natural habitat you are trying to reintroduce them into the areas. So, they may find it very difficult to cope.

Then it may also increase chances of inbreeding if not plant properly. So, why this happens is that when you have created your ex-situ conservation facility and suppose your facility can cater to n number of animals so, you have this facility.

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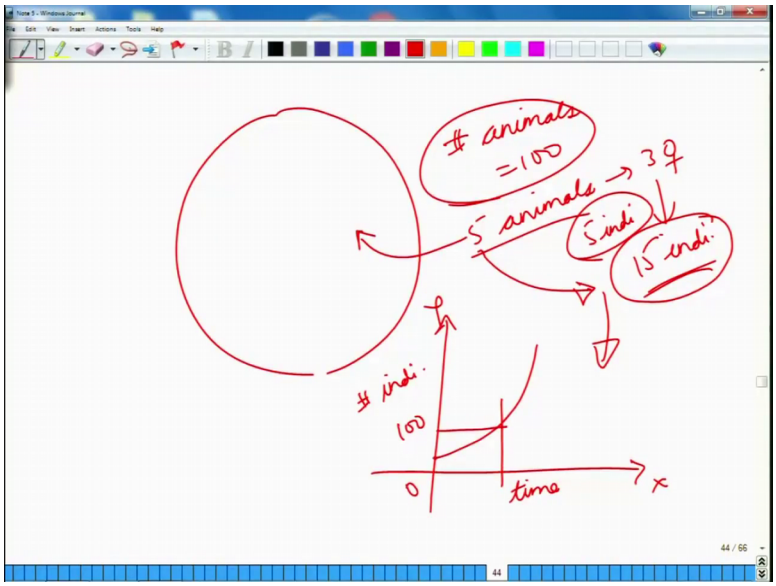

And the total number of animals that are possible is say 100 animals. So, that is the amount of space that you have, that is the amount of food and other resources that you have. Now, when you have this facility for say 100 animals and you started with say 5 animals. So, you introduced 5 animals into the facility have been shown in the first instance.

Now, your interventions were extremely directed, they were extremely intense so, you were given giving the animals all those things that they required for a successful

breeding. You were giving them a very nice climate a very good amount of food, a very nutritious diet these animals were also kept together so, that they were more interacting with each other.

And suppose they will a later clash of animals so, for instance in case of these 5 animals, we had 3 females and each female gave birth to say 5 individuals. So, you have an addition of 15 individuals. Now, what happens is that in the case of nature out of these 5 individuals it is possible that 4 of them die off and so, you are left with only one individual which is why this species was under a great threat or it is also possible that out of these 5 individuals, all 5 of them died out. But, then in your ex-situ conservation facility because your intervention is more intense, you are ensuring that all of these individuals survive to their maturity.

So, essentially all of these 15 individuals you are trying that they survive to their maturity. Now, this is something that is happening say every year. So, in a very short period of time you have shifted moved from 5 animals to 15 animals and then in the next breeding season and if these individuals also become sexually mature, then your population will start increasing and it exponential fashion. So, if this is your starting population, this is how your population will grow up. But then what happens is that here you have the number of individuals on the y axis and on the x axis you have the time.

So, in a very short period you will reach this stage which is your carrying capacity of your ex-situ conservation facility which was the 100 animals that could be kept. Now, when this situation arises so, you have a small facility and you have a large number of animals.

And probably you do not have enough number of natural areas in which to release your animals. So, what would happen? There would be a very little chance that you would be eager to bring more animals into your facility because you already have a very large number of animals. But, when that happens we will start seeing the impacts of inbreeding because you have a very small founder population.

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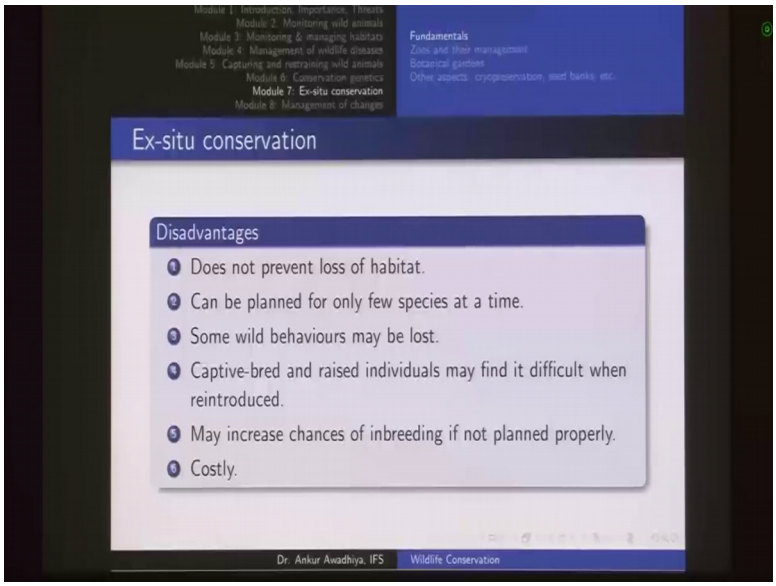

So, this is also one disadvantage, it may increase the chances of inbreeding if not planned properly. So, you have to continuously bring in new individuals and you have to continuously release some individuals back into their natural environment. But, then when you are releasing them, you do not want to take that risk right away because, you also know that these animals the release animals might not be having the wild behaviors and they might find it very difficult to cope when they are reintroduced.

So, all these factors mean that when you are starting in ex-situ conservation facility you should plan for a larger facility. So, not only are you giving these animals more amount of interventions, more intense observations, but also you need to plan for a larger facility and all of these increase the cost of the conservation. So, the ex-situ conservation becomes much more costly.

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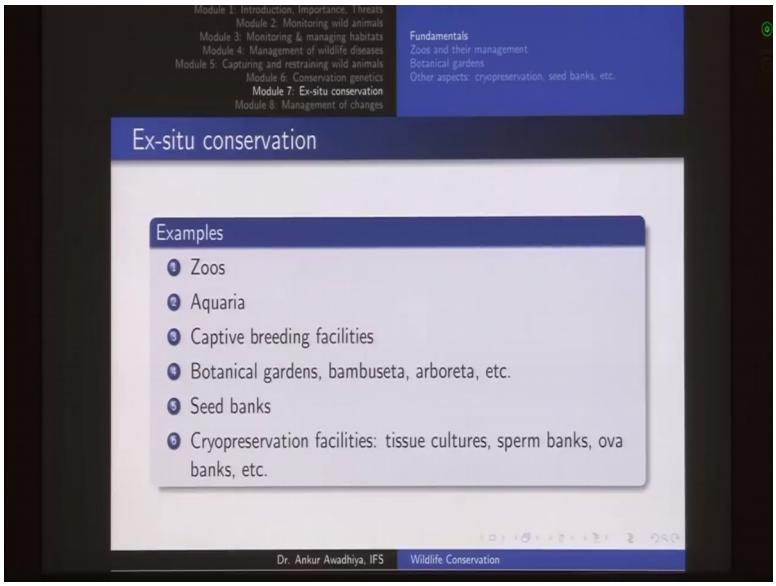

Now, some examples of ex-situ conservation include zoos, aquaria, captive breeding facilities, particle gardens in collection of bamboos which is known as bambuseta, correction of trees which is known as arboreta. So, in these cases you bring the seed so, you bring the saplings and you plant them together in an area.

So, they also become ex-situ conservation measures. Then you have seed banks in which you store the seeds of a number of plants, then you have care preservation facilities such as tissue cultures, perm banks, over banks and so on. So, these are the examples of ex-situ preservation facilities.

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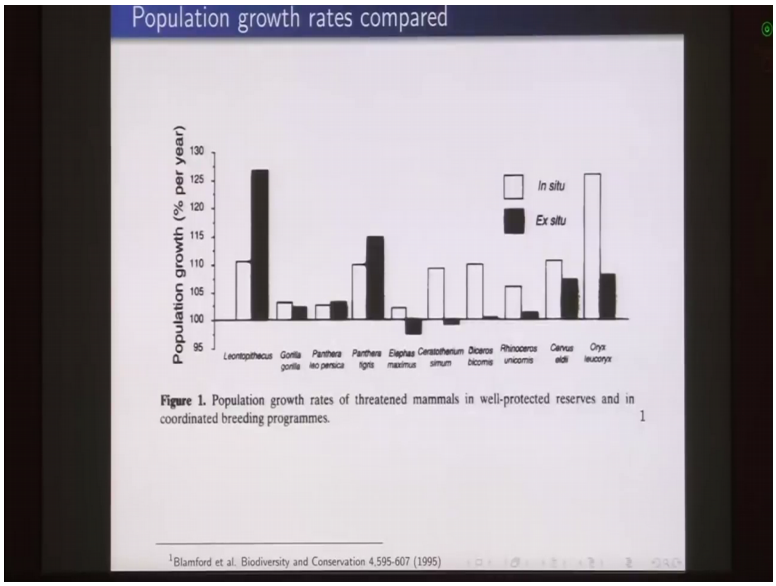

Now, if we look at both of these the in-situ conservation in the ex-situ conservation how do they compare with each other? So, this is a paper that was published that compared in-situ conservation measures and ex-situ conservation measures for the large number of species.

So, here we are looking at the population growth rates. So, on the y axis you have the population growth percent per year and on the x axis you have different species. The white one is in-situ the black one is ex-situ.

So, we can very clearly see that for some of this species like this one in this one the ex-situ conservation results in a larger or greater population growth as compared to the in-situ conservation method. So, essentially if you are bringing these species out into captivity situation then it is possible that their population will grow at a faster rate. So, these helped a lot, but on the other hand for some of these species including our rhinoceros we observe that the In-situ bars are very tall, but they ex-situ bars are very small.

So, what this tells us is that for some animals the rate of population growth in an ex-situ facilities very less. So, essentially it would make much more sense to go for the in-situ conservation method only. Now, in some of the other species such as elephants so, here we are observing that the population growth actually becomes less than what is our

benchmark that is the 100 percent. So, in these cases it is also possible that when you are bringing an animal into captivity then the population just does not grow.

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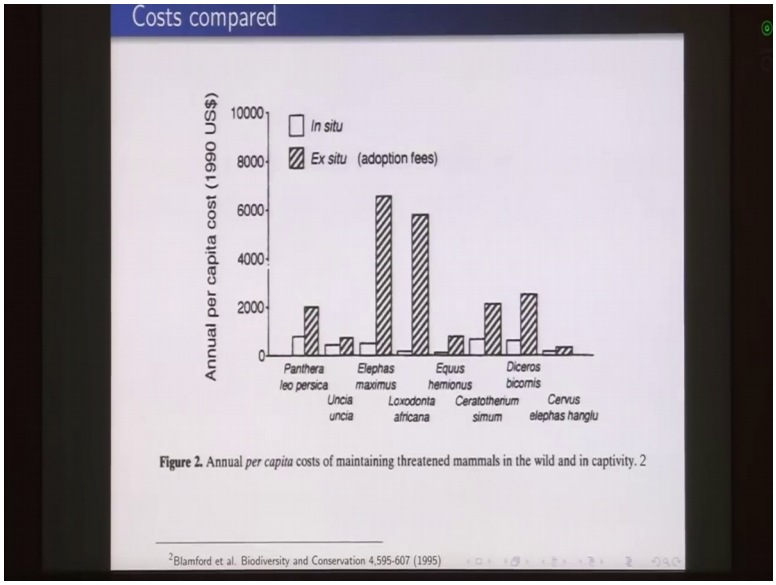

Next, looking at the costs so, here we are looking at cost per animal. Now, here also the white one has in-situ and the hashed ones are the ex-situ conservation method. So, here we observe that for almost all the species, in this case all the species we are observing that the ex-situ method is much more costly as compared to the in-situ method.

So, which is also a negative point that goes towards the ex-situ conservation method so, which is also another reason that we always try to prefer in-situ conservation method. And only in the case of very urgent situations like the species that is critically indigent and the number of individuals are very less only then do we go for an ex-situ conservation, but in-situ conservation is always the more preferred option.

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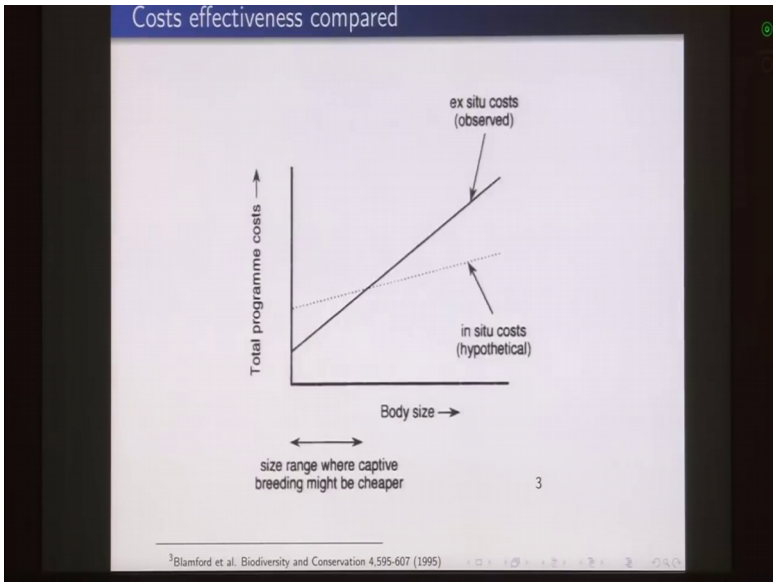

Next, this paper talked about cost as compared to the body size. Now, it turns out that in the case of ex-situ conservation methods if you have an animal with a very small body size. So, in the case of a of an animal with a very small body size so, you will have a room and in that room you can have here a very large number of individuals because each of these individuals is very small and does not require much of much of an area.

But then, when we go on increasing the body size so, for instance if we are moving from species such as say ground dwelling, squirrels towards elephants, now elephants require a very massive size. So, they also require a very massive area considering their last sizes. So, in that case our ex-situ cost increase at a faster rate as compared to the in-situ cost because, when we are considering the in-situ conservation in any our areas have to be larger size. So, this is the rate at which our In-situ conservation costs will increase and this is the rate at which our ex-situ conservation cost will increase.

So, just by looking at the cost effectiveness, they suggested that there is this critical body size below which the ex-situ conservation methods are most cost effective. So, here the cost of ex-situ conservation is very much less than the cost of the in-situ conservation method. But, then for the larger size species we need to go for the in-situ conservation method because ex-situ becomes prohibitively more costly. And this is primarily because most of these animals also require a larger range size.

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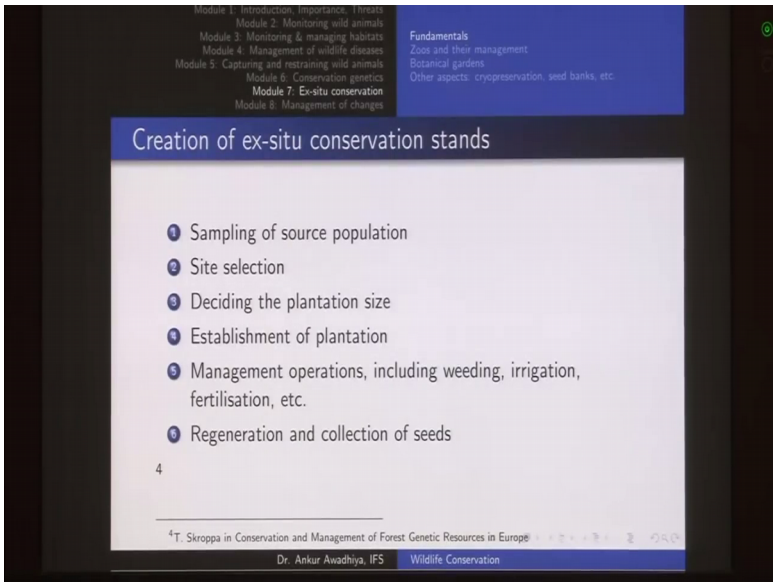

Now, if we consider anyone ex-situ conservation method. So, let us just consider for simplicity case ex-situ conservation of some plants. So, how would we go about creation of an ex-situ conservation stand? So, we will start by sampling of the source population. Now, this sampling wants to ask where are the species that we are trying to create the ex-situ conservation facility for where are they found?

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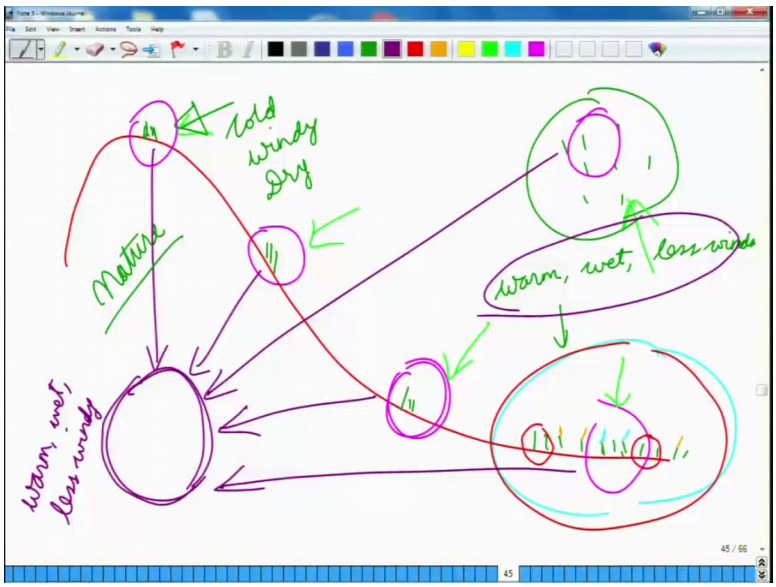

So, for instance, if you have a plant species that grows on top of the hills, that grows on the slopes, that grows on the talus and that also grows in the foothills. And maybe it is it

is also growing in some other area some island also it is growing. Now, when you are planning your ex-situ conservation facility and if you are if you are taking all your samples from just one site then you will not be creating a representative sample of the species for your ex-situ conservation.

So, essentially we start by first looking at where is the species found, how many individuals are found and where are they found? Once we have figured that out next we want to ask what sort of conditions do they require and then we need to have a sample from here we need to have a sample from here, a sample from here, a sample from here and a sample from here. So, that we create a representative of the species as it is found in the nature so, that is the first stage sampling of the source population.

Now, when we are sampling for the source population we also look at things what sorts of climatic conditions are required for this species. Now, based on those climatic conditions and based on the soil conditions that are required by this species then we will go for a site selection. So, our site needs to be as close to the natural sites as possible. Now of course, because this is an ex-situ conservation method it is quite possible that we would want to create these areas artificially. So, that is acceptable, but it needs to be as close to the natural conditions as possible.

Next we decide on the plantation size so, like as we saw in the case of an ex-situ conservation facility for our animals. When you looked at this example what we said was that if they can incapacity offer facilities 100 animals then we will have to stop at this particular time because, we will cross the number of 100. But, then if we had a larger sized facility then maybe we will be able to go on for some more time without creating conditions of inbreeding.

Now, similarly when we are talking about an ex-situ conservation for our plant species we need to decide on the plantation size. How many individuals do we want to keep in our facility? And then when are we also trying to increase their numbers? So, when we are trying to increase their numbers do we have sufficient space for any of the new offspring's that come up so, we need to decide on the plantation size.

So, once you have done the site selection, once we have decided on the initial plantation size and also the size of the area next we establish the plantation. Now, establishment would mean that we will bring seeds and we will bring the saplings from their natural

areas and then will translocate these individuals and we will try to establish them on our site.

Now, once that is done the next step is management operations including weeding, irrigation and fertilization and so on. In the case of animals it would be animal husbandry practices retain ad support and so on. So, all sorts of management operations are done so, that you are giving your plants the best of the environment to propagate themselves, to survive and to propagate. And once they propagate the next step is regeneration and collection of seeds so, in this case you would collect these seeds and maybe you will translocate them back into the natural environment. So, this is how the creation of with ex-situ conservation facility works.

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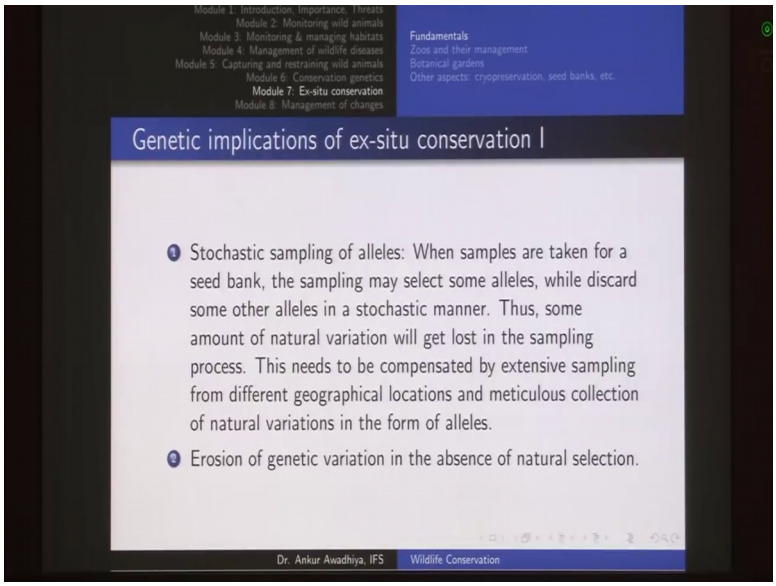

But, then as we saw before inbreeding is a major issue and there are also some other genetic implications of ex-situ conservation. One is the stochastic sampling of alleles, when samples are taken for a seed bank the sampling may select some alleles, will discard some other alleles in a stochastic manner. So, it is doing this in a random manner thus some amount of natural variation will get lost in the sampling process and this needs to be compensated by extensive sampling from different geographical locations and meticulous collection of natural variation in the form of alleles.

Now, what we are talking about here is that when we were considering our species that grows in all of these areas mountain tops, then the slopes, then the taggers, then also the foothills and also in some island. Now, when we are selecting some individuals one we need to select from all of these geographical locations. But then secondly, also it is possible that in the case of your foothills, you have a much larger size population as compared to what was there on the mountains.

Now, in the case of this population you might also be observing some individuals that are showing some differences because they are having some different alleles. Now, when you are selecting your individuals one is that your sample has to be representative of what is found in the nature.

So, for instance if in the case of your when your for your foothills on in the floodplains if you have a larger number of individuals then it makes much more sense to carry a larger number of samples from these floodplains. But, then we also need to ensure that as much of the variety that is possible is also retained in our samples. So, for instance if we took a sample in which we took only these green colored plants then this would not be a representative samples and we might be losing a number of alleles.

So, when we are even collecting our individuals from just one location, it is extremely crucial that we go for another level of sampling to understand what will sort of what kinds of alleles are available here, what kinds of phenotypes are we seeing and then take a representative sample from that.

So, the first genetic implication is that because of stochastic sampling of alleles we are going to lose some variety and our intention is to lose as little of this variety as possible. The second implication is that we can observe erosion of genetic variations in the absence of natural selection. Now, why is this important because when we were considering our natural keys so, this is how it existed in the nature?

Now, in the nature your same species were being exposed to very different climatic situations. So, here it was say cold and it was windy and it was dry. Whereas, here it was warm, it was wet and there was less of winds. Now, in nature you are having a very wide sort of environment into which your species has been put through. So, this will also result in some amount of natural selection and all of these different areas.

Now, when you are bringing all of these different phenotypes in to your facility so, suppose this is your facility and you are bringing individuals from all of these areas. Now, what happens is suppose you have created this facility in an area that is very similar to this area. So, it is warm, wet and less windy so, in that case your amount of natural selection that is acting would change as compared to what was there in the natural environment.

So, then your kinds of variations that are present here so, in the case of the natural system you are having a very wide amount of variations in the environment. So, you were also having a very wide amount of variation in the alleles. When you are bringing all of these together in just one small area then those individuals that were better adapted to this area will have a more reproductive fitness. So, with time you will also go on losing a number of alleles a number of variations. So, this is also another genetic application of an ex-situ conservation method that you observe genetic erosion or the erosion of the genetic variation in the absence of the natural selection.

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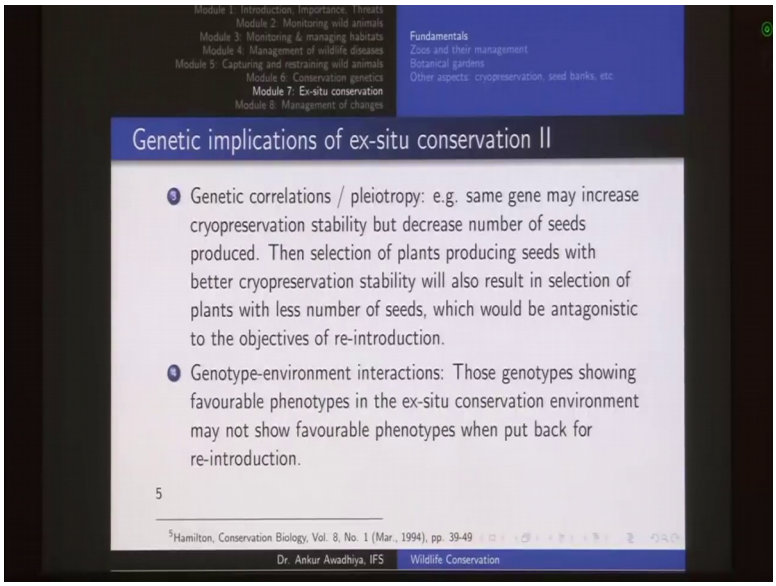

Now, the third implication is that you might also have some amount of genetic correlations or pleiotropy. Now, purity means that you have a gene that is having more than man effects. So, for instance in the case of human beings we could have a gene that codes for the colonist and that also calls for say the obesity that is there in an individual.

So, if a person is very tall this person is lean and if a person is short then this person is obese just to have a hypothetical example.

Now, if you are choosing for one variation so, suppose you are choosing for only tall individuals. So, in that case you are also choosing at the same time for the leaner individuals so, in the case of pleiotropic effects, in the case of genes that have more than one phenotype that they are influencing then our selection has or could have unintended consequences.

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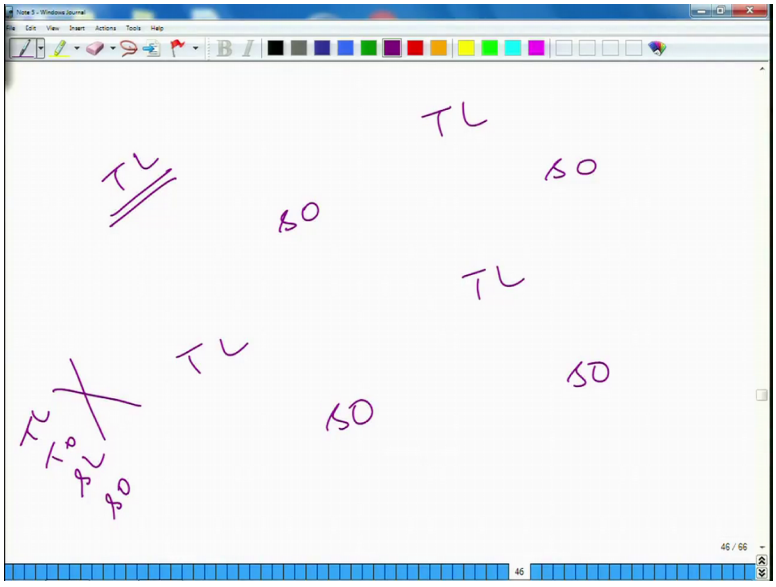

So, essentially you had a population in which you had people that were tall and then you had people that were short. Now, the shorter individuals say are obese and the taller individuals are say leaner. Now, when you were trying to create a representative of this whole population you wanted to have individuals that are both tall and lean and obese, short and lean and short and obese. But, then this would not be possible because both of these traits are being taken care of by a single gene.

Now, in the case of plants what happens is that you can have some genes that increase your cryopreservation stability. So, essentially when you are keeping your seats at a cooler temperature there could be a gene that increases the stability at these cooler temperatures. So, the other individuals might get lost when you are cooling the samples, but then this could also code for a decrease number of seeds that are produced.

Now, when you are selecting plants producing seeds with better cryopreservation stability because, in this case you are going to store your seeds at a lower temperature so, you want those plants that would be able to survive lower temperatures. So, you are selecting for those, but then what happens is that when you are selective for cryopreservation stability you are also selecting at the same time for a decrease number of seeds.

So, all the plants that are surviving in your facility would be producing a less number of seeds. Now, if there are less number of seeds then later on when you try to repopulate in area your repopulation will become very difficult. Because, all the individuals that you are putting out in the nature they would be giving out a very less number of seeds. Also, if you are trying to regenerate your seed population so, essentially, because of viability issues will take out some seeds from time to time from our facility then grow them again in their natural situations and then recollect the seeds and then put them back into the facility.

Now, if you are choosing for those individuals that already have a very decreased number of seeds then, it is also possible that your inbreeding impacts will become greater because the number of individuals are less in every generation.

So, genetic correlations or pleiotropy also are one genetic implication of creating an ex-situ conservation facility. So, you could be choosing for one factor while you are getting another factor at the same time. Now the fourth genetic implication is that of genotype environment interactions. So, those genotypes showing favorable phenotypes in the ex-situ conservation environment may not show favorable phenotypes when put back for introduction so, coming back to our example of this species that was found in all of these areas.

So, you brought your species into your conservation facility then you grew these seeds and maybe you grew them for a few generations. So, every generation you are create you are collecting some seeds, putting them back into your graft reservation facility then say in say around 5 years your viability goes down by 50 percent.

So, every 5 years you will take out these seeds, grow them again, let them grow, then collect their seeds again and then put them back again. So, this is what you are doing, but

then what will happen in that case is that you will select for these individuals that were having the environment that is very close to your ex-situ conservation facility.

So, after a few generations when you have these seeds and when you put these seeds back into their natural habitat. So, because this environment is very different from what was there on top of the hills then you might not get good results out there in the field. So, this is because of your genotype environment interactions, just because your environment is fixed here you only have a single type of environment. So, you will be selecting for those genotypes and you will be selecting for those traits that may not be useful for you when you are trying to put back your seeds into the environment.

So, in this lecture we had a look at what do we mean by in-situ conservation, what do we mean by ex-situ conservation? What are the pros and cons of both of these, what are the major advantages, what are the major disadvantages? We also looked at some of the examples. So, in the case of in-situ conservation, we have reserves, we have protected areas; we have national parks wildlife sanctuaries. In the case of ex-situ conservation, we have zoos, we have aquariums we have botanical gardens and so on. And then we also had a look at the cost and benefit analysis of both of these.

So, for instance for some species are in-situ conservation facility is much better because, they have a larger population growth when they are put in only in their natural environments. For some other species they might give a better result in the case of an exit to conservation facility. But, then the costs generally in the case of ex-situ conservation facility are much greater.

And also this has to do something with the size of the species. So, for the smaller size the species that require less amount of area and ex-situ conservation facility may be cost effective. But, in the case of larger species they become extremely cost prohibitive.

Then we also had a look at the genetic implications when you we are looking at the ex-situ conservation facilities. So, we do not get all the alleles that are there in the nature, the amount of variation gets lost with every generation. Then we also lose out on favorable phenotypes when we have grown them in our ex-situ conservation facility for some more time because, the amount of environmental variations are less.

And also because, there could be some pleiotropic genes in the case of those so, we will be selecting for some traits, but we are also getting some other traits selected at the same time. Which may or may not be useful when we are putting our seats back into the natural environment back again so, that is all for today.

Thank you for your attention [FL].