Wildlife Conservation
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Lecture - 17
Principles of disease management

[FL]. In today's class we will have a look at the Principles of disease management.

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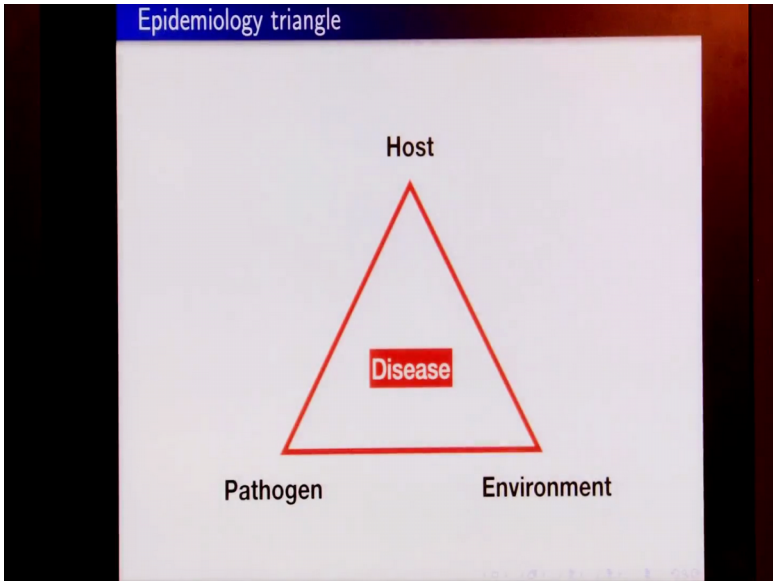

We begin by having a look at the epidemiology triangle. Now, epidemiology as we know is the study of spread of diseases and epidemiology triangle tells us that a disease will happen only when certain conditions of the host, the pathogen and the environment are favorable for the formation of the disease. So, there are 3 things that are involved in the progression of a disease the host, the pathogen and the environment.

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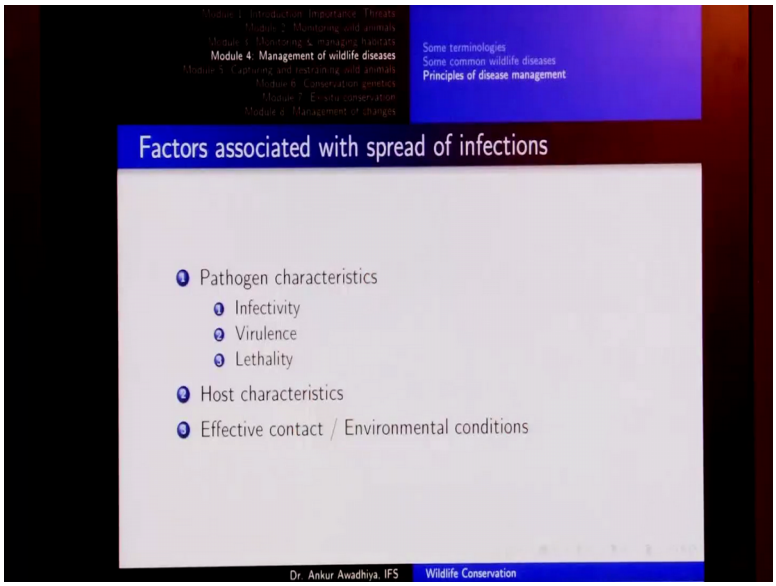

So, let us look at all of these one by one. Let us begin with the pathogen characteristics. Now, pathogens or the agents that cause the diseases like bacteria, virus, fungi, parasites and so on are characterized by a number of characteristics of which 3 are the most important infectivity, virulence and lethality.

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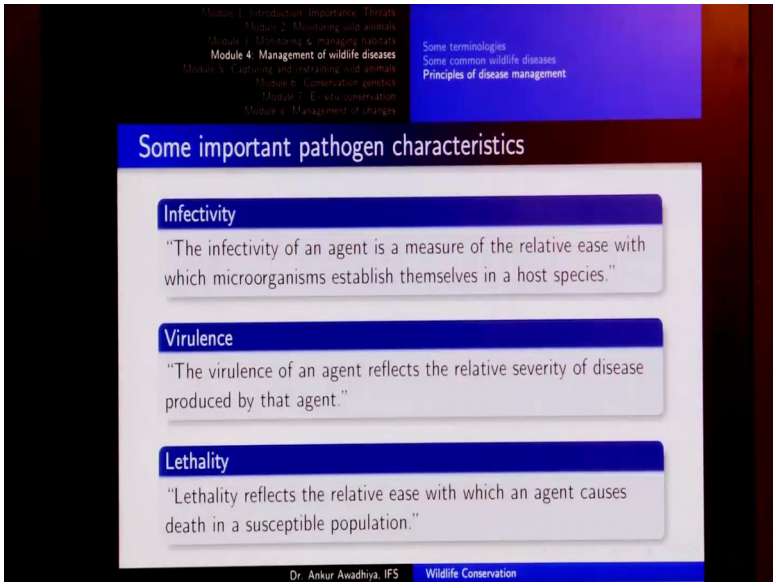

Now, infectivity tells us the relative ease with which the microorganisms or the pathogens establish themselves in a host species. So, essentially infectivity tells us how easy it is for a microorganism or a pathogen to infect an animal or a human being.

Virulence tells us the relative severity of the disease that is produced by the agent that is whether this disease is mild or whether this diseases severe. And lethality tells us the relative ease with which an agent causes depth in a susceptible population. Now, why are these 3 pathogen characteristics so important for the progression of a disease?

If there is a pathogen that has low levels of infectivity; so in that case even if it has a susceptible host even when the environmental conditions are favorable it will not be able to establish itself in a number of individuals. And when the level of establishment is less than the level at which this pathogen is removed from the population say by means of death of the individual or because of the immune response of the individual. So, if this pathogen is able to infect less number of animals and more number of animals are able to get rid of it from the system. So, in that case this disease will not be able to spread. So, infectivity tells us the speed with which the, this disease is going to spread in the population.

Virulence tells us the severity of the disease that is produced by the agent. So, for instance common cold would be considered to be a disease that is relatively mild. So, it does produce a few symptoms, but the symptoms are not very harsh. On the other hand if we look at influenza. So, influenza has degree of severity that is much greater than that of the common cold. Now, why is this important? Because if a disease is more virulent; so, in that case it would produce more severe symptoms and in that case the immunity of the animal would fall down even greater as compared to a disease that shows a very mild level of virulence. So, if an animal has an immune system that is we can so it becomes prey to other pathogens as well and then those pathogens will together determine the rate of course, of the disease.

The third factor is lethality, lethality tells us whether this agent is able to cause death of the host individual or whether it let us the individual survive; so, for instance in the case of some diseases such as common cold there is very little level of lethality. On the other hand for some diseases such as say Ebola the level of lethality is very high. Now, lethality also tells us the spread of the disease because when the host individuals die off very quickly they are not able to spread the pathogen to a larger number of other healthy individuals as compared to a pathogen that has a low level of lethality.

So, if a pathogen has a low level of lethality the individual will not die for quite some time it will come into contact with a number of other healthy individuals, and this disease will be able to spread more and more whereas, when there is a high degree of lethality then probably it will not be able to spread that fast because the individuals that are getting the disease die off. So, these are the 3 pathogen characteristics infectivity, virulence and lethality. Let us now have a look at the host characteristics.

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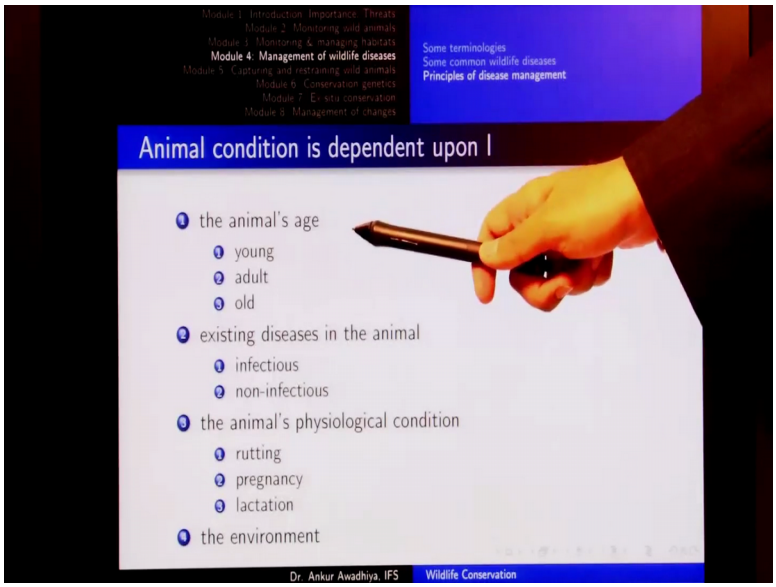

Now, host characteristics tells us the condition of the animal. So, the condition of the animal is dependent upon as we saw before the animals age so whether it is a young individual and adult individual or an old individual in the case of young and old individuals. So, like babies and very old individuals. So, the level of immunity is less and so the susceptibility to fall prey to a disease is more. In the case of adult individuals the level of immunity is much greater and so the animal is able to resist any disease.

The animal condition is also dependent upon existing diseases in their animal whether they are infectious or they are noninfectious. Now, this is because if an animal already has some diseases in its body. So, its immune system is already fighting those diseases. So, essentially the immune response of this individual is being used to already tackle in a preexisting disease that is there in the body. So, if a new pathogen comes the level of immune response that the body is able to put forward to counter this new pathogen will be much lesser. So, essentially if an animal is a pre disease animal, if it whether it is an

infectious disease or a non infectious disease it is much more susceptible to fall prey to the due disease it also depends on the animals physiological condition rutting pregnancy or lactation.

Now, rutting is a stage that is huge in the context of a number of animals in which breeding time. So, they are in their meeting period and they are primarily concerned about having a display of themselves to attract mates.

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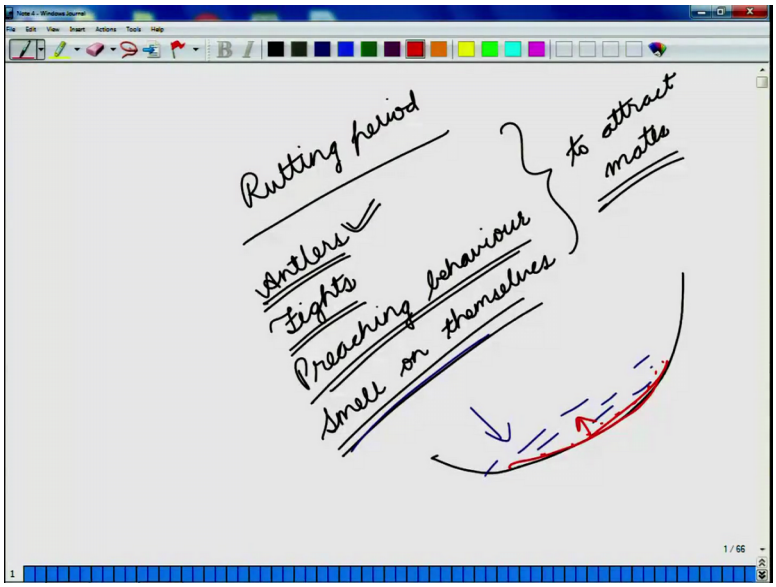

So, for instance in the case of the rutting period we would have animals that have say large sized antlers, they are doing fights amongst themselves, they are engaged in a preaching behavior or maybe they are engaged in a behavior of putting their smell on themselves to attract mates.

Now, to give an example in the case of Sambar, now Sambar is another deer. Now, when it is in its rutting season or the mating season the Sambar would be having large sized antlers. Now, antlers are extensions of the body that grow like this. So, they look very much similar to horns, but unlike horns that are hollow from inside and are bony structures antlers are more like our hairs, so they are made out of keratin.

Now, when the animal is developing antlers and it is having also a lot of calcium inside it is using most of the calcium that is there in the bones to grow up its antlers. So, essentially most of the resources of the body are being utilized to develop these organs

that are visual signatures to attract the mates. So, in such scenarios most of the energy in the body most of the reservoirs of nutrients in the body are being used to show to develop these for these signs, and so if a pathogen infects at this time the there is a words in the body are very less and so the animal is more susceptible to fall prey to a disease.

Next is fights. Now, these animals say in the case of Sambar itself they engage in fights with other male individual and in those circumstances they would have their antlers towards themselves and they would just go and bump against each other. Now, during these fights most of these fights are nonlethal but they do result in a number of injuries to the animal. Now, if the animal is injured then there is a better chance for any pathogen to infect this animal, and if there is any infection then this infection becomes a preexisting condition and any other pathogen would also be able to establish itself in a much faster way.

Third is preaching behavior. Now, preaching behavior is a behavior of say Sambar's in which they go to a high rock and there they stand on their two feet and put their other two hooves on the top and then this is another display technique in which they are trying to attract the mates. Now, it does not have a very direct relationship with diseases, but then again if this animal is going to two very top rocks and is trying to engage in this visual display then it is also utilizing quite a lot of resources from its body and so it becomes a little more susceptible to getting due diseases.

The fourth is that in the case of the rutting season of Sambar's they try to put their smell on themselves which acts as another there is to emulate to attract the mates. So, a closed scenario in the case of human beings would be would be the case of people putting up deodorants on their bodies. Now, these animals these wild animals they do not have access to deodorants, what they do is that if there is any pond or any source of water especially muddy water.

So, they would go there they would urinate in this water and then they would roll their body in this water. So, that all this mud which has it is which has the animals urine with it gets stuck all throughout its body. And the urine of this animal also contains some chemicals that are attractive to the mates. So, this is another behavior in which they engage during the rutting season.

Now, while they are engaging on this smell behavior what happens is that they are going into the into the water bodies they are, they are mixing up the water in the mud and then they are sticking that mud on it on their body. Now, one thing is that when the body of the animal is wet it is it has more chances of getting a fungal infection such as ringworms.

Also as we saw in our previous lecture that in the case of anthrax we have spores that come at the bottom of most of these water bodies, and when these animals are engaging in these behaviors what they are doing is that they are mixing up all the bottom portion of this water body into the top layer of fresh water. So, essentially all of these spores have come up to the surface and through the bodies of these animals they can also spread.

So, essentially coming back to the slides the animal condition is also dependent on its physiological conditions. So, during the rutting season the animal is not only a more susceptible to diseases, but can also spread these diseases much more then in the case of pregnancy and lactation. So, during pregnancy the female animal is devoting most of her energy into the development of the young fetus, and during lactation the mother animal is devoting most of her energy to the development of milk which is then secreted and is used as food for the offspring. So, because quite a lot of resource is diverted during pregnancy and lactation, so the female animal also are more susceptible to fall prey to diseases during these seasons because the immune response typically is lesser. Now, animal's condition also depends on the environment.

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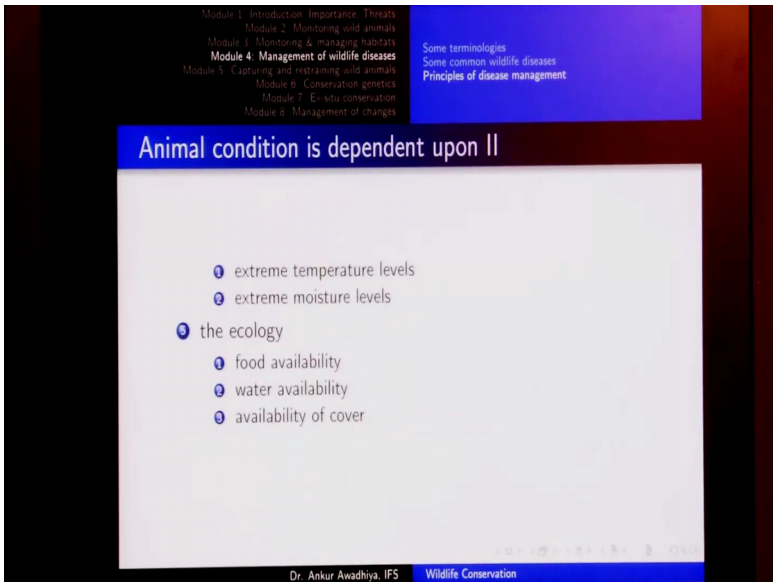

And these environmental conditions could include extreme temperature levels in extreme moisture levels. So, basically if we have a very hot season, so in the very hot season the animal does not have access to quite a lot of water it is sweating a lot and it is spending most of its energy to cool its body.

Similarly in the case of situations where we have extreme levels of cold, so the animal is using most of its energy to keep itself warm. Now, in such scenarios because most of the resources of the body are being used to counter the extreme levels of environment the level of immunity also goes down. So, the annual condition is also dependent on the environment, and it is also dependent on the ecology like food and water availability and availability of cover. Because as we saw before if the animal does not have enough food if it does not have enough water, so the level of immune response that the body can put up against any new pathogen would also be less and so the animal will be more susceptible to any new diseases.

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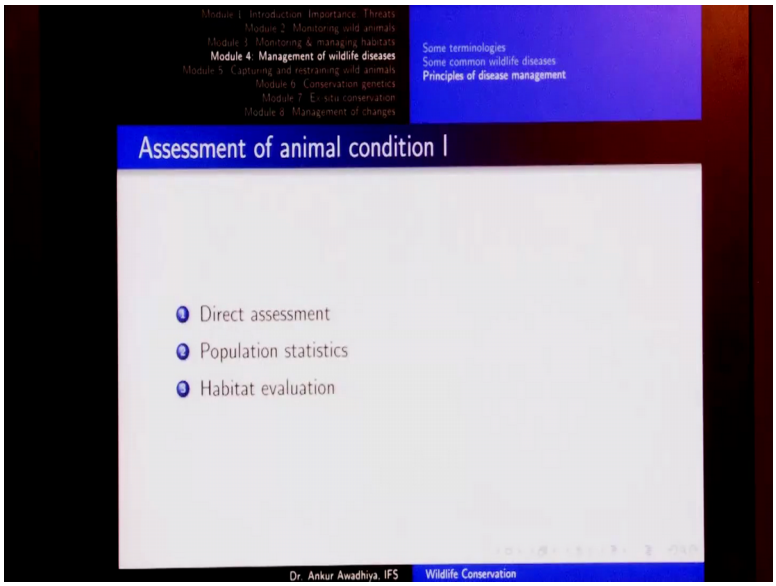

Now, coming to the animal conditions; in the field how do we assess the animals condition how do we know whether this animal is more susceptible to fall prey to our disease or whether this animal is healthy enough. So, that it would be able to thwart off any new diseases. So, we use 3 techniques in the field direct assessment, population statistics and habitat evaluation to understand the condition of the animal. Now, to give a human parlance how do we understand whether we are healthy or not?

So, most of the times if we get any disease we would have some sorts of features that would tell us; so, for instance we would be having fever or maybe we would be having a body ache or a headache. So, that would tell us that yeah there could be something wrong with us, then if we go to a doctor then the doctor would prescribe certain tests, so there could be blood tests he or she might note your body temperature might ask you to go for some pathological tests and so on. But in the case of animals if you go there in a forest and you see some animals how do you know whether these animals are healthy or not we cannot just go and capture each and every animal and measure its body temperature so which is why we require these assessments of the body condition.

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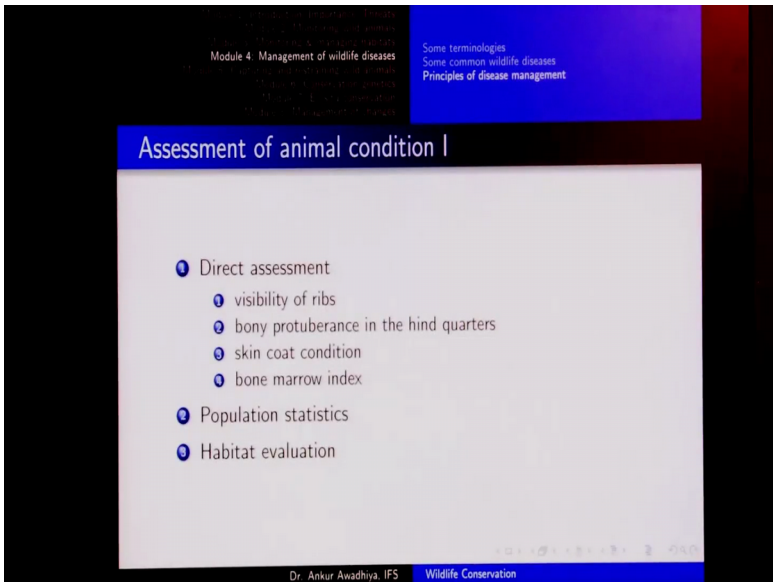

Now, we begin with the direct assessment. Now, direct assessment deals with what we can see from a distance. So, things like visibility of ribs, bony protuberance in the hind quarters, skin code condition and bone marrow index are direct assessments.

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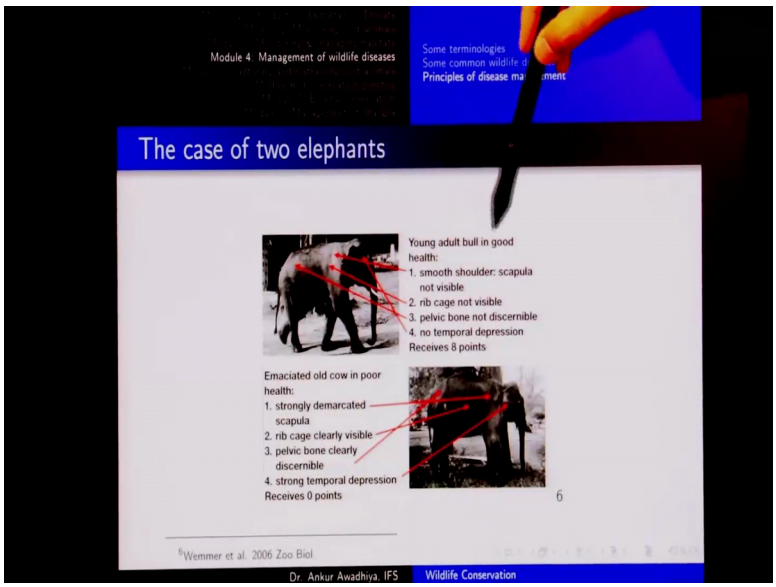

Now, to take a concrete example let us see these two elephants. Now, in the case of the first elephant we do not see any of the ribs on its body whereas, in this elephant we can see these ribs in the form of these lines. Similarly for this elephant we can see that its back is very much rounded, in this elephant we can see that we can see a bone here and

then we can also see the vertebral column on the top. So, all these bones are now much more visible. We can also see this heavy temporal depression which is there on the forehead.

Now, when we see an animal that is showing all of these bones outside, so we are seeing the ribs, we are seeing the pelvic girdle, we are even seeing the pectoral girdle or the scapula, we are seeing the vertebral column here, we are seeing depressions on its forehead. So, it means that this animal does not have quite a lot of fat in its body. So, because of which all the bones are not clearly visible.

Now, so normally if you see any animal you should the first thing that you should observe is whether the ribs are visible or not. In most of the animals and most of the healthy animals we would have a layer of fat that covers this region and so the ribs will not be visible and similarly all of these bones will not be very clearly visible. If the animal is diseased or if the animal is starving in those conditions only we would be able to see all these different bones.

At the same time we can also have a look at the skin of the animal. Now, from a distance if there is an animal that shows a skin that is very smooth, very shiny, has lots of hair. So, it looks like an oiled surface it looks like a surface that is very extremely polished. So, that would tell us that this animal is having enough hair and all of those hairs are having enough amount of oil because of which it is giving a very shiny coat. In the case of diseased animals we would observe that either this those animals would be losing up hair or their hair would be extremely rough or their hair would be without oil. So, it would give a very coarse appearance.

Now, coming back to the slides, we can say that in the case of this elephant this is a young adult, bull in good health and it is showing a smooth shoulder this the scapula is not a visible. Now, then the ribcage is also not visible the pelvic bone is not discernible this one, and no temporal depression on the forehead. So, this elephant receives 8 points.

On the other hand this elephant which is an emaciated old cow. So, emaciated means that it is a famished cow it does not have enough amount of nutrients and it is old in condition and it is in poor health. So, we can see strongly remarked its scapula this portion. So, it is very clearly visible. The rib cage which is very clearly visible, the pelvic

bone is clearly discernible and there is a strong temporal depression. So, we can say that that this elephant receives 0 points. So, this is in a very poor health.

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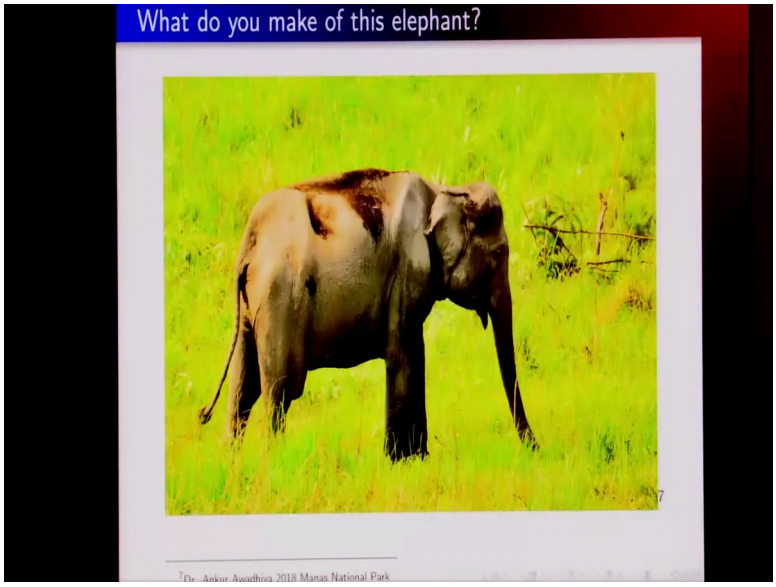

Now, we went to Manas Tiger Reserve and we saw this elephant. So, what can you make out of this elephant? Can you see that this pelvic bone is very clearly seen here, we can very clearly see the vertebral column, we can very clearly see the scapula and then we can very clearly see this huge depression that is there on its forehead.

Now, most of the skin look appears very loose. So, if it had any amount of fat in the body then the then this skin would look much more tighter. We can also see glimpses of the ribs at this portion. So, essentially this is telling us that this elephant even though there is greenery everywhere it is in a very poor health.

Now, this could occur, so whenever we see such an animal we try to infer what could be the reason. So, either this elephant is suffering from a disease such as tuberculosis that is a wasting disease or else it is also possible that this that all these grasses though they are green in color they are not providing sufficient amount of nutrition to this animal or maybe there is something wrong with the mouth parts of the animal because of which it is not able to eat this grass or maybe there is a heavy load of parasites in its intestine because of which it is not able to absorb the nutrients.

Once we have a identified such an animal then the next step would go to understand which of these hypothesis is actually causing it to have a such a poor health. The next question would be how many animals in the herd are showing such a health. If it is only, if this poor health is only there in one animal then probably it is not such a big worry as compared to a situation in which most of the animals have a poor health.

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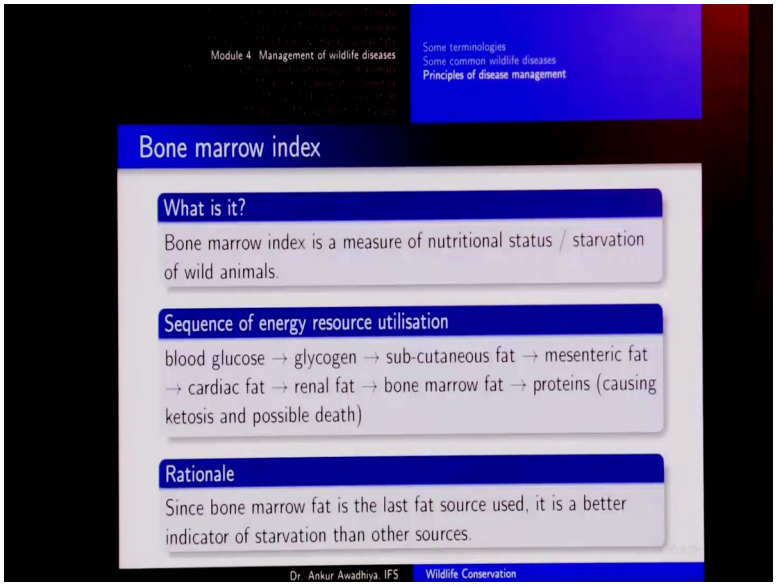

Another way of direct examination is a bone marrow index. So, what is a bone marrow index? It is a measure of the nutritional status or starvation of wild animals. Why do we use a bone marrow index? Because typically when an animal is not getting food or when an animal is diseased and is not able to eat food and so is using its own bodily resources. The first source of food that it uses is blood glucose after blood glucose it uses a glycogen that is stored in the liver and in the muscles followed by subcutaneous fat. So, subcutaneous fat means the fat that is below the skin, followed by mesenteric fat.

Mesenteric fat is the fat that is in your abdominal portion, followed by cardiac fat which surrounds the heart, followed by renal fat that surrounds the kidneys followed by bone marrow fat. So, this is the last source of fat that is utilized. After this source is used then the animal will start using up the proteins when an animal uses proteins for energy then it causes ketosis and may even lead to death. So, essentially the bone marrow fat is the last fat source that is used so which makes it a very good indicator of the level of it starvation in the animal.

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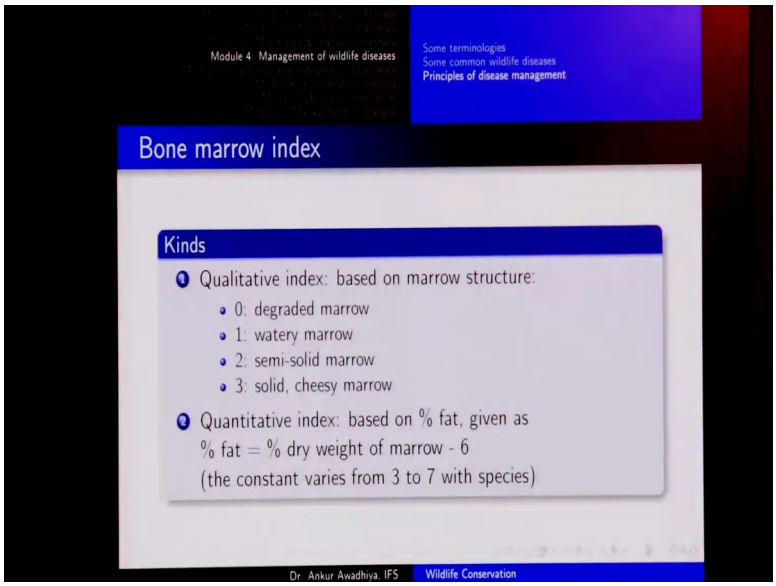

So, how do we use this bone marrow index? So, there are two indices that are used one is the qualitative index which is based on the marrow structure. Now, one other point to remember why we are using this bone marrow index is that if we come across any carcass of an animal. So, for instance there is a Sambar or a chital that was eaten up by say a tiger or a leopard. So, most of the meat portion would be eaten up, but then the bones would be left around, till some scavenger comes up and starts taking them away or eating them. So, in most of the circumstances we find the bones with the bone marrow there in the field and so it is very easy to have these samples. So, when we have this sample what we do is that we break the bone and we have a look at the bone marrow, and then in the qualitative index we divide it into 4 classes in a very healthy animal the bone marrow would look like cheese it would be solid and it would be cheesy.

So, in that scenario we give it a score of 3 which means that it is a very healthy bone marrow. Once the animal starts using this the fat from the bone marrow then it becomes a semi solid structure which in which case we give it a score of 2, when even more fat is taken away then it becomes watery. So, when you open it up it will look like a watery gel, and when all the fat is used up then it becomes a degraded marrow in which case it would look like a structure that crumbles by itself. So, we have these classifications of 3 2 1 and 0, 3 means that the animal is healthy or had or the animal was healthy before it was eaten, and the animal had enough amount of nutrition and 0 would tell us that the

animal when it was predated upon was already in a poor very poor health or already was very famished and emaciated.

Another way is a quantitative index in which we look at the percentage of fat that is present in the bone marrow. So, this can be done chemically or we can make use of equations such as these which just look at the percentage dry weight of the bone marrow, and then make a correlation between the percentage you drive it of the bone marrow and the amount of fat that must have been there.

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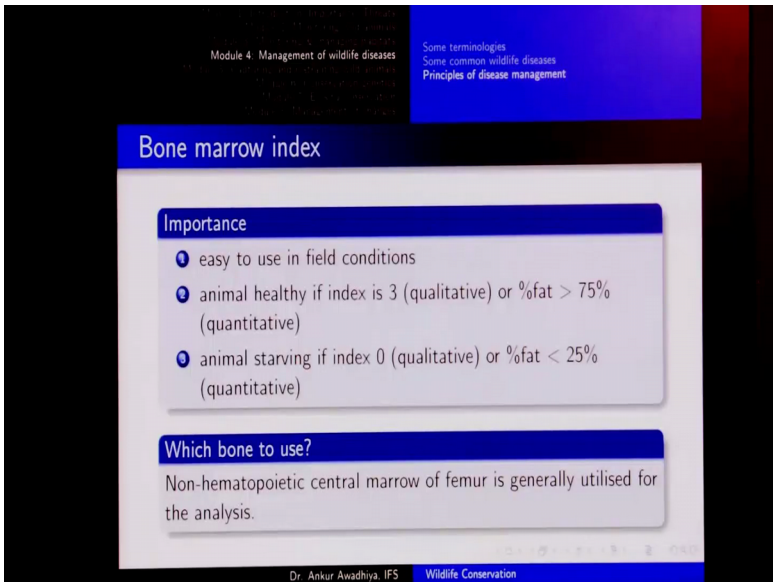

Now, why is it important to use this index? One it is easy to use in the field conditions because the samples are very easily available. Second it is very easy to use because we have a very clear indication that the animal is healthy if the index is 3 or level of fat is greater than 75 percent, the animal is starving if the index is 0 or the level of fat is less than 25 percent. Which bone is used? Typically the femur bone is used.

Now, femur bone is a very large sized bone and its non-hematopoietic. So, basically in the case of bone marrows we have some hematopoietic bone marrows that produce blood cells. So, they would look reddish in colour. So, the non-hematopoietic portions of femur is generally used because this is typically available to us and it is very easy to work with.

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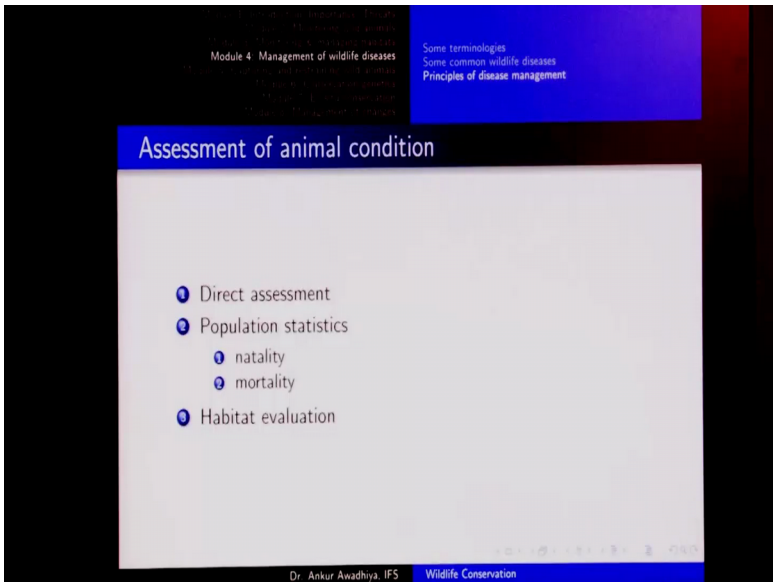

The another way of assessing of the animal condition is through population statistics, and in the case of population statistics we look at natality and mortality. Natality is the birth of young individuals and mortality is the death of animal. Now, if you go to any forest area and say after the breeding season most of the breeding season occurs in the rainy season. So, after the breeding season if you go into a forest area and you find that with every female animal or say more than 50 percent of the adult female animals, you are seeing some fawns, some young ones.

So, you would say that this whole population is healthy because childbirth and lactation requires such a huge amount of energy, it requires such a huge deployment of resources that an animal tries to avoid it if it is not in the prime of the health and if the habitat is not in the best of the condition otherwise it does not make any sense to devote so much amount of resources into making of a young one if that young one is going to die off in a small period of time.

So, essentially natality and mortality, similarly if you have a population in which a number of individuals are dying off, so we could say that there is some disease in the population. So, natality and mortality also become very easy field indices to assess the animal's condition.

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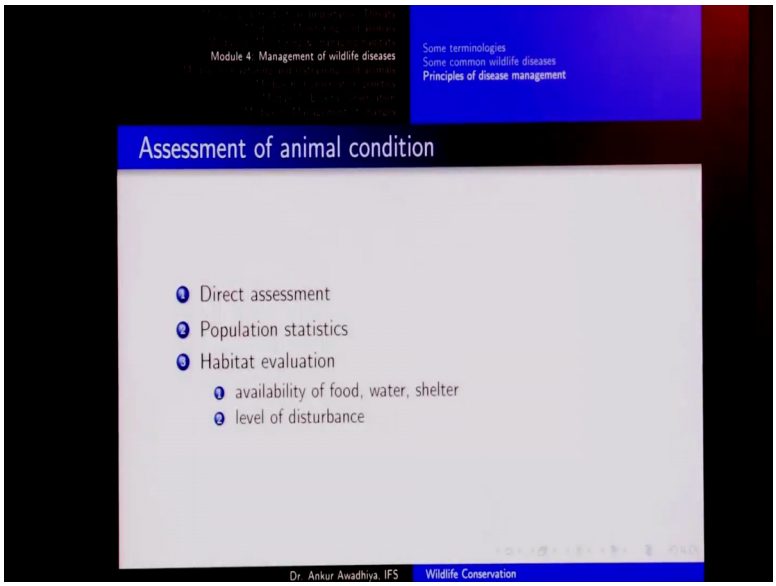

The third way in which we assess animal condition is through an evaluation of the habitat. So, in the habitat evaluation we look at the availability of food water and shelter and also the levels of disturbance. So, if adequate amounts of food water and shelter are available to the animals, and if the animals are not being disturbed then we can make a correlation that most of these animals are healthy because the environment is supporting them.

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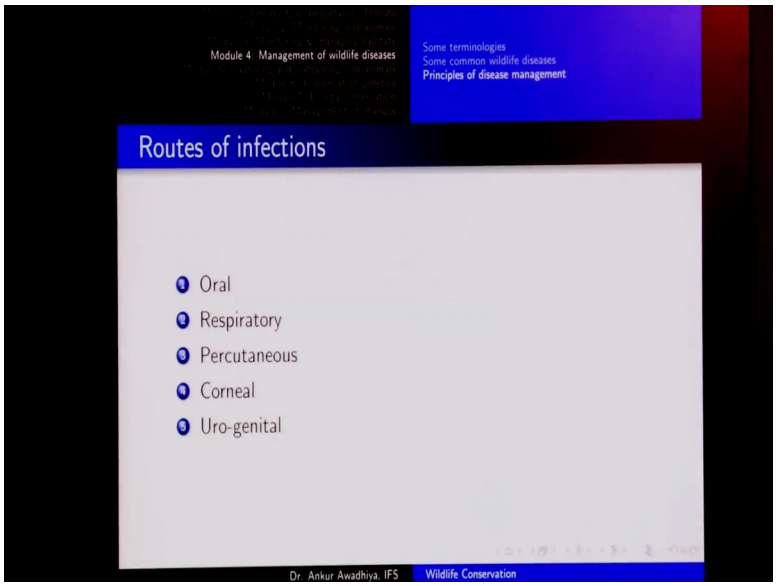

Next let us have a look at the routes of infection. So, when we are talking about disease management it is important to note the routes of infection so that we can have our own ways to counter them. Now, the routes of infection are oral. So, if the animal is eating or drinking the pathogens into the body it could be respiratory, when the animal is inhaling the spores or say the pathogens it could be percutaneous in which the pathogen is coming through the skin. It could be corneal in case the pathogen is being sprayed into the eyes and then is getting absorbed from the cornea or it could be urogenital in the case of urinary tract infections and also in the case of sexually transmitted diseases. Now, for all of these routes of infections we would have a different management strategy.

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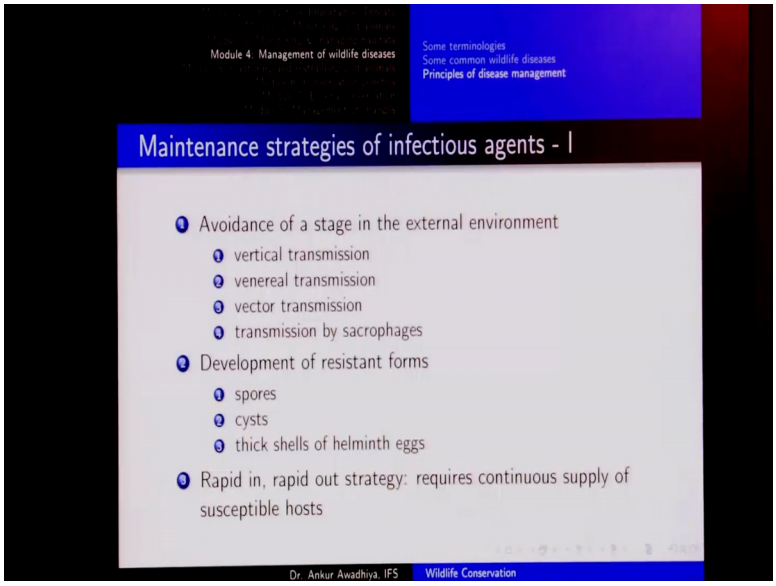

Then it is also important to note how the infectious agents or the pathogens are able to maintain themselves because as such if you think about a pathogen it is living life that is extremely dangerous because whenever it gets into a host there is an immune system that is trying to get rid of it. If it comes out in the open then it might dry off and die just because of exposure to air and exposure to sunlight. So, how does an infectious agent maintain itself in a population?

So, one way it does is avoidance of a stage in the external environment. So, for instance in cases of vertical transmission it is moving directly from the mother to the child. So, in this case it did not come out in the open it did not see the environment it just moved from one animal to another without coming out into the environment. Second is venereal

transmission which is transmission through mating. So, here also because both of these organs the male and the female genitalia come in very close contact. So, the animal can avoid coming out into the external environment.

Third is transmission by vectors. So, for instance in the case of say malarial parasite, so the parasite resides inside the body of an individual and then hitchhikes into the body of a mosquito to reach into the body of another organism. So, in all these it is avoiding coming in direct contact with the environment.

Next is transmission by sacrophages. So, sacrophages are animals that that get rid of dead and decaying matters. So, when it is getting transmitted by the sacrophages themselves it is also avoiding stage in the external environment. Next is development of resistant forms. So, these resistant forms could be spores take for example, this spores of bacteria, cysts which is a term generally used in the case of parasites and also thick shells in the case of helminth eggs. So, when it develops these resistant forms then the immune system is not able to penetrate into the body of the pathogen or the body of these infectious agents and so they are able to maintain themselves in the large population.

The third is a rapid in rapid out strategy which requires a continuous supply of susceptible hosts. So, in this strategy the pathogen gets into an animal spreads its disease multiplies itself and then rapidly it comes out and after that it would require another host in which it would rapidly go in rapidly come out. So, in this case it requires a continuous supply of susceptible host.

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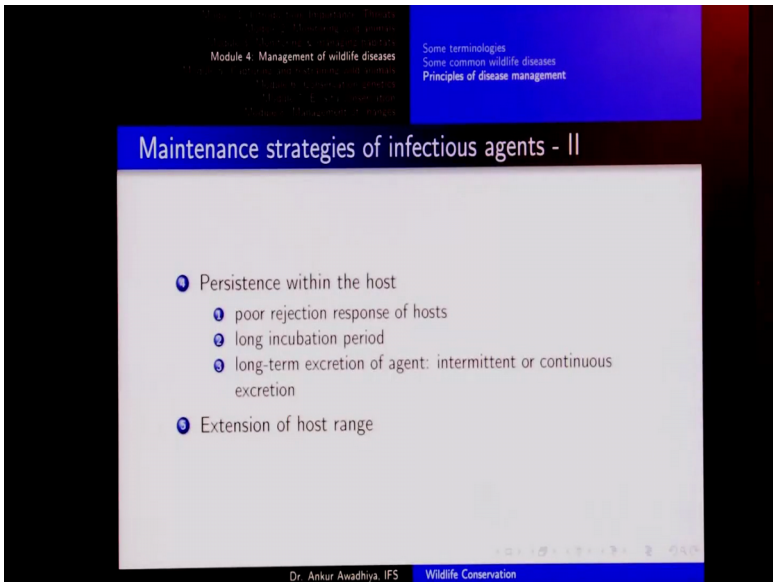

Next is persistence within the host. So, persistence within the host is a for example, in the case of poor rejection response or hosts. So, in a number of worms that are there in the in distant, they also secrete some extensions that reduce the immune response of the host. Also there could be some diseases that you use long incubation period. So, in long incubation period the animal is not showing any of the symptoms of the disease the animal is leading a perfectly healthy life, but at the same time it is acting as a multiplier of the pathogen and it is also spreading this pathogen to other animals by acting as carriers then there is long-term excretion of the agent intermittent or continuous excretion.

So, this for instance happens in the case of tapeworms. So, this tapeworm it resides in the body it persists within the body and then at times it goes on giving out its fragments and it also goes on giving out its eggs and then finally, we have the extension of the host range. So, in which case the pathogen would in place of affecting only one host would take a group of animals to in which to spread the infection. So, a common example for instance is rabies. So, rabies host could be pats it could be deer it could be dogs it could be cats it could be raccoons it could even be humans.

So, when there is a pathogen that has an extended range of host, so even when this pathogen is not getting one host it could always go into another host. Now, why are these maintenance strategy is important? Because if we know the maintenance strategy of a

pathogen; then we can make use of this information to mount our response. So, for instance if we know that there is a disease whose maintenance strategy is development of resistant forms in the form of spores.

Now, one example that we dealt with in detail is the disease called anthrax. Now, there are anthrax spores that are very resistant and they get into the bottom of water bodies and they just stay there. So, this is one maintenance strategy. So, that even when there is no anthrax in the whole of the system anthrax can come out again if there is an animal that goes into the water body and disturbs the water. So, if we know that the maintenance strategies is the formation of spores we can then categorically treat all our water bodies we can dry them out scrape out the bottom layer maybe burn it or maybe use some chemicals to sanitize it, similarly if we have a disease that has a rapid in rapid out strategy and requires a continuous supply of susceptible host.

So, in such scenarios our response could be to have a situation in which any disease animal is put into a quarantine and so does not and is not permitted to come in contact with other animals. So, in that case the pathogen would lose access to host and because this was the maintenance strategy it was using once you have broken this maintenance strategy you would be able to counter the disease. So, to sum up in the case of the epidemiology triangle it says that characteristics of the host the pathogen and the environment all 3 play together to form the disease. Now, we look at maintenance strategies and some specific maintenance breakdowns that we could do. But in general our strategy has a lot to do with monitoring and surveillance, and there is a difference between both of these.

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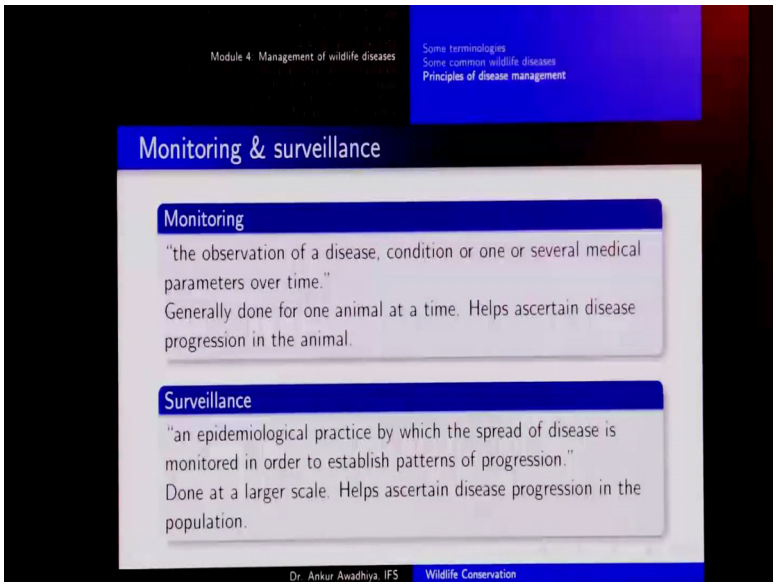

In the case of monitoring the observation of a disease condition or one or several medical parameters over time, it is generally done for one animal at a time and helps ascertain the disease progression in the animal. On the other hand surveillance is an epidemiological practice by which the spread of disease is monitored in order to establish patterns of progression, it is done at a larger scale and helps a certain disease progression in the population.

So, like even in the last lecture we always had this topic of surveillance in the management of the diseases. So, in the case of surveillance we keep a broad eye out into the system, we try to observe if there are any animals that are showing any signs of the disease how many of those animals are showing those signs and whether it is now, an appropriate time to put out a response. In the case of monitoring we do a more intensive monitoring of the animals maybe a few animals or maybe a group of animals to help ascertain the disease progression in the animal.

So, for instance during our surveillance operations if we come to know that there is some disease that is causing wasting of the annuals, so the animals are becoming thin, they are becoming weak. So, during our surveillance we found that there are some disease that is causing these features. So, which of the diseases could be there, to understand that more fully we could go for a monitoring operation in which a few animals or a group of

animals are monitored more intensively to understand the disease and its progression. So, that is all for today.

Thank you for your attention, [FL].