Wildlife Ecology
Dr. Ankur Awadhiya
Department of Biotechnology
Indian Institute of Technology, Kharagpur

Lecture – 35
Revision

[FL] Today we move with the second part of the Revision.

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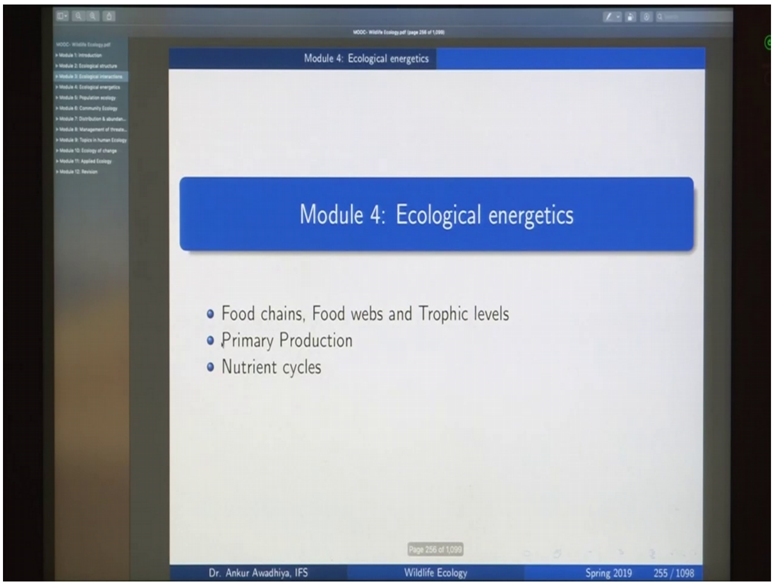

So we begin with the 4th module which was Ecological energetics. It had 3 lectures food chains, food webs and trophic levels, primary production and nutrient cycles.

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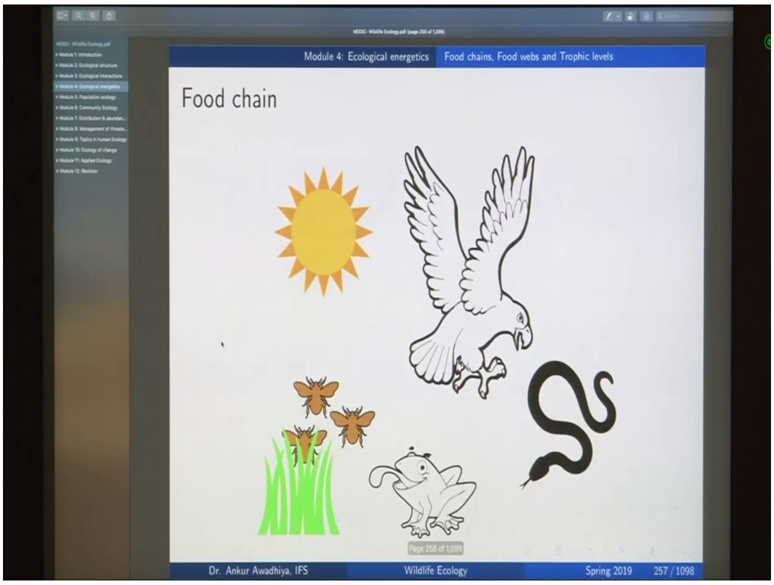

So, in the case of food chains this is one image that we know from our school days. So, grass is eaten by insects, insect is eaten by the frog, frog is eaten by the snake, snake is eaten by the eagle and the grass is making food by using the suns energy for photosynthesis. So, this is an example for food chain.

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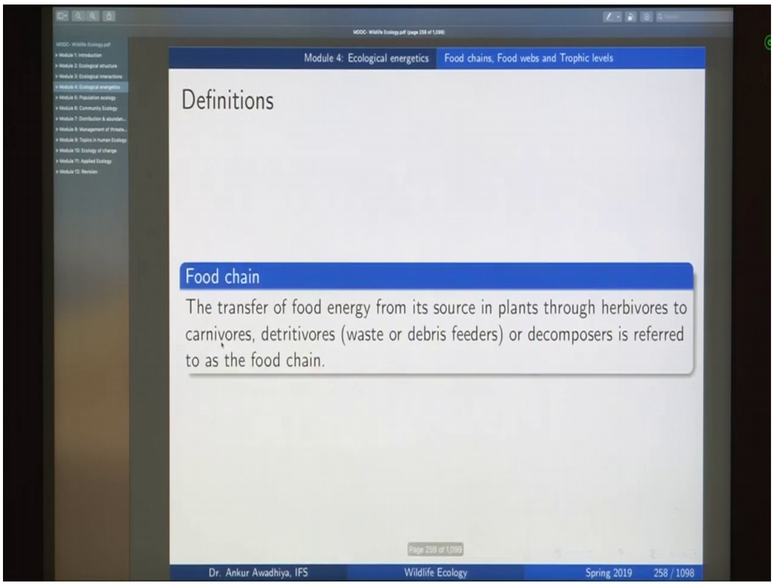

It is defined as the transfer of food energy, from its source and plants through herbivores to carnivorous, detritivores or decomposers and this is referred to as a food chain.

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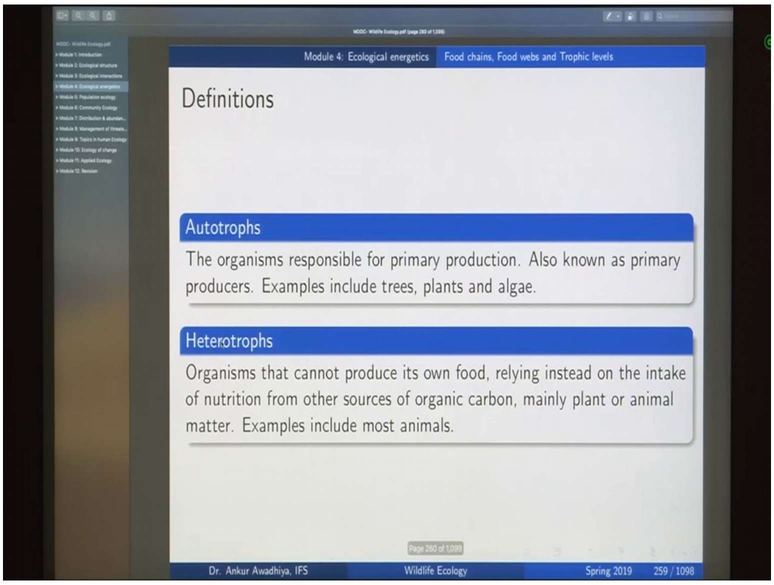

Then we defined autotroph and heterotrophy. Autotroph is an organism that can make its own food. Heterotroph is an organism that needs to eat some other organism for its food or to eat some other part of an organism for its food because it cannot make its own food.

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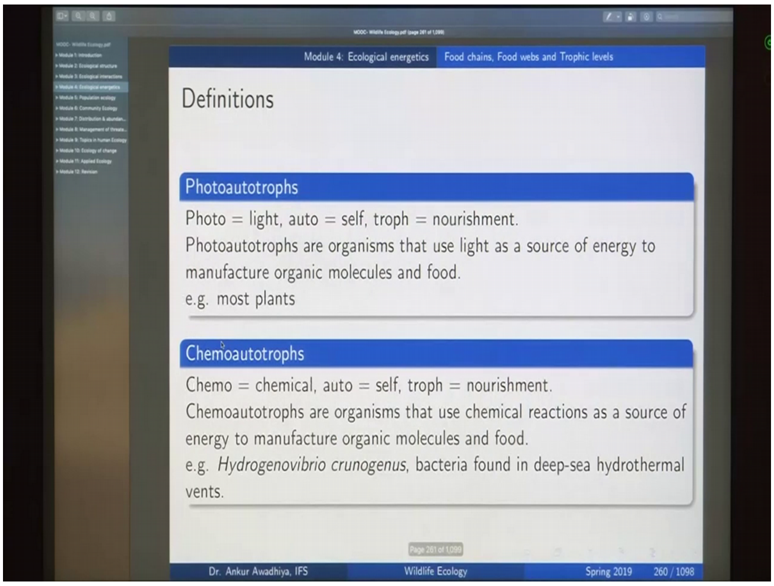

Autotrophs are divided into photoautotrophs and chemoautotrophs depending on whether they are using light for making their food or they are using some chemical reactions for making their food.

Then we define producers and consumers, producer is an organism that makes its own food consumer is an organism that consumes some other organism for food. Then we have consumers are divided into primary consumers, secondary consumer, tertiary, quaternary and so on. So, primary is the one that is feeding on the producers, secondary feeds on primary, tertiary feeds on the secondary, quaternary feeds on the tertiary and so on.

Next we defined herbivore and carnivore. So, herbivore is an organism that eats only plants. So, they are the primary consumers and carnivore is an organism that eats other animals. So, the can be secondary consumers, tertiary consumers or quaternary consumers such as tigers.

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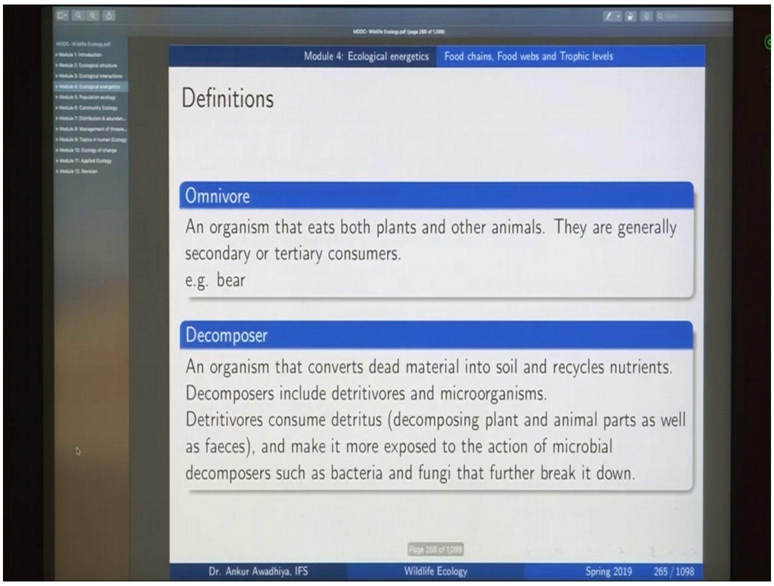

Then we have omnivore that it is both plants and animals such is there and decomposer is an organism that converts dead material into soil and recycles the nutrients. So, it plays a very important part in the functioning of the ecosystem and it includes detritivores and microorganisms. Detritivores are those organisms that feed on detritus, which is decomposing plant and animal parts as well as faeces and make it more exposed to the action of microbial decomposers such as bacteria and fungi that further break it down.

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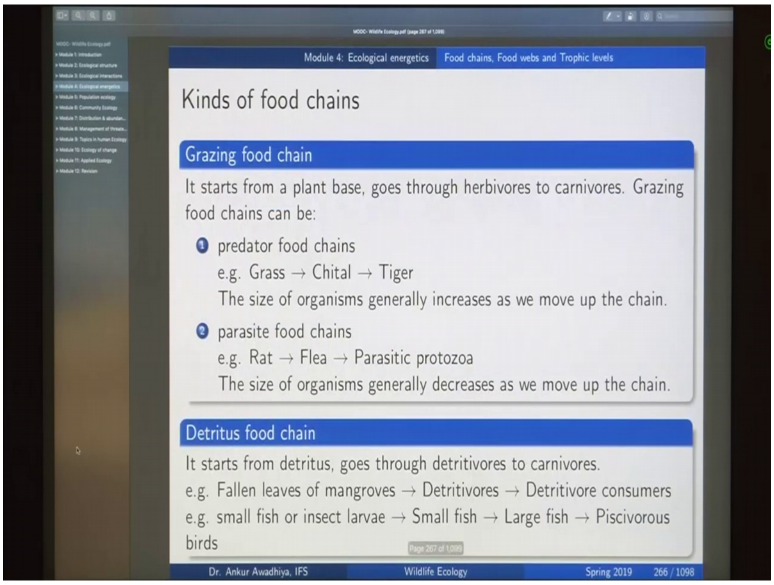

Then we looked at these two kinds of food chains. One is the increasing food chain which starts from our plant base and detritus food chain that starts from a detritus base. Now, grazing food chain have two categories we have the predator food chains in which the size of the organisms increases as we move up the food chain. And, the second one is a parasitic food chain or parasite food chain in which the size of the organism reduces as we move up ok.

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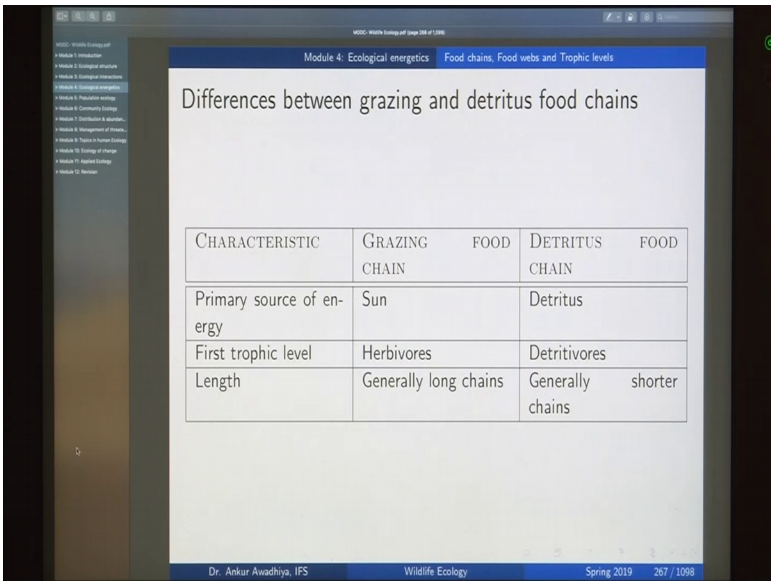

Then we had look at the differences and typically detritus food chains are shorter chains. Because they do not have sufficient energy to support a very long chain then we looked at food webs.

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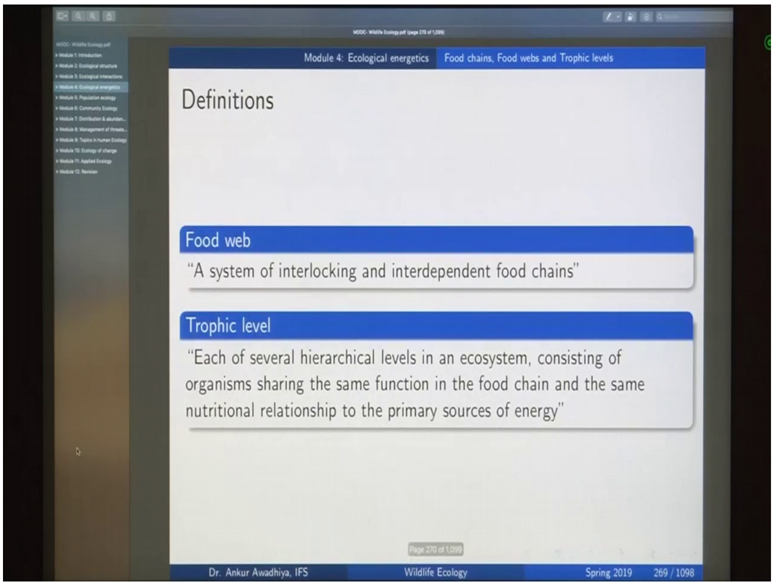

So, food web is a system of interlocking and interdependent food chains and each of the several hierarchical levels in the ecosystem is known as a trophic level. So, in this case this is a food web, and in this food web you have these organisms that are eating different organisms and in turn are getting eaten by different organisms and an actuality a number of food webs are extremely complicated.

Next we had a locate ecological pyramids, which is a graphical representation that is designed to show the biomass number or energy at each trophic level in a given ecosystem, and it is also known as your trophic pyramid or an eltonian pyramid or an energy pyramid or a food pyramid. Then we looked at pyramid of numbers how many organisms are there at each tropic level, it can be inverted in which case you have one plant that is feeding a number of herbivores which is feeding an even large number of carnivores and so, on or you can have pyramid of numbers.

So, this is that example, where you have a tree, and this one tree is feeding a number of birds each of these birds has different parasites, and each of these parasites have a number of hyperparasite. So, in this case the pyramid of numbers is inverted then you can have a spindle pyramid of numbers in which case you have a tree with the number of frugivorous birds, which have been eaten upon by a hawk or you can have some other spindle pyramid of numbers like phytoplankton, zooplankton fish, and sea lion. Here again it is spindle in shape, because the number of sea lions is less than the number of fish is less than the number of zooplanktons.

But in this case we have a small number of phytoplanktons that are supporting a large number of zooplanktons, probably because the phytoplanktons are reproducing it a much faster rate as compared to the zooplanktons. It can even be a dumbbell shape, such as grass rat and rabbit and fleas. The second one is a pyramid of energy, which measures the energy that is contained in organisms at each trophic level and this is typically an upright pyramid.

And then third is the pyramid of biomass which is the biomass of all the organisms in each trophic level it can be upright or it can be inverted as in the case of an oceanic pyramid in which case you have planktons which have a smaller biomass as compared to the small fishes, then large fishes, and then even larger fishes or maybe some larger mammals, such as, if you have a blue whale. So, the biomass will be very high.

Then we define standing crop is the total dried biomass of the living organisms that is present at a trophic level and we also define ecological efficiency as the efficiency with which energy is transferred from one trophic level to the next. We defined exploitation efficiency, assimilation efficiency, gross production efficiency, net production efficiency, and then we define ecological efficiency as a product of three of these.

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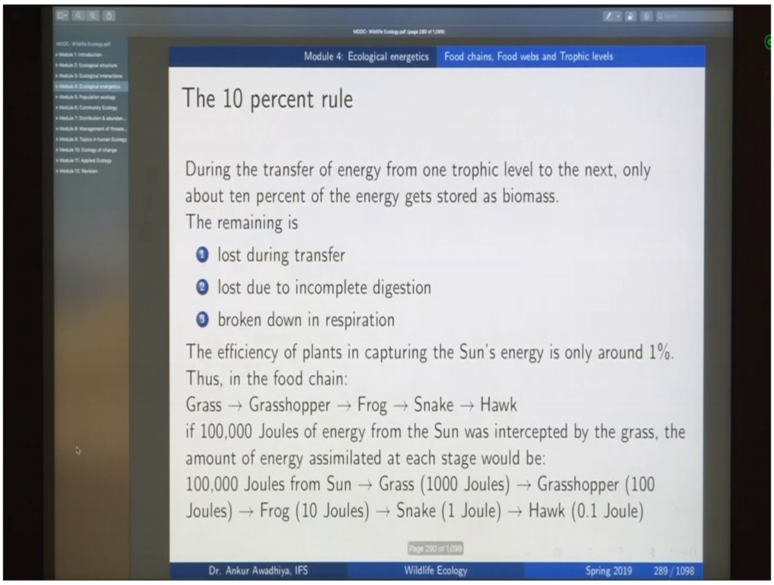

Then we had located 10 percent rule. So, whenever energy is being transferred from 1 trophic level to the next trophic level, typically only 10 percent of the energy is stored in the next trophic level, and as much is 90 percent is lost during transfer due to incomplete digestion or as part of the respiration.

So, typically if you have a tiger that has chasing the sambar. So, the tiger is using of energy during this process. Because it is expanding energy in chasing the sambar, then the tiger will not be able to to eat all the body parts of the sambar they will be some amount of incomplete digestion, and plus the tiger is also respiring it is also energy choosing energy for its own biological processes. So, it will also use of some other parts of energies so.

Typically 10 percent is past, except in the case of the very first stage where the plants have typically 1 percent of efficiency. So, which you have 100 1000 joules from the sun only 1000 joules that is 1 percent of that energy is stored in the grass.

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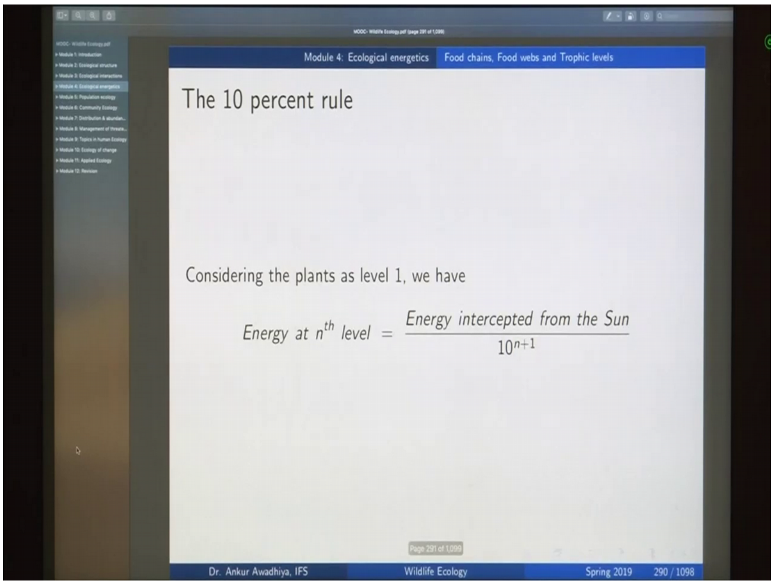

So, we can also write the 10 percent rule in this equation.

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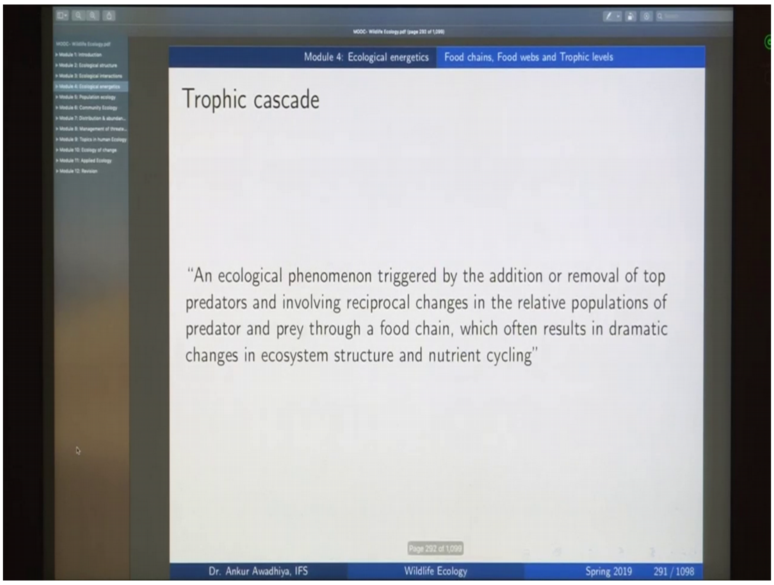

Then we looked at trophic cascade in ecological phenomenon that is triggered by addition or removal of top predators, and evolving reciprocal changes in the relative populations of predator and prey through a food chain, which often results in dramatic changes in ecosystem structure and the nutrient cycling.

So, in this case if you make changes in the top of the food chain, or the top of a food web, then these changes get prickle down along the whole of the food web.

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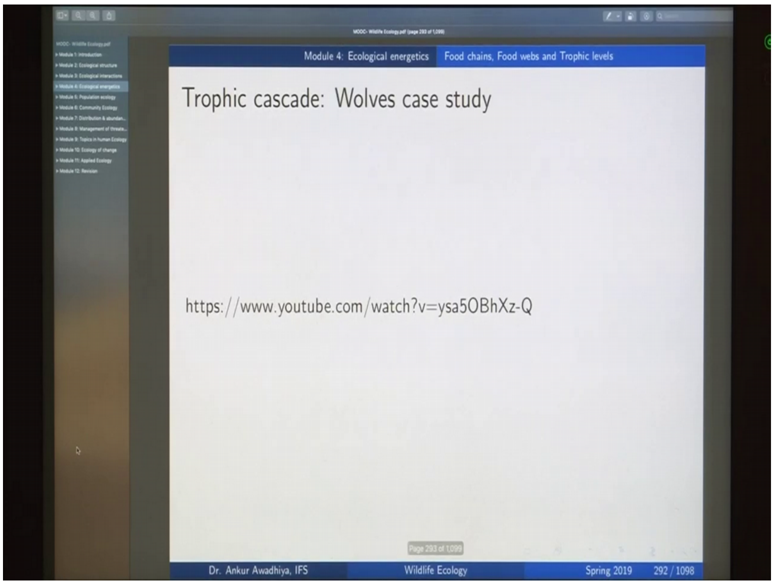

And a good example is the wolves case study, that we saw in which case when wolves when wolves come into the national park, they are able to change the behaviour of the deers. Because of which deers move away, and because of which a number of plants are able to survive and they are able to grow. Because of which you get more amount of berries. So, you start getting bears in that area you start getting birds in that area and so on. So, just the addition of wolves makes a huge difference in the whole of the food web.

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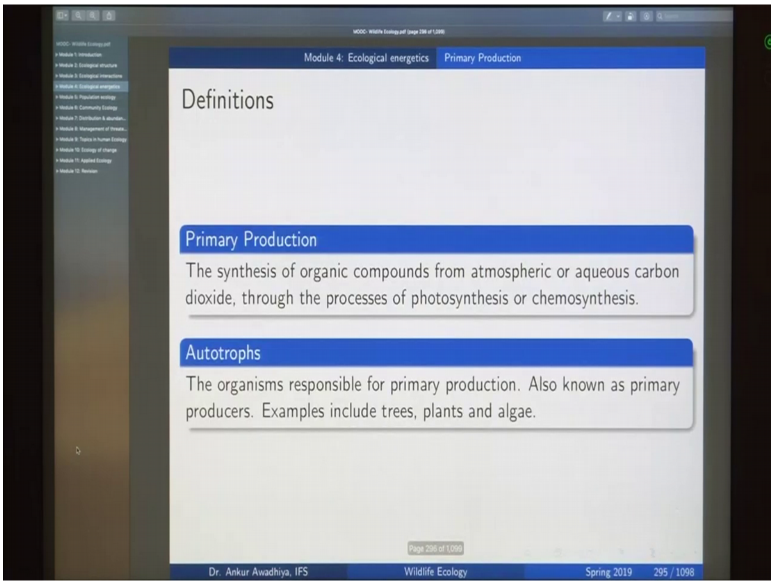

And, next we looked at. primary production which is the synthesis of organic compounds from atmospheric or aqueous carbon dioxide through the process of photosynthesis or chemosynthesis.

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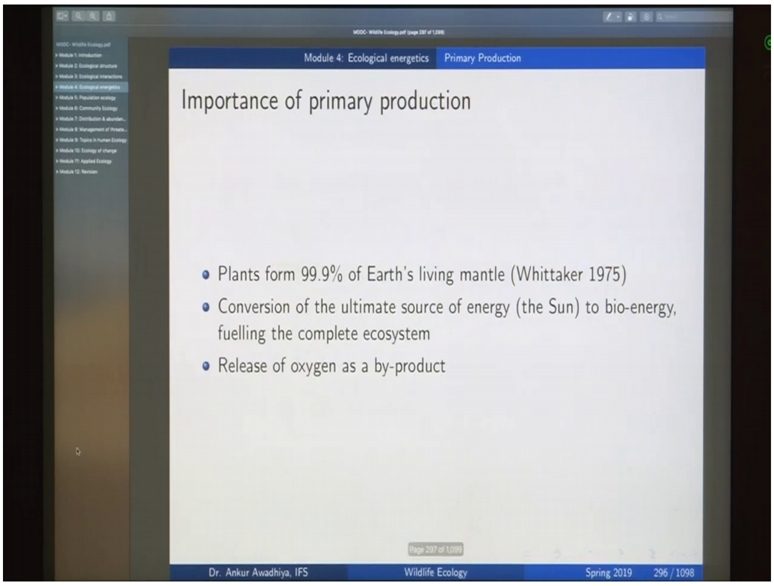

We have define photoautotrophs and the importance is that, it is releasing oxygen as a byproduct it is supporting the whole of the ecosystems, and plants form a very large part of the slimming mental. So, we looked at these two processes photosynthesis and respiration, which are essentially inverse of each other.

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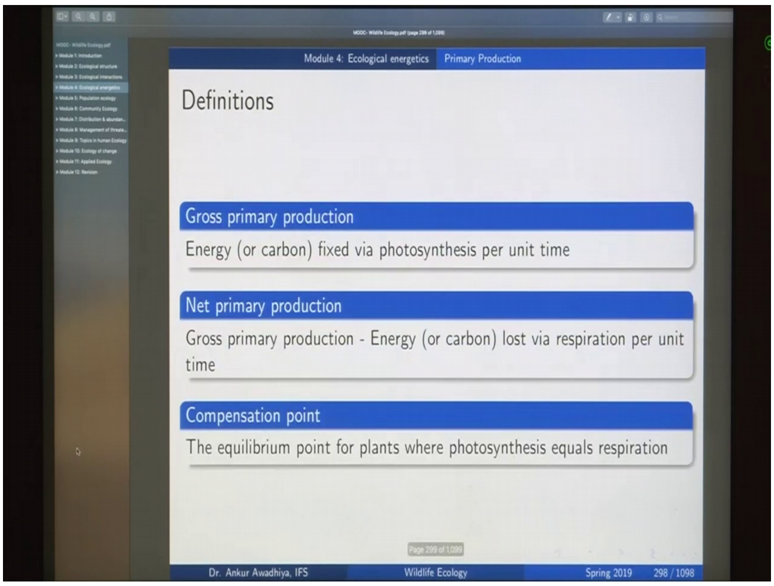

And then we define gross primary production, net primary production, and compensation point. So, compensation point is the equilibrium point for plants, where photosynthesis is equal to respiration and typically this occurs in early mornings and late evenings, where the plants are doing the photosynthesis, but at the same time the photosynthesis not so large that it would be able to counter the impacts of respiration.

In during the daytime typically you will have situations, where photosynthesis is greater than respiration in the night time respiration is greater than photosynthesis.

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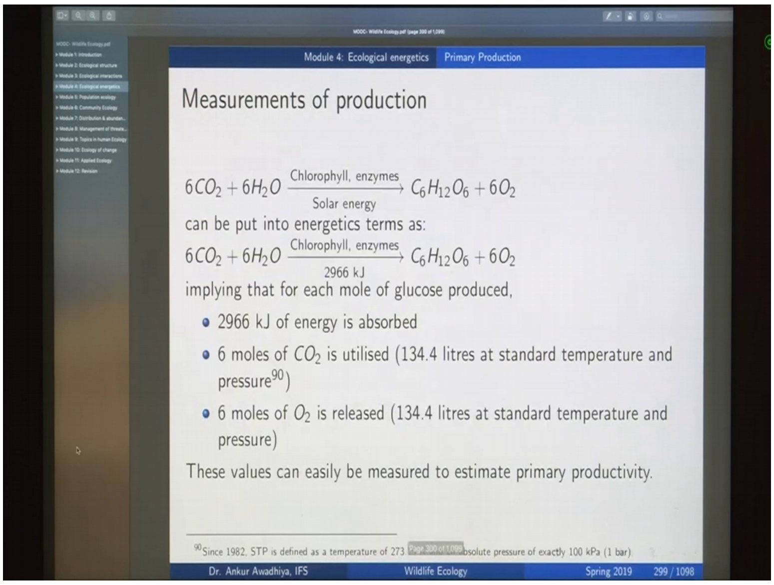

Then we can measure the production by a number of ways, we can look at the amount of gases that are utilized.

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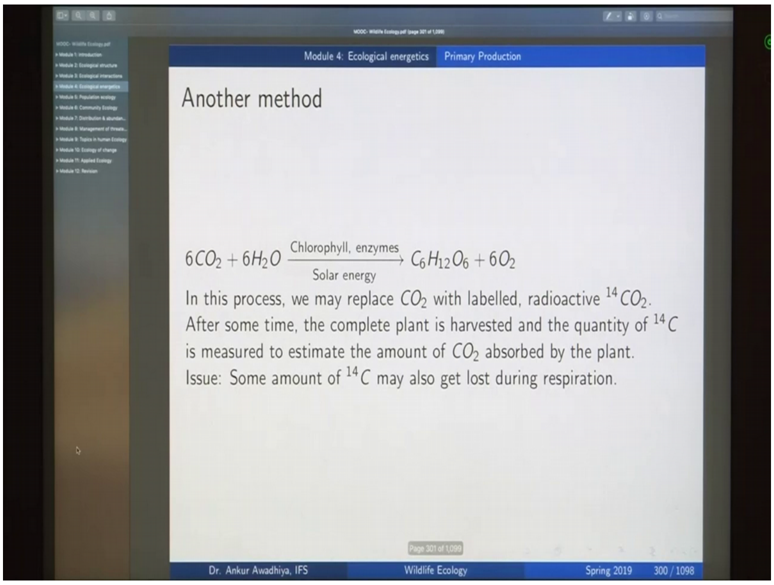

The amount of gases that are released or we can look at the amount of radioactive materials that get incorporated by labeling the carbon dioxide or you can look at the harvest or the total amount that is stored in the plants in a particular time frame. Then we defined efficiency, you have net you have gross efficiency and you have the net efficiency. So, in the case of the net efficiency you deduct the amount of energy that has fixed, which is now release because of respiration. Then productivity is defined as production per unit time, and we defined net primary productivity as APAR into LUE APAR is Absorbed Photosynthetically Active Radiation LUE is Light Use Efficiency, and by using these we can make use of satellite data or modelling data to locate these different values.

And productivity depends on a number of factors it depends on the species, that you have it depends on the amount of sunlight that you are getting, which plug in depend on the latitude and the cloudiness of that area, it will depend on the dust and water that is there in the environment the fertility of that area, of the leaf arrangement, the leaf area, the concentration of carbon dioxide and so on, and a number of other variables and then we looked at this use of modeling, through which we can set up a model by which we are able to match the field characteristics that are observed in different plants,.

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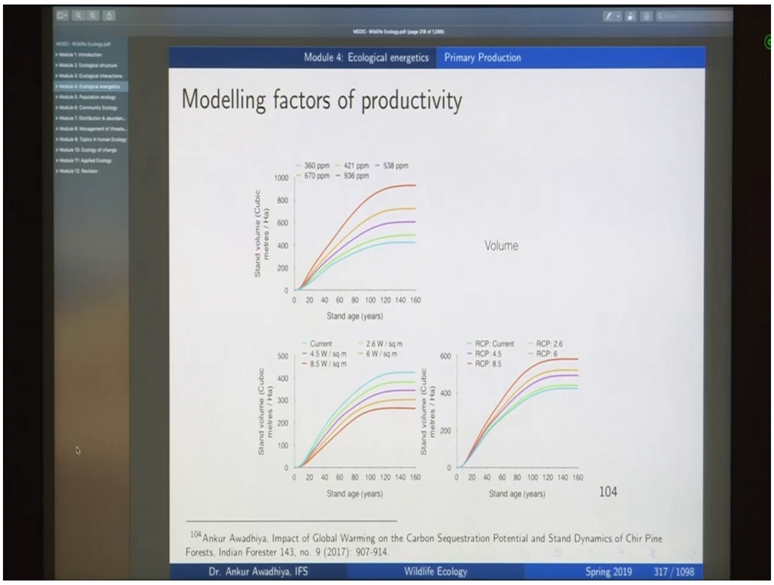

And once you are able to model all these characteristics then if you are ask different questions like what are the impacts of global warming on these different plants. So, when you have global warming, there is an increase in the concentration of carbon dioxide in the atmosphere, which will lead to an impact that is known as carbon dioxide fertilization because we have more carbon dioxide so, you will have more amount of productivity.

On the other hand because of changes in climate, you can have a positive impact or a negative impact. So, for every species for every location on this planet, you can compute whether this global warming is going to harm your plant species or whether it is going to benefit the plant species. And we can also see how the timing of harvest changes for a number of organism. So, in this case we see that in the current situation if the harvest period is say 110 years, after you have this global warming it may shift to as low as 75 years.

Next we defined oligotrophic lakes, mesotrophic lakes and eutrophic lakes. So, oligotrophic lake is that has low nutrient content, mesotrophic lake has a intermediate level of productivity, intermediate amount of nutrients and eutrophic lake that has a high amount of productivity high amount of nutrients, and hyper eutrophic lake that are even more, then we looked at different characteristics especially the secchi depth. So, secchi depth is a measure of the amount of turbidity that is there in water, and if you have hyper eutrophically the turbidity will be so high, that the secchi depth will be very less.

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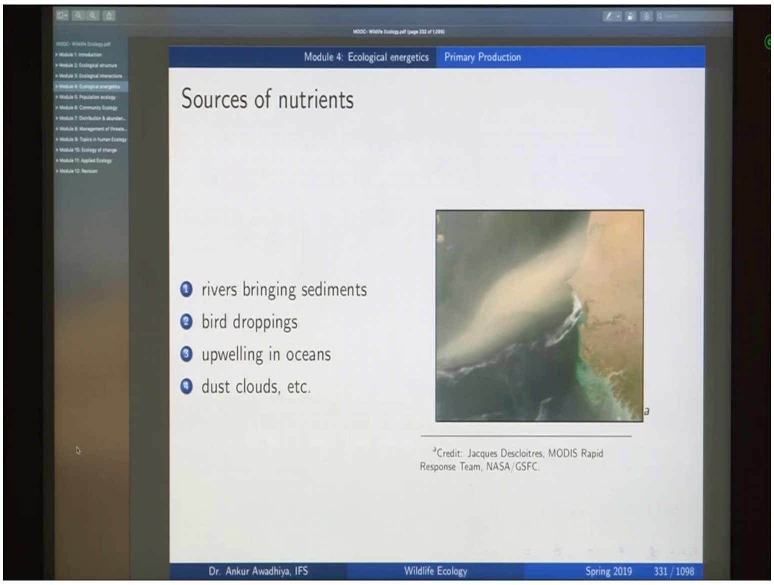

When we looked at the sources of nutrients, dust bird droppings, upwelling, rivers bringing, sediments and so on.

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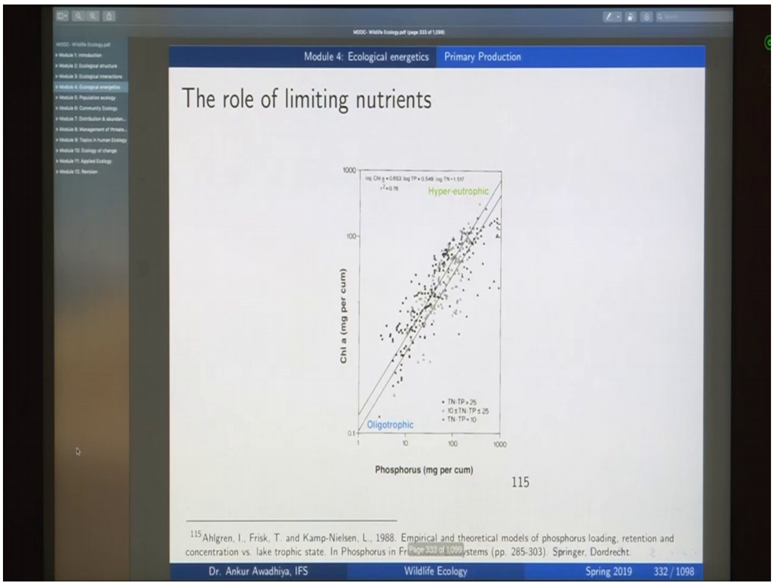

And, then there is this role of the limiting nutrient.

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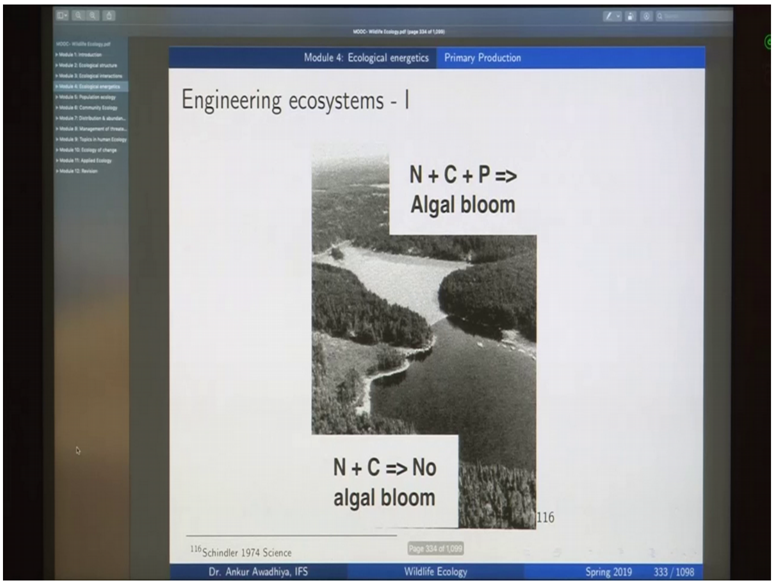

So, if there is a nutrient that is limiting the amount of productivity you can play with that nutrient.

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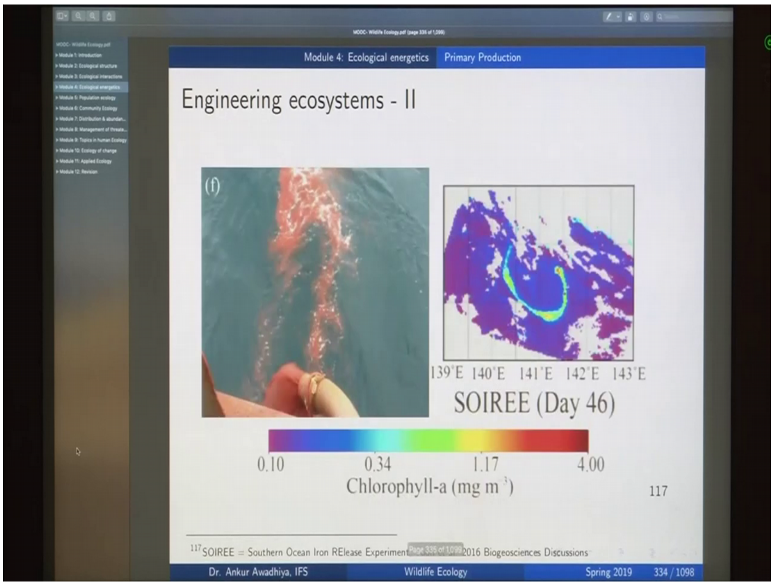

And even act on large, scale such as this example in which iron salts were put into the oceans and the photosynthetic efficiency increased a lot. So, this is known as iron fertilization.

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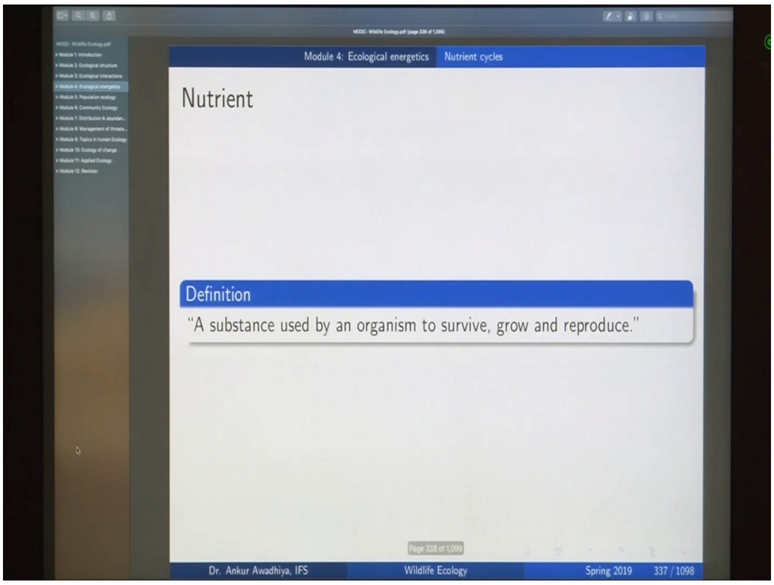

Next we had a look at nutrient cycles. So, nutrient is a substance that is used by an organism to survive grow and reproduce, you have macro nutrients and micronutrients.

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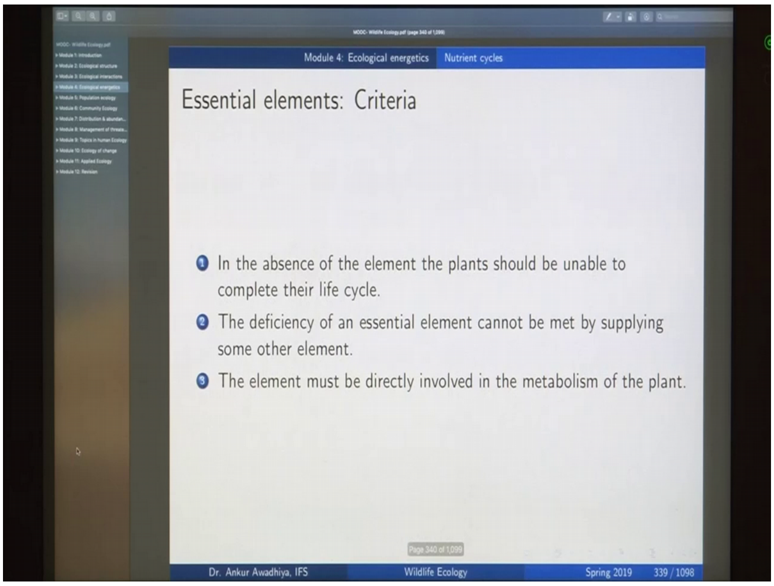

Micronutrients are required in large amount micronutrients are required in smaller amounts. Essential nutrients are those nutrients that the organism cannot live without and this cannot be substituted.

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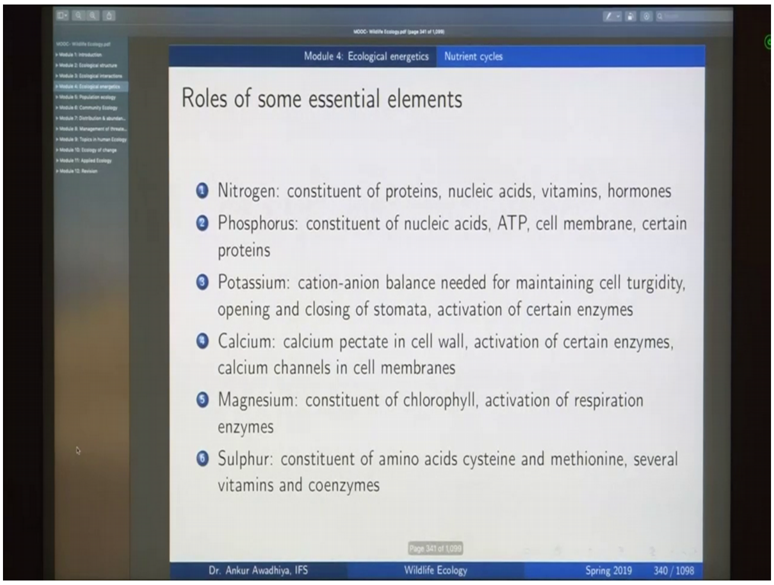

Then we looked at the rules of some essential elements and the list of macro and micronutrients. Now, plants need to have an access to all these nutrients, but then the earth does not have an infinite supply of these nutrients because of which the in the nature has to recycle these nutrients in the form of biogeochemical cycles, which is the pathway in which by which a chemical substance moves to the biotic and a abiotic compartments of the earth.

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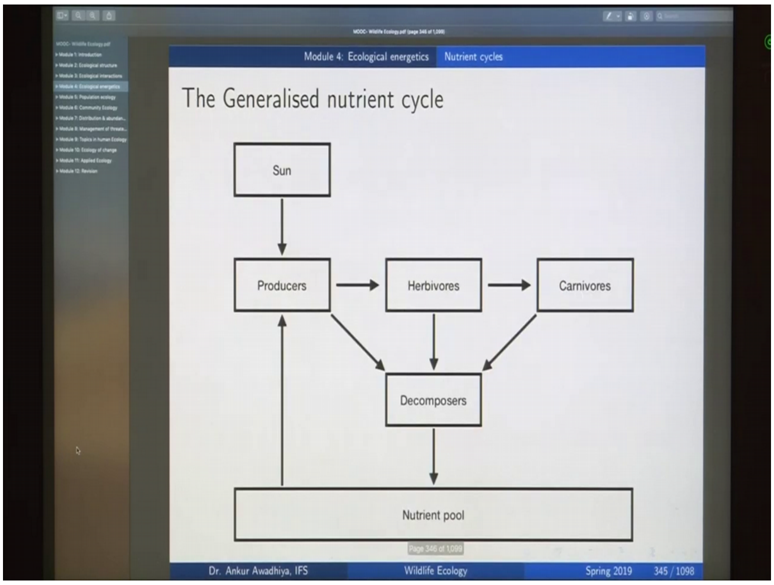

So, it this is a typical nutrient cycle we will have a pool; from this pool, the producers or the plants are taking up nutrients from there also using the energy from the sun, and from the plants it goes to the herbivorous from there to the carnivorous from all of these it goes to the decomposers and through this decomposers this nutrients again reach to the nutrient pool. So, this is a typical generalize nutrient cycle.

And then we looked at specific cycle, such as the nitrogen cycle and we also looked at the industrial processes of nitrogen fixation looked at carbon cycle, now in the case of carbon cycle all of these organisms are also directly putting in the this carbon back into the atmosphere through the process of respirations, that is one difference that we have and then in this case you have different pools, so you not only have the on the pool in the atmosphere, but you also have a pool in the rocks, you also have a pool in the ocean waters, you also have a pool in the form of fossil fuels.

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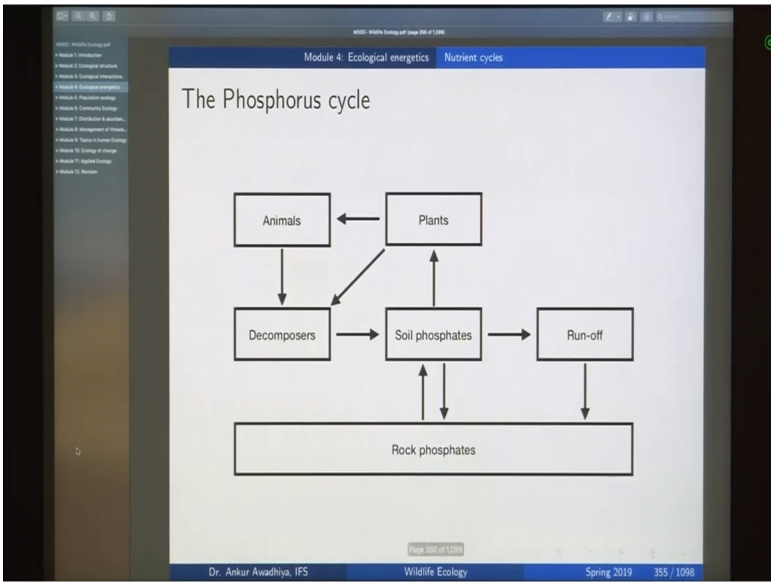

Then water cycle, phosphorus cycles, sulphur cycle and then we looked at the impact of humans species the kuczera curve. So if the plants are taken out, if you have a large scale deforestation or a large scale forest fire, the amount of water that will be flowing in your streams will go down, and then it will slowly start increasing and we will take a very long period of time to reach back to its original levels, then we looked at changes in ph and changes in the concentration of different nutrients in the water bodies.

Next just module was on population ecology. So, we began with population parameters and demographic techniques.

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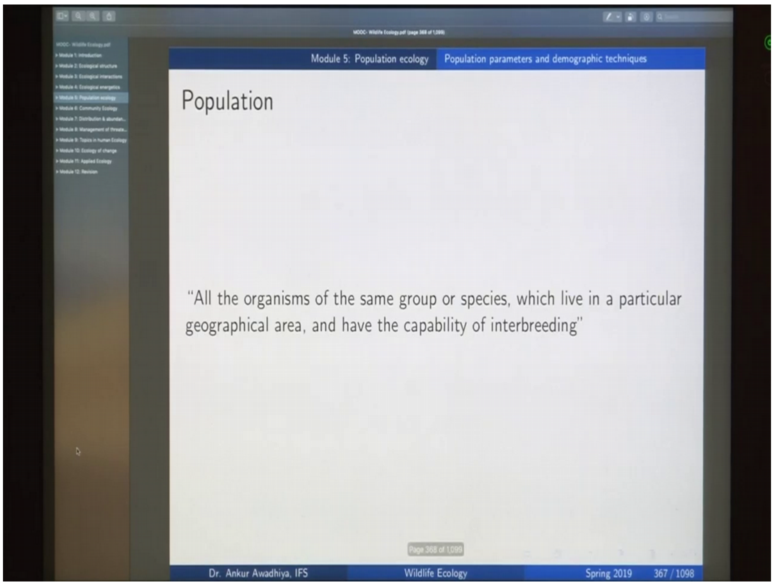

So, population is defined as all the organisms of the same group or species which live in a particular geographical area, and have the capability of interpreting, such as the impala population, cheetah population and so on, and this is the equation which is very important here. So, the population in the n plus 1th generation is equal to the population in the nth generation, plus number of birth, plus annuals that are coming in from outside, minus the number of deaths, minus the number of animals, that are going out of this population to become a part of some other population.

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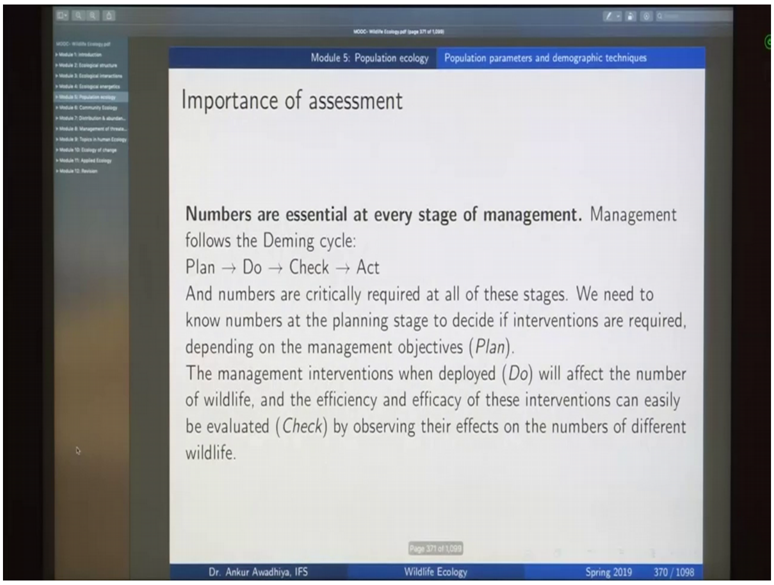

Then we looked at by these numbers are important, and, what are the kinds of demographic information that we are trying to get. So, we want to know the size of different populations, we want to know the density of different populations, and these densities can vary a lot. So, every different population may require a very different method for the its measurement, then we can have two kinds of densities, absolute densities, which is asking you the number of animals per unit area, and the relative density, whether area x has more animals then area y or vice versa.

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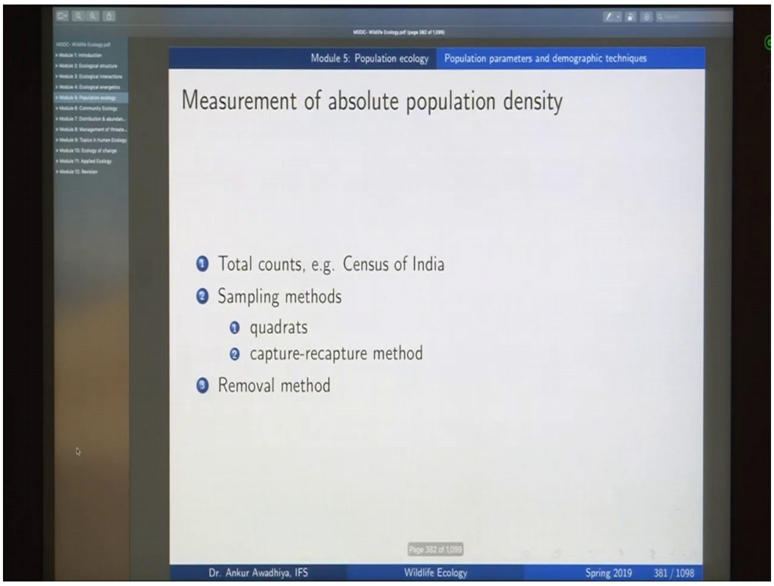

Then absolute population density can be measured in terms of total counts. So, which is the census of India in which each and every individual is counted or you can go for a sampling method in which you take a small sample of the whole population. So, this could include quadrates or capture recapture method, and third one is the removal method, which we typically do not use an Indian context, because we have a man on hunting the animals.

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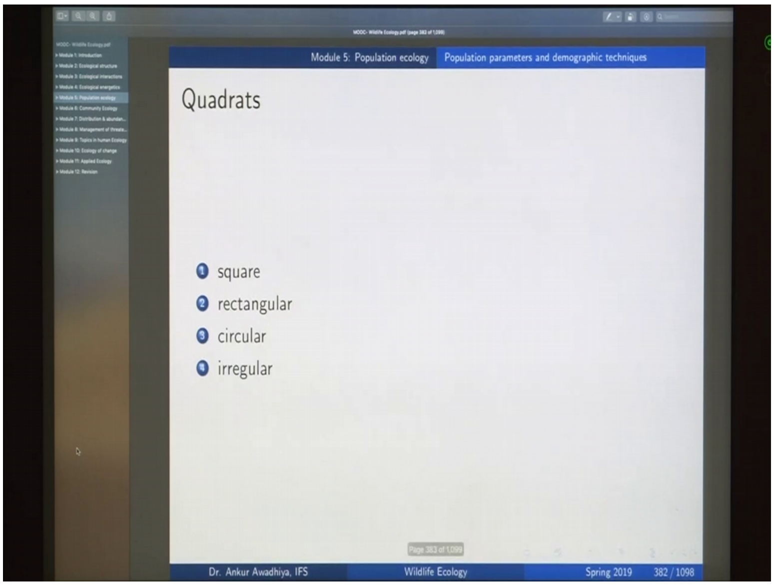

Then we looked at different kinds of quadrates, then we looked at, because we are looking at sampling, we looked at the different processes that are involved in sampling. So, the objective of the sampling is to have a sample that is representative of the whole population, it is able to reproduce the important characteristics of the population as closely as possible and at the same time it is not as intensive as measuring the whole of the population.

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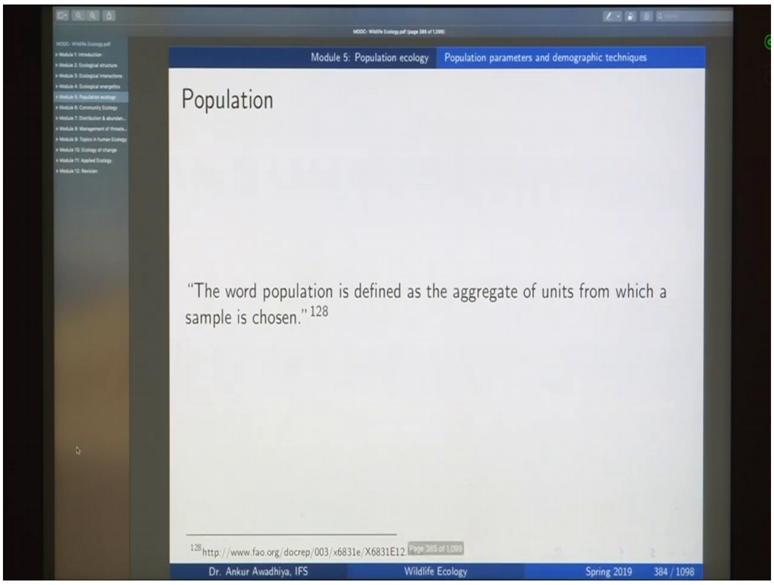

So, we defined population sampling units and so, on. So, all these definitions are important, then the kinds of plots you can have circular plots, rectangular plots, strip plots or topographical units, then we looked at different kinds of sampling, which is very important. So, we have simple random sampling, such as the lottery or a systematic sampling, in which you make it every kth individual or stratified sampling in which we will divide the whole population into strata or you can have multistage sampling or you can have probability proportional to size sampling.

Then we looked at capture recapture method. So, in this case, you capture some animals from the population at time 1, you mark them with something to you can typically put in some tags or you can colour them with certain dies, and then you release them. So, once they have mixed with the whole of the population, then you take another sample, and then in that sample you assess what are the number of animals that are having your marks.

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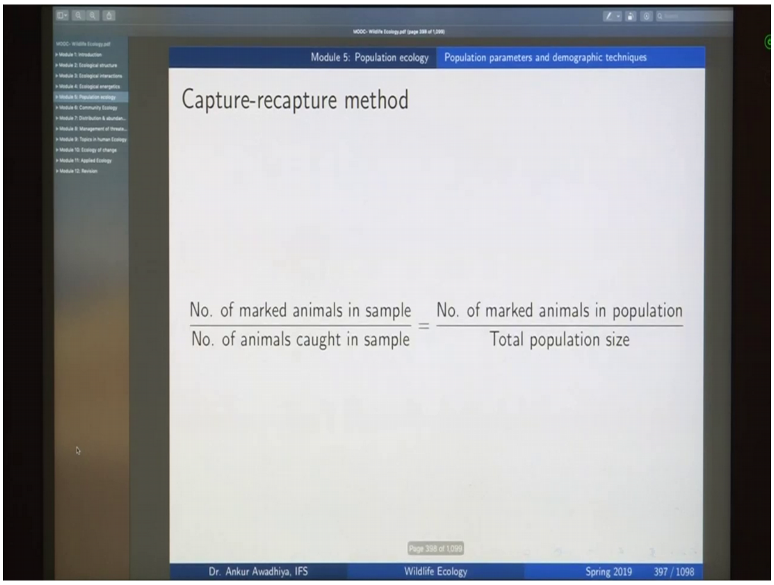

And then we can use this formula number of marked animals in the sample, divided by the number of animals caught in the sample is equal to the number of marked animals in the population, divided by the total population size. So, we know the number of marked animals in the sample, the number of animals caught in the sample, and number of marked animals in the population. So, in that case we can get to the total population size.

Of course, this includes a number of assumptions, and even the removal method so the removal method is not very applicable in the case of India, but then we also should know how this method works. So, we have these assumptions, and based on these assumptions, we can say that if the population is changing at a particular rate the number of animals is that are being caught will depend on the number of animals, that have actually present in that particular population, and we can integrate the situation to get to the to the curve that will give us the number of animals that have this time point.

Then if you want to measure the relative population density, you can use traps, faecal pellets, number of counts of vocalization, and so on, that the things that we want are h pyramid crude birth rate crude death rate. So, all these definitions are important here, the general fertility rate, age specific fertility rate, total fertility rate, replacement level fertility, juvenile mortality and life expectancy.

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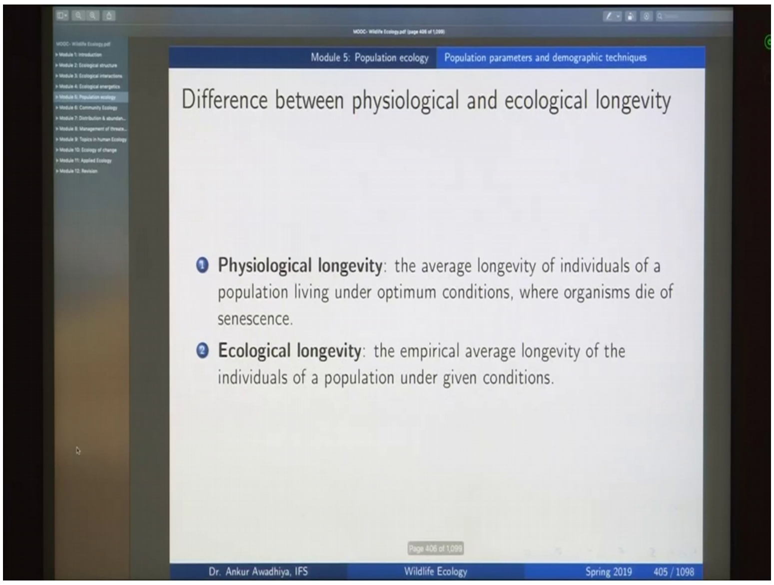

And in the case of life expectancy, we divided into physiological longevity that is the life of an individual effect is free of any predation pressure and this living under optimum conditions. But then in the forest zone in the [FL] the all the animals are not able to live to their physiological longevity, because they are not living in the most optimum conditions. So, the empirical average longevity of individuals of a population under given conditions is known as the ecological longevity.

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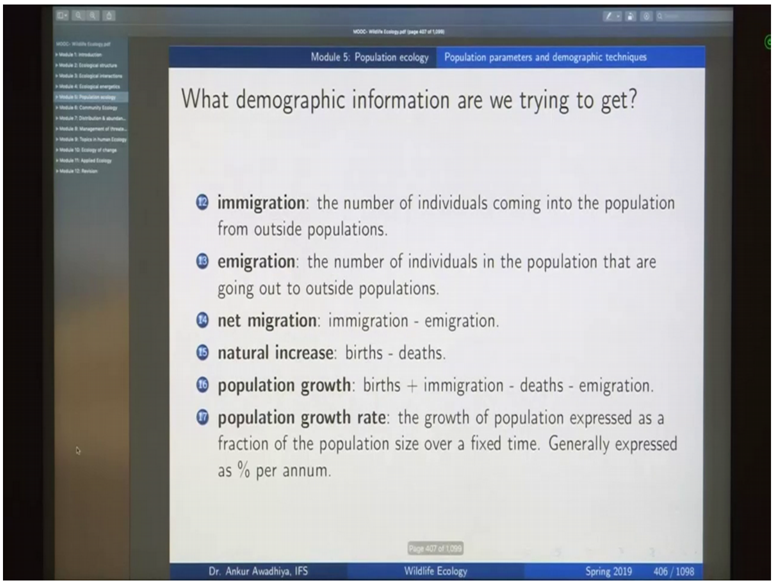

Then we, we want to note the immigration emigration net migration, naturally increase population growth, and growth rates. Then we looked at the difference between precision and accuracy. So, if your measurements are close together, we say that they are precise if your measurements are close to the actual value then it is accurate. So, we want to have those measurements that are both precise as well as accurate. Now if you have precise measurements, but not accurate measurement, so you need to calibrate your method to overcome the bias.

Next we had the look at population growth and regulation. So, we looked at some numerical examples of how to measure the main sizes, main population sizes, densities, and so on, we also looked at some methods for sampling of rain forest reptiles, and small amphibians and also we looked at some pan traps, and they are workings.

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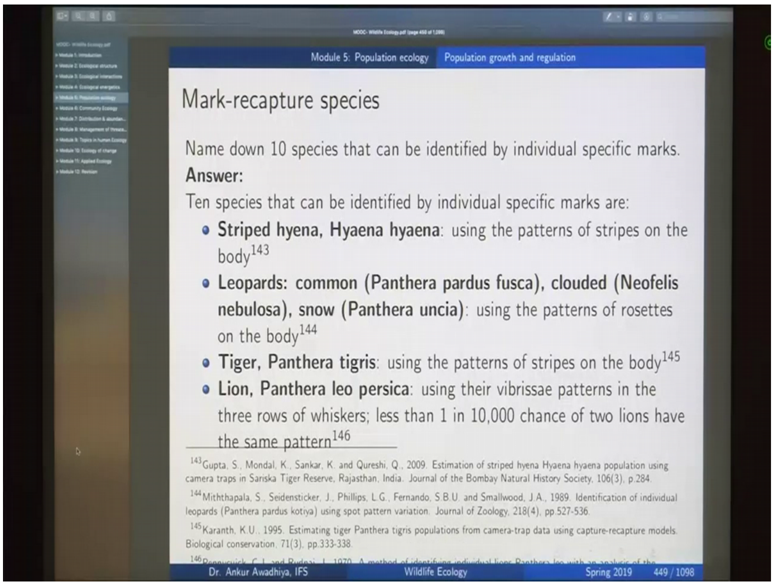

Now, in the case of the mark recapture species we were capturing the animals you are making them, but then there are a number of organisms, that have natural body patterns that can be used in view of marking the individuals one by one. So, for example, every tiger has a different markings on its body, every zebra has a different marking on its body or some animals that do not have such different markings, such as the lion you can make use of some other body part, such as even make use of their vibrissae pattern that is the pattern that is there in their moustache.

Even some toads, frogs, spotted deer they all have different markings on their body, and even an your reptiles, which is crocodiles and snakes some of them may also be having different body patterns. So, we can make use of them in the monitoring on these population sizes, then we had a look at the rate of population growth, and here we said, that the population size at generation t will be at generation t plus 1 will be equal to population size, and generation t multiplied by or growth rate of the population.

So, in this case we can have a curve, that is exponential. So, the population is increasing exponentially, but then in the in actuality your R naught or the growth rate is not constant. So, it varies with the population size, so that you get to the sigmoidal curve or the logistic curve. So, this is the logistic growth equation, dN by dt, that is the rate of change of population size per unit time is a factor of the growth rate it is a factor of the size of the population, because the more the larger area of population sizes the more number of bleeding females are there in your population, so you will have more number of provisioning and, but this factor is also modulated by this factor which is measured of the carrying capacity of your habitat. So, it is K minus N divided by K.

So, we looked at the growth equation, this is how it looks. So, any population will start at very low numbers, you will have this lag phase. So, in the lag phase, the population is not able to increase very much, because you have very low number of bleeding females, then it will enter into this log phase in which the population is increasing very fast, and then it will come to this the steady phase, where the carrying capacity of the environment is now, becoming a hurdle for the future growth of the population. So, the population sizes reach to the carrying capacity.

And then we did certain numerical, then we looked at the Lotka-Volterra equations, in the case of Lotka-Volterra equations, this is telling us the pre and the predator population. So, the population of the prey is governed by its own population size, which is telling you the number of bleeding females that are there in the population and at the same time it is also governed by the predator population so, because the more number of predators you will have the more will be the mortality of the animals, because more number of animals will be eaten up for food.

Similarly, the size of the of the predator population it will increase based on the size of its own population, which will tell you the number of bleeding females, plus it will also depend on the size of the prey population, which will tell you the amount of food that is available or it will be an indication of the carrying capacity of the environment. So, if you put both of this together, you will get to a situation where both the prey population as well as the predator population, it undergoes a cyclical phenomenon, it goes through cyclical movements, and we can also make use of these Lotka-Volterra equations to look at the impacts of two different organisms on each other. So, say two different herbivores on each other, and we looked at this numerical example as well.

Next we will looked at population studies and the equilibrium, and which case we talked about the problems of dynamics, and the problems of statics the problems of dynamics are how this a population change with time, the problem of statics is how does the equilibrium condition and the average value what does it depend on. So, in the case of dynamics we have to ask these three questions does the change occur in a particular time of the year, does the change occur in a particular stage in the life cycle of the organism, and what are the agents that operate at these times or in these stages.

So, some common agents that can operate are extrinsic agents and intrinsic agents, extrinsic agents of weather predator parasites diseases quantity and quality of food that is available, and shelter that is available, and intrinsic agents are physiological changes and the behavioural changes. In the case of statics, we say that the population size is not changing. So, we do not have to consider the dynamic factors, but we can experimentally manipulate different habitat variables to look for the responsible factors, that are responsible for this particular population size.

And in this case, we looked at the locals problem in which this species is found in 2 different forms one is the solitary form, one is the gregarious form, and even though, they look very different they are members of the same species, and then we looked at how they changed from one to another. So, the solitary phase moves by a transient phase into the gregarious phase, and the gregarious phase moves by a another transient phase into the solitary phase, and when the population dynamics of these organisms were worked out, then we found that there is this particular formation of plague.

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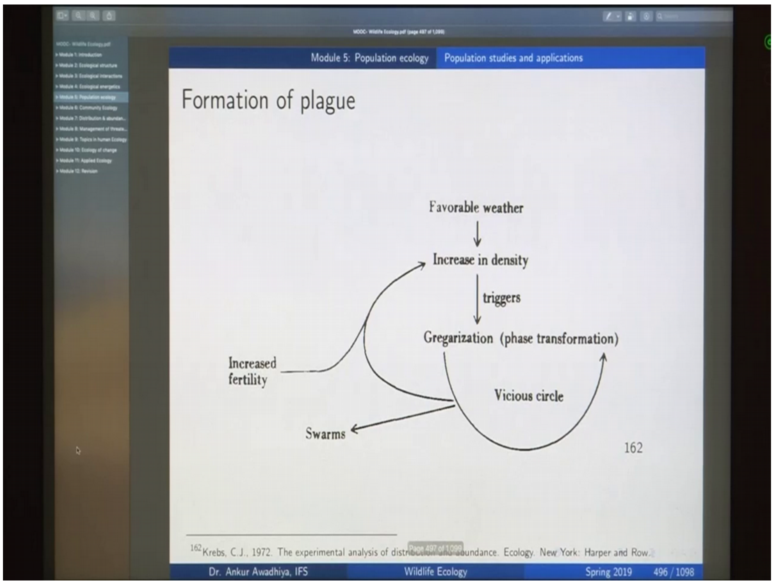

And this is the final outcome, that when you have a favorable weather it increases, the density of these insects which then triggers gregarization, in which case the solitary phase converts into the gregarious phase. Once you have this gregarious phase, you start this gregarious cycle, because, we have gregarious phase. So, this will give rise to more number of individuals, which will further increase density, it will further keep this gregarious phase on and in this case you will have the insects that will form last is formed they will start moving away.

Now this would continue for eternity, but it not further predators, but it not further extrinsic factors that are also operating here. So, if the weather becomes bad or if there is a large amount of predatory pressure or if there are certain diseases that affect this particular insect. So, in that case the population density will go down, and which will trigger a reverse phase transformation in which the gregarious phase will convert into a solitary phase. And then the still we are also looking into the biochemical factors, that are responsible for it.

Next in 6 module, we looked at community ecology. So, we began with community nature, and parameters community is an assemblage of populations of different living organisms, that are living in a prescribed area or habitat, and the transition area, we are 2 communities meet, and integrate is known as ecotone, which can be sharp or it can be diffused then we looked at community attributes. So, what are the things that are common between different communities how do we define a community? So, it will have co occurrence of species, these species are occurring together they will be a recurrence of groups of the same species, if you have two communities in two different areas, which are having similar climate. So, you will have a recurrence of the species, then a community is able to maintain itself, it is able to regulate itself through the process of homeostasis.

Then there are community characteristics, which tell you how to communities are different from each other, which are things likes species diversity growth form in structure, dominance relative abundance, and the trophic structure. So, they can vary between two different communities. Now, to describe our community, we have to describe the richness or the number of species that are there, the abundance of different species and the species dominance which is the ranking as per the abundance in terms of a number basal area etcetera. Then we defined the relative density, relative frequency, and relative dominance.

So, you can use this in the case of tree species, and then you can get to the importance value index. So, a species that has a high relative density which means, that it has more number of individuals in that community it has a high relative frequency, which means, that the members of this species are found in all different parts of the community, plus it has a high relative dominance that have a high importance value index, and will say that this community is being free dominated by this particular species.

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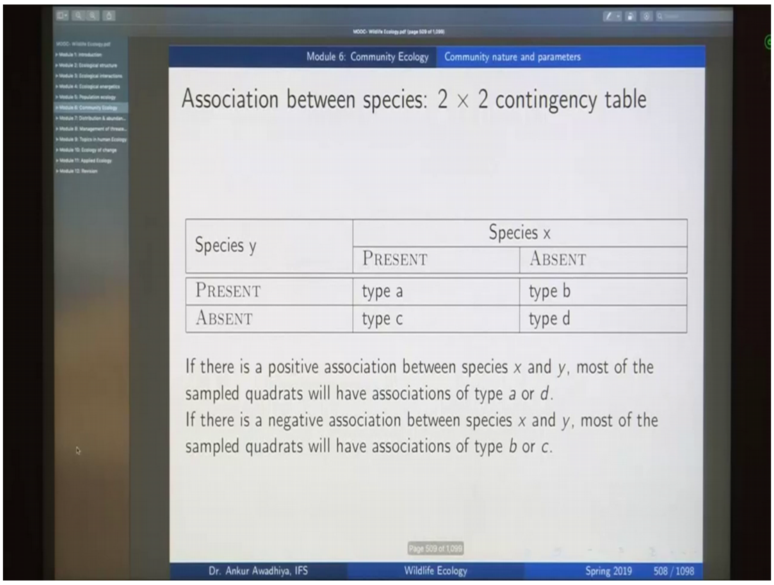

Now, if you locate the association between 2 species, we can make this contingency table and if we have situation that in most of the quadrates, you have 2 species either present together or absent together, then we will say that both of these species are positively correlated, but if you have situations in which one species is present the other is absent or the second one is present, and the first one is absent in that case, we will say that these 2 species are having a negative association. So, this is an example of negative association.

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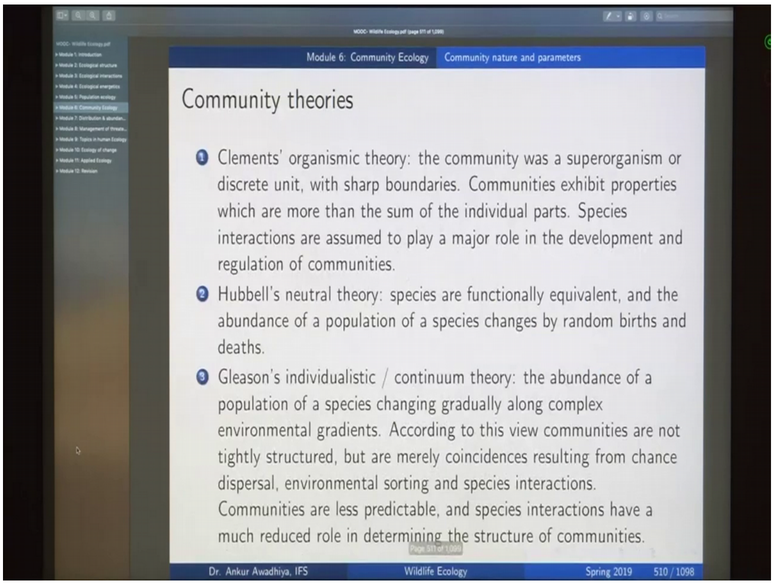

Then we looked at 3 community theories, we have the organismic theory, which was put forward by clements, who said that the community behaves like a super organism and it has properties that are more than the sum of its parts.

The on the other hand you have the individualistic theory or the continuum theory, which says that the communities are just mere coincidences and there is no such organismic relationship. And then there is the third one which is hubbells neutral theory, which comes somewhere in between it says that the species are functionally equivalent and the abundance of a population of a species changes by random births and deaths.

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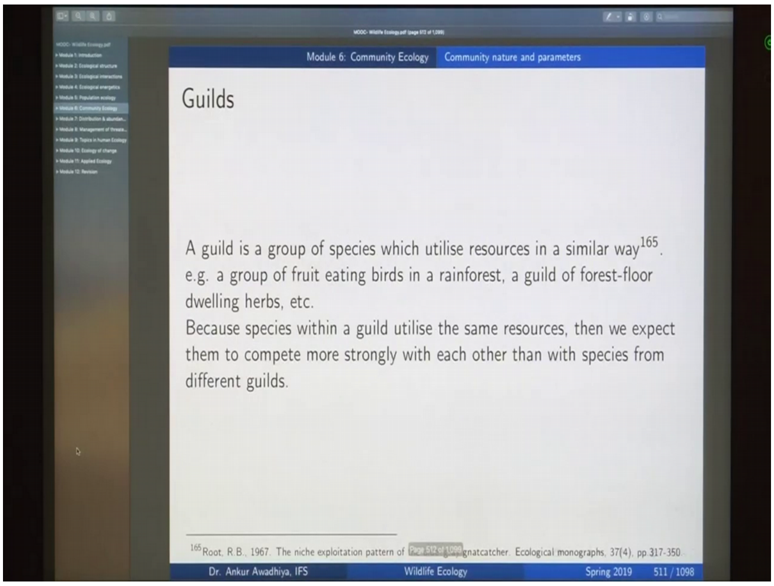

Then we talked about guilds. So, guilds are a group of species, which are utilized in resources in a similar way, such as a group of fruit eating birds in the rainforest of forest floor dwelling herbs and so on. Now because species in a guild utilize the same resource so, the amount of competition between these species is much more than compared to any 2 random species.

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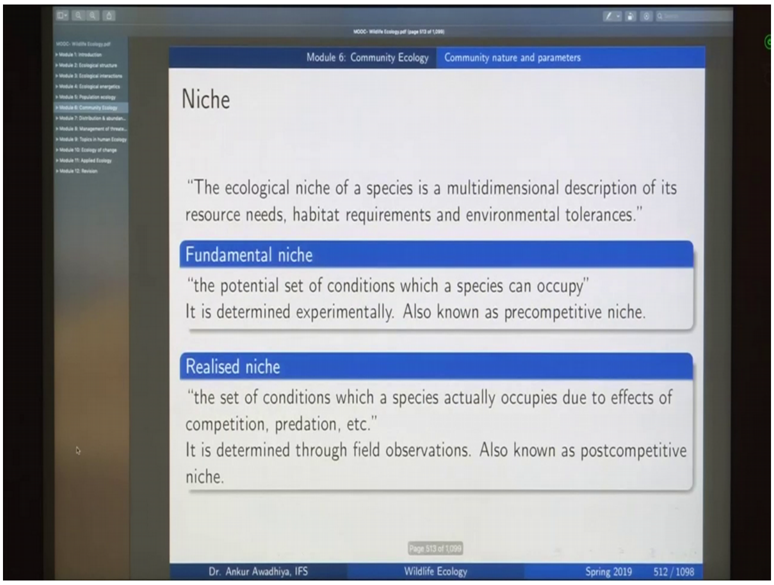

Then from guild, we also defined the niches. So, niche is a multidimensional description of a species, resource needs, habitat requirements and environmental tolerances. So, if you have 2 species that are having the same niche the level of competition is very high, and then in the case of these niches, we divided into fundamental and realized niches. So, fundamental niches are is a set of all the conditions, that the species can potentially occupy and we can determine it experimentally.

But then in nature, when the species are competing with each other, then they are not able to occupy all the niches that are possible and so, the niches, that are actually occupied although by the name of the realized niche or the post competitive niche. Now we looked at the characteristics of niches, and then the index of similarity how many individuals are common between 2 communities we will tell you the index of similarity.

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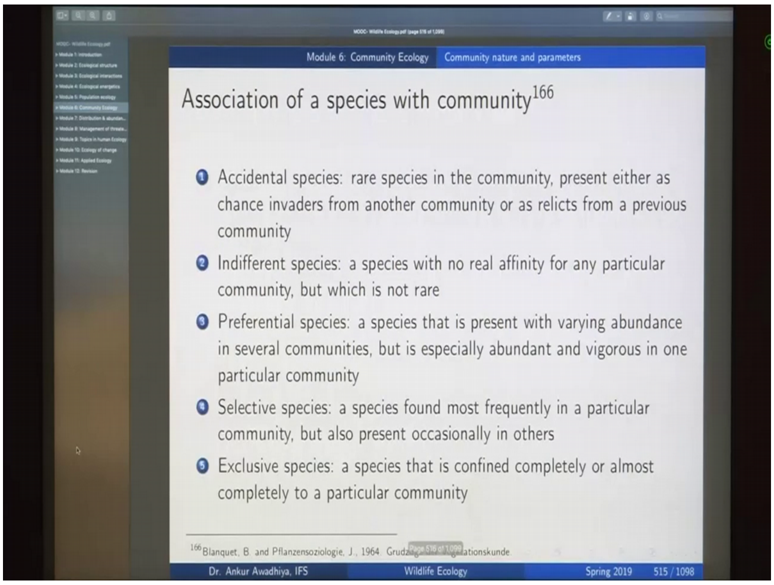

Next we have association of a species with the community. So, you can have certain species, that have a very high level of association, they are only found in a particular species in a particular community or you can have lesser amount of association in the case of indifferent species, which can be found in any particular community or accidental species, which are very rare species and they are either present as chance invaders from another community or as a relicts from a previous community.

So, you can have different levels of association of a species with the community, then we looked at community stability. So, stability is the ability of a community to recover following a disturbance, and it consists of 2 parts a resistance to changes and resilience to changes. Next we looked at these community changes and ecological succession. So, from bare rocks, you start getting some lichens. So, from bare rocks, you have crustose lichens, then you have foliose lichens, then moss, then grass, then shrub, then forest and all of and this process through which any area gets populated is ecological succession.

So, ecological succession is the process of change in the species structure of an ecological community overtime, and then we defined sere, a seral community or a sere is an intermediate stage found in the ecological succession in an ecosystem advancing towards its climax community. There are 3 kinds of seres hydrosere which is a community in water, xerosere, which is a community in a dry area, which can be a rocks or which can be sand, and halosere which is a community in a saline body such as a marsh.

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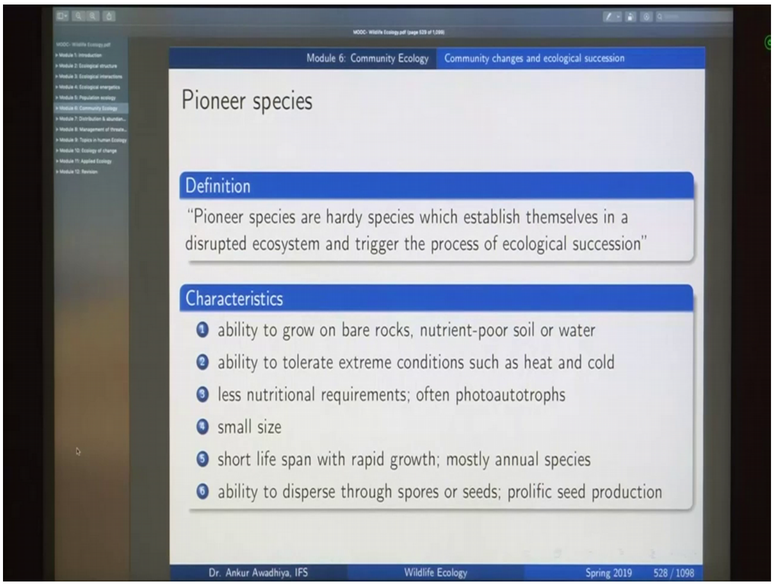

Next we defined pioneer species. So, these are hardy species, which established themselves in a disrupted ecosystem, and trigger the process of ecological succession. Now typically these species have the ability to grow on bare rocks, nutrient poor soil water. So, they do not have a very high nutritional requirement, they are pretty hardy species, because they have to tolerate bare sun and maybe even very cold conditions, and they are also species that are able to release copious amounts of seeds or spores, because of which they are able to move into any new area.

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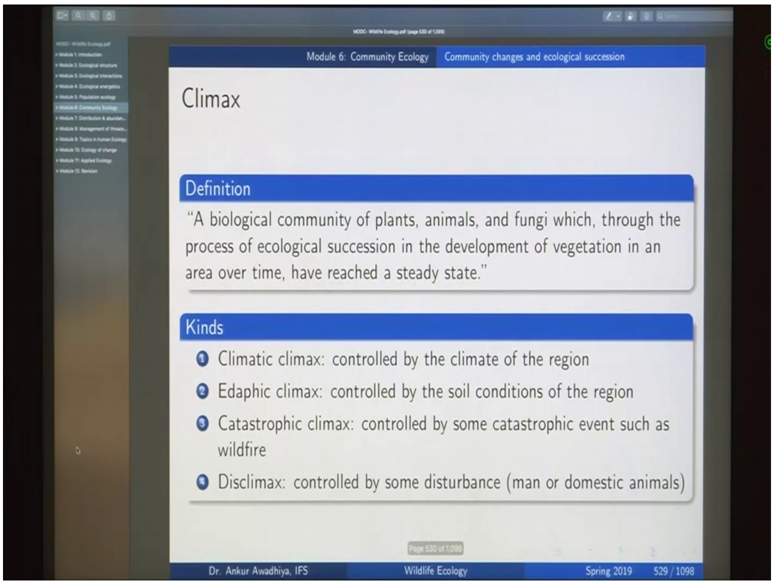

A climax species on the other hand is a biological community of plants animals, and fungi through which the process of ecological succession in the development of vegetation in an area over time has reached a steady state. So, this is the final level of succession. Now, climax community can be either a climatic climax, which is controlled by the climate or it can be an edaphic climate climax, which is controlled by the soil conditions. Or, a catastrophic climax, which is controlled by some catastrophic events, such as wildfires or floods or it can be a disclimax, where it is controlled by some disturbance either because of men or because of domestic animals.

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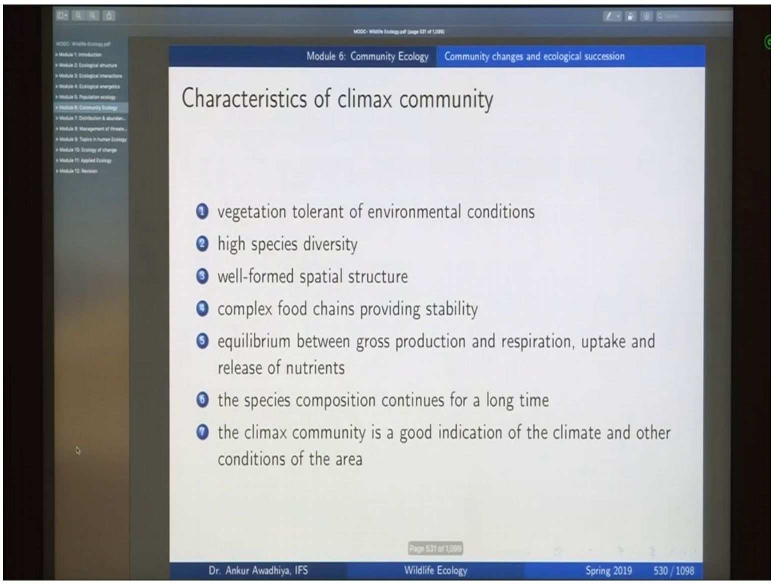

Next we looked at the characteristics of climax community. So, unlike the pioneer species, here you have a vegetation, that is extremely tolerant of this particular environmental condition, the species diversity is high, you have a well formed spatial structure complex food chains, which provides stability. There is equilibrium between gross production and respiration uptake and release of nutrients.

Species composition continuous for a very long time, now the second is an indication of this of this stability of the community and it is a good indication of the climate and other conditions of the area, because here you have species that are very much tolerant, and very much adapted to the particular conditions.

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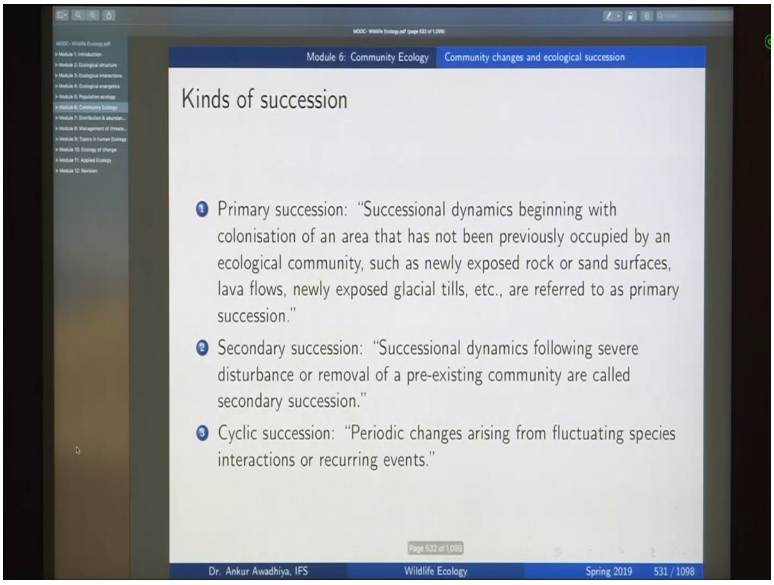

Now, you can have 3 different kinds of succession, the primary succession is a succession, that occurs in an area that was not previously occupied such as a lava flow, which has turned into a rock and this rock was never occupied previously. A secondary succession is the successional dynamics, that follows severe disturbance or removal of a pre existing community. So, which is a forest fire, and the cyclical succession is periodic changes that arise from fluctuating species interactions on recurring events, such as flooding events, if there are occurring regularly.

Now, in the case of primary succession, we have this lithosere primary succession, that we have just seen and the second one is the hydrosere primary succession, in which you start with water, which is very low amount of nutrients from water, you move to phytoplankton stage to submerged stage, to floating stage, to reed swamps, then sedge and meadows, then woodland and then finally, the climax stage in the case of secondary succession, you can start with the forest, this forest is support from a forest fire, and then you have a forest that is incompletely destroyed, and then begins with the succession, with the herbaceous stage, then the shrub stage, then the woodland stage, and the climax stag,.

And typically, the secondary succession is much faster than the primary succession, because you already have well formed soil, you already have nutrients, you already have spores and seeds, probably some plants that can regenerate from their roots and you also have a very high amount of fertility that can support a large number of organisms. Now succession can also be divided into autogenic succession and allogenic succession. So, autogenic succession are brought by changes in the soil that are caused by the organisms that are already present there. So, auto is self genis formation. So, it is a succession, that forms by itself.

On the other hand, the allogenic succession is caused by some external forces, external environmental influences and not by the vegetation, that is already present there. Then we looked at the 7 stages of succession, nudation migration ecesis aggregation competition reaction and stabilization.

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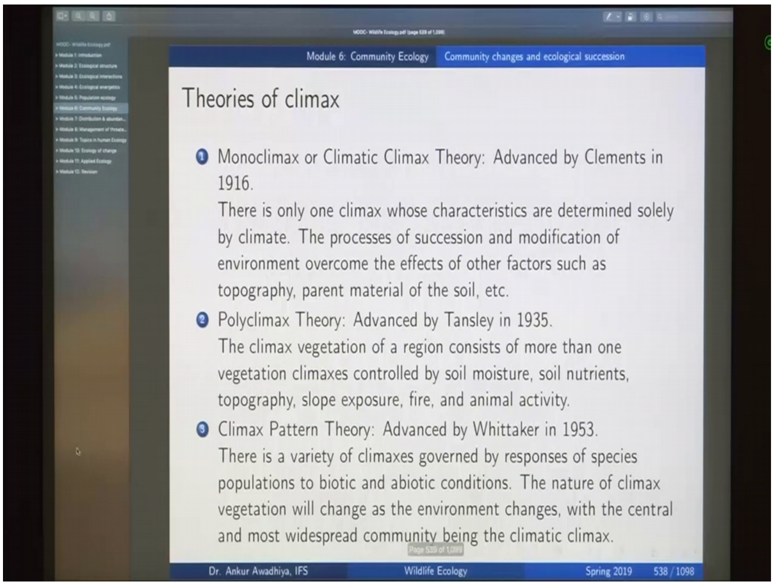

Then we have these 3 theories of climax, you can have a monoclimax theory, where we have only one particular climax, and one particular climatic area you can have a polyclimax theory, in which you can have more than one kinds of vegetation climaxes, which are controlled by soil moisture nutrients topography etcetera or you can have a climax pattern theory, in which you do not have one particular climax but you have a range of climaxes, which very near the climatic climax.

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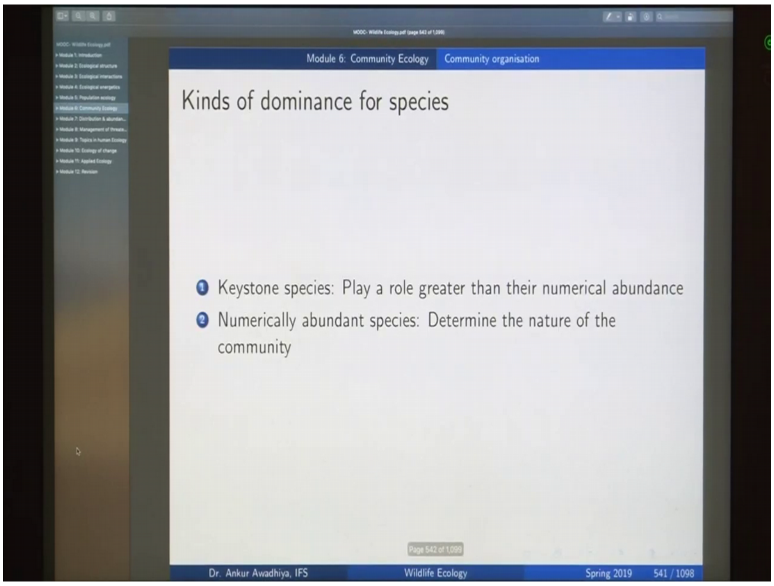

Next, we looked at community organization; so, there are two kinds of dominance for species. You can have a keystone species, which is playing a much larger role in the ecosystem as compared to its numerical abundance or you can have numerically abundant species; which are determining the nature of the community and so, we say that they are the dominant species in that particular community. Next, we defined the community dominance index, which is the percentage of abundance that is contributed by the two most abundant species.

Now, if you have more number of species typically the dominance reduces; but then this relationship is not a one to one relationship. if you have a community that has more amount of dominance; so, it is possible that you will have certain species that are much more efficient in producing a food and in that case the productivity increases.

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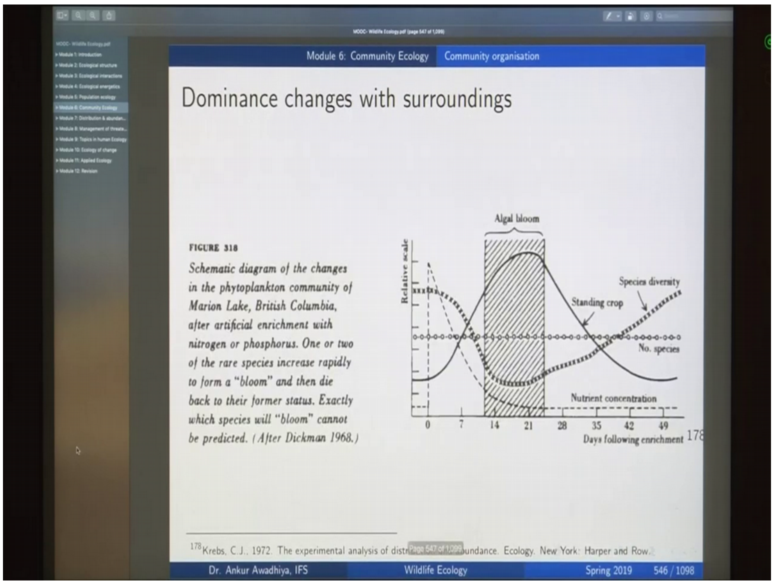

A dominance changes with the surroundings. So, if you have a nutrients that are put in to early that might result in an algal bloom; so, before this algal bloom, you had a certain level of dominance and because during this algal bloom a certain species has become predominant so, the dominance status of the community changes.

So, typically you will also see that the species diversity is going down, the rate increases again and in a number of situations, if this perturbation is not very large the community is able to bring itself back to the original position; which brings us to the concept of stability, which is defined as the ability of a community to defy change or to rebound from change. So, we have three different kinds of stability, you can have global stability or you can have local stability or you can have a situation, where you have neither local nor global stability.

So, in this case, if you have a community like this and you are giving it any amount of disturbance. If it is very small disturbance; then, probably this community will be locally stable, but it is if it is any greater this community will become unstable. Next, the question is does diversity increases stability; we typically see that diversity increases stability, but there are also some counter arguments. So, this is still a matter of some debate.

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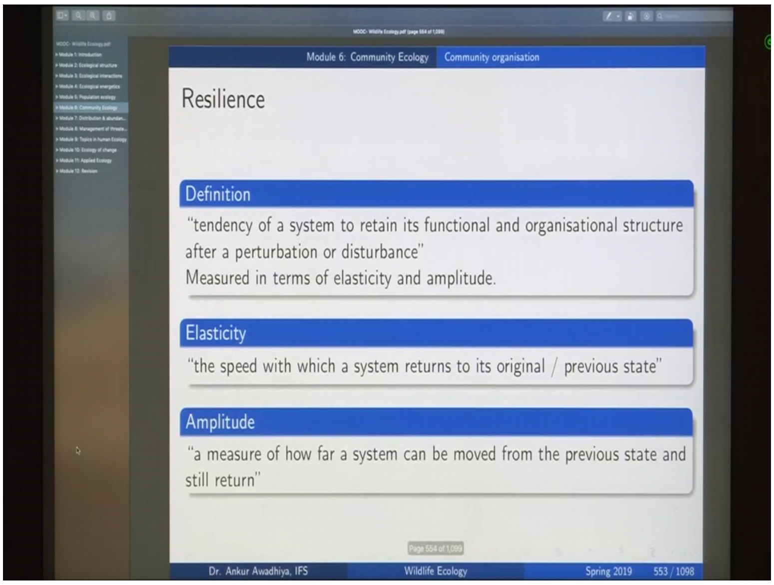

And, how does a system respond to a instability; you have resistance or inertia which is the ability of the living system to resist the external fluctuations or you can have resilience, which is the tendency of a system to retain its functional and organizational structure after perturbance of a disturbance. So, in the case of resistance the community is not changing, in the case of resilience the community has changed, but it is able to bring itself back to the original position.

Now, resilience can be measured in terms of elasticity and amplitude. Elasticity is the speed with which the system returns to its original state and amplitude is the maximum amount of disturbance that the community can tolerate. So, it is a measure of, how far a system can be moved from the previous state and still return back to the original conditions. Then, we had a case study of sewage lake Washington and even after, you had a large amount of disturbance, the community was again able to bring itself back to the normal conditions; which tells us that, if you are within the limits; then, the detrimental changes can be stopped and reversed. Now, in the seventh module, we looked at distribution and abundance of organisms.

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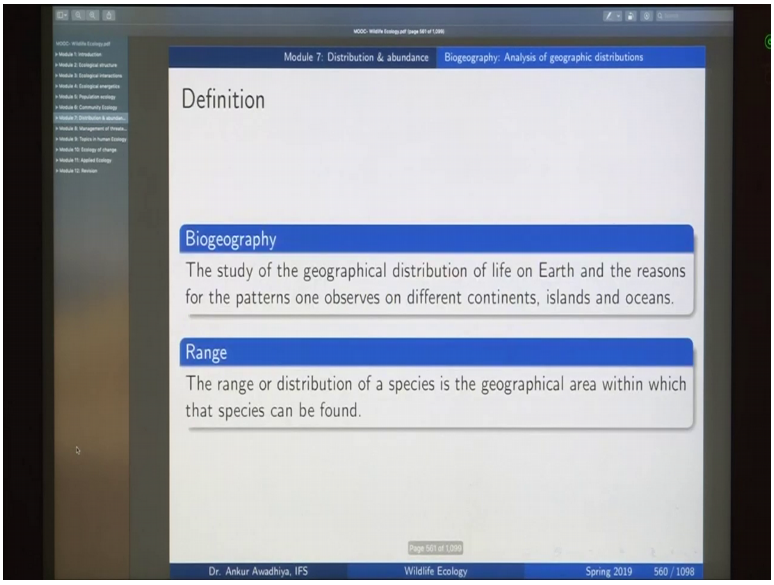

So, we began with biogeography, which is a study of the geographical distribution of life on earth and the reasons for the patterns one observes on different continents, islands and oceans; so, it asks the question, what is found where? And why is certain thing found in a certain location and not in some other location? Then, we looked at range, ranges or distribution of a species is the geographical area within which the species can be found. Then, we looked at major Indian habitats, Alpine meadows, forest; so, forests are also of different kinds, Alpine, Dry deciduous, moist deciduous, mixed forests, Scrub forests and so on.

Sand dunes then, we have estuaries; then, Runn of Kutch gives a very different kind of habitat. Then, we have lagoons we have floodplains; then; we have shola forest, equatorial forest, mangroves oceans and seas.

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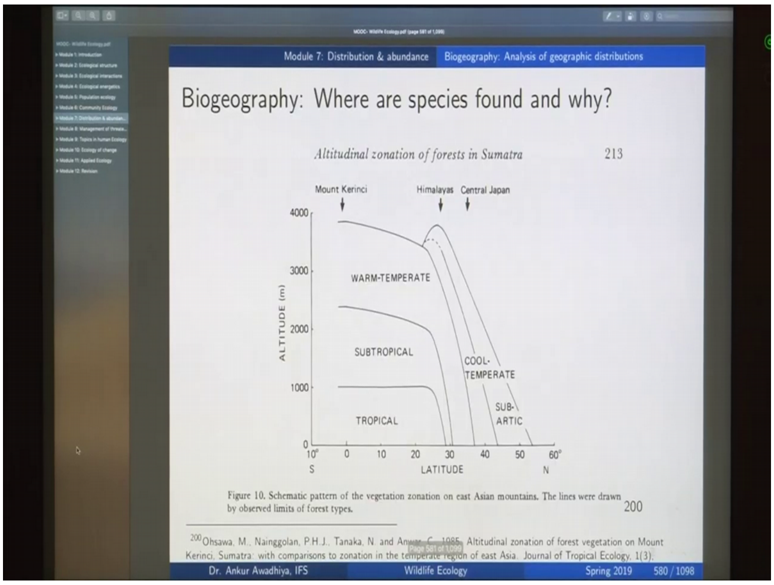

And all of these are very different habitats from one another and because of which, we have very different kinds of species that are found in all of these different areas. Now, we looked at this example, in which if you ascent in altitude, the temperature reduces and; so, you can have those species, which are typically not found in that particular latitude.

So, if you go very high; then, probably you will find even species that are more alpine even when we are close to the equator. Then, if we look at the distribution of any organisms, which is snow leopard or the coral reefs; we are in the case of biogeography. We are first noting down, where these organisms are found.

Then, we ask the question, what is there in this location that is making this organism come to this location or thrive at this location and what is there that is not present at the location, where this organism is not found because of which this organism is not found in that particular area; so, which brings us to the question of, why things are where they are.

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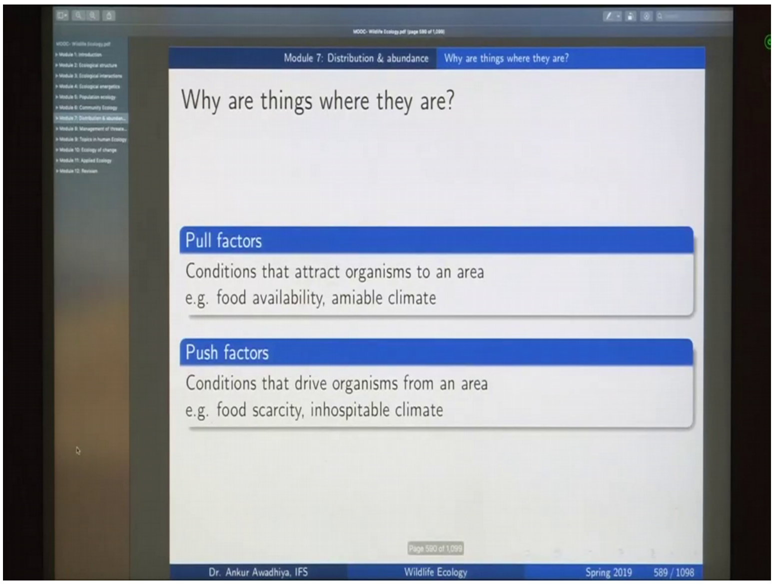

So, we looked at these examples and this is something that we have been looking for a very long period of time and we defined the factors that govern biogeography into push factors and pull factors. Now, pull factors are conditions that attract organisms to an area, good amount of food that is available or good climate that is available to the organisms and push factors are those condition that drive away organisms from an area; such as scarcity of food or in hospitable climate.

So, even in a small mountain, we can see that there are certain areas, where you have plants and there are certain areas, where you do not have plants. So, these things can be right next to each other. Then, we looked at the other factors; so, apart from push and pull factors you have the factors of dispersal, it is possible that the organism has not yet reached that area or you can have anthropogenic factors or manmade factors in which case in this area plants should be there, but then because of the influence of man; this area was all cleared off the vegetation.

So, you can have the anthropogenic factors; you also have the habitat selection factors, which refers to the hierarchical process of behavioral responses that may result in the disproportionate use of certain habitats to influence the survival and fitness of individuals.

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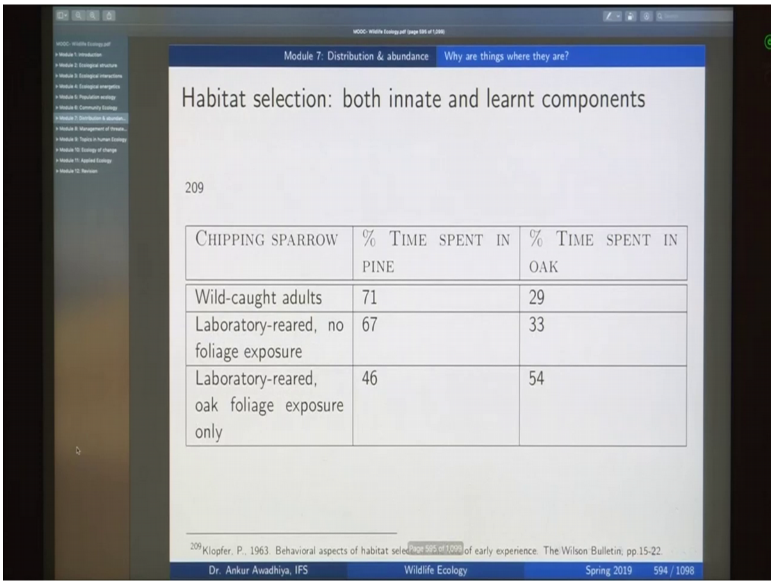

And habitat selection has both innate components, which are inborn components and some learnt components; so, this was the example in which, if you have wild caught adults of chipping sparrow; they spend majority of the time on pine and less amount of time on oak. But then, if you reared them in the laboratory and you do not give them any exposure, they are able to repeat the same pattern.

So, they will prefer the pine, but if you reared them in the laboratory together with the oak leaves; so, in that case they will start preferring the oak. So, in this case this one is telling you that the birds have learnt to prefer oak; in this case we are saying that, there in the absence of learning there are certain inborn preferences that the birds have. So, the habitat selection has both innate and learnt components. Then, we make use of transplant experiments to identify the potential range of an organism. So, if this organism is found in this green area, you can move an organism from one point in this green area to another point as a control experiment or you can move it to other areas, where it is not found.

Now, if it is not found there could be areas, where it survives; they could be some areas, where it does not survive and based on its survival or it is death, we can make some outcomes. So, if it is this transplant successful then, probably the organism is not found there because this area is currently inaccessible or it has not been able to disperse because of lack of time or because of habitats preference. But if the transplant is unsuccessful then, it could be limited by some other species or it could be limited because of some physical and chemical factors.

Then, we looked factors. Now, next we move on to the Liebig's law of the minimum, which says that the rate of any biological process is limited by that factor in least amount relative to requirements; so that there is a single limiting factor. So, if you have n number of requirements, the one that you have the least amount of that is going to be the limiting step.

The second one is the Shelford's law of tolerance, which says that the geographical distribution of a species will be controlled by that environmental factor for which the organism has the lowest range of tolerance or the narrowest range of tolerance. Now, it is important to know these difference different factors because we are these days observing changes in the range. So, if you have global warming those species that could not live in the colder areas are now able to increase in their ranges. So, we are saying that the mean that median altitude for malaria is increasing with temperature. Now one other factor that can regulate whether a species is found or not found is migration which is defined as regular and seasonal movement of animals, often along fixed roots.

Now, the reasons are you can have animals that are looking out for better resources, such as food or breeding sites or there are animals that are moving away because their original habitats are having a harsh climate; so, they are shifting to a more amiable climate. We looked at the example of demoiselle cranes. Now, going back to dispersion we have three different modes of dispersion; you can have diffusion, which is a gradual moment over several generations or you can have a jump dispersal in which you have a quick moment over large distances, often across unsustainable unsuitable terrains.

Such as the movement of zebra mussel through the ballast water or you can have the secular diffusion and dispersion, which is diffusion in an evolutionary time so, that the final migrants are very divergent from the original population. Then, we also had a locate allelopathy in which, there are certain organisms that are secreting certain chemicals that are inhabiting the growth of certain other organisms. So, this is the, the distribution flowchart. Next, we had a look at some portion pull factors in more detail, in which case we looked at the distribution of sea urchins and algae.

So, in this case, we are seeing that wherever you have sea urchins, you do not have algae and where you have algae, you do not have the sea urchins. So, this lead to ah study of whether predators can restrict the ranges of the prey organisms; so, a certain area was cleared of the sea urchins and if you remove the sea urchins the algae are able to come back to that area, which shows that there is nothing other than sea urchins that was wanting in that area.

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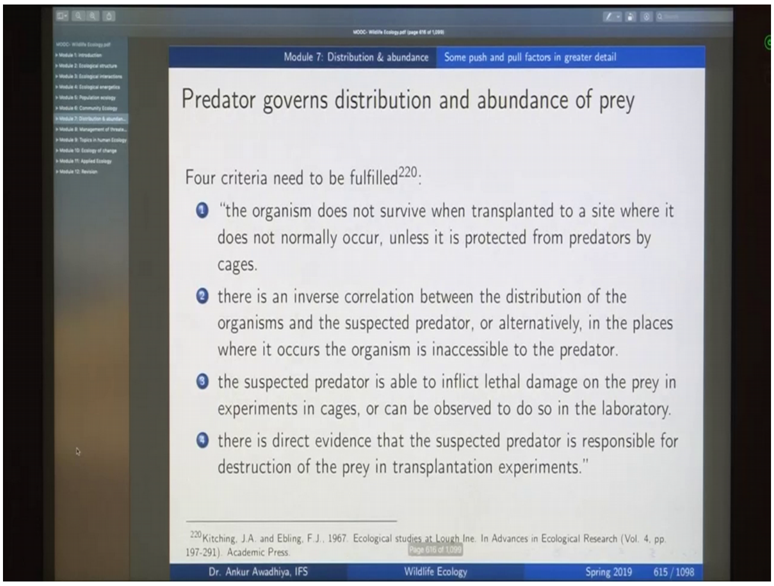

Then, if you have a situation where a predator is governing the distribution and abundance of prey; so, in that case you will have four conditions that will have to be fulfilled. The organism does not survive when transplanted to a site, where it does not normally occur unless it is protected from predators by cages. Second, there is an inverse correlation between the distribution of organisms and the suspected predator or alternatively in the places where it occurs the organism is inaccessible to the predator.

Third, you should be able to see that either in the field or in the laboratory that the suspected predator is inflicting a lethal damage on the prey. And fourth, there should be a direct evidence that the suspected predator is responsible for the destruction of the prey in the transplantation experiments. So, if all this four criteria are right; then, we can say that the predator is governing the distribution and abundance from the prey.

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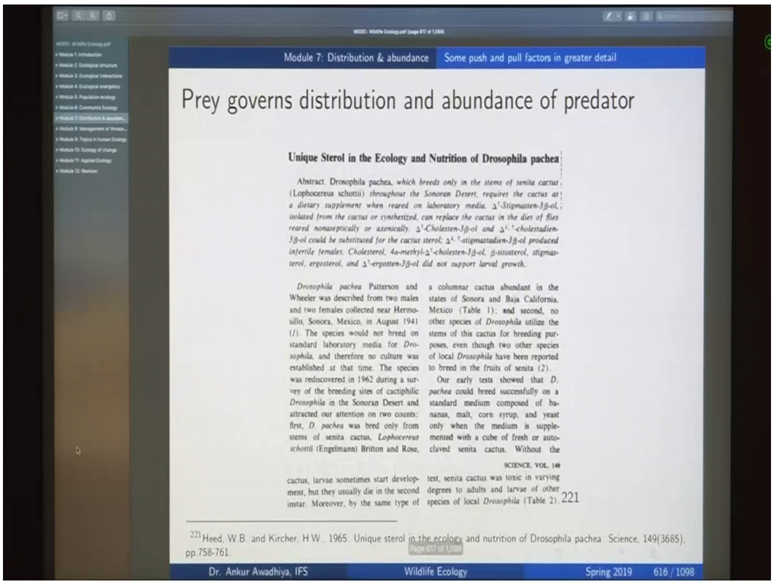

On the other hand, you can have this counter example, in which case the prey is governing the distribution and abundance of the predator; which we saw in the case of drosophila pachea which is only found in those areas where you have a particular species of cactus. Now, does it have any implications on biological control of pests and invasive species? Yes because, if you have a predator that is extremely exclusive to the prey species, you can make use of that predator as a biological control.

So, we looked at this example of controlling pine rust by eliminating the gooseberries because the fungus that was affecting the pines also was obligately dependent on the gooseberries. So, it spent some part of its life cycle on the pine and some part of its life cycle of the gooseberries. So, if you remove the gooseberries you will eliminate the pine rust.

Then, we looked at this other method of governing distribution, which is inter specific competition; in which you have a particular species of bird that is able to form colonies in this areas, but then it gets displaced by another species because of inter specific competition. And, this can also regulate the distribution and abundance of a particular species in a particular area. Because once this species is displaced; now, you do not have any individuals that are left in this particular area.

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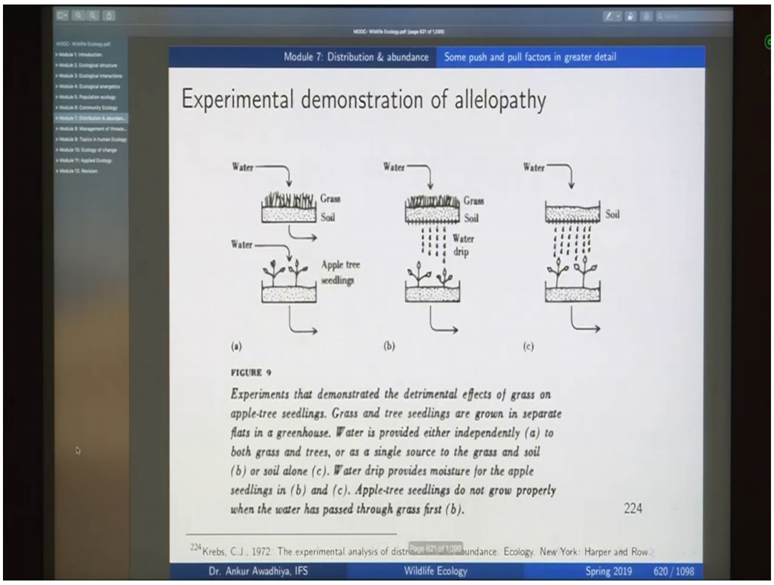

Next, we looked at experimental demonstration of allelopathy. So, in this case if you have the apple seedlings and you give it water; these apple seedlings are able to survive. But then, if you pour water through a grass bed and then put this water onto the apple seedlings, they start dying of. But then, if you put water only through a soil bed without the grasses, these apple seedlings are able to survive.

So, this is telling you that, there is something that is there in grass, which is leading to the death of these apple seedlings here. Because there is nothing in this soil that is leading to the death of the apple seedlings. So, this is how you can locate the impacts of allelopathy or you can experimentally play with the impacts of the allelopathy.

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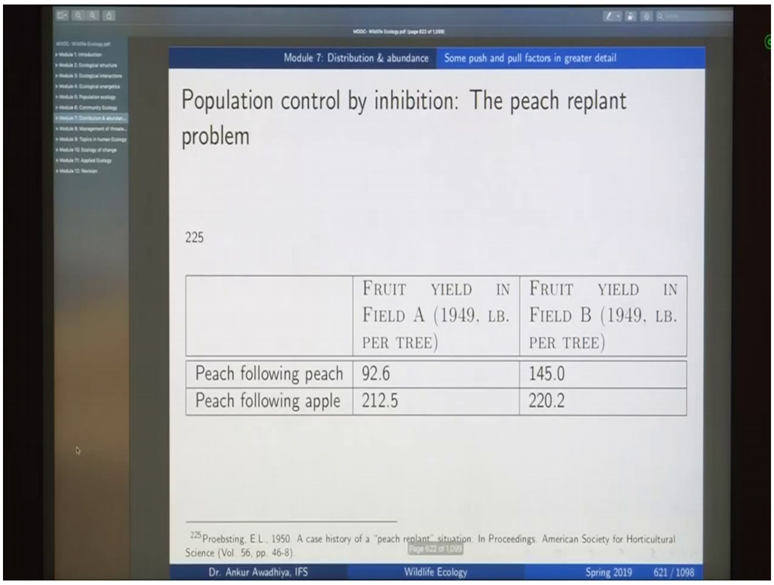

Now, in the case of allelopathy, it is not only that you have an impact on members of other species, but you can also have an impact on the members of your own species, such as this peach replant problem. If you have peach that is following an apple plantation, you have a good yield of fruits; whereas, if you have a peach that is following a peach, you will have a bad yield of fruits. So, there is essentially something that is released by the peach plants that is inhabiting the other peach plants and we looked at another example, in which case Grevillea robusta kills its own seedlings.

Now, there was one other variation that, we looked at. Now, whenever we are talking about the range of tolerances, those range of tolerances can be modified by acclimation of individuals. So, if you have individuals that have been living in a high temperature; they will probably be able to tolerate much higher temperatures as compared to other individuals of the same species that will living in lower temperatures.

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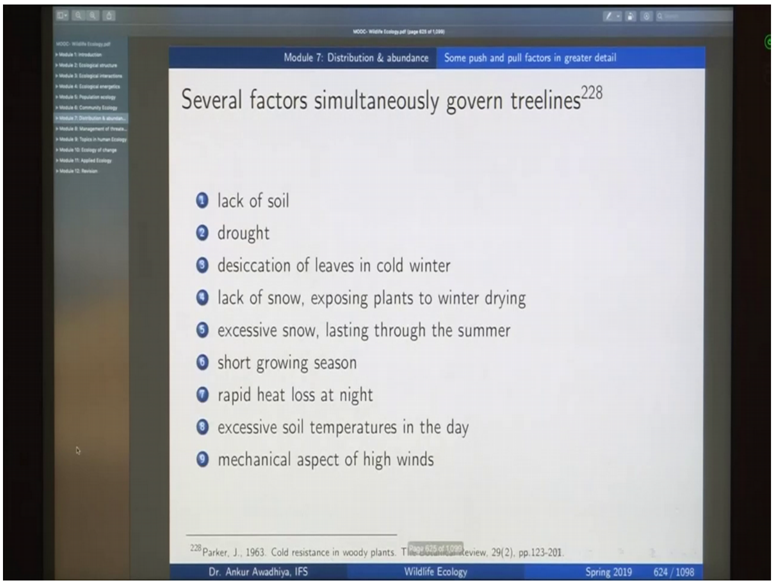

Then, we also looked at one other variation, that several factors can be simultaneously governing the presence or absence of a particular species in a particular area; so, especially in the case of these treelines. So, treeline is the line above which, there is no growth of trees. So, that can be because of lack of soil, draught, desiccation, lack of snow, excessive snow, short growing season, rapid heat loss at night, excessive soil temperatures in the day or mechanical aspect of high winds.

Now, which of these factors is playing a role or which combination of factors is playing a role, that needs to be looked at experimentally.

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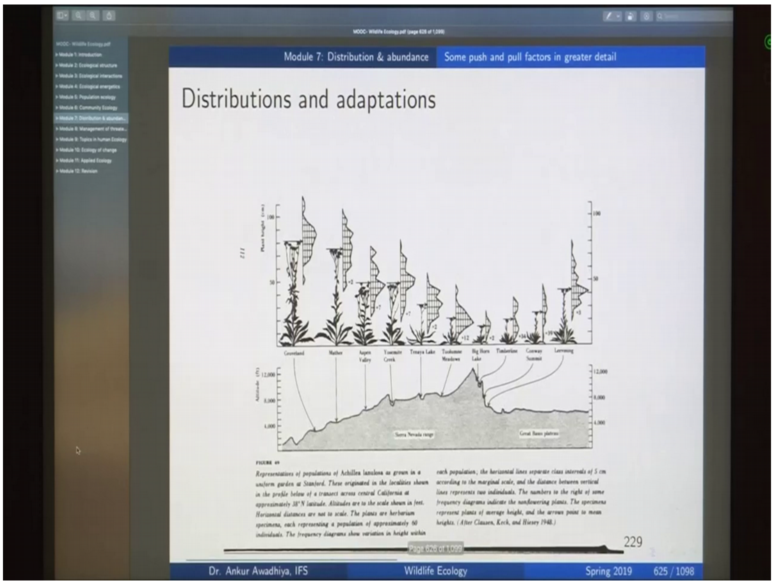

And then, we also saw that, that some amount of these variations are also stored genetically. So, for instance, if you take plants from different areas and these plants belong to the same species and you are bringing these same plants, these plants into the same area; they will start showing different features. So, whenever we are talking about these distributions, ranges, tolerances so, that is also modulated by the areas in which these organisms have been growing. So, that is all for today.

Thank you for your attention [FL].