Forest Biometry
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Lecture - 23
Canopy Attributes – Part III

[FL]. Today we will further continue with our discussion of canopy attributes in this third part of the series on canopy attributes.

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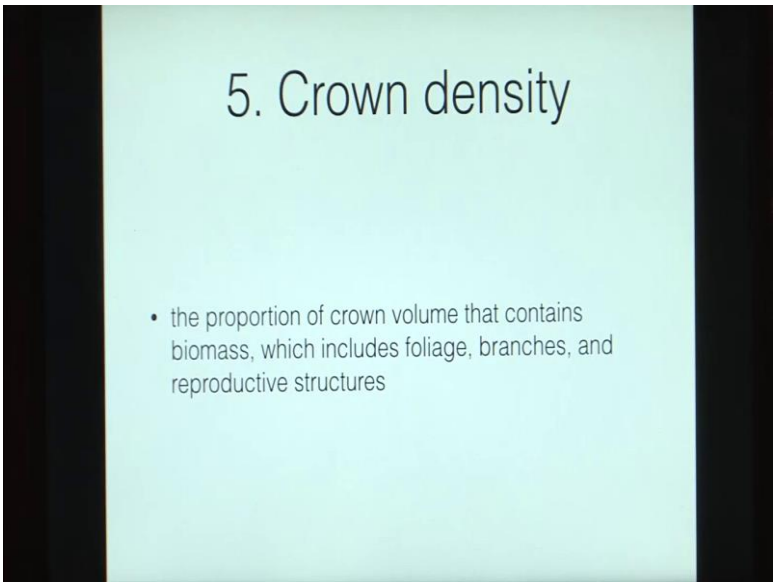

So, in the last class, we have seen, we have already gone through a few canopy attributes. So, to continue the discussion, the next point is crown density.

Now, crown density is the proportion of crown volume that contains biomass including foliage branches and reproductive structures. So, what proportion of your crown volume is containing the biomass will give you the crown density. So, how do we determine crown density?

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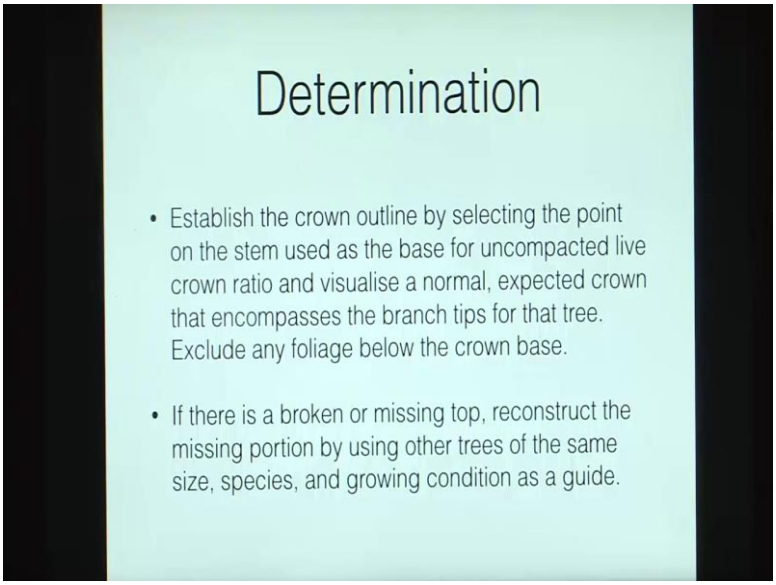

First we begin by establishing the crown outline by selecting the point on the stem used as the base for uncompacted live crown ratio and visualise a normal expected crown that encompasses the branch tips for that tree and we do not include any foliage that comes below the crown base.

So, in this case the first thing is we figure out the base that was computed as in the case of uncompacted live crown and once we have done that, we visualise a normal expected crown. So, this crown might not be present as this is clear in the second point. If there is a broken or missing top reconstruct, the missing portion by using other trees of the same size species and growing conditions as a guide, so even if some parts are broken or missing, we are going to reconstruct them. So, first we figured out where the base would lie and then, we reconstruct the whole of the top next after determining the outline, each crew member.

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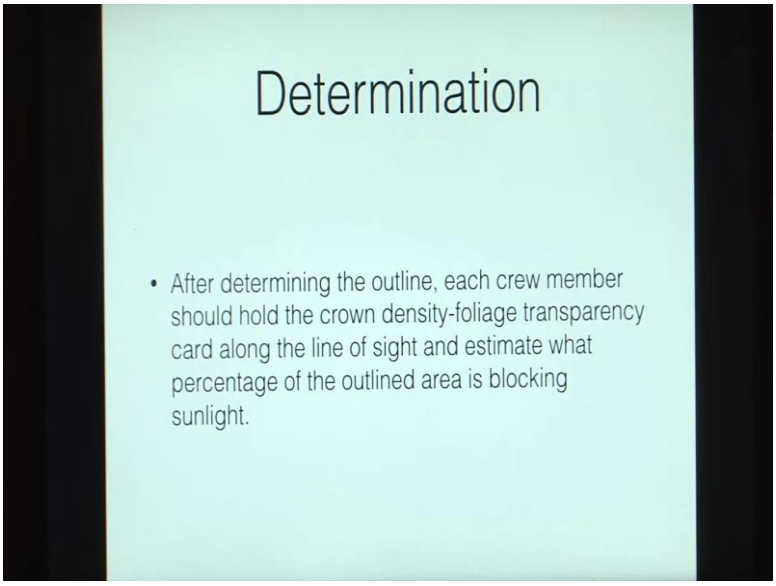

So, basically this activity will be done by more than one person. So, each person in the group should hold the crown density foliage transparency card along the line of sight and estimate what percentage of the outline area is blocking the sunlight.

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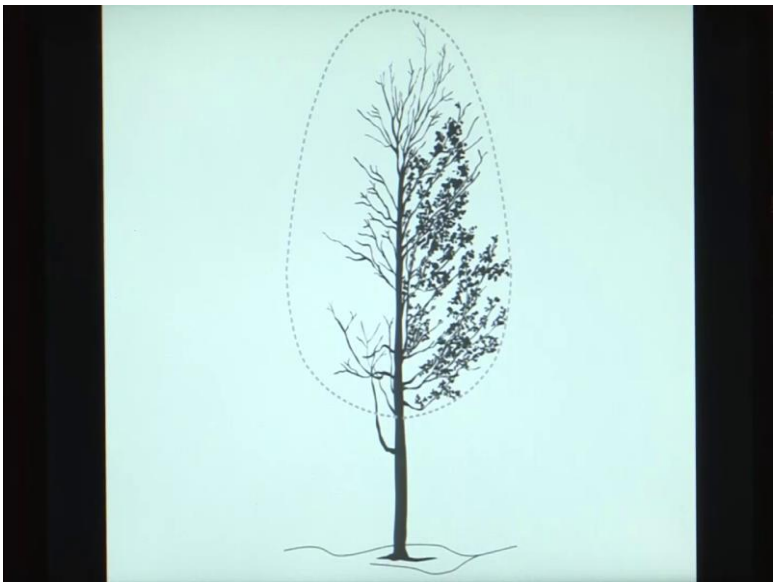

Now, to locate it in figures so for instance, this is your tree. More than half of it is already dead or may be defoliated, but we are going to reconstruct the whole crown by taking its base.

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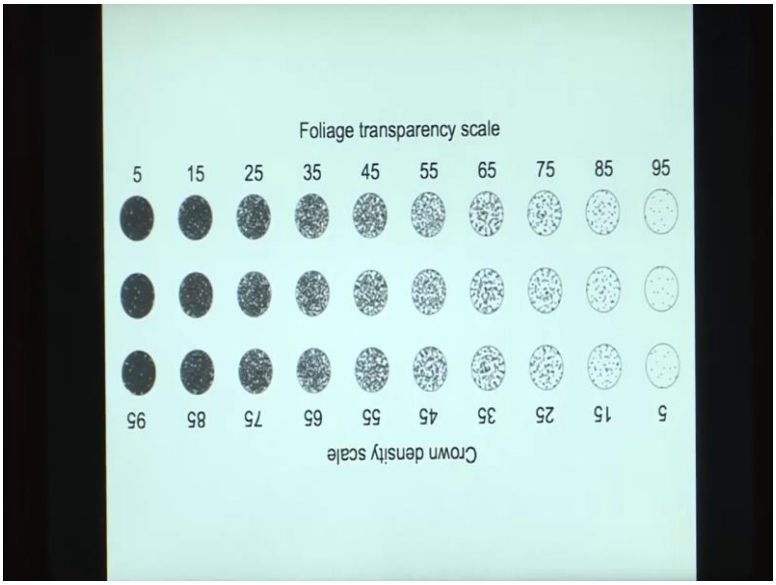

So, here we have the base of the crown, and then we reconstruct the whole of the top portion of the crown. Once we have done that, we need to calculate the amount of light that is going through by using this foliage transparency skill.

So, this is a card which is available, this is a transparent card and here you have 5 percent, 10 percent, 25 percent. So, this top is showing you the amount of transparency. So, transparency of 0 percent would be completely black, transparency of 100 percent would be completely white and this would give you all the transparencies.

On the other hand, you could also go on the opposite directions. For instance, if you look at the crown density, so here a zero percent density would permit whole of the light to go through. So, that would be a transparent slot and as this crown density increases in this direction, a 100 percent crown density would not allow any light to pass through it. So, here we have this scale from 5 percent to 95 percent. So, we are going to hold this against our eyes and look at and compare our tree with this.

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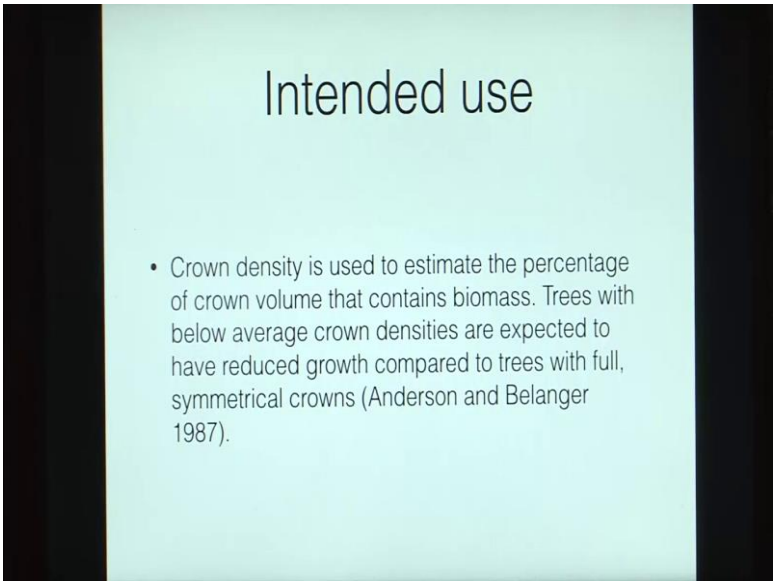

So, once you have determined the crown density, how is that useful? A crown density is used to estimate the percentage of crown volume that contains biomass which was its definition. Trees with below average crown densities are expected to have reduced growth as compared to trees with full and symmetrical crowns. Why so? It is because if you do not have any biomass there, if you do not have any leaves there, then in that case the amount of photosynthesis that this tree is going to perform will be less and a lesser amount of photosynthesis means that this tree is going to have lesser amount of biomass or lesser amount of growth. So, this is the utility of crown density.

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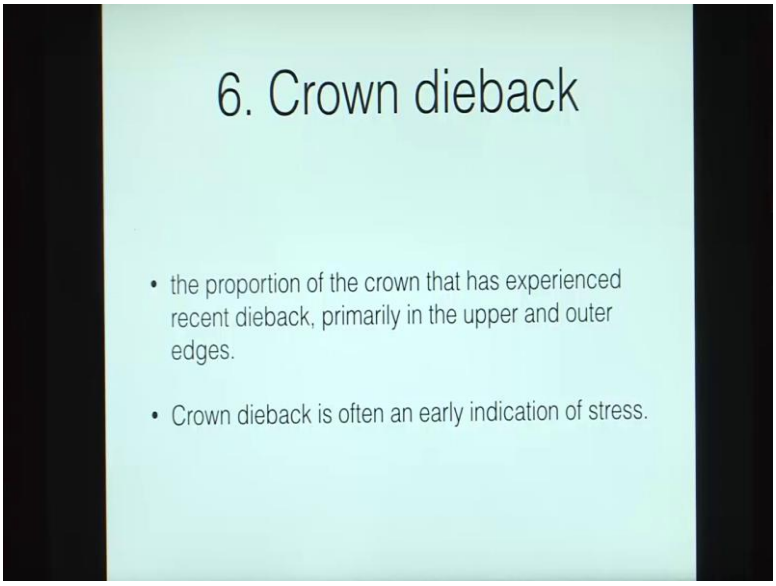

The next thing that we are going to look into is the crown dieback. So, coming back to the slides crown, dieback is the proportion of the crown that has experienced recent dieback primarily in the upper and outer edges.

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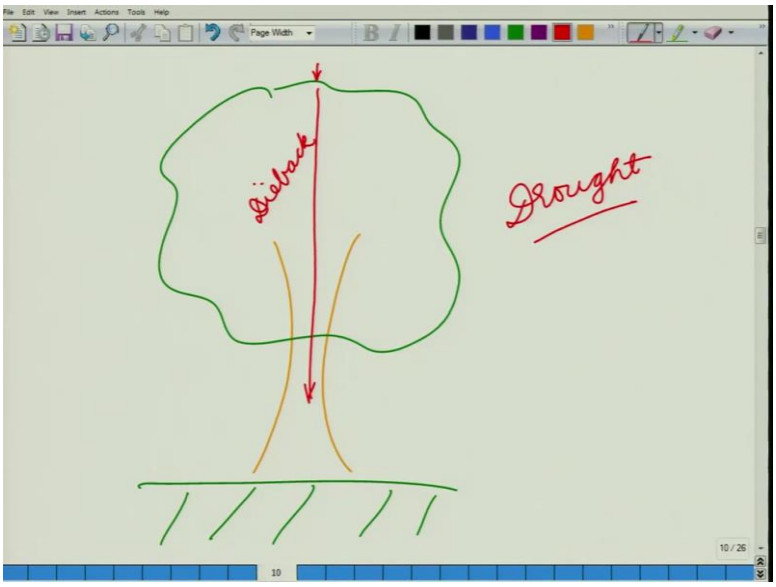

So, when a tree begins to die, so for instance if this is your tree and suppose you give it any form of stress. So, suppose this area is suffering a drought. So, in the case of a drought, this tree is going to start dying from the top towards its base which is why it is called dieback. Now, coming back to the slides.

In the case of a crown dieback, we measure the proportion of the crown that has experienced a recent dieback. So, any dieback that had occurred long back will not be counted here and it is primarily in the upper and the outer edges and this is an indication of stress.

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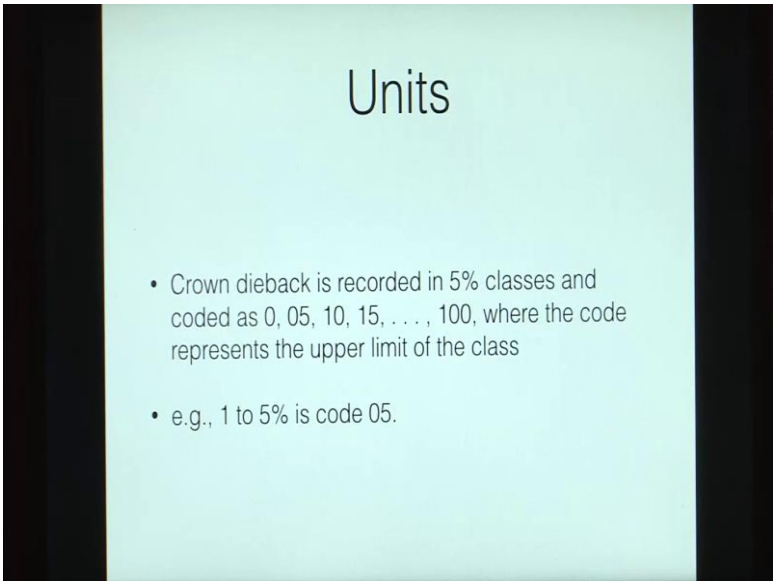

So, how do we measure this dieback? It is recorded again in 5 percent classes as 0 5 10 15 up till 100, where the code represents the upper limit of the class. For instance, 1 2 5 percent will be code 0 5.

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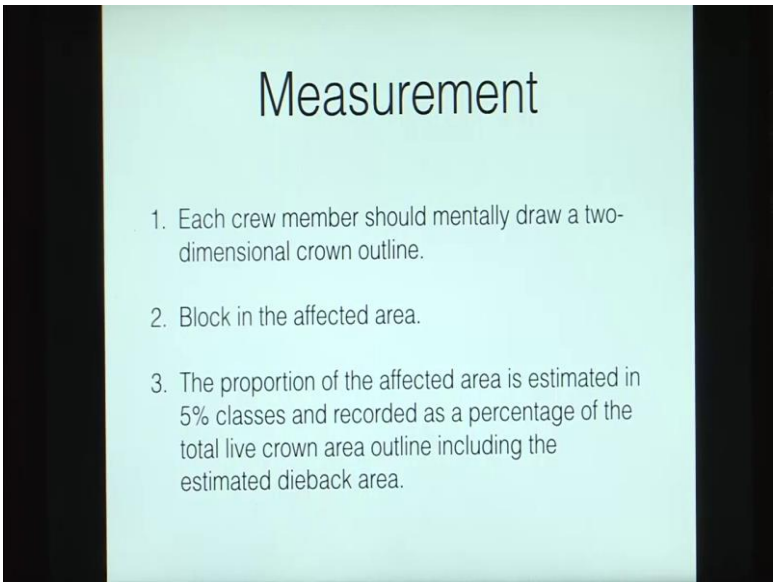

So, how are we going to measure it in the field? So, here are the steps. One each crew member should mentally draw a two-dimensional crown outline. So, this is a two-dimensional crown outline and next we block in the affected area.

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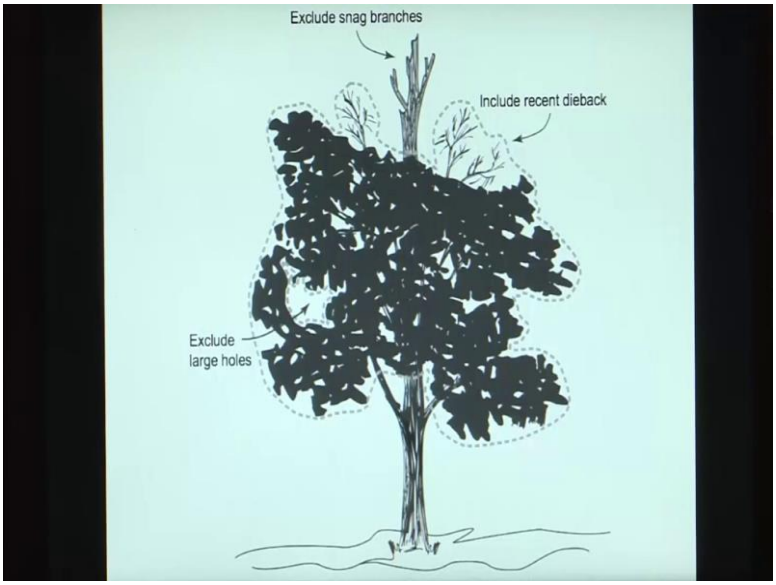

So, affected area is the area that has experienced a dieback. The proportion of the affected area is estimated in 5 percent classes and recorded as a percentage of the total life crown area outline including the estimated dieback area. So, to give it as an example in this case, the snack branches are not included.

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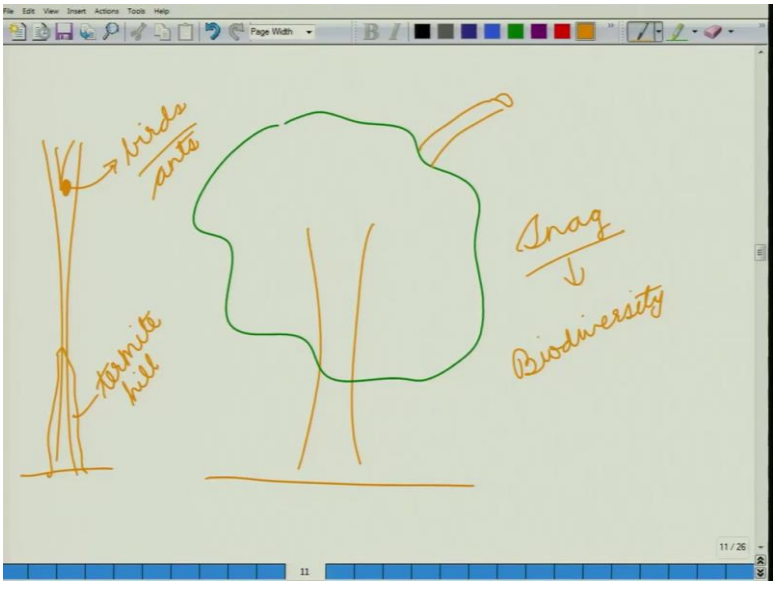

Now, what are snags? Snags are so for instance if we have this tree and suppose it has some branch that is dead, then to that branch has some utility for instance we normally use the stumps snag in the case of management for biodiversity purposes.

So, for instance even if you have a tree that is all dead, it does not have any leaves, but still it might have some holes that might be used for birds or for instance some ants or maybe this tree would be a termite hell. So, a termite hell might form on this tree and utilize its resources. So, even this tree which is completely dead has its own biodiversity utility. So, we leave these trees in a protected area, such as a national park or wildlife sanctuary for use by birds, ants, termites and so on. So, a snag is essentially a dead branch.

So, now coming back to the slide. Any dead branches because they are dead from long back, they are not included in this calculation. We include the recent diebacks and we exclude the large holes. So, for instance this hole is a national hole, so we are not going to compute this area, but we are going to compute the area that is given here in the outline. So, we calculate this total area, we calculate the area of the recent diebacks and then, we calculate the ratio and then, express it as a percentage or in the class distribution.

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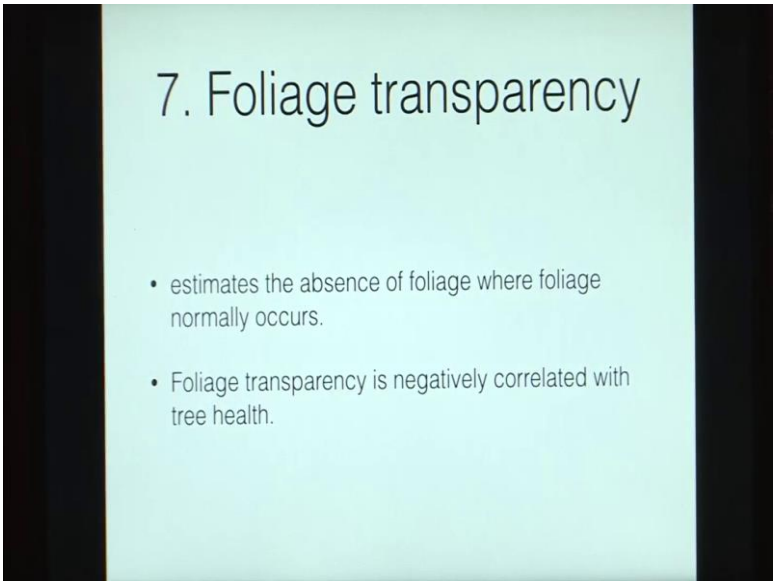

Next we can have a look at the foliage transparency. Now, foliage transparency estimates the absence of foliage, where foliage normally occurs. Now, what is foliage? Foliage refers to the leaves of a tree. So, it estimates the absence of leaves where lives should have occurred and it is negatively correlated with tree health. So, for instance a tree is completely transparent. So, it does not have any leaves where it should be having leaves. So, if it does not have any leaves; it will not be able to perform photosynthesis, it will not be able to accrue biomass and it will not be able to grow.

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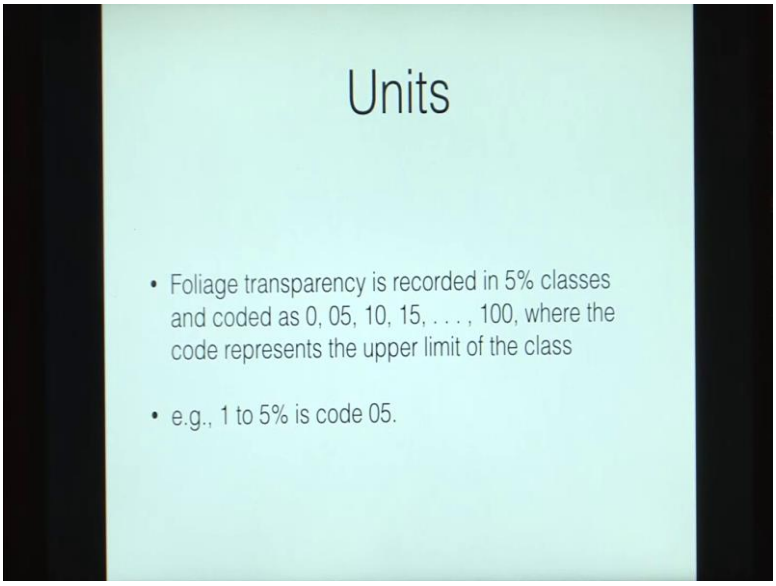

So, foliage transparency is negatively correlated with tree health. So, how do we calculate foliage transparency? Here also we represented in the form of 5 percent classes as we have seen before.

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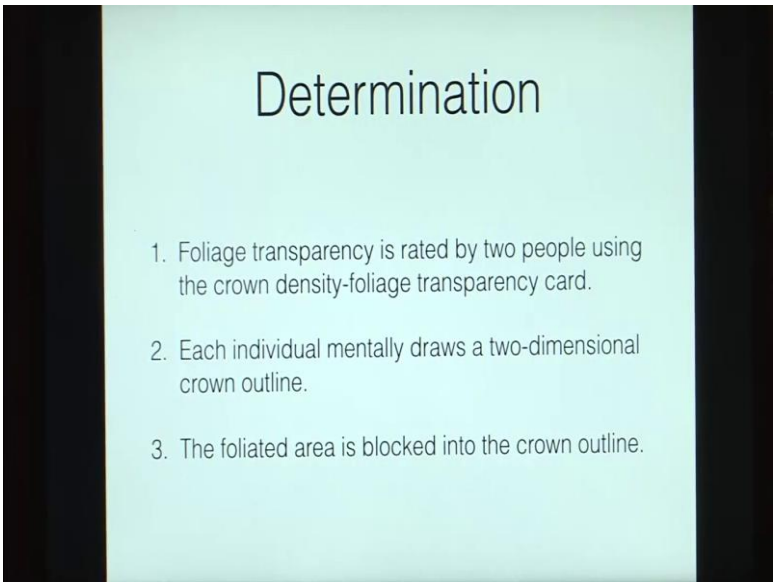

How do we determine it? We begin by having at least two people. So, it is rated by two people using the crown density foliage transparency card as we have seen before.

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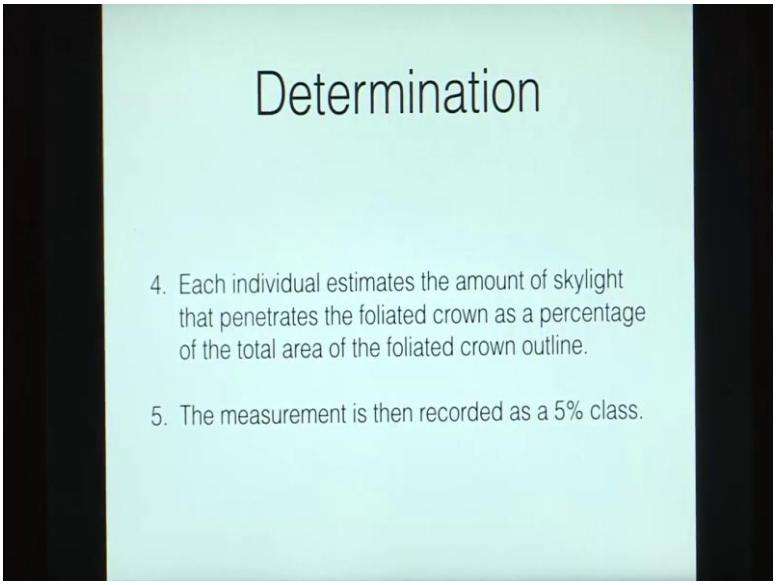

Each individual mentally draws a two-dimensional crown outline and the foliated area is blocked into the crown outline. Next each individual estimates the amount of skylight that penetrates the foliated crown as a percentage of the total area of the foliated crown outline and then, records it in 5 percent class.

So, in this case, we are not going to include the recent diebacks that we did before, but we are going to include all those reasons that are living here as well we are going to exclude the large holes. Now, we will try to figure out how much is the percentage of light that can pass through this foliage which will be given as a foliage transparency, where can we have light passing through. For instance, in this small holes like this hole, this hole or may be even these smaller holes, light is going to pass through these and we can use our density or the foliage transparency card to get an estimate.

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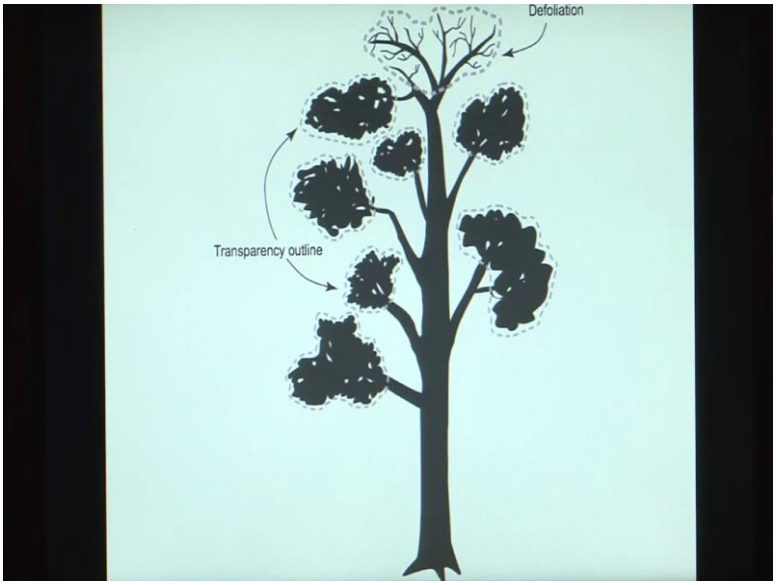

This is another figure. So, in this figure, it is not a dieback, but it is a defoliation. So, defoliation is shedding of the leaves. So, in this top portion that does not have any amount of leaves, we might have a transparency that is going close to 100 percent transparency, whereas in the case of these other canopies will be having some values here.

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Again here in this tree which is not having any diebacks, here also we are going to find out an outline and then, calculate the amount of lights that can pass through this figure.

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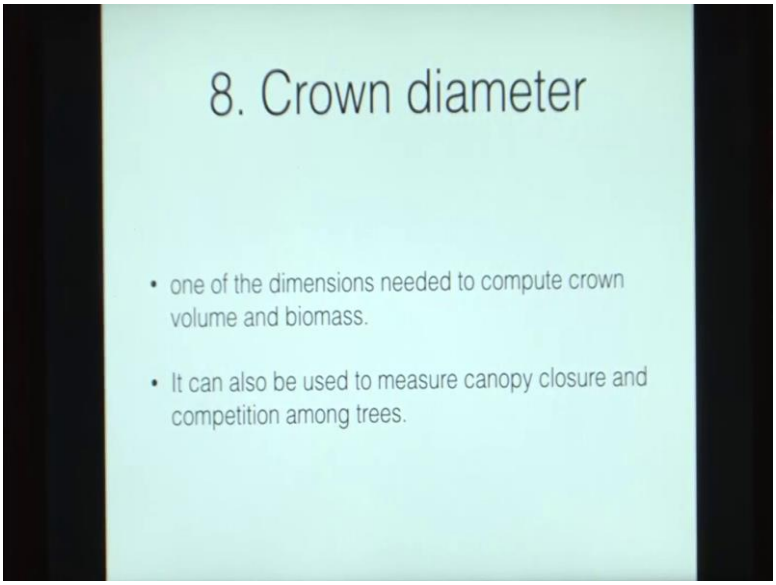

The next attribute in the case of this canopy or the crown is the crown diameter. Now, crown diameter is a dimension that is needed to compute crown volume and biomass.

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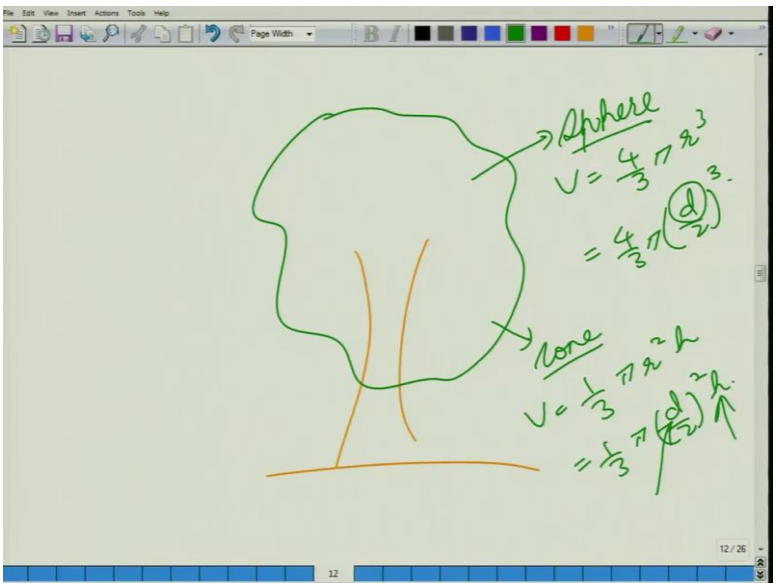

So, for instance if you considered your tree and suppose you considered its volume to be a sphere, then the volume would be given by 4 by 3 pi r cube or 4 by 3 pi d by 2 whole cube. So, in this case to calculate its volume, you only need one parameter that is the diameter.

Suppose you considered it to be a cone, so the volume of a cone if you considered it to be a cone, the volume would be given by 1 by 3 pi r square h or 1 by 3 pi d by 2 whole square h.

So, in this case you will require two parameters to be measured; the diameter and the height and you will be able to get the volume.

Now, from the volume you can then calculate the biomass. So, now coming back to the slide, crown diameter is one of the dimensions that is needed to compute crown volume and biomass. It can also be used to measure canopy closure and competition among tress.

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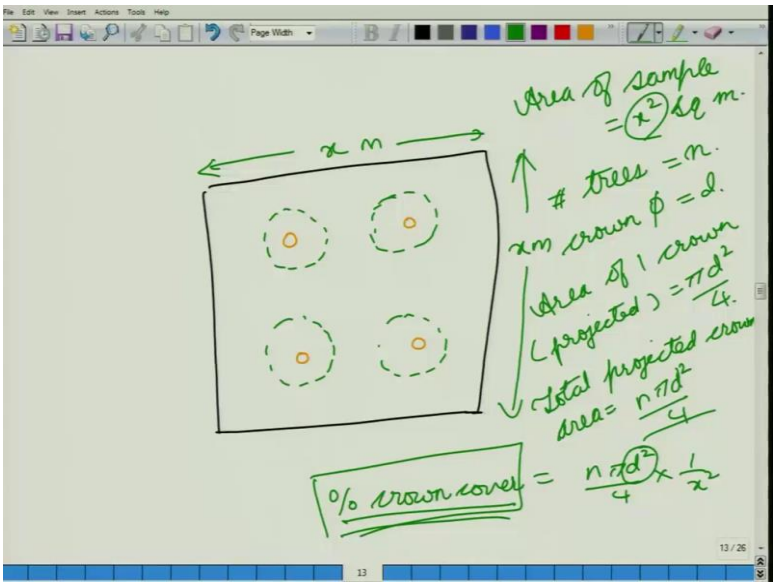

So, for instance if in one given area suppose in this area, suppose you have four trees. So, these are the stems and let us consider the first diameter. So, if we know the number of trees that are present per unit area and the crown diameter, so suppose this area is say x meters by x metres. So, we are considering squarish cross-section. So, the area of sample is given by x square metres.

Now, the number of trees for instances n and the crown diameter is d. So, in this case the area of one crown that is projected down to the crown will be given by pi r square or pi d square by 4. So, the total projected crown area because there are n trees, so it will be n into pi d square by 4 and if we wanted to get it in a percentage, so the percentage of the crown cover will be given by this area that is n times of pi d square by 4 divided by this area 1 by x square.

So, here we can see that as we increase d, our percentage of crown cover also increases which is why you can use your crown diameter to measure the canopy closure and the competition.

So, if your crown cover if it goes close to 100 percent, so in that case you will be having a lot of competition amongst your trees and a lot of closure.

So, now crown diameter is measured in the units of metres or feet. So, how do we determine the crown diameters?

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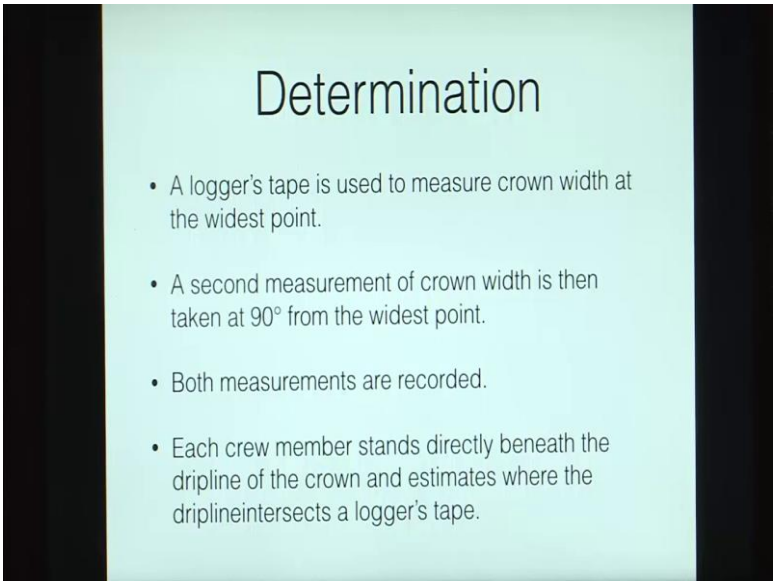

So, coming back to the slides, so for its determination, a loggers tape is used to measure crown width at its widest point and then, you take a second measurement of crown width that is at 90 degrees to the widest point. Both the measurements are recorded and then, each crew member stands directly beneath the dripline of the crown and estimates whether the dripline intersects a loggers tape, ok.

So, this is how we are going to measure it. So, how do you get this dripline? So, to get a dripline, you go under a a tree and you figure out which is the most outermost branch and from that branch you can either physically or you can mentally put down a plumb line. So, a plumb line is essentially a thread with a weight beneath it, so that it is kept vertical so you can figure out various driplines and then, you can find out which is the longest diameter.

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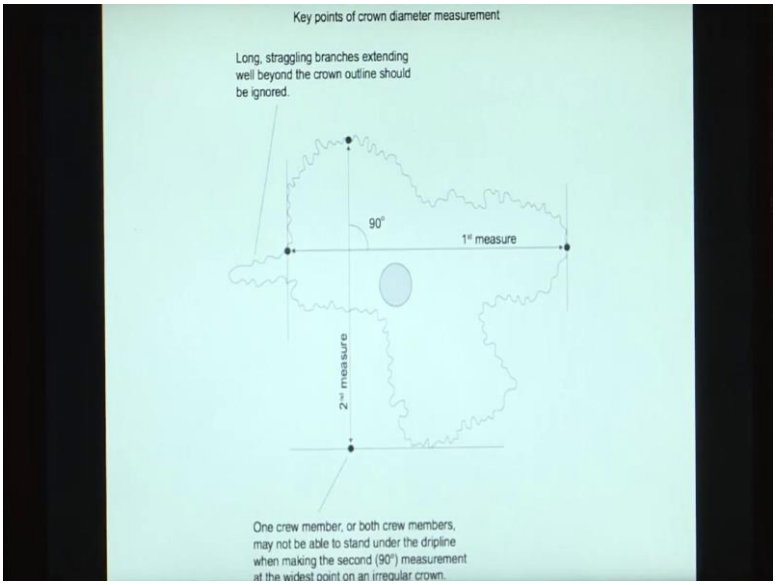

So, for instance in this case to take this example here, we are removing any long straggling branches that are extending well beyond the crown outline. So, if that is an exception, we remove it. Other than that we calculate the first major measure at the longest diameter that we can get. Once you have gotten that, we can then go in 90 degree position and then, you figure out a second diameter.

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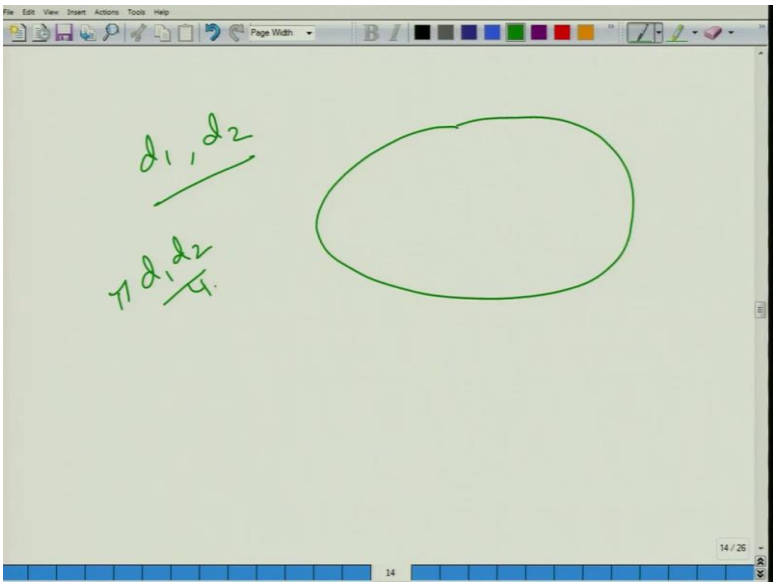

So, you will be be recording two diameters. So, it will be d 1 and d 2. So, why is that important? Suppose you take your crown to be an ellipse. So, if it has an elliptical cross-

section, your area will be pi d 1 d 2 by 4 figures. We can also calculate its perimeter. You can then multiply it whether it is height to maybe get its volume or an indication of the volume which is why you take both these measures together.

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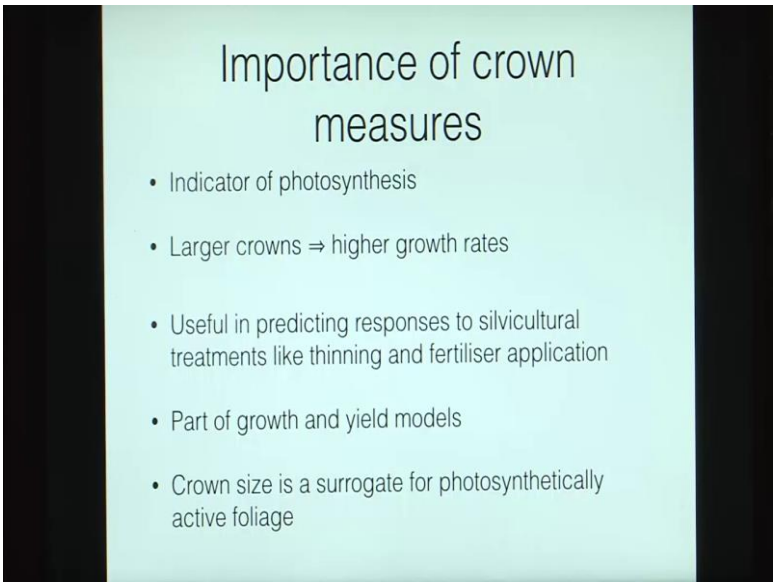

So, now what is the importance of crown measures? One, they are the indicators of photosynthesis as we have seen now larger crowns because they are able to perform more photosynthesis and thus, get more biomass. So, these will correspond with higher growth rates. Now, the crown measurements are useful in predicting response to silvicultural treatments like thinning and fertilizer application.

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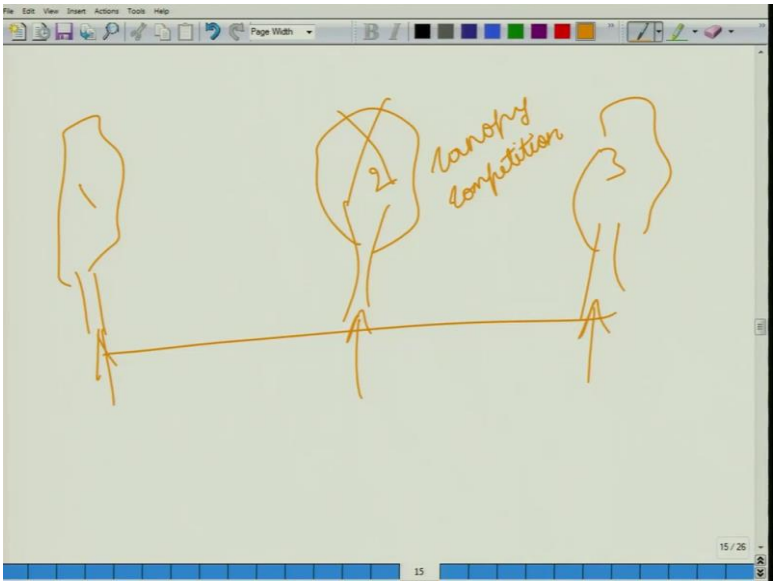

So, in the case of thinning, what we do is we take a stand. So, this sand is getting crowded. So, what we will do is, we will remove a few trees. So, when we remove those trees, so now we have removed this, so now these trees are having less competition and so they will be able to get more sunlight, more nutrients, more resources and so they will be able to put on a greater amount of growth.

Now, the response of a stand to thinning will depend on its crown parameters. So, for instance if you have your stand that is currently in this position should you thin it? Even further so basically should remove this tree or not that would depend on the crown parameters of all these trees; 1 2 and 3. So, if by measuring your crown parameter, you can send that you have some amount of competition here only. In that case, this thinning is going to be of any use, otherwise it will not be of any use. So, there would not be any need for thinning.

Similarly, if you want to put fertilizers into into your stand, now fertilizers will be taken up by your trees and then, used to make biomass, but then fertilizer will only be useful if your tree is not having any canopy competition. So, if you have any canopy competition, then probably light is becoming bottleneck for your reaction. So, in that case application of fertilizers will not be able to give you the desired results.

Now, coming back to the slides. Crown measures are also a part of growth and yield models because of these reasons and they can also be used as a surrogate for photo synthetically active foliage once if you want to model the growth of this tree.

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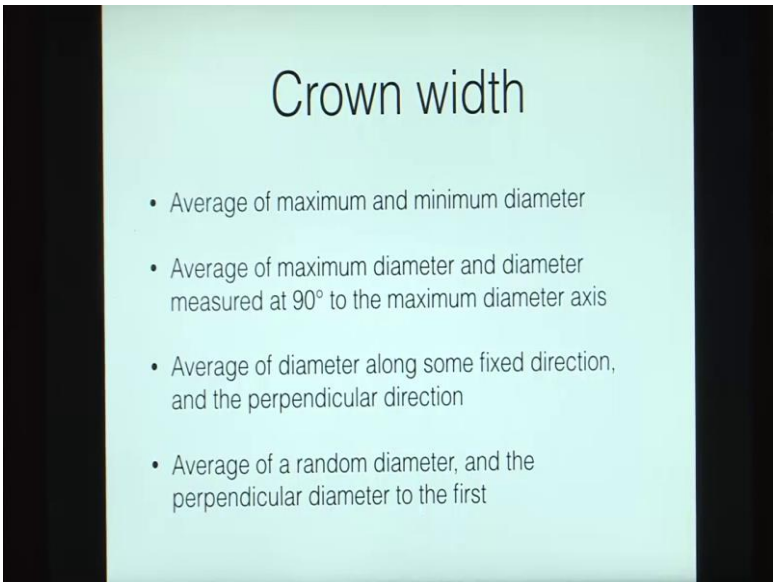

Now, when we talk about the crown diameter, we can also talk about the crown width. Now, crown width will be the average of the maximum and the minimum diameter, but then this term is not as well defined.

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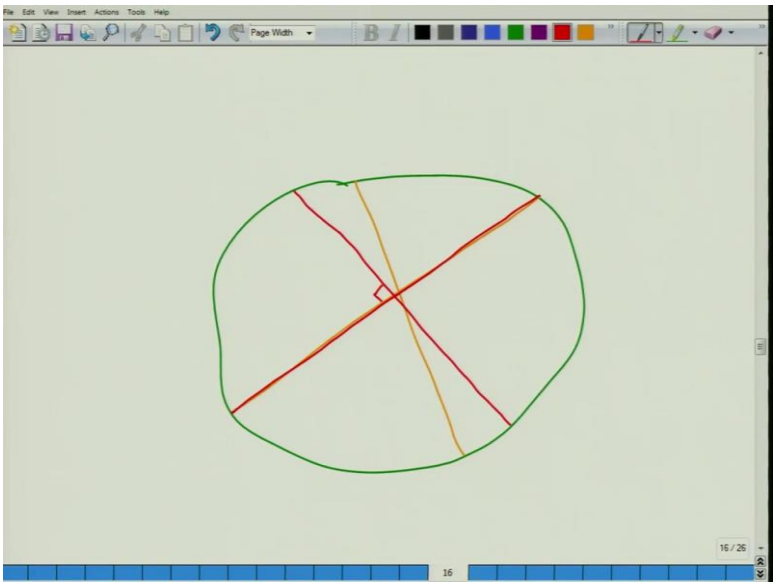

So, what are these maximum and minimum diameters? Maybe if you have your tree, if this is your canopy, then maybe this is your maximum diameter and maybe this is your minimum diameter. So, you could take it like this or else you can take the maximum diameter and then, take a position that is 90 degrees to it and then, you could call this as your second diameter or maybe you can take all your trees.

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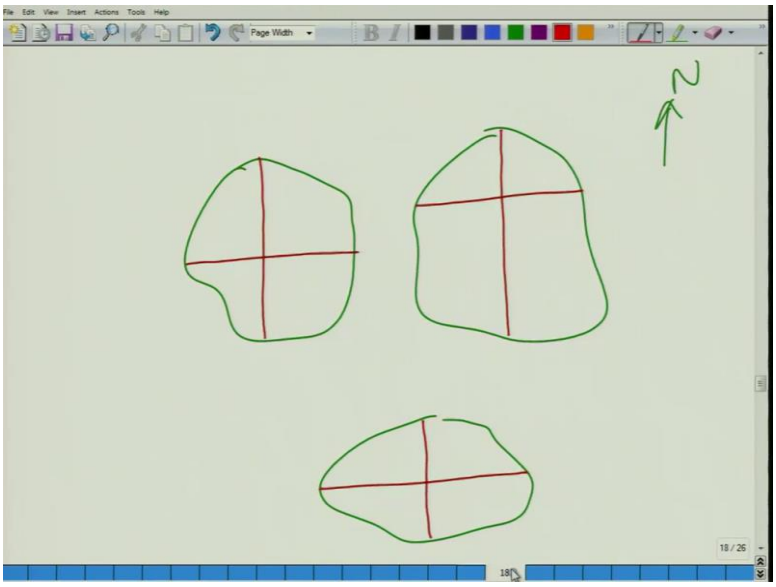

So, for instance if you have a number of trees, then maybe you would say that you are north. So, north as your direction along which you will measure the first diameter for all the trees. So, in that case regardless of whether or not it is the longest diameter, you will measure your diameters like this and then, take 90 degrees to get the other diameters and then, take the average. So, that would be a crown width or otherwise you can take any random diameter.

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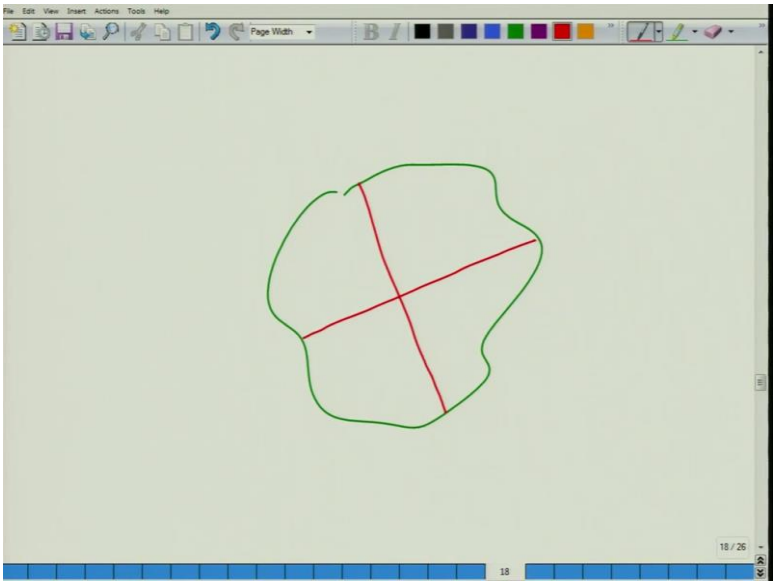

So, in which case regardless of your whether it is maximum or a minimum diameter, you take a random diameter and then, you take a perpendicular diameter.

So, the average of both of these will give you the crown width. So, this term is not as well defined as the other terms.

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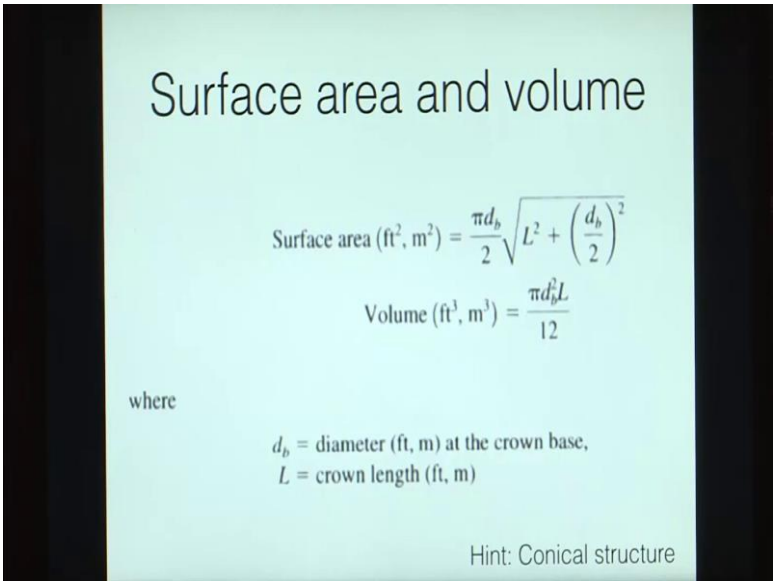

Now, once you have these numbers, so coming back to the slides, you can use it to calculate the surface area and volume. So, these are the formula for the surface area and the volumes.

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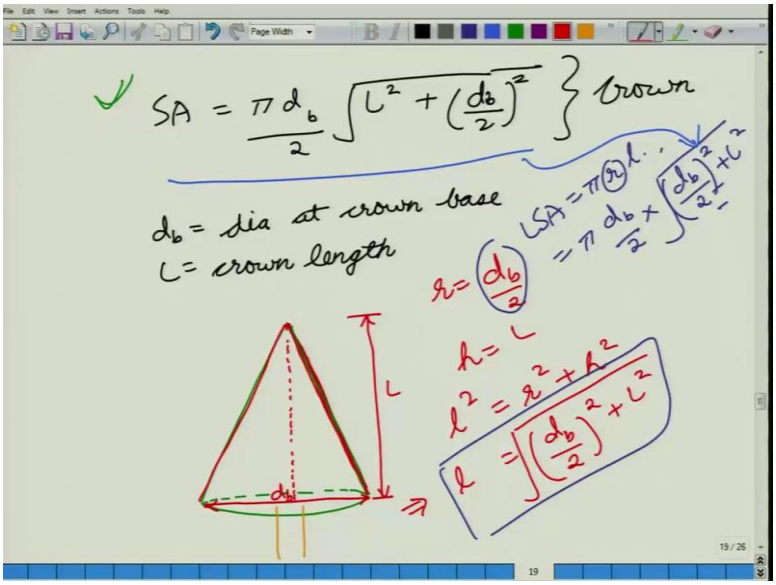

Now, these look a bit tricky in the first glance. So, if I wrote it down, so we have surface area is equal to pi d b by 2 square root of L square plus d b by 2. Its square where d b is the diameter at crown base and L is the crown length, so this is the surface area of the crown. Now, how do we get to this equation?

So, let us consider a crown and let us approximate it to be a cone. So, essentially this is your tree. Now, in this cone you have the diameter at the base, as diameter at the base and your crown length is capital L. So, now if we do a perpendicular here in this cone school, we have the radius is equal to d b by 2 and the height is given by capital L.

So, what is lateral? This lateral surface length if by using our equations for a cone, we have L square is equal to R square plus H square which is d b by 2 square plus L square. So, we will get that your small l is the square root of this portion. Now, the surface area of a cone, this lateral surface area is given by the equation surface area or the lateral surface s pi r l. So, putting these values we have pi r is equal to d b by 2 d b by 2 times L. Now, this is the value of L. So, it is square root of d b by 2 square plus L square.

So, essentially this equation is the same as the equation of a cone. So, pi d b by 2 pi d b by 2 square root of l square plus d b by 2 whole square L square plus d b by 2 whole square. So, this is how we calculate the surface area of the crown when we consider it to be of a conical section.

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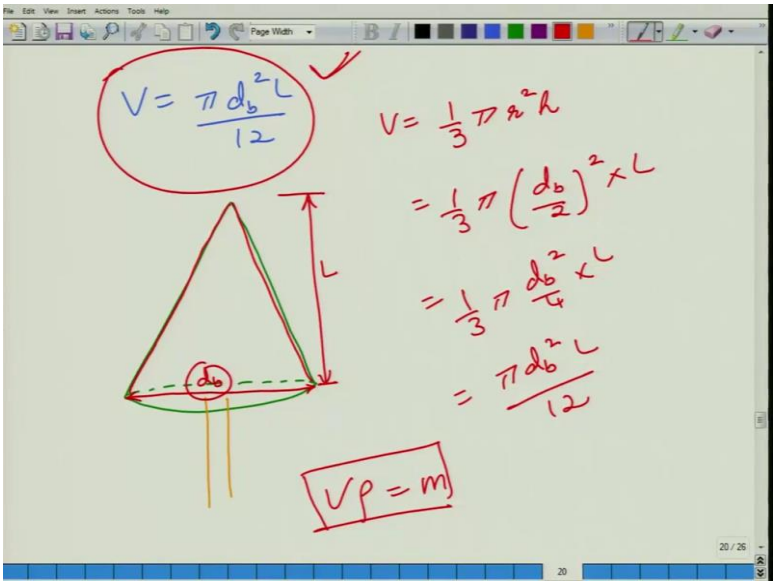

Now, let us look at the other formula. So, we have volume is equal to pi d b square l by 12. So, coming back to the slides. So, here we have the volume in feet is pi d b square l upon 12. So, how do we get to that equation?

So, now coming back to the tablet again, we are considering our crown to be a cone. Now, in this cone we have the base diameter as d b and the height as capital L. So, in the equation of a cone, we have volume is 1 by 3 pi r square h is equal to 1 by 3 pi. Now, r in this case is d b by 2 square into high. Now, the height of this cone is given as capital L which is the crown length. So, this becomes 1 by 3 pi d b square by 4 into l which is pi d b square l upon 12 which is the same as this equation.

So, essentially when we are trying to measure the surface area of the crown and by the surface area, we are referring to the lateral surface area or the volume of the crown, then we can use these equations of the cone.

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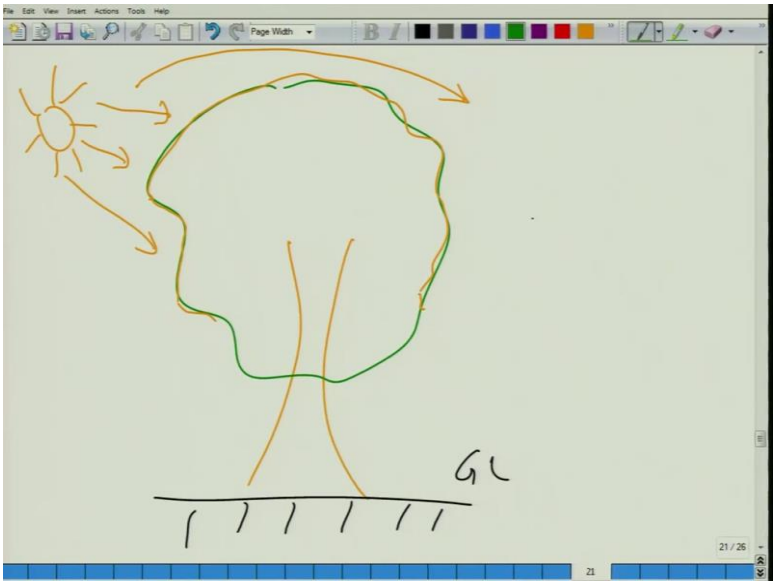

Now, why is it important? So, when we have a tree, so this is the crown level. So, now when we look at the sun that is giving out light and light is an important component of the photosynthesis. So, this light is intercepted by the lateral surface of the cone. Now, when the position of the sun related to the relative to this tree changes with the passage of time during a day, then essentially all these areas become illuminated. So, these are the lateral surface areas in which we are not considering the bottom surface area.

Now, when we talk about the surface of this cone, so when we are talking about this lateral surface given by, we are considering this area given by this equation. We are considering the lateral surfaces. So, the lateral surfaces will be an indication of the amount of sunlight your plant is getting which will be an indication of the amount of photosynthesis there that it is going.

Similarly, when we consider this volume, the volume of this cone will correspond to the volume of the biomass that is there inside. So, it will comprise of the volume of the branches, the volumes of the leaves and so on. So, this volume is the volume of the cone or the volume of the biomass. Now, multiplying the volume with density will give you the mass. So, for instance multiplying it by the average density of the leaves and the branches will give you the mass of the crown.

Now, in this mass we need to remove those portions that do not have any biomass which is where are transparency indices and the density indices come into picture. So, in that case

after we have the mass of the crown which is an indication of the biomass, now we can use our ratios of the amount of carbon that is there in the biomass.

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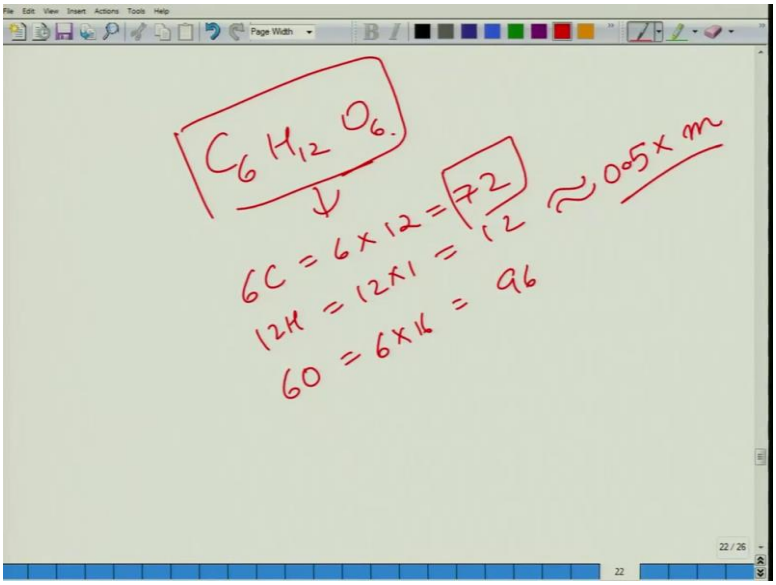

So, for instance if you consider the equation of this glucose, we have 6 carbons. So, 6 carbon is 6 into 12 is 72 units i.e. 12 hydrogen which is 12 into 1 is 12 units and then, 6 oxygens which is 6 into is 96. So, essentially the amount of carbon that is there in this biomass is roughly 0.5 times the mass of this sugar. So, by using the volume of the crown and the mass of the crown, we can calculate the amount of carbon that is there in the crown which is an indication of the carbon sequestration that this tree is doing. So, that is all for today.

Thank you for your attention. [FL].