Conference Rewind: Jake Miesbauer

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Music: [00:00:00] (Introduction Music playing) Every country, you know, we can work together and learn what we need to meet the challenge. Traditional skills and modern techniques, whatever language you speak, you have a world to offer every day. Climb with the ISA.

Tom Smiley: Welcome to the ISA science of Arboriculture Podcast Series. This is Dr. Tom Smiley at the Bartlett Tree Research Laboratory, host of this podcast series, which is brought to you by the International Society of Arboriculture and the FA Bartlett Tree Expert Company. Today's podcast is by Dr. Jake Miesbauer. He is an Arboricultural scientist at the Morton Arboretum. He will be speaking on the effects of restoration pruning treatments on damaged trees.

Jake Miesbauer: Hi, my name is Jacob Miesbauer. I'm an arboriculture scientist at the Morton Arboretum in Lisle, Illinois. Today, I'm going to be talking with you about crown restoration, pruning and storm damaged trees. I'll be going over what to do with trees from the beginning of when the storm occurs, all the way through the crown restoration process, including a couple of projects that we've worked on recently, that we've got some preliminary results for that I'd like to share with you.

So without further ado to start out with, I would like to just kind of begin by discussing what is crown restoration. And in the ANSI standards, which are the standards that are used in the United States, the American National Standards Institute, they define crown [00:02:00] restorations: a restoration shall consist of selective pruning to redevelop the structure form and appearance of severely pruned, vandalized, or damaged tree. And in the ISA BMPs, looking through the crown restoration process, it pretty much outlines the exact same thing as a companion publication to the ANSI standards.

So what are the important things to consider when we're talking about crown restoration? Well, first of all, while when storm damage occurs and we're looking at the process of what to do. There are several things to consider. You have to look at the severity of damage. How badly is the tree damaged relative to its size, its age, its location. These are all things that need to be considered. The root stability, is the tree partially uprooted or are their roots stably intact in the ground.

Species considerations, in your area is this tree known to be a good compartmentalizer or poor compartmentalizer. Do they typically respond well, or not, to to being severely damaged. And will they be able to deal with the, the restoration process over several iterations of pruning down the road? So these are all things that need to be considered when when, considering what to do after a storm.

So starting with immediately afterward, the first thing that we need to do is remove all the hazards. In this picture, you can see that there's power lines across the street. There's several large hanging, broken branches, trees on houses and across utility lines. All of those hazards need to be removed before we can even consider starting any type of crown restoration printing or even what to do with the [00:04:00] standing trees that are intact.

So once all the, the hazards have been removed, the next step is to stand up or stake trees if possible. This is typically done usually with younger and smaller trees and there's with larger trees or even medium-sized trees if possible. There's a cost considerations that need to be brought into account.

So for example, this large spruce tree in this cemetery you can, you notice at the back side of the tree and the the root plate is, is lifted up off the ground and and this tree absolutely needs to be removed. This tree, however, it's quite small and young, you can see by the stake over here that this tree has recently been planted.

If the root system is acceptable, this tree possibly could be stood up and restaked properly and monitored to make sure that the tree root system is established.

So getting onto what to do with the crown of the tree itself. The next step is to clean the crown meaning to remove all broken and hanging branches, stubs, and, and the other problem branches that you see within the crown itself. Here, we see a tree that was damaged some year ago in a storm. There's a branch that had partially severed and it's laying horizontally across the the crown and it's still attached and it's still alive.

So this branch is now growing. It's still continuing to, you know, put out new leaves and everything, but it's [00:06:00] laying across the forks of several other branches within the crown. And it is starting to have bad problems with inclusion within other branches. And in the long-term this will cause a major problem for not only that branch itself, but other parts of the crown.

Also in this picture, you'll notice several broken stubs. Those should get cut off, either back to a lateral branch or back to the parents stem as well. Preferably we'd do crown cleaning with a reduction removal, pruning cuts. But heading cuts, maybe the only option if damage is very severe and there's really no lateral branches to do any reduction in pruning back to. I especially, ask you to look at the picture on the lower, right. These three large silver maple trees.

I'm going to be talking about a project in a little while, and I want you to think back to these trees when we look at that, what that project entails. So so now, once we gotten to this point of standing up the trees, removing all of the broken branches, cleaning out the crown. Now we're at the point where we need to allow the trees to sprout.

Sprouts are branches that arise either as epicormic shoots from dormant or latent buds or as adventitious shoots that arise from undifferentiated callous tissue that forms around an injury in that um, undifferentiated tissue was born during the cambium forming that callous. So on the lower left, you see many sprouts that are spaced out along the lower branch and then several smaller sprouts coming out of the, where it broke off on the top.

So we've [00:08:00] got all of these epicormic shoots along the branch, and then either epicormic or possibly the adventitious shoots up here at the very tip. And then this lower right picture you see. sprout, the sprout is arising from undifferentiated callous tissue after uh, removal cut had been made on this particular tree.

So sprouting is a natural response to injury and they're absolutely necessary for new crown development. With a loss of a lot of branches within the trees, sprouts are going to be a major component of photosynthesis. So providing those carbohydrates back to the tree that it needs. Sprouts might, in some cases it's been shown sprouts will help slow the spread of decay.

And the leaves on the sprouts will help protect exposed bark from the sun. So especially on thin bark, smooth bark, trees that are susceptible to getting sun scald damage, the new leaves, and the new sprouts will help to protect that. And over time, these sprouts will form the new crown of the tree.

Now it will take a while to develop over several pruning rounds, but over time, the sprouts will form the new crop. And the objective is not to try to be able to restore the crown back to its pre damaged phase, because it's very unlikely that it will ever get back to that, but it's to try to restore the crown to be uh, productive, healthy, um, tree that that's within the risk parameters that we have set.

So looking at these sprouts, again, that the picture with the several sprouts spaced out along this lower [00:10:00] branch and on the picture on the right, there are several, a little bit older sprouts, growing on this broken branch. These are still too young to worry about doing any restoration. You need to let these grow for a while yet we got before we worry about doing any pruning.

Here, you can see in this this Platanus tree though, this, got a large sprout that had developed, you can see in the old injury. And then this large sprout that has grown up into the canopy and it frankly takes up probably 25% of the whole crown.

And so this is an example of where these sprouts over time will develop part of the new crown. This picture isn't really clear, but a couple of these other branches over on the left also appear to be sprouts. But again, it's not real clear from this picture.

Here you can see several old injuries on, on this tree that had been severely damaged in the storm. And from each of the major branches, there are several sprouts growing up into the, you know, forming basically a majority of the crown of the tree. We take a closeup look at one of the main leads of this tree you'll see that there are several sprouts, mostly originating from right at the top of the injury.

So restoration pruning at this point is now needed to reduce the crowding of all of these sprouting branches that are growing very closely and very tightly within that small area of that particular branch.

So crown restoration, pruning guidelines, according to our current standards is, um, a process of determining which one of those sprouts we want to have as the new leader for that particular parent stem. And [00:12:00] then the general rule of thumb is to, with the remaining sprouts, remove one one-third of them. Reduce approximately one third of them back to lateral branches and nodes. And then retain approximately one third of them, doing no pruning treatment. With the goal of spacing them out along the parent stem as best as possible. And again, multiple pruning cycles will be typically needed to restore the crown to a full functioning mature tree crown.

So let's take a look at an example. This is a old, storm damaged branch. The arrow's pointing to where the injury had occurred. And there are several sprouts in other branches growing right around the the end of this branch. So all of these branches are sprouts either from the adventitious tissue or from the epicormic buds that formed after this tree had been damaged.

So looking at this branch. The first step is to determine the new leader and what branches to retain. So we'll retain these branches right here, that the arrows are pointing to. And the large terminal sprout near the injury, we'll call the new leader. And then we'll use reduction pruning to reduce a couple of these other larger sprouts so that they're not competing with that new leader for dominance. So it will suppress them. However, they're fairly large and again, the sprout large sprouts there's evidence to show that they help slow the spread of decay um, in the parent stem. So we want to maintain some that are fairly sizeable when we can. But reducing them will help to promote the, the new leader [00:14:00] as, as the future parent stem on this branch.

And then we'll remove the remaining branches. So these small branches up here at the top and a little bit further down, we'll remove them so that we have some branches that are still well spaced along the stem, but we have a clear leader and still enough branches to help provide the, the carbohydrates that the branch that tree needs.

However in some cases, especially if there's a lot of noticeable decay near the very top of, of the stem, it might be a better to make that large sprout on the left, the new leader and cut off the parent stem above that at that point. So kind of giving, the whole stem kind of a start over point where this new leader is this large vigorously growing sprout on the left.

And again, there's a lot of experience and nuance that goes into um, decisions and it's something that needs to be considered. And it's not a situation where it's only one correct way of doing it is just to highlight that we can achieve the same goal by possibly doing different things.

So I'd like to take a look at a couple of different studies that we've been working on. This study is a cutting study on [unknown]. Where of the trees were topped to simulate storm damage. Here you can see that tree, six years later, and the sprouts that had grown from the topping cuts over the years. The closeup on the [00:16:00] left is simply the boxed in area here on the right. You can see where the old heading cuts had been made.

And this particular one right down here, had died back. So it did sprout initially, but the branches had died. So, and you can see that these sprouts have made up the new crown of the trees, especially toward the top. So we wanted to look at how well the sprouts were attached to their parent stems.

So we conducted a series of static poll tests to measure the breaking strengths of the sprout attachments. The yellow area, the yellow arrow, here is pointing at where we attach the sling to the sprout just a little bit out from the from where the, the sprout originated on the parent stem.

And we've pulled downward by anchoring some winches to uh, a beam and secure them to the ground. And then out, beyond the edge of this picture, there's a winch attached to a tractor that we use to, to pull on the rope and pull downward on the sprout just below the, the arrow there's a load cell and this measures the amount of force. So we measured the amount of force that it caused for failure. So we pulled these sprouts off of the parent stamps or branches.

So with our preliminary findings on this study, we found first that there were three types of failure. There's either failure in the sprout, failure and the parent branch, or wound wood fail.

So here you can see, this is a picture of sprout failure where the failure occurred in the sprout wood itself. Not at where the sprout was attached to the parent stem. The parent branch failure occurred [00:18:00] beyond the area where the sprout originated back into the parent stem. So the arrows pointing to where the failure occurred and the area circled is where the sprout originated. You can see that the the branch is slightly swelled in the upward turn of the branch where the sprout originates.

And then wound wood to failure. So the picture on the left shows where we pulled the sprout from and the other arrow points to where the original topic cut was made and where the sprout originates from. And then the pictures on the left to show that the branch, after it had failed right along wound wood, and that arrow is pointing toward the original. You can see in the original surface of the cut on the parent stem with, uh, the growth rings and the wound wood kind of circling around it. And the top picture just shows the inverse side of that.

And we also looked at wound wood closure. So after the sprouts starts growing some of the stems closed stronger so that it was completely sealed over. Others did not. So this is one where there was partial closure over the original heading cut. And this getting back to this picture, you can see that it had completely sealed over where the cut was.

And looking at the mode of failure. So what we found was that stressed the failure. Stress being a force times the length of the pole arm, normalized per unit area. So forced times length per unit area gives us stress. And we found that with the sprouts it took more stress to cause failure when the failure occurred in the sprout itself versus either in the parent [00:20:00] branch or the wound wood.

We further found that when the wound was closed over, it took a lot more for stress to cause that to break. Then when there was only partial wound closure.

So just to kind of reiterate that when we had, there was no difference when, when the force went back through the connection of the sprout to the parent branch, then there was when it was failed off the wound wood itself. But there was a stronger or higher breaking strength when it was the sprout itself that failed.

The second study I would like to talk about is a restoration pruning study that we did on silver maple trees, or [unknown]. So this test was conducted as a part of the tree biomechanics research week at the Davey Research site in Schererville, Ohio. And the goal here was to test the tree response and subsequent attachments strength to sprouts using different levels of restoration pruning.

So with this study, 60 branches were topped from eight mature silver maple trees in August of 2013. We measured the diameter of all of our cuts, which were 7.7 to almost 22 centimeters in diameter. So fairly large size heading cuts. We measured the length of the branch, both what we removed and the remaining stubs the height of the cut. The azimuth of the branch. So we were interested in if there were any different growth responses based on where the branches were in the crown and their direction. We looked at the parent branch [00:22:00] angle and we measured the distance and diameter of any remaining little branches along the stub that, that we retained. So that down the road, we would know if those branches were there prior to the heading cut and if they were, what was responding versus latent buds that had broken after heading cuts were made.

So we made all of the heading cuts and we let the trees respond for three years. Returned in 2016 to conduct crown restoration pruning treatments. Unfortunately out of the 20, I'm sorry, out of the original 60 topping cuts that we made, 19 of the branches had no sprouts. In other words, 19 of the 60 had died. Of the remaining 41 branches, 17 had only a very few number of small sprouts or where the decay was so extensive that we had to remove them from the study as well.

And that left us with 24 branches that remained for restoration pruning treatments. So the four restoration printing treatments that were applied, or either a control where we did no pruning whatsoever. One of the treatments was following industry best management practices, where we retained one third, we reduced one-third, and we removed one third of the sprouts. We did a treatment while we retain the leader, and then we reduced one half and we removed one half of the sprouts. And then finally we re did a treatment where we only retain the leader. So the largest, main sprout that was on the on that parent branch, we retain that and removed [00:24:00] everything else.

The original plan was to have a less heavy handed pruning treatment as well. But given that we lost so many of the of the replicates during the during the three years after we made our original heading cuts, we had removed that treatment from the study.

We also, as, as industry recommendations, we, we removed the stub back to the top sprout. Here you can see a couple of examples of that, where the sprouts didn't originate right at the very end of the cut, but further back. So if there was a dead stop, we removed it back to the first main retaining sprout.

We measured the diameter and length of all of the sprouts, the distance from the topping cut to each cut, to each of the sprouts. And the size of the reduction cuts for the sprouts that we reduced.

So we let the trees respond for three more years, and then we went back to harvest the parent branches. Conduct measurements, looking at the attachment strength of the sprouts. So here you can see the great team of volunteers. And I just want to take a moment to thank all the volunteers over the several years during the the iterations of True Biomechanics Research Week. There are too many to name them all in this short presentation, but just a very strong, heartfelt thanks to all of you.

So here you can see they're up in the tree removing the parent branches, but the sprouts and a picture of Jordan here, holding the the sample that we harvested for, for pulling. So we cut that, the sprout out [00:26:00] and we measured the size of all the remaining sprouts. And then we conducted the pull test on the, the leader sprout where we, we winched it and measured the force until failure occurred. And from there we conducted our, our breaking stress calculations.

And here you can see the camera we recorded each of these so that we could properly measure the, the angle of the branch to the, the pull direction when failure occurred. And the, the load cell here is measuring the force and recording into our data acquisition system. So preliminary findings were that when only the leader was retained the sprout was more weakly attached then for either the controlled treatment or the treatment with just the leader and one half retained in one half removed. The treatment that follows best management practices, where we retain one third, we remove one third, we reduce one third. There was no difference in breaking stress between that and the other treatments. Suggesting that there was no, nothing in this study that would suggest that that recommendation currently is, um, is any different than, than these other treatments.

But there's a few major caveats that need to be addressed here, that we had a low number of replicates due to the high number of mortality and a lot of the top branches. So it was very difficult for us to draw sweeping conclusions from this, by any stretch of imagination. Also, we were hoping to measure the extent of decay, but given the advanced amount of dysfunctional wood through the parent stems in the size of them, there was just no way that we could measure the extent of the decay, given the [00:28:00] constraints of, of the experiment and the amount of time that we had for this study. But absolutely more research is needed on this this particular topic.

So getting back to the size of the cuts, which had a lot to do with the amount of decay and probably a lot to do with the high level of mortality. Early on in this presentation, I asked you to remember those three large silver maple trees that had been damaged in a tornado.

And you saw that they were had just several large heading cuts and that was all that could be done. So we need to consider a silver maple being a tree that is not very good at compartmentalizing decay. It's got a reputation for being somewhat prone to storm damage to begin with. Is it a good option for restoration pruning or are those trees that were too far beyond being able to restore?

It's not something that I can really answer here right now, but it's certainly something to consider that when you get trees that, that don't compartmentalize well. It's really, they really need to be managed fairly well in order to to justify keeping them in my opinion.

So there were a few additional observations that we had. So there was less dysfunctional wood observationally with the small number that we, we cut open that we had time to cut open and you can see on the left.

We had one major sprout, but here's the, the attenuation of the dysfunctional wood. With these larger sprouts that, that this particular branch on the right had you notice a much greater attenuation or [00:30:00] narrowing or better compartmentalization essentially than than the branch on the right. And these cuts are about the same size. But you'll even notice that even with a small branch, like the one that was growing here, there's still a fairly good band of, you know, you're the, the barrier zone is, is fairly well formed on the left side of this left picture. Going down even to where there's a little stub, you can see where we'd cut off another small branch prior to pulling.

Another observation and that this is an area that really needs to be studied quite a bit more as the amount of cambial die back from reduction cuts. So these are the sprouts that we had done, the reduction pruning on, and there was pretty severe cambial die back on a lot of the sprouts that we had reduced back to a lateral branch. And we did not have an opportunity to quantify this in any meaningful way, but observationally, you'll see that where other branches, other than the the primary lateral that we reduced back to the, the cambial died back, went all the way back to wherever those other sprouts occurred.

Now, sprouts, especially in their first few years of development, typically do not tend to be branched very much so. If we reduce a sprout back to a lateral branch, and that's the only lateral branch around that area. You know, in, in observationally, in this study, we did find that in quite a few cases that there was extensive cambial diabetic. So this is an area that we need to look at more how the low, and if this is only if this is different with these sprouting branches, or if it's different with you know, lateral more [00:32:00] branches that originate not due to storm damage. So again, quite an area for fertile for research moving forward.

So just to summarize this, these studies generally support our current management recommendations. Retaining all sprouts on the sides of the stem is encouraged. So if we have the sprouts more laterally arranged that is something that we should absolutely try for as our recommendations encourage. I think it's better that we take a lighter handed approach to pruning vigorous sprouts, especially in that they are forming that new part of the cambium and the more vigorous the growth. Anecdotally here, but also in other studies that have been done by other researchers, those sprouts tend to really play a strong role in in preventing the spread of the dysfunctional wood. So taking a light-handed approach when doing the reduction cuts, I think is, is something we can, we can garner from these studies.

And it might be better to do reduction preventing when sprouts are dormant or early in the growing season. All of these treatments for done in August towards the end of the growing season. So the trees were at the, because they were at the end of the growing season and they didn't have much of an opportunity to really respond to the treatments before before fall, when they go into dormancy.

So I think it would be well worthwhile to look at if it, you know, if there are seasonal differences, especially in temperate climates, such as where this study took place, this lighter study took place here.

So [00:34:00] with that again, thank you to all the volunteers and the hosts that Tree Biomechanics Week, Tree Fund, and Davey Tree for hosting the site and financial support.

Chris Harcheck the research field manager. The University of Florida where the the sycamore sprout test was conducted. He was a great help down there. So thank you very much. I hope that this was an informative presentation.

Tom Smiley: This concludes, Dr. Jake, Miesbauer's talk on the effects of restoration pruning treatments on damaged trees. This talk was originally presented at the 2020 ISA Virtual Conference. The views and information expressed are those of the presenter. Please join us next month for another presentation in the ISA Science of Arboriculture podcast series.

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