TreeMatters

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INTERNATIONAL SOCIETY OF ARBORICULTURE
32nd CHAPTER
NZARB™
New Zealand Arboricultural Association Inc.

In this issue

NZARB™
New Zealand Arboricultural Association Inc.

New Zealand Arboricultural Association Inc.,
PO Box 1193, Nelson, 7040, New Zealand nzarb.org.nz

Mission statement: *To encourage, foster, improve and educate members and others in all aspects of arboriculture throughout New Zealand.*

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NZ Arb Husqvarna National Tree Climbing Championship Results


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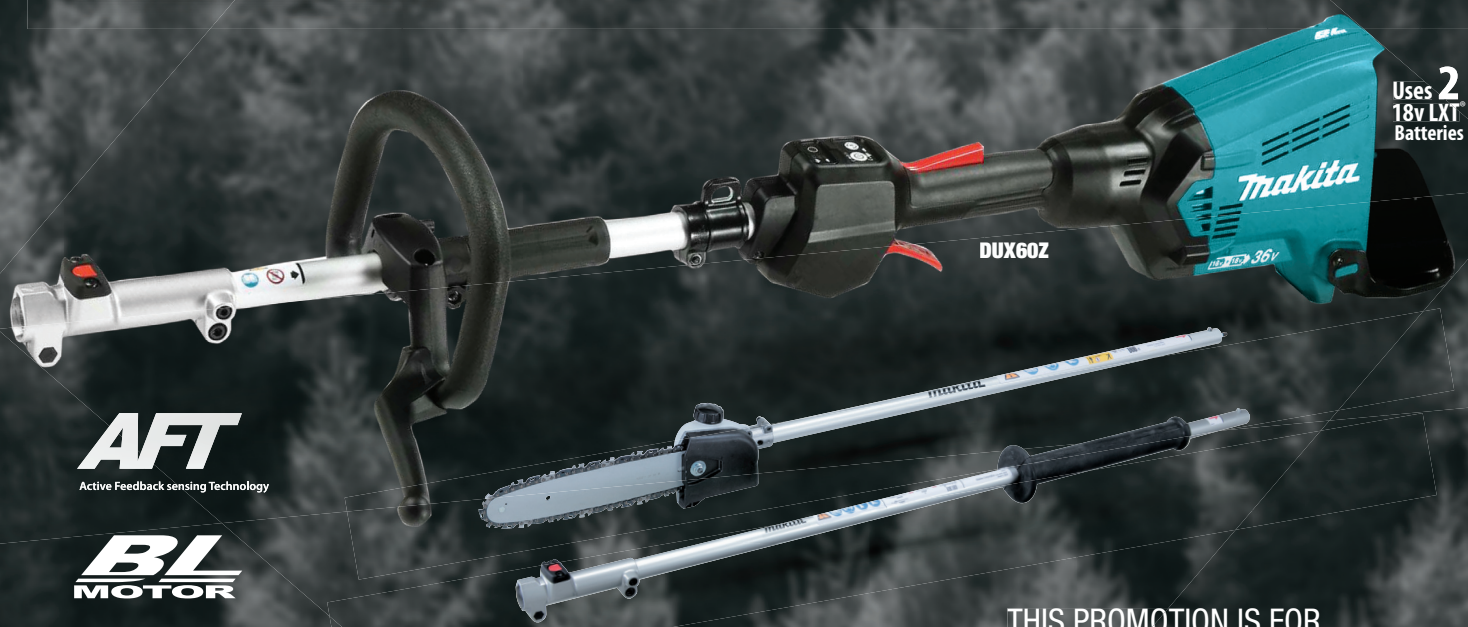

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Prez Release

Collaboration and Engagement

By Will Melville
President NZ Arb

correspondence to:
president@nzarb.org.nz

Photo: Treetools

I am grateful to be writing my first Prez Release on the back of an amazing New Arborist of the Year Competition, National Tree Climbing Competition (NTCC) and Annual Conference in Tauranga, which has left me feeling energised and full of enthusiasm about the passion that our members have for trees and arboriculture.

While the weather in Tauranga did not come to the party, all the competitors in the climbing competition certainly put on an excellent performance at the NTCC, proving why they are the best in New Zealand and that they can perform in any conditions. Congratulations to Craig Wilson and Nicky Ward-Allen, and to everyone who took part or volunteered to make the event a success.

The rain did not dampen any of the delegates' spirits at the conference either. There was an outstanding range of national and international speakers across all fields of arboriculture, and I hope everyone left the conference with new connections and new ideas.

Personally, I came away from Tauranga with two notions. Firstly, I am a terrible Millennial in not knowing what Snapchat, Tumblr, Reddit and WeChat were and thinking I was ahead of the game by discovering WhatsApp. Paul Johnson's talks on community engagement made me realise how important it is for us as an industry to play more of a role in growing public awareness about the value of trees and why we need arborists to care for them.

The second thing I took away with me is that we need to work together more as an industry. There were over 250 professionals gathered together in Tauranga and a lot of people came to me and the other executive members with great ideas and initiatives.

Now that the hangovers have worn off and it is business as usual, I have a challenge for you: get involved in NZ Arb. You could volunteer at a climbing comp, become an approved contractor, join a committee that you are passionate about, or just share your ideas with me or another executive member. I can be contacted at president@nzarb.org.nz or info@nzarb.org.nz, so get in touch and get involved.

In this edition of Tree Matters we have a round up the events Tauranga, some interesting articles from the ISA and some good information on the Seoul Action Plan where The Hon. Murray McCully signed up to expand New Zealand's Urban Forest. I look forward to hearing from you.

Events

It's a Wrap! NZ Arb Conference, in association with Asplundh 2017

By Jenna Collett
On-Cue Conferences & Events

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In late October, more than 200 delegates, trade exhibitors, and speakers descended on Tauranga, for the two-day NZ Arb Annual Conference at Trinity Wharf Hotel.

The conference opened on Thursday morning with a full house and an engaging presentation on 'Keys to Collaborative Engagement' from Paul Johnson of Texas A&M Forest Service and the International Society of Arboriculture (ISA) Board.

Day one continued with the same momentum it started with. Both the Notable Trees stream and the Practitioners Stream were well supported, to the point of standing room only in some cases. The weather participated in allowing Andy Neverman to take his 'Rescues with a Rope Wrench' session outdoors for a practical demonstration and some fresh air.

The NZ Arb AGM took place on Thursday afternoon just prior to the Annual Tane Mahuta Public Lecture and the popular Exhibitor Welcome function

The Trade Zone during the Exhibitor Welcome function hummed with the buzz of arboriculture networking, among 19 indoor and outdoor exhibitor displays. Around all this action, climbers queued up to have their gear checked ahead of the two days of climbing to follow.

Day two kicked off with a business-focused breakfast with Clinton Yeats of Yeats Consulting, followed by two popular international speakers, Duncan Slater (UK) on 'The Effects of Natural Bracing in Trees' and Brian French (US) who donned the wet-weather gear to demonstrate 'Creating Cavities with Chainsaws' in the Hotel carpark.

The Utility Arb stream returned for 2017, with a popular discussion-style format hosted by members of the NZ Arb Utility Arb Committee. Topics covered matters relevant to electricity industry arborists including – Qualifications, New Technology, Health and Safety, Tree Regulations, and Electrical Awareness.

The conference programme finished earlier than in previous years to enable delegates to get across to Tauranga Domain and catch the Preliminary Event action at the Husqvarna NZ Arb National Tree Climbing Championships (NTCC).

Following the NTCC climbing action, all factions of arboriculture came together for the NZ Arb Conference Awards Dinner back at Trinity Wharf. The dinner was hosted by Brodie Kane and the energy in the room was high all night. A number of exceptional members of the arboriculture community were acknowledged during the awards part of the agenda.

Award citations are available later in this issue of Tree Matters. In summary however, these awards included;

The Ronald Flook Award: Helen Lowe
President's Award: Scott Forrest
Services to Arboriculture: Fredrick Hjelm
Volunteer of the Year: Hiro Ikeno

Acknowledgement is due to the commitment and investment of all sponsors and supporters of the 2017 Conference, in particular the 2017 Platinum Conference Sponsor Asplundh.

Be sure to mark your diaries for the 2018 NZ Arb Conference: Dunedin, 8 - 10 Nov

Top Right: Alvar del Castillo of Otago Polytech scooped up this great collection of prizes in the Exhibitor Passport Promotion
Right: Arbor gear and conversation filled the Trade Zone throughout the Conference
Bottom: Paul Johnson of Texas A&M Forestry Services and the ISA Board opens the Conference

Events

Event Round-Up:
New Arborist of the Year 2017

By Craig Lamb
Coordinator NAOTY

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Over two days of intense competition, covering a wide range of arboricultural topics, the seven finalists from around the country displayed great skills and knowledge, along with loads of passion and enthusiasm, which took this year's New Arborist of the Year competition down to the wire. Going into the second day's practical events, it was anyone's game and you could sense the excitement from the competitors to get the job done well.

With only nine points between the top three finalists, it was clear that the competitive spirit was well alive within the group. Each of the guys showed great skills and spirit, and I give credit also to their respective trainers and employers.

A big congratulations goes to Joshua Talsma for winning the New Arborist of the Year (NAoTY) for 2017. Josh's consistency, and calm saw him rise above the other competitors and claim the sought-after title.

Joshua is a recent graduate of Wintec in Hamilton, having completed his Level 4 certificate just this year. He works for Tree Menders, also in Hamilton, and as he is only 24 years old I can see a bright future for him. Well done Joshua!

Each event was based around what the competitors might come across on any given work day. The theory-based tests were done on Friday with some great support from the crowd. Practical tests were on Saturday, which allowed the competitors to also get involved with the National Tree Climbing Competition.

The tree ID test comprised 30 tree samples ranging from flowers, cones and dried pressingsto deciduous winter cuttings. Well done to Paul Wynen for winning the test, once it was opened up to everyone else. We raised some money for the Sempervirens Fund and the top three people walked away with a Silky saw each.

The knot-tying test was held at the Treetools stand in the trade zone just after lunch on Thursday. The guys performed very well considering the pressure of tying 17 knots within a five-minute time limit. Yoan Willman got a perfect score, with the other competitors not too far behind.

The quick-fire quiz was a hit with the audience during the evening's function. Simon Carey smashed the opposition with getting in first on 20 of the 60 questions. With only one question wrong, it appeared Simon had a good advantage. However, the great knowledge of the other competitors allowed them to gather points too, which kept everyone in the game.

Above: Series Coordinator Craig Lamb presents Joshua Talsma with the 2017 New Arborist of the Year Award **Left:** close-up of the award

The Aerial Rescue and Work Site events were held at the Tauranga Domain on Saturday morning. The competitors impressed us all with their passion and enthusiasm, especially considering the average weather. All events included an instructional element so each competitor could further increase their skillset and hopefully help them achieve more great things. We wrapped up around midday and were then able to head over and watch the Masters' Challenge climbers in the afternoon.

Individual event winners were:

Tree ID Test – Yoan Willman
Knot Tying Test – Yoan Willman
Quick Fire Quiz – Simon Carey
Aerial Rescue Event – Joshua Talsma & Yoan Willman
Work Site Setup & Hazard Assessment – Dexter Brennan & Joseph Newdick

A huge thank you goes out to the sponsors Hansa Chippers & Tree Hub. Without them we would not be able to supply this great platform to boost our new arborists coming into this great industry. Big thanks also goes to the many volunteers that gave their time to ensure this event ran smoothly for the competitors.

The New Arborist of the Year competition has now been going for five years and has seen some future stars come up through the ranks. I'm looking forward to continuing with this competition and developing it to assist our new arborists in reaching the great heights of our arboricultural idols from New Zealand and abroad. Let's all get behind the new arborists joining our community and help them develop the professionalism and ethics that will ensure them a long and successful career in arboriculture.

Events

National Championship Climbing Round-up

Husqvarna NZ Arb National Tree Climbing Championship 27-28 Oct'17, Tauranga Domain

By Craig Webb

Correspondence to craig@cwca.co.nz

We returned to Wharepai Domain, Tauranga, for the 2017 Husqvarna New Zealand Arb National Tree Climbing Championship. The event was held in this venue back in 2003 – I still have the t-shirt.

The Domain has a great array of trees, with all the criteria for tree climbing events catered for within a relatively tight group. The small but dedicated crew did an amazing job setting up the events in preparation for the competition to come. Massive thanks to Paul Kenny, Chrissy Spence, Freddie Hjelm, Andrew Harrison and Hiro Ikeno for their efforts in setting up on Wednesday before the conference.

The two-day format saw climbing start on Friday, when the Work Climb, Throwline and Aerial Rescue events were held under grey skies and in drizzly rain.

The KASK Work Climb was in a large tulip tree (Liriodendron tulipifera) that provided great opportunity for climbers to demonstrate their techniques for controlled swings and lateral movement to and from the works stations. The landing station was a massive jump that proved to be difficult for most to land on target (and keep stable). Matt Glen showed his class with a score of 76.01 from the maximum 80, heading off Tiago Miranda (66.16 points) and Craig Wilson (65.89), followed by Zane Wedding (63.50) and Noel Galloway (63.09).Notably absent from the top five (actually outside the top 20), was Scott Forrest, who inexplicably neglected to sound the bell before landing, which meant a score of only 34 points, despite recording the fastest time of the day and nailing the landing. Competitors receive no time points or landing points for failing to ring the bell before the final descent from the tree. In very tightly contested women's event Nicky Ward-Allen (60.19 points) narrowly pipped Stef White (59.43) and Stephanie Dryhout (59.00). Amazing, just 1.19 points separating the three climbers.

The Silky Aerial Rescue was set up in a mature camphor laurel (Cinnamomum camphora). The arrival of Rescue Randy and his trailer-top travel coffin (thanks to Treetools) was a source of wonder and excitement amongst climbers and volunteers alike. This has prompted the, some would say, premature retirement of Woody, the tireless and unbreakable (of spirit) "volunteer" that has spent many happy days being hoisted, man-handled, rescued (or dropped) or left hanging around in trees across the country. Long live Woody.But I digress... Nicky Ward-Allen completed the rescue within the six-minute time limit to finish clear of Stef White and Sami Baker in the women's event. In the men's, Shaun Hardman rounded out the top three behind Tiago Miranda and first-placed Dan Beres. Dan scored an excellent 45 out of a possible 50 points in this event.

The Metrogreen Throwline event was set up in a large and typically messy silky oak (Grevillea robusta). Scott Forrest scored an incredible 21 points, putting him well ahead of the pack, with Craig Wilson (11 points) and Zane Wedding (10) coming in some distance behind. For the most part the rest of the competitors were further back in this event, with 14 out the 24 climbers scoring 0 points . The women fared no better, with only Stef White registering points in this very challenging throwline tree. Perhaps someone should have taken a Silky to the silky oak?

Day two, Saturday, saw the poor weather continue – it pretty much rained all day. Huge appreciation for all the technicians and volunteers who just got on with it, especially the in-tree techs who spent long hours aloft in the increasingly wet trees. Spirits were not dampened and all involved got stuck in to another enthralling day of competition. The final two preliminary events were staged side by side in the centre of the tree grove, giving spectators good views of both events.

The AB Equipment Belayed Speed Climb was a scramble to the top of a beautiful dawn redwood (Metasequoia glyptosroboides - don't it just roll off the tongue?). Once again the women's event was close, with Stephanie Dryhout finishing just 1.29 seconds behind first placed Nicky Ward-Allen. Stef White finished third and also picked up valuable points by being not too far behind the fastest time. In the men's event Scott Forrest was fastest, just ahead of Sam James with only 0.21 seconds the difference. Two seconds back in third place was Matt Glen.

The Donaghys Footlock event was in the tulip tree used for the Work Climb. Matt Glen and Seb Bainbridge were the only two climbers to go under 20 seconds for the 15-metre vertical rope ascent. Matt's time of 19.49sec took first place and maximum points and Seb and Sam James finished second and third. Most of the other climbers received valuable points in this time event, where any time under 40 seconds resulted in some score. Not surprisingly, world record-holder Nicky Ward-Allen took out the women's event with a smoking 20.18 seconds, which is 0.01 seconds outside of world-record pace for the 15-metre climb.

With rain still falling and the forecast set to get worse, the Masters' Challenge, sponsored by Treetech and Arb Innovations, was under way as soon as possible. Finalists for the women were Nicky Ward-Allen and Stef White. Top of the men's field were Matt Glen, Craig Wilson, Sam James, Tiago Miranda and Zane Wedding.

The tulip tree for the Work Climb was a large tree. The tulip tree for the Masters' Challenge was bigger. A massive specimen, which would be challenging on a dry day.

Nicky Ward-Allen convincingly won the Arb Innovations Women's Masters' Challenge, completing two stations and retrieving all gear from the tree within the 30-minute time allocation. Congratulations Nicky on your definitive display of skill and style.

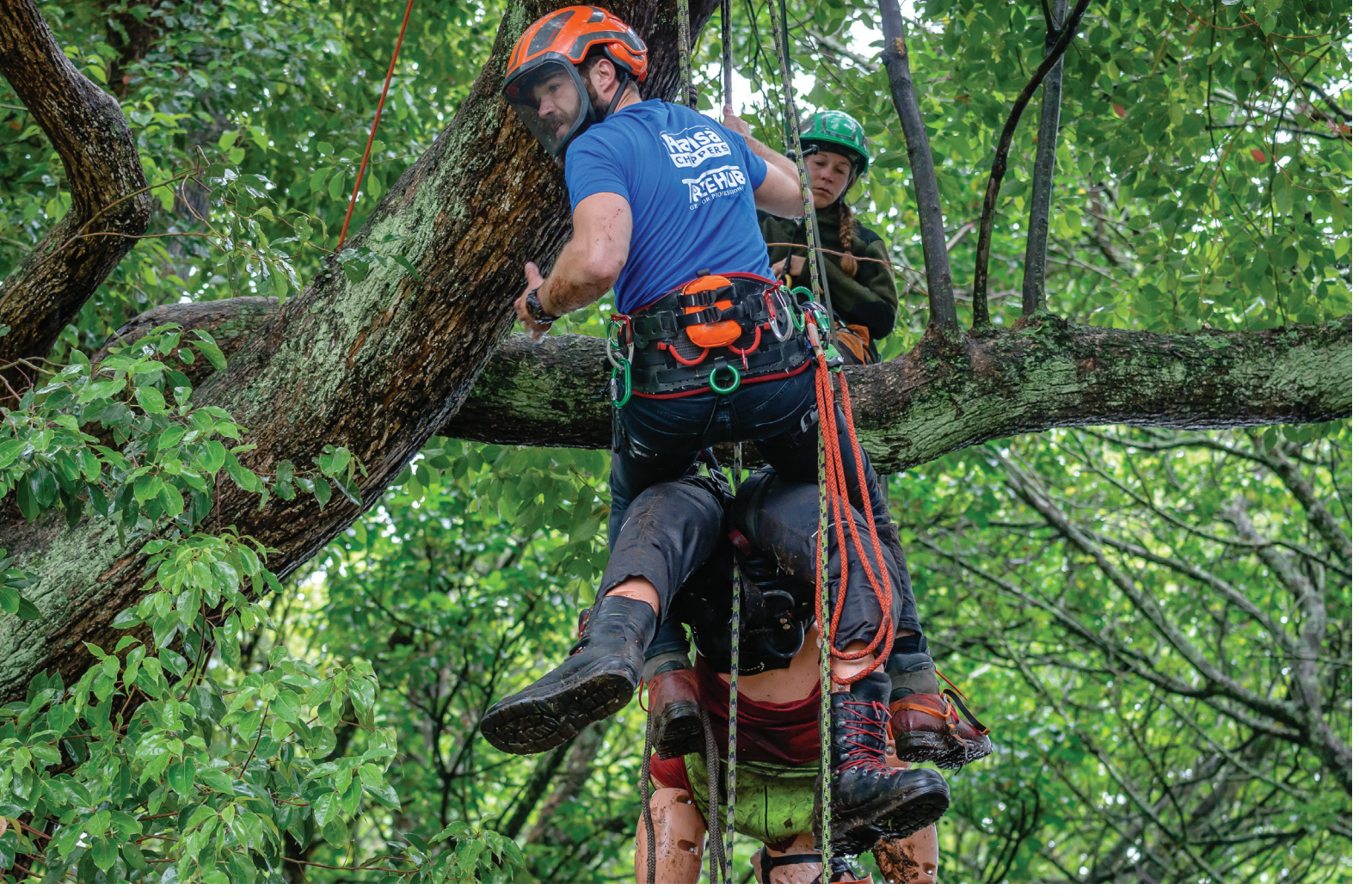
Winner of the Treetech Men's Masters'Challenge event was Craig Wilson, erasing the horrors of his first Masters in the same park in 2003. Craig completed all four works stations in the tree with consistent style, but just failed to retrieve all the gear from the tree. Matt Glen and Tiago Miranda finished commendably in second and third, respectively, having completed three stations before running out of time.

All participants must be congratulated for an excellent event, completed under trying conditions. Thanks to all involved, those hardy spectators that hung around to see the action were treated to another world-class tree climbing competition in New Zealand.

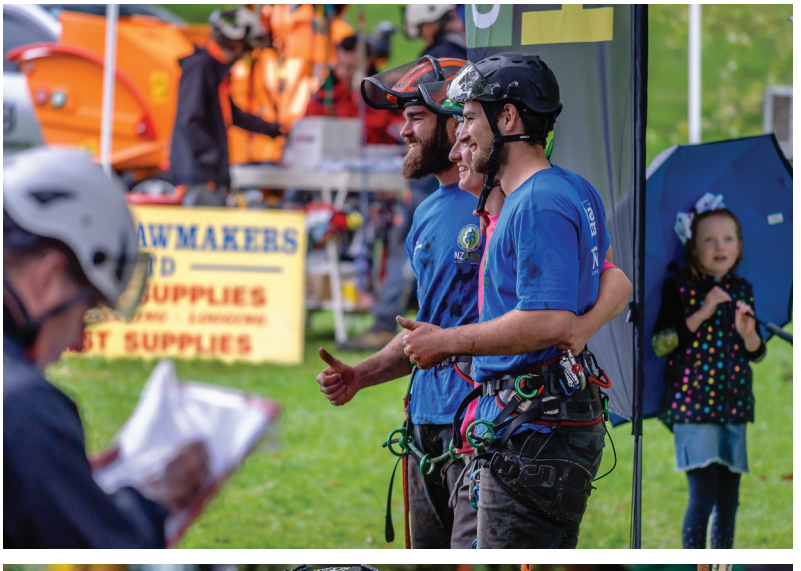
Huge thanks to all our sponsors, without whom we would not have a competition (or fantastic prizes). Husqvarna – you rock!

To all of the judges, technicians, scorers and other volunteers that made the competition a success – thankyou, your contributions really make the tree climbing competitions in New Zealand great.

Clockwise from top: Dale Thomas, Nicky Ward-Allen, unknown, Sami Baker, Callum Hay. (All photos this page and following: Treetools)



Scott Forrest



Sam Smith

Events

NZ Arb Husqvarna National Tree Climbing Championship results

Men's Masters Results

Name	Score
1. Craig Wilson	196.00
2. Matt Glen	139.00
3. Tiago Miranda	135.33

Women's Masters Results

Name	Points
1. Nicky Ward-Allen	118.33
2. Stef White	26.67

Men's Preliminary Event Results

Aerial Rescue

Name	Score
1. Dan Beres	45.00
2. Tiago Miranda	43.67
3. Shaun Hardman	42.67

Belayed Speed Climb

Name	Time
1. Scott Forrest	32.88
2. Sam James	33.09
3. Matt Glen	35.33

Secured Footlock

Name	Time
1. Matt Glen	19.49
2. Seb Bainbridge	19.95
3. Sam James	20.30

Throwline

Name	Score
1. Scott Forrest	21
2. Craig Wilson	11
3. Zane Wedding	10

Work Climb

Name	Score
1. Matt Glen	76.01
2. Tiago Miranda	66.16
3. Craig Wilson	65.18

Overall Preliminary Ranking

Name	Score
1. Matt Glen	156.23
2. Craig Wilson	140.25
3. Sam James	135.44
Tiago Miranda	135.40
Zane Wedding	133.89
Scott Forrest	132.87

Women's Preliminary Event Results

Aerial Rescue

Name	Score
1. Nicky Ward-Allen	39.33
2. Stef White	27.33
3. Sami Baker	15.33

Belayed Speed Climb

Name	Time
1. Nicky Ward-Allen	62.59
2. Stephanie Dryfhaut	63.88

Secured Footlock

Name	Time
1. Nicky Ward-Allen	20.18
2. Stef White	35.96
3. Stephanie Dryfhaut	49.11

Throwline

Name	Score
1. Stef White	3
2. Stephanie Dryfhaut	0

Work Climb

Name	Score
1. Nicky Ward-Allen	60.19
2. Stef White	59.43
3. Stephanie Dryfhaut	59.00

Overall Preliminary Ranking

Name	Score
1. Nicky Ward-Allen	139.53
2. Stef White	109.61
3. Step Dryfhaut	78.35
Sami Baker	38.17

ABOVE Craig Wilson accepting his award for Winner of the 2017 Treetech NZ Arb Men's Masters. **BELOW** Nicky Ward-Allen accepting her award for Winner of the 2017 Arb Innovations NZ Arb Women's Masters

more awards photos on the next page >

This page top left: Stef White, Sami Baker, Nicky Ward-Allen **Bottom left:** Secured Footlock winner Matt Glenn, Seb Bainbridge and Sam James **Top right:** Belayed Speed Climb winner Scott Forrest, Sam James and Matt Glenn

INNOVATIVE THINKING CORNER

Custom attachment point

NZ Arb member Li Tane of Arbor Culture, Geraldine has been doing some trial and testing on a custom attachment point for the tool strop of the Stihl MS 201 TC-M for quick connection to Carritool or TransPorter. The sturdy steel design should last a lifetime and makes single hand use of attaching and retrieving chainsaw a breeze while minimising saw movement and reducing damage to trouser legs. Features straightforward install directly onto existing tool strop attachment point. Carabiner hole, Carritool / TransPorter attachment ring.

For more information contact Li Tane - Arbor Culture info@arborculture.co.nz

CLOCKWISE FROM TOP The custom attachment point fitted to the Stihl MS 201 TC; in position on the TransPorter; internal set up on Stihl chainsaw (photos: Arbor Culture)

People

FIVE MINUTES WITH...
Will Melville, President NZ Arb

By Tree Matters Acting Editor

Correspondence to editor@nzarb.org.nz

Over the next few issues of Tree Matters, we will be asking members of the NZ Arb Executive Committee to share with us a bit about themselves. We hope to get to know a bit more about the people that volunteer their time to provide governance to NZ Arb for its members. In this issue we meet Will Melville, recently (Oct 2017) appointed President of NZ Arb, and Erika Commers of Treescape, who is new to the Executive Committee.

Will is originally from England and lives in Wellington where he works for Wellington City Council (WCC) as the Arboriculture Manager. He joined the executive in 2014 and has chaired the Approved Contractor committee, sits on the municipal arborist group committee and is the Asia Pacific representative for the International Society of Arboriculture (ISA) membership committee.

What inspired you to pursue a career in arboriculture?
My first job in arboriculture was a bit of a fortunate accident, but I soon found that I really enjoyed the challenges of tree work and was inspired to learn more by the people I worked with. The unique friendships and bonds that you develop in this industry make it a very special job and that has kept me motivated. The more I learned about arboriculture and the benefits of trees, the more passionate I became. I decided I wanted to go further in the industry, but I was aware that as I got older I may not be physically able to continue climbing. I started to read more articles and papers about arboriculture and urban forestry and found that I was really interested in the human interaction with trees in the urban environment and the challenges this presents. This led me to take a job on the tools at WCC and when an opportunity came to move into my current role I applied for it and have not looked back.

What is the best part of your current job?
WCC still has an internal tree team and I love watching the crew progress and improve. We are really lucky to have over 4000ha of town belt that we can experiment on and I encourage my crews to find something they are interested in and go and try it out. We have created habitat for specific wildlife, planted epiphytes in pine and macrocarpa trees and set up and run regional aerial rescue days, all of which the crew are involved in and lead. I worked commercially for 10 years before joining the council and it is really good to feel like I am contributing towards tree preservation in the urban environment by being involved in policy reviews at a local level and convincing people why they should retain trees rather that remove and replace.

What is the best job you have had in arboriculture?
I have enjoyed all of the jobs that I have had and have been lucky enough to work in the UK, USA and here as an employee, contract climber, project manager and now municipal arborist. All of which have challenged me for different reasons and it is hard to pick which one has been the best. I do enjoy my current role because no two days are the same. I can go from organising truck maintenance to sitting with the CEO and Mayor of WCC trying to convince them to invest in engineered tree pits for the central business district (CBD). It is also satisfying to convince developers to retain trees by incorporating them into their design in a way that minimises impacts on tree health. The bad part of my job is that I deal with a lot of residents who do not see the value of trees. It is challenging having to repeat the same messages about why we try to retain trees and how they contribute to more than just that one house. However, when you turn someone around and they become an advocate for you it is really satisfying and rewarding. Having said all that, I have some awesome memories working with land-clearing crews too.

What motivated you to volunteer for NZ Arb?
I first joined NZ Arb as an individual member when I worked for Treescape in Wellington. I was reading Tree Matters in a truck and thought that I wanted to get involved with the association. I entered my first regional climbing competitions in 2006, coming 25th out of 26 people (and someone was a no-show). After that, I either entered or volunteered to help out both here and in New England. When I moved back from the States I decided that I wanted to get involved on the executive to help out and support the association in any way that I would be useful.

What do you think is one of the biggest challenges facing arboriculture in New Zealand?
I may be biased because of my job, but I feel one of the biggest challenges is that too many people do not value trees in the urban environment and as a result don't see the need for arborists to care for them. Too often the final solution of removal is taken by tree owners due to, in part, bad advice, but also because trees are often not viewed as an asset. One thing I would like to focus on over the next two years as president is a programme that promotes the value of trees in cities to schools and the younger generation as I think this is where we will get the most traction and chance of change for the future.

If you were a tree what tree would you be and why?
I would be any one of the Betula genus. While they are not the nicest trees to work with, they are hardy, can colonise extreme environments and have many practical uses. My wife also agrees, as while I'm not the easiest person to live with, I do apparently have some practical uses.

People

FIVE MINUTES WITH...

Erika Commers NZ Arb Exec Committee member & Tree Matters Editor-in-Chief

Erika is a Consultant in Urban Forestry and Arboriculture at Treescape and newly appointed NZ Arb Executive Committee member and (as of Autumn 2018) the new Tree Matters Editor-in-Chief.

What inspired you to pursue a career in arboriculture?
Always drawn to nature, I pursued studies in natural resource management in hopes of working outdoors and for the betterment of the environment. While taking courses at university I was immediately hooked on trees while in my first dendrology class; this drove much of my course selection thereafter. I quickly discovered that managing trees in an urban environment was a viable career option so I focused my studies in this area and secured a job working as a city forestry technician after finishing my BSc and there it all began...

What is the best part of your current job?
Feeling a sense of gratification is very important to me, and I also enjoy having a highly varied and continuously challenging job.

What is the best job you have had in Arboriculture?
In my home state of Minnesota, I worked for a state government agency as a forest pest and pathogen specialist. The role predominantly consisted of community education and outreach, plant sample collection, organism identification and some regulatory enforcement. Any job where I can talk to people about trees is a good job for me.

What motivated you to volunteer for NZ Arb?
Volunteering in community forestry programs had been part of my life before moving to New Zealand. I guess I like being involved with trees in ways that aren't necessarily fulfilled by traditional work. I also appreciate how membership and participation in a professional organisation are a great way to expand horizons, contribute to a broader community and continue learning.

What do you think one of the biggest challenges facing Arboriculture in New Zealand is?
Having a professional image to present to other industries and the general populace, which includes adapting and progressing accordingly.

If you were a tree what tree would you be and why?
I'd be a very long-lived tree. I'd love to witness how the world changes and remains the same over a long stretch of time. At this rate, the most I can hope for is 100 years.

People

FIVE MINUTES WITH...

Joshua Talsma winner of the 2017 NZ Arb New Arborist of the Year

Recently, you were named the 2017 NZ Arb New Arborist of the Year (NAoTY). Congratulations, an outstanding achievement. What does this award mean to you personally?
Thank you. It was pretty exciting to win this award and I have to credit a lot of it to my excellent training at Wintec. It was also a great opportunity to put that teaching into practice and really see it pay off.

How did you find the experience of the NAoTY competition and what did you learn from that experience?
I really enjoyed being a part of the NAoTY competition and the annual NZ Arb conference. It was awesome to learn about some of the new and exciting ideas within the NZ Arb industry.

What advice would you give to aspiring 2018 NAoTY competitors?
Brush up on your tree ID. And make the most of the experience and the opportunity to meet some amazing climbers – who I'm sure will have much greater advice than me.

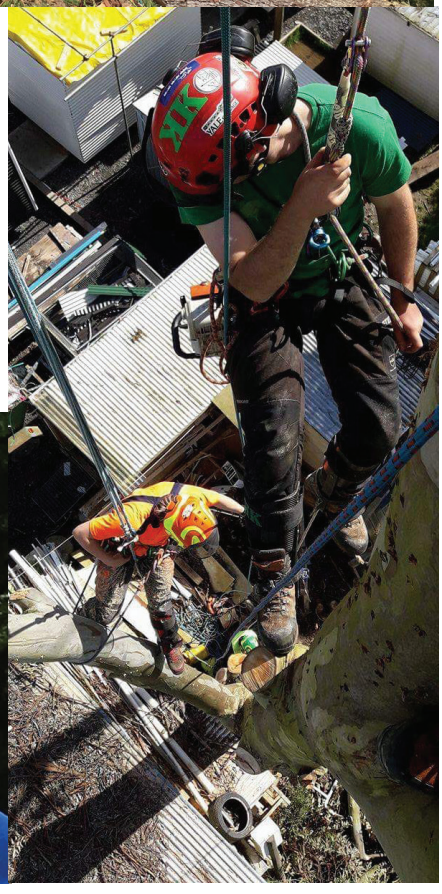
Tell us, what inspired you to pursue a career in arboriculture?
I was fortunate enough to be given the opportunity to help out with a couple of days of work for a Hamilton-based arb company, and this is what sparked my interest in arboriculture. I then decided to study and recently, I achieved my Level 4 qualification at Wintec and was lucky enough to be employed full time with the same company, Tree Menders Ltd.

Aside from winning this title, what has been the highlight of your career so far?
That would probably be my time at Wintec, where I made so many great friends who share my interest in arb, and made achieving our qualification so much more fun.

What keeps you motivated in your work?
I really like the variety of work in this industry and what motivates me is that each job offers a new challenge and an opportunity to improve my skillset.

What do you do to relax outside of arboriculture?
Splicing ropes and recreational climbing (with the boys and Steph)

And finally, where would you like to see yourself ten years' time?
Well, hopefully I'll have over ten years' experience in the industry which I can be using to lead new, up-and-coming arborists in the field. Also, my boss will be getting on by then so who knows what might happen...



People

Helen Elizabeth Lowe

winner of the 2017 Ronald Flook Award

Citation by Seth Thompson

Correspondence to comms@nzarb.org.nz

The 2017 recipient of the prestigious Ronald Flook Award was announced at the NZ Arb Annual Conference Awards Dinner on 28 October. This year it was presented to Christchurch based Helen Lowe acknowledging the tremendous effort she made to save approximately 1500 heritage and notable trees by ensuring they remain protected on the Christchurch Replacement District Plan.

Unfortunately, Helen Lowe was unable to be there to personally accept the Award, so the Award was accepted on her behalf by Brad Cadwallader of the NZ Notable Trees Trust. Shortly after, the Award was personally delivered to Helen in Christchurch by NZ Arb representative Ra Hammer.

The Ronald Flook Award is an accolade presented annually to recognise high standards of practice in Arboriculture, including tree raising, tree health and management, and amenity tree protection or design. The recipient is required to have demonstrated exceptional management of trees, whether functional or aesthetic in any stage of development.

NZ Arb chose to name this award after well-known, Nelson-based Landscape Architect Ron Flook for his tireless contribution to Arboriculture in New Zealand through the Notable Trees Scheme and the development of the Standard Tree Evaluation Method (STEM).

Citation by Seth Thompson, NZ Arb President, at the 2017 Awards Dinner proceeding the presentation of the 2017 Ronald Flook Award:

"The Ronald Flook Award recognises outstanding service to the care and protection of trees in New Zealand.

By awarding this to Helen Lowe, the New Zealand Arboricultural Association recognises the tremendous effort she made in 2016 to save approximately1500 heritage and notable trees of Christchurch by ensuring they remain protected on the Christchurch Replacement District Plan. This involved a huge personal sacrifice and comprised:

- leading a small team of experts;
- negotiating with other parties including securing a mediated agreement with the Christchurch City Council and an independent agreement with the Crown;
- preparing planning evidence for the hearing and appearing twice before the Independent Hearing Panel in Christchurch to give evidence; while also
- playing a lead role in liaising with other submitters, experts, the legal team, media and the public over this time; and simultaneously
- playing an active part in fund-raising to meet the significant financial costs of the quasi-judicial, Independent Hearing process.

Helen's achievement is regarded as significant, not only because of the importance of Christchurch's most notable trees to both the city—and New Zealand's—natural and cultural heritage, but because of the importance of retaining their physical presence and cultural legacy in Christchurch's post-earthquake "geography of loss."Helen used this specific phrase in her submission and evidence to the Independent Hearing Panel, based on her training and experience in social and cultural impact assessment.

The importance of Helen's contribution was also recognised by the Independent Hearing Panel itself which, in reaching their decision on the Trees section of the Christchurch Replacement District Plan, noted that:

"... we acknowledge her expertise as a planner from her previous experience and accept without question the very competent and professional way in which she gave her evidence... and accordingly attach significant weight to it."

Helen Lowe's qualifications include a Bachelor of Arts (Geography) from the University of Waikato and a postgraduate Diploma in Social Science (Urban and Regional Planning) from the University of Stockholm.

Her Stockholm qualification was focused in the field of community-based planning, including community revitalisation, and the assessment of effects on social and cultural values.

She practised as a planner for eighteen years and was a full member of the New Zealand Planning Institute (NZPI). She was also a member of the New Zealand Association for Impact Assessment.

She undertook a wide range of planning and resource management work within both the public and private sectors, including:

- Working with amenity character and notable tree provisions for Manukau City Council (1985-7) and the former One Tree Hill Borough Council (1987-9);

Ra Hammer presenting the Ron Flook Award, on behalf of NZ Arb, to Helen Lowe in Christchurch

" ...(She) saved approximately 1500 heritage and notable trees of Christchurch by ensuring they remain protected."

- As Regional Manager of the NZ Historic Places Trust in Otago and Southland from1997-1999; and
- Regional Manager for Transit New Zealand: Canterbury/West Coast from 2001-2003.

While Helen worked professionally as a planner and environmental manager for many years, she is now primarily known for her writing. She is a highly acclaimed novelist and poet, having received many awards for her writing including the international Gemmell Morningstar Award and being a four-time recipient of the Sir Julius Vogel Award – three times for her writing and in the fourth instance for service to the genre in New Zealand. Significantly, given Helen's involvement in the Christchurch Replacement District Plan process with respect to heritage and notable trees, the significance of naturalness and the natural world has been noted as a theme in her writing in reviews from as far afield as India.

The NZ Arboricultural Association considers Helen to be a well-deserving recipient of this award which acknowledges her outstanding contribution to tree protection in New Zealand. It also acknowledges the gratitude of the Christchurch Civic Trust, the people of Christchurch and the wider community for the role she played in ensuring that the city's heritage trees remain a significant component of the garden city.

Acceptance Words Helen Lowe

When I was very young, one of my uncles was awarded the OBE and when I asked what it was for, he assured me that the acronym stood for "Other Buggers' Efforts." Although humorous, the incident still left a lasting impression, to the effect that the recipient of an award is often only the visible tip of an iceberg comprising significant team effort. I believe this to be the case in terms of the Christchurch Replacement District Plan and the endeavour to maintain recognition and protection of the city's most significant trees. So while thrilled and delighted to be receiving the Ron Flook Award tonight, I first and foremost wish to acknowledge the team: the submitters, the expert professionals and community witnesses, the publicity spokespersons, the video makers and fundraisers, and the many individual and group donors.

Nonetheless, teams must be coordinated, and once having made a submission I was fortunate—or cursed, depending on one's perspective—to have the professional background that enabled me to understand how the Independent Hearing process operated and what was required to participate effectively. My background also included considerable experience of coordinating teams to undertake projects in high pressure timeframes—which the Christchurch Replacement District Plan process undoubtedly was. Yet even so, without each and every one of the individual people and groups I have mentioned, the significant body of work undertaken for Christchurch's trees would not have been possible.

I am aware that the rationale for giving up a year of one's life for trees may seem self-evident to those gathered here—but I would still like to briefly touch on some of my reasons in the Christchurch case. I know I have no need to enumerate the environmental benefits of trees to a NZ Arb Conference. Those of you who have been to Christchurch will probably agree, too, that the city's urban character is in large part defined by its trees. Both research and my own impact assessment experience also suggest that trees can play a really significant part in defining a community's sense of place and belonging. So in the aftermath of the Christchurch earthquakes, within a geography defined by loss, I believed—and still feel—that retaining and celebrating trees and their contribution is a really important part of the earthquake Recovery process. Yet the focus of the Plan seemed directed toward driving more losses, which—because of the nature of trees and landscapes—risked extending far beyond the five year life of the Plan and becoming generational.

These conclusions led to the process that has been addressed in the citation. Turning to which, I can only say that some of the best things in life come to us out of the proverbial blue—and so it was when notified I was to receive the Ron Flook Award. I was so surprised it took me several seconds to process the email and what it all meant. Once I did, I felt greatly honoured but also moved that I should be regarded as worthy of so prestigious an accolade. I would like to reiterate those feelings tonight and to thank the NZ Arboricultural Association (NZ Arb), most sincerely, for honouring me with the Award. I would have loved to accept in person but am very grateful to Brad Cadwallader for doing the honours on my behalf.

People

Scott Forrest
winner of the 2017 NZ Arb President's Award

Citation by Seth Thompson

Correspondence to comms@nzarb.org.nz

The President's Award honours New Zealand Arboricultural Association (NZARB) members and professionals who represent the profession well in many ways, such as their interaction with customers, leadership of employees and communication with the larger communities in which they work.

The winner of the 2017 NZ Arb Presidents' Award was Scott Forrest, who accepted the award at the NZ Arb Conference Awards Dinner at Trinity Wharf Hotel on 28 October.

Citation by Seth Thompson:
"I first met Scott some 20-odd years ago when we worked briefly together for Tree Care in Auckland. He joined Tree Care when he was a 17-year-old kid who was addicted to sugar, living off energy drinks and junk food. He was full of energy, good with the banter and always willing and keen to learn as much as he could. He earned the name 'Gumpy' early on from the movie Forest Gump and embraced the name with pride. I've been told there was a time in those early days where he had been out stump grinding in an old Land Cruiser and came across some workmates. He proceeded to beep the horn to get their attention, waving out the window. Unfortunately, the beeping and waving didn't get their attention but when he crashed into the back of their work truck at 50kph they definitely knew he was there. The Land Cruiser was a write-off.

Some of Scott's many achievements since those early days as a rookie started with his being awarded the Best Practical Student in the Advanced Certificate in Arboriculture, class of 2001-2002.

He then went on to achieve great things, including: * First place 2008, 2009, 2010, 2016 at the New Zealand National Tree Climbing Competition (NTCC); * Second place 2008 and 5th place 2009 as a guest climber at the International Society of Arboriculture (ISA) European Tree Climbing Competition; * First place 2013 and 2014 at the Pacific Tree Climbing Competition (Asia Pacific region); * First place 2014 at the Asia Open Tree Climbing Competition (Hong Kong); * First place 2011, 2013, 2014 while representing NZ at the ISA International Tree Climbing Competition.

Through his many achievements, Scott has done our industry proud with his accomplishments at the highest level.

He is a role model and mentor to our young arborists. He is an ambassador for arboricultural community as a whole. He shows leadership, passion and is just a genuinely nice guy and he receives the 2017 President's Award in recognition of his hard work and dedication to our industry."

People

Fredrik Hjelm
winner of the 2017 Services to Arboriculture Award

Citation by Seth Thompson
Correspondence to comms@nzarb.org.nz

This year a special award was presented by NZ Arb to acknowledge the services of an individual to arboriculture. This special award was presented at the 2017 NZ Arb Conference Awards Dinner at Trinity Wharf Tauranga to Fredrik Hjelm.

" Fredrik Hjelm (Freddy) is the founder of The Living Tree Company. Swedish-born, he has many years' experience in the tree care industry and has worked throughout Europe and New Zealand. Freddy has been the head technician of the New Zealand Tree Climbing Competition for the past three years and in that capacity, he has helped to improve safety, and assisted with the development of climbing competition Standard Operating Procedures and drug and alcohol policies.

Freddy is heavily involved with the kauri dieback programme. He has led kauri survey projects in a host of tracks in the Waitakere ranges and also surveyed over 20,000 trees in the Hunua ranges and Awhitu peninsula. His company The Living Tree Company based in Devonport in Auckland has hosted several bush walks with the EcoWest festival, informing the public about native trees in the Waitakere ranges, and a walk for arborists was to be held in November in conjunction with Auckland council, discussing and educating arborists in the best practices when working with kauri.

While Freddy works with scientists and ecologists from Auckland university on kauri projects, studying water uptake and photosynthetic and transpiration rates, he also attends epiphyte and bryophyte workshops to extend his knowledge of New Zealand native species of flora. He has an impressive collection of NZ native tree books. In one project where Freddy worked with ecologists, he was climbing trees for bat roost identification, relocation and habitat creation for a roading project.

Freddy is the resident arborist for the Radio Live gardening show, hosted fortnightly on Saturdays mornings, educating the nation in the importance of trees and raising awareness of arboriculture. Freddy is a genuine advocate for the arboriculture profession and to quote Scott Forest, 'The bloke is a legend'. He receives the 2017 Services to Arboriculture Award in recognition of his hard work and dedication to New Zealand's arboricultural industry."

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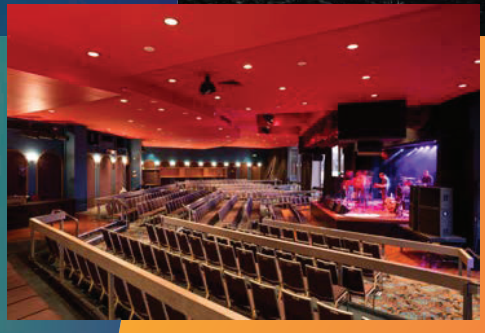

Next year will see us return to beautiful Hobart, Tasmania to the glistening water views of Wrest Point! Mark your calendars with the dates below as it's a conference not to be missed!

ATCC: 27th & 28th April 2018
Conference: 29th, 30th April and 1st May 2018

More details to come! Keep an eye on *www.arboriculture.org.au*

WREST POINT

People

Hiro Ikeno NZ Arb Volunteer of the Year

Citation by Seth Thompson

Correspondence to comms@nzarb.org.nz

A new award for 2017, the Volunteer of the Year was introduced to celebrate the dedication and tireless commitment some of the industry's long-standing volunteers. NZ Arb as an association is driven by the hundreds of volunteers, who donate many hours of their time to the industry. Without volunteers many NZ Arb events would not be possible, including but not limited to; tree climbing, conferences, workshops and seminars, and committees.

The 2017 Volunteer of the Year Awards was presented at the NZ Arb Conference Awards Dinner to Hiro Ikeno who has demonstrated exceptional commitment to the arboricultural industry through his history and dedication as a volunteer.

Some people are instantly recognisable as committed volunteers, they are at the forefront of events with everything under control, they might put their hand up to be a chair of a committee, the local group liaison, or the 'go to' contact for members to talk with.

On the contrary you may be surprised to hear; the inaugural NZ Arb Volunteer of the Year Award will go to someone who does not fit that description. Instead it will go to a person who consistently works quietly away in the background, a person who always puts his hand up to help, a person who does the most thorough job of everything he puts his hand to.

Our 2017 NZ Arb Volunteer of the Year attended all four Husqvarna NZ Arb Regional Climbing Competitions and was again there at the Husqvarna NZ Arb National Tree Climbing Championship. He turned up early at each of these events to help with the set-up. He is also the custodian of the gear trailers.

It is for this dedicated volunteer work that the inaugural NZ Arb Volunteer of the Year Award has been presented to Hiro Ikeno.

Industry

The Seoul Action Plan for Urban Forestry

by Mark Roberts
Roberts Consulting Ltd

Correspondence to:
mark@robertsconsulting.co.nz

In September, I was lucky enough to attend the 2nd Asia Pacific Urban Forestry Meeting (APUFM) in Seoul. The very able Justin Morgenroth from the University of Canterbury was unable to attend, so he suggested that I might like to fill the New Zealand slot. All I had to do was submit a full conference paper to United Nations within two weeks. So, I did.

The Seoul APUFM is quite important, potentially quite significant on a national and international level, so I'll hold off talking about Korean experiences for now.

In September 2017, industry experts from across the Asia-Pacific region met for the 2nd Asia Pacific Urban Forestry Meeting (APUFM); a United Nations Food and Agriculture Organisation (FAO) meeting with the purpose of creating practical methods and outcomes as a means of assisting Asia-Pacific countries in reaching some of the United Nations Sustainable Development Goals (SDGs). As a result of that meeting the Seoul Action Plan (SAP) was created.

Two years before that, the United Nations General Assembly convened in New York. The purpose of that meeting was to adopt 16 Sustainable Development Goals (SDGs) designed to stimulate action in areas of critical importance for humanity and the planet. The SDGs balance the three dimensions of sustainable development; economic, social and environmental (in October of this year a 'Partnership' goal was added, to bring the SDGs to 17).

Back in 2015 the Hon. Murray McCully (Minister of Foreign Affairs) agreed to the UN resolution on behalf of New Zealand on September 25 saying;

"New Zealand welcomes the adoption of the SDGs. If we are to succeed in the way in which the MDG's [Millennium Development Goals] did not, we will need to learn from the significant lessons of the recent past.

These are lessons about hard work and hard decisions, about choosing the right priorities and focusing of practical outcomes. In that respect, you may be assured that New Zealand will play its full part."

For a full list of the UN's SDGs visit: http://www.un.org/sustainabledevelopment/sustainable-development-goals/

Each goal has specific targets to be achieved over the next 15 years, but the important bit here is that, on September 25, 2015 New Zealand stood up in front of the entire United Nations General Assembly and made a commitment to adopt a set of 16 goals to end poverty, protect the planet, and ensure prosperity for all.

Two years after that industry experts from across the Asia-Pacific region met for the 2nd Asia Pacific Urban Forestry Meeting with the purpose of creating practical methods and outcomes as a means of assisting Asia-Pacific countries in reaching some of the SDGs. The Seoul Action Plan (SAP) is the result of that meeting. The SAP lists outcomes, actions, and indicators for achieving seven (7) of the SDGs through the use and expansion of Urban Forestry in our towns and cities.

The SAP is split into eight themes: Greener, Cleaner, Cooler, Healthier, More Cultured, More Biodiverse, Wealthier and Safer cities

Some of the key outcomes are as follows:

Greener cities: To increase the canopy cover in cities by at least 10 percent by 2027

Cleaner Cities (Air pollution): To include the contribution of urban forests and trees (UFTs) in strategies for the reduction and removal of air pollutants in regional and national air quality by 2020

Cooler cities: To prepare a regional framework for support and incentives for the creation and sustainable management of urban forests and other green infrastructure components aimed at climate-change adaptation and mitigation by 2020

Healthier cities: To incorporate the role of UFTs as a positive component of human health and well-being into national public health plans by 2020

More cultured cities: To prepare by 2020 a reference framework for the designation and inventory of trees and forests of sociocultural significance in and around Asia-Pacific cities

More biodiverse cities: To promote the conservation of natural heritage in urban areas by 2020

Wealthier cities: To prepare by 2020 guidance framework and eco-models adapted to Asia- Pacific cities for accounting the ecosystem services, benefits and savings derived by UFT and green spaces development

Safer cities: To prepare by 2025 Evidence-based policy briefs on the past, present, and future role of urban forests and green infrastructure in regulating Increasing resilience to extreme weather events, flooding events/stormwater runoff, land and landscape degradation at regional/national level

Why the SAP is potentially significant on a national and international level, is that the NZ Government has made a commitment to achieving the SDGs. By expanding NZ's urban forests by as little as 10% the NZ Government could potentially achieve seven of the 17 SDGs. Ensuring that our urban forest is maintained and managed could be the easiest and cheapest way for the NZ Government to meet its commitments.

The SAP is the easy solution, it is the answer to a question that I suspect most policymakers don't even know has been asked. Our Government needs to be held to account and reminded that they have committed New Zealand to protecting the planet and have agreed upon economic, social and environmental goals. Local government can't go against this – in fact, the local government should get funding achieve the SDGs and a good chunk of that funding should be set aside for maintaining and managing our urban forests.

The SAP is potentially significant because it is a tool that gives us a chance to push down from the very top, to hold the government to account. Maybe the new government will listen, I don't know – but if it is to listen, it needs to be told and we need to tell it through as many channels as possible and as often as possible.

You can download a copy of the Seoul Action Plan for the development of Urban Forestry in the Asia-Pacific Region from the NZ Arb website: www.nzarb.org.nz/News/LatestNews

APUFM
2nd Asia-Pacific Urban Forestry Meeting
13-15 September 2017, Seoul, Republic of Korea

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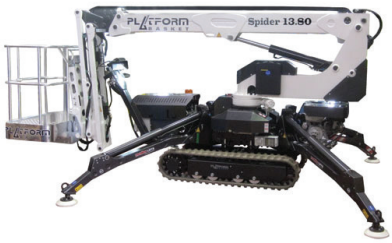
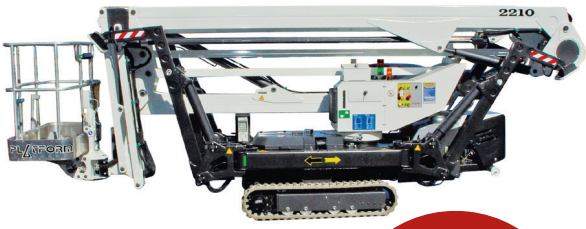


Model: PB13.80
Weight: 1760kg
Working Height: 12.99m
Dual Energy - Engine Powered & Electric

Model: PB18.90
Weight: 2475kg
Working Height: 17.7m
Dual Energy - Engine Powered & Electric



Model: PB22.10
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Working on Spikes

by Mark Bridge

Working on spikes—or gaffs—is an integral part of tree work. Putting on the spikes in the morning to ascend a tree prior to felling it is a familiar action for many arborists the world over. And yet, from a formal and training point of view, our relationship with this ubiquitous positioning aid remains inexplicably vague. What exactly constitutes best practice? How do we instruct trainee arborists to use this tool safely, effectively, and in an ergonomic fashion? The following article seeks to elaborate a few of these points, based on observations from many years of working on spikes, as well as from a training point of view.

One unhelpful aspect, when discussing work on spikes, is that there are a number of myths surrounding them—often based on a lack of discussion and a somewhat macho attitude.

"Anybody can spike up a stem," is one of these myths. And while this statement may contain a grain of truth, experience shows this can be true to a greater or lesser degree. Not every tree is as easy to ascend with spikes, depending up its growth pattern, inclination, wood structure, diameter, as well as the temperature and humidity, to name a few factors. So if the introduction of a trainee arborist to spikes is just "Here are the spikes, strap them on and get up the tree," then this is obviously quite limited and probably inadequate.

The other myth is that gaffing out is a given, just something that happens, while working on spikes. (i.e., being knocked off the spikes in a rigging situation, in which a top is snatched onto a rigging block, the ensuing movement of the stem causing the spikes to be knocked out of the wood.)

Is it really as simple as that? Gaffing out—is it a big deal, a major hazard an arborist has to deal with, or is it a minor risk that one just has to take into account?

If indeed the premise that gaffing out is as much a part of working on spikes as tripping is part of walking, then the response to that would have to be: while walking, one attempts not to trip, as depending upon when and where a trip occurs, the consequences can be either negligible or very significant.

Probably the same can be said of gaffing out: it is ultimately down to the situation in which it occurs, whether it is more or less serious.

Gaffing out while using a chainsaw is obviously extremely hazardous. Doing so on low-diameter, smooth-bark stems with little or no taper can lead to potentially dangerous situations, and can be exacerbated by an unfortunately positioned stump in the way of a fall. Wet or freezing conditions can further change the picture radically.

In view of these reflections, complacency seems an inappropriate way in which to mitigate the risks mentioned here. Equally so, is the suggestion that all one needs to do to address this situation is to harden up.

Solutions

Solutions to addressing the risks associated with working on spikes are really quite easy and plentiful:

- Trainees need a proper introduction to working on spikes. One should explain points such as: how to adjust the length of the shaft correctly, how tightly they need to be worn, how to avoid injury and damage to the line due to inadvertent contact with the spikes, and maintenance of the spikes (i.e., how to sharpen them correctly). Also, time should be taken to explain tie-in options while ascending the stem, lanyard placement, and the possibilities of second tie-in points. For one who is ascending on spikes for the first time, it may be appropriate to consider having the trainee on a belay to exclude the risk of a sliding fall—the need for this depends on the person and their aptitude.

- Spikes/gaffs (figure 1) come in all sorts of shapes and lengths. Use the right ones for the type of wood being worked on. Hard wood is easier to position on with short spikes, whereas thick-barked species are easier to work on with longer ones. Doing the opposite, one struggles either to get a good purchase through the bark or to place the spikes well into the stem.

Figure 01
Spikes—or gaffs—are an integral part of tree work, and they come in all shapes and lengths.

- Double-wrap the lanyard on low-diameter stems to prevent sliding down. This is not a trivial matter. In truth, it is an uncontrolled fall, despite the fact that the lanyard is installed around the stem while it is happening. The climber has no control over his or her fall.

- Use a link between the two parts of the lanyard on either side of the stem. For example, a low-diameter (min. 6 mm diameter) Prusik loop with a karabiner on it. This link can be pushed up against the stem, which prevents a sliding fall. In France, for instance, this is a legal obligation defined in legislation.

- Encourage a better understanding of the tool employed. It is not unusual to see people ramming their spikes into the stem repeatedly before making a cut, just to make sure it is really well in. This seems indicative of a person who does not trust their tools. If the spikes are

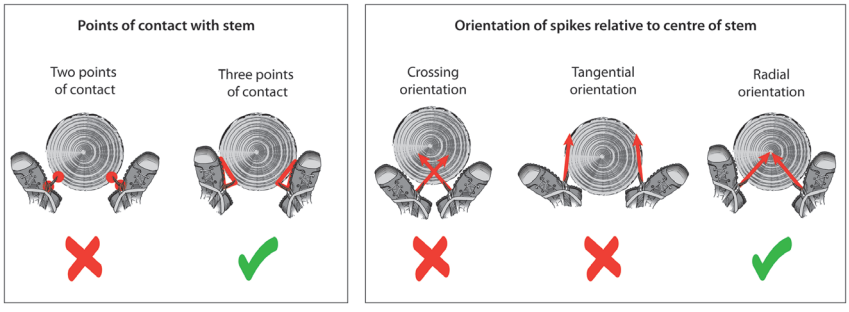

Figure 02
llustrating the proper points of contact and orientation of climbing spikes while in use.

Mark Adams, Adams Arbor Care, LLC, Bugwood.org

sharp and well placed, there is a low risk of them popping out—thereby removing the need to repeatedly ram them in forcefully.

- Place the spikes in a radial orientation towards the middle of the stem rather than tangentially, across the stem. Do not balance on the spikes (two points of contact); rather, rotate the foot inward, so that the front of the foot makes contact with the stem. This position creates three contact points, increases the contact area, and is inherently more stable. (figure 2)

Guidelines

It seems surprising that for a tool that is so ubiquitous in the arborist trade there are so few formalised guidelines on how to use it. One would have to assume this is because the general assumption is that the tool is self-explanatory. Obviously, this is not so, and one would have to say, based upon experience when training people to use spikes or when observing climbers moving around on them, that this view falls short of the truth, which is somewhat more complex.

One point remains undisputed: if used correctly, gaffs or spikes are a valuable, versatile work positioning tool. However, gaffing out is not an inevitability that simply has to be accepted. Rather, this is a further example of a risk that needs to be managed, and there are a range of measures to do so. With these mitigating actions in place, the question of whether gaffing out is a drama or a triviality becomes a managed risk, and consequently a moot point.

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Education

A Matter of Life in Death

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As an arborist, I thought that I had a fairly good understanding of life and death – a dead dog is a dead dog, rabbits exist in two states (alive or dead) and Schrodinger's Cat is both alive and dead at the same time (until you open the box). But then I met an ecologist who suggested that a tree is a more alive when it is dead, and mostly dead when it's alive. How can this be, and how can something as black and white as death, actually be… grey?

We know that there are trees that can regenerate in a type of Dr Who fashion: the above-ground portion of the tree grows up then dies and then a new tree regenerates from the roots. Some trees can do this hundreds and hundreds of times; but is it the same tree after all the parts have been replaced several times over? Other trees take this to the next level and form entire forests with hundreds if not thousands of trees growing up and dying down. These regenerating trees and/or self-cloning forests can survive for 10,000 years or more. There is nothing left of the original tree except its DNA – so is the original tree dead? Is DNA 'alive'?

Such ponderous things require beer and consideration and I must confess that I have invested time in the pursuit understanding such matters, but the ecologist wasn't playing by the rules. Musing on mega-organisms like forests or sub-cellular proteins is one thing, but the ecologist was talking about tangible things, things you can touch.

Visualise a majestic conifer if you will — yes, I know that I've just said, 'things you can touch' and now I'm asking you to visualise something, but go with it-- visualise a tree perfect in every way – visualise the specimen example of all specimen examples.

Your perfect majestic tree is more dead than alive. Your perfect tree most likely 90 percent dead. I'm not sure about you, but when I first thought about this, a 90 percent dead tree didn't come to mind. Only about ten percent of the cells in your tree may actually be living: the leaves (three percent), inner bark (phloem and cambium, five percent), and ray cells in sapwood (two percent).

In contrast, visualise a log in an advanced state of decay, visualise a rotting tree corpse lying on the ground. There is a reasonable chance that 35 percent of the bulk of that log (its biomass) is living. Your lump of rotting log has become a fungal mega-structure with more living 'tissue' in it as a corpse than when it was alive as a tree.

Now visualise a standing tree in decline; a few patches of green but with tip die-back, bacterial ooze, cavities, fungal fruiting bodies and whatever else comes to mind – that tree has probably never been so alive.

As an arborist, I thought that I had a fairly good understanding of life and death, but it seems that I've killed a lot of mostly dead things, and in doing so I've prevented a lot of dead things making an awful lot of living things.

On the flip side – I have been planting trees (trying to replace some of the ones that I've killed). I don't get to kill many trees any more and planting is good, but maybe we should all stop removing all of the things that we kill. Keep planting, because we need new trees, but keep some of the dead stuff too - a tree is a more alive when it is dead.

Decay. Photo: Joseph OBrien, USDA Forest Service, Bugwood.org

Education

Palms: Woody Giants of the Monocots

Part II: Culture and Management

by Leonard Burkhart, Jr. and A. D. Ali

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In Part I, which appeared in the Spring 2017 issue of Tree Matters, we discussed palm identification and pruning methods. In Part II, we will cover various cultural aspects of palms, as well as Plant Health Care of palms in the landscape.

Propagation

Most palms are propagated by seed, which vary in size, from as small as 1/4 inch (0.64 cm) to as large as 12 inches (30.5 cm) in diameter. The largest palm seed is coco de mer, which belongs to Lodoicea maldivica, native to the Seychelles in eastern Africa. That seed measures 12 inches (30.5cm) in length and may weigh up to 55 lbs (24.9 kg). Date palms (Phoenix dactylfera) that produce the edible date of commerce are mostly propagated vegetatively from offshoots, which are small plantlets growing at the base of the mature palm. These vegetatively produced palms, known as cultivars, have been selected for their superior fruit. Desirable U.S. cultivars include: 'Medjool', 'Deglet Noor', and 'Zahidi'.

Transplanting

In order to maximise the chances of establishment, palms should be transplanted during the beginning of the growing season. Young palms transplanted from containers will preserve the roots and minimise transplant shock. Large mature palms can be transplanted, as many species regenerate new roots from severed ones. Sabal palms (Sabal palmetto) are an exception, as roots die back after severance, and new ones grow from the root initiation zone (found at the base of the trunk close to the soil surface). Therefore, when transplanting sabal palms, all fronds should be removed to accommodate for the loss of roots (Figure 1). The planting depth for mature palms should match the original growing depth; staking is recommended for the first six to eight months, or until roots are reestablished. Planting trunks deeper than the original depth will jeopardise transplant success and can lead to root and trunk decay. Ideally, the soil should be kept moist but not saturated. Mulching the soil will help conserve moisture and insulate soil from temperature extremes. These best management practices will encourage strong root growth and optimal nutrient uptake.

Fertilisation

For optimal nutrition, palms should receive a slow-release nitrogen fertiliser with potassium, magnesium, and micronutrients. Use a fertiliser formulated for palms and avoid standard tree and landscape fertilisers. Standard tree and landscape fertilisers can cause micronutrient deficiencies from the incorrect nutrient ratios (i.e., a human-induced nutrient imbalance). Fertiliser application can be made three to four times per year in the southeastern United States and in Florida, and two to three times per year in Texas and in western states.

Symptoms of deficiencies can be specific and relatively easy to diagnose in the field. Generally, deficiencies of macronutrients like nitrogen, potassium, and magnesium occur because they are deficient in the soil. Micronutrients on the other hand, are usually in the soil in sufficient quantity, but are chemically bound to the soil particles as a function of high soil pH and high levels of calcium. This makes the micronutrients unavailable for absorption by the roots. The buffering capacity of the calcium makes soil pH modification nearly impossible.

Symptoms of nitrogen deficiency, a macronutrient, usually are uniformly chlorotic fronds. Unlike the other nutrient deficiencies, all fronds are affected (Figure 2).

The macronutrients potassium and magnesium are mobile in the palm. If deficient, the palm will take these macronutrients from older leaves up into the apical meristem for new leaf and fruit development. Thus, deficiencies of these two elements are first seen on older, lower leaves. Potassium deficiency is first seen as translucent spots and yellow-orange or even black flecking on leaflets of lower fronds, followed by frizzling of leaflets that are distal on the frond (Figure 3).

Magnesium deficiency is common on Canary Island date palms (Phoenix canariensis). On magnesium deficient palms, the tips of leaflets become chlorotic with the base of the leaflet still green where it attaches to the rachis (middle of the frond). Symptoms are observed on oldest fronds (Figure 4a).

A deficiency of manganese, a minor element, causes stunting and curling of new fronds, a phenomenon termed "frizzle top" (Figure 4b).

Deficiencies of boron, another minor element, expresses as twisting and deformity of the crown in a phenomenon termed "epinasty." Occasionally, a new bud starts growing to form multiple heads in an otherwise single-head palm (Figure 4c; Figure 4d). Boron deficiency leads to excess auxin production, which causes the twisting and deformity like those seen with phenoxy herbicide damage in other plants.

If applying a granular fertiliser, place it in a circular pattern six to eight inches (15.24–20.32 cm) away from the trunk and not piled against the new, emerging roots. If applying a liquid fertiliser, inject it into the soil around the trunk six to eight inches (15.24–20.32 cm) away for smaller palms; for larger ones, two circles may be needed, with the outer one 18–20 inches (45.72–50.80 cm) away from the trunk. Granular fertilisers work well where reliable precipitation occurs during the growing season. In the arid west, irrigation using water conservation practices, such as drip irrigation, may not be sufficient to move nutrients into the soil profile for uptake by the root system. The micronutrients in granular fertiliser will stain paved surfaces and pool liners. Unfortunately, movement of granular fertilisers can easily occur during heavy rains, especially when palms are planted on a slope.

Insect Pests:

Palm aphids are small, flattened insects with dark, round bodies surrounded by a ring of white wax (Figure 5). They feed on the sap, and live in tightly appressed areas, such as newly developing leaves. Their presence is indicated by black, sooty mould growth on fronds and trunks. Several scale and mealybug species are other occasional sap-feeding insect pests on palms that produce honeydew, which eventually becomes colonised by black, sooty mould.

Other sap-feeding arthropods include leafhoppers and mites. The leafhoppers are integral to the transmission of diseases, which will be discussed later. In California, the palm leafhopper feeds on young spear leaves of pygmy date palm

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

Figure 8

Figure 9

Figure 10

(Phoenix roebelenii), an activity that goes unnoticed until the leaves unfold. The yellow spots on the fronds (Figure 6) resemble potassium deficiency.

The palmetto weevil (Rhynchophorus cruentatus) is a borer that attacks species such as Canary Island date palms and Bismarck palms (Bismarckia nobilis) in the southeastern United States, as well as in the Caribbean and México. Adult palmetto weevils are brownish with red markings, up to two-and-a-half inches (6.35 cm) long, and are strong flyers. They are attracted to stressed palms, and they lay their eggs in the crown. As the grubs hatch, they feed in the central portion of the crown and damage the growing bud (Figure 7). An indicator of activity is the spear leaf starting to bend and eventually fall off.

A lesser-known, native California borer, called the giant palm borer (Dinapate wrightii), attacks declining Mexican fan palm (Washingtonia robusta), California fan palm (Washingtonia filifera), Canary Island date palm, and true date palm. If the infestation is heavy enough, the borer will cause trunk failure. This borer is probably a secondary pest.

The South American palm weevil (Rhynchophorus palmarum), which is native to Mexico, Central America, and South America, has recently expanded its range to San Diego and Imperial counties in California. The weevil has also been collected in Yuma, Arizona, and Alamo, Texas. This new borer kills Canary Island date palm and true date palm.

A chewing pest of minor status is the palm leaf skeletoniser (Homaledra sabalella), which is a caterpillar that feeds superficially (skeletoniing) on fronds. The damage is strictly cosmetic, and if objectionable, the affected frond may be pruned off.

Diseases

One of the more common diseases in the landscape of many southeastern palm species is Ganoderma basal stem rot. This is caused by a fungal pathogen (Ganoderma zonatum) that destroys woody tissue and damages the vascular bundles, resulting in slow wilt and eventual death. Initial symptoms include wilting of lower fronds. Conks, which are the spore producing structures, may be seen at the lower portion of the trunk in advanced stages of infection (Figure 8).

Fusarium wilt is caused by another fungal pathogen that clogs up vascular tissue and causes slow death. Initial symptoms often include lopsided wilt of fronds, with one half of the leaflets brown and the opposite half green (Figure 9).

Figure 11

Figure 12

Figure 13

Figure 14

Figure 15

Figure 16

Thielaviopsis rot is caused by a fungal pathogen that is occasionally found decaying internal trunk tissue. Initial symptoms include the bleeding of a brownish, foul-smelling liquid, as seen on the outside of the trunk (Figure 10). As the crown dies back, the trunk may break in advanced stages (Figure 10).

Sudden crown drop is a rot disease affecting Canary Island date palm and true date palm in California. Both date palms with this disease develop a slight lean, and within days the whole crown breaks off. Palms that have suddenly developed a lean should be considered extremely dangerous and never be climbed. The disease is not visibly detectable. Arborists climbing both date palms should use a sounding mallet to discover possible decayed trunk areas as they ascend. While Thielaviopsis is occasionally isolated from palms that have failed, the exact cause is unknown. Sudden-crown-drop reports seem to increase several years following wet California winters. As a precaution, do not prune either date palm during winter months and always avoid using chainsaws.

Pink rot (Nalanthamala vermoeseni) can affect queen palm (Syagrus romanzoffiana), Canary Island date palm, California fan palm, Mexican fan palm, and most other landscape palms (Figure 11). Often, the upper portion of the crown and spear leaves are affected first. As the fronds die, they turn a straw-brown. The upper crown of dead fronds often develops a lean. Pink-coloured spores of the disease are produced in large quantities at the base of the frond. The pink colour vaguely looks like cooked salmon. This lethal disease is common on water-stressed palms and is easily spread during cool, rainy weather. To minimise, avoid pruning during the winter months and closely monitor soil moisture on newly transplanted palms.

A sporadic fungal pathogen is Graphiola leaf spot. This pathogen infects older fronds of stressed palm trees, such as Canary Island date palm and true date palm. Evidence of the pathogen is seen as bumps on the leaflets with fine, hairlike, spore-bearing structures protruding from the centre.

Diamond scale disease (Phaeochoropsis neowashingtoniae) is a foliar disease that is problematic on California fan palms planted near coastal California. The disease gets its name from the diamond-shaped fruiting bodies it produces on the leaves (Figure 12). California fan palms grown in their native desert climate, where humidity levels are low, usually lack the disease.

Lethal yellowing is a vascular disease caused by a mycoplasma (a bacteria-like organism) that is transmitted by a leafhopper, the American palm cixiid, Haplaxius (Myndus) crudus. The disease primarily infects older cultivars of coconut trees, such as 'Jamaica Tall', and is occasionally seen in Canary Island date palms and true date palms.

Texas phoenix palm decline is another disease caused by a mycoplasma that is transmitted by a planthopping insect. Initial symptoms include missing spear leaves and a reddish coloration of the middle fronds (Figure 13). In advanced stages, the entire crown dies back and collapses. Common hosts include windmill palms (Trachycarpus fortunei), sabal palms, and Canary Island date palms.

Abiotic Problems

Besides the insects, diseases, and nutritional problems, palms can also be damaged by weather events, cultural practices, and mechanical damage. Lightning damage is an acute injury that may cause death in a matter of days. Normally, the entire canopy dies back and gradually collapses (Figure 14). Sometimes, evidence of lightning is observed as a jagged line of fibrous tissue erupted on the trunk (Figure 14).

Ascending palm trunks with climbing spurs results in permanent injuries to the trunk that may lead to pathogen entry (Figure 15). This practice must only be used when removing a palm.

Because palms lack vascular cambium, they cannot replace trunk tissue eroded by string trimmers or by spray irrigation. Spray irrigation directly contacting the palm will erode the trunk and eventually lead to whole palm failure (Figure 16).

Bicycles repeatedly chained to trunks will mechanically damage trunks. A more extreme example of mechanical trunk damage is the tiki carvings on these two

Figure 20

Figure 18

Figure 19

Mexican fan palms (Figure 17). Chisels and propane torches were used to carve the faces. While the palms did not die immediately, the concern for rot and decay organisms colonising the trunk led to the palms being removed for safety concerns.

Palms growing next to the ocean are subjected to salt sprays that may cause distal tissue necrosis in fronds (Figure 18). Some palms, such as Guadalupe palm, can tolerate salt spray, so evaluate your site before selecting your palm species. Freeze-damage symptoms can be seen as uniform browning of the canopy (Figure 19). Coconut palms may display delayed symptoms of cold injury by the drooping and dying back of old fronds (Figure 20). Trunk constrictions are caused by abiotic stress factors, the most common of which is drought. When moisture is limited, the growth of vascular bundles and other trunk tissue is reduced. Trunk girth will increase when moisture becomes available (Figure 21). If a palm is over-watered, and the soil moisture fluctuates widely, palm trunks will swell and shrink, and can develop vertical cracks as a result. (Figure 22).

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Figure 22

Figure 21

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Education

Bark Patch Grafting to Facilitate Tree Wound Closure

by G.M. Moore and P.G. McGarry

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Investigation of the Potential for Bark Patch Grafting to Facilitate Tree Wound Closure in Arboricultural Management Practice

ABSTRACT. Grafting and budding are common horticultural techniques, and similar techniques have been successfully used in the management of tree wounds by bridge and approach grafting. The success of bark grafts raises the possibility of using bark patch grafts to span trunk wounds and pruning cuts. Fifty seedling trees from each of six commonly planted Australian native and exotic species—*Acacia dealbata*, *Banksia integrifolia*, *Eucalyptus viminalis*, *Platanus × acerifolia*, *Quercus robur*, and *Pinus radiata*—had circular plugs of bark removed from their stem using a #3 cork borer (9 mm diameter). The plugs were lifted from the stem and then re-attached at one of four rotations (0, 90, 180, and 270 degrees) to the original cambial orientation in each of the four seasons.

While there was no successful re-attachment for Pinus radiata, the data for the successful re-attachment of the other five species showed that the most successful orientation for re-attachment was in the original position (0 degrees); successful attachment did occur at other orientations. The best season for re-attachment was spring, but successful attachment did occur in other seasons; success was lowest when grafting was undertaken in winter.

The use of bark patch grafts may provide arborists with an additional method for dealing with large wounds caused by vandalism and accidents, and would be particularly useful if a tree was of special, historic, or environmental significance to the landscape. Covering the wound with a bark patch graft may conceal the removal of a branch, hide obvious scarring, and at the same time reduce the risk of disease and stress to the tree by closing the wound more quickly than would normally occur due to natural callusing.

KEY WORDS. *Acacia dealbata*; *Australia; Banksia integrifolia*; Bark Grafting; Callus; *Eucalyptus viminalis*; Native Tree Species; *Pinus radiate; Platanus × acerifolia*; *Quercus robur;* Seasonal Wound Responses; Tree Wound Closure.

In the urban environment, damage to trees may result from storms, human activity, or from structural defects (Pirone et al. 1988; Pirone et al. 1991; Harris et al. 2004). Wounding also occurs from vehicle collisions, power-line clearing, building and construction activities, road works, and vandalism, all of which can cause damage ranging from minor scarring on trunks to limb removal and tears that remove large areas of bark. Pruning is also a common cause of bark damage, as improper pruning remains a major problem worldwide despite being relatively easy to prevent through the adoption of proper techniques and standards (Shigo 1986; Moore 1990; Standards Australia 2007). A successful response by a tree to wounding is usually through compartmentalisation (Shigo and Marx 1977). Trees don't heal wounds (Shigo and Marx 1977; Shortle 1979), but rather confine or compartmentalise injured and infected wood (Shortle 1979) through wound closure and wound compartmentalisation (Harris et al. 2004) that has been described in many tree species (McQuilkin 1950; Neely 1970; Shigo and Marx 1977; Kramer and Kozlowski 1979; Hudler 1984; Smith 1988; Biggs 1990; Harris et al. 2004).

One of a tree's early responses to wounding is the formation of callus tissue that can grow over wounds (Shigo and Marx 1977; Pirone et al. 1988; Moore 1990; Shigo 1991; Harris et al. 2004). Callus tissue is a mass of large, undifferentiated, homogeneous parenchyma cells that is formed at the margins of wounds that arises from cambial derivatives or from parenchyma cells of the phloem, cortex, or vascular rays, and from immature xylem rays (Esau 1965; Kramer and Kozlowski 1979). However, it mostly commonly derives from the cambium (Fahn 1985), and under certain circumstances, such cells can be described as the equivalent of stem cells in animal tissues (Vernoux and Benfey 2005; Dinneny and Benfey 2008). The production of callus is largely dependent on the interaction of phytohormones and particularly auxins, gibberellins, and cytokinins (Aloni et al. 2010; Aloni 2015). Callus formation is the basis of the formation of graft unions utilised in horticulture (Neely 1970; Shigo and Marx 1977; Hudler 1984; Perry and Hickman 1987; Mattheck and Korseska 1989; McDougall and Blanchette 1996; McGarry 2001).

Callus formation not only serves to reconnect vascular and other tissues across a wound (David–Schwartz and Sinha 2007), but also has an important role in forming a cap on the external edges of the wound, closing them (Shigo 1986). The shape of a wound has little effect on the rate of wound closure but its width does, with wounds less than 12 mm in diameter likely to close within a year (Neely 1970; Neely 1983). Closure occurs after the same length of time for similar-sized wounds (Neely 1970; Kramer and Kozlowski 1979; Harris et al. 2004), and wound closure rates correlate positively with rates of trunk growth but vary with species and years after wounding (Neely 1988b). More callus tissue was produced around large wounds than small and callus growth at the edge of the wound was shown to be greater than the radial growth of the stem. Wound size and location have an impact on the rates of wound closure (Neely 1988c). Once a mass of callus cells becomes lignified it is termed woundwood (Harris et al. 2004), and as it grows it eventually seals the wound. In small wounds, the callus tissue normally closes the wound quickly before woundwood can be formed. The formation of callus tissue, and subsequent woundwood, is part of the tree's defensive response to wounding.

The differentiation of callus into xylem or phloem tissues is largely controlled by the concentrations and interactions of the hormones auxin, gibberellins, cytokinins, and ethylene (Alomi 2015). However, the importance of the auxin, indole-3-acetic acid (IAA), is of particular significance in vascular tissue differentiation and involves the basipetal movement of IAA (Sawchuk and Scarpella 2013). The auxin canalisation hypothesis is based on mature tissue responses to applied auxin application, but is also consistent with cellular development in embryonic tissues and shoot organ development (Sawchuk and Scarpella 2013).

However, if the bark that has been damaged, lost, or cannot be replaced, techniques such as bridge grafting, approach grafting, and inarching can be used for repairing damaged orchard and valuable ornamental trees (McGarry 2001; Goren et al. 2004; Harris et al. 2004; Hartmann et al. 2010). These techniques involve growing young seedlings that are progeny

of the damaged plant, clones, or at least of the same species as the damaged plant around the base of the damaged tree. (Harris et al. 2004; Hartmann et al. 2010). These techniques require considerable skill and are expensive to undertake, but can be used to repair damaged ornamental trees of historic, heritage, cultural, landscape, environmental, and horticultural significance that warrant the expenditure.

THE EFFECT OF SEASON ON TREE RESPONSES TO DAMAGE

Tree wound healing rates in three species of deciduous trees and *Eucalyptus camaldulensis* were fastest during the active growth phase from mid-spring through to early summer (Neely 1970; Perry and Hickman 1987). Mercer (1979) described late-winter and spring as the seasons when wounds generally callus-over best. The slowest rates of wound closure occur in wounds made during late-autumn and early-winter (Neely 1970; Perry and Hickman 1987), and wounds inflicted in autumn may be detrimental to tree health because of the increased risk of infection, as many fungi sporulate at this time (Felix and Shigo 1977; Mercer 1979).

Callus cell division, enlargement and differentiation occur best from mid-winter through to summer, when sap flow is heavy. In regions with definite seasonal climates, the cambium may cease activity and become dormant for periods as long as from late-summer to early-spring (Fahn 1985). The cambium is often responsible for generating callus tissue, which means that a tree is best able to react to damage and close wounds at times of the year when the cambium is most active. The rate of wound closure in *Prunus persica* depended most on the average temperature after wounding (Biggs 1990); the warmer the temperature, the faster the healing (Kozlowski et al. 1991). Moisture stress and temperature have been shown to influence wound responses (Hudler and Banik 1986).

Callus production and wound closure can be expected to be greatest in spring and early-summer (Clearwater et al. 2007). The large number of active young leaves gives rise to high levels of IAA, which moves basipetally; and active root growth produces high levels of cytokinins, which move acropetally; while high levels of both stimulate callus production, especially if water and photosynthate are available (Aloni 2015). Good growth by plants at this time of the year increases the production of sugars, which act as signals that further stimulate IAA production, especially if there is rapid transpiration and available water (Lilley et al. 2012) The warmer temperatures also stimulate increased auxin and cytokinin production in young leaves and roots tips, respectively, which continues until very warm temperatures and/or reduced water supply change phytohormone production in response to stress (Aloni 2015). Such changes are significant in the subsequent differentiation of the callus.

THE EFFECT OF SPECIES ON TREE RESPONSES TO DAMAGE

There is genetic control of wound closure (Shigo 1986; Kozlowski et al. 1991) and compartmentalisation (Shigo and Marx 1977; Shortle 1979; David–Schwartz and Sinha 2007). There are large differences between tree species when it comes to the rate of wound responses after pruning (Mercer 1979). Significant variability in wound closure rates exists within tree populations (Neely 1988b), and the time it takes for the callus to complete wound closure varies with species (Neely 1988a). Not only does cambial activity differ from species to species but the rate of formation of boundaries within a tree after wounding varies with species as well (Shigo 1986; Kramer and Kozlowski 1979; Kozlowski et al. 1991; Waisel 1991).

Variation also exists within trees of the same species as identical wounds inflicted on trees of the same species, at the same time, have different rates of wound closure (Neely 1988b). It has been shown that some clones, or varieties of trees are particularly good at compartmentalising, while other trees of the same species are poor (Mercer 1979; Shigo 1986; Santamour 1987a). Differences between and within plant species are to be expected as trees may be ring or diffuse porous and have vessels and tracheids of different diameter sizes, both of which can influence the free flow of phytohormones and so also their concentration in plant tissues (Aloni 2015). Furthermore, the growth rate of the individual tree can influence the production of and response to hormones. Grafting, which has been practised for centuries, may have unwittingly assisted in the selection of strong compartmentalisation as a characteristic of common horticultural species, as trees that graft successfully tend to be strong at wound compartmentalisation (Shigo 1991).

GRAFTING

The process of grafting is based on the ability of the cambium, or other tissue, to form the callus at the junction of the joining tissues and relies on the callus differentiating to connect the xylem and phloem (McGarry 2001; Moore 2013). Successful grafts are usually between plants of the same genus; however, in some instances, plants of different genera, but of the same family, may be compatible (Moore 2013). The type of grafting that is particularly useful in relation to tree wounds is the bridge graft, which is used to restore sap flow in repairing the bark of a damaged tree trunk (Smith 2008). Bridge grafting, sometimes referred to as repair grafting (Smith 2008), is also used to repair bark damage to trees from grazing animals, such as deer, horses, and rabbits (Anonymous 2004). A number of scions are prepared and inserted under the intact bark across the wound. Most plants that can be grafted will respond successfully (Moore 2013), especially in early spring just as active growth of the tree is beginning and the bark is slipping easily (Hartmann et al. 2010).

Patch budding/grafting is a method of grafting that involves removing a square patch, containing one bud, from the scion and inserting it into a same-sized square wound that has been prepared in the rootstock. The relationship between scion and stock at the cellular level is becoming better understood (Koepke and Dhingra 2013), but the basipetal movement of IAA is a significant factor in the production and subsequent differentiation of callus and the vascular connection between scion and stock tissues (Grebe 2004; Aloni et al. 2010; Aloni 2015). Some of the seasonal influences observed on budding and grafting success can be explained by high production of IAA in early spring by young and actively growing leaves, which influences both callus production and differentiation (Aloni 2015)

Large bark patch grafts could be an alternative to bridge-grafting for spanning trunk wounds and pruning cuts. Girdling wounds can be bridged with bark implants or bridge grafts (Harris et al. 2004), so why not consider a bark patch grafting technique using bark patches cut from branches or other areas on the trunk of an affected tree? The patches should be cut with clean edges, positioned to ensure good cambial contact, and protected from desiccation (Priestly and Scott 1955; Fahn 1985; Hartmann et al. 2010), which can be achieved by covering the graft with materials such as grafting clay, wax or tape, rubber latex, paraffin wax, waxed cloth, plastic strips, and raffia (McGarry 2001; Hartmann et al. 2010). Proper orientation of the patch is important, as experiments have shown that tissues can be adversely affected if the orientation is changed from the original (Thair and Steeves 1976).

In 1991, a bark patch was attached to an *Ulmus procera* growing in the gardens of Burnley College, Melbourne, Australia, following the removal of a large branch. Before the branch was removed, a large flap of bark on the underside of the limb was carefully removed from contact with the limb and when the limb was cut the flap was folded upward and used as a bark patch to cover the wound (Figure 1). The connection of the patch with the tissue below it remained intact and the patch remained in place and healthy until the removal of the tree in 2014. The wound had been included and had successfully compartmentalised.

This successful bark patch graft precipitated this experiment which investigated whether bark patches could be removed and then successfully replaced on the same tree, whether there were differences between tree species in their responses, and whether the season when the damage and patch grafting was done had any effect of successful re-attachment. The bark patches used in the experiments were small and were done on seedling trees as a model system. However, the production of callus and its differentiation have been reported to be similar in studies on mature and embryonic tissues, callus-based research, and shoot organ development (Sawchuk and Scarpella 2013). Because plant responses to phytohormones

Species	Nursery of origin	Seedling size at purchase	1st bark patch season	Container size
Quercus robur	Corella Nursery, Kallista, Victoria	30 cm, bare-rooted	Year 1 mid-winter (July)	300 mm squat pot
Platanus × acerifolia	Corella Nursery, Kallista, Victoria	20 cm, bare-rooted	Year 1 mid-winter (July)	200 mm pot
Pinus radiata	Amcor Cowwarr Weir Nursery, Cowwarr, Victoria	15-20 cm, field-grown	Year 1 mid-autumn (April)	200 mm pot
Eucalyptus viminalis *Acacia dealbata*	NRCL Nursery, Springvale, Victoria	20-30 cm, forestry tube	Year 1 mid-winter (July)	200 mm pot
Banksia integrifolia	NRCL Nursery, Springvale, Victoria	<20 cm, forestry tube	Year 1 mid-autumn (April)	200 mm pot

Table 1. Source, size and dates related to the six species used in Experiment 1.

Species	Plug graft #1	Plug graft #2	Plug graft #3	Plug graft #4
Quercus robur, Acacia dealbata, Eucalyptus viminalis, Platanus × acerifolia	Year 1 mid-winter (July)	Year 1 mid-spring (October)	Year 1 mid-summer (February)	Year 1 mid-autumn (April)
Pinus radiata, Banksia integrifolia	Year 1 mid-autumn (April)	Year 1 mid-winter (July)	Year 1 mid-spring (October)	Year 1 mid-summer (February)

Table 2. Month for the commencement of each season's patch bark grafting trial (n=10 for each treatment).

Weeks	*Pinus radiata*				*Banksia integriflia*				*Platanus x acerfolia*			
	0	90	180	270 degrees	0	90	180	270 degrees	0	90	180	270 degrees
2 weeks	15	0	0	0	77.5	40	65	52.5	21.6	0	23.5	25
4 weeks	15	0	0	0	72.5	32.5	47.5	27.5	21.6	0	23.5	20
8, 13, 32, 64 weeks	0	0	0	0	72.5	32.5	47.5	27.5	21.6	0	23.5	20

Weeks	*Quercus robur*				*Acacia dealbata*				*Eucalyptus viminalis*			
	0	90	180	270 degrees	0	90	180	270 degrees	0	90	180	270 degrees
2 weeks	38.5	20	22.2	35.1	50	25	35	32.5	75	25	80	30
4 weeks	38.5	20	19.4	21.6	37.5	15	17.5	32.5	50	2.5	35	5
8 weeks	38.5	0	16.7	2.7	37.5	15	12.5	15	50	2.5	20	5
16, 32, 64 weeks	18	0	8.3	2.7	37.5	15	12.5	5	50	2.5	20	5

Table 3. Table 3. Success (%) of bark plug re-attachment in six tree species, 2, 4, 8, 16, 32, and 64 weeks after treatment after orientating the plugs at 0, 90, 180, and 270 degrees to their original position (n = 10 for each treatment).

occur at the cellular level, consistent tissue responses are to be expected (Nakamura et al. 2012; Koepke and Dhingra 2013). The experiments provided data that could inform the use of bark from damaged trees as a patch over parts of the trunk or branch stubs to facilitate rapid growing over and compartmentalisation.

MATERIALS AND METHODS

Fifty trees from each of six species commonly planted in Australia streets and gardens, comprising both native and exotics. *Acacia dealbata* Link, *Banksia integrifolia* L.f., *Eucalyptus viminalis* Labill, *Platanus × acerifolia* (Air) Willd., *Quercus robur* L., and *Pinus radiata* D. Don. were grown outdoors and maintained with regular irrigation and fortnightly liquid fertiliser applications of Phostrogen® at 74 mg N/L. Seedlings of *A. dealbata, B. integrifolia*, and *E. viminalis* were purchased as tubestock and potted to standard, black 150 mm pots. *P. × acerifolia* and *Q. robur* were sourced as bare-rooted material and the *P. × acerifolia* were potted to standard 150 mm pots and the *Q. robur*, with larger root systems, were potted into larger 300 mm squat pots sprayed with Spinout® to reduce the likelihood of the trees becoming pot bound. *Pinus radiata* trees were sourced as "treelings" from in-ground cutting beds and potted to standard 150 mm pots (Table 1). All trees ranged from 700–1000 mm in height with a stem caliper in excess of 15 mm diameter before treatments were commenced. Of the 50 trees grown, the largest 40 of each species were used in the experiments, with ten trees available in case any of the trees proved unsuitable in either size or health.

Circular plugs of bark were removed from the stem using a #3 cork borer, which cut a 9 mm diameter plug of bark tissue (Figure 2). The plug was lifted from the stem and then re-attached at one of four rotations—0, 90, 180, and 270 degrees—to the original cambial orientation. The plugs were rotated to ascertain the importance of cambial orientation in the reconnection of the vascular tissues. To determine the effect of season, four different bark patch graft rotations were performed on each specimen tree of all species with 10 replicates. Each patch treatment was performed in the middle of each of the four seasons—spring, summer, autumn, and winter—so that each tree received four bark patch grafts at the same orientation (Table 2).

Once the bark plugs had been removed from the seedlings and then repositioned, they were held in position using budding tape. The tape holding the bark plug in place was removed two weeks later. Whether the bark plugs had successfully re-attached was monitored at 2, 4, 8, 16, 32, and 64 weeks after grafting. The first treatments were imposed in mid-autumn of Year 1 on the *B.*

Figure 1
A bark graft patch, attached to the trunk of an Ulmus procera growing in Burnley Gardens, Australia (approximately 240 mm in diameter), 10 years prior to the photograph. Note the uniform ring of callus forming at the branch bark ridge.

Figure 2
Examples of bark patch grafts on seedlings of Banksia integrifolia, Platanus × acerifolia, and Eucalyptus viminalis.

integrifolia and *P. radiata* saplings, which were of suitable size. The other four species were treated in mid-winter of Year 1 when they had attained suitable size (Table 2). The trees remained in pots for the duration of the experiment.

In the early weeks after treatment, weeks 2 and 4, callus production was taken as being indicative of possible re-attachment, and was thus scored positively. After this time, however, the plugs were either attached to the surrounding bark so that they could not be dislodged or were falling out or easily dislodged with a probe at the time of inspection. The experiment involved six species, ten replicates of which were subjected to four plug orientations in each of four seasons. There were 240 trees in total, and the data collected at weeks 2 and 32 were subjected to a logarithmic regression analysis to test the significance of seasonal, orientation, and species differences. These weeks were chosen because week 2 was immediately after the protective tape was removed, and by week 32, plugs had either re-attached or had failed. In the course of the experiment, four *P. radiata*, two *Platanus × acerifolia*, and three *Q. robur* plants died, but there were sufficient replicates of all species and treatments for statistical analysis.

RESULTS

The data for the successful re-attachment of the bark plugs for the six different species at different orientations show that the most successful orientation was in the original position (or 0 degrees), but successful attachment did occur at other orientations (Table 3; Figure 3; Figure 4). The best season for reattachment was spring (Table 4), but successful attachment did occur in other seasons. Successful attachment occurred in all species but P. radiata (Table 3; Table 5). The data demonstrate (Table 3; Table 4; Table 5) that with one exception (*E. viminalis*), if re-attachment was successful at 16 weeks, then the plugs were likely to remain attached and

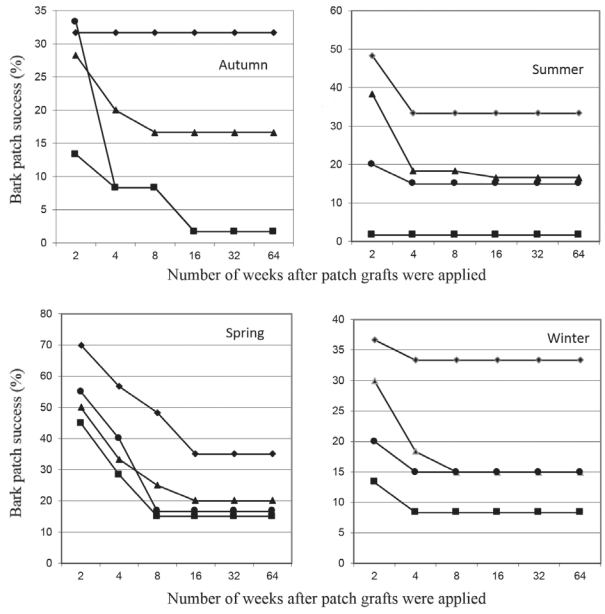

Figure 3
Success of patch grafts for six species of trees at four different orientations for four seasons: 0 degrees (◆—◆), 90 degrees (■—■), 180 degrees (■—■),and 270 degrees (●—●).

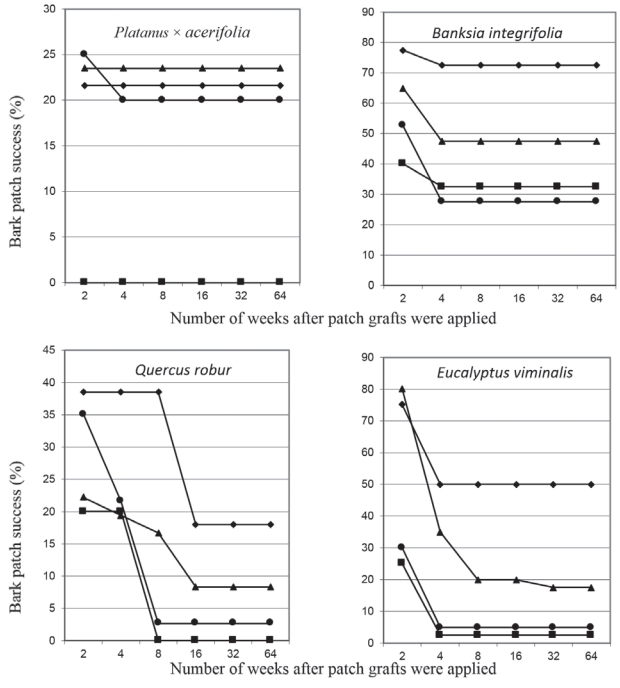

Figure 4
Success of patch grafts for Platanus × acerifolia, Banksia integrifolia, Quercus robur, and Eucalyptus viminalis at different orientations across all seasons: 0 degrees (◆—◆), 90 degrees (■—■),, 180 degrees (■—■), and 270 degrees (●—●).

there was no change after week 32 for any species (Figure 4). The results for bark plug re-attachment show that there was no success with *Pinus radiata*. Callus was produced for only a maximum 15% of trees with the 0-degree orientations, but there was no attachment after eight weeks. The results for *P. × acerifolia*, showed a higher rate of successful bark patch graft re-attachment with orientations of 0, 180, and 270 degrees all having successful re-attachment in the range of 20%–25%, but there was no success at the 90-degree orientation. *Quercus robur* had some successful re-attachment at all orientations initially, but most subsequently failed over time.

For *A. dealbata*, bark plugs re-attached at a rate of about 30% for the 0-degree orientation, and for all other orientations the rates

Weeks	Winter				Spring			
	0	90	180	270 degrees	0	90	180	270 degrees
2 weeks	36.7	13.33	30	20	70	45	50	55
4 weeks	33.33	8.33	18.33	15	56.67	28.33	33.33	40
8 weeks	33.33	8.33	15	15	48.33	15	25	16.67
16, 32, 64 weeks	33.33	8.33	15	15	35	15	20	16.67
Weeks	**Summer**				**Autumn**			
	0	90	180	270 degrees	0	90	180	270 degrees
2 weeks	48.33	1.67	38.33	20	13.33	28.3	33.33	13.33
4 weeks	33.33	1.67	18.33	15	8.33	20	8.33	8.33
8 weeks	33.33	1.67	18.33	15	8.33	16.67	8.33	8.33
16, 32, 64 weeks	33.33	1.67	16.67	15	1.67	16.67	1.67	1.67

Table 4. Success (%) of bark plug re-attachment, 2, 4, 8, 16, 32, and 64 weeks after treatment after orientating the plugs at 0, 90, 180, and 270 degrees to their original position in winter, spring, summer, and autumn (n = 10 for each treatment).

"While it is difficult to generalise about the influence of season, without considering species and orientation, winter and spring appeared to be the best seasons for most species for re-attachment."

were between 5%–10%. *Banksia integrifolia* had the highest rates of successful re-attachment of the six species tested, especially for the 0-degree orientation, which had 72.5% of the bark plugs remaining attached for the duration of the experiment. However, attachment was above 27% for all orientations. For *E. viminalis*, more than 50% of the 0-degree orientation bark plugs successfully reattached, and even the 180-degree orientation re-attached at a rate of 17.5%. Curiously, the rates for 90 and 270 degrees were very low.

While it is difficult to generalise about the influence of season, without considering species and orientation, winter and spring appeared to be the best seasons for most species for re-attachment. Autumn was the least likely season for success for deciduous species. However, successful re-attachment could be achieved in all seasons.

Logarithmic regression analysis of the data at weeks 2 and 32 showed (Table 6) that there were no significant differences for the interaction of season, plug orientation, and species except for week 2 data for summer and autumn where $P < 0.05$. However, there were significant differences ($P < 0.05$) when orientation and species were considered for the different seasons for weeks 2 and 32. There were also significant differences for orientation, except for spring, where the P values were slightly greater than 0.05 for both week 2 and 32. There were significant differences for all seasons for all species with $P < 0.05$ for both data sets.

DISCUSSION

In all seasons, the highest rates of bark plug re-attachment was at an orientation of 0 degrees, which was to be expected. For several species, inverting the original orientation of the bark plug (180 degrees) yielded the second highest rate of successful re-attachment. Orientation of 90 and 270 degrees were generally the least successful, and their rates were different. The successful re-attachment at other orientations is surprising given the complexity of the phloem and bark tissues involved (Grebe 2004), but can perhaps be explained by the juvenile nature of the trees used in the experiments and the plasticity of callus tissue (David–Schwartz and Sinha 2007).

Polarity is an important aspect of successful budding and grafting, and the directional movement of hormones contributes to their effects on plant tissues (Hartmann et al. 2010; Yin 2012). Based on research into budding and grafting success (Grebe 2004; Aloni 2015), it was not expected that rotating the bark patch plugs through 90, 180, or 270 degrees would have resulted in successful re-attachment. However, there were successes, which suggest that over the volumes of plant tissue that the patches involved there were sufficient concentrations of IAA and cytokinins for callus production. The species differences in the responses to patch rotation were consistent with research showing that different species can respond differently to hormone concentrations that are influenced by the rate of transport and the sizes of the cells through which they are transported (Olmstead et al. 2006; Sawchuk and Scarpella 2013; Aloni 2015).

Different species responded differently to the treatments imposed, which is consistent with research showing that there are important species differences in cambial activity and callus formation (Kramer and Kozlowski 1979; Mercer 1979; Santamour 1987b; Neely 1988b; Shigo 1991; David–Schwartz and Sinha 2007; Olmstead et al. 2007). Banksia integrifolia proved well-suited to the bark plug treatments, and there were high rates of attachment for all orientations and for most seasons, except summer. In contrast, for P. radiata, all of the bark plugs remained unattached. This species is particularly resinous and quickly deposited significant quantities of resin in the wound area, completely sealing the cork borer wounds and making re-attachment difficult. The resin acts as a barrier to the rapid diffusion and transport of hormones such as IAA by blocking xylem tissue, and so callus production is low (Aloni 2015).

Given that these treatments were imposed as a means of providing data on the potential for successfully grafting bark on wounded trees, the successful re-attachment of bark plugs at all orientations indicates that while tissue alignment does have an effect on the success of bark plug re-attachments, the tissues do not necessarily have to be aligned perfectly (Thair and Steeves 1976). What this means for an arborist is that there is some margin for operator error when grafting bark tissue in the field. Similarly, when considering seasonal effects, while spring would appear to be optimal for successful bark plug re-attachment, there can be success at other times of the year. This may be important, as a practising arborist cannot choose the time of year that wounds occur and need treatment. This also widens the opportunity for arborists to consider attempting bark

Weeks	*Pinus radiata*				*Banksia integrifolia*				*Platanus × acerifolia*			
	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut
2 weeks	0	15.0	0	0	52.5	87.5	10	85.0	0	2.50	62.50	0
4 weeks	0	15.0	0	0	45.0	87.5	7.5	40.0	0	2.50	57.50	0
8, 16, 32, 64 weeks	0	0	0	0	45.0	87.5	7.5	40.0	0	2.50	57.50	0
Weeks	*Quercus robur*				*Quercus robur*				*Eucalyptus viminalis*			
	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut
2 weeks	10.0	70.0	10.0	20	10.0	62.5	27.5	42.5	57.5	90.0	52.5	10.0
4 weeks	10.0	67.5	10.0	7.5	10.0	27.5	22.5	42.5	35.0	40.0	7.5	10.0
8 weeks	10.0	27.5	10.0	7.5	10.0	10.0	22.5	37.5	30.0	30.0	7.5	10.0
16, 32, 64 weeks	10.0	0	10.0	7.5	10.0	10.0	22.5	17.5	30.0	30.0	5.0	10.0

Table 5. Success (%) of bark plug re-attachment in six tree species 2, 4, 8, 16, 32, and 64 weeks after treatment after orientating in winter, spring, summer, and autumn (n = 10 for each treatment).

Logarithmic likelihood values for Logarithmic regression analysis								
	Winter		Spring		Summer		Autumn	
Week	2	32	2	32	2	32	2	32
Full model	-56.97	-57.97	-79.52	-43.77	-44.16	-45.32	-53.71	-39.12
Orient & species	-63.60	-65.52	-90.62	-46.38	-61.81	-50.91	-68.38	-48.03
Species	-80.96	-77.97	-97.94	-57.11	-100.31	-75.94	-76.26	-68.62
Patch	-114.34	-93.95	-157.49	-118.11	-111.75	-89.88	-131.64	-72.32
P values derived from logarithmic regression analysis								
	Winter		Spring		Summer		Autumn	
Week	2	32	2	32	2	32	2	32
Parameter	df							
Interaction	15	0.582	0.419	0.102	0.990	0.002	0.0.739	0.015	0.72
Orient/Species	3	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001
Species / Orient	5	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Species	5	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Orientation	3	0.001	0.001	0.053	0.056	0.001	0.001	0.034	0.001

Table 6. Logarithmic regression analysis of patch graft success at 2 and 32 weeks for all species, orientations and seasons using the logarithmic likelihood of the model fitted (n = 10 for each treatment).

grafting for most species; however, grafting deciduous species in winter is unlikely to prove successful.

The statistical analysis of data for weeks 2 and 32 using logarithmic regression investigated whether successful re-attachment depended on i) species, ii) plug orientation, and iii) an interaction between species and plug orientation. In all cases except for autumn week 2 and summer week 2, successful plug re-attachment depended on both species and orientation. The data for autumn week 2 and summer week 2 indicated that success depended on species or orientation. However, the data for week 2 were early in the experiment and were not always indicative of the long-term success of re-attachment, but data obtained on success at week 32 did not change thereafter.

The use of small bark patch plugs and seedling trees as a model system for investigating the behavior of larger trees has limitations, but it also has advantages. Research suggests that the interaction of phytohormones and cambial tissue in the production of callus is consistent in plant tissues regardless of age (Nakamura et al. 2012; Koepke and Dhingra 2013; Sawchuk and Scarpella 2013; Aloni 2015). Furthermore, by using small plugs, the concerns over using vertically aligned multiple plugs is reduced, as one is unlikely to get variation in hormone concentrations that might impact on tissue responses and callus production if wounds and plugs were larger, because the volume over which the hormones are transported and diffuse is small, which provides a consistent and even concentration (Aloni 2015).

The practical issue of where one gets material for the bark patch can be resolved if the patch is to be placed over a living branch, as the material can be sourced from the branch itself (Figure 1). If the patch is to be placed on the trunk, then the bark may be sourced from a branch that would be sacrificed and patched, or as in repair or bridge grafting, material may be specifically grown for patch grafting using clones or seedlings of the same parent plant or trees of the same species (Smith 2008; Moore 2013).

Overall, the results of the experiment are conclusive. The comparatively poor re-attachment rates at 90 and 270 degree orientations confirm that attempting to replace bark tissue at the right orientation enhances the potential of successful re-attachment in all seasons, and greatest success was achieved when tissues were re-attached at their original orientation in spring. Spring appeared to be the best season for patch grafting, perhaps because increased sap flow allowed rapid callus growth (Neely 1988a; Clearwater et al. 2007). Increased sap flow may also affect the viability of attached patches by shortening the time taken for a viable graft union to form.

Bark patch grafts need protection from desiccation for the first two to four weeks after grafting, which is consistent with well-documented horticultural grafting procedures (McDougall and Blanchette 1996; Hartmann et al. 2010). Grafts larger than 100 mm in diameter may also need to be secured in position.

The following are suggestions for successful patch graft re-attachment:

- Bark patch grafts should be applied to a trunk wound or branch stub as soon as possible after wounding or pruning.
- The wound site needs to be kept clean and moist while preparing the bark patch graft. The material for the patch may come from the damaged bark, or from fresh bark taken from a limb removed from the tree.
- The edges of the wound and the bark patch graft must be as clean and neat as possible to ensure good cambial contact and to minimize the risk of disease.
- The bark patch grafts should be placed in cambial contact that ensures the maximum amount of cambial alignment.
- The orientation of the tissue should be as close as possible to the original (0-degree change).
- The bark patch graft should be tightly covered with budding tape (or similar) for at least two weeks, and up to four weeks.
- If the bark patch graft is not attached when the wound area is uncovered, remove the patch and allow natural callus growth to enclose the wound.

Bark patch grafts are most successful in spring, so every effort should be made to perform elective bark patch grafts during this season. The use of bark patch grafts may mean that the removal of a tree limb could be less of an eyesore. Covering the wound with a bark patch graft conceals the fact that a limb has been removed and hides obvious scarring, while at the same time the risk of disease and stress to the tree may be reduced by closing the wound more quickly than would normally occur due to natural callusing. The use of bark patch grafts provides arborists with a method of dealing with tree trunk wounds caused by vandalism and accidents, and would be particularly useful if a tree was of special, historic, or environmental significance to the landscape.

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Education

Biology of Callus and Woundwood, an ISA Continuing Education Unit article

By Christopher J. Luley

Tree response to wounding has attracted much attention from pathologists and botanists for the past two hundred years (Stobbe et al. 2002), and man has been attempting to treat tree wounds for over 4,000 years (Neely 1979). The reaction of trees to wounding is also a topic of importance to arborists who regularly wound trees by pruning, and are also called upon to evaluate tree response to wounding in risk and Plant Health Care assessments (Fig. 1).

Historically, wound response has been divided into wound closure (new growth formed after the wounding event and discussed in this article) and compartmentalisation (various responses of pre-existing tissues) (Shigo 1984). Two terms have dominated the discussion of wound closure, callus and woundwood. Understanding these terms has been a source of confusion for both scientists and arborists. This article will review the biology of callus and woundwood formation, and demonstrate how this knowledge can provide diagnostic information about overall tree health, reaction to pathogens and insect pests, tree stability, and forensics.

Callus v. Woundwood

Unfortunately, the term callus has been used interchangeably with the term woundwood almost since the terms were coined. According to Wikipedia, callus was first used in the early 18th century to designate cell growth in elms after wounding (Wikipedia 2015). Küster (1913) later identified callus as "homogeneous, parenchymatic" and "very thin walled, undifferentiated cells" (Fig. 2) generally lacking lignin (Shigo 1989). Ikeuchi et al. (2013) indicated the term is now used more broadly in botany to describe disorganised cell masses, citing several references that suggest varying levels of genetic and organ differentiation can occur in a callus. Fink's (1999) authoritative discussion of callus represented the historic, more conservative definition; he referred to it as undifferentiated parenchymatic proliferations frequently of mixed origin but finally having a homogenous appearance.

In contrast, woundwood is highly organised wood with lignin (Shigo 1989). The term was coined by de Vries (Hartig 1894) when he observed that wood formed after wounding had shorter than normal cells with a scarcity of vessels and medullary rays (Hartig 1894) (Fig. 3). Küster (1913) broadened the term woundwood to include tissues formed after wounding that appeared similar to wood (Fig 4).

So, why the confusion? It likely stems from several facts. One is that callus formation initially precedes woundwood but soon (within months) differentiates to produce vascular cambium, which then produces woundwood. So callus is quickly obscured by this developing woundwood and is seldom observable—except in the initial weeks or months after its formation. Therefore, the tissue visible to arborists in the years after wounding is woundwood, while the tissue it is initially generated from is callus.

Despite the clear anatomical and functional differences between woundwood and callus, many arborists, older scientific publications, and even some recent texts still use the terms interchangeably. A closer look at the biology of callus tissue and woundwood formation will help explain why confusion persists in the scientific and arboricultural world, and why proper use of these terms is important.

Figure 1a

Figure 1b

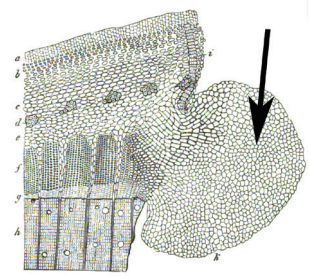

Figure 2a

Figure 2b

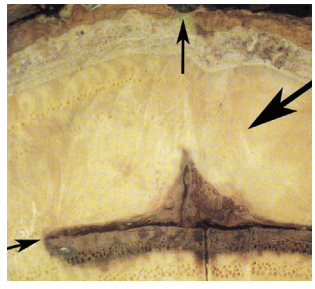

Figure 3

Figure 4

Callus and Woundwood Biology

Woundwood develops from callus or from uninjured vascular cambium at the margin of injuries that have damaged or exposed the phloem, vascular cambium, or sapwood (Fink 1999). These wounds also result in a biochemical and physical reaction of pre-existing tissues that contribute to compartmentalisation (Shigo 1984). Shallow wounds that damage only the outer bark do not stimulate the production of woundwood. Bark reacts to wounding in its own distinct way by forming wound or necrophylatic periderm (see Hudler 1984 for a good discussion of this process). However, cells in the phloem or inner bark can contribute to the formation of callus and woundwood (Fig. 2). (The biology of compartmentalisation, and the formation of necrophylactic periderm, are complex and will not be discussed further here.)

Callus

Callus development can be detected within weeks in actively growing trees, usually after cells on the edge of the wound die. Callus is produced by enlargement (hypertrophy) or increased division (hyperplasia) of cells adjacent to the edge of cell dieback.

Figure 5

Figure 7

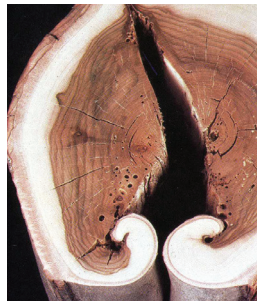

Figure 8

Figure 11

Figure 13

Figure 6

Figure 9

Figure 12

Figure 14

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Callus

Callus development can be detected within weeks in actively growing trees, usually after cells on the edge of the wound die. Callus is produced by enlargement (hypertrophy) or increased division (hyperplasia) of cells adjacent to the edge of cell dieback. Living cells without secondary cell walls can produce callus, including sapwood ray parenchyma, vascular cambium, and parenchyma cells in the bark (Küster 1913; Neely 1979). If patches of bark are removed that leave behind cambium and undifferentiated xylem, callus can form directly on the surface of the wound. Because of this, bark, cambium, and woundwood can re-form on trees even when large patches of bark are removed (Fig. 5). Stobbe et al. (2002) showed for Tilia that callus on the surface of these injuries had formed wound periderm (bark) before the formation of vascular cambium.

Cells from the vascular cambium usually contribute significantly to callus, but callus can also form from living ray cells in the absence of living vascular cambium (Noel 1968). Regardless of the origin of the callus, a new vascular cambium can form from it and produce woundwood xylem and phloem.

After vascular cambium formation, the callus cells no longer divide but lignify while retaining their isodiametric shape. This means that the cell dimensions are about the same in all directions (Kevin T. Smith, USDA Forest Service, pers. comm.). The new vascular cambium continues to divide and covers the callus from which it was derived.

Callus growth itself can seal small wounds, or form extensively over larger surfaces when larger patches of bark are removed, but it is usually covered over by woundwood within the first growing season. The rate of callus formation varies due to several host and environmental factors, but is usually fastest on young or fast-growing trees. Callus and woundwood growth varies considerably amongst tree species (Neely 1979; Marshall 1931) and has been related to insect pest resistance, such as the red oak borer in red oak (Fierke and Stephen 2008).

Callus can be formed by most organs of trees, including stems, roots (Fig. 2b), leaves, and fruit (Küster 1913). Once formed, callus is totipotent, meaning it can be induced to form the entire plant (Ikeuchi et al. 2013), or individual organs, such as shoots (Fig. 6), roots (Fig. 7), or buds. It has long been known, as a result of in vitro culturing, that varying ratios of the plant hormones auxin and cytokinin influence what type of organs develop from callus.

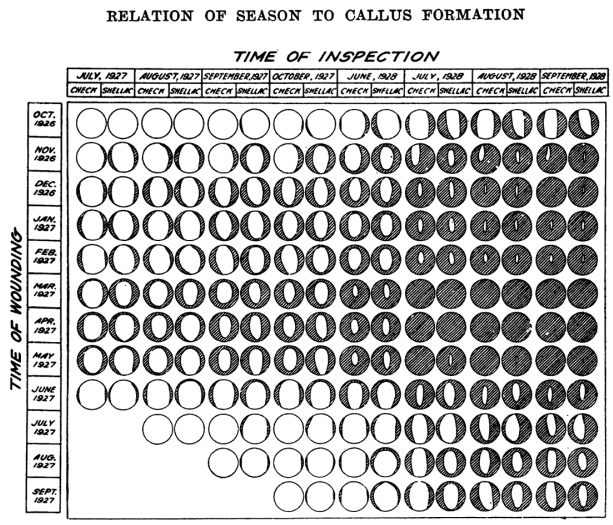

Figure 10

Vascular Cambium and Woundwood

Woundwood forms from vascular cambium that differentiates from callus, or can form directly from uninjured vascular cambium. Depending on the time of year, callus can develop and vascular cambium can differentiate from it within a few weeks after wounding (Neely 1979; Oven and Torelli 1999; Copini et al. 2014a). Once the vascular cambium is formed, woundwood with xylem (wood) and phloem (inner bark) can grow to start to seal larger wounds not sealed initially by callus.

Vascular cambium produced by callus usually becomes continuous with pre-existing vascular cambium after its formation (Küster 1913). The vascular cambium on both sides of a wound will also join and become continuous if callus and woundwood quickly seal or cover over a wound (Fig. 3). Shigo (1989) pointed out that natural cracks may form where woundwood and callus initially join and seal a wound, and this can be the source of future seams or cracks that never completely seal.

Normal bark, with its own bark cambium, can form from woundwood or it can extend from existing bark on the edges of the wound. Also, woundwood has no definite or predetermined form but commonly takes the shape of the wound and callus that formed along the wound (Küster 1913) (Fig. 8).

As many studies have shown, woundwood that forms initially is anatomically different than normal xylem sapwood. In conifers, woundwood typically has increased density of resin canals (Oven and Torelli 1999). In deciduous trees, cells have increased lignin content, thicker secondary cell walls, and cells are often shorter than in normal wood (Küster 1913; Smith 1980; Frankenstein and Schmidt 2006). Vek et al. (2012) recently showed that woundwood in beech (Fagus spp.) also contains extractives that are inhibitory to some fungi. With time, woundwood appears essentially the same as normal sapwood (Fig. 4).

Growth of callus and woundwood is faster towards the open face of the wound, presumably because of the absence of pressure from bark and other tissues (Hartig 1894). This effectively helps seal the wound more quickly. Callus and woundwood can seal small wounds [0.5 inches (12.7 mm) or less] in one growing season on fast-growing trees of some species (Neely 1979). Once the wound is sealed or covered by woundwood, further discoloration of the sapwood is slowed (Sinclair and Lyons 2005) and progression of decay may be stopped or inhibited (Fink 1999). Wounds not sealed by woundwood over several growing seasons almost always result in decay. For example, stem wounds larger than one square foot (900 cm2) are twice as likely to become decayed as smaller wounds (Greifenhagen and Hopkin 2000).

Ram's horns are often found on large wounds if the woundwood curls into an opening or cavity formed by the wound or subsequent decay, or if thick bark forms on opposing ribs of woundwood that prevent their confluence (Fig. 8). Ram's horns usually prevent any chance of the wound eventually sealing (Shigo 1989) (Fig. 9).

Research by Kane and Ryan (2003) showed some red maples have woundwood that is tougher and denser than normal sapwood. This appears to support common knowledge of the elevated strength and toughness of woundwood, and its use in hand tools where these characteristics are advantageous.

Timing of Callus and Woundwood Formation

Callus and subsequent woundwood development closely track cambial activity in trees. Numerous research articles have reported that wounds made after growth ceases, or made during the winter, will not form callus and woundwood until the next spring. These wounds will also seal more slowly once growth resumes (Fig. 9). Dieback around wounds is also greater when wounds occur in autumn (Neely 1988). Conversely, callus and woundwood formation is fastest after wounding, and the amount of woundwood produced is greatest (and wound closure is therefore fastest) on wounds made shortly before or early in the season of active tree growth. Recent research has also shown that callus and woundwood can form even when trees are dormant, if temperatures are moderate (Copini et al. 2014a).

The Heal v. the Seal

Shigo (1989) taught that wounds do not heal in the sense of restoring or replacing damaged tissues in the same spatial position. Rather, trees replace lost tissues and their function by sealing or closing over the wound surface. Both callus and woundwood can seal wounds, but woundwood is the tissue that seals larger wounds in trees and returns the function to the stem. It is generally accepted that wound dressings are not needed and generally do not increase wound sealing or decrease decay, possibly because of their inhibitory effect on callus and woundwood formation. However, some studies have shown that Shellac® and Lac Balsam® can increase initial wound closure on some species depending on the time of the year they are applied (Marshall 1931; Hudler and Jensen-Tracy 2002). McDougall and Blanchette (1996) showed that polyethylene plastic wrap increased callus and reduced dieback around wounds when applied right after wounding on certain tree species. This effect may have been due to the enhancement of conditions, such as high humidity, which apparently fosters callus development along the edge of wounds (Hartig 1894).

Woundwood Assessment

Woundwood is considered a type of response growth that requires evaluation in tree risk assessment (Smiley et al. 2011). Close observation of the presence or absence of woundwood, the amount and rate of formation, and its age can provide valuable information on when wounds occurred, tree health, and infection and resistance to pests.

Presence or absence of woundwood formation is a key

observation. Lack of woundwood formation after a full growing season can be due to several factors, some of which can have implications for tree health and the capacity of trees to contain decay or other pests. Neely (1988) indicated callus growth is regulated by basipetal (crown to root) flow of carbohydrates and growth regulators. Callus and woundwood may not develop, or develop slowly, if radial growth is slow in a particular area (Neely 1988). Physical restrictions, such as included bark, may also inhibit callus and woundwood formation after a branch is removed (Shigo 1989). Shigo (1989) also showed how the evaluation of woundwood around pruning wounds indicates whether a branch was pruned properly (Fig. 1).

Absence of woundwood formation can mean the tree did not have adequate vitality (measured in this case as available growth resources) to support its growth (Fig. 11) or the tissues were damaged beyond response before, during, or after wounding. Absence of woundwood formation may also be due to the presence of pathogens (usually fungal) that are killing the tissues involved in woundwood response (Fig. 12). In both cases, absence of woundwood formation is an indicator that a tree's defense mechanisms are likely compromised, and could indicate decay or other pathogens are not being slowed by active tree defense responses.

Forensics

As woundwood grows, it produces annual rings the same as annual growth increments in normal wood. On some species, annual increments of bark and woundwood growth can be seen on the surface of the woundwood (Fig. 13), providing a general indication of the age and rate of woundwood formation. Species differ in their rate of woundwood production (Marshall 1931; Neeley 1979), and so species differences should be accounted for when assessing woundwood production.

Internally, woundwood forms annual wood growth increments as in normal xylem growth. Counting these annual increments is a reliable method to age wounds, as well as cavities or decay columns that formed after a wound (Fig. 4). The year and time of year that insect borer pest damage occurred have been dated using this method (Copini et al 2014b).

Woundwood formation along a crack can also provide evidence for the presence and age of cracks between codominant stems or branch unions (Fig. 14), or in wood before or after a stem failure. Assessment of the woundwood can therefore provide evidence of the location, age, and length of the crack.

Summary

Callus is formed first in response to wounding by cells in the bark, cambium, and sapwood. Shortly after its formation, it differentiates to form woundwood. Initially, woundwood is anatomically different from normal wood. The rate of callus and woundwood formation is influenced by species, tree health, and the time of year a wound occurs. Callus and woundwood formation are fastest when wounds are made just before the growing season starts or when cambium is actively growing. Once woundwood or callus seals a wound, discoloration and decay of sapwood are slowed or may not develop further. Evaluation of callus and woundwood formation can provide evidence of when the wound occurred, tree health, and the response of a tree to pest attack.

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Contact NZ Arb for full list of literature cited in this article

Education

Trees for Habitats

Habitat creation in trees for the New Zealand environment

By Fredrik Hjelm

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Hollows occur naturally in the old grove forests, mature exotics and native trees around New Zealand, and provide an opportunity to encourage biodiversity in our environments. Natural hollows are a direct result of physiological stress to the tree, when the heartwood is exposed to the environment. This can be caused by environmental factors, fungi, bacteria, insects, natural canopy reduction and age. (Figure 1)

Pruning for Biodiversity

Hollows for habitat creation can also be encouraged by human intervention. Pruning for biodiversity is commonly done in Europe, America and Australia and is called habitat pruning, eco-pruning or fracture pruning. These types of pruning involve simulating natural break-outs in the tree to leave natural-looking stumps and branch tear-outs. The Oak in Figure 2 has been left in Auckland Domain and is a great example of how declining trees can be an asset in speeding up the senescence in a tree and encouraging decaying wood to harbour a bigger biodiversity.

Factors to consider when creating habitats:

- Various entrance hole and cavity sizes which will determine the different types of wildlife that might use them
- Protection from predators and pests
- Light minimisation for nocturnal wildlife
- Drainage
- Association with food crops
- Introduction of guano to encourage roosting sites
- Use of a vegetable oil as lubrication for your chainsaw bar
- Protection against prevailing wind and weather

Habitat Creation in Trunk Wood

By chainsawing into the heartwood, habitats can be customised for numerous wildlife species. Here is an example of habitats we created for the long-tailed bat in standing trunks. (This requires good chainsaw knowledge as many of the cuts use the tip of the bar and can promote dangerous kickback.)

LONG-TAILED BAT HABITAT:

Cut into the trunk horizontally with two cuts at the desired height. Bore cut the face plate out. Bore into the wood and make the chosen number of chambers. Cut the chambers into a fork-shaped pattern with the horizontal cut meeting the entrance hole (as shown in the picture). The entrance needs to be on a slope so it works as drainage. The size of the sloping entrance should be 17–21mm for long-tailed bats. Make sure the chambers are smaller than the face plate so that the hollow will be sealed. Drill into the face plate and then screw the face plate back on to the wood. (Figures 3a-3c)

Human-made constructions

Human-made constructions are also an alternative. Here is a bat house made for long-tailed bats; there are endless ways to make them and numerous materials that might be used. These constructions could harbour any type of wildlife depending on construction type. (Figure 4)

Pest Proofing

Pest proofing the tree is important. On the trunk of the tree, below where the habitat is to be created, it is a good idea to mound around the tree's circumference a metal, aluminium or plastic sheath that predators cannot climb above. We tend to use polycarbonate joined with aluminium as it does not visually degrade the integrity of the tree as much. Make sure to prune neighbouring trees well clear of the host tree as possums can easily jump from one tree to another. For living trees, the pest guard needs to be revisited and checked to allow the expansion of the trunk.

PEST GUARD EXAMPLE

Measure the tree and cut out the polycarbonate (60mm wide) with a 20mm overlap for joining with the aluminium bracket. Drill into the aluminium and make three holes. Match up the middle hole with the plastic and drill into the plastic. Tape the plastic tight to the tree and insert the aluminium bracket underneath the plastic. Pop rivet the middle hole through the aluminium bracket and plastic. Pull the plastic together and match up the top and bottom drill holes in the plastic and the aluminium bracket. A piece of wood could

Figure 1

Figure 2

Figure 3a

Figure 3b

Figure 3c

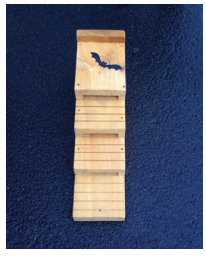

Figure 4

Figure 5

come handy to make sure there is no drilling into the tree. If the tree has a natural taper, the guard can be moved downwards to get it as tight as possible. (Figure5)

Relocation of Habitats

Relocation of habitats is sometimes required. For example, relocation would be needed in tree failures or trees that are condemned for removal. The tree wood containing the habitat can be safely lowered to the ground by rigging and can be re-erected onto living trees. With the help of familiar pheromones, the wildlife could have a better chance of finding their way to the new roosting site. This has been shown to be successful for bats in the UK and we are now making trials in New Zealand and are excitedly awaiting results. Many trees are being removed to ground level in urban environments due to factors such as:

- Changes in RMA
- Urban development
- Diseases and pests, such as Kauri Dieback, Dutch Elm and Cypress canker
- Declining and dying trees for public and structural safety
- Landscaping trends and poor knowledge.

By using some of the techniques discussed in this text, we could enhance biodiversity by leaving trunks as new habitats and still ensure safety for the public.
"We should always remember that the description 'dead wood' implies a static state, without consideration for the process of decay and the diversity of lifeforms involved." (Andrew Cowan).

Revegetation

For revegetation we could also apply some of these techniques to use in existing exotic trees. We might also use fast-growing exotic trees that could be transformed into desirable nesting spots to harbour many species essential to our ecosystem before the native trees reach their maturity. As one tree species might be a problematic weed in Auckland but considered a specimen tree in the Waikato, it pays to talk to local Arborists, council, DOC or environmental organisations. Some factors to consider are:

Will these trees become a weed infestation? What would you like to attract – invertebrates, birds or bats? Could the temporary exotic tree be easily be killed off after a desired period of time? Heavy fruiting and flowering could work as a food crop for birds but also pests. Will they naturally be good species to create hollows? What has been used in other projects around your area?

About the Living Tree Company

The Living Tree Company is an Auckland-based environmental arborist company with a passion for maintaining and improving New Zealand's unique natural environment. We are currently taking part in various trials for habitat creation and other ecological and arboreal projects. We believe the more work we do together the bigger and stronger the impact we can have. Please contact us with any enquiries or to share information. This is an introduction to habitat creation in trees for the New Zealand environment. The text is prepared from an arboricultural standpoint and is to be used as an introductory discussion for ecologists.

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- Twin hydraulic feed rollers
- No-stress power control
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Christmas break

Please note that the NZ Arb office will be closed COB Wednesday 20th December 2017 and will return on Monday 8th January 2018.

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Gaining NZ Arb Approved Contractor status is demonstrating your company's commitment to quality. This point of difference will be what helps to separate you from the field, amongst your competitors. Benefits of becoming an Approved Contractor:

- **Potential access to local body works and industry contracts;**
- **Continuous improvement, quality and investment;**
- **Use of the New Zealand Arboricultural Association Approved Contractor logo and advertising;**
- **Promotion on the New Zealand Arboricultural Association website**

To become a NZ Arb Approved Contractor visit the NZ Arb website (www.NZArb.org.nz) and download the Pre-Approval Guide here

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