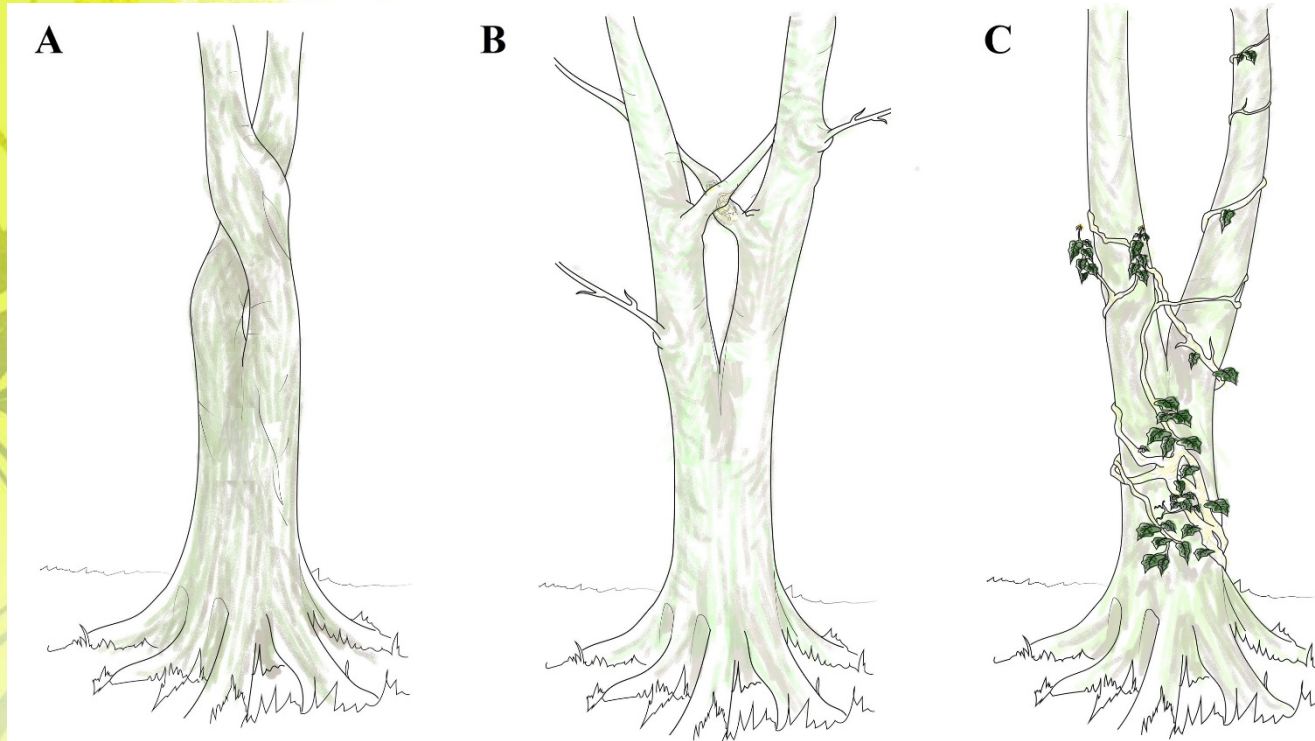




# Natural Bracing in Trees: INDUSTRY QUESTIONNAIRE

Duncan Slater BSc BA MSc PGDip PhD MArborA MICFor

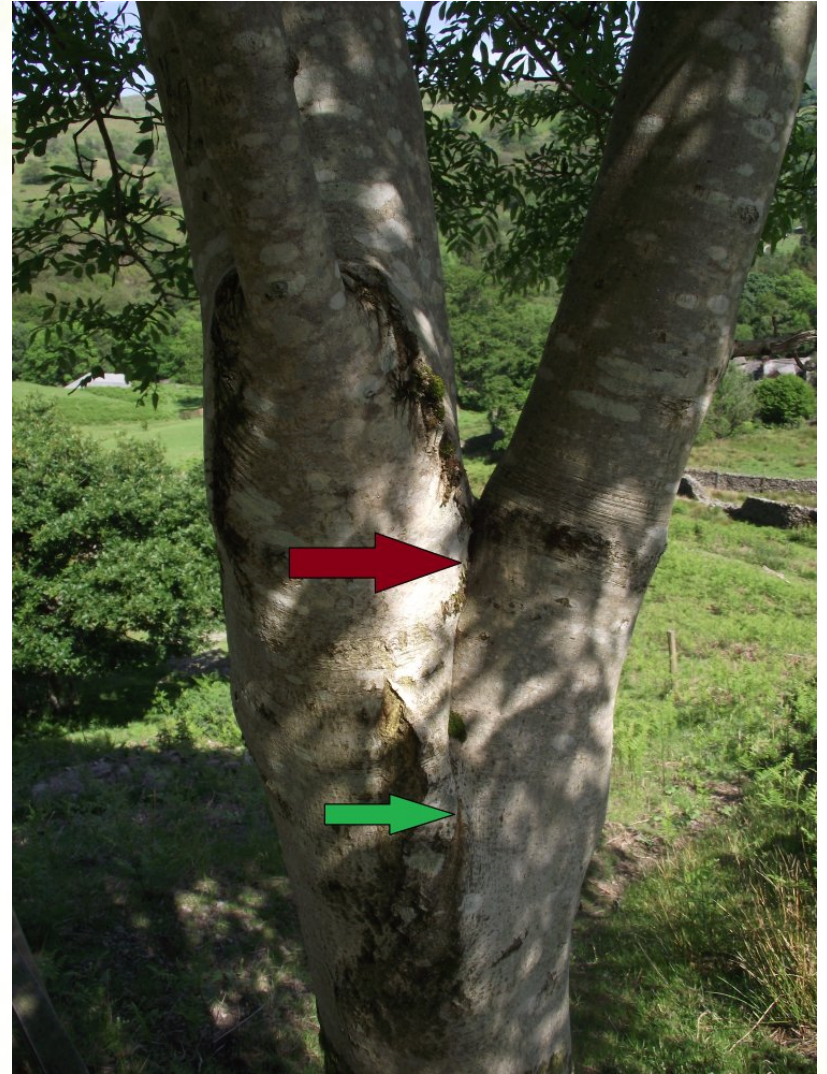


# A brief introduction into natural bracing

# Definition

- A '**natural brace**' is a structure formed above a junction, in the crown of a tree, which restricts the junction's movement.
- Without mechanical stimulus, the centre of a junction will not develop normally.
- A bark-included junction will develop in this situation (in most cases)

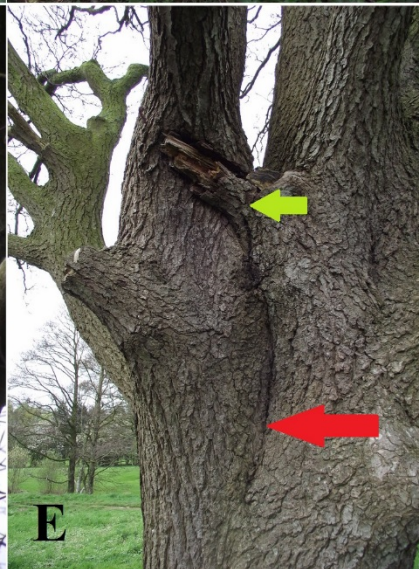
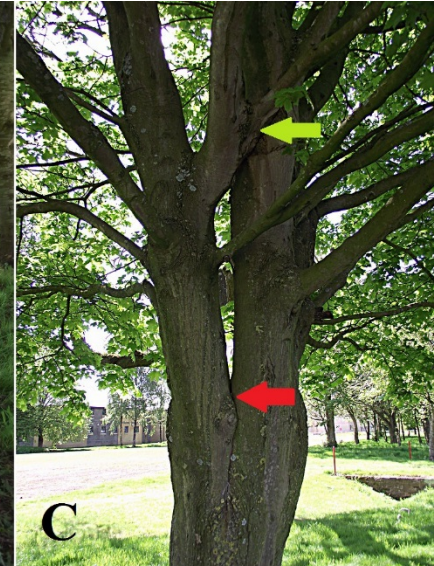
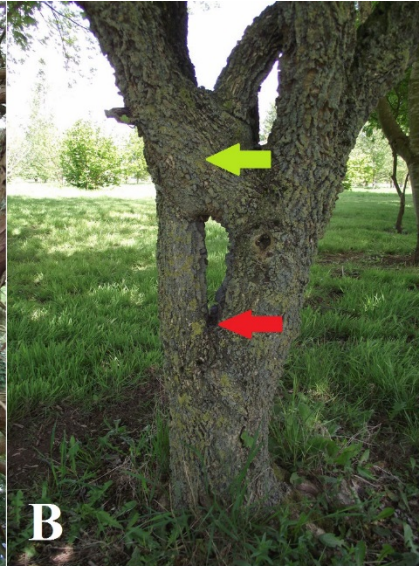
# An example of natural bracing



# An example of natural bracing



# A very common phenomenon





**Braced**

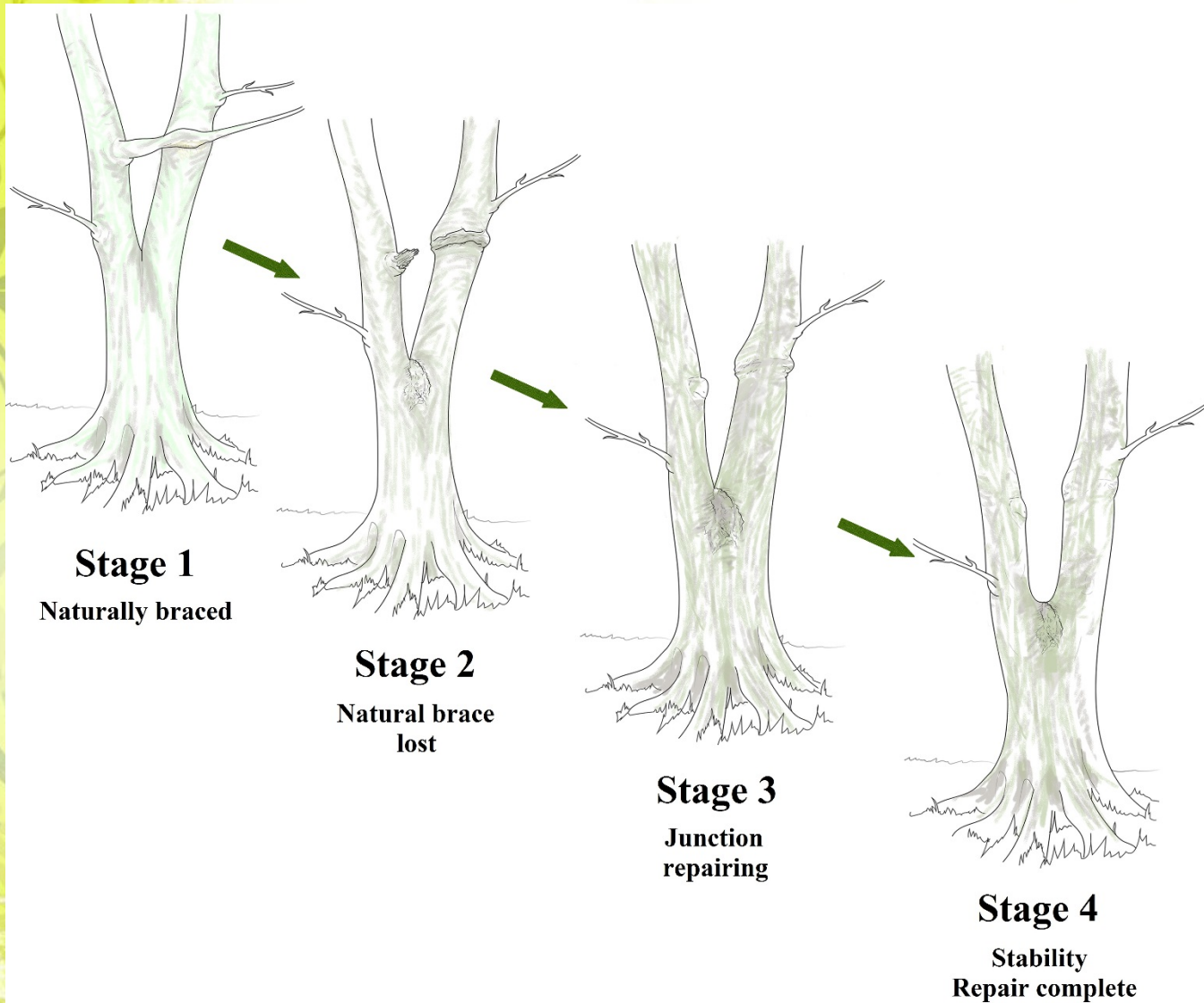
**Free to move**

**Long  
Bark  
Inclusion**

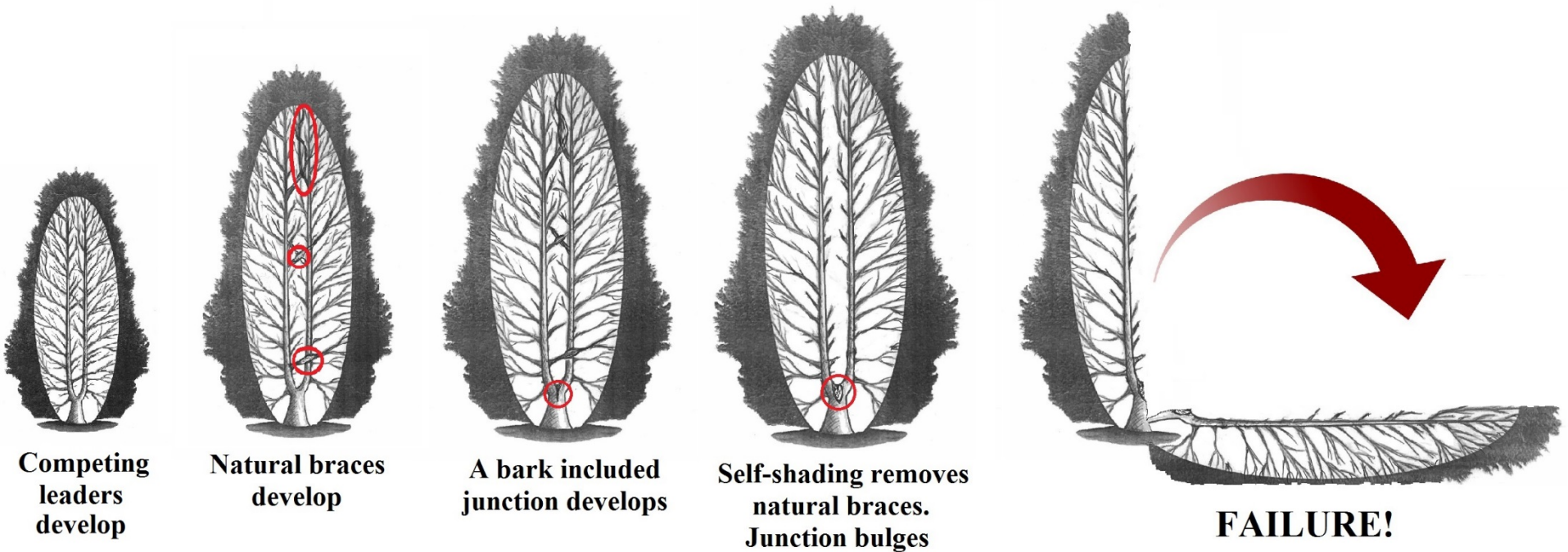
**Long  
BBR**

**Long  
BBR**

# The effect of natural bracing...



# Natural bracing can explain a lot of tree morphology and failures



Do arborists cut out natural  
braces?... Unfortunately, yes!



# Key outcomes from this research

- The primary cause of BI junctions is via natural bracing
- We can formatively prune trees to prevent the creation of BI junctions
- BI junctions should be assessed by taking into account any natural bracing – they do not inevitably fail
- Tree pruning guidelines and standards need to be updated

# Education & Training changes

- 1985 model for branch attachment ✖
- “Compression forks” ✖
- Axiom of uniform stress ✖
- That if a BI junction has large bulges associated with it, it is by default more dangerous than one with no or only small bulges associated with it ✖

# Large bulges around BI junctions





# Industry Questionnaire

# Questionnaire Details

- Data comes from eleven Fork Workshops run between August and September 2016
- Completed by 348 attendees
- Some fantastic results from this questionnaire:
  - Individualism evident,
  - but mostly agreement...
- Submitted as a paper to the Arb Journal

# Question 1

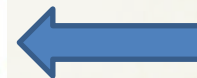
- Average years of experience:  
**19.1 years**
- Cumulative years of experience:  
**6,635 years**
- That's a lot  
of arb experience!!!



# Question 2

## Academic/Training Level:

<b>Entry</b>	<ul style="list-style-type: none"><li>• Entry level Certificates</li><li>• Skills for life</li></ul>	<ul style="list-style-type: none"><li>• Entry level Awards, Certificates and Diplomas</li></ul>
<b>1</b>	<ul style="list-style-type: none"><li>• GCSE grades D - G</li><li>• Key Skills level 1</li></ul>	<ul style="list-style-type: none"><li>• BTEC level 1</li><li>• OCR Nationals</li><li>• FLT Pathways</li></ul>
<b>2</b>	<ul style="list-style-type: none"><li>• GCSE grades A* - C</li><li>• Key Skills level 2</li></ul>	<ul style="list-style-type: none"><li>• BTEC level 2</li><li>• Functional Skills level 2</li></ul>
<b>3</b>	<ul style="list-style-type: none"><li>• AS-/A-levels</li><li>• International Baccalaureate</li><li>• Key Skills level 3</li></ul>	<ul style="list-style-type: none"><li>• BTEC level 3</li><li>• OCR Nationals</li></ul>
<b>4</b>	<ul style="list-style-type: none"><li>• Key Skills level 4</li><li>• Certificates of Higher Education</li></ul>	<ul style="list-style-type: none"><li>• BTEC Professional Diplomas, Certificates and awards</li></ul>
<b>5</b>	<ul style="list-style-type: none"><li>• Foundation Degrees</li><li>• Diploma</li></ul>	<ul style="list-style-type: none"><li>• HNCs and HNDs</li><li>• BTEC Professional Diplomas, Certificates and awards</li></ul>
<b>6</b>	<ul style="list-style-type: none"><li>• Bachelor Degrees</li></ul>	<ul style="list-style-type: none"><li>• BTEC Professional Diplomas, Certificates and awards</li></ul>
<b>7</b>	<ul style="list-style-type: none"><li>• Masters Degrees</li><li>• Postgraduate certificates</li></ul>	<ul style="list-style-type: none"><li>• NVQs at level 5</li><li>• Advanced Professional Awards, Certificates and Diplomas</li></ul>
<b>8</b>	<ul style="list-style-type: none"><li>• Doctorates</li></ul>	<ul style="list-style-type: none"><li>• Award, Certificate and Diploma in strategic direction</li></ul>



**Average**

# Question 3

## Country of Work:



# Question 5

## Failure Frequencies:

Branches	Bases	BI junctions	Root plates	Stems	Normal junctions	Long branches
3.3	2.3	2.8	2.0	1.6	1.0	1.9
Frequent	Occasional	Frequent	Occasional	Occasional	Rare	Occasional

# Question 6

## Failure mode for bark inclusions:

**A**

Tensile failure



**90.7%**

**B**




Torsional failure



**9.3%**

# Question 7

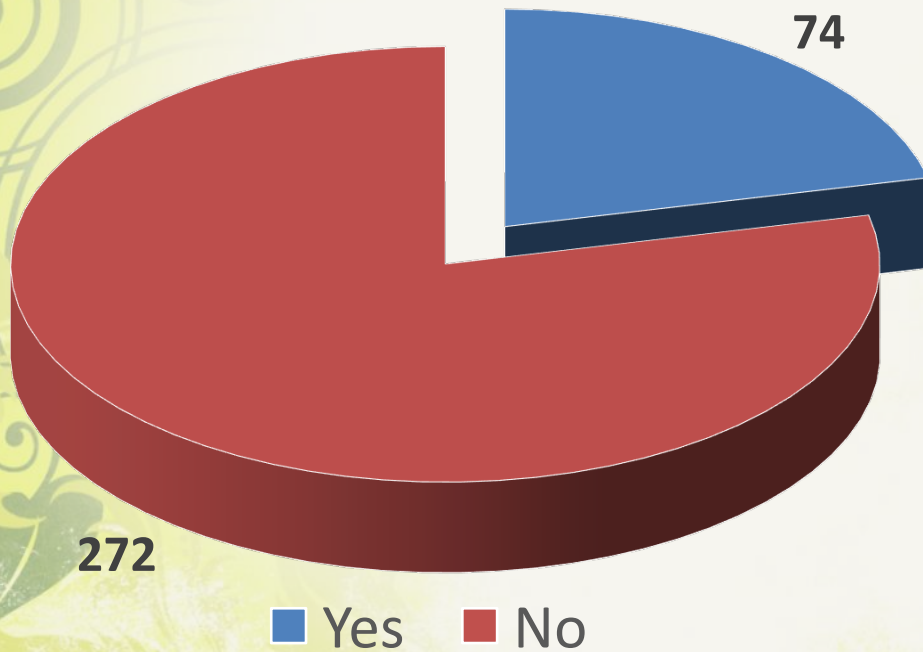
## Photo assessment of three forks:

A	B	C
		
Bulging BI	Cup union	Wide-mouthed
2.96 ✓	2.37 ✓	3.46 ✓
Medium	Low	Medium to High

# Question 8

**Is the failure of a bark-inclusion inevitable?:**

Inevitable?



# Question 9

## Main cause of BI failure:

Storms	Growth pressures	Limb weight with age	Snow loading	Failure of adjacent trees & branches
187	53	94	5	2
54%	15%	27%	1%	0.6%

# Question 10

Norway maple	3.0	Frequent
Hawthorn	1.4	Uncommon
Beech	3.0	Frequent
Ginkgo	1.3	Uncommon
London Plane	2.0	Occasional
Oak	1.7	Occasional
Lime	2.4	Occasional
Leyland Cypress	3.4	Frequent

# Question 11 – Problem Species

<b>Genus</b>	<b>No. of mentions</b>
<i>Acer</i> spp. (maples)	191
<i>Salix</i> spp. (willows)	156
<i>Fraxinus</i> spp. (ashes)	143
<i>Fagus</i> spp. (beech)	114
<i>Platanus</i> spp. (planes)	66
<i>Tilia</i> spp. (limes)	64
<i>X Cuprocyparis</i> (Leylandii)	59

# Question 12

<b>Type of abatement</b>	<b>No. of votes</b>
Minor crown reduction	<b>205</b>
Reduce weight on one limb only	<b>197</b>
Flexible bracing	<b>124</b>
Major crown reduction	<b>115</b>
Fell the tree	<b>84</b>
Monolith	<b>36</b>
Rigid bracing	<b>18</b>

# Question 13: Crossing branches



Failure rating	2.69	
	Infrequently	
Remove rubbing branch?	Yes – 24% No – 76%	
Other actions:	Reduction:	130
	No action:	81
	Monitor:	31
	Cut natural brace:	26
	Install a brace:	42
	Encourage fusion:	12

# Question 14: Fused branches



<b>Failure rating</b>	<b>1.97</b>
	<b>Rarely</b>
<b>Remove natural brace?</b>	<b>Yes – 2.0%</b> <b>No – 98%</b>
<b>Other actions:</b>	<b>No action: 238</b> <b>Monitor: 29</b> <b>Reduction: 49</b> <b>Install a brace: 13</b> <b>Just cut out brace: 3</b>

# Question 15: Cracked Fork



Failure rating	4.78
	Highly prone to failure
Artificial brace?	Yes – 30.6% No – 69.3%
Other actions:	Fell the tree: 173 Crown reduction: 171 Monolith: 51 Pollard: 26 No other action: 2

## Question 16: Bulging BI junction



Failure rating	3.45
	Prone to failure
Crown reduction?	Yes – 69% No – 31%
Other actions:	Brace: 153 Reduction: 58 No further action: 47 No action: 36 Monitor: 29 Fell the tree: 10

# Conclusions

- These answers contribute to understanding the failure mode and common trees in the UK with higher rates of failure at bark-inclusions
- Only two scenarios split the respondents:
  - **Rubbing branches** – 24% of respondents wanted to remove that form of natural brace from a mature tree
  - **Bulging bark-included junction** – more research is needed on their rate of failure and structural strength
- Respondents' level of experience was related to different answers to questions 5 and 12

# WITH THANKS...

- All 348 respondents to this questionnaire
- The Arboricultural Association for helping this to happen
- Have a safe journey 😊

**Duncan Slater** BSc BA MSc PGDip PhD MArborA MICFor