

## **Position identification of spotted hyena (*Crocuta crocuta*) tracks using different methods of data recording and features extraction**

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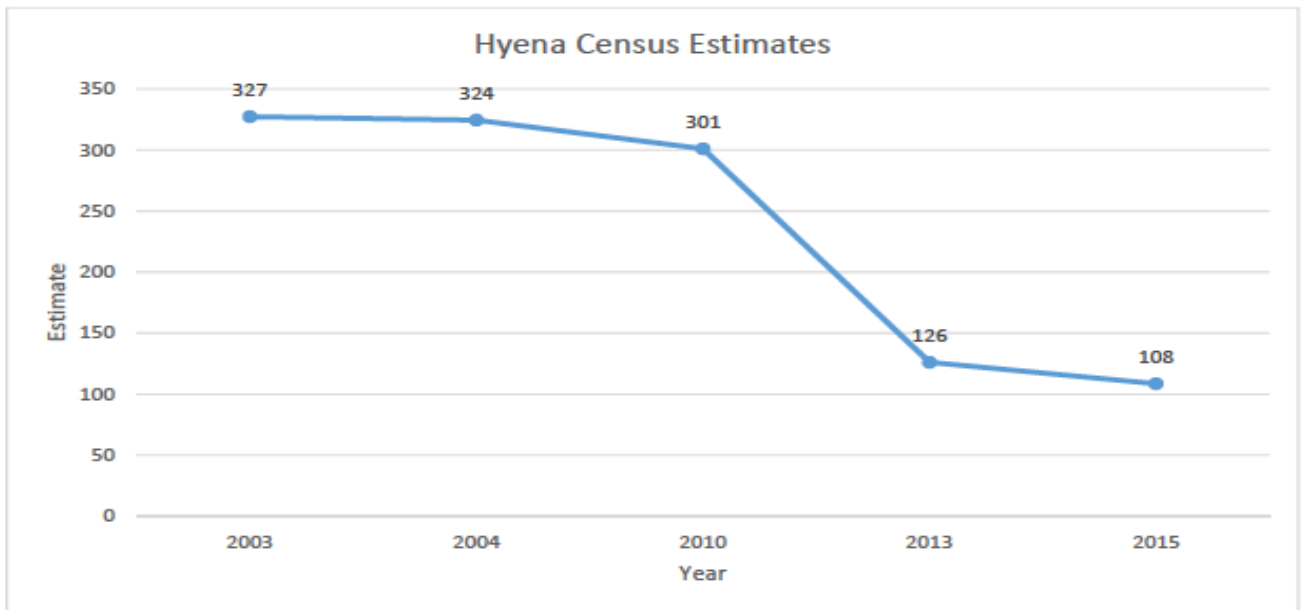
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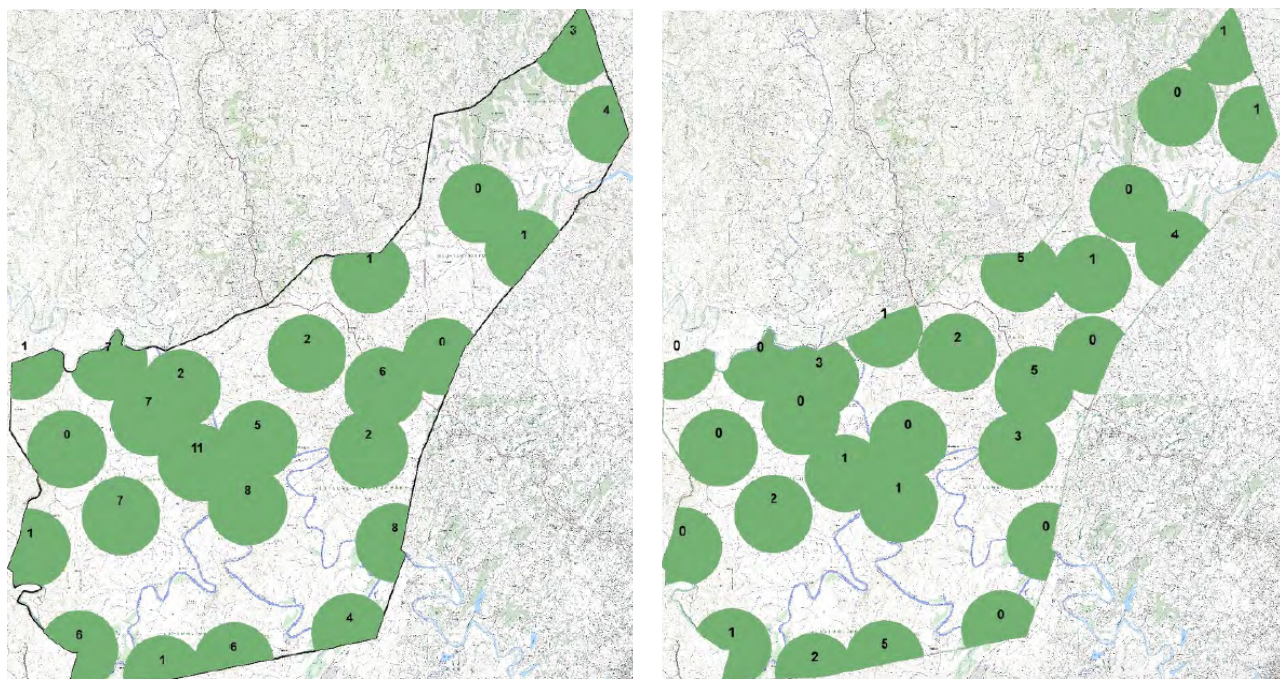
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## APPENDICES

### Appendix A: Evolution of Spotted Hyena population in HiP



**Figure 33** - Census estimates of Spotted Hyena population in HiP from 2003 to 2015 (EKZNW, 2015).



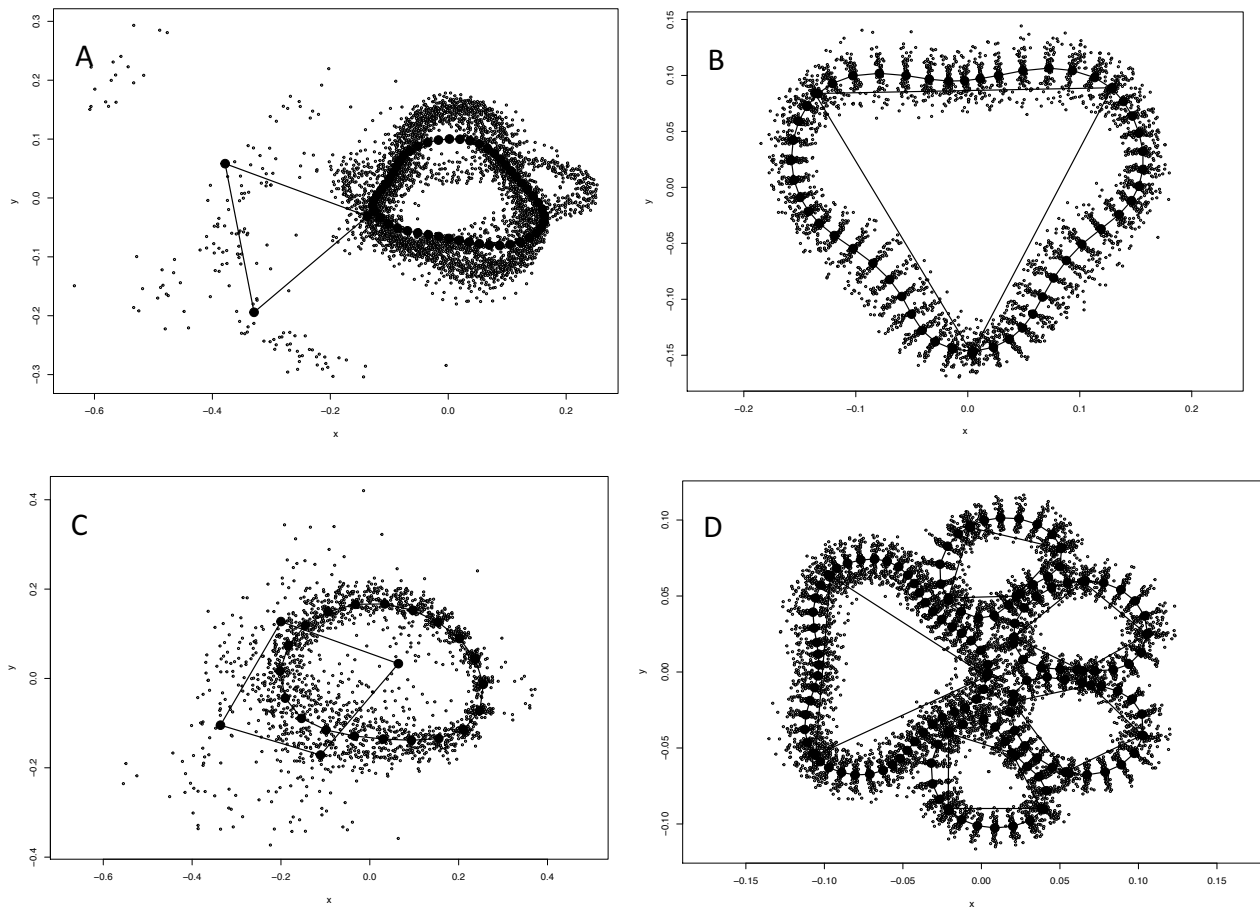
**Figure 34** – Location of the call-ins station for censusing spotted hyena population in HiP, and number of spotted hyenas having responded in 2010 (A) and 2015 (B) (EKZNW, 2015).

## Appendix B: Landmark displacements on 2D-entities

Fixed landmarks were initially digitized in *Geomorph* using the function `digitize2d`. The coordinates of the curve-sliders were exported from ImageJ, as suggested by Sherratt (2015), and joined to the coordinates of the fixed landmarks in a same *Geomorph* array. But after the Procrustes superimposition, displacements such as the one displayed by Figure 34 A, occurred for every pad. We assumed it was due to a modification of the scale of the image when it was imported in *Geomorph*. This scaling issue could not be solved at the time.

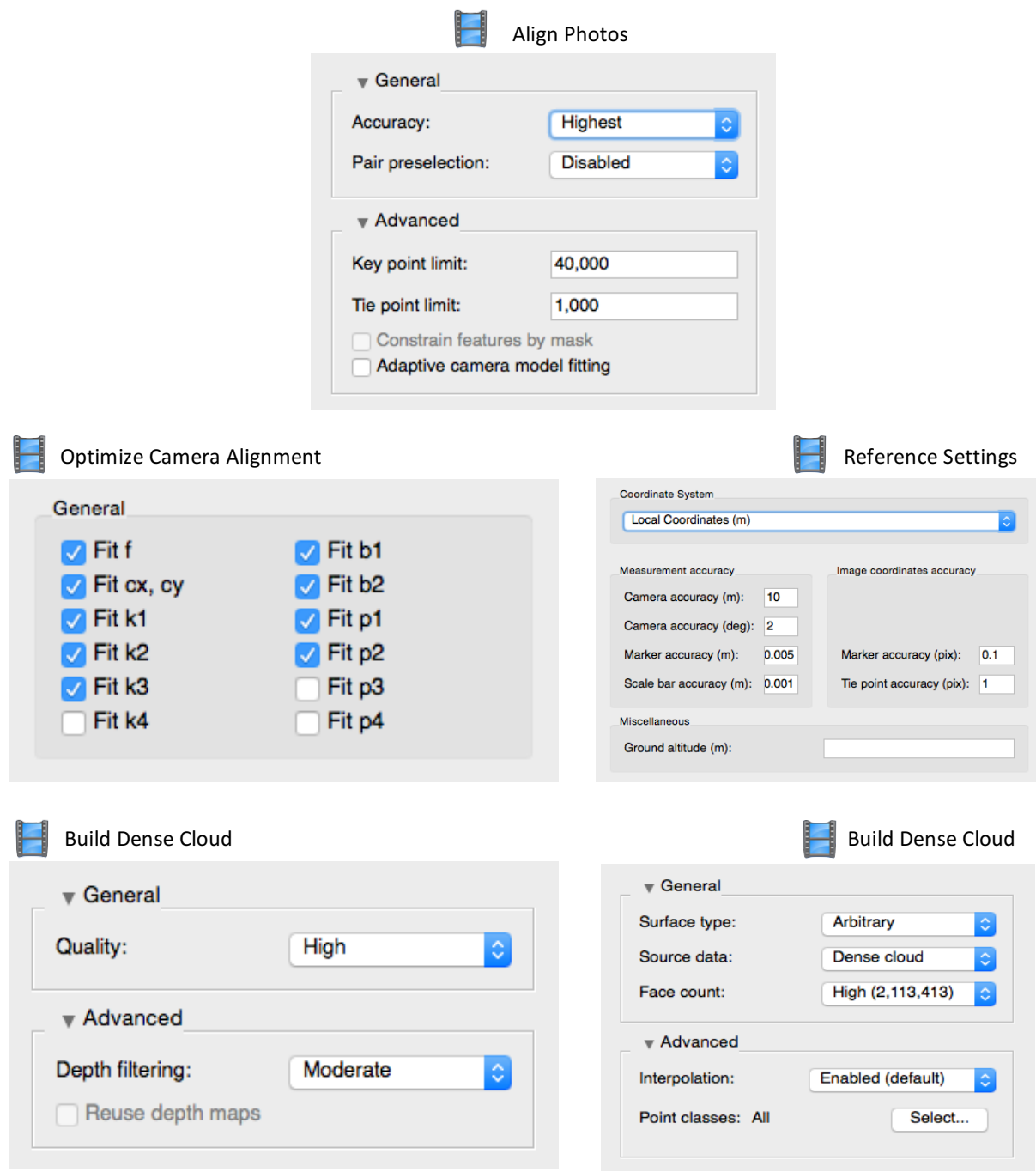
To get around this, fixed landmarks were digitized and exported from ImageJ (as for the curve-sliders), so that the same scale could be guaranteed for both types of landmarks. It worked for the main pads and toes 1 (Figure 34 B), but not for toes 2, 3 and 4, as displacements such as the one displayed by Figure 34 C kept occurring after the Procrustes superimposition. However, when the coordinates of the landmarks of the pads were grouped all together to represent the entire segmented track, no displacement occurred for any of the pad (Figure 34 D), although the same \*.txt files containing the same coordinates were used both for the independent pads and for the entire track.

As this displacement issue could not be solved at the time, the scenarios involving the combination “2D –fixed+curve – independent pads” was not conducted and compared to the others.



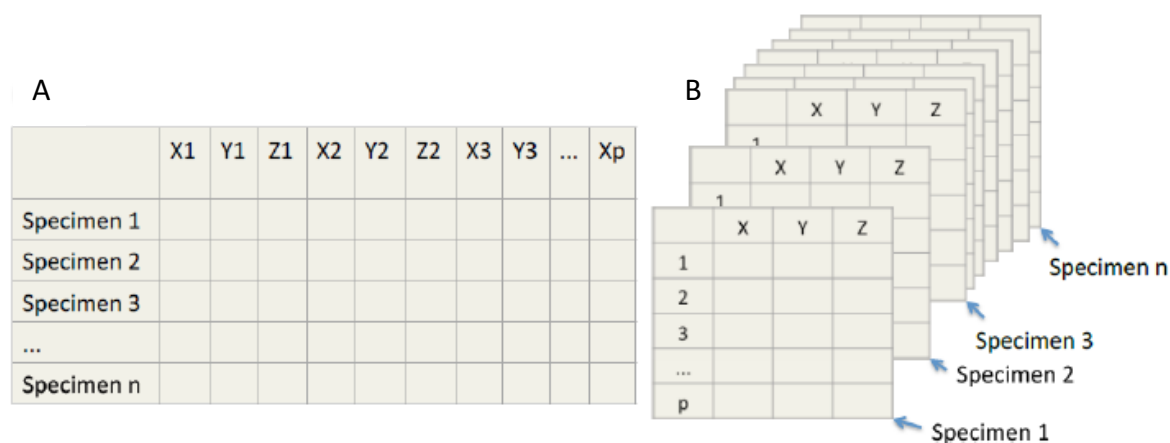
**Figure 35** - Displacements between mean configurations of fixed landmarks and curve-sliders in 2D. Each grey dot corresponds to the Procrustes coordinates of a landmark of a specimen; the black dots represent the landmarks of the mean shape. The straight lines connect the fixed landmarks of the mean shape to each other, while the curved lines surround the mean configuration characterized by the curve-sliders. Displacements between the two types of landmarks occurred when fixed landmarks were digitized in Geomorph (A), but not when they were positioned in ImageJ and exported as \*.txt file. This was the case for main pads (B) and toes 1, but not for toes 2, 3 and 4, for which displacements kept occurring (C). However, when Procrustes superimposition was applied on the entire track, there was no displacement for any of the pads (D), although the coordinates of the landmarks originated from the same \*.txt files both for the independent pads and for the entire track.

Appendix C: *Photoscan* parameters



**Figure 36** - Parameters applied during the “Camera Alignment”, “Build Dense Point”, and “Build Mesh” steps of the 3D-modelling process in *Photoscan*.

Appendix D: 2D and 3D arrays in *Geomorph*



**Figure 37** – Schematic of 2D (A) and 3D (B) arrays, two formats used for data treatment in *Geomorph*, both for 2D and 3D landmarks. (Sherratt, 2015).

## Appendix E: Procrustes ANOVA



**Table 6** - Results of the Procrustes ANOVAs conducted on the different 2D objects (entire track, main pad (MP), or one of the four toes (T1 to T4)) which were characterized by fixed landmarks only (fixed) or by fixed landmarks and curve-sliders (“fixed+curve”).

| Object       | Fixed  | Fixed + curve  |
|--------------|--|--|
| Entire track | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.45024 0.150079 0.34647 13.43 9.0891 0.001 ** Residuals 76 0.84928 0.011175 Total 79 1.29952 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>    | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.20919 0.069729 0.35907 14.193 9.6005 0.001 ** Residuals 76 0.37339 0.004913 Total 79 0.58258 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>   |
| MP           | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.31778 0.105926 0.33201 12.591 4.2529 0.001 ** Residuals 76 0.63935 0.008413 Total 79 0.95713 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>   | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.25626 0.085419 0.34408 13.289 6.2041 0.001 ** Residuals 76 0.48851 0.006428 Total 79 0.74477 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>   |
| T1           | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.05143 0.0171429 0.089722 2.497 2.1728 0.005 ** Residuals 76 0.52177 0.0068654 Total 79 0.57320 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre> | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.05143 0.0171429 0.089722 2.497 2.1728 0.005 ** Residuals 76 0.52177 0.0068654 Total 79 0.57320 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre> |
| T2           | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.11375 0.037918 0.15247 4.5576 3.5353 0.001 ** Residuals 76 0.63230 0.008320 Total 79 0.74605 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>   | NA   |
| T3           | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.11165 0.037218 0.17164 5.2491 3.6136 0.001 ** Residuals 76 0.53886 0.007090 Total 79 0.65051 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>   | NA   |
| T4           | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.05030 0.0167658 0.065652 1.78 1.4362 0.069 . Residuals 76 0.71583 0.0094188 Total 79 0.76612 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>   | NA   |

**Table 7** - Results of the Procrustes ANOVAs conducted on the different 2D objects (entire track, main pad (MP), or one of the four toes (T1 to T4)) which were characterized by fixed landmarks only (fixed), fixed landmarks and curve-sliders (“fixed+curve”), or fixed landmarks and curve- and surface-sliders (“fixed+curve+surface”)

| Object       | Fixed   | Fixed + curve   | Fixed + curve + surface   |
|--------------|---|---|---|
| Entire track | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.68380 0.22793 0.41449 17.934 9.4914 0.001 ** Residuals 76 0.96593 0.01271 Total 79 1.64973 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>      | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.35809 0.119365 0.39187 16.325 10.404 0.001 ** Residuals 76 0.55570 0.007312 Total 79 0.91380 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>  | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.22478 0.074927 0.36451 14.531 10.995 0.001 ** Residuals 76 0.39189 0.005157 Total 79 0.61668 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>    |
| MP           | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.86096 0.286988 0.61421 40.333 5.4301 0.001 ** Residuals 76 0.54078 0.007115 Total 79 1.40174 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>    | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.52453 0.17484 0.45402 21.066 7.4135 0.001 ** Residuals 76 0.63078 0.00830 Total 79 1.15531 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>    | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.32674 0.108914 0.37565 15.242 7.9913 0.001 ** Residuals 76 0.54305 0.007145 Total 79 0.86979 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>    |
| T1           | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.04414 0.0147118 0.06249 1.6886 1.4545 0.067 . Residuals 76 0.66214 0.0087124 Total 79 0.70627 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>   | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.08405 0.028016 0.092726 2.5891 4.7649 0.001 ** Residuals 76 0.82238 0.010821 Total 79 0.90643 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre> | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.08097 0.0269907 0.097208 2.7278 5.5626 0.001 ** Residuals 76 0.75200 0.0098948 Total 79 0.83298 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre> |
| T2           | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.02470 0.0082335 0.031294 0.8184 -0.29722 0.65 Residuals 76 0.76462 0.0100607 Total 79 0.78932 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>   | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.05603 0.018676 0.055318 1.4834 2.0895 0.021 * Residuals 76 0.95681 0.012590 Total 79 1.01283 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>  | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.04885 0.016283 0.049993 1.3331 1.5761 0.056 . Residuals 76 0.92826 0.012214 Total 79 0.97711 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>    |
| T3           | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.06457 0.0215245 0.089936 2.5035 2.3535 0.006 ** Residuals 76 0.65342 0.0085976 Total 79 0.71799 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre> | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.05191 0.017303 0.06011 1.6202 2.4657 0.005 ** Residuals 76 0.81166 0.010680 Total 79 0.86357 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>  | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.05037 0.016791 0.054328 1.4554 1.8546 0.036 * Residuals 76 0.87685 0.011537 Total 79 0.92722 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>    |
| T4           | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.05695 0.018984 0.057723 1.5519 1.2993 0.073 . Residuals 76 0.92971 0.012233 Total 79 0.98667 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>    | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.06696 0.022319 0.074045 2.0258 3.372 0.001 ** Residuals 76 0.83732 0.011017 Total 79 0.90427 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>  | <pre> Df      SS      MS      Rsq      F      Z Pr(&gt;F) position 3 0.05523 0.018409 0.059664 1.6074 2.0732 0.032 * Residuals 76 0.87043 0.011453 Total 79 0.92566 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 </pre>    |

## Appendix F: Centroid size analyses

**Table 8** - Results of statistical analyses conducted on the Centroid sizes of the entire track and main pad of 2D-models of spotted hyena tracks. The 2D-models were characterized either by fixed landmarks only ("fixed") or by fixed landmarks and curve-sliders ("fixed+curve").

| 2D – entire track – fixed  | 2D – entire track – fixed+curve | 2D – MP – fixed |            |           |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
|--|---------------------------------|-----------------|------------|-----------|---------------|--------|---------------------------|---|--------|--------|--------|---------------|-----------|----|--------|------|--|--|--|------|-----|-----|-------|-------|-----------|-----------|----------|-----------|-------|------------|------------|------------|-----------|-------|------------|------------|------------|-----------|-------|------------|------------|------------|-----------|-------|------------|------------|------------|-----------|-------|----------|-----------|----------|-----------|--|--|----|--------|---------|---------|--------|---------------------------|---|---------|---------|--------|---------------|-----------|----|---------|-------|--|--|--|------|-----|-----|-------|-------|-----------|-----------|----------|-----------|-------|------------|-----------|-----------|-----------|-------|------------|-----------|-----------|-----------|-------|------------|-----------|-----------|-----------|-------|------------|-----------|-----------|-----------|-------|----------|-----------|----------|-----------|---|--|----|--------|---------|---------|--------|---------------------------|---|-------|---------|--------|---------------|-----------|----|--------|--------|--|--|--|------|-----|-----|-------|-------|----------|-----------|----------|-----------|-------|-----------|-----------|-----------|-----------|-------|-----------|-----------|-----------|-----------|-------|-----------|------------|-----------|-----------|-------|-----------|-----------|-----------|-----------|-------|----------|-----------|----------|-----------|
| <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.98386, p-value = 0.4111</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$position)<br/>Bartlett's K-squared = 2.8957, df = 3, p-value = 0.408</p> <pre>&gt; anova(analysis)</pre> <p>Analysis of Variance Table</p> <p>Response: data\$Csize</p> <table><thead><tr><th></th><th>Df</th><th>Sum Sq</th><th>Mean Sq</th><th>F value</th><th>Pr(&gt;F)</th></tr></thead><tbody><tr><td>as.factor(data\$position)</td><td>3</td><td>682736</td><td>227579</td><td>43.808</td><td>&lt; 2.2e-16 ***</td></tr><tr><td>Residuals</td><td>76</td><td>394810</td><td>5195</td><td></td><td></td></tr></tbody></table> <p>---<br/>Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1</p> <pre>&gt; TukeyHSD(aov(analysis))</pre> <p>Tukey multiple comparisons of means<br/>95% family-wise confidence level</p> <p>Fit: aov(formula = analysis)</p> <pre>\$`as.factor(data\$position)`</pre> <table><thead><tr><th></th><th>diff</th><th>lwr</th><th>upr</th><th>p adj</th></tr></thead><tbody><tr><td>FR-FL</td><td>-11.37679</td><td>-71.24741</td><td>48.49384</td><td>0.9590199</td></tr><tr><td>HL-FL</td><td>-204.19974</td><td>-264.07036</td><td>-144.32912</td><td>0.0000000</td></tr><tr><td>HR-FL</td><td>-173.84528</td><td>-233.71590</td><td>-113.97465</td><td>0.0000000</td></tr><tr><td>HL-FR</td><td>-192.82295</td><td>-252.69358</td><td>-132.95233</td><td>0.0000000</td></tr><tr><td>HR-FR</td><td>-162.46849</td><td>-222.33911</td><td>-102.59787</td><td>0.0000000</td></tr><tr><td>HR-HL</td><td>30.35446</td><td>-29.51616</td><td>90.22509</td><td>0.5457995</td></tr></tbody></table> |                                 | Df              | Sum Sq     | Mean Sq   | F value       | Pr(>F) | as.factor(data\$position) | 3 | 682736 | 227579 | 43.808 | < 2.2e-16 *** | Residuals | 76 | 394810 | 5195 |  |  |  | diff | lwr | upr | p adj | FR-FL | -11.37679 | -71.24741 | 48.49384 | 0.9590199 | HL-FL | -204.19974 | -264.07036 | -144.32912 | 0.0000000 | HR-FL | -173.84528 | -233.71590 | -113.97465 | 0.0000000 | HL-FR | -192.82295 | -252.69358 | -132.95233 | 0.0000000 | HR-FR | -162.46849 | -222.33911 | -102.59787 | 0.0000000 | HR-HL | 30.35446 | -29.51616 | 90.22509 | 0.5457995 | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.98363, p-value = 0.3993</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$position)<br/>Bartlett's K-squared = 3.1512, df = 3, p-value = 0.3689</p> <pre>&gt; anova(analysis)</pre> <p>Analysis of Variance Table</p> <p>Response: data\$Csize</p> <table><thead><tr><th></th><th>Df</th><th>Sum Sq</th><th>Mean Sq</th><th>F value</th><th>Pr(&gt;F)</th></tr></thead><tbody><tr><td>as.factor(data\$position)</td><td>3</td><td>4451441</td><td>1483814</td><td>32.425</td><td>1.332e-13 ***</td></tr><tr><td>Residuals</td><td>76</td><td>3477863</td><td>45761</td><td></td><td></td></tr></tbody></table> <p>---<br/>Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1</p> <pre>&gt; TukeyHSD(aov(analysis))</pre> <p>Tukey multiple comparisons of means<br/>95% family-wise confidence level</p> <p>Fit: aov(formula = analysis)</p> <pre>\$`as.factor(data\$position)`</pre> <table><thead><tr><th></th><th>diff</th><th>lwr</th><th>upr</th><th>p adj</th></tr></thead><tbody><tr><td>FR-FL</td><td>-32.50588</td><td>-210.2012</td><td>145.1894</td><td>0.9631844</td></tr><tr><td>HL-FL</td><td>-520.03690</td><td>-697.7322</td><td>-342.3416</td><td>0.0000000</td></tr><tr><td>HR-FL</td><td>-449.62368</td><td>-627.3190</td><td>-271.9284</td><td>0.0000000</td></tr><tr><td>HL-FR</td><td>-487.53102</td><td>-665.2263</td><td>-309.8357</td><td>0.0000000</td></tr><tr><td>HR-FR</td><td>-417.11780</td><td>-594.8131</td><td>-239.4225</td><td>0.0000002</td></tr><tr><td>HR-HL</td><td>70.41322</td><td>-107.2821</td><td>248.1085</td><td>0.7260468</td></tr></tbody></table> |  | Df | Sum Sq | Mean Sq | F value | Pr(>F) | as.factor(data\$position) | 3 | 4451441 | 1483814 | 32.425 | 1.332e-13 *** | Residuals | 76 | 3477863 | 45761 |  |  |  | diff | lwr | upr | p adj | FR-FL | -32.50588 | -210.2012 | 145.1894 | 0.9631844 | HL-FL | -520.03690 | -697.7322 | -342.3416 | 0.0000000 | HR-FL | -449.62368 | -627.3190 | -271.9284 | 0.0000000 | HL-FR | -487.53102 | -665.2263 | -309.8357 | 0.0000000 | HR-FR | -417.11780 | -594.8131 | -239.4225 | 0.0000002 | HR-HL | 70.41322 | -107.2821 | 248.1085 | 0.7260468 | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.97786, p-value = 0.1797</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$position)<br/>Bartlett's K-squared = 6.5611, df = 3, p-value = 0.08728</p> <pre>&gt; anova(analysis)</pre> <p>Analysis of Variance Table</p> <p>Response: data\$Csize</p> <table><thead><tr><th></th><th>Df</th><th>Sum Sq</th><th>Mean Sq</th><th>F value</th><th>Pr(&gt;F)</th></tr></thead><tbody><tr><td>as.factor(data\$position)</td><td>3</td><td>84998</td><td>28332.6</td><td>16.226</td><td>3.031e-08 ***</td></tr><tr><td>Residuals</td><td>76</td><td>132703</td><td>1746.1</td><td></td><td></td></tr></tbody></table> <p>---<br/>Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1</p> <pre>&gt; TukeyHSD(aov(analysis))</pre> <p>Tukey multiple comparisons of means<br/>95% family-wise confidence level</p> <p>Fit: aov(formula = analysis)</p> <pre>\$`as.factor(data\$position)`</pre> <table><thead><tr><th></th><th>diff</th><th>lwr</th><th>upr</th><th>p adj</th></tr></thead><tbody><tr><td>FR-FL</td><td>14.36987</td><td>-20.34050</td><td>49.08024</td><td>0.6982131</td></tr><tr><td>HL-FL</td><td>-64.39719</td><td>-99.10756</td><td>-29.68681</td><td>0.0000343</td></tr><tr><td>HR-FL</td><td>-47.88793</td><td>-82.59830</td><td>-13.17756</td><td>0.0028775</td></tr><tr><td>HL-FR</td><td>-78.76706</td><td>-113.47743</td><td>-44.05669</td><td>0.0000004</td></tr><tr><td>HR-FR</td><td>-62.25780</td><td>-96.96817</td><td>-27.54743</td><td>0.0000634</td></tr><tr><td>HR-HL</td><td>16.50926</td><td>-18.20111</td><td>51.21963</td><td>0.5976903</td></tr></tbody></table> |  | Df | Sum Sq | Mean Sq | F value | Pr(>F) | as.factor(data\$position) | 3 | 84998 | 28332.6 | 16.226 | 3.031e-08 *** | Residuals | 76 | 132703 | 1746.1 |  |  |  | diff | lwr | upr | p adj | FR-FL | 14.36987 | -20.34050 | 49.08024 | 0.6982131 | HL-FL | -64.39719 | -99.10756 | -29.68681 | 0.0000343 | HR-FL | -47.88793 | -82.59830 | -13.17756 | 0.0028775 | HL-FR | -78.76706 | -113.47743 | -44.05669 | 0.0000004 | HR-FR | -62.25780 | -96.96817 | -27.54743 | 0.0000634 | HR-HL | 16.50926 | -18.20111 | 51.21963 | 0.5976903 |
|  | Df                              | Sum Sq          | Mean Sq    | F value   | Pr(>F)        |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| as.factor(data\$position)  | 3                               | 682736          | 227579     | 43.808    | < 2.2e-16 *** |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| Residuals  | 76                              | 394810          | 5195       |           |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
|  | diff                            | lwr             | upr        | p adj     |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| FR-FL  | -11.37679                       | -71.24741       | 48.49384   | 0.9590199 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HL-FL  | -204.19974                      | -264.07036      | -144.32912 | 0.0000000 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HR-FL  | -173.84528                      | -233.71590      | -113.97465 | 0.0000000 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HL-FR  | -192.82295                      | -252.69358      | -132.95233 | 0.0000000 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HR-FR  | -162.46849                      | -222.33911      | -102.59787 | 0.0000000 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HR-HL  | 30.35446                        | -29.51616       | 90.22509   | 0.5457995 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
|  | Df                              | Sum Sq          | Mean Sq    | F value   | Pr(>F)        |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| as.factor(data\$position)  | 3                               | 4451441         | 1483814    | 32.425    | 1.332e-13 *** |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| Residuals  | 76                              | 3477863         | 45761      |           |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
|  | diff                            | lwr             | upr        | p adj     |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| FR-FL  | -32.50588                       | -210.2012       | 145.1894   | 0.9631844 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HL-FL  | -520.03690                      | -697.7322       | -342.3416  | 0.0000000 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HR-FL  | -449.62368                      | -627.3190       | -271.9284  | 0.0000000 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HL-FR  | -487.53102                      | -665.2263       | -309.8357  | 0.0000000 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HR-FR  | -417.11780                      | -594.8131       | -239.4225  | 0.0000002 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HR-HL  | 70.41322                        | -107.2821       | 248.1085   | 0.7260468 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
|  | Df                              | Sum Sq          | Mean Sq    | F value   | Pr(>F)        |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| as.factor(data\$position)  | 3                               | 84998           | 28332.6    | 16.226    | 3.031e-08 *** |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| Residuals  | 76                              | 132703          | 1746.1     |           |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
|  | diff                            | lwr             | upr        | p adj     |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| FR-FL  | 14.36987                        | -20.34050       | 49.08024   | 0.6982131 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HL-FL  | -64.39719                       | -99.10756       | -29.68681  | 0.0000343 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HR-FL  | -47.88793                       | -82.59830       | -13.17756  | 0.0028775 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HL-FR  | -78.76706                       | -113.47743      | -44.05669  | 0.0000004 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HR-FR  | -62.25780                       | -96.96817       | -27.54743  | 0.0000634 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |
| HR-HL  | 16.50926                        | -18.20111       | 51.21963   | 0.5976903 |               |        |                           |   |        |        |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |            |            |            |           |       |          |           |          |           |  |  |    |        |         |         |        |                           |   |         |         |        |               |           |    |         |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |   |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |        |        |  |  |  |      |     |     |       |       |          |           |          |           |       |           |           |           |           |       |           |           |           |           |       |           |            |           |           |       |           |           |           |           |       |          |           |          |           |

**Table 9** - Results of statistical analyses conducted on the Centroid sizes of the main pad and toe 1 of 2D-models of spotted hyena tracks. The 2D-models were characterized either by fixed landmarks only ("fixed") or by fixed landmarks and curve-sliders ("fixed+curve").

| 2D – MP – fixed+curve   | 2D – T1 – fixed | 2D – T1 – fixed+curve |            |           |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
|---|-----------------|-----------------------|------------|-----------|---------------|--------|---------------------------|---|---------|--------|-------|---------------|-----------|----|---------|-------|--|--|--|------|-----|-----|-------|-------|----------|-----------|-----------|-----------|-------|------------|------------|-----------|-----------|-------|------------|------------|-----------|-----------|-------|------------|------------|------------|-----------|-------|------------|------------|------------|-----------|-------|----------|-----------|-----------|-----------|--|--|----|--------|---------|---------|--------|---------------------------|---|-------|--------|--------|---------------|-----------|----|-------|-------|--|--|--|------|-----|-----|-------|-------|------------|-----------|----------|-----------|-------|-------------|-----------|-----------|-----------|-------|-------------|-----------|-----------|-----------|-------|-------------|-----------|-----------|-----------|-------|-------------|-----------|-----------|-----------|-------|-----------|-----------|----------|-----------|---|--|----|--------|---------|---------|--------|---------------------------|---|--------|-------|--------|---------------|-----------|----|--------|------|--|--|--|------|-----|-----|-------|-------|-----------|-----------|----------|-----------|-------|-------------|------------|-----------|-----------|-------|------------|------------|-----------|-----------|-------|------------|------------|-----------|-----------|-------|------------|------------|-----------|-----------|-------|-----------|-----------|----------|-----------|
| <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.98461, p-value = 0.4521</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$position)<br/>Bartlett's K-squared = 3.8976, df = 3, p-value = 0.2727</p> <pre>&gt; anova(analysis)</pre> <p>Analysis of Variance Table</p> <p>Response: data\$Csize</p> <table><tr><th></th><th>Df</th><th>Sum Sq</th><th>Mean Sq</th><th>F value</th><th>Pr(&gt;F)</th></tr><tr><td>as.factor(data\$position)</td><td>3</td><td>1053780</td><td>351260</td><td>16.45</td><td>2.481e-08 ***</td></tr><tr><td>Residuals</td><td>76</td><td>1622828</td><td>21353</td><td></td><td></td></tr></table> <p>---<br/>Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1</p> <pre>&gt; TukeyHSD(aov(analysis))</pre> <p>Tukey multiple comparisons of means<br/>95% family-wise confidence level</p> <p>Fit: aov(formula = analysis)</p> <pre>\$`as.factor(data\$position)`</pre> <table><tr><th></th><th>diff</th><th>lwr</th><th>upr</th><th>p adj</th></tr><tr><td>FR-FL</td><td>57.71981</td><td>-63.66265</td><td>179.10227</td><td>0.5978704</td></tr><tr><td>HL-FL</td><td>-218.44727</td><td>-339.82973</td><td>-97.06481</td><td>0.0000598</td></tr><tr><td>HR-FL</td><td>-170.47642</td><td>-291.85888</td><td>-49.09396</td><td>0.0023311</td></tr><tr><td>HL-FR</td><td>-276.16708</td><td>-397.54954</td><td>-154.78462</td><td>0.0000004</td></tr><tr><td>HR-FR</td><td>-228.19623</td><td>-349.57869</td><td>-106.81377</td><td>0.0000267</td></tr><tr><td>HR-HL</td><td>47.97085</td><td>-73.41161</td><td>169.35331</td><td>0.7276779</td></tr></table> |                 | Df                    | Sum Sq     | Mean Sq   | F value       | Pr(>F) | as.factor(data\$position) | 3 | 1053780 | 351260 | 16.45 | 2.481e-08 *** | Residuals | 76 | 1622828 | 21353 |  |  |  | diff | lwr | upr | p adj | FR-FL | 57.71981 | -63.66265 | 179.10227 | 0.5978704 | HL-FL | -218.44727 | -339.82973 | -97.06481 | 0.0000598 | HR-FL | -170.47642 | -291.85888 | -49.09396 | 0.0023311 | HL-FR | -276.16708 | -397.54954 | -154.78462 | 0.0000004 | HR-FR | -228.19623 | -349.57869 | -106.81377 | 0.0000267 | HR-HL | 47.97085 | -73.41161 | 169.35331 | 0.7276779 | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.9694, p-value = 0.05197</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$position)<br/>Bartlett's K-squared = 3.822, df = 3, p-value = 0.2813</p> <pre>&gt; anova(analysis)</pre> <p>Analysis of Variance Table</p> <p>Response: data\$Csize</p> <table><tr><th></th><th>Df</th><th>Sum Sq</th><th>Mean Sq</th><th>F value</th><th>Pr(&gt;F)</th></tr><tr><td>as.factor(data\$position)</td><td>3</td><td>29676</td><td>9892.0</td><td>26.401</td><td>8.368e-12 ***</td></tr><tr><td>Residuals</td><td>76</td><td>28476</td><td>374.7</td><td></td><td></td></tr></table> <p>---<br/>Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1</p> <pre>&gt; TukeyHSD(aov(analysis))</pre> <p>Tukey multiple comparisons of means<br/>95% family-wise confidence level</p> <p>Fit: aov(formula = analysis)</p> <pre>\$`as.factor(data\$position)`</pre> <table><tr><th></th><th>diff</th><th>lwr</th><th>upr</th><th>p adj</th></tr><tr><td>FR-FL</td><td>-0.5046587</td><td>-16.58379</td><td>15.57448</td><td>0.9997973</td></tr><tr><td>HL-FL</td><td>-41.4556594</td><td>-57.53479</td><td>-25.37653</td><td>0.0000000</td></tr><tr><td>HR-FL</td><td>-35.6468803</td><td>-51.72601</td><td>-19.56775</td><td>0.0000008</td></tr><tr><td>HL-FR</td><td>-40.9510007</td><td>-57.03013</td><td>-24.87187</td><td>0.0000000</td></tr><tr><td>HR-FR</td><td>-35.1422217</td><td>-51.22136</td><td>-19.06309</td><td>0.0000011</td></tr><tr><td>HR-HL</td><td>5.8087790</td><td>-10.27035</td><td>21.88791</td><td>0.7785301</td></tr></table> |  | Df | Sum Sq | Mean Sq | F value | Pr(>F) | as.factor(data\$position) | 3 | 29676 | 9892.0 | 26.401 | 8.368e-12 *** | Residuals | 76 | 28476 | 374.7 |  |  |  | diff | lwr | upr | p adj | FR-FL | -0.5046587 | -16.58379 | 15.57448 | 0.9997973 | HL-FL | -41.4556594 | -57.53479 | -25.37653 | 0.0000000 | HR-FL | -35.6468803 | -51.72601 | -19.56775 | 0.0000008 | HL-FR | -40.9510007 | -57.03013 | -24.87187 | 0.0000000 | HR-FR | -35.1422217 | -51.22136 | -19.06309 | 0.0000011 | HR-HL | 5.8087790 | -10.27035 | 21.88791 | 0.7785301 | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.97039, p-value = 0.06007</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$position)<br/>Bartlett's K-squared = 1.2797, df = 3, p-value = 0.734</p> <pre>&gt; anova(analysis)</pre> <p>Analysis of Variance Table</p> <p>Response: data\$Csize</p> <table><tr><th></th><th>Df</th><th>Sum Sq</th><th>Mean Sq</th><th>F value</th><th>Pr(&gt;F)</th></tr><tr><td>as.factor(data\$position)</td><td>3</td><td>187055</td><td>62352</td><td>32.553</td><td>1.225e-13 ***</td></tr><tr><td>Residuals</td><td>76</td><td>145568</td><td>1915</td><td></td><td></td></tr></table> <p>---<br/>Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1</p> <pre>&gt; TukeyHSD(aov(analysis))</pre> <p>Tukey multiple comparisons of means<br/>95% family-wise confidence level</p> <p>Fit: aov(formula = analysis)</p> <pre>\$`as.factor(data\$position)`</pre> <table><tr><th></th><th>diff</th><th>lwr</th><th>upr</th><th>p adj</th></tr><tr><td>FR-FL</td><td>-9.594784</td><td>-45.94882</td><td>26.75925</td><td>0.8993602</td></tr><tr><td>HL-FL</td><td>-108.643427</td><td>-144.99746</td><td>-72.28939</td><td>0.0000000</td></tr><tr><td>HR-FL</td><td>-92.546609</td><td>-128.90065</td><td>-56.19257</td><td>0.0000000</td></tr><tr><td>HL-FR</td><td>-99.048643</td><td>-135.40268</td><td>-62.69461</td><td>0.0000000</td></tr><tr><td>HR-FR</td><td>-82.951825</td><td>-119.30586</td><td>-46.59779</td><td>0.0000004</td></tr><tr><td>HR-HL</td><td>16.096818</td><td>-20.25722</td><td>52.45086</td><td>0.6517867</td></tr></table> |  | Df | Sum Sq | Mean Sq | F value | Pr(>F) | as.factor(data\$position) | 3 | 187055 | 62352 | 32.553 | 1.225e-13 *** | Residuals | 76 | 145568 | 1915 |  |  |  | diff | lwr | upr | p adj | FR-FL | -9.594784 | -45.94882 | 26.75925 | 0.8993602 | HL-FL | -108.643427 | -144.99746 | -72.28939 | 0.0000000 | HR-FL | -92.546609 | -128.90065 | -56.19257 | 0.0000000 | HL-FR | -99.048643 | -135.40268 | -62.69461 | 0.0000000 | HR-FR | -82.951825 | -119.30586 | -46.59779 | 0.0000004 | HR-HL | 16.096818 | -20.25722 | 52.45086 | 0.6517867 |
|   | Df              | Sum Sq                | Mean Sq    | F value   | Pr(>F)        |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| as.factor(data\$position)   | 3               | 1053780               | 351260     | 16.45     | 2.481e-08 *** |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| Residuals   | 76              | 1622828               | 21353      |           |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
|   | diff            | lwr                   | upr        | p adj     |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| FR-FL   | 57.71981        | -63.66265             | 179.10227  | 0.5978704 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HL-FL   | -218.44727      | -339.82973            | -97.06481  | 0.0000598 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HR-FL   | -170.47642      | -291.85888            | -49.09396  | 0.0023311 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HL-FR   | -276.16708      | -397.54954            | -154.78462 | 0.0000004 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HR-FR   | -228.19623      | -349.57869            | -106.81377 | 0.0000267 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HR-HL   | 47.97085        | -73.41161             | 169.35331  | 0.7276779 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
|   | Df              | Sum Sq                | Mean Sq    | F value   | Pr(>F)        |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| as.factor(data\$position)   | 3               | 29676                 | 9892.0     | 26.401    | 8.368e-12 *** |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| Residuals   | 76              | 28476                 | 374.7      |           |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
|   | diff            | lwr                   | upr        | p adj     |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| FR-FL   | -0.5046587      | -16.58379             | 15.57448   | 0.9997973 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HL-FL   | -41.4556594     | -57.53479             | -25.37653  | 0.0000000 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HR-FL   | -35.6468803     | -51.72601             | -19.56775  | 0.0000008 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HL-FR   | -40.9510007     | -57.03013             | -24.87187  | 0.0000000 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HR-FR   | -35.1422217     | -51.22136             | -19.06309  | 0.0000011 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HR-HL   | 5.8087790       | -10.27035             | 21.88791   | 0.7785301 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
|   | Df              | Sum Sq                | Mean Sq    | F value   | Pr(>F)        |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| as.factor(data\$position)   | 3               | 187055                | 62352      | 32.553    | 1.225e-13 *** |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| Residuals   | 76              | 145568                | 1915       |           |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
|   | diff            | lwr                   | upr        | p adj     |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| FR-FL   | -9.594784       | -45.94882             | 26.75925   | 0.8993602 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HL-FL   | -108.643427     | -144.99746            | -72.28939  | 0.0000000 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HR-FL   | -92.546609      | -128.90065            | -56.19257  | 0.0000000 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HL-FR   | -99.048643      | -135.40268            | -62.69461  | 0.0000000 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HR-FR   | -82.951825      | -119.30586            | -46.59779  | 0.0000004 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |
| HR-HL   | 16.096818       | -20.25722             | 52.45086   | 0.6517867 |               |        |                           |   |         |        |       |               |           |    |         |       |  |  |  |      |     |     |       |       |          |           |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |            |           |       |            |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |        |        |               |           |    |       |       |  |  |  |      |     |     |       |       |            |           |          |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |             |           |           |           |       |           |           |          |           |   |  |    |        |         |         |        |                           |   |        |       |        |               |           |    |        |      |  |  |  |      |     |     |       |       |           |           |          |           |       |             |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |           |           |          |           |

**Table 10** - Results of statistical analyses conducted on the Centroid sizes of toes 2, 3 and 4 of 2D-models of spotted hyena tracks. The 2D-models were characterized by fixed landmarks only ("fixed").

| 2D – T2 – fixed   | 2D – T3 – fixed | 2D – T4 – fixed |            |           |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
|---|-----------------|-----------------|------------|-----------|---------------|--------|---------------------------|---|-------|--------|-------|---------------|-----------|----|-------|-------|--|--|--|------|-----|-----|-------|-------|-----------|-----------|----------|-----------|-------|------------|-----------|-----------|-----------|-------|------------|-----------|-----------|-----------|-------|------------|-----------|-----------|-----------|-------|------------|-----------|-----------|-----------|-------|----------|-----------|----------|-----------|--|--|------|-----|-----|-------|-------|----------|-----------|-----------|-----------|-------|-----------|------------|-----------|-----------|-------|-----------|------------|----------|-----------|-------|-----------|------------|------------|-----------|-------|-----------|------------|------------|-----------|-------|----------|-----------|-----------|-----------|--|--|----|--------|---------|---------|--------|---------------------------|---|-------|---------|--------|---------------|-----------|----|-------|-------|--|--|--|------|-----|-----|-------|-------|----------|-----------|----------|-----------|-------|------------|------------|-----------|-----------|-------|------------|------------|-----------|-----------|-------|------------|------------|-----------|-----------|-------|------------|------------|-----------|-----------|-------|----------|------------|----------|-----------|
| <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.98008, p-value = 0.2465<pre>&gt; bartlett.test(data\$Csize~as.factor(data\$position))</pre><p>Bartlett test of homogeneity of variances</p><p>data: data\$Csize by as.factor(data\$position)<br/>Bartlett's K-squared = 5.0935, df = 3, p-value = 0.1651<pre>&gt; anova(analysis)</pre><p>Analysis of Variance Table</p><p>Response: data\$Csize</p><table><tr><th></th><th>Df</th><th>Sum Sq</th><th>Mean Sq</th><th>F value</th><th>Pr(&gt;F)</th></tr><tr><td>as.factor(data\$position)</td><td>3</td><td>23883</td><td>7961.1</td><td>16.58</td><td>2.211e-08 ***</td></tr><tr><td>Residuals</td><td>76</td><td>36493</td><td>480.2</td><td></td><td></td></tr></table><p>---<br/>Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1</p><pre>&gt; TukeyHSD(aov(analysis))</pre><p>Tukey multiple comparisons of means<br/>95% family-wise confidence level</p><p>Fit: aov(formula = analysis)</p><pre>\$`as.factor(data\$position)`</pre><table><tr><th></th><th>diff</th><th>lwr</th><th>upr</th><th>p adj</th></tr><tr><td>FR-FL</td><td>-1.524390</td><td>-19.72657</td><td>16.67779</td><td>0.9962105</td></tr><tr><td>HL-FL</td><td>-38.211096</td><td>-56.41327</td><td>-20.00892</td><td>0.0000027</td></tr><tr><td>HR-FL</td><td>-31.794257</td><td>-49.99643</td><td>-13.59208</td><td>0.0001006</td></tr><tr><td>HL-FR</td><td>-36.686706</td><td>-54.88888</td><td>-18.48453</td><td>0.0000066</td></tr><tr><td>HR-FR</td><td>-30.269867</td><td>-48.47204</td><td>-12.06769</td><td>0.0002253</td></tr><tr><td>HR-HL</td><td>6.416839</td><td>-11.78534</td><td>24.61902</td><td>0.7910112</td></tr></table></p></p> |                 | Df              | Sum Sq     | Mean Sq   | F value       | Pr(>F) | as.factor(data\$position) | 3 | 23883 | 7961.1 | 16.58 | 2.211e-08 *** | Residuals | 76 | 36493 | 480.2 |  |  |  | diff | lwr | upr | p adj | FR-FL | -1.524390 | -19.72657 | 16.67779 | 0.9962105 | HL-FL | -38.211096 | -56.41327 | -20.00892 | 0.0000027 | HR-FL | -31.794257 | -49.99643 | -13.59208 | 0.0001006 | HL-FR | -36.686706 | -54.88888 | -18.48453 | 0.0000066 | HR-FR | -30.269867 | -48.47204 | -12.06769 | 0.0002253 | HR-HL | 6.416839 | -11.78534 | 24.61902 | 0.7910112 | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.964, p-value = 0.02372<pre>&gt; bartlett.test(data\$Csize~as.factor(data\$position))</pre><p>Bartlett test of homogeneity of variances</p><p>data: data\$Csize by as.factor(data\$position)<br/>Bartlett's K-squared = 1.282, df = 3, p-value = 0.7334<pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre><p>Kruskal-Wallis rank sum test</p><p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 29.465, df = 3, p-value = 1.788e-06<pre>&gt; TukeyHSD(aov(analysis))</pre><p>Tukey multiple comparisons of means<br/>95% family-wise confidence level</p><p>Fit: aov(formula = analysis)</p><pre>\$`as.factor(data\$position)`</pre><table><tr><th></th><th>diff</th><th>lwr</th><th>upr</th><th>p adj</th></tr><tr><td>FR-FL</td><td>16.80907</td><td>-3.770900</td><td>37.389044</td><td>0.1482339</td></tr><tr><td>HL-FL</td><td>-30.49763</td><td>-51.077604</td><td>-9.917660</td><td>0.0011885</td></tr><tr><td>HR-FL</td><td>-15.96674</td><td>-36.546715</td><td>4.613229</td><td>0.1833381</td></tr><tr><td>HL-FR</td><td>-47.30670</td><td>-67.886676</td><td>-26.726732</td><td>0.0000003</td></tr><tr><td>HR-FR</td><td>-32.77581</td><td>-53.355787</td><td>-12.195843</td><td>0.0004359</td></tr><tr><td>HR-HL</td><td>14.53089</td><td>-6.049083</td><td>35.110861</td><td>0.2563180</td></tr></table></p></p></p> |  | diff | lwr | upr | p adj | FR-FL | 16.80907 | -3.770900 | 37.389044 | 0.1482339 | HL-FL | -30.49763 | -51.077604 | -9.917660 | 0.0011885 | HR-FL | -15.96674 | -36.546715 | 4.613229 | 0.1833381 | HL-FR | -47.30670 | -67.886676 | -26.726732 | 0.0000003 | HR-FR | -32.77581 | -53.355787 | -12.195843 | 0.0004359 | HR-HL | 14.53089 | -6.049083 | 35.110861 | 0.2563180 | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.97915, p-value = 0.2161<pre>&gt; bartlett.test(data\$Csize~as.factor(data\$position))</pre><p>Bartlett test of homogeneity of variances</p><p>data: data\$Csize by as.factor(data\$position)<br/>Bartlett's K-squared = 6.9887, df = 3, p-value = 0.07226<pre>&gt; anova(analysis)</pre><p>Analysis of Variance Table</p><p>Response: data\$Csize</p><table><tr><th></th><th>Df</th><th>Sum Sq</th><th>Mean Sq</th><th>F value</th><th>Pr(&gt;F)</th></tr><tr><td>as.factor(data\$position)</td><td>3</td><td>33810</td><td>11270.1</td><td>26.312</td><td>8.925e-12 ***</td></tr><tr><td>Residuals</td><td>76</td><td>32553</td><td>428.3</td><td></td><td></td></tr></table><p>---<br/>Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1</p><pre>&gt; TukeyHSD(aov(analysis))</pre><p>Tukey multiple comparisons of means<br/>95% family-wise confidence level</p><p>Fit: aov(formula = analysis)</p><pre>\$`as.factor(data\$position)`</pre><table><tr><th></th><th>diff</th><th>lwr</th><th>upr</th><th>p adj</th></tr><tr><td>FR-FL</td><td>9.914868</td><td>-7.276659</td><td>27.10640</td><td>0.4337085</td></tr><tr><td>HL-FL</td><td>-36.315617</td><td>-53.507145</td><td>-19.12409</td><td>0.0000024</td></tr><tr><td>HR-FL</td><td>-34.767210</td><td>-51.958738</td><td>-17.57568</td><td>0.0000062</td></tr><tr><td>HL-FR</td><td>-46.230485</td><td>-63.422013</td><td>-29.03896</td><td>0.0000000</td></tr><tr><td>HR-FR</td><td>-44.682078</td><td>-61.873606</td><td>-27.49055</td><td>0.0000000</td></tr><tr><td>HR-HL</td><td>1.548407</td><td>-15.643121</td><td>18.73993</td><td>0.9953000</td></tr></table></p></p> |  | Df | Sum Sq | Mean Sq | F value | Pr(>F) | as.factor(data\$position) | 3 | 33810 | 11270.1 | 26.312 | 8.925e-12 *** | Residuals | 76 | 32553 | 428.3 |  |  |  | diff | lwr | upr | p adj | FR-FL | 9.914868 | -7.276659 | 27.10640 | 0.4337085 | HL-FL | -36.315617 | -53.507145 | -19.12409 | 0.0000024 | HR-FL | -34.767210 | -51.958738 | -17.57568 | 0.0000062 | HL-FR | -46.230485 | -63.422013 | -29.03896 | 0.0000000 | HR-FR | -44.682078 | -61.873606 | -27.49055 | 0.0000000 | HR-HL | 1.548407 | -15.643121 | 18.73993 | 0.9953000 |
|   | Df              | Sum Sq          | Mean Sq    | F value   | Pr(>F)        |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| as.factor(data\$position)   | 3               | 23883           | 7961.1     | 16.58     | 2.211e-08 *** |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| Residuals   | 76              | 36493           | 480.2      |           |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
|   | diff            | lwr             | upr        | p adj     |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| FR-FL   | -1.524390       | -19.72657       | 16.67779   | 0.9962105 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HL-FL   | -38.211096      | -56.41327       | -20.00892  | 0.0000027 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HR-FL   | -31.794257      | -49.99643       | -13.59208  | 0.0001006 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HL-FR   | -36.686706      | -54.88888       | -18.48453  | 0.0000066 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HR-FR   | -30.269867      | -48.47204       | -12.06769  | 0.0002253 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HR-HL   | 6.416839        | -11.78534       | 24.61902   | 0.7910112 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
|   | diff            | lwr             | upr        | p adj     |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| FR-FL   | 16.80907        | -3.770900       | 37.389044  | 0.1482339 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HL-FL   | -30.49763       | -51.077604      | -9.917660  | 0.0011885 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HR-FL   | -15.96674       | -36.546715      | 4.613229   | 0.1833381 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HL-FR   | -47.30670       | -67.886676      | -26.726732 | 0.0000003 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HR-FR   | -32.77581       | -53.355787      | -12.195843 | 0.0004359 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HR-HL   | 14.53089        | -6.049083       | 35.110861  | 0.2563180 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
|   | Df              | Sum Sq          | Mean Sq    | F value   | Pr(>F)        |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| as.factor(data\$position)   | 3               | 33810           | 11270.1    | 26.312    | 8.925e-12 *** |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| Residuals   | 76              | 32553           | 428.3      |           |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
|   | diff            | lwr             | upr        | p adj     |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| FR-FL   | 9.914868        | -7.276659       | 27.10640   | 0.4337085 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HL-FL   | -36.315617      | -53.507145      | -19.12409  | 0.0000024 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HR-FL   | -34.767210      | -51.958738      | -17.57568  | 0.0000062 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HL-FR   | -46.230485      | -63.422013      | -29.03896  | 0.0000000 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HR-FR   | -44.682078      | -61.873606      | -27.49055  | 0.0000000 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |
| HR-HL   | 1.548407        | -15.643121      | 18.73993   | 0.9953000 |               |        |                           |   |       |        |       |               |           |    |       |       |  |  |  |      |     |     |       |       |           |           |          |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |            |           |           |           |       |          |           |          |           |  |  |      |     |     |       |       |          |           |           |           |       |           |            |           |           |       |           |            |          |           |       |           |            |            |           |       |           |            |            |           |       |          |           |           |           |  |  |    |        |         |         |        |                           |   |       |         |        |               |           |    |       |       |  |  |  |      |     |     |       |       |          |           |          |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |            |            |           |           |       |          |            |          |           |

**Table 11** - Results of statistical analyses conducted on the Centroid sizes of the entire track of 3D-models of spotted hyena tracks. The 3D-models were characterized either by fixed landmarks only (“fixed”), fixed landmarks and curve-sliders (“fixed+curve”), or fixed landmarks and curve- and surface-sliders (“fixed+curve+surf”).

| 3D – entire track – fixed  | 3D – entire track – fixed+curve   | 3D – entire track – fixed+curve+surf   |
|--|---|--|
| <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95814, p-value = 0.01037</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 0.85103, df = 3, p-value = 0.8372</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 1.665, df = 3, p-value = 0.6447</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.9565, p-value = 0.008273</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 0.63072, df = 3, p-value = 0.8894</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 1.22, df = 3, p-value = 0.7482</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95683, p-value = 0.008654</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 0.59421, df = 3, p-value = 0.8978</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 1.3796, df = 3, p-value = 0.7103</p> |

**Table 12** - Results of statistical analyses conducted on the Centroid sizes of the main pad of 3D-models of spotted hyena tracks. The 3D-models were characterized either by fixed landmarks only (“fixed”), fixed landmarks and curve-sliders (“fixed+curve”), or fixed landmarks and curve- and surface-sliders (“fixed+curve+surf”).

| 3D – MP – fixed   | 3D – MP – fixed+curve   | 3D – MP – fixed+curve+surf   |
|---|---|--|
| <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95831, p-value = 0.01062</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 0.60492, df = 3, p-value = 0.8953</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 2.3835, df = 3, p-value = 0.4967</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95724, p-value = 0.00916</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 0.56997, df = 3, p-value = 0.9033</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 2.2098, df = 3, p-value = 0.53</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95709, p-value = 0.00897</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 0.56803, df = 3, p-value = 0.9037</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 2.1944, df = 3, p-value = 0.533</p> |



**Table 13** - Results of statistical analyses conducted on the Centroid sizes of the toe 1 of 3D-models of spotted hyena tracks. The 3D-models were characterized either by fixed landmarks only (“fixed”), fixed landmarks and curve-sliders (“fixed+curve”), or fixed landmarks and curve- and surface-sliders (“fixed+curve+surf”).

| 3D – T1 – fixed   | 3D – T1 – fixed+curve  | 3D – T1 – fixed+curve+surf   |
|---|--|--|
| <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95904, p-value = 0.01176</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.5037, df = 3, p-value = 0.6814</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 2.588, df = 3, p-value = 0.4596</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95902, p-value = 0.01173</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.8104, df = 3, p-value = 0.6127</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 2.6846, df = 3, p-value = 0.4428</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.96055, p-value = 0.01453</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.7071, df = 3, p-value = 0.6354</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 2.8413, df = 3, p-value = 0.4167</p> |

**Table 14** - Results of statistical analyses conducted on the Centroid sizes of the toe 2 of 3D-models of spotted hyena tracks. The 3D-models were characterized either by fixed landmarks only (“fixed”), fixed landmarks and curve-sliders (“fixed+curve”), or fixed landmarks and curve- and surface-sliders (“fixed+curve+surf”).

| 3D – T2 – fixed  | 3D – T2 – fixed+curve   | 3D – T2 – fixed+curve+surf   |
|--|---|--|
| <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95729, p-value = 0.009215</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.367, df = 3, p-value = 0.7133</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 2.1191, df = 3, p-value = 0.5481</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95686, p-value = 0.008695</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.4398, df = 3, p-value = 0.6962</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 2.2956, df = 3, p-value = 0.5134</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95789, p-value = 0.01002</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.4653, df = 3, p-value = 0.6903</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 2.3933, df = 3, p-value = 0.4949</p> |

**Table 15** - Results of statistical analyses conducted on the Centroid sizes of the toe 3 of 3D-models of spotted hyena tracks. The 3D-models were characterized either by fixed landmarks only (“fixed”), fixed landmarks and curve-sliders (“fixed+curve”), or fixed landmarks and curve- and surface-sliders (“fixed+curve+surf”).

| 3D – T3 – fixed   | 3D – T3 – fixed+curve   | 3D – T3 – fixed+curve+surf  |
|---|---|---|
| <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95557, p-value = 0.007276</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.0462, df = 3, p-value = 0.7901</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 1.8452, df = 3, p-value = 0.6052</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95582, p-value = 0.007528</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.224, df = 3, p-value = 0.7473</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 1.8137, df = 3, p-value = 0.612</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95684, p-value = 0.008666</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.3291, df = 3, p-value = 0.7222</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 1.7872, df = 3, p-value = 0.6177</p> |

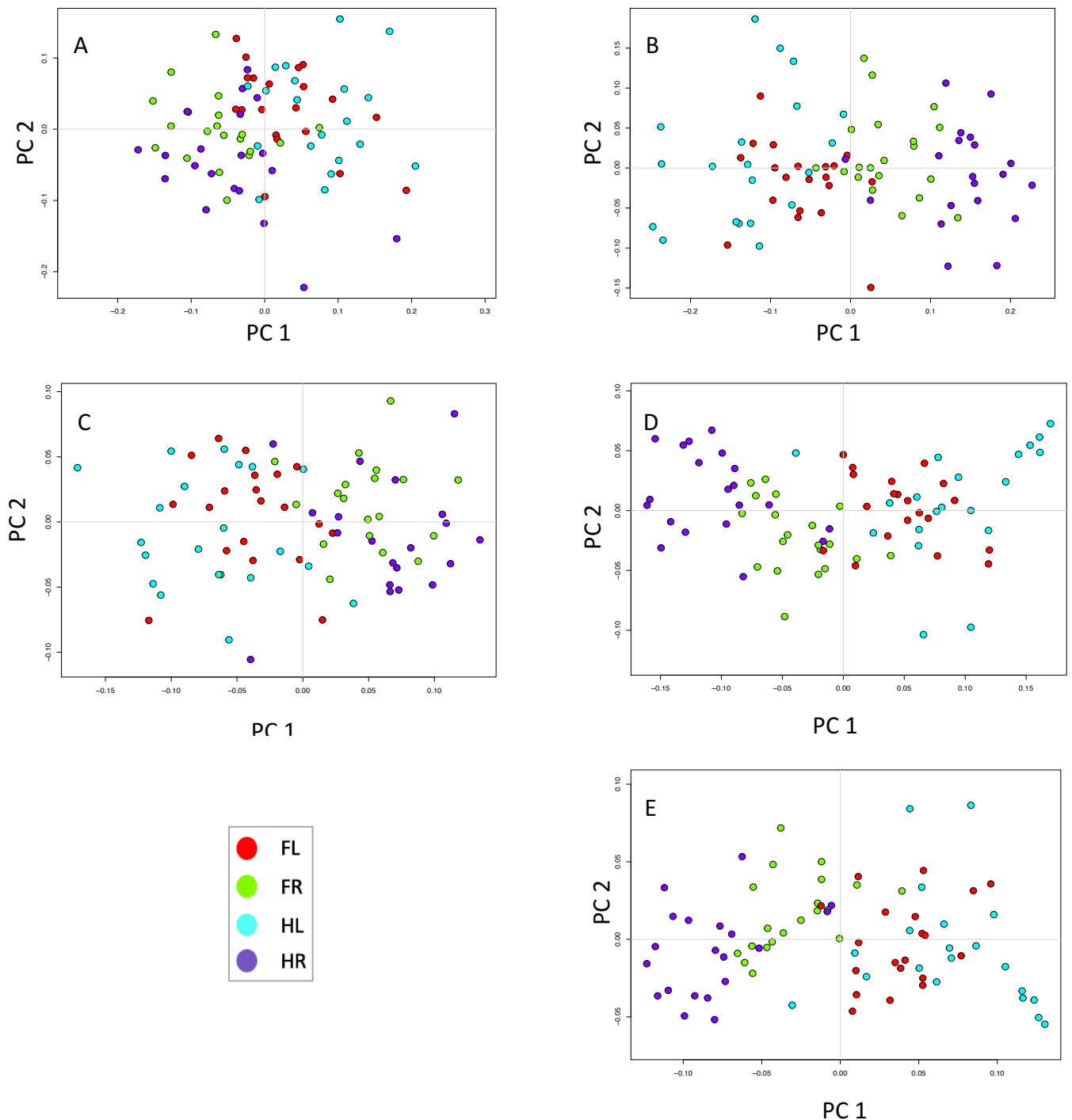
**Table 16** - Results of statistical analyses conducted on the Centroid sizes of the toe 3 of 3D-models of spotted hyena tracks. The 3D-models were characterized either by fixed landmarks only (“fixed”), fixed landmarks and curve-sliders (“fixed+curve”), or fixed landmarks and curve- and surface-sliders (“fixed+curve+surf”).

| 3D – T3 – fixed   | 3D – T3 – fixed+curve   | 3D – T3 – fixed+curve+surf  |
|---|---|---|
| <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95557, p-value = 0.007276</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.0462, df = 3, p-value = 0.7901</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 1.8452, df = 3, p-value = 0.6052</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95582, p-value = 0.007528</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.224, df = 3, p-value = 0.7473</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 1.8137, df = 3, p-value = 0.612</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.95684, p-value = 0.008666</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.3291, df = 3, p-value = 0.7222</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 1.7872, df = 3, p-value = 0.6177</p> |

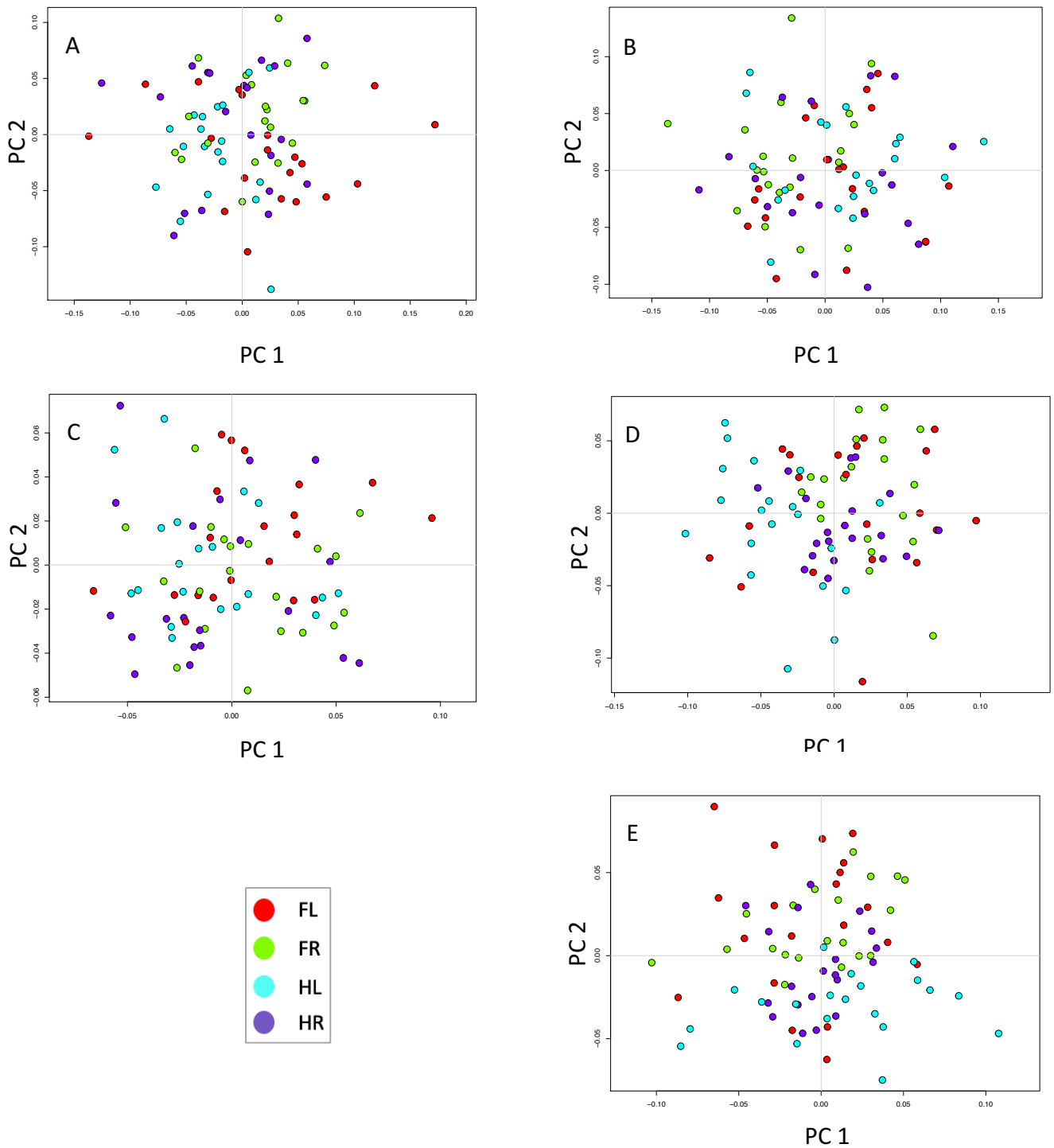
**Table 17** - Results of statistical analyses conducted on the Centroid sizes of the toe 4 of 3D-models of spotted hyena tracks. The 3D-models were characterized either by fixed landmarks only (“fixed”), fixed landmarks and curve-sliders (“fixed+curve”), or fixed landmarks and curve- and surface-sliders (“fixed+curve+surf”).

| 3D – T4 – fixed   | 3D – T4 – fixed+curve   | 3D – T4 – fixed+curve+surf  |
|---|---|---|
| <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.96179, p-value = 0.01732</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 0.97668, df = 3, p-value = 0.8069</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 2.0531, df = 3, p-value = 0.5614</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.96173, p-value = 0.01717</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.2586, df = 3, p-value = 0.739</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 1.9974, df = 3, p-value = 0.5729</p> | <pre>&gt; shapiro.test(data\$Csize)</pre> <p>Shapiro-Wilk normality test</p> <p>data: data\$Csize<br/>W = 0.96151, p-value = 0.01664</p> <pre>&gt; bartlett.test(data\$Csize~as.factor(data\$Position))</pre> <p>Bartlett test of homogeneity of variances</p> <p>data: data\$Csize by as.factor(data\$Position)<br/>Bartlett's K-squared = 1.284, df = 3, p-value = 0.7329</p> <pre>&gt; kruskal.test(x=data\$Csize, g=data\$position)</pre> <p>Kruskal-Wallis rank sum test</p> <p>data: data\$Csize and data\$position<br/>Kruskal-Wallis chi-squared = 2.1961, df = 3, p-value = 0.5327</p> |

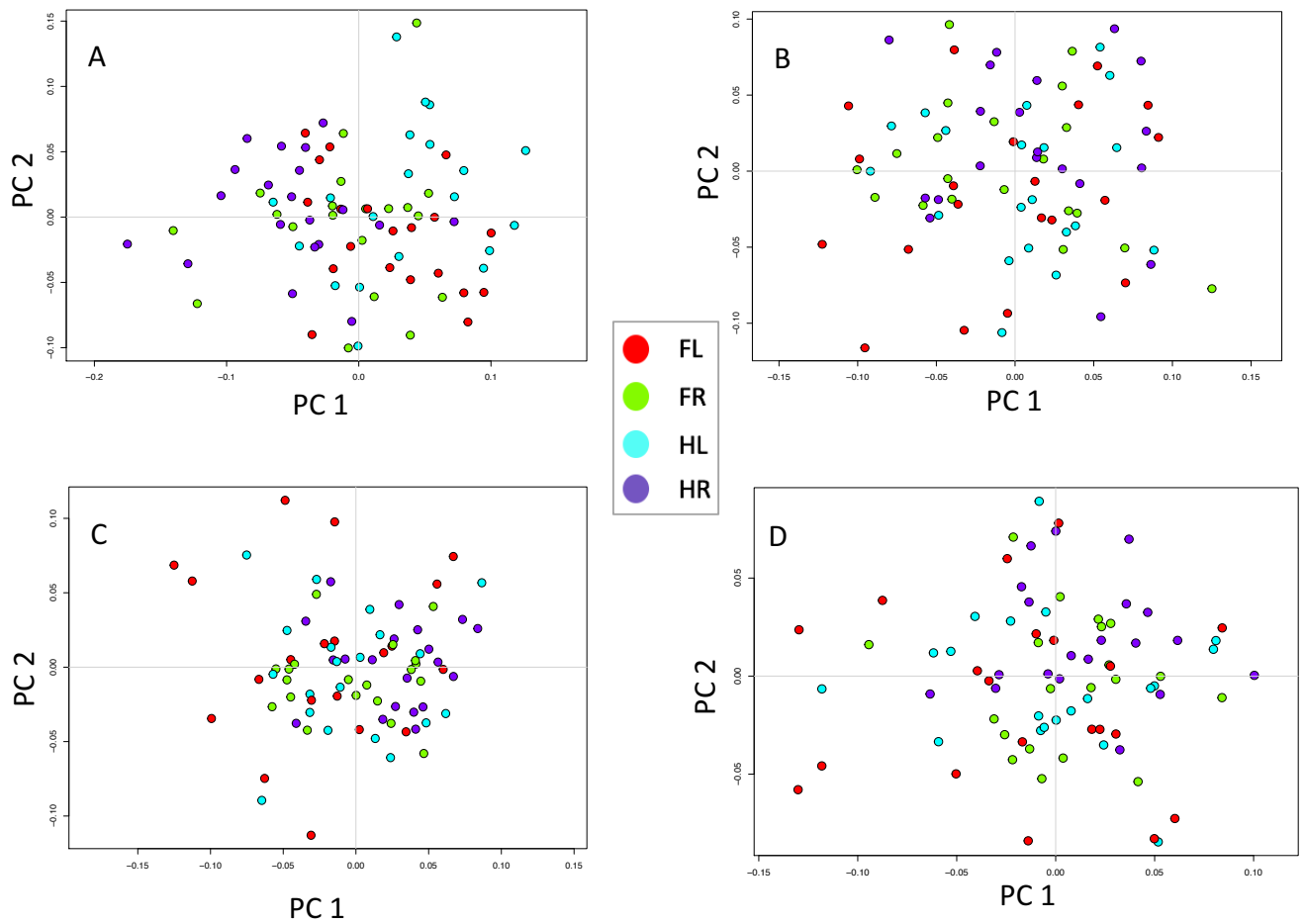
## Appendix G: PCA plots



**Figure 38** – Principal Components Analyses conducted on main pads. Figures A and B display the PCA conducted on data that were extracted using fixed landmarks on 2D- and 3D-models respectively. Figures C and D display the PCA conducted on data that were extracted using fixed landmarks and curve-sliders on 2D- and 3D-models respectively. Figure E displays the PCA conducted on data that were extracted using fixed landmarks, curve- and surface-sliders on 3D-models. The colour code corresponds to the different track positions: red for Front Left (“FL”), green for Front Right (“FR”), blue for Hind Left (“HL”), and purple for Hind Right (“HR”).

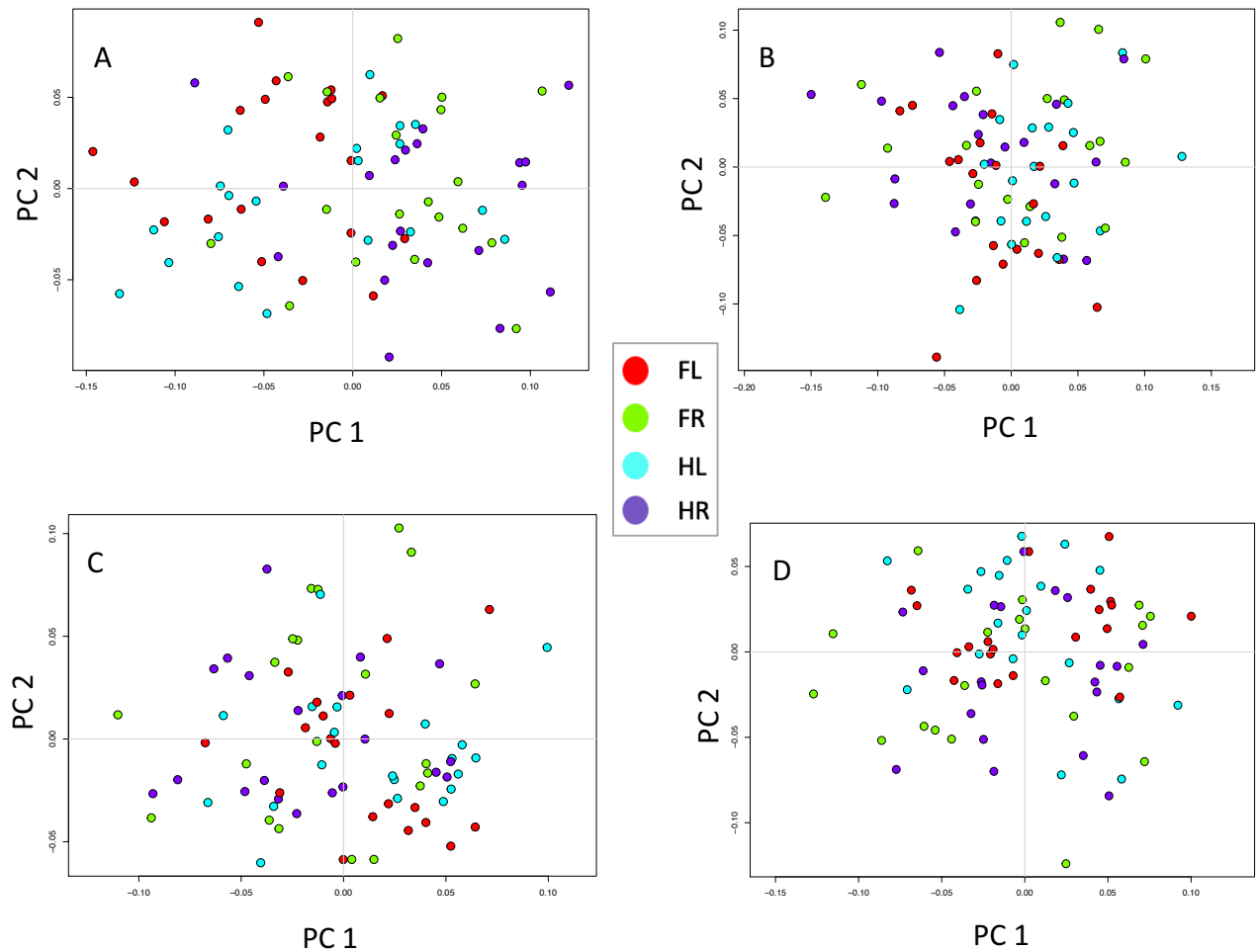


**Figure 39** - Principal Components Analyses conducted on toes 1. Figures A and B display the PCA conducted on data that were extracted using fixed landmarks on 2D- and 3D-models respectively. Figures C and D display the PCA conducted on data that were extracted using fixed landmarks and curve-sliders on 2D- and 3D-models respectively. Figure E displays the PCA conducted on data that were extracted using fixed landmarks, curve- and surface-sliders on 3D-models. The colour code corresponds to the different track positions: red for Front Left (“FL”), green for Front Right (“FR”), blue for Hind Left (“HL”), and purple for Hind Right (“HR”).

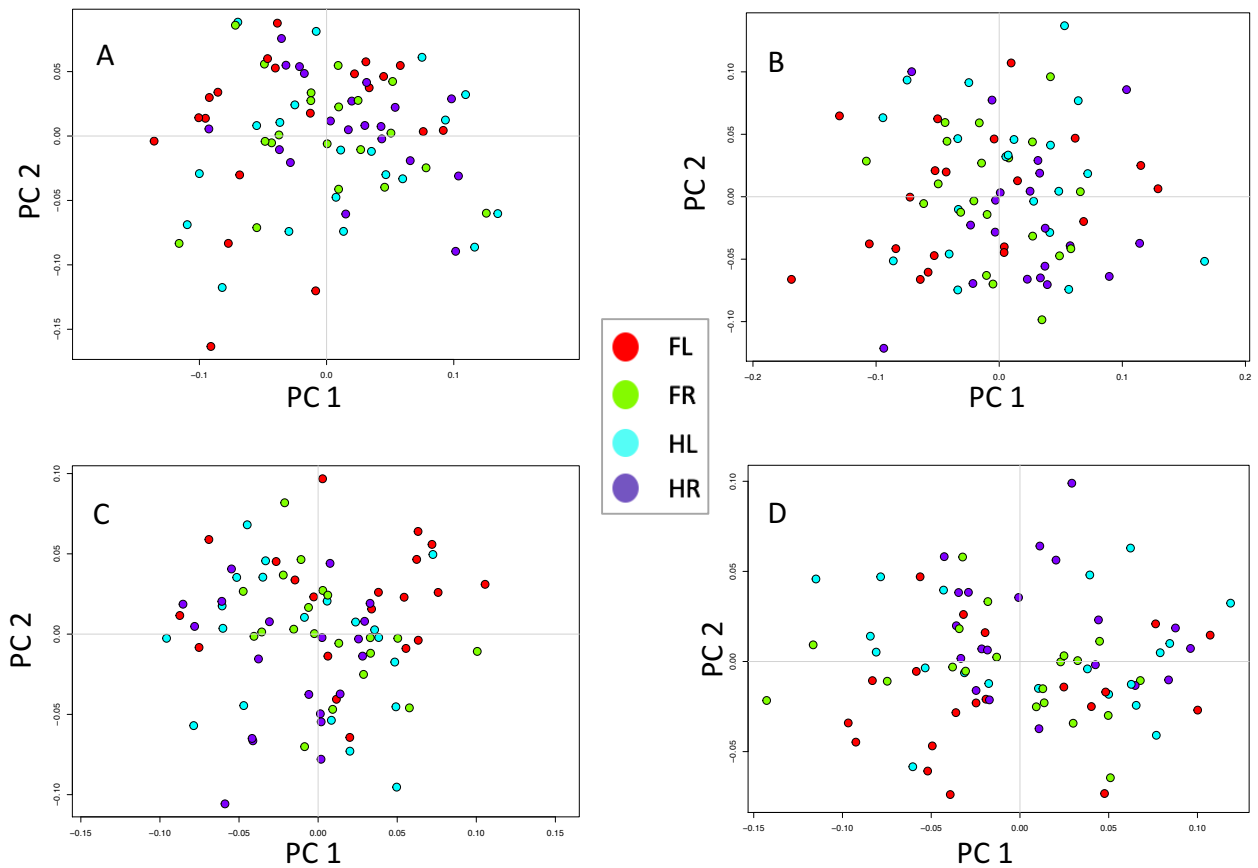


**Figure 40** - Principal Components Analyses conducted on toes 2. Figures A and B display the PCA conducted on data that were extracted using fixed landmarks on 2D- and 3D-models respectively. Figure C displays the PCA conducted on data that were extracted using fixed landmarks and curve-sliders on 3D-models. Figure D displays the PCA conducted on data that were extracted using fixed landmarks, curve- and surface-sliders on 3D-models. The colour code corresponds to the different track positions: red for Front Left ("FL"), green for Front Right ("FR"), blue for Hind Left ("HL"), and purple for Hind Right ("HR").

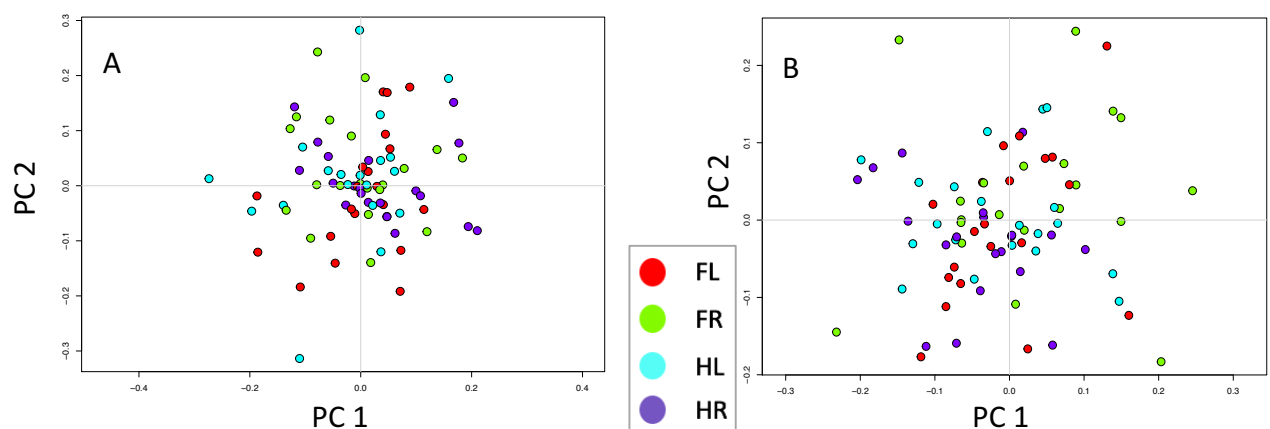




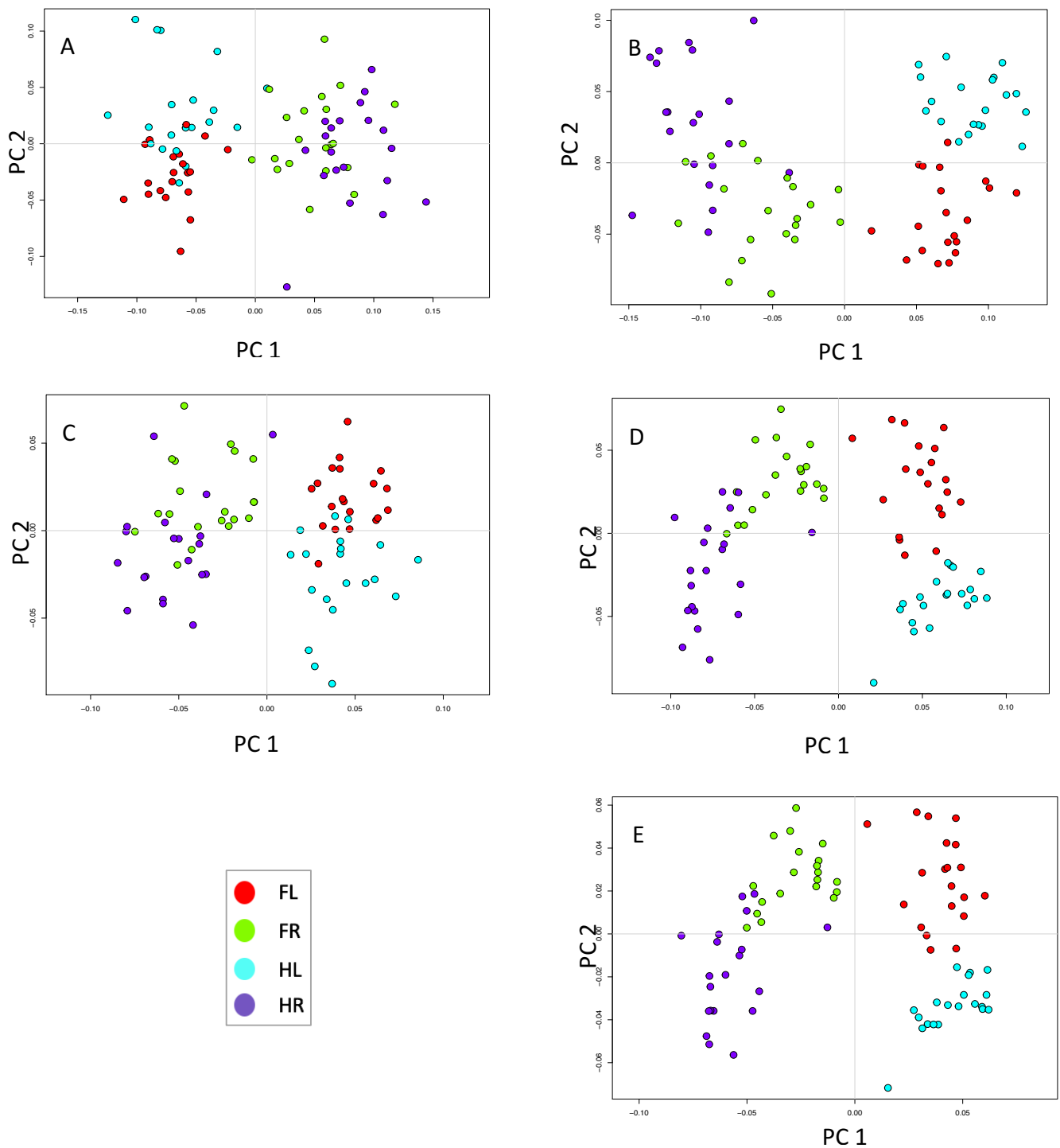
**Figure 41** - *Principal Components Analyses conducted on toes 3. Figures A and B display the PCA conducted on data that were extracted using fixed landmarks on 2D- and 3D-models respectively. Figure C displays the PCA conducted on data that were extracted using fixed landmarks and curve-sliders on 3D-models. Figure D displays the PCA conducted on data that were extracted using fixed landmarks, curve- and surface-sliders on 3D-models. The colour code corresponds to the different track positions: red for Front Left ("FL"), green for Front Right ("FR"), blue for Hind Left ("HL"), and purple for Hind Right ("HR").*



**Figure 42** - Principal Components Analyses conducted on toes 4. Figures A and B display the PCA conducted on data that were extracted using fixed landmarks on 2D- and 3D-models respectively. Figure C displays the PCA conducted on data that were extracted using fixed landmarks and curve-sliders on 3D-models. Figure D displays the PCA conducted on data that were extracted using fixed landmarks, curve- and surface-sliders on 3D-models. The colour code corresponds to the different track positions: red for Front Left (“FL”), green for Front Right (“FR”), blue for Hind Left (“HL”), and purple for Hind Right (“HR”).



**Figure 43** – Principal Components Analysis conducted on entire tracks, on which traditional morphometrics (fixed landmarks) was applied to extract data from 2D (A) and 3D (B) entire tracks. red for Front Left (“FL”), green for Front Right (“FR”), blue for Hind Left (“HL”), and purple for Hind Right (“HR”).



**Figure 44** - Principal Components Analyses conducted on entire tracks. Figures A and B display the PCA conducted on data that were extracted using fixed landmarks on 2D- and 3D-models respectively. Figures C and D display the PCA conducted on data that were extracted using fixed landmarks and curve-sliders on 2D- and 3D-models respectively. Figure E displays the PCA conducted on data that were extracted using fixed landmarks, curve- and surface-sliders on 3D-models. The colour code corresponds to the different track positions: red for Front Left (“FL”), green for Front Right (“FR”), blue for Hind Left (“HL”), and purple for Hind Right (“HR”).

## Appendix H: accuracies of prediction

**Table 18** – Accuracy of prediction (in %) of the algorithms resulting from the LDA conducted on the scenarios that involved geometric morphometric analyses on 2D-models. The objects (“pads” or “track”) were characterized either by fixed landmarks only (“fixed”) or fixed landmarks and curve-sliders (“fixed+curve”). The variables taken into account by the algorithms were the centroid size only (“Csize”), the shape components only (“shape”), or both at the same time (“Shape&Size”).

| Type of model                      |    | Two-dimension           |            |              |            |               |            |
|------------------------------------|----|-------------------------|------------|--------------|------------|---------------|------------|
| Feature extraction                 |    | Geometric Morphometrics |            |              |            |               |            |
| Type of landmarks                  |    | fixed                   |            |              |            | fixed + curve |            |
| Type of object                     |    | pad                     |            | track        |            | track         |            |
| Type of variable                   |    | Csize: 56.25            |            | Csize: 50.00 |            | Csize: 26.25  |            |
|                                    |    | Shape                   | Shape&Size | Shape        | Shape&Size | Shape         | Shape&Size |
| Number of PC used by the algorithm | 1  | 21.25                   | 51.25      | 58.75        | 91.25      | 72.50         | 88.75      |
|                                    | 2  | 47.50                   | 58.75      | 70.00        | 93.75      | 88.75         | 95.00      |
|                                    | 3  | 53.75                   | 67.50      | 80.00        | 95.00      | 92.50         | 95.00      |
|                                    | 4  | 48.75                   | 73.75      | 80.00        | 96.25      | 92.50         | 93.75      |
|                                    | 5  | 50.00                   | 76.25      | 81.25        | 95.00      | 91.25         | 95.00      |
|                                    | 6  | 50.00                   | 76.25      | 76.25        | 95.00      | 95.00         | 95.00      |
|                                    | 7  | 51.25                   | 73.75      | 87.50        | 97.50      | 95.00         | 95.00      |
|                                    | 8  | 41.25                   | 70.00      | 83.75        | 97.50      | 95.00         | 95.00      |
|                                    | 9  | 48.75                   | 68.75      | 85.00        | 96.25      | 95.00         | 95.00      |
|                                    | 10 | 48.75                   | 70.00      | 85.00        | 95.00      | 96.25         | 98.75      |
|                                    | 11 | 43.75                   | 68.75      | 86.25        | 95.00      | 95.00         | 98.75      |
|                                    | 12 | 43.75                   | 73.75      | 87.50        | 96.25      | 95.00         | 98.75      |
|                                    | 13 | 48.75                   | 68.75      | 85.00        | 96.25      | 95.00         | 97.50      |
|                                    | 14 | 46.25                   | 71.25      | 83.75        | 97.50      | 95.00         | 95.00      |
|                                    | 15 | 48.75                   | 68.75      | 86.25        | 98.75      | 95.00         | 96.25      |
|                                    | 16 | 46.25                   | 67.50      | 85.00        | 96.25      | 93.75         | 97.50      |
|                                    | 17 | 43.75                   | 66.25      | 83.75        | 96.25      | 93.75         | 96.25      |
|                                    | 18 | 41.25                   | 67.50      | 87.50        | 96.25      | 95.00         | 95.00      |
|                                    | 19 | 45.00                   | 68.75      | 83.75        | 96.25      | 93.75         | 93.75      |
|                                    | 20 | 43.75                   | 68.75      | 82.50        | 95.00      | 93.75         | 95.00      |
|                                    | 21 | 47.50                   | 67.50      | 80.00        | 92.50      | 93.75         | 93.75      |
|                                    | 22 | 46.25                   | 76.25      | 80.00        | 92.50      | 95.00         | 92.50      |
|                                    | 23 | 47.50                   | 75.00      | 77.50        | 93.75      | 96.25         | 93.75      |
|                                    | 24 | 46.25                   | 71.25      | 76.25        | 93.75      | 96.25         | 93.75      |
|                                    | 25 | 46.25                   | 75.00      | 78.75        | 92.50      | 95.00         | 90.00      |
|                                    | 26 | 41.25                   | 77.50      | 80.00        | 91.25      | 95.00         | 92.50      |
|                                    | 27 | 41.25                   | 76.25      | 80.00        | 92.50      | 93.75         | 91.25      |
|                                    | 28 | 41.25                   | 80.00      | 77.50        | 91.25      | 95.00         | 92.50      |
|                                    | 29 | 38.75                   | 77.50      | 77.50        | 93.75      | 95.00         | 92.50      |
|                                    | 30 | 38.75                   | 76.25      | 81.25        | 93.75      | 92.50         | 91.25      |

**Table 19 - Accuracy of prediction (in %) of the algorithms resulting from the LDA conducted on the scenarios that involved geometric morphometric analyses on 3D-models. The objects (“pads” or “track”) were characterized by fixed landmarks only (“fixed”), fixed landmarks and curve-sliders (“fixed+curve”), or fixed landmarks and curve- and surface-sliders (“fixed+curve+surface”, presented in Table 20). The variables taken into account by the algorithms were the centroid size only (“Csize”), the shape components only (“shape”), or both at the same time (“Shape&Size”).**

| Type of model                      |    | Three-dimension         |            |               |            |               |            |               |            |
|------------------------------------|----|-------------------------|------------|---------------|------------|---------------|------------|---------------|------------|
| Feature extraction                 |    | Geometric morphometrics |            |               |            |               |            |               |            |
| Type of landmarks                  |    | fixed                   |            |               |            | fixed + curve |            |               |            |
| Type of object                     |    | pad                     |            | track         |            | pad           |            | track         |            |
| Type of variable                   |    | Csize = 38.75           |            | Csize = 26.25 |            | Csize = 41.25 |            | Csize = 26.25 |            |
|                                    |    | Shape                   | Shape&Size | Shape         | Shape&Size | Shape         | Shape&Size | Shape         | Shape&Size |
| Number of PC used by the algorithm | 1  | 27.50                   | 31.25      | 77.50         | 72.50      | 35.00         | 28.75      | 72.50         | 70.00      |
|                                    | 2  | 43.75                   | 32.50      | 90.00         | 90.00      | 50.00         | 41.25      | 88.75         | 90.00      |
|                                    | 3  | 35.00                   | 42.50      | 90.00         | 90.00      | 55.00         | 51.25      | 92.50         | 92.50      |
|                                    | 4  | 47.50                   | 33.75      | 90.00         | 90.00      | 65.00         | 52.50      | 92.50         | 92.50      |
|                                    | 5  | 52.50                   | 45.00      | 93.75         | 92.50      | 65.00         | 60.00      | 91.25         | 88.75      |
|                                    | 6  | 48.75                   | 50.00      | 92.50         | 92.50      | 66.25         | 57.50      | 95.00         | 93.75      |
|                                    | 7  | 47.50                   | 46.25      | 95.00         | 92.50      | 67.50         | 66.25      | 95.00         | 93.75      |
|                                    | 8  | 53.75                   | 47.50      | 93.75         | 93.75      | 63.75         | 63.75      | 95.00         | 95.00      |
|                                    | 9  | 53.75                   | 55.00      | 95.00         | 93.75      | 66.25         | 60.00      | 95.00         | 93.75      |
|                                    | 10 | 53.75                   | 51.25      | 96.25         | 96.25      | 68.75         | 62.50      | 96.25         | 96.25      |
|                                    | 11 | 53.75                   | 51.25      | 97.50         | 97.50      | 70.00         | 65.00      | 95.00         | 95.00      |
|                                    | 12 | 50.00                   | 48.75      | 96.25         | 95.00      | 71.25         | 66.25      | 95.00         | 95.00      |
|                                    | 13 | 55.00                   | 50.00      | 95.00         | 95.00      | 65.00         | 66.25      | 95.00         | 95.00      |
|                                    | 14 | 53.75                   | 55.00      | 95.00         | 95.00      | 67.50         | 70.00      | 95.00         | 95.00      |
|                                    | 15 | 53.75                   | 56.25      | 95.00         | 95.00      | 70.00         | 71.25      | 95.00         | 95.00      |
|                                    | 16 | 55.00                   | 51.25      | 95.00         | 95.00      | 68.75         | 67.50      | 93.75         | 93.75      |
|                                    | 17 | 55.00                   | 55.00      | 93.75         | 93.75      | 72.50         | 68.75      | 93.75         | 93.75      |
|                                    | 18 | 62.50                   | 55.00      | 92.50         | 92.50      | 70.00         | 65.00      | 95.00         | 95.00      |
|                                    | 19 | 60.00                   | 61.25      | 92.50         | 92.50      | 72.50         | 70.00      | 93.75         | 93.75      |
|                                    | 20 | 60.00                   | 60.00      | 92.50         | 92.50      | 68.75         | 70.00      | 93.75         | 93.75      |
|                                    | 21 | 57.50                   | 61.25      | 91.25         | 91.25      | 66.25         | 67.50      | 93.75         | 93.75      |
|                                    | 22 | 53.75                   | 61.25      | 92.50         | 92.50      | 70.00         | 66.25      | 95.00         | 95.00      |
|                                    | 23 | 60.00                   | 58.75      | 91.25         | 91.25      | 72.50         | 68.75      | 96.25         | 96.25      |
|                                    | 24 | 62.50                   | 61.25      | 91.25         | 91.25      | 75.00         | 72.50      | 96.25         | 96.25      |
|                                    | 25 | 65.00                   | 62.50      | 90.00         | 90.00      | 73.75         | 70.00      | 95.00         | 95.00      |
|                                    | 26 | 63.75                   | 61.25      | 92.50         | 91.25      | 72.50         | 72.50      | 95.00         | 93.75      |
|                                    | 27 | 63.75                   | 61.25      | 91.25         | 91.25      | 72.50         | 71.25      | 93.75         | 93.75      |
|                                    | 28 | 61.25                   | 60.00      | 95.00         | 95.00      | 72.50         | 70.00      | 95.00         | 93.75      |
|                                    | 29 | 61.25                   | 58.75      | 93.75         | 93.75      | 73.75         | 75.00      | 95.00         | 93.75      |
|                                    | 30 | 0.00                    | 58.75      | 93.75         | 92.50      | 73.75         | 73.75      | 92.50         | 93.75      |

**Table 20** - Accuracy of prediction (in %) of the algorithms resulting from the LDA conducted on the scenarios that involved traditional morphometrics analyses on 2D and 3D models (“fixed” landmarks only, positioned either on “pads” or “tracks”) and geometric morphometrics on 3D models (fixed landmarks and curve- and surface-sliders (“fixed+curve+surface”), positioned either on “pads” or “tracks”). In traditional morphometrics, the variables considered by the algorithms were the distances between each landmark. In geometric morphometrics, the variables considered by the algorithms were the centroid size only (“Csize”), the shape components only (“shape”), or both at the same time (“Shape&Size”).

| Type of model                      | Two-dimension             |          | Three-dimension |          | Three-dimension         |            |               |            |       |
|------------------------------------|---------------------------|----------|-----------------|----------|-------------------------|------------|---------------|------------|-------|
| Feature extraction                 | Traditional morphometrics |          |                 |          | Geometric morphometrics |            |               |            |       |
| Type of landmarks                  | fixed                     |          |                 |          | fixed + curve + surface |            |               |            |       |
| Type of object                     | pad                       |          | track           |          | pad                     |            | track         |            |       |
| Type of variable                   | Distance                  | Distance | Distance        | Distance | Csize = 45.00           |            | Csize = 26.25 |            |       |
|                                    |                           |          |                 |          | Shape                   | Shape&Size | Shape         | Shape&Size |       |
| Number of PC used by the algorithm | 1                         | 51.25    | 51.25           | 30.00    | 27.50                   | 25.00      | 26.25         | 67.50      | 67.50 |
|                                    | 2                         | 51.25    | 91.25           | 43.75    | 58.75                   | 23.75      | 26.25         | 90.00      | 90.00 |
|                                    | 3                         | 58.75    | 92.50           | 45.00    | 77.50                   | 32.50      | 30.00         | 92.50      | 92.50 |
|                                    | 4                         | 53.75    | 92.50           | 46.25    | 80.00                   | 37.50      | 35.00         | 91.25      | 91.25 |
|                                    | 5                         | 80.00    | 92.50           | 57.50    | 82.50                   | 47.50      | 38.75         | 95.00      | 93.75 |
|                                    | 6                         | 80.00    | 96.25           | 57.50    | 78.75                   | 50.00      | 46.25         | 93.75      | 92.50 |
|                                    | 7                         | 78.75    | 96.25           | 53.75    | 78.75                   | 56.25      | 51.25         | 93.75      | 92.50 |
|                                    | 8                         | 77.50    | 97.50           | 52.50    | 83.75                   | 56.25      | 58.75         | 96.25      | 96.25 |
|                                    | 9                         | 73.75    | 96.25           | 53.75    | 87.50                   | 56.25      | 60.00         | 95.00      | 95.00 |
|                                    | 10                        | 76.25    | 95.00           | 52.50    | 87.50                   | 56.25      | 56.25         | 93.75      | 93.75 |
|                                    | 11                        | 77.50    | 95.00           | 53.75    | 86.25                   | 53.75      | 61.25         | 95.00      | 93.75 |
|                                    | 12                        | 80.00    | 95.00           | 52.50    | 85.00                   | 50.00      | 57.50         | 95.00      | 95.00 |
|                                    | 13                        | 77.50    | 96.25           | 52.50    | 86.25                   | 57.50      | 56.25         | 95.00      | 95.00 |
|                                    | 14                        | 77.50    | 95.00           | 51.25    | 87.50                   | 57.50      | 60.00         | 95.00      | 95.00 |
|                                    | 15                        | 73.75    | 95.00           | 53.75    | 86.25                   | 60.00      | 56.25         | 95.00      | 95.00 |
|                                    | 16                        | 78.75    | 96.25           | 50.00    | 85.00                   | 57.50      | 56.25         | 95.00      | 95.00 |
|                                    | 17                        | 80.00    | 95.00           | 46.25    | 88.75                   | 55.00      | 57.50         | 95.00      | 95.00 |
|                                    | 18                        | 78.75    | 95.00           | 43.75    | 88.75                   | 53.75      | 52.50         | 95.00      | 95.00 |
|                                    | 19                        | 81.25    | 95.00           | 45.00    | 90.00                   | 60.00      | 57.50         | 96.25      | 96.25 |
|                                    | 20                        | 82.50    | 95.00           | 46.25    | 90.00                   | 62.50      | 62.50         | 96.25      | 96.25 |
|                                    | 21                        | 78.75    | 93.75           | 43.75    | 87.50                   | 62.50      | 66.25         | 96.25      | 96.25 |
|                                    | 22                        | 82.50    | 95.00           | 47.50    | 88.75                   | 61.25      | 65.00         | 96.25      | 96.25 |
|                                    | 23                        | 77.50    | 95.00           | 41.25    | 91.25                   | 72.50      | 63.75         | 96.25      | 96.25 |
|                                    | 24                        | 77.50    | 95.00           | 45.00    | 91.25                   | 72.50      | 66.25         | 96.25      | 96.25 |
|                                    | 25                        | 78.75    | 93.75           | 46.25    | 91.25                   | 75.00      | 71.25         | 96.25      | 96.25 |
|                                    | 26                        | 77.50    | 93.75           | 42.50    | 91.25                   | 71.25      | 70.00         | 96.25      | 96.25 |
|                                    | 27                        | 77.50    | 93.75           | 42.50    | 91.25                   | 73.75      | 68.75         | 95.00      | 95.00 |
|                                    | 28                        | 0.00     | 93.75           | 0.00     | 88.75                   | 71.25      | 71.25         | 93.75      | 95.00 |
|                                    | 29                        | 0.00     | 92.50           | 0.00     | 90.00                   | 70.00      | 71.25         | 95.00      | 96.25 |
|                                    | 30                        | 0.00     | 95.00           | 0.00     | 88.75                   | 75.00      | 73.75         | 93.75      | 93.75 |