Comparing Pollen Size Distributions in Northern Brazil to Identify Significant Temporal Changes

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https://www.google.com/search?q=poaceae&rlz=1C1UEAD_enUS1006US1006&source=lnms&tbm=isch&sa=X&ved=2ahUKEwi12oixgM74AhUNnWoFHRZUCIYQ_AUoAXoECAIQAw&biw=1920&bih=969&dpr=1#imgrc=Ql06Ok

OUTLINE

- Main objective
- Background
- Methods
  - Graphs
  - Statistical analyses
- Results
- Next steps
- Conclusion

Main Objective

- Identify when significant environmental changes occurred in time (turning/tipping points)

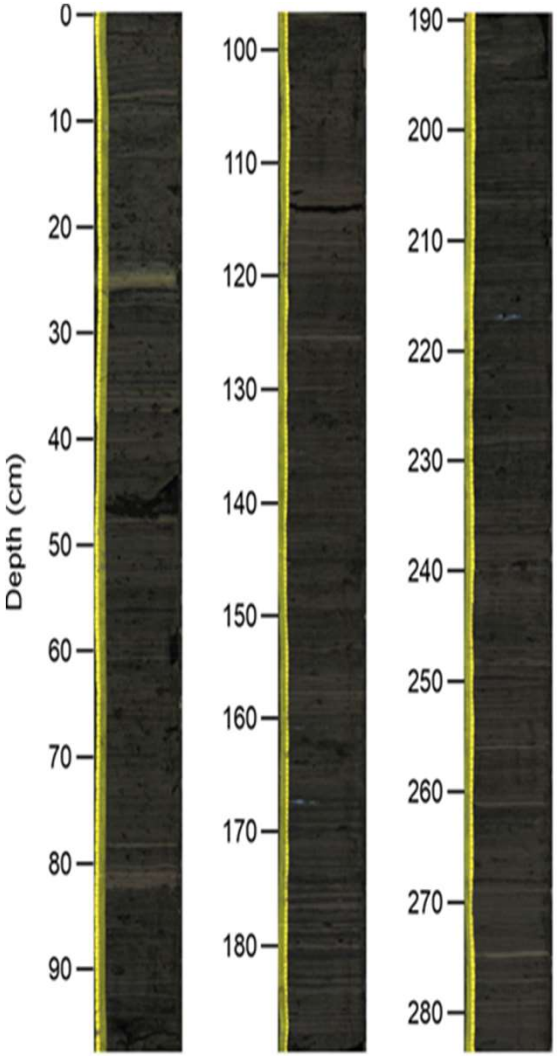
GAME PLAN

- Model and compare distributions of grass pollen sizes throughout time

BACKGROUND

- POACEAE GRASS POLLEN FOSSILS
- MUD CORES
- DIFFICULT TO DISTINGUISH BETWEEN POACEAE SPECIES
- ALTERNATE APPROACH

https://goo.gl/maps/KrUWBqmpVrgX4Vbu9



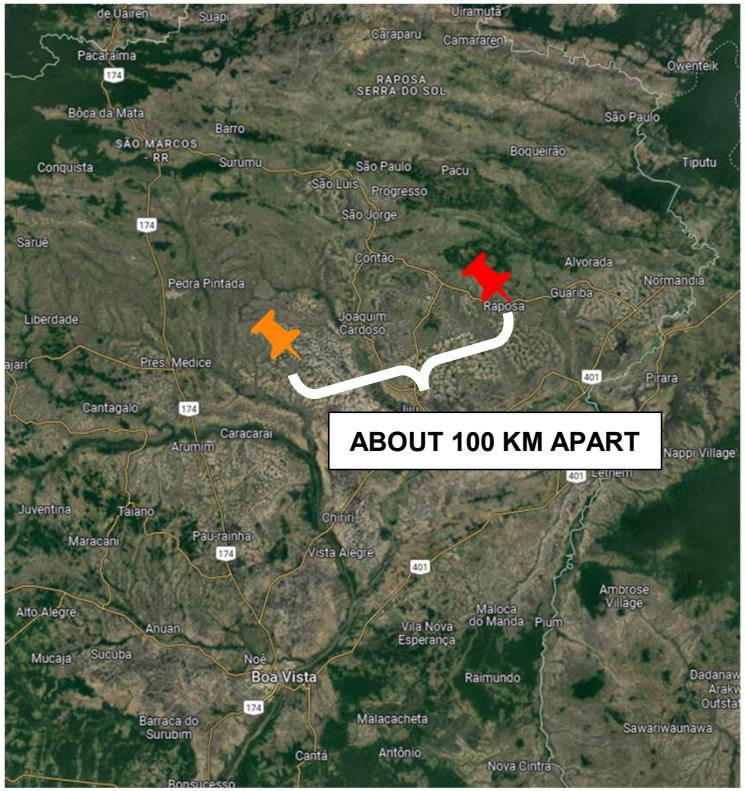
LOCATIONS

LAKE INDIGENA

LAKE CARACARANA

Broader look

Closer look



SNIPPET OF OUR DATA SETS

Lake Indigena:

Pollen Sizes (mm)	Sediment Depth (cm)	Age (Years Before Present)
69.00	2	1
32.00	2	1
…	…	…
29.00	4	58
25.90	4	58
…	…	…
35.83	18	635
46.23	18	635

Lake Caracarana:

Pollen Sizes (mm)	Sediment Depth (cm)	Age (Years Before Present)
27.40	2	17
32.00	2	17
…	…	…
29.00	4	103
30.00	4	103
…	…	…
23.72	18	515
21.22	18	515

METHODS

GRAPHS

Created graphical representations of the data

STATISTICAL ANALYSES

Performed statistical tests on the data

ANALYZE RESULTS

Analyzed the results in order to form conclusions

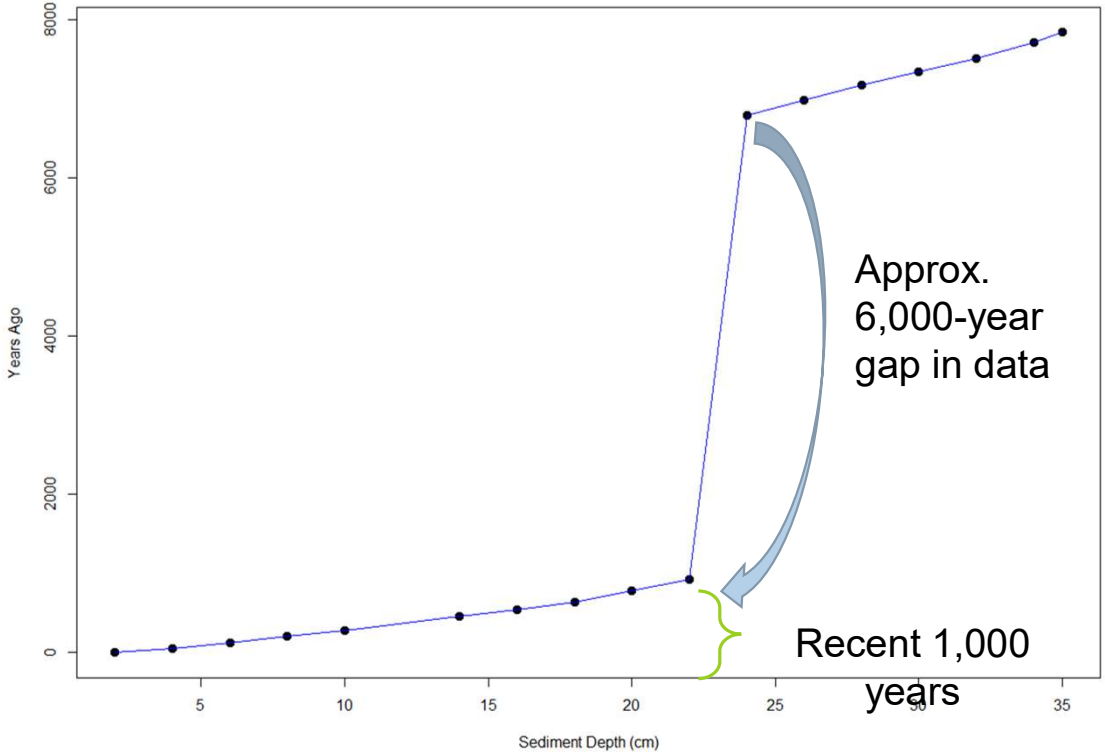
ECOLOGICAL COMPARISONS

Compare results to major climatic events and periods of human impact


GRAPHS

LAKE INDIGENA

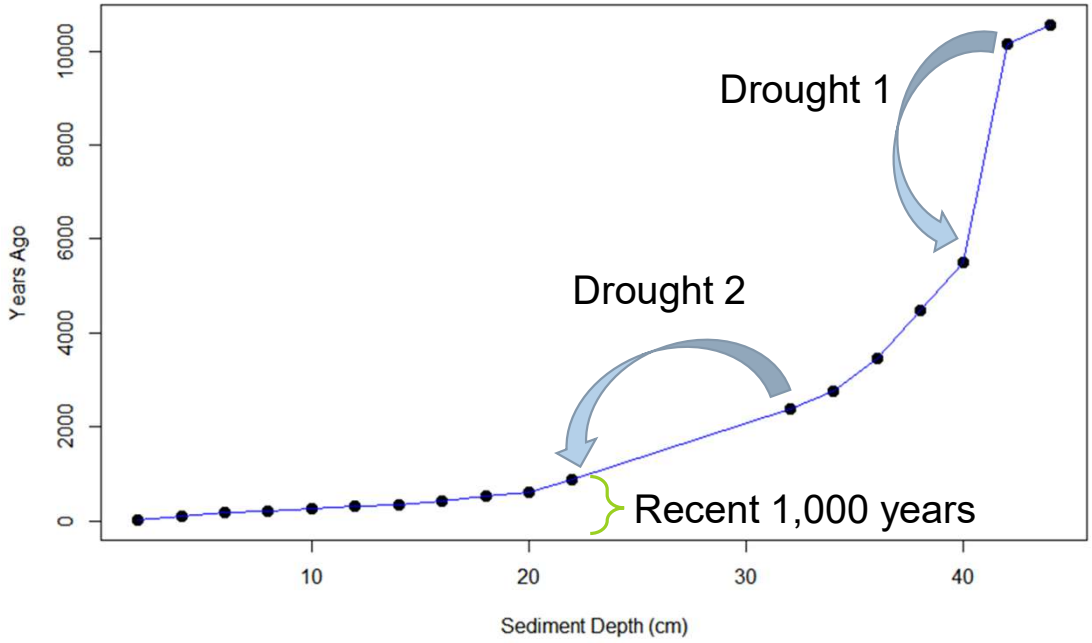
DEPTH AND TIME RELATIONSHIP



SMAG REU 2022

LAKE CARACARAN A

DEPTH AND TIME RELATIONSHIP



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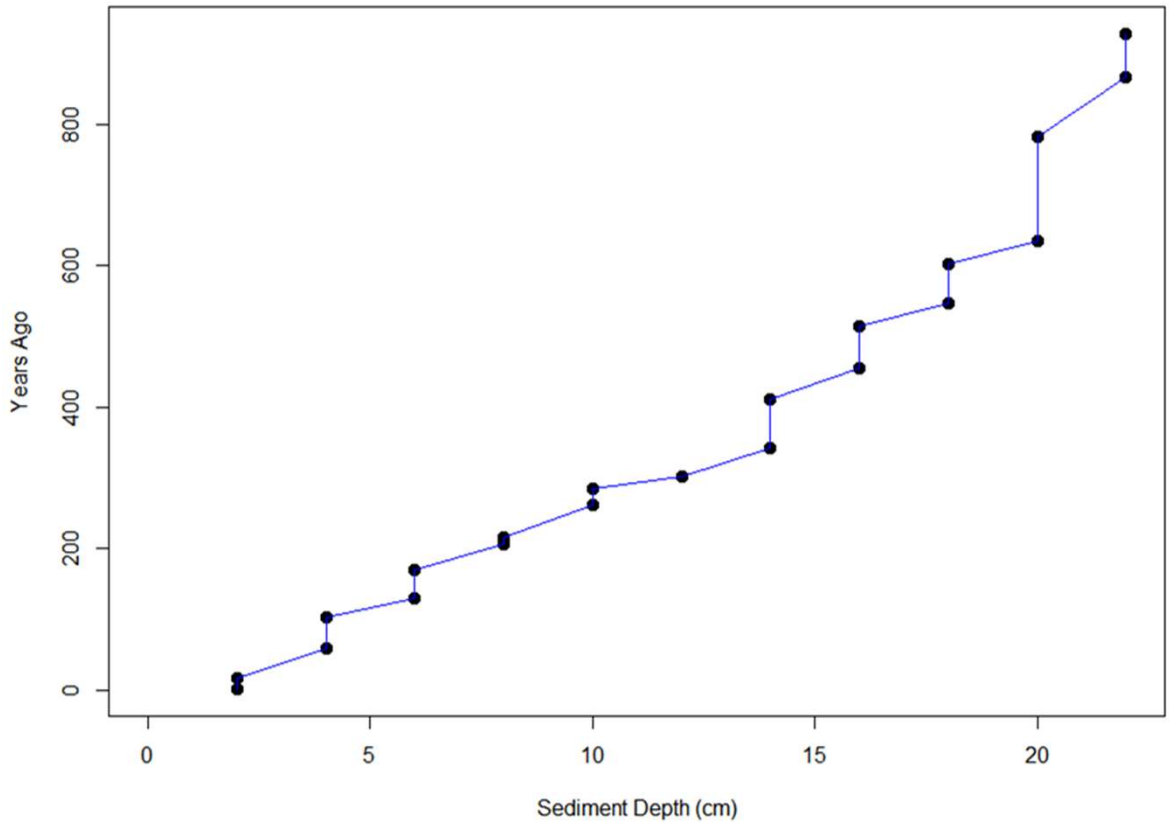
COMBINED LAKES

DEPTH AND TIME RELATIONSHIP



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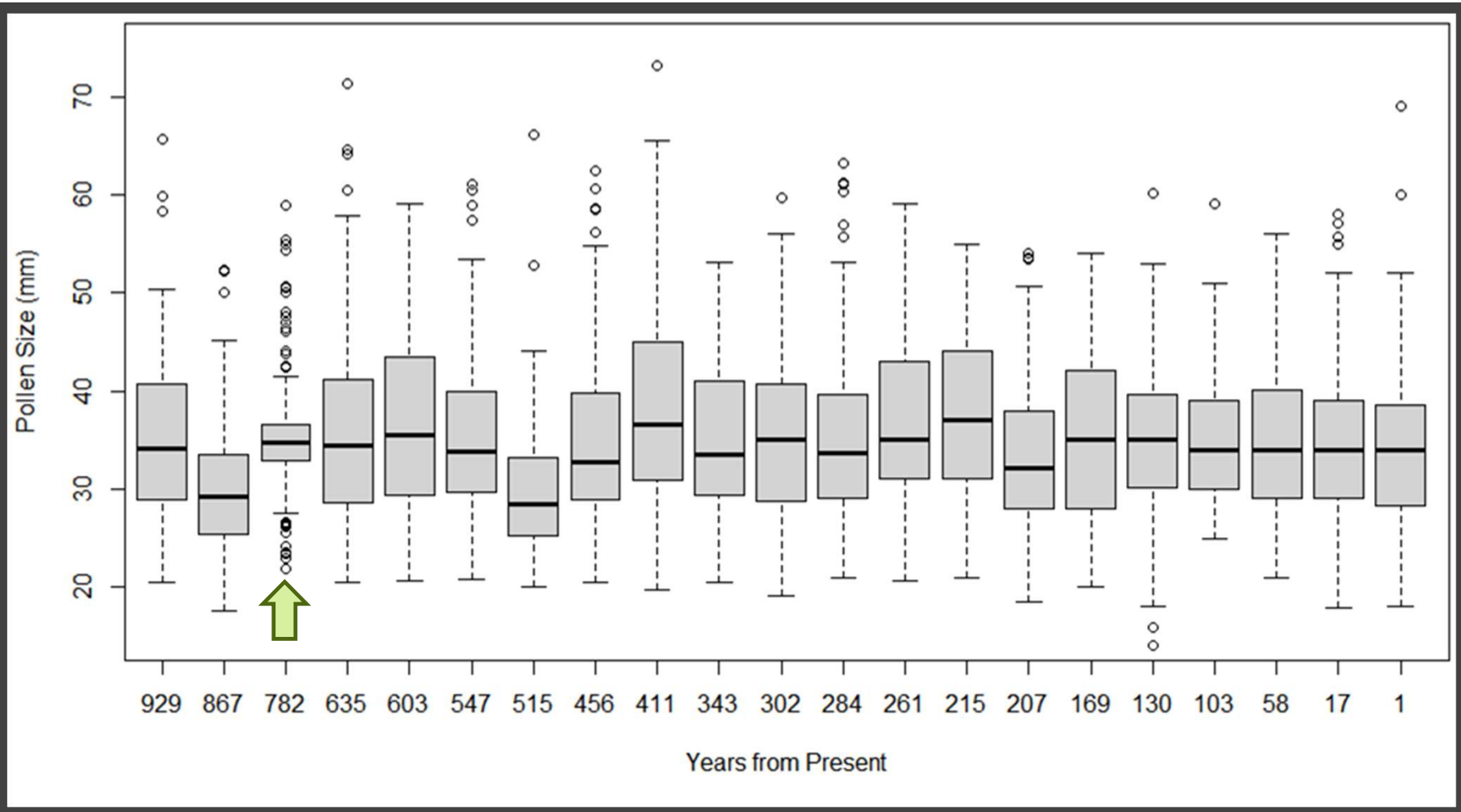
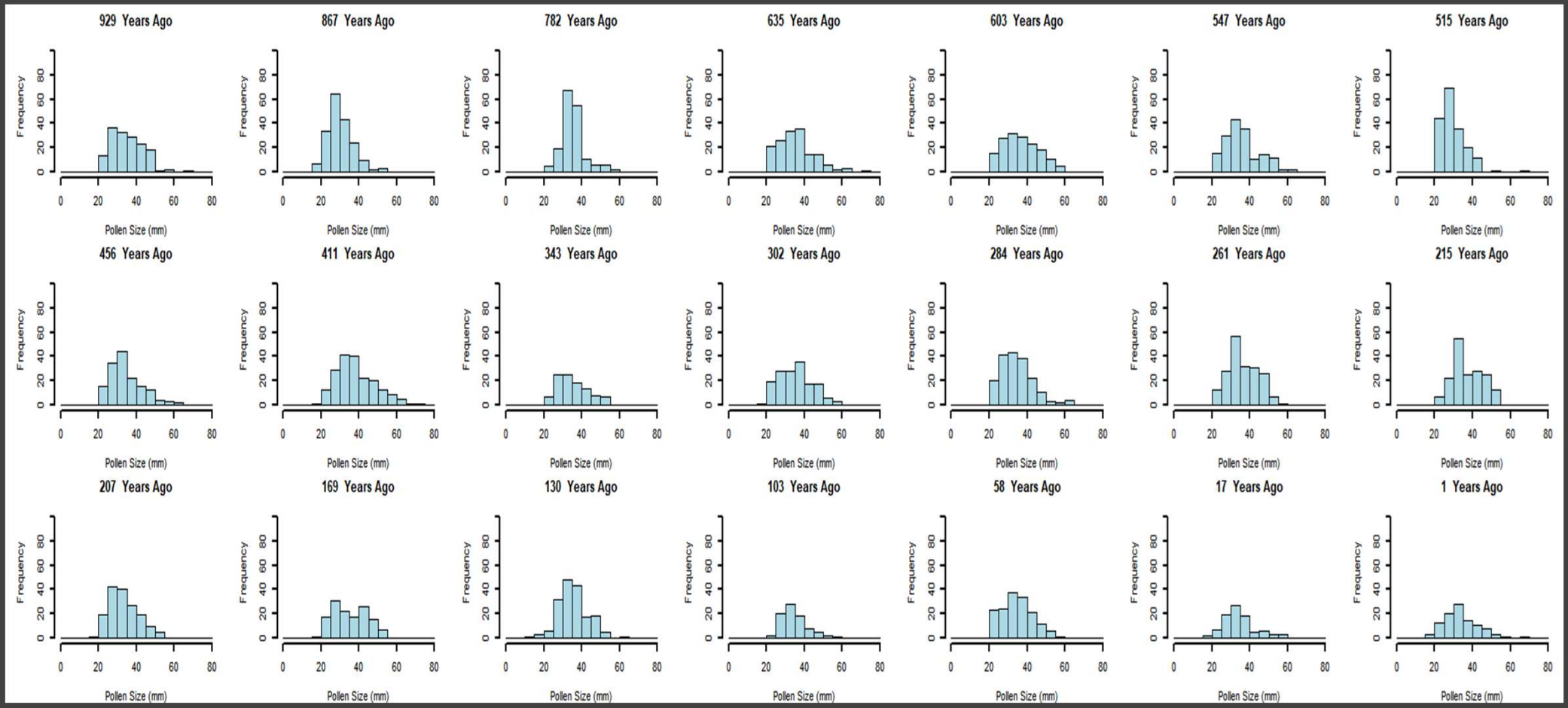


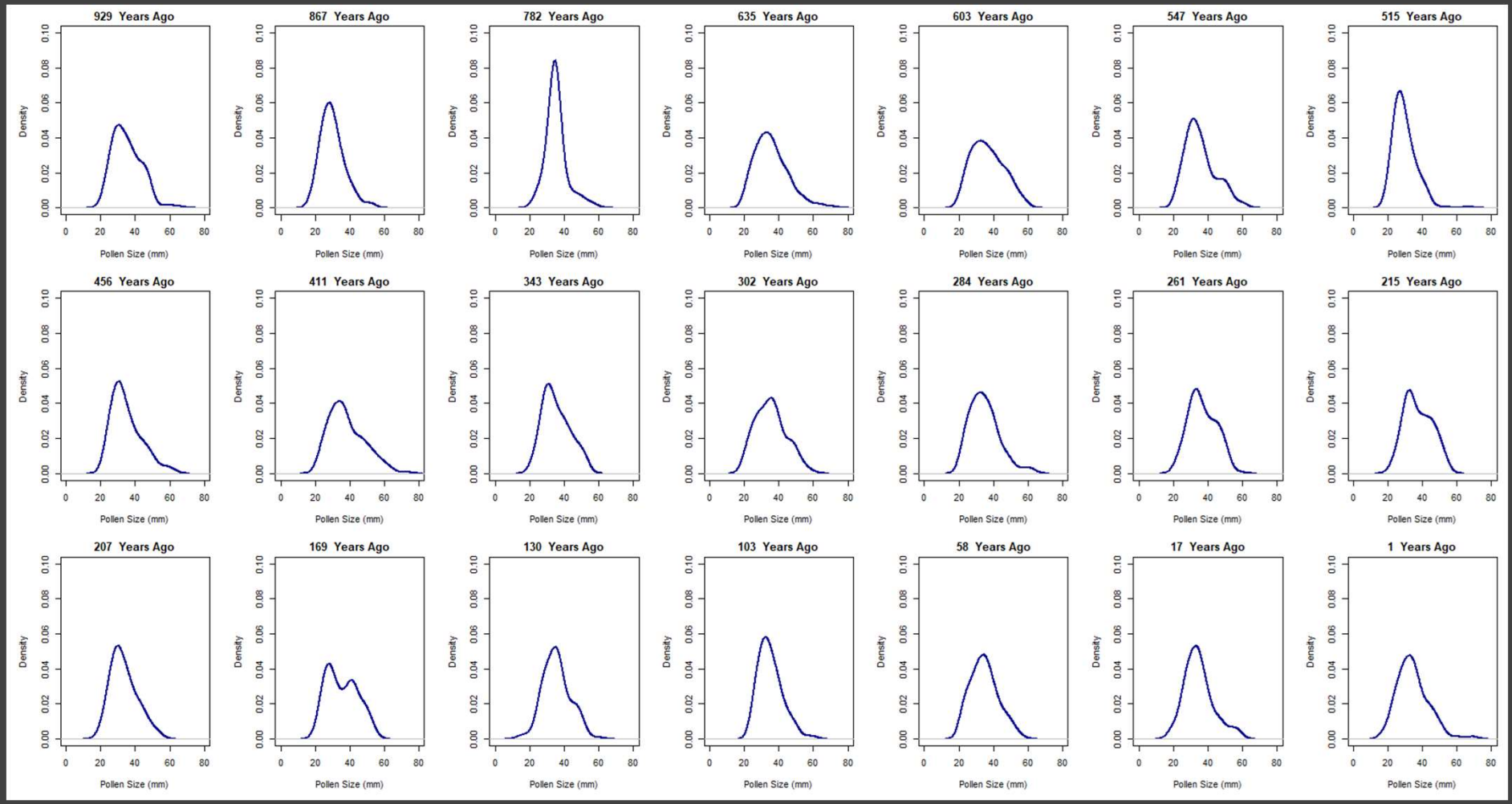
COMBINED LAKES

DISTRIBUTION OF POLLEN SIZES THROUGHOUT TIME – BOX PLOTS



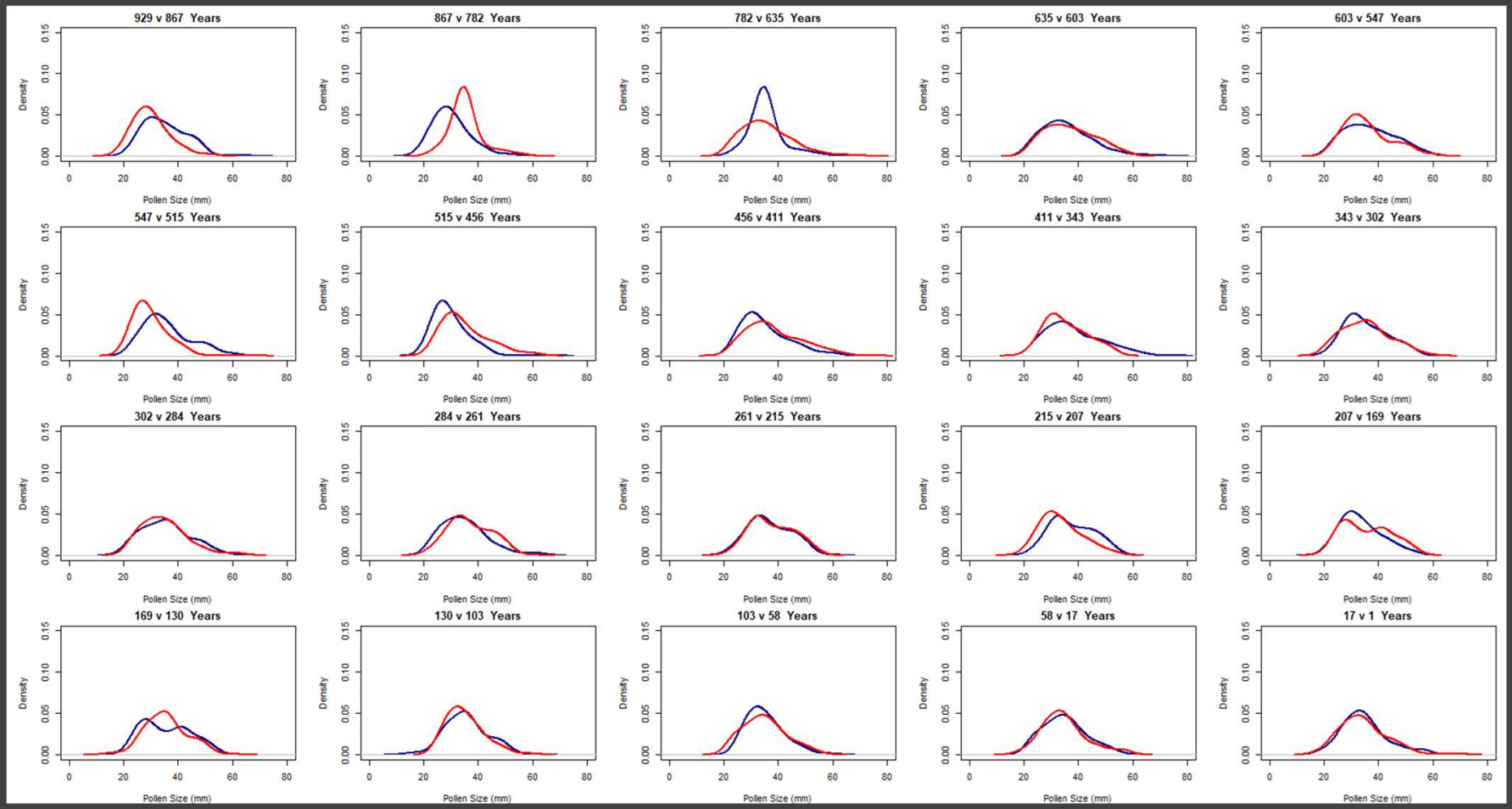
COMBINED LAKES

DISTRIBUTION OF POLLEN SIZES THROUGHOUT TIME – HISTOGRAMS



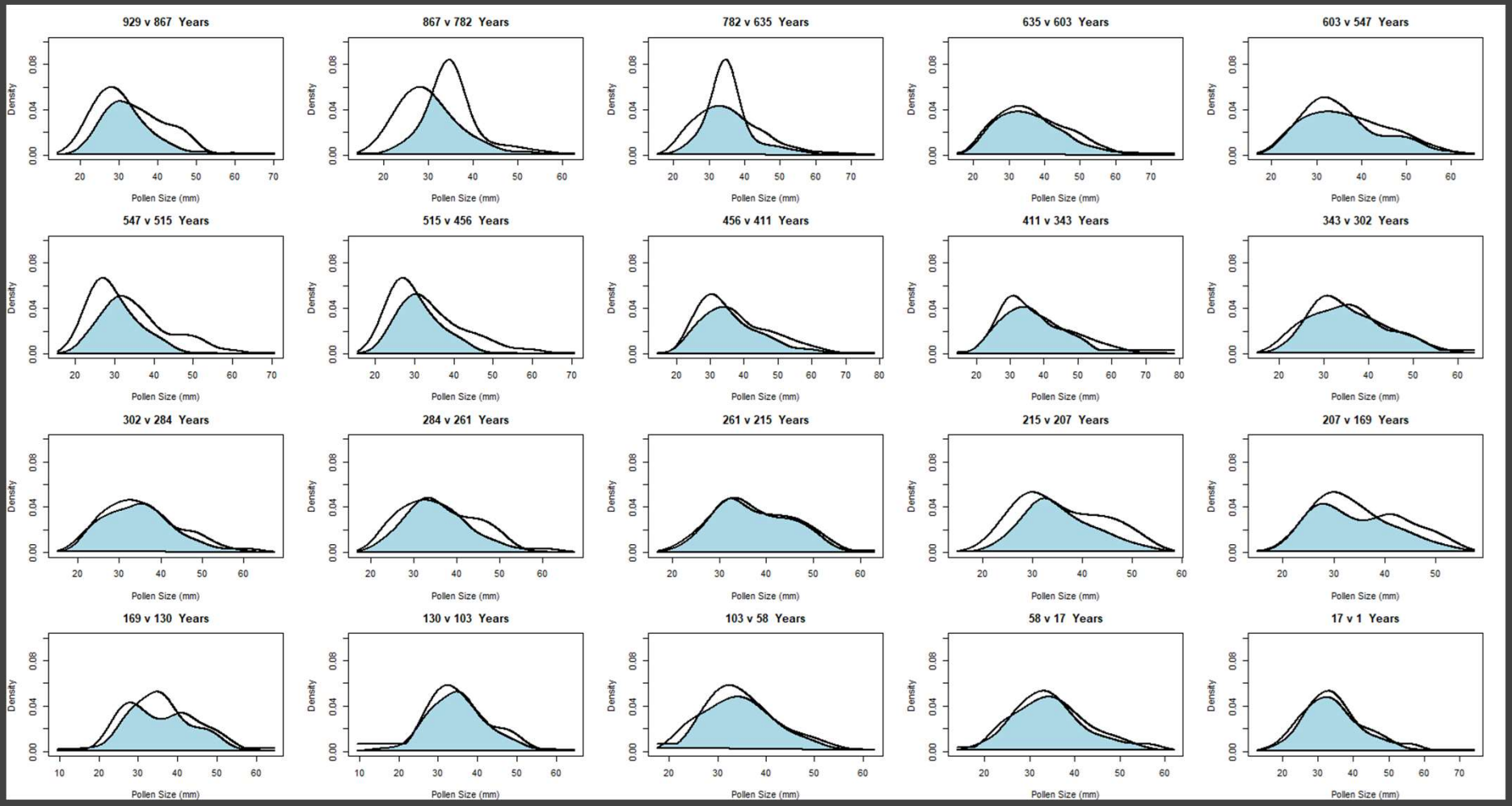
COMBINED LAKES

DISTRIBUTION OF POLLEN SIZES THROUGHOUT TIME – DENSITY CURVES



COMBINED LAKES

DISTRIBUTION OF POLLEN SIZES THROUGHOUT TIME – OVERLAPPING DENSITY CURVES



COMBINED LAKES

DISTRIBUTION OF POLLEN SIZES THROUGHOUT TIME – OVERLAPPING AREA


STATISTICAL
ANALYSES

METHODS FOR COMPARING DISTRIBUTIONS:

SUMMARY STATISTICS

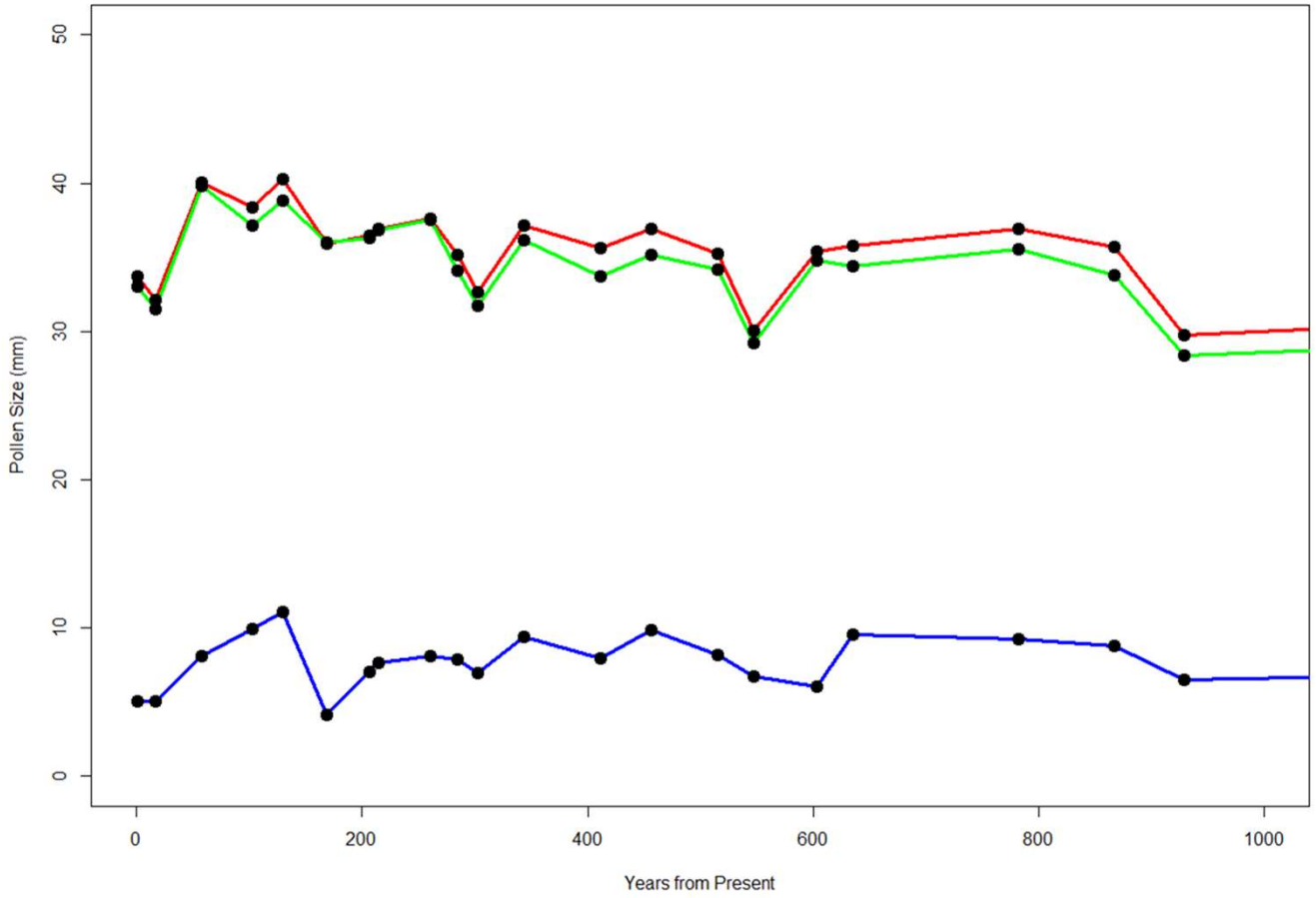
- MEAN
- MEDIAN
- STANDARD DEVIATION
- MINIMUM
- MAXIMUM
- RANGE
- Q1 & Q3
- IQR

STATISTICAL ANALYSES

- KRUSKAL-WALLIS TEST
- KOLMOGOROV-SMIRNOV TEST
- KULLBACK-LEIBLER DIVERGENCE TEST
- OVERLAP COEFFICIENT
- SKEWNESS
- KURTOSIS

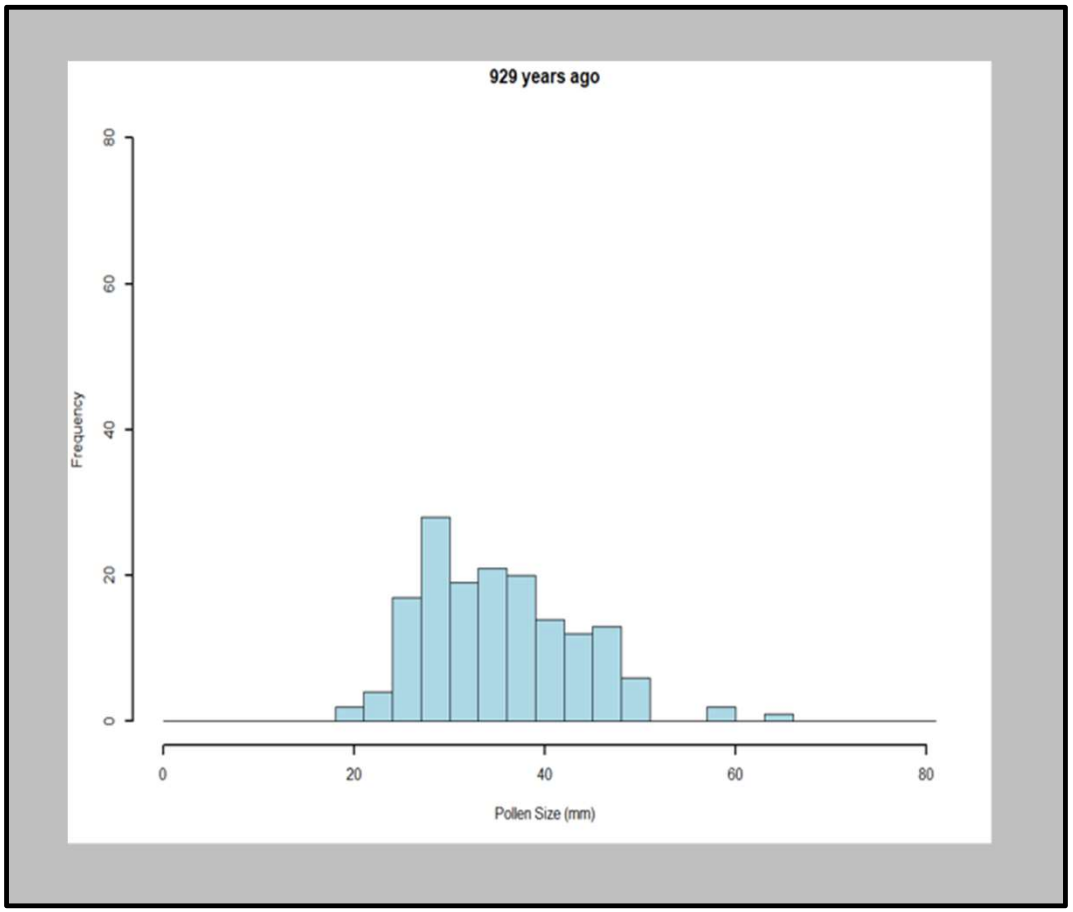
SUMMARY STATISTICS

MEAN, MEDIAN, AND STANDARD DEVIATION OF POLLEN SIZES OVER TIME



Red – Mean
Green - Median
Blue – Standard Deviation

FOR EVERY TIME PERIOD...



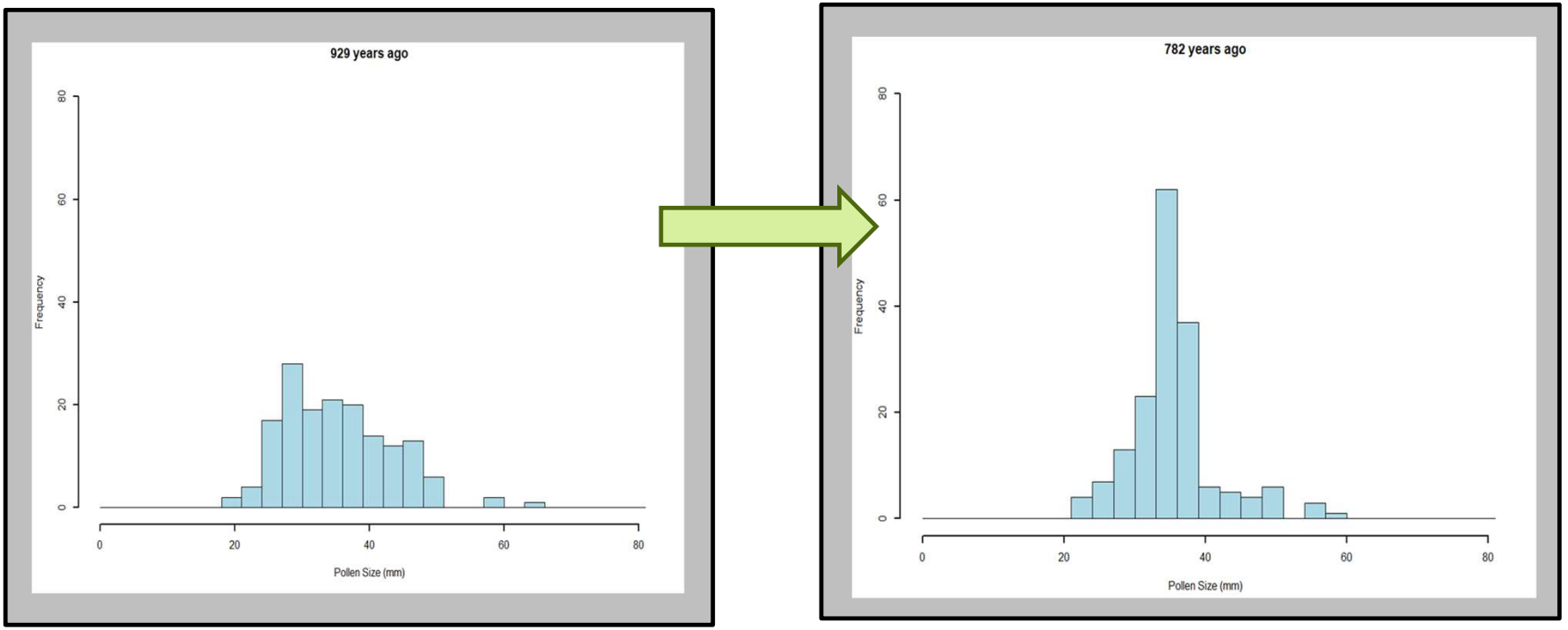
RECORDED THE:

- MEAN
- MEDIAN
- STANDARD DEVIATION
- SKEWNESS
- KURTOSIS
- MINIMUM
- MAXIMUM
- RANGE
- Q1 & Q3
- IQR

FOR EVERY PAIR OF ADJACENT TIME PERIODS...

RECORDED THE CHANGE IN:

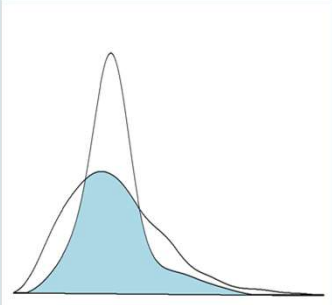
- MEAN
- MEDIAN
- STANDARD DEVIATION
- SKEWNESS
- KURTOSIS
- MINIMUM
- MAXIMUM
- RANGE
- Q1 & Q3
- IQR



SHAPIRO-WILK TEST

Years Before Present	Shapiro Test P-Value
929	0.000134881
867	8.10E-06
782	2.66E-10
635	2.11E-05
603	0.002087057
547	3.41E-06
515	7.16E-10
456	7.63E-07
411	1.80E-05
343	0.003990711
302	0.01713536
284	5.66E-06
261	0.002958356
215	0.00052256
207	0.00038698
169	0.000115487
130	0.043785916
103	0.001188376
58	0.004946978
17	0.004397484
1	0.002159499

- Are these samples normally distributed? [2]
- $\geq .05$ Null hypothesis is normally distributed
- $\leq .05$ Alternative hypothesis is not normally distributed
- Alternative accepted



STATISTICAL ANALYSES

Kruskal-Wallis Test

- Nonparametric test that compares medians [1]

Kullback-Leibler Divergence Test

- Measures how different two distributions are from one another [4]

Kolmogorov-Smirnov Test

- Quantifies the distance between two distributions [3]

Overlap Coefficient

- Measures the overlapping area between two probability density functions (PDFs)


RESULTS

TABLE OF TEST RESULTS & CHANGES IN SUMMARY STATISTICS

Time Period (Years Ago)	Difference in Years	Kruskal-Wallis P-Value	Kolmogorov-Smirnov P-Value	Kullback-Leibler Divergence Sum	Overlap Coefficient	Change in Mean
929 v 867	62			0.0439	0.7417	-5.2348
867 v 782	85		0	0.1822	0.5972	5.3723
782 v 635	147	0.6102	0.0002	0.2538	0.6973	0.3795
547 v 515	32			0.4990	0.7032	-5.9841
515 v 456	59			0.5866	0.7466	5.2213

- 5 main statistical comparisons
- 5 pairs of time periods with the most significant changes

TIME PERIODS WITH SIGNIFICANT CHANGES IN DISTRIBUTION

Kruskal-Wallis Test P-Value: 1.50×10^{-9}

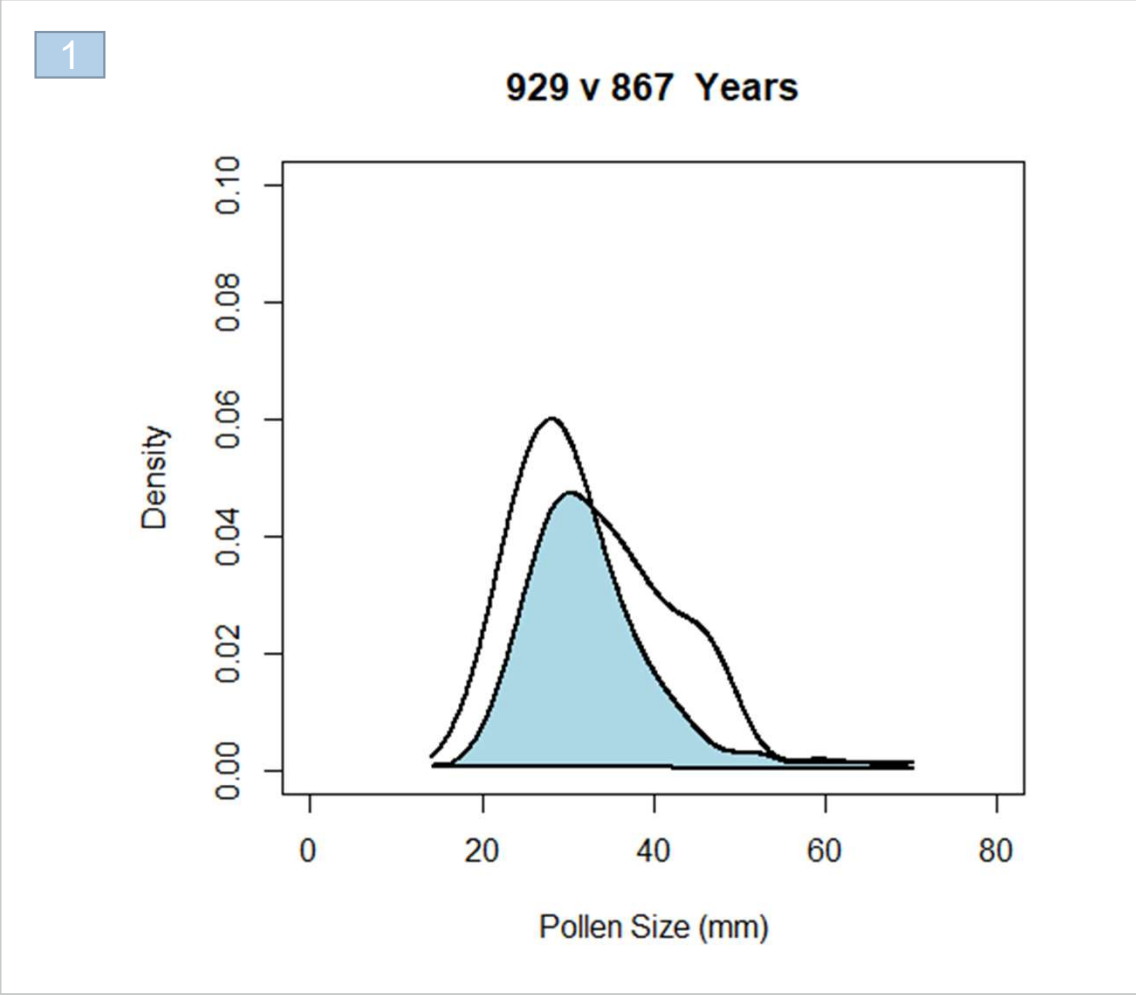
Smirnov Test P-Value: 9.51×10^{-7}

KL Divergence Sum: 0.044

Overlap Coefficient: 0.742

Change in Mean: -5.235

1



TIME PERIODS WITH SIGNIFICANT CHANGES IN DISTRIBUTION

Kruskal-Wallis Test P-Value:
1.88×10^{-16}

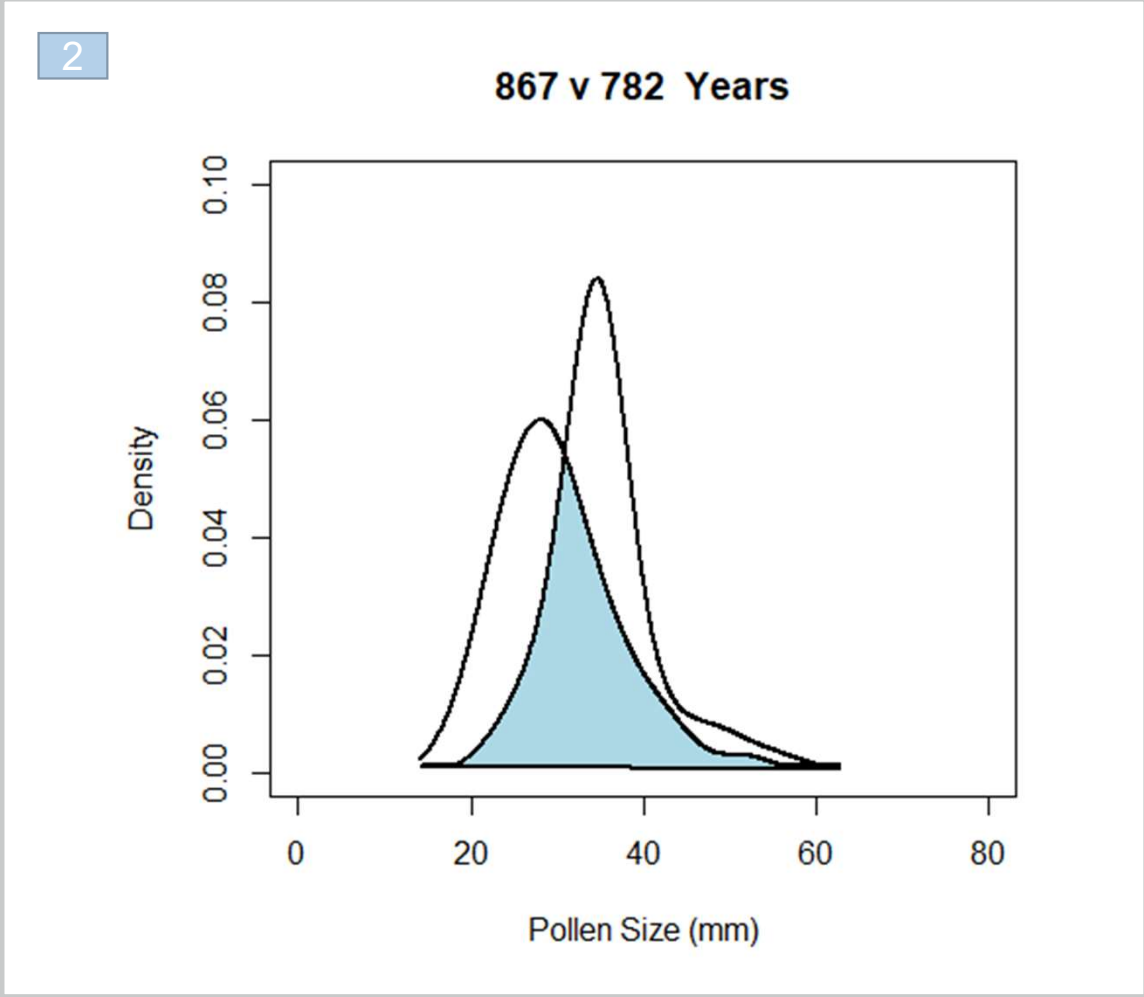
Smirnov Test P-Value: 0

KL Divergence Sum: 0.182

Overlap Coefficient: 0.597

Change in Mean: 5.372

2



TIME PERIODS WITH SIGNIFICANT CHANGES IN DISTRIBUTION

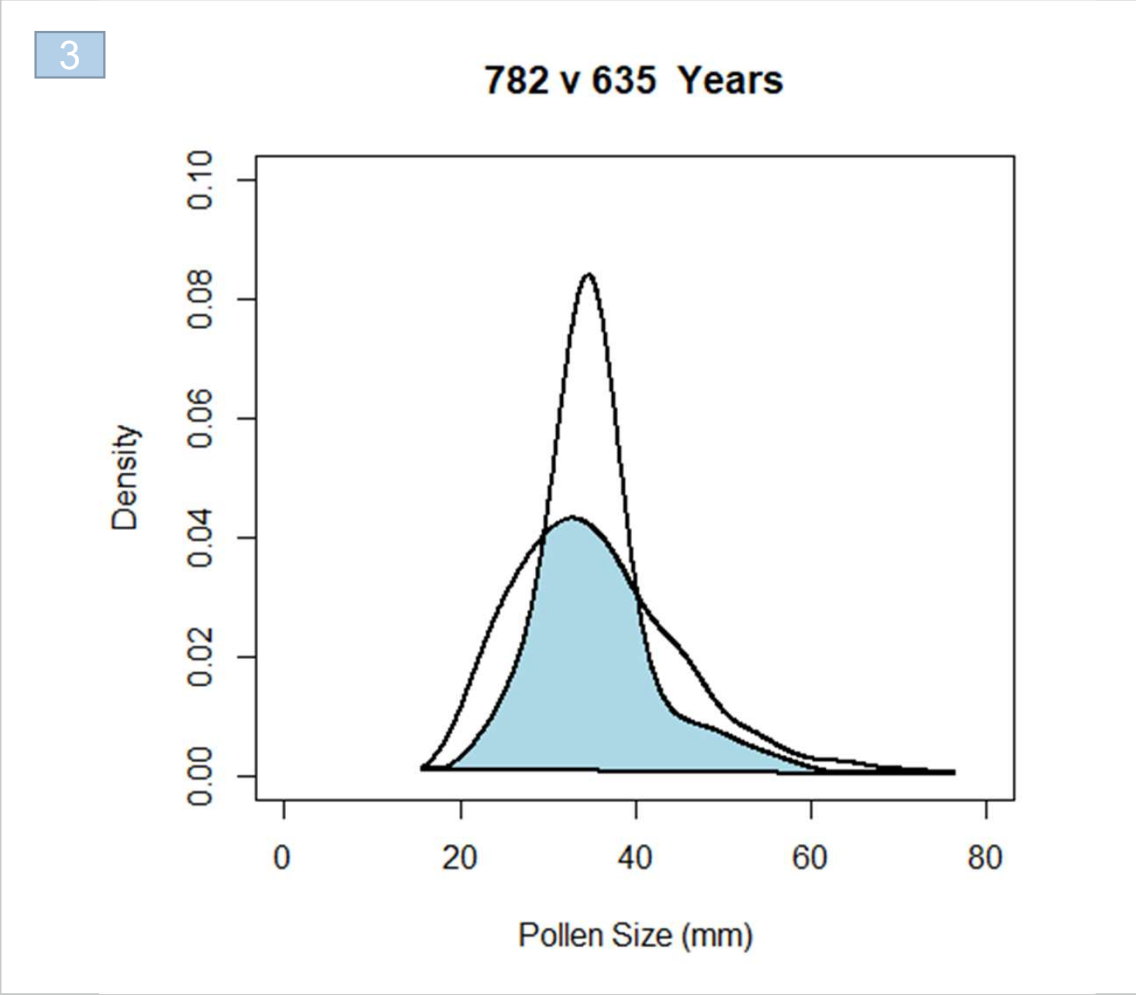
Kruskal-Wallis Test P-Value: 0.610

Smirnov Test P-Value: 0

KL Divergence Sum: 0.254

Overlap Coefficient: 0.69

Change in Mean: 0.380



TIME PERIODS WITH SIGNIFICANT CHANGES IN DISTRIBUTION

Kruskal-Wallis Test P-Value: 3.97×10^{-12}

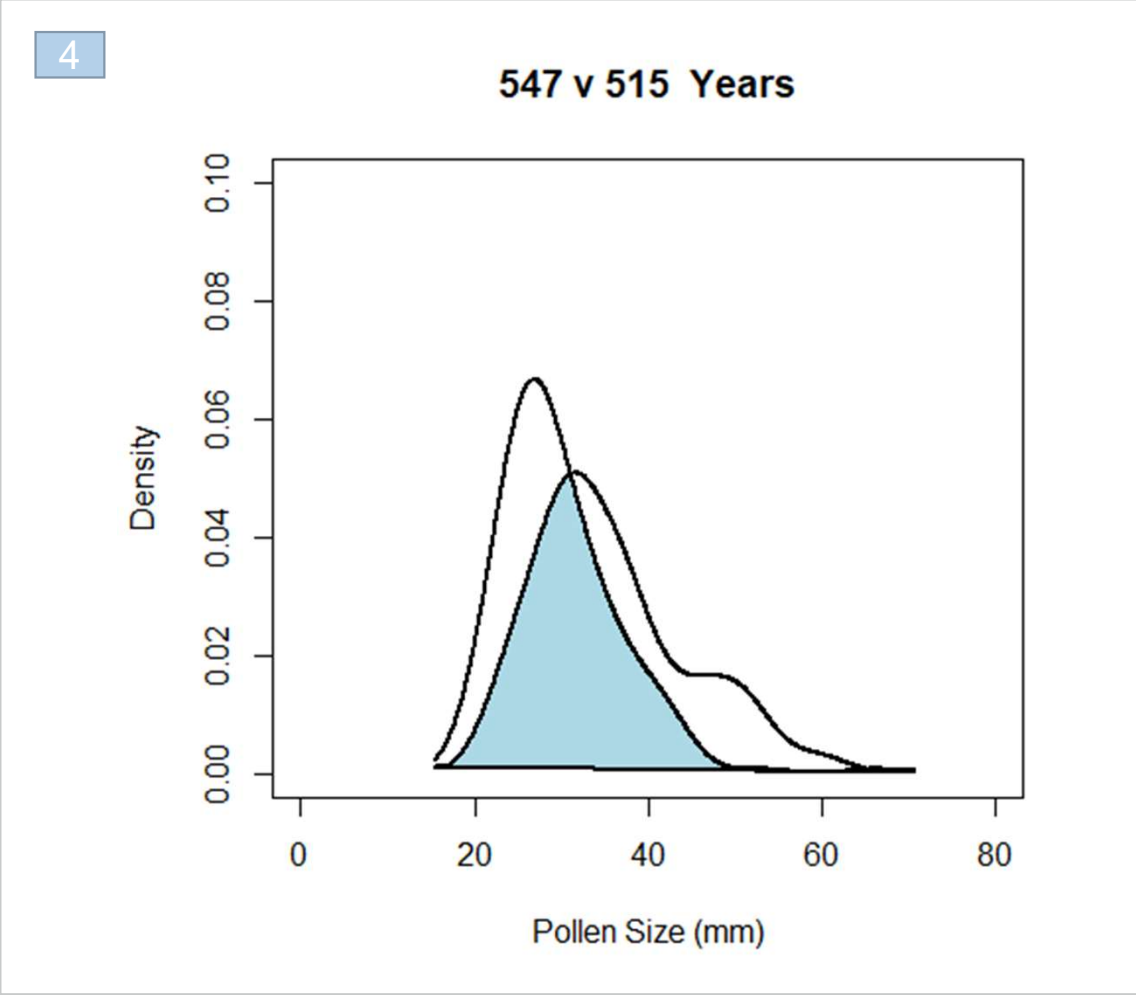
Smirnov Test P-Value: 1.34×10^{-9}

KL Divergence Sum: 0.499

Overlap Coefficient:0.703

Change in Mean: -5.984

4



TIME PERIODS WITH SIGNIFICANT CHANGES IN DISTRIBUTION

Kruskal-Wallis Test P-Value:
1.51×10^{-9}

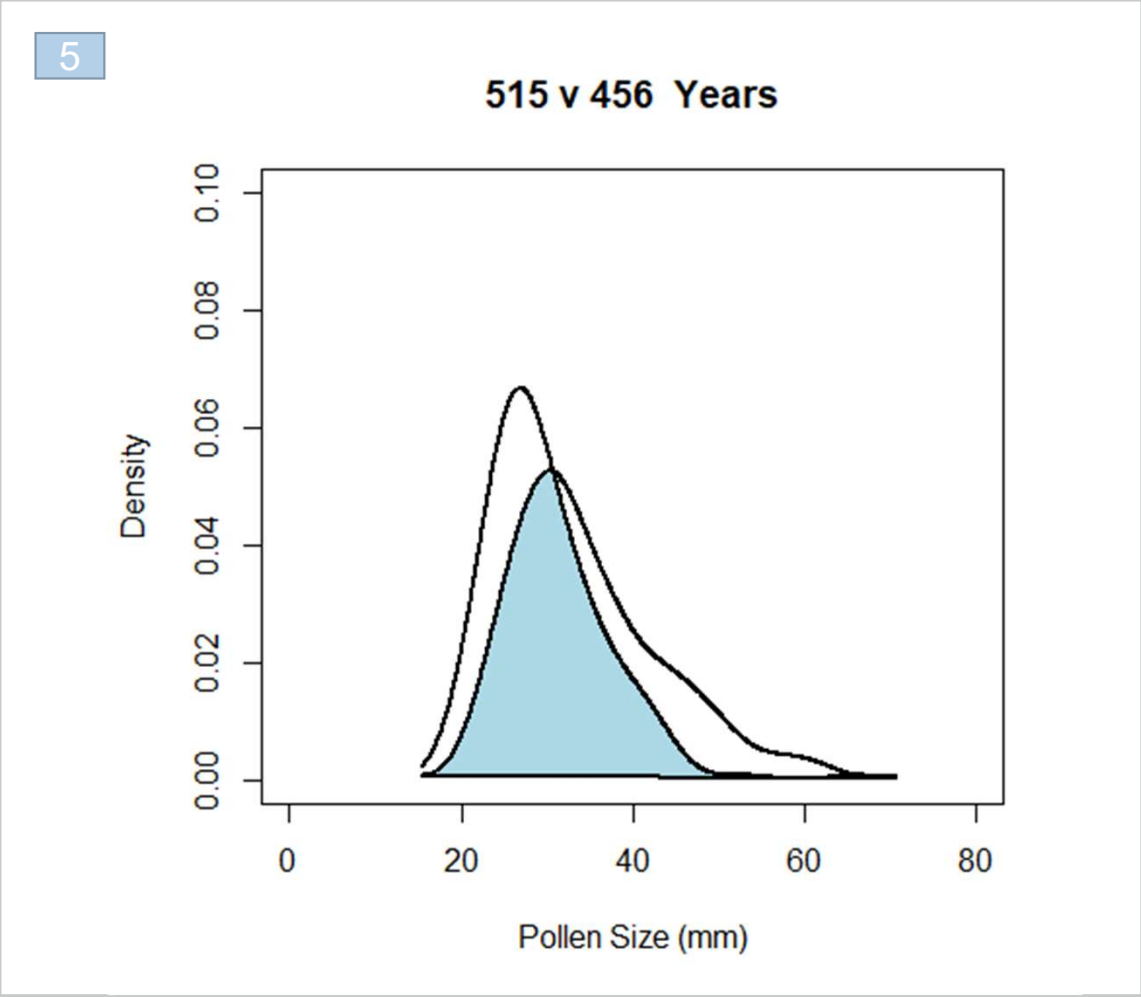
Smirnov Test P-Value:
3.96×10^{-7}

KL Divergence Sum: 0.587

Overlap Coefficient: 0.747

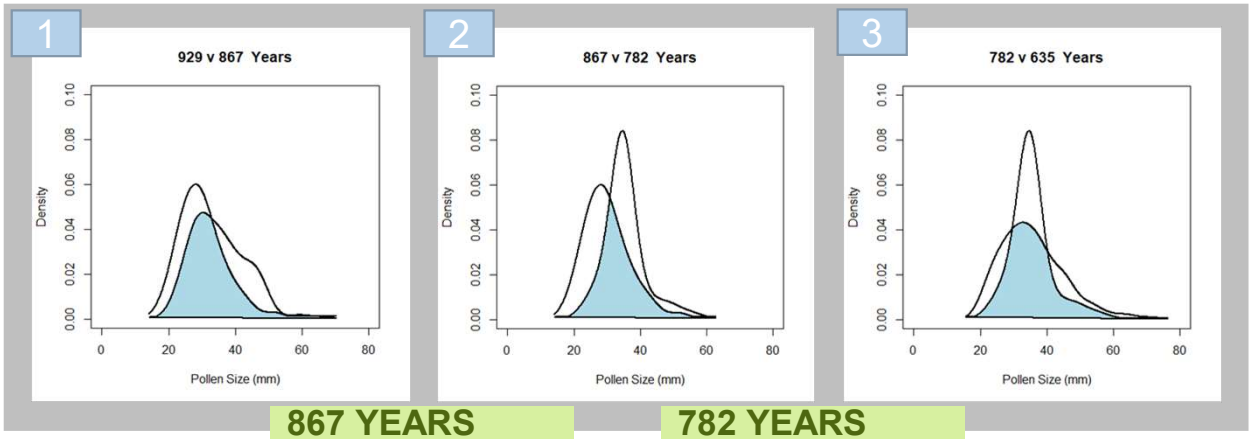
Change in Mean: 5.221

5



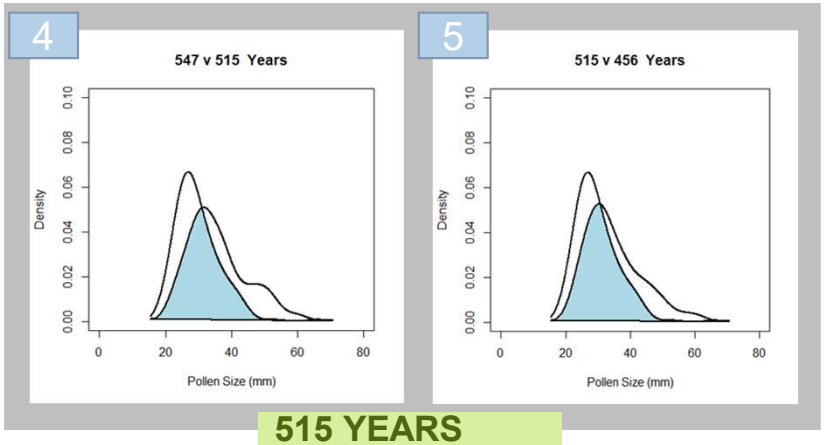
SIGNIFICANT TIME PERIODS

- 867 years ago — 1083 AD
- 782 years ago — 1168 AD
- 515 years ago — 1435 AD



867 YEARS AGO

782 YEARS AGO



515 YEARS AGO

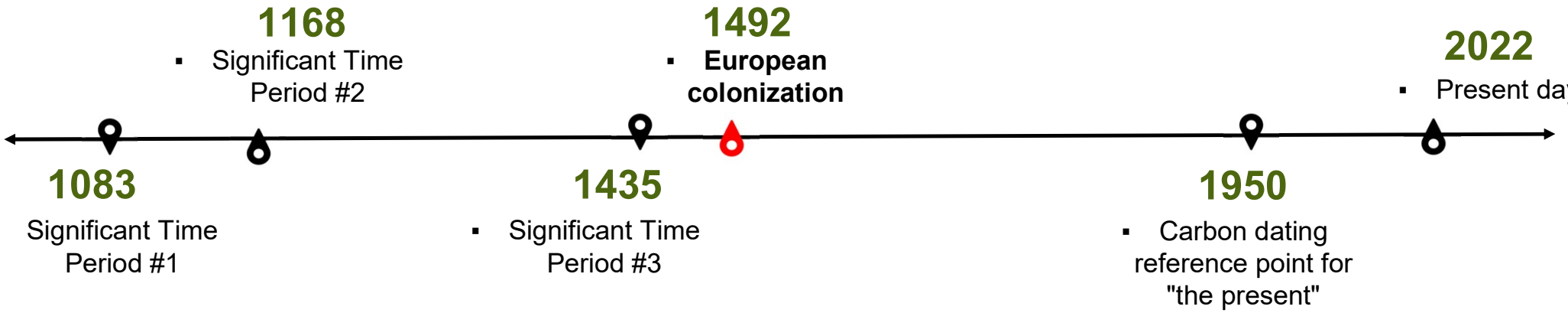

NEXT STEPS

COMPARE TO PERIODS OF MAJOR CLIMATIC EVENTS

- GLOBAL WARMING
- GLOBAL COOLING
- DROUGHTS

COMPARE TO PERIODS OF HUMAN INTERFERENCE

- COLONIZATION
- FIRE USAGE
- AGRICULTURE



SUMMARY:

MAIN OBJECTIVE

GRAPHICAL REPRESENTATIONS

STATISTICAL ANALYSES

3 SIGNIFICANT TIME PERIODS

NEXT STEP: ECOLOGICAL COMPARISONS


THANK YOU!

REFERENCES

1. Glen, S. (n.d.). *Kruskal Wallis H Test: Definition, Examples, Assumptions, SPSS*. Statistics How To. Retrieved July 1, 2022, from https://www.statisticshowto.com/probability-and- statistics/statistics-definitions/kruskal-wallis/
2. *How to Report the Shapiro-Wilk Test – Quantifying Health*. (n.d.). Quantifying Health. Retrieved July 1, 2022, from https://quantifyinghealth.com/report-shapiro-wilk-test/
3. Kolmogrov- Smirnov Test. (2008). In *The Concise Encyclopedia of Statistics* (p. 214). Springer. https://doi.org/10.1007/978-0-387-32833-1_214
4. Stephanie. (2016, September 17). *How to Report the Shapiro-Wilk Test – Quantifying Health*. Quantifying Health. Retrieved July 5, 2022, from https://quantifyinghealth.com/report-shapiro-wilk-test/