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SHEARWATER CHICK MORPHOMETRICS

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OBJECTIVE

- The objective of this analysis was to explore the patterns of this dataset
- Ultimately, I want to compare the two years (2009 and 2010)
 - See if one year is more 'successful' than the other
- I predicted that size measurements would be correlated to one another for the birds, and that larger birds would have higher overall condition and overall health scores



DATASET DESCRIPTION

Main Matrix

142	birds				
5	variable				
	Q	Q	Q	Q	Q
	CULMEN LE	HEAD & BI	TARSUS (R	WING LEGT	WEIGHT
2009-01	40	80	50	230	180

Second Matrix

142	birds				
5	variable				
	C	C	C	Q	Q
	PRIMARY	OVERALLC	OVERALLH	AVGPRIME	OVERALLD
2009-01	3	1	13	46.5	0

- 142 birds and 5 variables
- Variables
 - Culmen length (upper ridge of birds beak, in mm)
 - Head & bill length (in mm)
 - Tarsus (leg length, in mm)
 - Wing length (in mm)
 - Weight (in grams)
- Second Matrix
 - Primary score
 - Overall condition
 - Overall health
 - Average primary
 - Overall down (%)

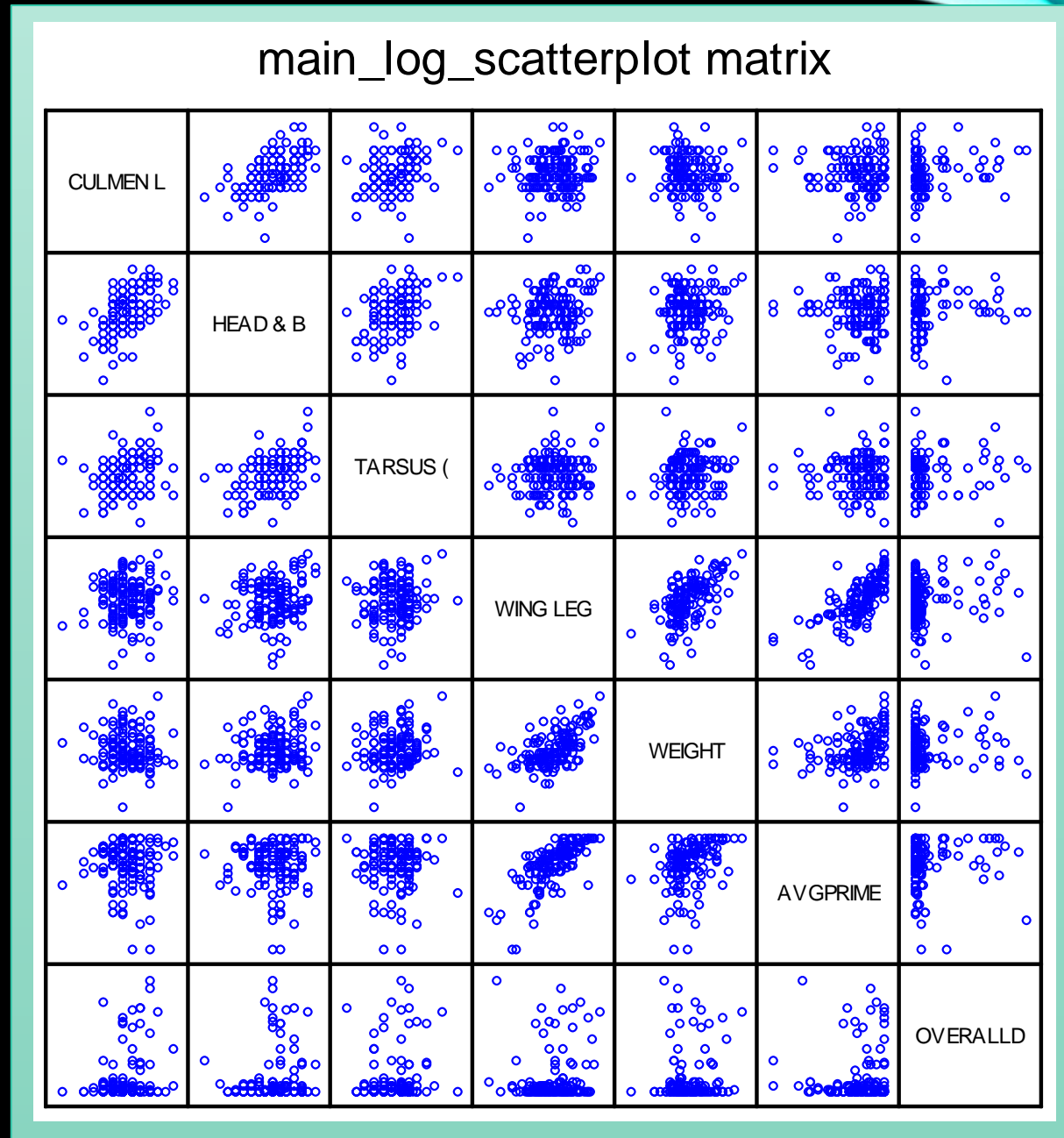
DATASET PROCESSING

- Despite numerous attempted transformations (log, arcsine sqrt) overall down and average primary had skew outside acceptable range (-1 to +1)
 - These variables were removed from the main matrix and added to second matrix
- All remaining variables were log-transformed
- Skew was acceptable and variables had roughly equal sums (equal weights in analysis)
- No empty cells

Summary of: 5 variable N = 142 birds											Skewness Kurtosis			
Num.	Name	Mean	Stand.Dev.	Sum	Minimum	Maximum	S	E	H	D'				
1	CULMEN L	1.585	0.022	225.0878	1.505	1.643	142	1.000	4.956	0.9930	1	CULMEN L	-0.132	1.008
2	HEAD & B	1.914	0.015	271.8006	1.863	1.944	142	1.000	4.956	0.9930	2	HEAD & B	-0.537	0.448
3	TARSUS (	1.685	0.018	239.2508	1.633	1.748	142	1.000	4.956	0.9930	3	TARSUS (	0.013	0.775
4	WING LEG	2.404	0.034	341.3508	2.292	2.481	142	1.000	4.956	0.9930	4	WING LEG	-0.407	0.495
5	WEIGHT	2.323	0.083	329.8621	2.041	2.576	142	1.000	4.955	0.9929	5	WEIGHT	0.455	0.859
AVERAGES:		1.982	0.3431E-01	281.5	1.867	2.079	142.0	1.000	4.956	0.9930	Averages:		-0.122	0.717

DATASET EXPLORATION

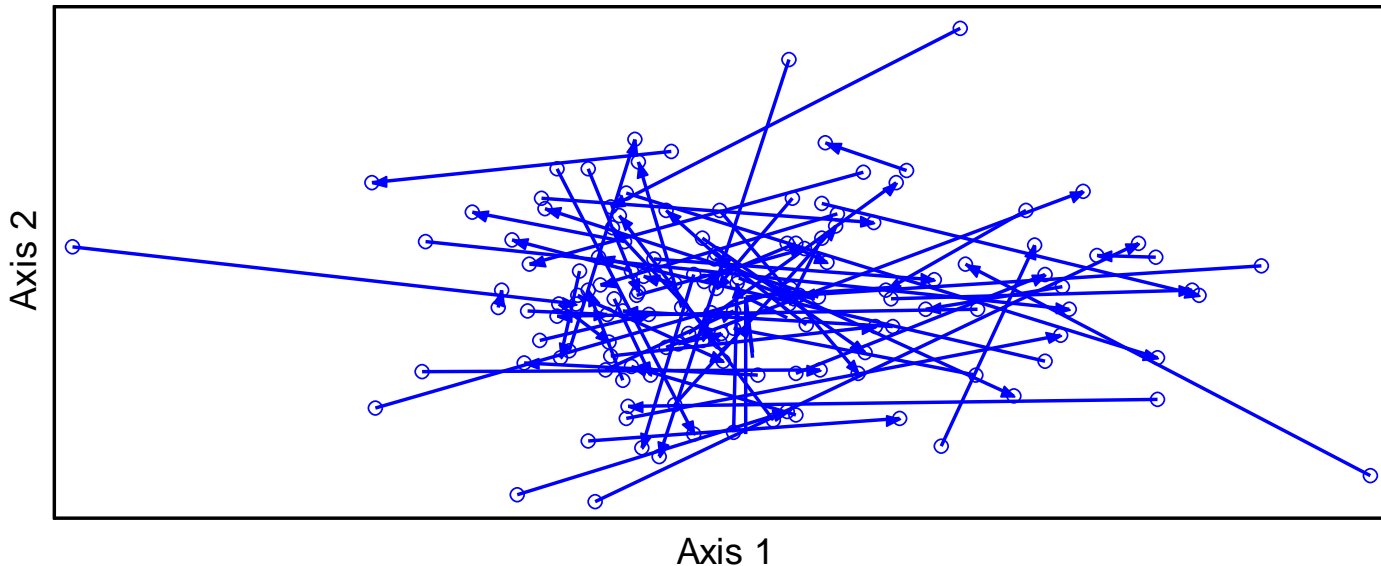
- Culmen length and head/bill length
 - $r = 0.5483$, $r^2 = 0.3$, $p < 0.001$
- Wing length and weight
 - $r = 0.5993$, $r^2 = 0.36$, $p < 0.001$
- Average primary and wing length
 - $r = 0.7282$, $r^2 = 0.53$, $p < 0.001$
- Average primary and weight
 - $r = 0.3547$, $r^2 = 0.13$, $p < 0.001$



DATA ANALYSIS

- Principal Components Analysis

main_log_gen rel p=2_PCA



VARIANCE EXTRACTED, FIRST 5 AXES

AXIS	Eigenvalue	% of Variance	Cum.% of Var.	Broken-stick Eigenvalue
1	0.007	80.939	80.939	0.004
2	0.001	8.358	89.298	0.002
3	0.001	6.594	95.891	0.001
4	0.000	2.847	98.738	0.001
5	0.000	1.262	100.000	0.000

RANDOMIZATION RESULTS

999 = number of randomizations

Axis	Eigenvalue	Eigenvalues from randomizations				p *
	from real data	Minimum	Average	Maximum		
1	0.73242E-02	0.68630E-02	0.68802E-02	0.70054E-02	0.001000	
2	0.75634E-03	0.10599E-02	0.11745E-02	0.12364E-02	1.000000	
3	0.59667E-03	0.42348E-03	0.46879E-03	0.53222E-03	0.001000	
4	0.25762E-03	0.25788E-03	0.31845E-03	0.36109E-03	1.000000	
5	0.11418E-03	0.16699E-03	0.20708E-03	0.21699E-03	1.000000	

FIRST 5 EIGENVECTORS, scaled to unit length.

These can be used as coordinates in a distance-based biplot, where the distances among objects approximate their Euclidean distances.

variable	Eigenvector				
	1	2	3	4	5
CULMEN L	-0.0016	-0.3506	-0.7090	-0.4795	0.3801
HEAD & B	0.0344	-0.1951	-0.3813	-0.0094	-0.9029
TARSUS (	0.0278	-0.1183	-0.4268	0.8741	0.1977
WING LEG	0.2607	-0.8744	0.4033	0.0641	0.0278
WEIGHT	0.9644	0.2461	-0.0843	-0.0430	0.0196

RESULTS INTERPRETATION

- **Criterion 1:** Observed Eigenvalue > Broken-stick Eigenvalue
- **Criterion 2:** Observed Eigenvalue > Mean Randomization
- **Criterion 3:** p-value < 0.05
- 2 out of 3 criterion agree → 1 significant axis

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RANDOMIZATION RESULTS

999 = number of randomizations

Axis	Eigenvalue from	Eigenvalues from randomizations			
	real data	Minimum	Average	Maximum	p *
1	0.73242E-02	0.68630E-02	0.68802E-02	0.70054E-02	0.001000
2	0.75634E-03	0.10599E-02	0.11745E-02	0.12364E-02	1.000000
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RESULTS INTERPRETATION

- Coefficient of determination (R^2)

Coefficients of determination for the correlations between ordination distances and distances in the original n-dimensional space:

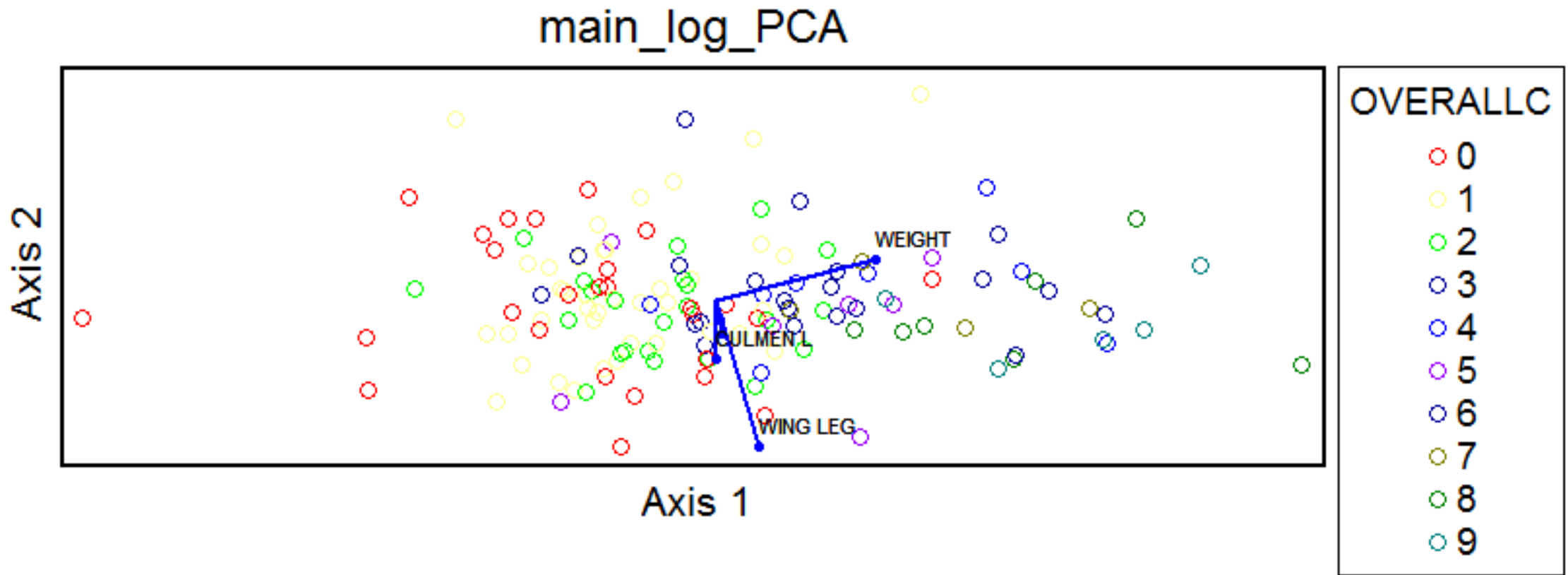
Axis	R Squared	
	Increment	Cumulative
1	.934	.934
2	.041	.975
3	.019	.995

- Orthogonality

Increment and cumulative R-squared were adjusted for any lack of orthogonality of axes.

Axis pair	r	Orthogonality, % = $100(1-r^2)$
1 vs 2	0.000	100.0
1 vs 3	0.000	100.0
2 vs 3	0.000	100.0

RESULTS INTERPRETATION



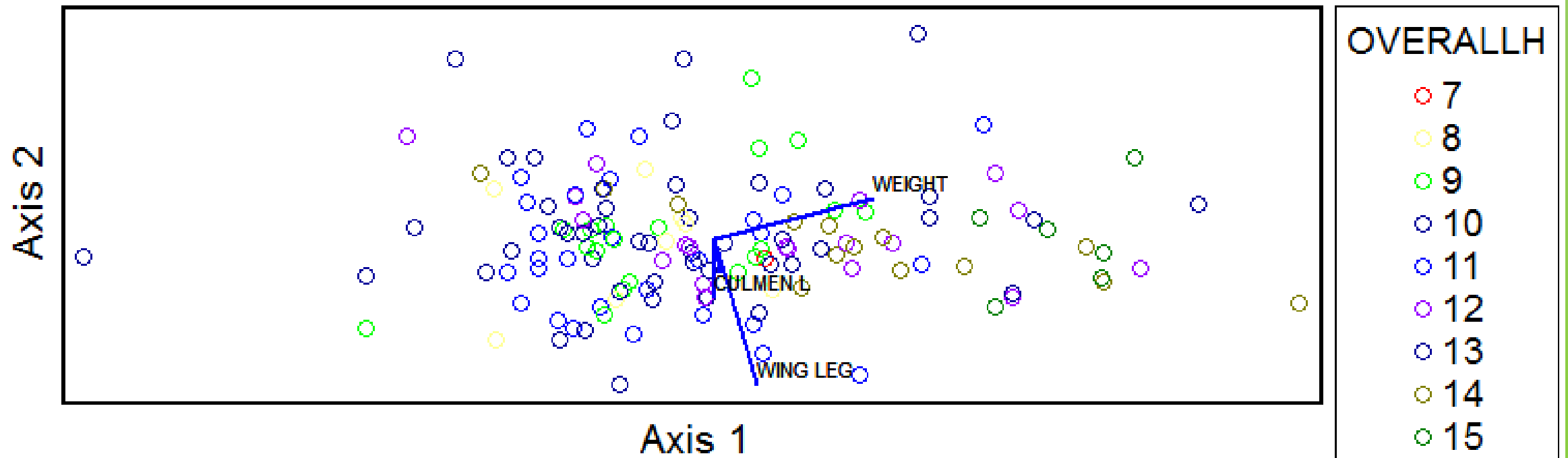
- Weight is strongly correlated with axis 1
- Other size measurements are positively correlated with the axis

Pearson and Kendall Correlations with Ordination Axes N=

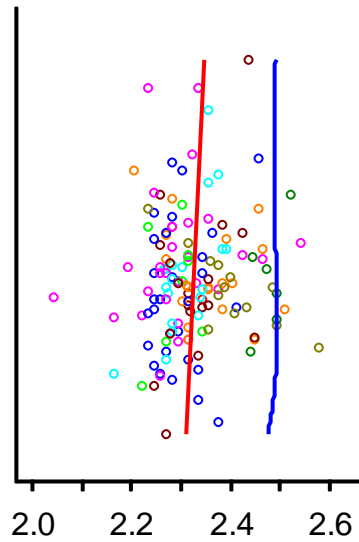
Axis:	r	1	tau	r	2	tau	r
		r-sq			r-sq		
CULMEN L	-.006	.000	-.031	-.445	.198	-.282	-.800
HEAD & B	.200	.040	.079	-.364	.132	-.274	-.632
TARSUS (	.132	.017	.086	-.180	.032	-.099	-.577
WING LEG	.651	.424	.477	-.702	.492	-.491	.288
WEIGHT	.996	.993	.946	.082	.007	.052	-.025

RESULTS INTERPRETATION

main_log_PCA



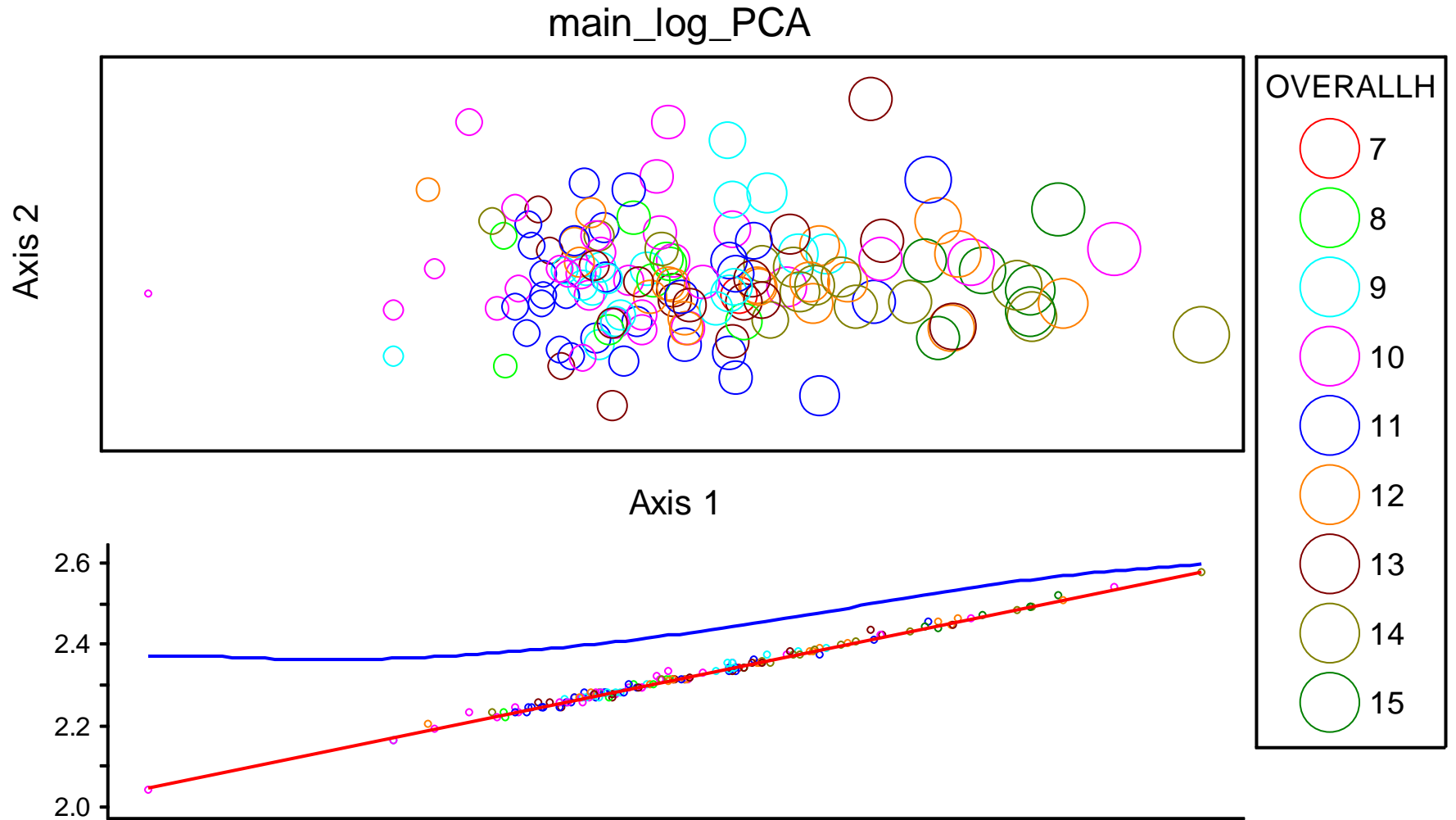
RESULTS INTERPRETATION



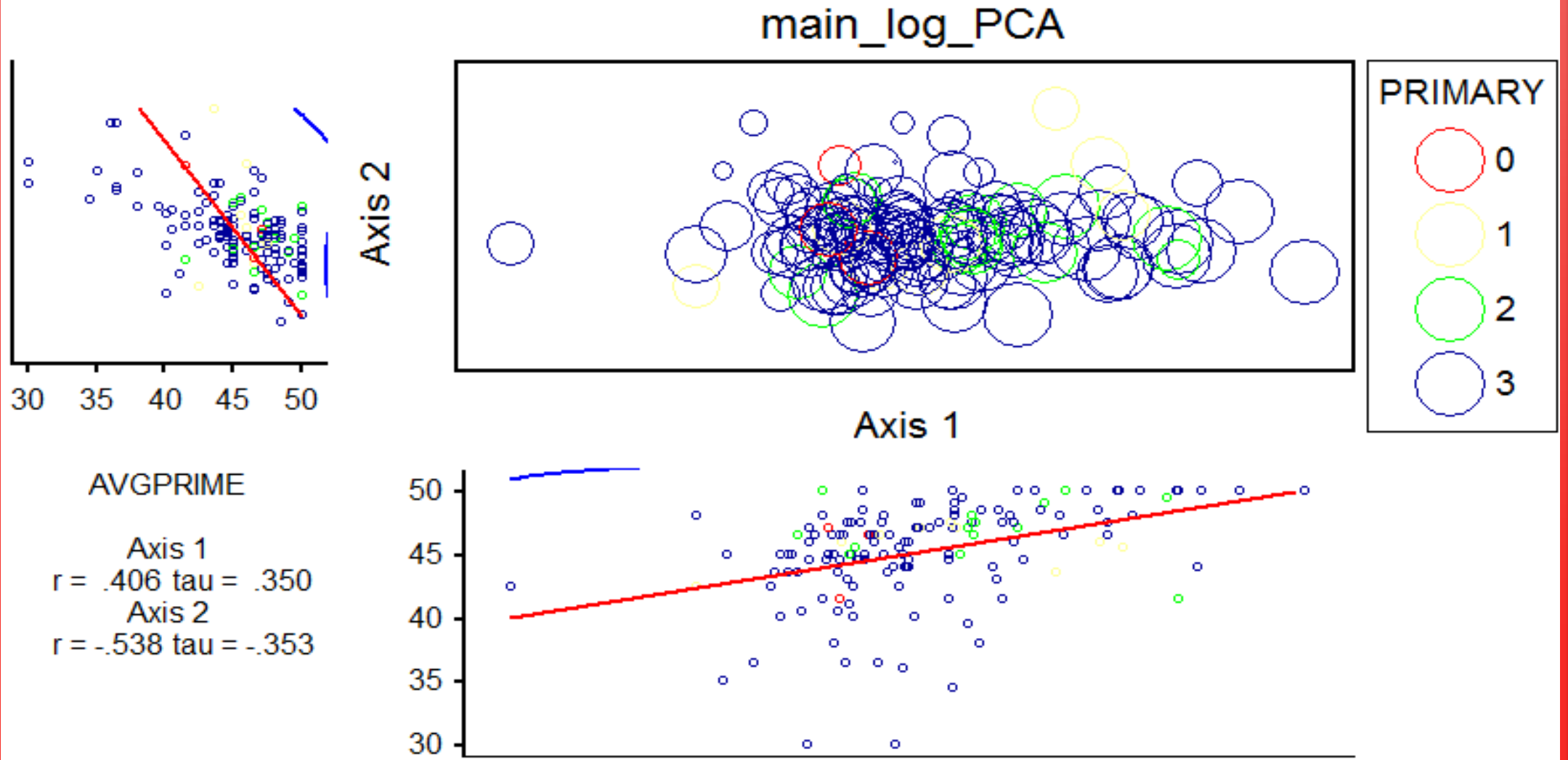
WEIGHT

Axis 1
 $r = .996$ $\tau = .946$

Axis 2
 $r = .082$ $\tau = .052$



RESULTS INTERPRETATION



DISCUSSION

- The results appear to support the predictions
 - Size measurements were positively correlated to axis 1
 - A bigger bird is bigger in every way
 - In general, bigger birds had higher overall condition/overall health scores
- This method worked well for exploring the data but did not highlight any differences between the two years
- For my re-analysis, I will do an MRPP to see if there are differences between the two years
 - Differences may indicate that one year, chicks were more successful than the other



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