

Presented to an advisory committee of the DRBC on February 19, 2019. Contents should not be published or re-posted in whole or in part without permission of DRBC.



Multivariate Analysis Thermal Stress at Lordville

Del. R. Basin Comm., SEF

Feb 2019

Mission: To protect, conserve, and enhance the Commonwealth's aquatic resources and provide fishing and boating opportunities

Multivariate Approach

- Attempt to classify thermal type @ Lordville
 - Analogous to classifying species (meristics & morphometrics)
- Attempts identify relative influences of predictor variables explain most variation
 - Pattern recognition for constituting thermal stress
- Defined classification scheme
 - Cold: ≤ 68 °F
 - Tolerate: > 60 °F but < 75 °F
 - Stress: ≥ 75 °F but < 77 °F
 - Lethal: ≥ 77 °F



Frequency of Hourly Thermal Types

2008-'18 Month	Hourly Thermal Grouping					Total Cum. Hour Possible	Percent In Stress	Percent in Lethal
	Cold	Toler	Stres	Leth	Unk			
5	7548	584	41	11	0	8184	0.5%	0.1%
6	6086	1741	67	25	1	7920	0.8%	0.3%
7	4341	3486	252	82	23	8184	3.1%	1.0%
8	6377	1716	77	13	1	8184	0.9%	0.2%
9	7424	389	11	0	96	7920	0.1%	0.0%
Total	31776	7916	448	131	121	40392	1.1%	0.3%

79 % all hours are classified as being ≤ 68 °F

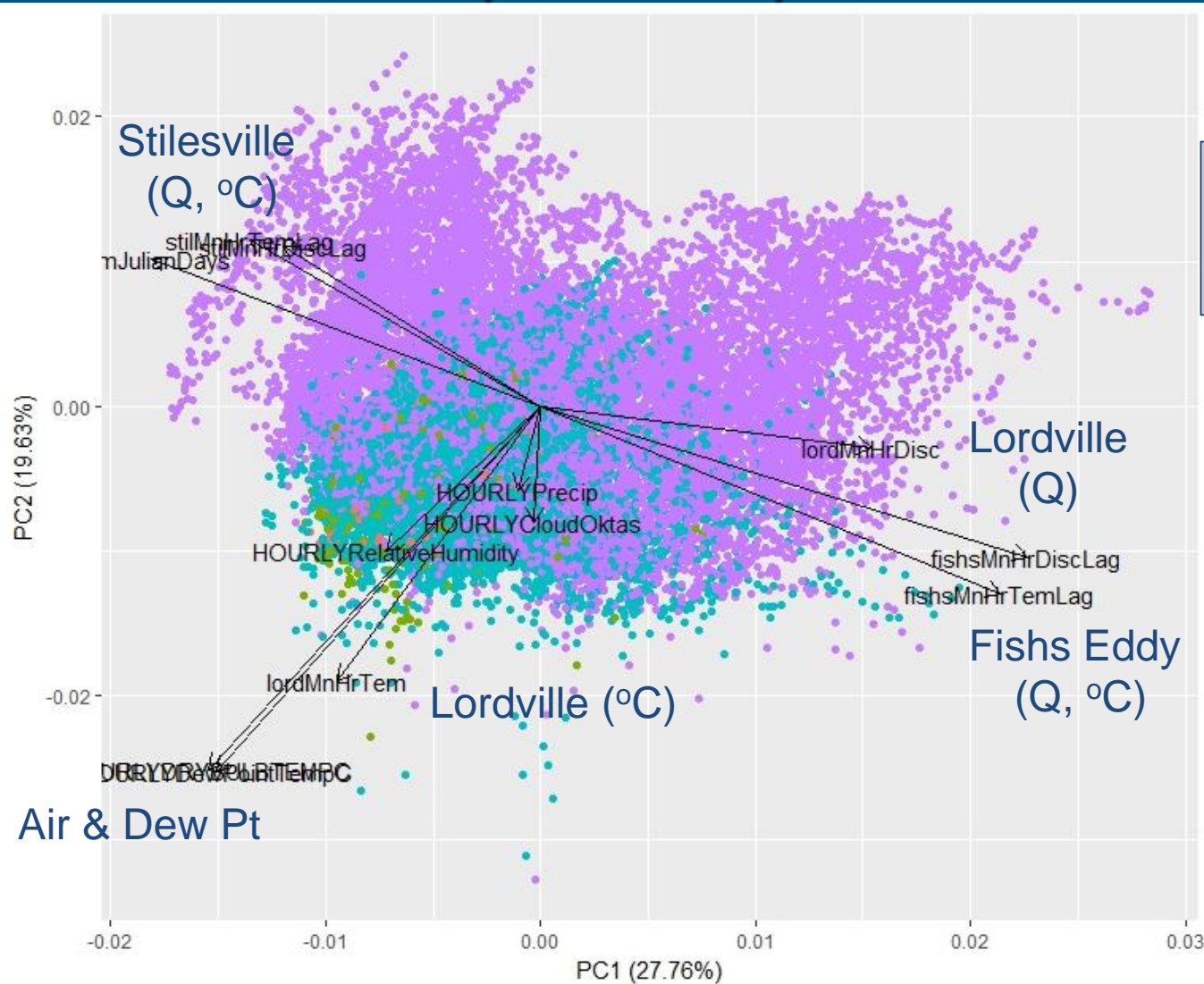


Data Handling

- Use hour temporal resolution, 2008-2018 (Apr-Oct)
 - Mean of every USGS Gage 15-minute obs
 - Exclude > 2,000 cfs @ Lordville
 - Exclude dates of known thermal releases
 - Binghamton hour weather obs
- Normalized variables (i.e., Mean = 0; Std = 1)
- Predictor variables (N = 12)
 - Lordville, Stilesville, lag & Fishs Eddy, lag (Q, °C)
 - Air Tem. (°C)
 - Dew Point (°C)
 - Re. Hum. (%)
 - Precip. (inches)
 - Cloud Cov. (%)
 - Julian hour (#)



Principal Components Analysis



1st PC Loading

- Fishes E., Q & °C

hourThermalType

- 1Leth
- 2Stres
- 3Toler
- 4Cold

2nd PC Loading

- Air Tem., oC
- Dew Point, oC
- Lordville, oC

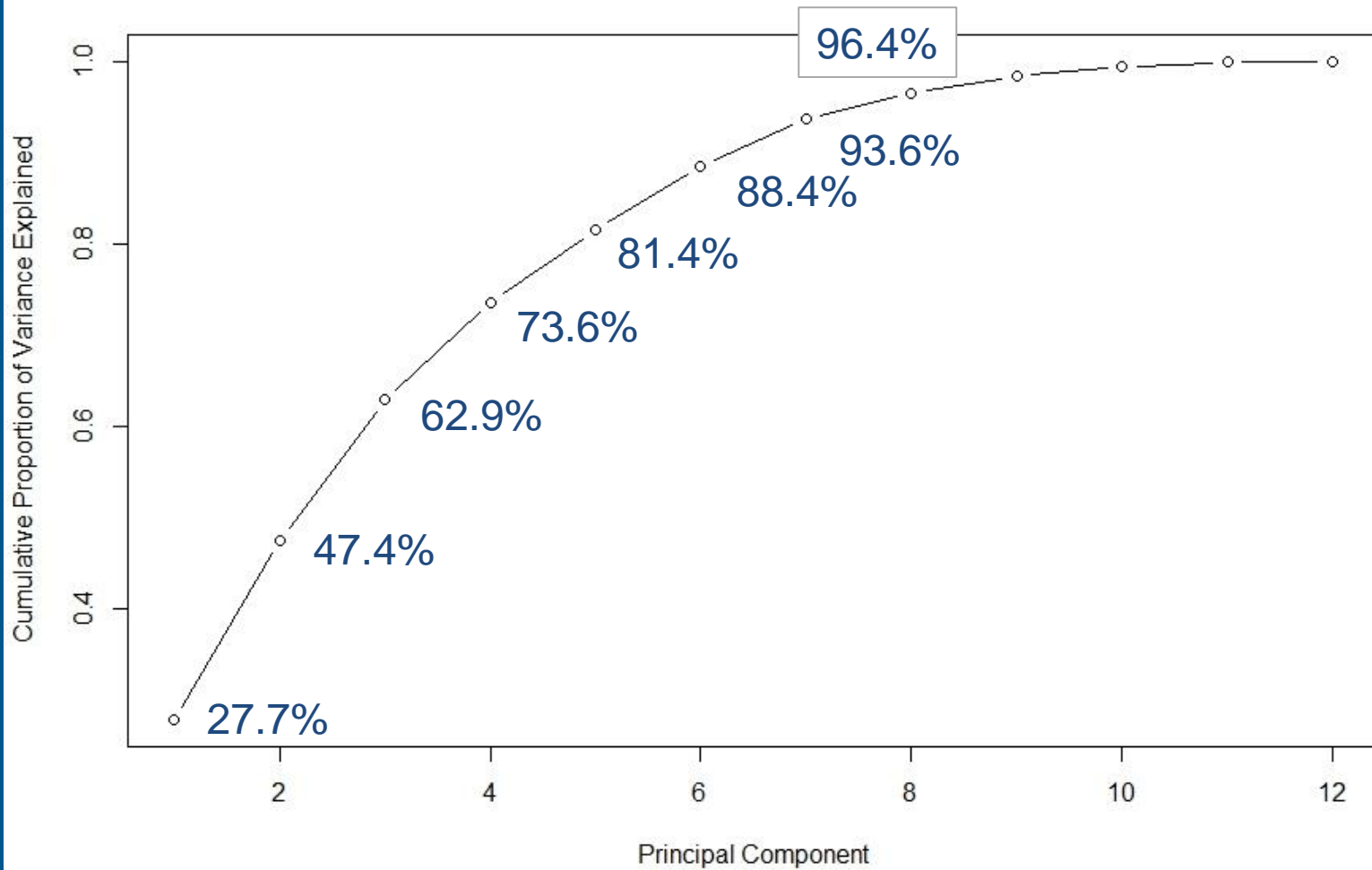


PCA, Eigenvectors

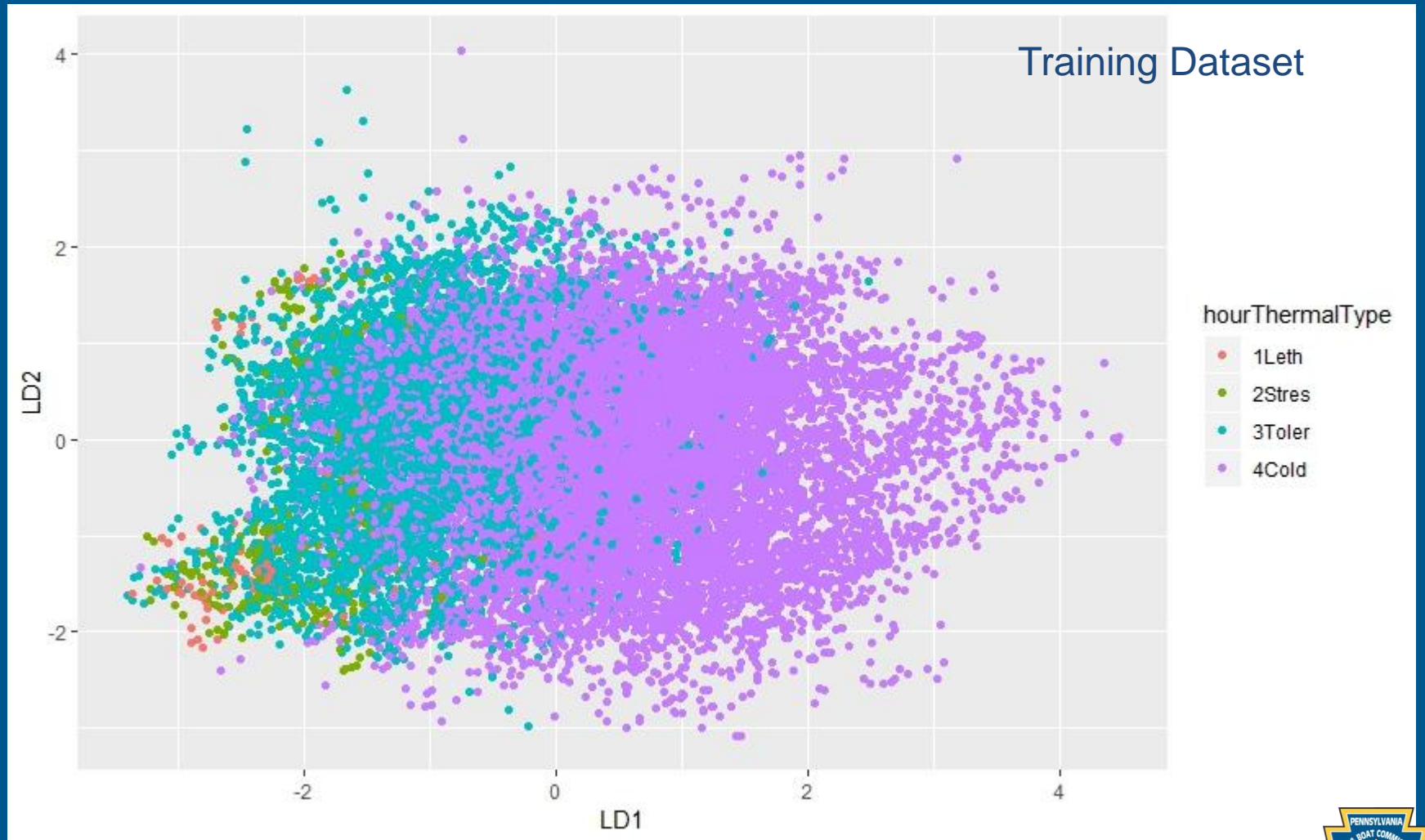
	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Lordville Q	0.310	-0.058	0.491	-0.337	0.095	-0.184	0.000	0.132
Lordville oC (lag)	-0.190	-0.382	-0.346	-0.275	0.038	0.153	-0.362	0.299
Stilesville Q (lag)	-0.241	0.222	0.343	-0.392	0.183	-0.480	0.101	0.153
Stilesville oC (lag)	-0.273	0.231	0.357	-0.004	-0.097	0.482	-0.301	0.564
Fishs E Q (lag)	0.455	-0.210	0.219	-0.109	-0.039	0.200	-0.141	-0.067
Fishs E oC (lag)	0.430	-0.261	0.180	-0.140	-0.029	0.205	-0.163	-0.141
Air oC	-0.311	-0.505	0.095	-0.138	-0.027	-0.068	0.085	-0.066
Dew Point	-0.304	-0.509	0.090	-0.139	-0.024	-0.074	0.092	-0.068
Re. Hum.	-0.144	-0.201	0.415	0.408	-0.145	0.270	0.517	0.030
Precip.	-0.021	-0.117	0.087	0.323	0.923	0.073	-0.125	-0.002
Cloud Cov.	-0.006	-0.162	0.219	0.545	-0.263	-0.507	-0.543	0.057
Julian Decimal Days	-0.364	0.204	0.262	-0.140	-0.020	0.231	-0.358	-0.717



PCA, Explained Variance



Linear Discriminant Function Analysis

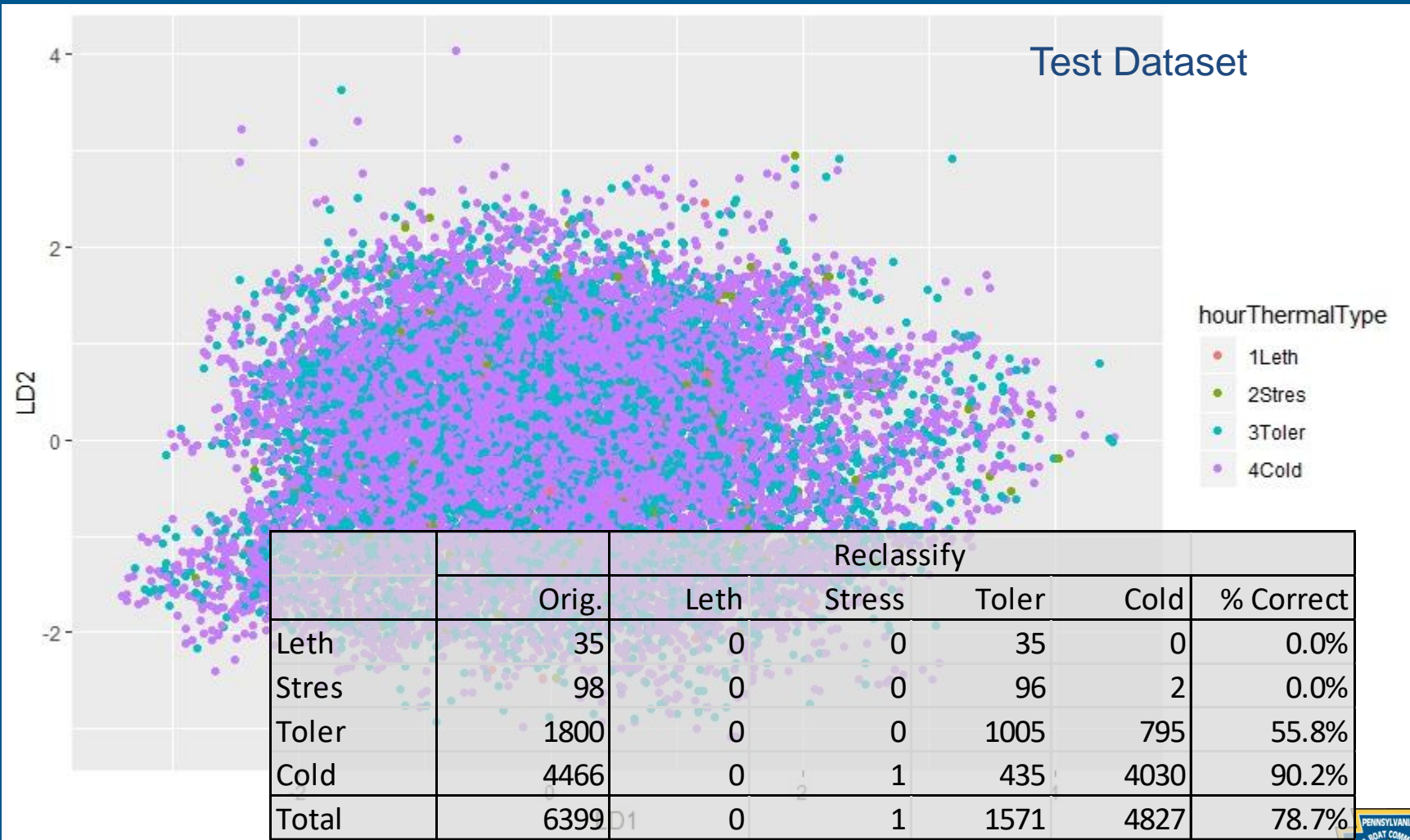


Linear Discriminant Function Analysis

	LD1	LD2	LD3
Lordville Q	0.748387	0.096688	0.02657
Stilesville Q (lag)	0.050911	-0.07933	0.945821
Stilesville oC (lag)	-0.15133	-0.07049	-0.35939
Fishs E. Q (lag)	-0.17577	-1.46231	0.544766
Fishs E. oC (lag)	-0.14483	1.873644	-0.25149
Air oC	-0.63642	0.110033	-0.07305
Dew Point oC	-0.41953	-0.04519	0.494236
Re. Humidity	0.655705	0.332085	0.03252
Precip.	-0.04951	0.076472	-0.08865
Cloud Cov.	0.166261	-0.02745	0.123747
Julian Dec. Days	0.359219	0.204002	-0.34829



Linear Discriminant Function Analysis



Summary

- Principal Components Analysis
 - Able to pattern recognize what constitutes thermal stress
 - Lordville Water °C & Air °C are best variables for identifying those occurrences
 - Difficult to interpret not overly adaptable to forecasting
- Linear Discriminant Functions Analysis
 - Separation of thermal events based on °C
 - Inability to accurately classify test “forecast” classification
 - Pursue parametric assumption violations and/or non-metric multidimensional scaling

