

Can Skin Lesion Development and Inflammation be Correlated to Climate or Diet Variation (temperature, humidity, age of grain, browse offered, etc.)



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Busch Gardens Black Rhinos

Chai

- 2.1 Black Rhinos at Busch Gardens
- Jody (26 yrs) is currently housed with 1.0 “Chai” (20 yrs)
 - Chai had similar sores not long after arriving in 1999, but after a few years they resolved and have never returned.
- 1.0 “Forrest” is Jody’s grandson (14 yrs)
 - He has never developed the sores
- Previous black rhinos at BG never developed the sores
- Busch Gardens Tampa is located in Florida – wet and warm climate

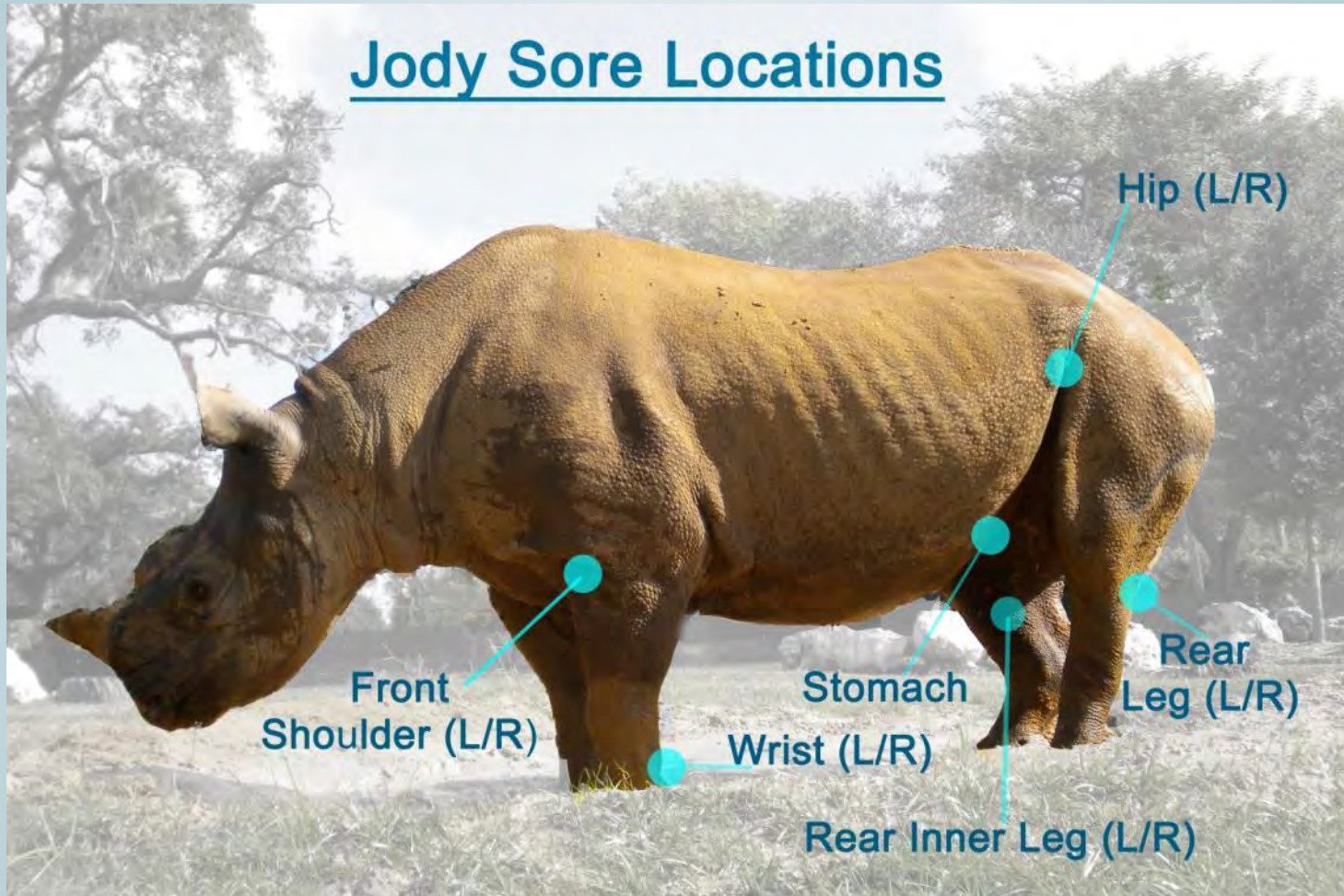


Forrest



Jody

Jody Sore Locations



- Born 1989
- 1st calf 1994
- Sores first noted in medical records in 1996
- 2nd calf 1998
- Sores began to be consistently recorded in September 2010 (3 sore sites)
- By March of 2015 she had 13 recorded sore sites (not all active at same time)

Sore Evaluation

- Sores are based on severity, from 0 – 5
- 0 = no activity, 5 = sore open, bloody and weepy, usually attracting flies.
- Sores value is based off of visual observations



0

1

2

3

4

5

- Values are gathered on a weekly basis, though occasionally, due to behavioral or animal dynamics issues, values or photos are not always possible.
- Consistent monitoring began with a vet request for pictures of the sores to track their development and severity. After several years of pictures I went back and established the 0 – 5 scale.

Signs

- Inflammation
- Raw/Bloody
- Excess Fluid/Moisture
- Weeping
- Attracts flies
- Causes irritation to Jody
- De-pigmentation/scarring



Size of Sores

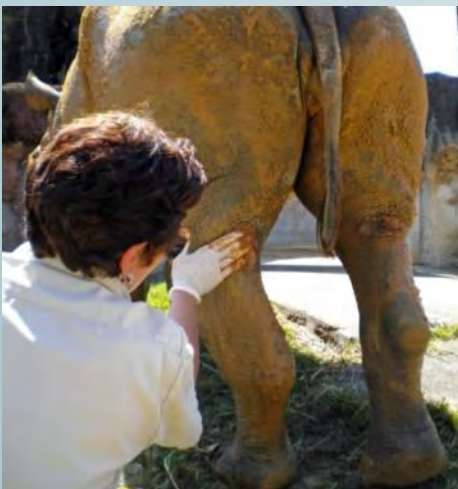
- The greatest severity of each sore seems to reach a static max size; there is a locality to the sores.
- Individual sores have not “grown” or spread linearly over time.



- The sores seem to cause her discomfort
- She will “itch” them on rocks and logs, often stretching into almost “yoga” like poses to reach the sores
- This can aggravate the sores by breaking more of the skin open



Clay Application



- Helps reduce inflammation and reduce the severity of the sores
- Gives some relief to the irritation it causes her
- Helps keep out flies
- Clay is by far the most effective treatment we've tried:
 - Other treatments – trypzyme, fly ointment, triple antibiotic ointment, betadine scrub, nolvasan rinse, honey, cold laser

The Data – Sore Values

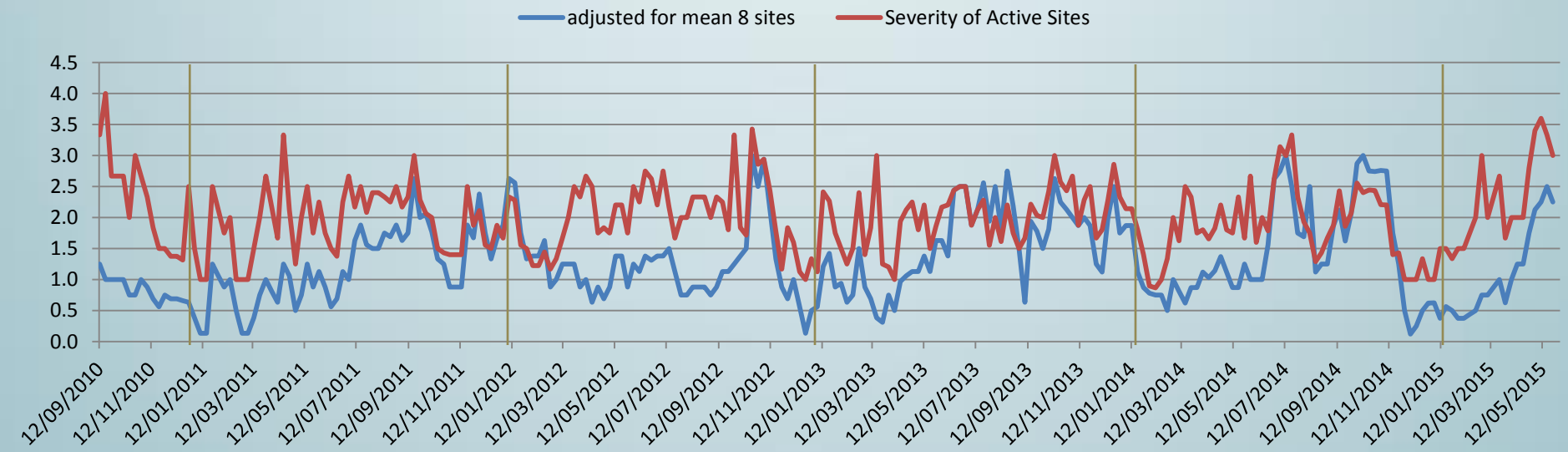
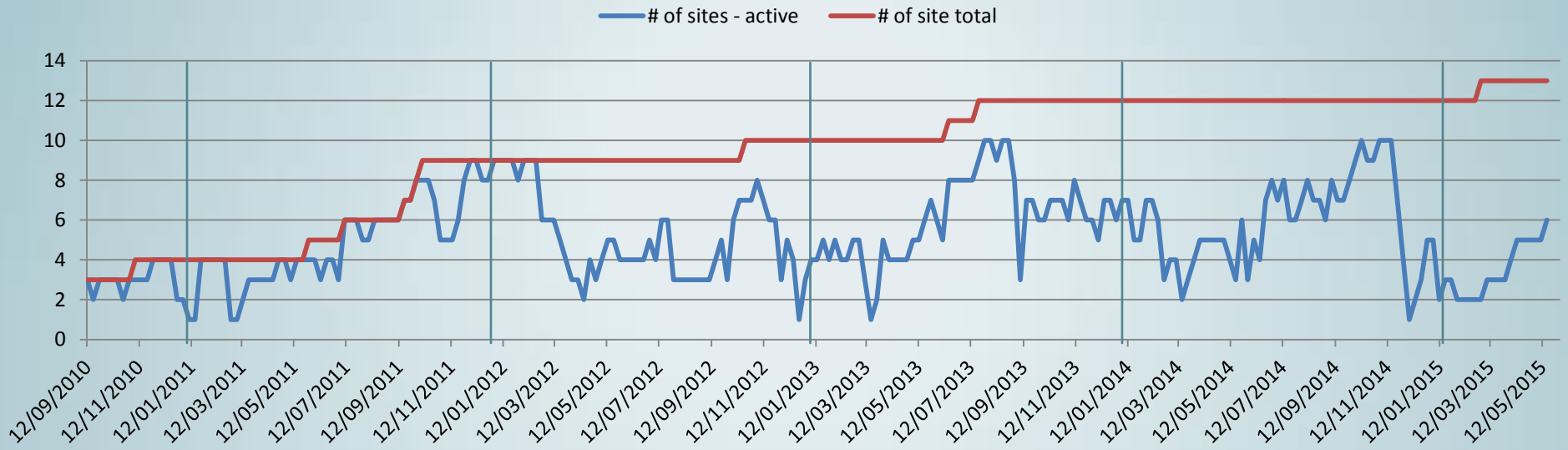
- Rear right leg
- Stomach
- Rear left leg
- Inner rear right
- Left hip
- Right shoulder
- Left shoulder
- Right hip
- Inner rear left
- Right elbow
- Left wrist
- Right armpit
- Right wrist
- Sum value of sores
- Mean score
- # active sites
- Adjusted mean- 8 sites
- # of sites total
- Severity of active sites

(Bolded used for correlations)

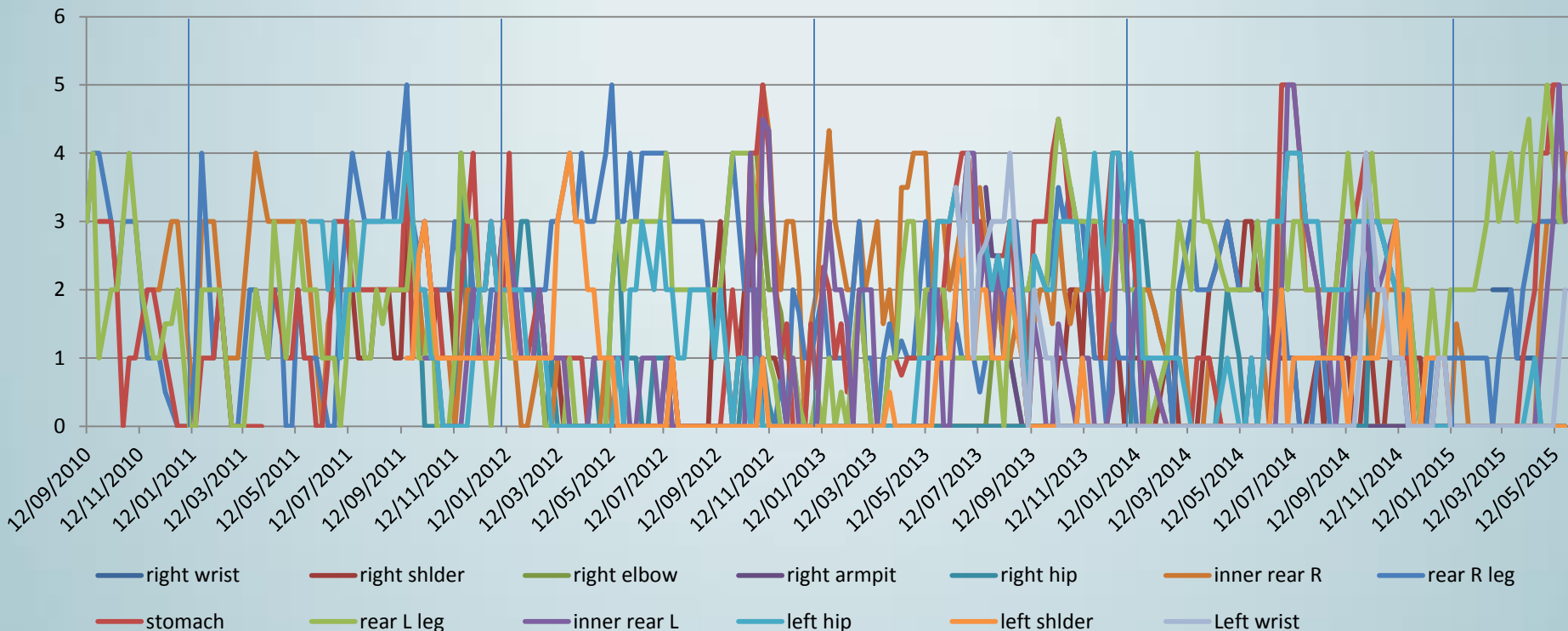
Jody Sores Project weekly - Official raw and weekly data - Microsoft Excel non-commercial use

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1 week	right wrist	right shlder	right elbow	right armpit	right hip	inner rear R	rear R leg	stomach	rear L leg	inner rear L	left hip	left shlder	Left wrist	Sum	mean score	# of sites - active	adjusted for mean 8 sites	# of site total	Severity of Active Sites	
178	5/12/2013		0	0		0	4	3	1	2	0	1	0		11	1.1	5	1.38	10	2.20
179	5/19/2013		0	0		0	2	1	1	2	2	1	0		9	0.9	6	1.13	10	1.50
180	5/26/2013		0	0		0	3	1	1	2	2	3	1		13	1.3	7	1.63	10	1.86
181	6/2/2013		0	0		0	3	2	2	2	0	3	1		13	1.44	6	1.63	10	2.17
182	6/9/2013		0	0		0	2	1	3	1	0	3	1		11	1.1	5	1.38	10	2.20
183	6/16/2013		0	0		0	2.5	1.5	3.5	1	2	3.5	2	3.5	19.5	1.77	8	2.44	11	2.44
184	6/23/2013		0	0		0	3	1	4	1	3	2.5	3	2.5	20	1.81	8	2.50	11	2.50
185	6/30/2013		0	0		0	4	1	4	1	4	1	1	4	20	1.81	8	2.50	11	2.50
186	7/7/2013		0	0		0	3	1	3	1	4	1	1	1	15	1.36	8	1.88	11	1.88
187	7/14/2013		0	0		0	3.5	0.5	3	1	2	2.5	2	2.5	17	1.54	8	2.13	11	2.13
188	7/21/2013		0	0	3.5	0	2.67	1	2.33	1	2.67	2	2.67	20.51	1.71	9	2.56	12	2.28	
189	7/28/2013		0	1	2.5	0	1	1	2	1	1	2	1	3	15.5	1.29	10	1.94	12	1.55
190	8/4/2013		0	2	2.5	0	2	1	2.5	1	2.5	2.5	1	3	20	1.67	10	2.50	12	2.00
191	8/11/2013		0	1	1.5	0	1	1	2.5	0	1.5	2	1	3	14.5	1.21	9	1.81	12	1.61
192	8/18/2013		0	1	1	0	1	3	3	2	2	3	2	4	22	1.83	10	2.75	12	2.20
193	8/25/2013		0	0.5	0.5	0	1.5	3	2	1.5	2	2.5	1.5	2.5	17.5	1.45	10	2.19	12	1.75
194	9/1/2013		0	0	0	0	1	2	2	2	1	2	1	1	12	1	8	1.50	12	1.50
195	9/8/2013		0	0	0	0	0	2	1	2	0	0	0	0	5	0.41	3	0.63	12	1.67
196	9/15/2013		0	0	0	0	1.5	2.5	3	2.5	1.5	2.5	0	2	15.5	1.29	7	1.94	12	2.21
197	9/22/2013		0	0	0	0	2	2.25	3	2.25	1	2.25	0	1.5	14.25	1.19	7	1.78	12	2.04
198	9/29/2013		0	0	0	0	2	2	3	2	0	2	0	1	12	1	6	1.50	12	2.00
199	10/6/2013		0	0	0	0	1.5	2.5	4	3.5	0	2	0	1	14.5	1.21	6	1.81	12	2.42
200	10/13/2013		1	0	0	0	3	3.5	4.5	4.5	1.5	3	0	0	21	1.75	7	2.63	12	3.00
201	10/20/2013		1	0	0	0	2	3	4	4	1	3	0	0	18	1.5	7	2.25	12	2.57
202	10/27/2013		2	0	0	0	1.5	3.5	3	3.5	0.5	3	0	0	17	1.42	7	2.13	12	2.43
203	11/3/2013		2	0	0	0	2	3	3	3	0	3	0	0	16	1.33	6	2.00	12	2.67
204	11/10/2013		1	0	0	0	2	3	2	3	1	2	1	0	15	1.25	8	1.87	12	1.88
205	11/17/2013		3	0	0	0	2	2	2	3	1	3	0	0	16	1.33	7	2.00	12	2.29
206	11/24/2013		3	0	0	0	1	1	3	3	0	4	0	0	15	1.25	6	1.87	12	2.50
207	12/1/2013		1	0	0	0	1	1	1	3	0	3	0	0	10	0.83	6	1.25	12	1.67
208	12/8/2013		1	0	0	0	1	0	3	2	0	2	0	0	9	0.75	5	1.12	12	1.80
209	12/15/2013		1	0	0	0	2	1.5	4	3	0.5	4	0	0	16	1.33	7	2.00	12	2.29
210	12/22/2013		1	0	0	0	3	1	4	3	4	4	0	0	20	1.67	7	2.50	12	2.86
211	12/29/2013		0	0	0	0	2	1	3	2	3	3	0	0	14	1.17	6	1.75	12	2.33
212	1/5/2014		1	0	0	0	3	1	3	2	1	4	0	0	15	1.25	7	1.87	12	2.14
213	1/12/2014		1	0	0	3	2	0	2	2	2	3	0	0	15	1.25	7	1.87	12	2.14

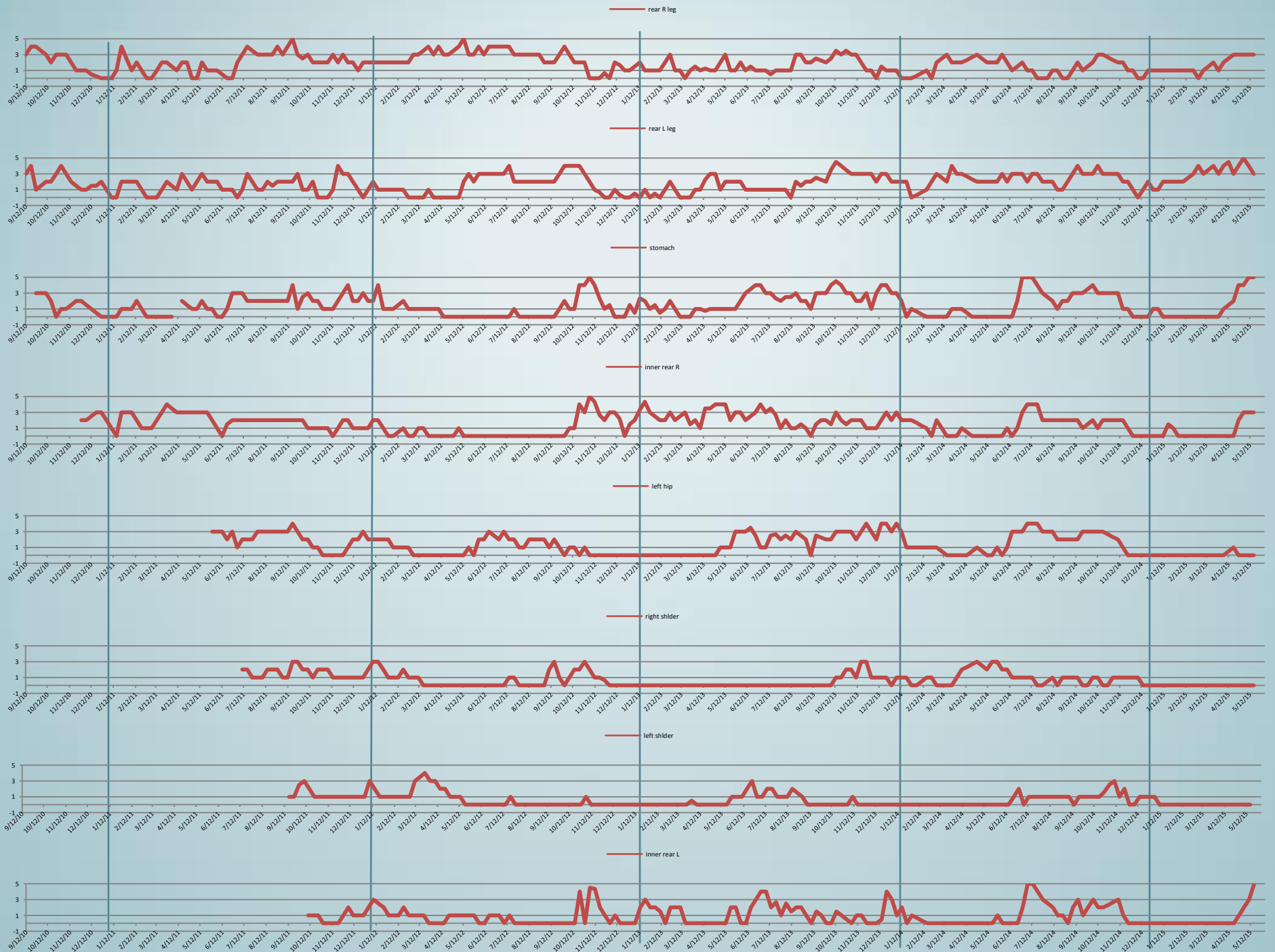
4.5 years of sore data



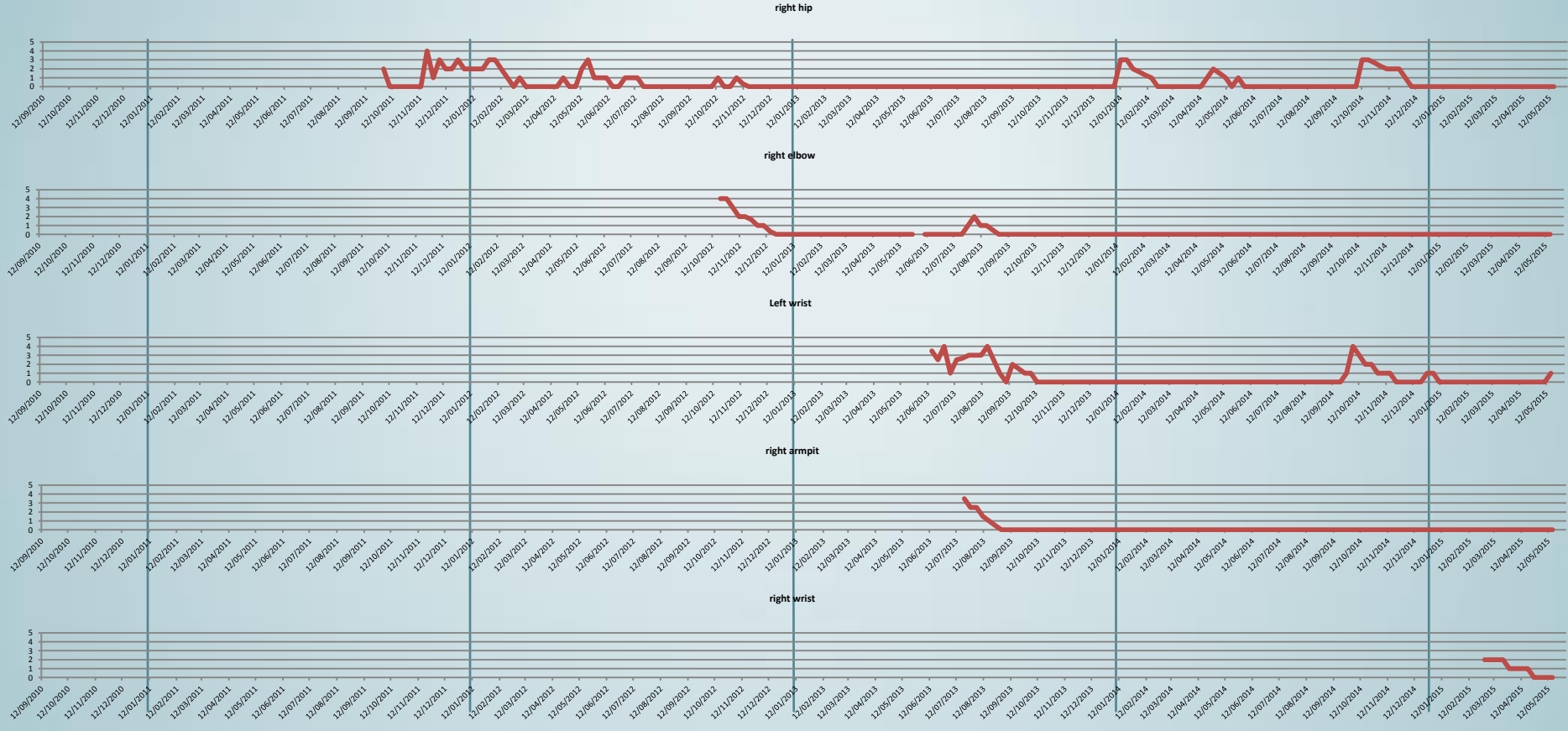
Individual Sore Data



- Individual sores flare up and resolve at different times.



Last 5 sores to develop



Observations -

- Sores don't seem to affect each other
- Sores can go a year between flare-ups
- Sores can take weeks to reach a 5 or can flare up to 5 in a week
- Sores do not always drop down to a 0 before flaring up again
- The original 3 sores – backside of both legs and stomach – flare up the most often and for the longest
- Do I continue to count sore sites that haven't flared up in 2 years?

What factors were compared to the sore values?



- Climate
- Browse
- Grain
- Clay application



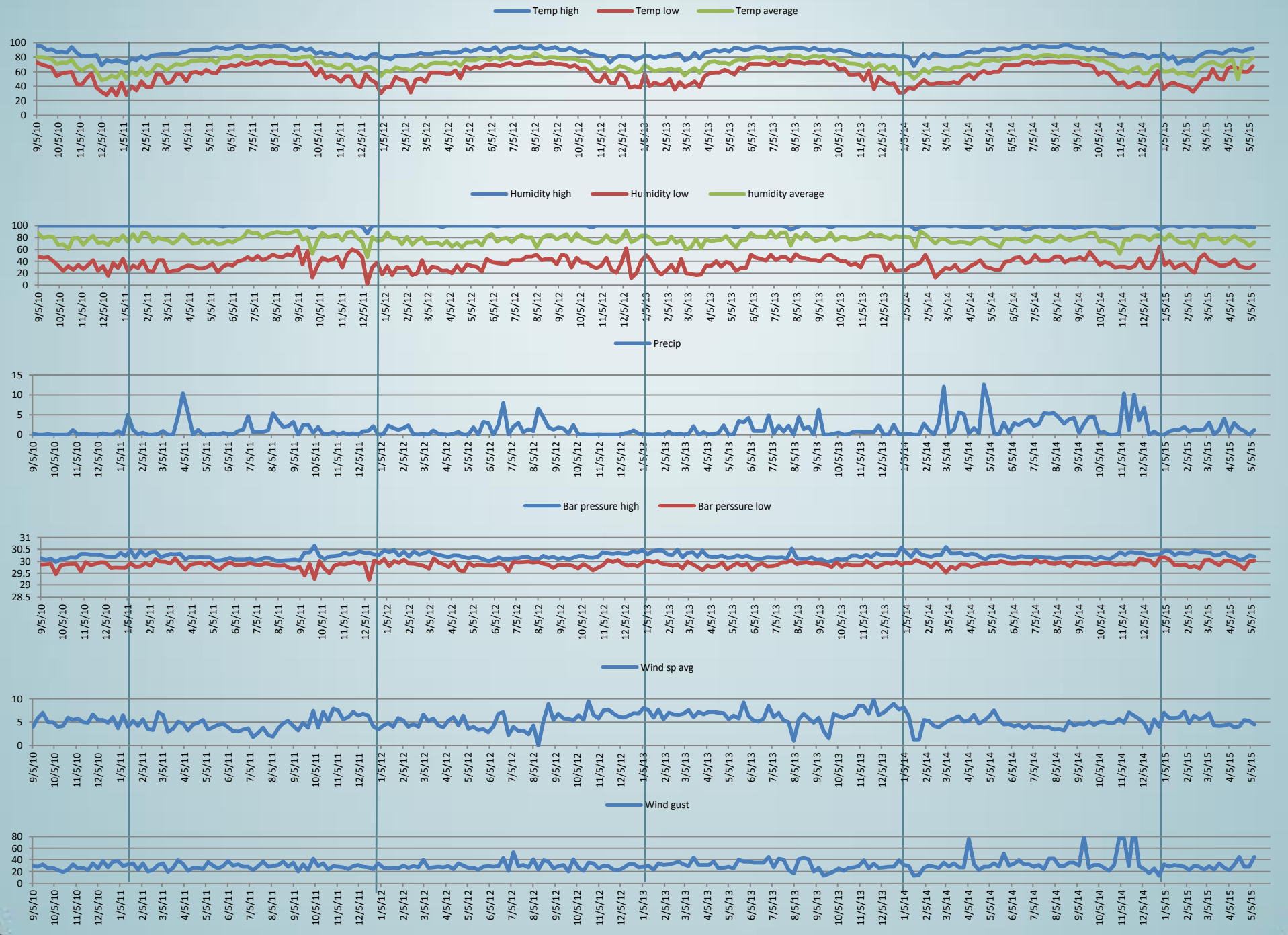
- The purpose of this study was to look at possible external factors.



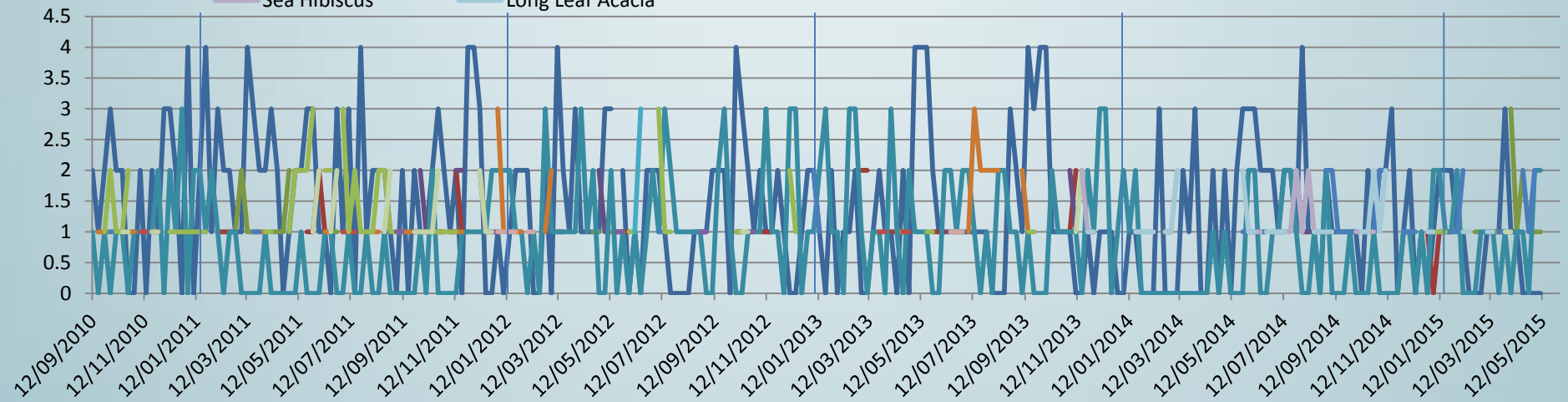
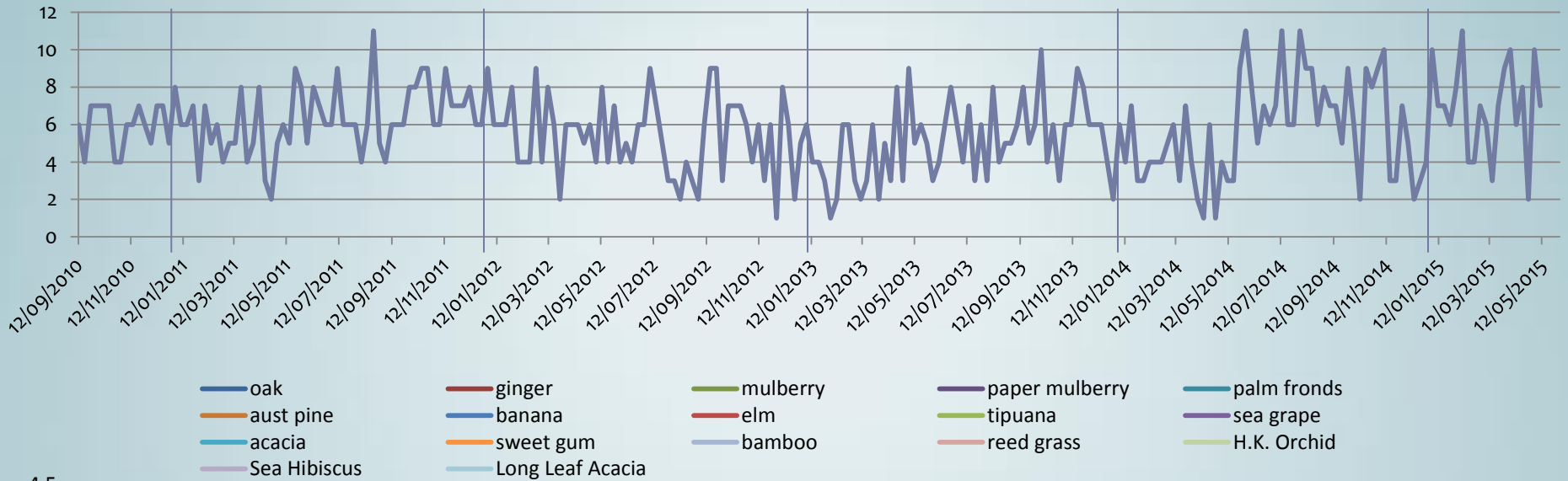
The Data – Climate

- Temp high
 - Temp low
 - Temp avg
 - Dew point avg
 - Humidity high
 - Humidity low
 - Humidity avg
 - Wind speed avg
 - Wind gusts (max)
 - Bar pressure high
 - Bar pressure low
 - Precipitation
- Weather data was pulled from a station within ½ mile of the park.
- (**Bolded** used for correlations)

	A	B	C	D	E	F	G	H	I	J	K	L	M	
1 week		Temp high	Temp low	Temp average	Dew point avg.	Humidity high	Humidity low	humidity average	Wind sp avg	Wind gust	Bar pressure	Bar perssure	Precip	date of th
218	2/16/2014	85	43	65	53.3	100	13	70.1	4.2	28	30.28	29.96	0.07	
219	2/23/2014	83	45	65.7	57.5	100	22	77.8	3.9	26	30.27	29.77	2.97	
220	3/2/2014	81	44	63.9	55.8	100	29	77.2	4.7	35	30.59	29.53	12.1	
221	3/9/2014	81	44	61.9	51.4	99	27	71.6	5.4	28	30.33	29.78	0.32	
222	3/16/2014	82	46	66.6	56.2	100	34	71.6	5.8	34	30.33	29.69	1.34	
223	3/23/2014	82	44	66.3	56.2	99	23	72.9	6.3	27	30.36	29.88	5.62	
224	3/30/2014	85	52	67.7	57.3	98	25	72.3	5.1	27	30.25	29.88	5.21	
225	4/6/2014	88	56	71.7	59.8	98	32	68.8	5.3	76	30.32	29.77	0.32	
226	4/13/2014	86	50	70.3	61.2	98	36	75.3	6.6	32	30.3	29.82	1.65	
227	4/20/2014	87	58	69.5	62.4	98	42	79.8	4.7	22	30.16	29.9	0.37	
228	4/27/2014	91	61	75.5	67.3	100	31	78.2	5.3	28	30.1	29.89	12.64	
229	5/4/2014	90	58	75.3	63.2	100	29	70.3	6.2	28	30.23	29.92	7.76	
230	5/11/2014	90	60	76.5	64.2	95	26	68.4	7.5	34	30.22	29.92	0.49	
231	5/18/2014	92	60	74.7	60.5	96	26	63.9	5.6	28	30.25	30.01	0	
232	5/25/2014	92	69	77.6	69.2	100	39	77.9	4.5	51	30.22	29.96	3	
233	6/1/2014	90	69	76.8	68.4	98	40	77	4.6	30	30.15	29.9	0.5	
234	6/8/2014	92	69	78.6	70.8	97	46	78.8	4.1	33	30.14	29.9	2.85	
235	6/15/2014	92	69	79.1	70.4	98	47	76.7	4.4	39	30.22	29.95	2.41	
236	6/22/2014	96	73	82.5	72	93	37	72.3	3.7	32	30.2	29.94	3.27	
237	6/29/2014	96	74	82.3	72.8	95	39	74.8	4.4	32	30.2	29.89	3.77	
238	7/6/2014	92	71	79.1	72.8	98	50	82.3	3.8	28	30.19	30.06	2.26	
239	7/13/2014	95	73	80.4	73	99	41	79.9	4	31	30.19	29.95	2.65	
240	7/20/2014	95	72	82.7	73.2	98	41	74.8	3.8	24	30.16	30.01	5.41	
241	7/27/2014	94	74	83.2	72.9	100	41	72.7	3.9	42	30.16	29.91	5.23	
242	8/3/2014	94	74	82.3	73.7	98	48	76.4	3.4	42	30.12	29.89	5.39	
243	8/10/2014	94	73	80.2	74.4	98	48	83.4	3.5	29	30.14	29.97	4.17	
244	8/17/2014	97	73	82.4	74.4	98	38	78.4	3.2	29	30.18	29.91	2.73	
245	8/24/2014	97	73	82.1	72.6	98	43	74.8	5.2	35	30.18	29.79	3.86	
246	8/31/2014	94	74	80.8	73	96	43	78.6	4.3	35	30.18	29.98	4.2	
247	9/7/2014	93	73	79.8	72.7	98	47	80.4	4.7	30	30.17	29.94	0.49	
248	9/14/2014	93	69	78.5	72.3	99	42	82.8	4.5	81	30.21	29.89	2.68	
249	9/21/2014	89	69	76.1	72.2	99	56	88.6	5.1	26	30.16	29.92	4.42	



Browse weekly total



- Florida climate allows us access to browse year round
- Oak and palm fronds are the most often fed
- These numbers are for browse offered
- Most browse is offered the same day it is trimmed



The Data – Grain, Meds, other

- Benadryl
- Fatty acid
- Vitamin E
- **Treated sores with clay**
- Cold laser
- Moves (within BG)
- **Dumped grain**
- Possible breeding

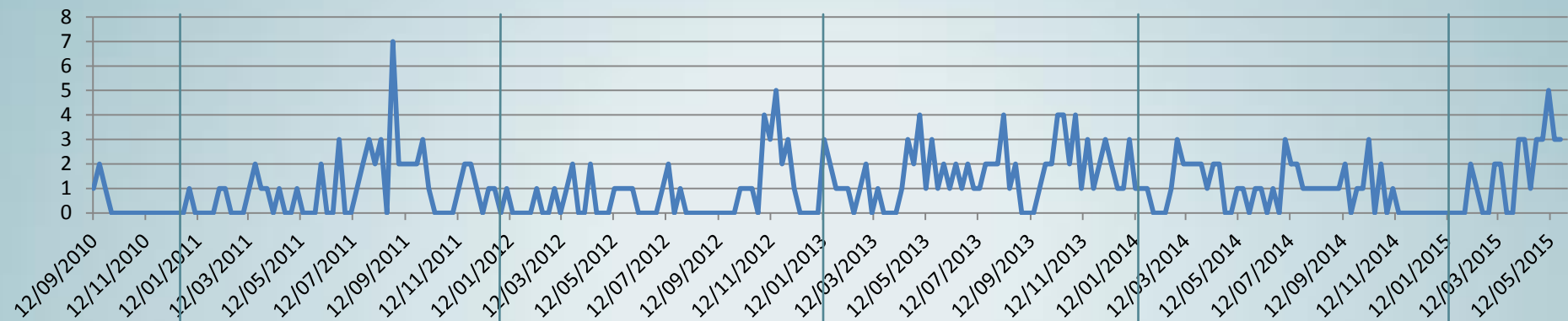
(**Bolded** used for correlations)

Jody Sores Project weekly - Official raw and weekly data - Microsoft Excel non-commercial use

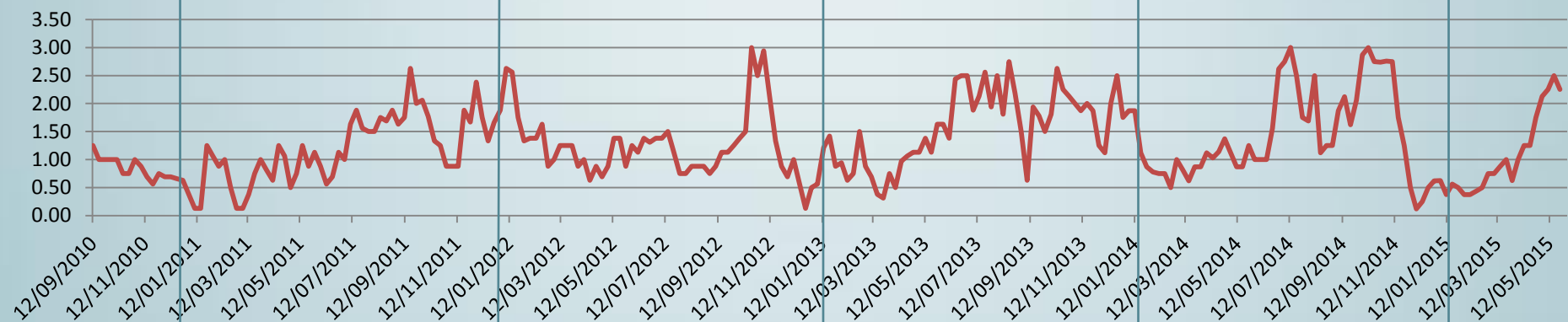
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		Benadryl (mg)	fatty acid	vitamin E (mL)	treated sores	Cold Laser	treated sores b	moves	weight	dumped grain	new grain shipment		Possible Breeding?	
233	6/1/2014	0	0	35	1	0	1			7				
234	6/8/2014	0	0	35	1	0	1			0	0	in bags!		
235	6/15/2014	0	0	35	0	0	0		1970	1				
236	6/22/2014	0	0	35	1	0	1			2				
237	6/29/2014	0	0	35	0	0	0			3				
238	7/6/2014	0	0	35	3	0	3		1966	4				
239	7/13/2014	0	0	35	2	0	2			0	0			
240	7/20/2014	0	0	35	2	0	2			1				
241	7/27/2014	0	0	35	1	0	1			2				
242	8/3/2014	0	0	35	1	0	1		2020	3			8/5/2014	
243	8/10/2014	0	0	35	1	0	1			4				
244	8/17/2014	0	0	35	1	0	1			5				
245	8/24/2014	0	0	35	1	0	1			6				
246	8/31/2014	0	0	35	1	0	1	Station to RR		0	0			
247	9/7/2014	0	0	35	1	0	1		2020	1				
248	9/14/2014	0	0	35	2	0	2			2				
249	9/21/2014	0	0	35	0	0	0			3				
250	9/28/2014	0	0	35	1	0	1			4			10/4/2014	
251	10/5/2014	0	0	35	1	0	1			5				
252	10/12/2014	0	0	35	3	0	3		2020	0	0			
253	10/19/2014	0	0	35	0	0	0			1				
254	10/26/2014	0	0	35	2	0	2			2				
255	11/2/2014	0	0	35	0	0	0			3				
256	11/9/2014	0	0	35	1	0	1			4				
257	11/16/2014	0	0	35	0	0	0	teeth float		0	0			
258	11/23/2014	0	0	35	0	0	0			1				
259	11/30/2014	0	0	35	0	0	0			2				
260	12/7/2014	0	0	35	0	0	0			3				
261	12/14/2014	0	0	35	0	0	0			4				
262	12/21/2014	0	0	35	0	0	0			5				
263	12/28/2014	0	0	35	0	0	0			6				
264	1/4/2015	0	0	35	0	0	0			7				

Ready | weekly sore data | Weekly sore data - adjusted | Weekly Climate Data | browse, meds | Wee | 100%

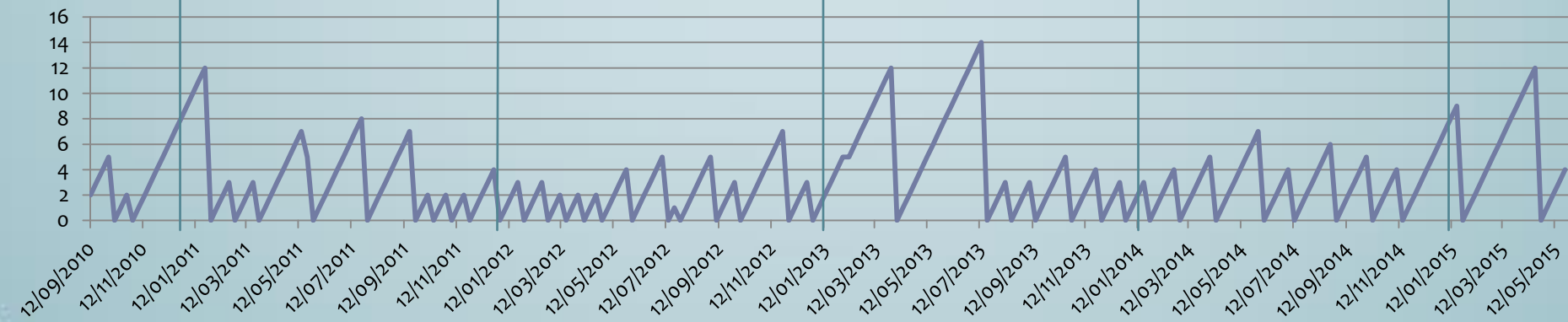
Treated Sores with clay



Adjusted for mean 8 sites



Age of Grain



The Data – Putting it All Together

The Sores

- # active sites
- Adjusted mean - 8 sites
- Severity of active sites
- Mean score
- Rear right leg
- Stomach
- Rear left leg



Climate

- Temp high
- Temp low
- Temp avg
- Humidity avg
- Humidity low
- Wind speed avg
- Wind gusts (max)
- Bar pressure high
- Precipitation

Browse

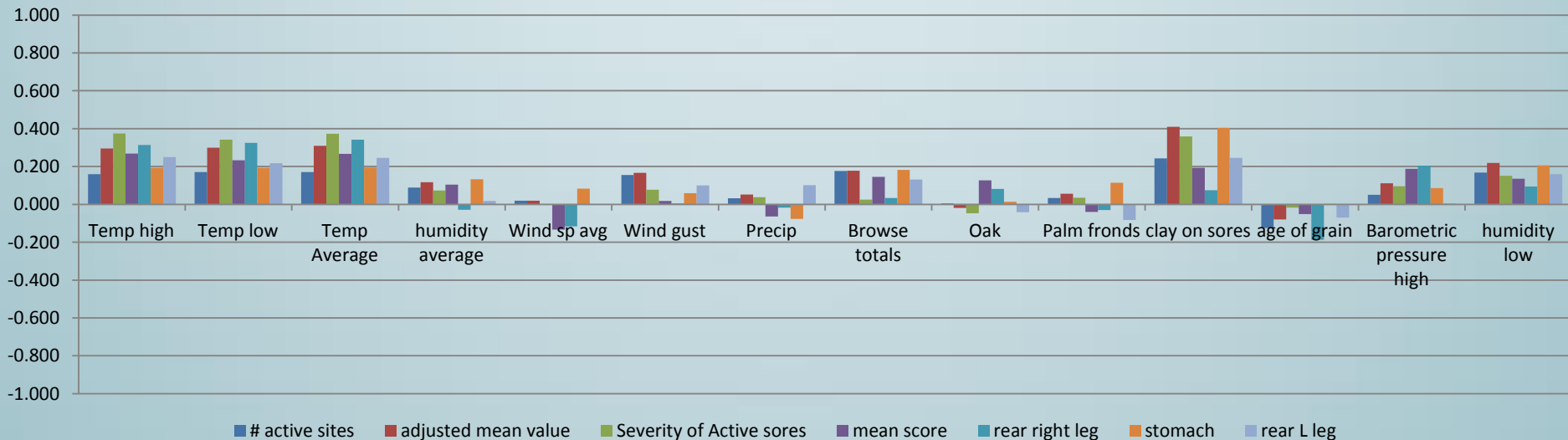
- Oak
- Palm fronds
- Weekly total

- Age of Grain
- Clay on sores

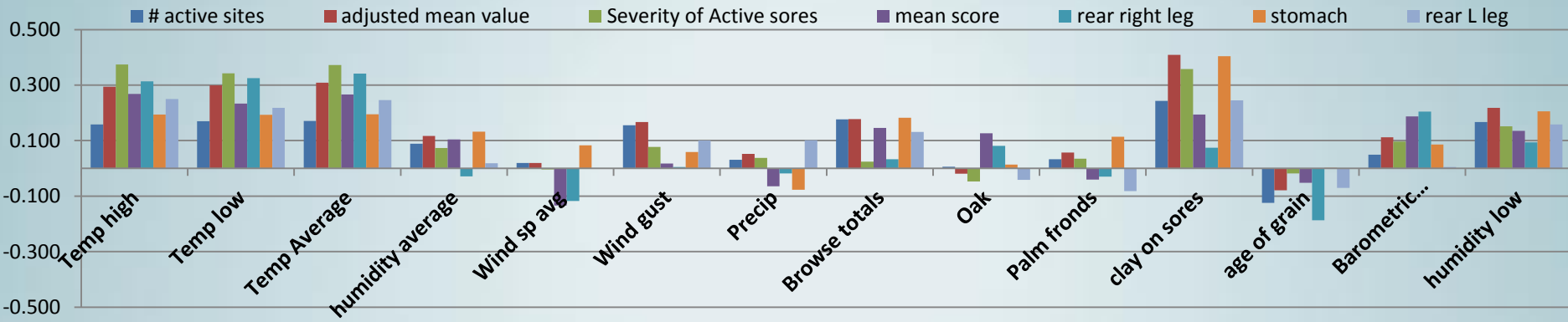
Correlation Values

- 0.0 value = no correlation
- 1.0 value = perfect positive correlation
- -1.0 value = perfect negative (inverse) correlation
- Values above 0.25 are highlighted

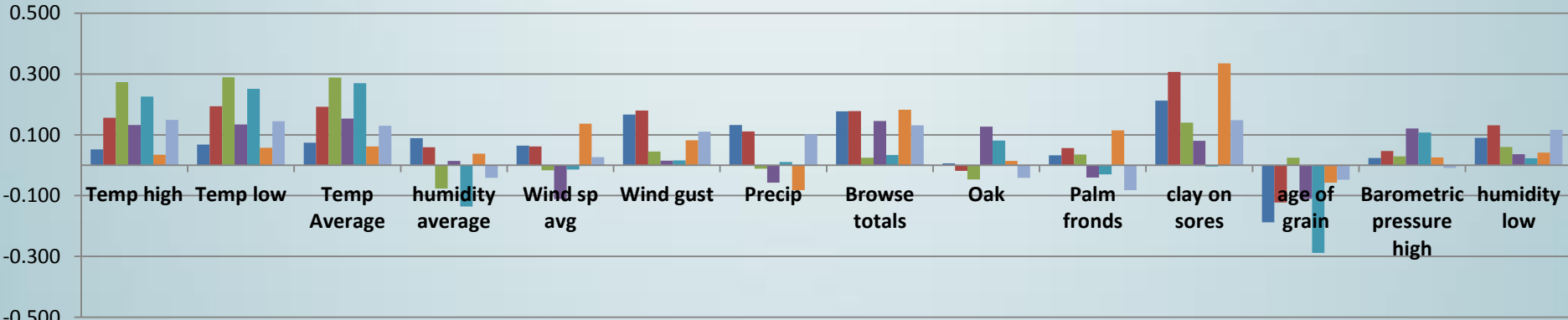
	# active sites	adjusted mean value	Severity of Active sores	mean score	rear right leg	stomach	rear L leg
Temp high	0.159	0.295	0.374	0.268	0.314	0.194	0.250
Temp low	0.170	0.300	0.342	0.233	0.325	0.193	0.218
Temp Average	0.170	0.309	0.373	0.267	0.342	0.195	0.246
humidity average	0.089	0.117	0.074	0.105	-0.028	0.133	0.018
Wind sp avg	0.019	0.019	-0.004	-0.134	-0.117	0.084	0.001
Wind gust	0.155	0.167	0.077	0.018	0.005	0.059	0.100
Precip	0.031	0.052	0.037	-0.064	-0.018	-0.077	0.102
Browse totals	0.177	0.178	0.024	0.146	0.033	0.183	0.131
Oak	0.006	-0.019	-0.047	0.127	0.081	0.014	-0.042
Palm fronds	0.033	0.057	0.035	-0.040	-0.030	0.114	-0.082
clay on sores	0.243	0.409	0.358	0.194	0.074	0.404	0.245
age of grain	-0.125	-0.079	-0.018	-0.052	-0.187	0.002	-0.070
Barometric pressure high	0.050	0.112	0.096	0.187	0.204	0.086	0.005
humidity low	0.167	0.218	0.151	0.136	0.094	0.205	0.159



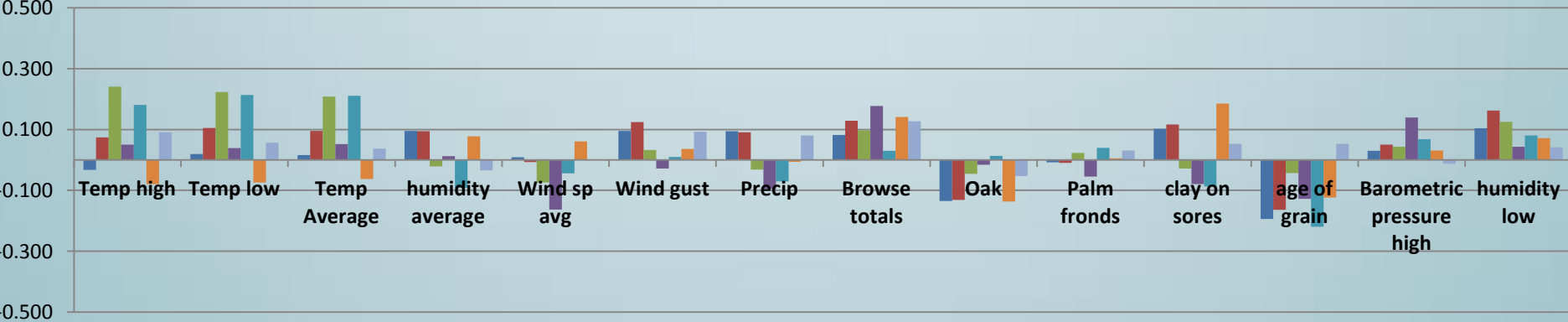
What if there is a lag in sore response to weather or browse?



2 week shift in sores



4 week shift in sores



Conclusion

- There were no strong correlations
- Strongest correlations were seen between clay on sores and their values – which is to be expected.
- There seemed to be a slight correlation between severity of sores and temperature suggesting that, while temp may not have triggered the sores, when the temperature rose the sores worsened.
- Correlations actually decreased when sores shifted forward to represent possible delayed effects of weather value → sore value
 - If there is a correlation, it is an immediate effect/quick response time for the sores

Margin of Error

- Correlation does not equal causation, so-
 - Flies? (are definitely more active in the warmer months)
 - Seasonal variation in grain ingredients on the production side?
- Missing Data? - Browse, age of grain and clay application values are dependent on reliability of zoo keeper recordkeeping.
- She may not choose to eat the browse or grain that is offered
- Clay application does seem to help reduce the sores, so their severity values may be artificially manipulated by the treatment.

What to change/try for the future.

- Future factors to monitor
 - Actual amount of grain consumed (currently only new shipments are recorded); She tends to eat newer grain better, so there is already a potential consumption component.
 - Removal of specific browse for a period of time
 - Analyze the clay; put clay on sores every day for a period of time

Questions?

