Patterns of Growth and Erosion of blades of the kelp *Saccharina latissima*

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Introduction

Kelp, large seaweeds of the Phylum Ochrophyta (or Phaeophyta), Order Laminariales provide many essential functions to intertidal habitats all over the world, yet the factors that govern their productivity are understudied. This is becoming an increasingly important issue as kelp productivity and population sizes have decreased over time due to an overabundance of predation and changes in the environment, resulting in kelp deforestation with decreased resilience (Steneck et al. 2002; Krumhansl and Scheibling 2012, Wernberg et al. 2019). Kelp deforestation not only posits a biological problem to its surrounding ecosystem but also an economic problem as they are an important aspect of aquaculture, are utilized in many commercial products and support many commercial fisheries by providing habitats and food web support. The increasing vulnerability of these kelp forests has become a growing problem, especially as we find out more about the vital role that kelp plays in its ecosystem.

Kelp forests play in important role in fighting climate change; they sequester carbon and provide blue carbon sinks, ameliorate ocean acidification, and provide complex habitats that encourage intertidal biodiversity. This suggests that kelp aquaculture is key to fighting climate change as well (Duarte et al. 2017).They are autotrophic and are primary producers that serve as a food source, both for herbivores as live plants that are fed on as well as through the detritus that they shed (Mann 1973). They exude dissolved organic material (DOM) from their blades that contribute to both the biotic composition of their surroundings as well as to epiphyte activity (James et al. 2020). Kelp provide structural functions as well; their detritus often forms complex habitats that allow for greater biodiversity of micro-organisms that live on the ocean floor, and the kelp beds can provide a similar function as well for macro-organisms such as juvenile fish (Figure 1, Branch and Griffiths 1988).

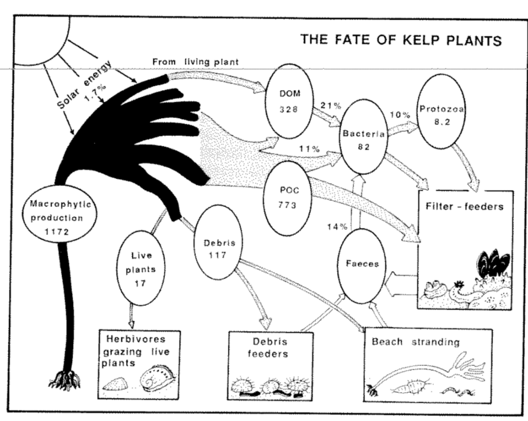

Fig. 18.—Summary of the production of kelp and its fate, particularly in relation to the potential production of microorganisms. Percentages indicate conversion efficiencies between different components, while the figures within each circle represent production in g $C{\cdot}m^{-2}{\cdot}yr^{-1}$. After Branch & Branch (1981), modified by the addition of data from Newell & Lucas (1981) and Newell, Field & Griffiths (1982).

Figure 1 Figure from Branch and Griffiths (1988) that displays the various pathways of kelp and their estimated amounts.

As we increasingly discover the ways in which kelp are essential contributors to its local ecosystems, it becomes more important that further studies are conducted to learn more about their rates of growth and erosion and to study which factors may affect these rates. In this study we looked specifically at *Saccharina latissima* (sugar kelp), a brown alga that grows along the western coast of the US and is ecologically important to its surrounding habitat in the Salish Sea where this experiment took place. This experiment was conducted over the course of 6 years as a part of a spring quarter class at Friday Harbor Labs and we used a simple but effective method that can measure growth and erosion of *S. latissim*a that was used at different depths and thus at different light levels. With this data we ask what the patterns of growth and erosion are in *S. latissima* and estimate the rate of growth and erosion in April and May.

Methods

Experiments were conducted as part of a Spring quarter botany class (BIOL 445 and FHL 470) at Friday Harbor Labs over the course of 6 years (2014-2019) in April and May; total lengths of the experiment varied throughout the years but typically averaged one month. Teams of students worked together to measure and keep track of the same individuals of *S. latissima* from the beginning of the experiment. *S. latissima* blades growing naturally in old tire fenders on the FHL floating portion of the dock (48°32’42.3”N, 123°00’43.3”W) were randomly selected and carefully removed from the tires with the holdfasts intact. Using a plastic tubing connector, 2.5mm diameter holes were made along the center of the blade in 5cm increments starting from the base of the blade. The hole punch method was first described in Mann and Kirkman (1981) see also (Tala and Edding 2007, Gagné and Mann 1987) and is used to track where growth occurs along the kelp blade. In addition, total blade length, holdfast length, and maximum width were measured and recorded (Figure 2).

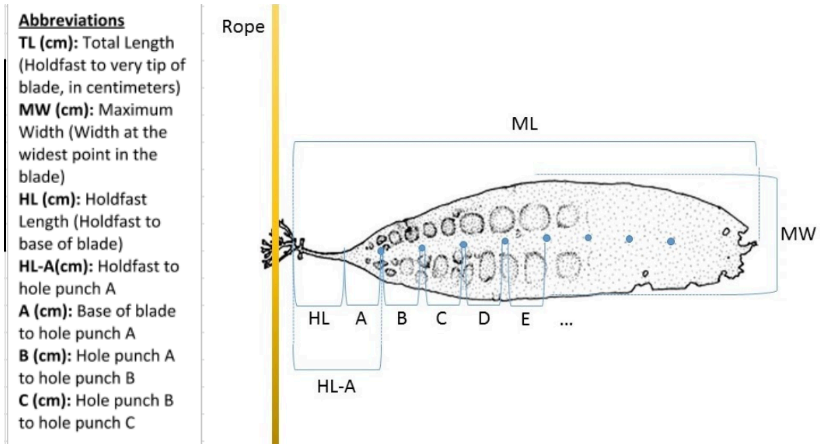

Figure 2 Diagram of where on S. latissima measurements were taken and where hole punches were made.

Each team selected three separate *S. latissima* plants. Each individual's holdfast were inserted into the lay of the rope at three different depths: surface (0m), shallow (1m), and deep (3m). A weight (brick or flowerpot) was added to the bottom of the rope to keep the rope vertical and the kelp as near as possible to the proper depth. The plants were retrieved weekly throughout the course of the experiment and the distance between the holes were measured and recorded, as were blade and holdfast length and max width. Light levels (PAR) were measured using the LiCor spherical underwater sensor (LI-192 Underwater Quantum Sensor) attached to a 30m cable and a LiCor Model LI- 250A light meter, at the three different depths at the beginning and end of the experiment. Data analysis was conducted with the dataset collected from 6 years of these ongoing experiments. Excel and R with RStudio were used to run ANOVA tests and plot linear regressions.

Data files can be found in Appendix A

During the months of April and May from 2014-2019, average rate of growth for S. latissima was 1.24 cm/day and average rate of erosion was 0.54 cm/day (Table 1). The growth rate ranged from 0.21 cm/day to 4.66 cm/day, and erosion rate ranged from 0.00 cm/day to 10.68 cm/day (Table 1). The average relative growth rate was 0.04 cm/day/cm^2, and ranged from -0.48 to 0.46 cm/day/cm^2.

	Growth Rate (cm/day)	*Erosion Rate (cm/day)*	*Relative Growth Rate (cm/day/cm^2)*
Mean	1.24	0.54	0.04
Standard Deviation	0.79	1.14	0.12
Minimum	0.21	0.00	-0.48
Maximum	4.66	10.68	0.46

Table 1 Estimated mean and range of Growth, Erosion, and Relative Growth Rate of S. latissima during April and May. Data collected at Friday Harbor Labs from 2014-2019.

Growth rate at the 3 different depths did not differ significantly and averaged at around 1cm/day for all three depths (Figure 3a, $p = 0.31$). Erosion rate also did not differ between depths and averaged at

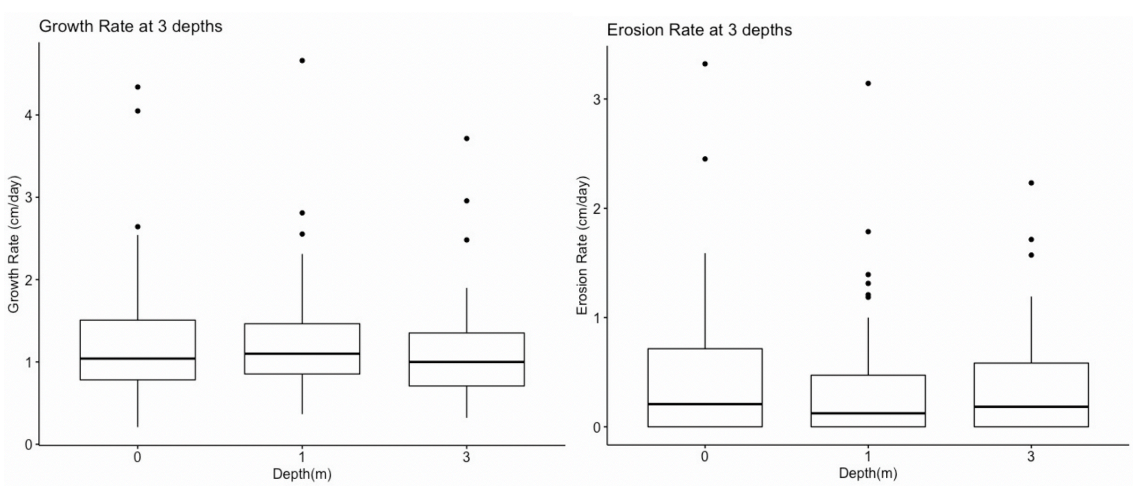

Figure 3 Boxplots of (a) Growth and (b) Erosion rates of S. latissima grown at three different depths during April/May over a 6-year period, data collected at Friday Harbor Labs.

0.25cm/day between the three depths (Figure 3b, p=0.57). The growth rate in sections A and B (0.96cm/day) was significantly higher than that of sections C+D (0.16cm/day) on the blade (Figure 4, p<<0.05). Growth rate was not significantly different across years (Figure 5, p=0.091) though 2016 did have a significantly higher average growth rate compared to all other years. A number of linear regressions were run comparing growth and erosion rates to size, both the initial area as well as the total change in blade size, all of which were nonsignificant (Table 2). We also compared erosion rate with growth rate which was also nonsignificant ($R^2 = 0.39$).

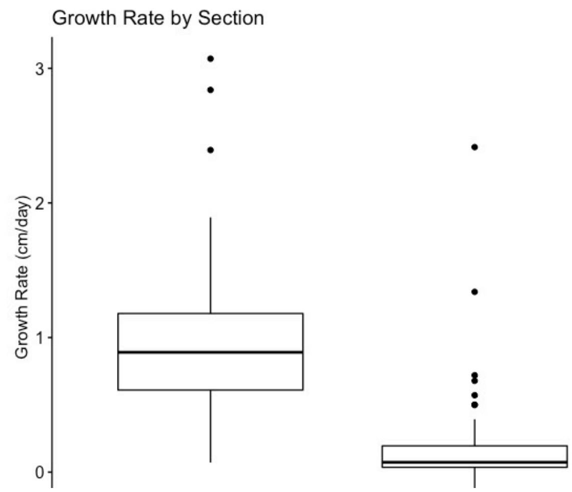

Figure 3 Boxplot of growth rate of S. latissima categorized by section of blade. Each section consisted of the space between holes punched in 5cm increments. Data was collected at Friday Harbor Labs from 2014-2019, during April and May.

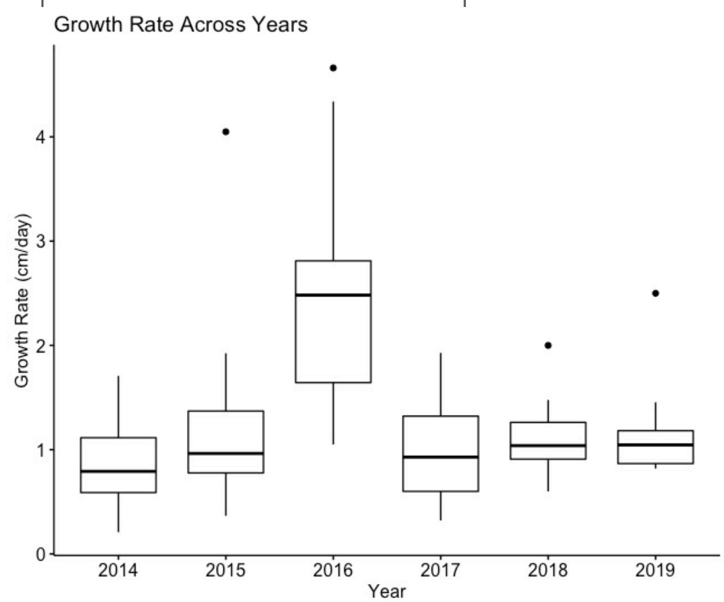

Figure 4 Boxplot of average growth rate of S. latissima across the years in which the experiment was conducted at Friday Harbor Labs, during April and May from 2014-2019.

What was compared	R^2 value
Growth Rate vs. Blade Size Change	= 0.214
Growth Rate vs. Initial Area	= 0.169
Erosion Rate vs. Blade Size Change	= 0.042
Erosion Rate vs. Initial Area	= 0.254
Growth Rate vs. Erosion Rate	= 0.395

Table 2 Linear regression run comparing growth and erosion rates of kelp to its change in size as well as original blade size. Growth rate of kelp was also compared to erosion rate. Data was collected at Friday Harbor Labs in April/May from 2014-2019.

Discussion

The seasonality of *S. latissima* is important to consider when tracking growth because they are an annual species that undergo a high amount of variance in their growth and erosion throughout the year. *S. latissima* specifically tend to grow rapidly in winter and spring but experience high levels of erosion with little growth in the summer (Brady-Campbell et al. 1984). Seasonality is an important trait of kelp growth and fluctuations in it can lead to trophic mismatches and affect the organisms within the intertidal that rely on kelp for food and habitat. We found the average growth rate in April and May for our *S. latissima* to 1.24 cm/day and was similar to the findings of Brady-Campbell et al (1984)., which estimated the average growth rate of *S. latissima* to be ~1.30 cm/day for April/May. Seasonality appears to be quite ubiquitous among all kelp in various populations regardless of differences in population diversity, site, light, or wave exposure. (Miller et al. 2011). Effectively tracking seasonal growth in kelp populations over time is important as long-term changes in temperature, light, and nutrient availability may result in changes to its growth and erosion patterns (Broch and Slagstad 2012).

In our analyses we found that depth with this experiment did not have any effect on growth or erosion of *S. latissima*. Gradients of depth experience different abiotic conditions such as light, wave exposure, and temperature which in turn affect the photosynthetic ability of kelp and result in changes to its growth and erosion rates (Nielsen et al. 2014). We hypothesize that the range in depth tested in our experiment did not exceed the photosynthetic extremes of kelp and thus growth and erosion did not decrease because it still received ample light for max growth. Although water movement was not measured explicitly, higher intensities of wave motion at the surface may also provide additional stress that limits growth and mitigates the benefits of additional light exposure for growth (Gerard and Mann 1979). Kelp growth and erosion are not just affected by environmental context – depth, light, wave action, water flow, nutrient availability, but by biological context as well – morphology, epiphyte levels, and herbivore activity. Not only do both affect growth and erosion patterns in kelp, environmental factors may also result in morphological adaptations by changing the strength of holdfasts, thickness of blades, and blade size/shape (Krumhansl and Scheibling 2016). We did not find any correlations between blade size growth and erosion rates, but other studies have found that de-blading certain areas of the kelp will limit or completely prevent photosynthetic activity (Nicholson 1970). This suggests that the setup of our experiment created a favorable enough growing environment for the *S. latissima* that limitations such as differences in size or light exposure did not negatively affect kelp growth and erosion in any quantitative way.

These results gave us a broad overview of how much *S. latissima* grows and erodes in April/May and where this occurs, but will require additional sample sizes and improvements to experiment design in the future to learn more about the effects of abiotic factors such as depth, light, and wave motion on kelp growth and erosion. Improvements likely include growing kelp at deeper depths with larger sample sizes as well as tying down the *S. latissima* to the bottom of the ocean floor to better simulate the variable levels of light and wave exposure due to the tides.

Acknowledgements

This research could not have happened and would not have been nearly as successful without Abigail Ames and Megan Dethier who orchestrated this fantastic virtual opportunity. Thanks as well to all the past ZooBot students and TAs for running the experiments year after year and doing all the hard work by collecting and recording the data. Many thanks to Chris Wells, Robin Fales, Eliza Heery, Mo Turner, and the UW Biostats consulting team for all their help with RStudio and statistical analysis. A mountain of thanks of course to Tom Mumford whose valuable mentorship and kelp expertise helped propel and guide this project and allowed for some wonderful scientific learning to occur, even virtually.

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Appendix A

Year						total length	blade width	stipe length	1	2	3	4	5	6	7
	Group Names	Group	Depth (m)	Date	Days	ML (cm)	MW (cm)	HL (cm)	A (cm)	B (cm)	C (cm)	D (cm)	E (cm)	F (cm)	G (cm)
2019	AC, RK, CP	1	0	4/8/19	0	73	35.5	2	5	5	5	5	5	5	5
2019	AC, RK, CP	1	0	4/15/19	7	80	41.5	4.5	10	13	7	5	5	5	5
2019	AC, RK, CP	1	0	4/23/19	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019	AC, RK, CP	1	0	4/30/19	22	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019	AC, RK, CP	1	1	4/8/19	0	39	15	1.5	5	5	5	5	5	5	5
2019	AC, RK, CP	1	1	4/15/19	7	43	17.5	4.5	9.5	5	5	5	5	5	0
2019	AC, RK, CP	1	1	4/23/19	15	51.4	20	4.5	17.5	5	6	5	5	3.3	0
2019	AC, RK, CP	1	1	4/30/19	22	59.5	26	4.5	26.5	6.5	5	5	5	0	0
2019	AC, RK, CP	1	3	4/8/19	0	44	18	2.5	5	5	5	5	5	5	5
2019	AC, RK, CP	1	3	4/15/19	7	48.5	20	5	16.5	6.5	5	5	5	5	5
2019	AC, RK, CP	1	3	4/23/19	15	55.9	24	5	12	9	6.5	5.5	0	0	0
2019	AC, RK, CP	1	3	4/30/19	22	61	28	5	19.5	9.5	5.5	6	0	0	0
2019	HK, HM, AL, MT	2	0	4/8/19	0	42	10	5	5	5	5	5	5	5	5
2019	HK, HM, AL, MT	2	0	4/15/19	7	42	10	5	7	12	5	5	5		
2019	HK, HM, AL, MT	2	0	4/23/19	15	40	10	5	10	13	5	5			
2019	HK, HM, AL, MT	2	0	4/30/19	22	35	10	5	15	13					
2019	HK, HM, AL, MT	2	1	4/8/19	0	42	10	5	5	5	5	5	5	5	5
2019	HK, HM, AL, MT	2	1	4/15/19	7	42	10	5	7	12	5	5	5		
2019	HK, HM, AL, MT	2	1	4/23/19	15	40	10	5	10	13	5	5			
2019	HK, HM, AL, MT	2	1	4/30/19	22										
2019	HK, HM, AL, MT	2	3	4/8/19	0	42	10	5	5	5	5	5	5	5	5
2019	HK, HM, AL, MT	2	3	4/15/19	7	42	10	5	7	12	5	5	5	0	0
2019	HK, HM, AL, MT	2	3	4/23/19	15	40	10	5	10	13	5	5	0	0	0
2019	HK, HM, AL, MT	2	3	4/30/19	22	0	0	0	0	0	0	0	0	0	0
2019	KH, KT, LW	3	0	4/8/19	0	69	39	3	5	5	5	5	5	5	5
2019	KH, KT, LW	3	0	4/15/19	7	79	46.5	3	10	7.5	7	4.5	6	5.5	4.5
2019	KH, KT, LW	3	0	4/23/19	15	89	51	3	17	7	9	7	7	5.5	4.5
2019	KH, KT, LW	3	0	4/30/19	22	103	58	3	25	9	12.5	5	5.5	5	5
2019	KH, KT, LW	3	1	4/8/19	0	73	33.5	2.5	5	5	5	5	5	5	5
2019	KH, KT, LW	3	1	4/15/19	7	81	36.5	2.5	9	7	6	5	5	5.5	5
2019	KH, KT, LW	3	1	4/23/19	15	90.5	40.7	2	14	11	5.5	6	4.5	5	5
2019	KH, KT, LW	3	1	4/30/19	22										
2019	KH, KT, LW	3	3	4/8/19	0	46	16	2	5	5	5	5	5	5	5
2019	KH, KT, LW	3	3	4/15/19	7	52	17	2	6	7	5.5	5	5	5.5	5
2019	KH, KT, LW	3	3	4/23/19	15	57	24	2	15	5	5.5	4.5	6	4	
2019	KH, KT, LW	3	3	4/30/19	22	66	32	2	23	8.5	4.5	5	6		
2018	Elena + Jamie	1	0	2-Apr	0	43	12	4	5	5	5	5	5	5	5
2018	Elena + Jamie	1	0	9-Apr	7	50	15	5	8.5	8	6	5.5	5	5	5
2018	Elena + Jamie	1	0	17-Apr	15	57	18	5.5	12	9	6.3	5.3	5	5.2	5.2
2018	Elena + Jamie	1	0	30-Apr	22	63	20	6	19	9	6.5	5.5	5	5.5	5.2
2018	Elena + Jamie	1	1	2-Apr	0	41	12	4	5	5	5	5	5	5	5
2018	Elena + Jamie	1	1	9-Apr	7	48	13.5	4	9	8	6	5.5	5	5	5
2018	Elena + Jamie	1	1	17-Apr	15	56	16	4.5	18	8.5	6	5.5	5	5	gone
2018	Elena + Jamie	1	1	30-Apr	22	77	23	5	38	9.5	6	5.5	7	7	gone
2018	Elena + Jamie	1	3	2-Apr	0	35	15	4	5	5	5	5	5	5	NA
2018	Elena + Jamie	1	3	9-Apr	7	41	15.5	4.5	6.5	8	6	5.5	5	5.5	NA
2018	Elena + Jamie	1	3	17-Apr	15	48	17.5	4.5	10.5	9	6	5	5	5	NA

2018	Elena + Jamie	1	3	30-Apr	22	62	21.5	4.5	24	10	6	5.5	5	5.5	
2018	Jessica + Lauren	2	0	2-Apr	0	33.5	18.5	2.5	5	5	5	5	5		
2018	Jessica + Lauren	2	0	9-Apr	7	35	20	3	8	6	5.5	5	6		
2018	Jessica + Lauren	2	0	17-Apr	15	43	22	5	12	6	5	5	5		
2018	Jessica + Lauren	2	0	30-Apr	22	53	25	3.5	22.5	6.5	6	5	5.5		
2018	Jessica + Lauren	2	1	2-Apr	0	24.5	16	2	5	5	5	5			
2018	Jessica + Lauren	2	1	9-Apr	7	29	16.8	3	8	6	5	6			
2018	Jessica + Lauren	2	1	17-Apr	15	32	17.5	3	11	6	5	6			
2018	Jessica + Lauren	2	1	30-Apr	22	46	15	2.5	25	6.5	5.5	5.5			
2018	Jessica + Lauren	2	3	2-Apr	0	33.5	14	2.25	5	5	5	5	5	5	
2018	Jessica + Lauren	2	3	9-Apr	7	37	15	3	8	5.5	5	5	5	5	
2018	Jessica + Lauren	2	3	17-Apr	15	37	18	4	8	6	5	5	5	5	
2018	Jessica + Lauren	2	3	30-Apr	22	40	16.5	3	16	6	5.5	5.5			
2018	Henry	3	0	2-Apr	0	43	11	6	3	5	5				
2018	Henry	3	0	9-Apr	7	49	15	6	6	5	5				
2018	Henry	3	0	17-Apr	15	54	16	7	11	8	5				
2018	Henry	3	0	30-Apr	22	71.5	24	6	23.5						
2018	Henry	3	1	2-Apr	0	42	12.5	6	3	5	5				
2018	Henry	3	1	9-Apr	7	48	13.5	6	6	5	5				
2018	Henry	3	1	17-Apr	15	50	14	6	11	8	5				
2018	Henry	3	1	30-Apr	22	64.5	22.5	6	31.5	8.5	5.5				
2018	Henry	3	3	2-Apr	0	34	11	6	4	5	5	5			
2018	Henry	3	3	9-Apr	7	36	11.5	6	4	5	5	5			
2018	Henry	3	3	17-Apr	15	42	14	6	7.5	5	5	5			
2018	Henry	3	3	30-Apr	22	52.5	21.5	6	22	5.5	5	5			
2018	Scott	4	0	2-Apr	0	51	17	3.5	5	5	5	5	5	5	5
2018	Scott	4	0	9-Apr	7	52	17	5	6	5.5	5	5	5	5	5
2018	Scott	4	0	17-Apr	15	56	19	8	8	7	7	5	5	5	5
2018	Scott	4	0	30-Apr	22	68	19	9	19	8	8	5.5	5	5	5
2018	Scott	4	1	2-Apr	0	61	23	4	5	5	5	5	5	5	5
2018	Scott	4	1	9-Apr	7	71	26.5	4	8	6	5.5	6	5	5	5
2018	Scott	4	1	17-Apr	15	86	33	7	16	9	7	6.5	5	5	5
2018	Scott	4	1	30-Apr	22	lost	lost	lost	lost	lost	lost	lost	lost	lost	lost
2018	Scott	4	3	2-Apr	0	56	24	4	5	5	5	5	5	5	5
2018	Scott	4	3	9-Apr	7	69	24	4	7	6	5	5	5	5	5
2018	Scott	4	3	17-Apr	15	64	27	4	10	8	6	5	5	5	5
2018	Scott	4	3	30-Apr	22	lost	lost	lost	lost	lost	lost	lost	lost	lost	lost
2017	Sweet Team	1	0	4/4/17	0	50	16	2.5	5	5	5	5	5	5	5
2017	Sweet Team	1	0	4/10/17	6	51.5	14	4.5	5	5	5	-	-	-	-
2017	Sweet Team	1	0	4/18/17	14	61	17	4	11.5	7	6	-	-	-	-
2017	Sweet Team	1	1	4/4/17	0	39.5	14	3.5	5	5	5	5	5	5	5
2017	Sweet Team	1	1	4/10/17	6	45	15	3.5	9	7	7.5	5	5	5	-
2017	Sweet Team	1	1	4/18/17	14	53	19.5	4	11	6	8	7.5	5	5	-
2017	Sweet Team	1	3	4/4/17	0	46	13	4	5	5	5	5	5	5	-
2017	Sweet Team	1	3	4/10/17	6	50.5	15	4	7.5	6.5	5.5	5	5	5	-
2017	Sweet Team	1	3	4/18/17	14	60	20	4.5	8.5	5.5	5	5	5	5	-
2017	Hackey Sacchirin	2	0	4/4/17	0	61	21.5	4	5.2	5.2	5.2	5	4.75	5	5
2017	Hackey Sacchirin	2	0	4/10/17	6	68	25	5.5	9.1	8.1	6.3	6.5	5	5.3	5
2017	Hackey Sacchirin	2	0	4/18/17	14	77	28.5	5	18	10.2	7.5	6.5	5	5	5

2017	Hackey Sacchirin	2	1	4/4/17	0	51	26	4	5	5	5	5	5	5	5
2017	Hackey Sacchirin	2	1	4/10/17	6	56	26.9	3.85	7.5	7.3	5.8	5.8	5.45	-	-
2017	Hackey Sacchirin	2	1	4/18/17	14	67.5	33.7	4	16	10.5	6.5	6	5.5	-	-
2017	Hackey Sacchirin	2	3	4/4/17	0	62	23	2.5	5	4.75	5.5	5.25	5	5	5
2017	Hackey Sacchirin	2	3	4/10/17	6	69	25	3	7	6.5	6.75	6	5.5	5.2	5
2017	Hackey Sacchirin	2	3	4/18/17	14	76.5	28.5	3	13.5	9.5	7.5	6	5.5	5	5
2017	Pink Panther	3	0	4/4/17	0	78.5	36.5	2	5	5	5	5	5	5	5
2017	Pink Panther	3	0	4/10/17	6	87	36.5	1.5	7.5	8	7.5	6	6	5	5.5
2017	Pink Panther	3	0	4/18/17	14	102	51	2.5	13.5	13	8	9	6	6	6
2017	Pink Panther	3	1	4/4/17	0	124.5	27	4	5	5	5	5	5	5	5
2017	Pink Panther	3	1	4/10/17	6	88	27.5	4	8.5	6.5	5.5	5.5	5	5	5.5
2017	Pink Panther	3	1	4/18/17	14	101	28	4	12	12	9	6	5.5	5.5	5.5
2017	Pink Panther	3	3	4/4/17	0	72.5	41	4	5	5	5	5	5	5	5
2017	Pink Panther	3	3	4/10/17	6	78	42	4.5	6	7	7	7	5.5	5.5	5.5
2017	Pink Panther	3	3	4/18/17	14	87	47	4	7	11.5	9	8	6	5.5	5.5
2017	Team ARC	4	0	4/4/17	0	46	24	5	5	5	5	5	5	5	/
2017	Team ARC	4	0	4/10/17	6	27.5	27.5	2	9.33	6.5	5	5	5	5	/
2017	Team ARC	4	0	4/18/17	14	32	32	1.5	8.5	5.8	5	5.5	5.5	fell off	/
2017	Team ARC	4	1	4/4/17	0	50	25	7	5	5	5	5	5	/	/
2017	Team ARC	4	1	4/10/17	6	44.5	25	3	8	5.5	6	5.5	5.5	/	/
2017	Team ARC	4	1	4/18/17	14	51	27	3.5	7.5	7	5.5	6.5	fell off	/	/
2017	Team ARC	4	3	4/4/17	0	48	22	5.5	5	5	5	5	5	5	5
2017	Team ARC	4	3	4/10/17	6	57	29	2	7	7	6	4.5	5	5	5
2017	Team ARC	4	3	4/18/17	14	68.5	31.9	3.2	11	6.5	6.8	6	5	5	5
2017	Tilikum	5	0	4/4/17	0	58	26.5	4.5	5	5	5	5	5	5	5
2017	Tilikum	5	0	4/10/17	6	63	27.5	5	9	6	5.5	6	6	6	6
2017	Tilikum	5	0	4/18/17	14	68	32.5	4	14.5	6.5	6	6.5	6	6	6
2017	Tilikum	5	1	4/4/17	0	56	18	5.5	5	5	5	5	5	5	5
2017	Tilikum	5	1	4/10/17	6	57	18	5	7	7	5	5	5	5	5
2017	Tilikum	5	1	4/18/17	14	61.5	20.5	4.5	8	5	6	5	5	5	7
2017	Tilikum	5	3	4/4/17	0	57	28.5	7.5	5	5	5	5	5	5	5
2017	Tilikum	5	3	4/10/17	6	64	30	7.5	7	8	6.5	6	6	5	5.5
2017	Tilikum	5	3	4/18/17	14	68	33	7.5	10	7	6	6	6	6	6
2016	Eryca, Molly, Paul	1	0	4/4/16	0	83	80		8	5	5	5	5	5	5
2016	Eryca, Molly, Paul	1	0	4/18/16	14	71.5	68		7	3.5	8	5.25	6.25	5.25	3.25
2016	Eryca, Molly, Paul	1	0	5/2/16	28	78	75	31	9	6	10.5	5.5	5.5	4.5	4
2016	Gina, Jamee, Ale:	2	0	4/4/16	0	62	58.5	22.5	8.5	5	5	5	5	5	
2016	Gina, Jamee, Ale:	2	0	4/18/16	14	80.4	76.4	23.6	13	9	11.4	6.5	6.6	5.9	
2016	Gina, Jamee, Ale:	2	0	5/2/16	28	95.5	89.5	29.5	31.5	25.5	16	8	7.3	9.4	
2016	Maya, Anna, Zoe	3	0	4/4/16	0	55.5	55.5	17		0	5	5	5	5	
2016	Maya, Anna, Zoe	3	0	4/18/16	14	55.5	55.5	14	5	5	11	6	5	6	
2016	Maya, Anna, Zoe	3	0	5/2/16	28	61.9	59.8	15.4	9.6	7.5	14	6.6	6.5	5.2	
2016	Maria, Juliette	4	0	4/4/16	0	49	44	21	10	5	5	5	5	5	5
2016	Maria, Juliette	4	0	4/18/16	14	55	52	27	13	10	7	5	5	5	5
2016	Maria, Juliette	4	0	5/2/16	28	73	71		29	27	11.5	8	5	5	5
2016	Nadia, Marisa, Su	5	0	4/4/16	0	0					5	5	5	5	
2016	Nadia, Marisa, Su	5	0	4/18/16	14	62.5	58		19	14.5	7.5	6	5	5	
2016	Nadia, Marisa, Su	5	0	5/2/16	28	0									
2016	Alia, Marshall, Wil	6	0	4/4/16	0	49	49				5	5	5	5	5

2016	Alia, Marshall, Wil	6	0	4/18/16	14	50	50		13		5	5	5	5.5	5
2016	Alia, Marshall, Wil	6	0	5/2/16	28	77.5	71	38.5	43	36.5	8	5	5	5.5	5
2016	Eryca, Molly, Paul	1	1	4/4/16	0	57	54		8	5	5	5	5	5	5
2016	Eryca, Molly, Paul	1	1	4/18/16	14	63	60		9.5	6.5	5	9.25	6.5	5	5
2016	Eryca, Molly, Paul	1	1	5/2/16	28	78.5	75.5	37	18.5	15.5	13	6.5	7	7	3.73
2016	Gina, Jamee, Ale:	2	1	4/4/16	0	61	59	37	7	5	5	5	5	5	
2016	Gina, Jamee, Ale:	2	1	4/18/16	14	75	72.5	27	11	8.5	11.9	6.6	5.7	5.7	
2016	Gina, Jamee, Ale:	2	1	5/2/16	28	89	85	37.75	30	26	16	13	6		
2016	Maya, Anna, Zoe	3	1	4/4/16	0	57	57	20		0	5	5	5	5	
2016	Maya, Anna, Zoe	3	1	4/18/16	14	73.5	73.5	27	7	7	18.5	10.5	7	6	
2016	Maya, Anna, Zoe	3	1	5/2/16	28	102.5	98	31.5	15.5	11	37	10.5	7.2	6	
2016	Maria, Juliette	4	1	4/4/16	0	48	45	23	8	5	5	5	5	5	5
2016	Maria, Juliette	4	1	4/18/16	14	52.5	48	22	14.5	10	8.5	5	5	5	5
2016	Maria, Juliette	4	1	5/2/16	28	69	65		29	25	10	5	5	5	5
2016	Nadia, Marisa, Su	5	1	4/4/16	0	0					5	5	5	5	
2016	Nadia, Marisa, Su	5	1	4/18/16	14	70.5	64.5		24	18	8.5	5.5	5	5.5	
2016	Nadia, Marisa, Su	5	1	5/2/16	28	91.5	85.5	39	46	40	9	6	5.5	5	
2016	Alia, Marshall, Wil	6	1	4/4/16	0	72	72				5	5	5	5	5
2016	Alia, Marshall, Wil	6	1	4/18/16	14	109.5	109.5		26		5	5	6	5	5
2016	Alia, Marshall, Wil	6	1	5/2/16	28	0									
2016	Eryca, Molly, Paul	1	3	4/4/16	0	55	52		8	5	5	5	5	5	5
2016	Eryca, Molly, Paul	1	3	4/18/16	14	55	52		12.5	9.5	11.5	6	13		
2016	Eryca, Molly, Paul	1	3	5/2/16	28	62	59	34	20.5	17.5	14.5	6			
2016	Gina, Jamee, Ale:	2	3	4/4/16	0	62.2	58.5	22.5	8.7	5	5	5	5	5	
2016	Gina, Jamee, Ale:	2	3	4/18/16	14	80.5	77	27	14	10.5	12	7.5	6	6	
2016	Gina, Jamee, Ale:	2	3	5/2/16	28	101	94.5	35.5	35.5	29	17	9	6.5	6.5	
2016	Maya, Anna, Zoe	3	3	4/4/16	0	35	35	20		0	5	5	5	5	
2016	Maya, Anna, Zoe	3	3	4/18/16	14	40	40	22	5	5	8	6	5.5	5.25	
2016	Maya, Anna, Zoe	3	3	5/2/16	28	41.9	39.5	24.5	17.7	15.3	5.5	5.5	5.3	6.5	
2016	Maria, Juliette	4	3	4/4/16	0	48	45	25	8	5	5	5	5	5	5
2016	Maria, Juliette	4	3	4/18/16	14	56	53	29	15	12	7	5	5	5	5
2016	Maria, Juliette	4	3	5/2/16	28	70	68		28	26	8	5	5	5	5
2016	Nadia, Marisa, Su	5	3	4/4/16	0	0					5	5	5	5	
2016	Nadia, Marisa, Su	5	3	4/18/16	14	48	41.5		19.5	13	5	5	5	5	
2016	Nadia, Marisa, Su	5	3	5/2/16	28	76	71	23	32	27	7	5.5	5	4.5	
2016	Alia, Marshall, Wil	6	3	4/4/16	0	91	91				5	5	5	5	5
2016	Alia, Marshall, Wil	6	3	4/18/16	14	0									
2016	Alia, Marshall, Wil	6	3	5/2/16	28	0									
2015	Maddie/Joelle	1-1	0	3/31/15	0	73	26	3	4	5	5	5			
2015	Maddie/Joelle	1-2	0	3/31/15	0	33	16	2	3.3	5	5	5			
2015	Maddie/Joelle	1-1	0	4/21/15	21	86	30	4	12	21.5	8.5	6.8			
2015	Maddie/Joelle	1-2	0	4/21/15	21	38	18	2	7	10	5	5.5			
2015	Maddie/Joelle	1-1	0	5/11/15	41										
2015	Maddie/Joelle	1-2	0	5/11/15	41	75	39	3	26	13					
2015	Jack/Marine/Susa	2-1	0	4/21/15	21	47.5	19	2	12	11.5	6	8.5			
2015	Jack/Marine/Susa	2-2	0	4/21/15	21	31	16	2	10	16	6				
2015	Jack/Marine/Susa	2-1	0	5/11/15	41	70	30	2	34	14.5	7	5			
2015	Jack/Marine/Susa	2-2	0	5/11/15	41	47.5	32	1.5	23	12.5					
2015	Suzanne/Drew/R	3-1	0	3/31/15	0	31.8	13	2.2	3	5	5.5	5			

2015	Suzanne/Drew/R	3-2	0	3/31/15	0	49.5	27	1.5	4.5	5	5	5
2015	Suzanne/Drew/R	3-1	0	4/21/15	21	66	23	2	21	12	6	5
2015	Suzanne/Drew/R	3-2	0	4/21/15	21	82.5	33	1.5	24	16	10	7
2015	Suzanne/Drew/R	3-1	0	5/11/15	41	90	40	5	44	11	7	6
2015	Suzanne/Drew/R	3-2	0	5/11/15	41	115	41	2	56	20	101	8
2015	Gabby/Bill/Keena	4-1	0	3/31/15	0	52	27	2	3.25	5	5	5
2015	Gabby/Bill/Keena	4-2	0	3/31/15	0	27	7.5	2	3.5	5	5	5
2015	Gabby/Bill/Keena	4-1	0	4/21/15	21	80	44	1	12	22	8	6.5
2015	Gabby/Bill/Keena	4-2	0	4/21/15	21	35	12	3	10	12	6	5
2015	Gabby/Bill/Keena	4-1	0	5/11/15	41	104	57	2	38	31	14	10
2015	Gabby/Bill/Keena	4-2	0	5/11/15	41	52	22	3	36			
2015	Brian/Chloe/Julia	5-1	0	3/31/15	0	32	14	3	4	5.5	5.2	5.5
2015	Brian/Chloe/Julia	5-2	0	3/31/15	0	32	13	3	4	5.3	5.7	5
2015	Brian/Chloe/Julia	5-1	0	4/21/15	21	43.5	24	3.5	3.5	14.5	4.5	5
2015	Brian/Chloe/Julia	5-2	0	4/21/15	21	59.5	20	3.5	1.5	17.5	6	4.5
2015	Brian/Chloe/Julia	5-1	0	5/11/15	41	63	35	3	28	15.5	6	
2015	Brian/Chloe/Julia	5-2	0	5/11/15	41	107.5	32	6.5	20	25.5	4.5	
2015	Camille/Hannah/	6-1	0	3/31/15	0	34	13	2	1	4	5	5
2015	Camille/Hannah/	6-2	0	3/31/15	0	44	29	2	1	5	5	5
2015	Camille/Hannah/	6-1	0	4/21/15	21	53.5	20	1.5	7	11	5	6
2015	Camille/Hannah/	6-2	0	4/21/15	21	21	8.5	3				
2015	Camille/Hannah/	6-1	0	5/11/15	41	68.5	21	2.5	12	15	12	11
2015	Camille/Hannah/	6-2	0	5/11/15	41	36	22.5	2	19			
2015	Maddie/Joelle	1-1	1	3/31/15	0	46	20	3	4	5	5	5
2015	Maddie/Joelle	1-2	1	3/31/15	0	32.5	24	1.5	2.5	5	5	5
2015	Maddie/Joelle	1-1	1	4/21/15	21	64.5	25.2	3.5	12	5.5	12.5	7.3
2015	Maddie/Joelle	1-2	1	4/21/15	21	51	31	1	6	13	4.5	7
2015	Maddie/Joelle	1-1	1	5/11/15	41	74	42	1	21	19.5	5	13
2015	Maddie/Joelle	1-2	1	5/11/15	41	90	38	4	32	12	13.5	26
2015	Jack/Marine/Susa	2-1	1	4/21/15	21	49	24	3	6.5	15.5	6	5
2015	Jack/Marine/Susa	2-2	1	4/21/15	21	90.5	31.5	2.5	7	26	9	7.5
2015	Jack/Marine/Susa	2-1	1	5/11/15	41	66	41	2	20	27.5	7.5	5.5
2015	Jack/Marine/Susa	2-2	1	5/11/15	41	115.5	46	2.5	30	40	10	8
2015	Suzanne/Drew/R	3-1	1	3/31/15	0	50.5	22.2	2.5	7	4.5	5.5	5.5
2015	Suzanne/Drew/R	3-2	1	3/31/15	0	52.5	34.5	2.5	4	5	5	4.5
2015	Suzanne/Drew/R	3-1	1	4/21/15	21	81.5	32	2.5	30	10	7	5
2015	Suzanne/Drew/R	3-2	1	4/21/15	21	64.5	45	3.5	16	14	8	7
2015	Suzanne/Drew/R	3-1	1	5/11/15	41							
2015	Suzanne/Drew/R	3-2	1	5/11/15	41	88	51	3	32	20	9	7
2015	Gabby/Bill/Keena	4-1	1	3/31/15	0	30	17	2	3	5	5	5
2015	Gabby/Bill/Keena	4-2	1	3/31/15	0	29	15	2	2.5	5	5	5
2015	Gabby/Bill/Keena	4-1	1	4/21/15	21	46	24.5	2	10	12	5.5	5.5
2015	Gabby/Bill/Keena	4-2	1	4/21/15	21	42.5	23	1	11	13	5.5	5
2015	Gabby/Bill/Keena	4-1	1	5/11/15	41	67.5	37	2.5	25.5	16	6.5	6
2015	Gabby/Bill/Keena	4-2	1	5/11/15	41	59	30	1.5	23	17	6.5	6
2015	Brian/Chloe/Julia	5-1	1	3/31/15	0	29	13	2	3.5	5.5	5	5.7
2015	Brian/Chloe/Julia	5-2	1	3/31/15	0	32	16	2	3	5	6	5
2015	Brian/Chloe/Julia	5-1	1	4/21/15	21	46.5	21	2.5	5.5	14.5	5.5	5.5
2015	Brian/Chloe/Julia	5-2	1	4/21/15	21	39	22	2	2	12	12	

2015	Brian/Chloe/Julia	5-1	1	5/11/15	41	76.5	30	2.5	29	17.5	6	
2015	Brian/Chloe/Julia	5-2	1	5/11/15	41	44.5	29	2.5	9	11	8.5	
2015	Camille/Hannah/(	6-1	1	3/31/15	0	473	20	3	1	5	5	5
2015	Camille/Hannah/(	6-2	1	3/31/15	0	47	25	3	1	5	5	5
2015	Camille/Hannah/(	6-1	1	4/21/15	21	58	25	2	11	14	7	5
2015	Camille/Hannah/(	6-2	1	4/21/15	21	67	26	3	6.5	12.5	5.5	4.5
2015	Camille/Hannah/(	6-1	1	5/11/15	41	84	34	2	35	17	8	5
2015	Camille/Hannah/(	6-2	1	5/11/15	41	84.5	40	2.5	25	20	7	5
2015	Maddie/Joelle	1-1	3	3/31/15	0	57	22	4	5	5	5	5
2015	Maddie/Joelle	1-2	3	3/31/15	0	28.5	17	2.5	3.5	5	5	5
2015	Maddie/Joelle	1-1	3	4/21/15	21	92.5	30	2.5	4.5	22	10	7
2015	Maddie/Joelle	1-2	3	4/21/15	21	31	21	2	4.5	10	6.5	
2015	Maddie/Joelle	1-1	3	5/11/15	41	37	24	2	10	15.5	7	
2015	Maddie/Joelle	1-2	3	5/11/15	41	115	34.5	3	17	39.5	10.5	7
2015	Jack/Marine/Susa	2-1	3	4/21/15	21	96	32	4	19	21	8.5	8
2015	Jack/Marine/Susa	2-2	3	4/21/15	21	109.7	29.5	2.2	5	23	12	8
2015	Jack/Marine/Susa	2-1	3	5/11/15	41							
2015	Jack/Marine/Susa	2-2	3	5/11/15	41	142	36	2	20.5	44	13	8.5
2015	Suzanne/Drew/R(	3-1	3	3/31/15	0	44	19.8	2	4	4.5	5	5
2015	Suzanne/Drew/R(	3-2	3	3/31/15	0	30.8	2.3	1.8	3	5.5	5	5
2015	Suzanne/Drew/R(	3-1	3	4/21/15	21	56	26	3	21	15	5	5
2015	Suzanne/Drew/R(	3-2	3	4/21/15	21	45	33	2	8	13	7	5
2015	Suzanne/Drew/R(	3-1	3	5/11/15	41	85.5	34	2.5	50	16.5	6	5.5
2015	Suzanne/Drew/R(	3-2	3	5/11/15	41	63	38	2	23	15	7	5
2015	Gabby/Bill/Keena	4-1	3	3/31/15	0	52	32	3	3.5	5	5	5
2015	Gabby/Bill/Keena	4-2	3	3/31/15	0	59	19	3	3.5	5	5	5
2015	Gabby/Bill/Keena	4-1	3	4/21/15	21	60.5	37	2.5	5	10	6.5	6
2015	Gabby/Bill/Keena	4-2	3	4/21/15	21	78.5	29	2.5	7	19	13	7
2015	Gabby/Bill/Keena	4-1	3	5/11/15	41	70	57	3	10	22	6	6
2015	Gabby/Bill/Keena	4-2	3	5/11/15	41	57	37	3	23	22	7	6
2015	Brian/Chloe/Julia	5-1	3	3/31/15	0	29.5	12.5	2.5	3.5	5.5	5.3	6
2015	Brian/Chloe/Julia	5-2	3	3/31/15	0	23.5	28	2.5	3.5	5.5	5	5.3
2015	Brian/Chloe/Julia	5-1	3	4/21/15	21	48.5	23	2.5	12	13	6	5
2015	Brian/Chloe/Julia	5-2	3	4/21/15	21	45.5	38	2.5	2	14	5.5	
2015	Brian/Chloe/Julia	5-1	3	5/11/15	41	80.5	33	3.5	27	7	5	
2015	Brian/Chloe/Julia	5-2	3	5/11/15	41	58	47	3	11	17.5	5.5	6
2015	Camille/Hannah/(	6-1	3	3/31/15	0	42	25	2	1	5	5	5
2015	Camille/Hannah/(	6-2	3	3/31/15	0	48.5	18	2	1	5	5	5
2015	Camille/Hannah/(	6-1	3	4/21/15	21	36	17	2	6	13	5	5
2015	Camille/Hannah/(	6-2	3	4/21/15	21	51	23	2	16	9	6.5	6
2015	Camille/Hannah/(	6-1	3	5/11/15	41	52	28	2	19	18	6	5
2015	Camille/Hannah/(	6-2	3	5/11/15	41							
2014	a	1	0	04/07/2014	0	42	23	2	3	4	3.5	
2014	a	1	0	05/01/2014	24	44.5	39	3.5	2	16	6	
2014	b	1	1	04/07/2014	0	41	20	3	3.4	4	4	
2014	b	1	1	05/01/2014	24	84.5	37	3.5	6	36		
2014	c	1	3	04/07/2014	0	48	20	3	3.8	6.5	3.8	
2014	c	1	3	05/01/2014	24	2.5		2.5				
2014	a	2	0	04/07/2014	0	56	17	4	5	4	4.5	

2014	a	2	0	05/01/2014	24	64	20	4	4	7	6.5	
2014	b	2	1	04/07/2014	0	44.5	30.8	4.5	5.5	6	3.5	
2014	b	2	1	05/01/2014	24	54.5	35	5.5	3.5	13.5	4.5	
2014	c	2	3	04/07/2014	0	50.5	18	2.5	3	6	6.5	
2014	c	2	3	05/01/2014	24	0						
2014	a	3	0	04/07/2014	0	47	24	4	5	4	5	5
2014	a	3	0	05/01/2014	24	63	36	4	10	21		
2014	b	3	1	04/07/2014	0	34	12	2	3	5	5	5
2014	b	3	1	05/01/2014	24	0						
2014	c	3	3	04/07/2014	0	45	23	2	3	5	5	5
2014	c	3	3	05/01/2014	24	0						
2014	a	4	0	04/07/2014	0	32.5	27	5.5	7	5	5	
2014	a	4	0	05/01/2014	24	0						
2014	b	4	1	04/07/2014	0	53	21	6	7	5	5	5
2014	b	4	1	05/01/2014	24	36	22	5	12	7	9	6
2014	c	4	3	04/07/2014	0	43.5	22	4.5	5.5	5	5	5
2014	c	4	3	05/01/2014	24	66	32	5	14	19	8.5	5.5
2014	a	5	0	04/07/2014	0	27.5	15	2.5	3.4	5.1	5.1	
2014	a	5	0	05/01/2014	24	0						
2014	b	5	1	04/07/2014	0	39.5	11.5	2.5	4.2	5	5.2	
2014	b	5	1	05/01/2014	24	61.5	22.5	3.5	14	25	6.25	
2014	c	5	3	04/07/2014	0	38	16.5	3	4.7	5.2	5.1	
2014	c	5	3	05/01/2014	24	65.25	32.5	4	25.5	16	6.5	
2014	a	6	0	04/07/2014	0	29.9	12.4	2.9	4.3	5.2	5.2	
2014	a	6	0	05/01/2014	24	58	27	4	10.5	25	6.5	
2014	b	6	1	04/07/2014	0	19.4	8.2	1.9	3	5	4.9	
2014	b	6	1	05/01/2014	24	35	15.25	3	13			
2014	c	6	3	04/07/2014	0	19.7	7.7	1.7	2.5	5	5.1	
2014	c	6	3	05/01/2014	24	40	17	2.5	13	18	5.5	
2014	a	7	0	04/07/2014	0	39.3	16.1	2.3	3.7	5	4.7	
2014	a	7	0	05/01/2014	24	37.5	18	2.5	0	15	9	
2014	b	7	1	04/07/2014	0	25.5	11	2	3	5	5	
2014	b	7	1	05/01/2014	24	44.5	20.5	2	4	20	5.5	
2014	c	7	3	04/07/2014	0	34.3	11	1.8	3.75	5.5	5	
2014	c	7	3	05/01/2014	24	62.5	22	2.5	14	20	12	
2014	a	8	0	04/07/2014	0	33.9	11.6	1.5	2.9	5	5	
2014	a	8	0	05/01/2014	24	44	15	1	6	14	6	
2014	b	8	1	04/07/2014	0	27.5	7	3	4.6	5	5	
2014	b	8	1	05/01/2014	24	52.3	14	1.3	10.13	20	6	
2014	c	8	3	04/07/2014	0	32.6	5.5	2.8	4.5	5	5	
2014	c	8	3	05/01/2014	24	54.5	11	2.5	10.5	18	6.5	
2014	a	9	0	04/07/2014	0	42.5	7.5	3	4	5	5	5
2014	a	9	0	05/01/2014	24	55	11	3.5	6	17.5	7.5	
2014	b	9	1	04/07/2014	0	27.5	9	2.5	3.5	5	5	5
2014	b	9	1	05/01/2014	24	54	20	4	9	22	6	
2014	c	9	3	04/07/2014	0	36.5	7	3.5	4.5	5	5	5
2014	c	9	3	05/01/2014	24	55	12	4	6	19.5	8	
2014	a	10	0	04/07/2014	0	33.5	29	2.5	3.5	5	5	5
2014	a	10	0	05/01/2014	24	134	39.5	6	7	30	19	

2014	b	10	1	04/07/2014	0	44.5	20	1.5	2.5	5	5	5
2014	b	10	1	05/01/2014	24	63	25	3	5	6.5	13.5	
2014	c	10	3	04/07/2014	0	64	27	5	6	5	5	5
2014	c	10	3	05/01/2014	24	73.5	38	3.5	4	14		7
2014	a	11	0	04/07/2014	0	33	3	3	4	5	5	5
2014	a	11	0	05/01/2014	24	66	33.5	3	30	7	8	
2014	b	11	1	04/07/2014	0	31	2.5	4	5	5	5	5
2014	b	11	1	05/01/2014	24	54	28	5	10	22	7	6
2014	c	11	3	04/07/2014	0	47	3.5	4	5	5	5	5
2014	c	11	3	05/01/2014	24	62	32	3	7	17	7	6
2014	a	12	0	04/07/2014	0	23	2.5	5	5	5	5	5
2014	a	12	0	05/01/2014	24	40	12	3	7	12	3.5	6
2014	b	12	1	04/07/2014	0	26	1.5	3	3	5	5	5
2014	b	12	1	05/01/2014	24	44	28	4	12	12	6	
2014	c	12	3	04/07/2014	0	36	5	6	6	5	5	5
2014	c	12	3	05/01/2014	24	46	19	6	18	13	8	6

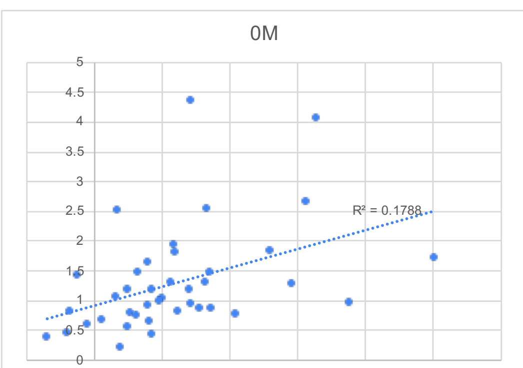
Year	Days	Depth (m)	Blade Change	Initial Length (cm)	Initial Width (cm)	Initial Area (cm^2)	Width Growth	Stipe Growth	A	B	C	D	E	F	G	Total Growth	Total Erosion	Growth Rate (cm/day)	Growth Rate/Size	Relative Growth Rate	Erosion Rate (cm/day)
2019	7	0	7	73	35.5	2591.5	6	2.5	5	8	2	0	0	0	0	17.5	10.5	2.5	0.000964692	0.357142857	1.5
2019	22	1	20.5	39	15	585	11	3	21.5	1.5	0	0	0			26	5.5	1.181818182	0.002020202	0.057649667	0.25
2019	22	3	17	44	18	792	10	2.5	14.5	4.5	0.5	1				23	6	1.045454545	0.001320018	0.061497326	0.272727273
2019	22	0	-7	42	10	420	0	0	10	8						18	25	0.818181818	0.001948052	-0.116883117	1.136363636
2019	15	1	-2	42	10	420	0	0	5	8	0	0				13	15	0.866666667	0.002063492	-0.433333333	1
2019	15	3	-2	42	10	420	0	0	5	8	0	0				13	15	0.866666667	0.002063492	-0.433333333	1
2019	22	0	34	69	39	2691	19	0	20	4	7.5	0	0.5	0	0	32	0	1.454545455	0.000540522	0.042780749	0
2019	15	1	17.5	73	33.5	2445.5	7.2	-0.5	9	6	0.5	1	0	0	0	16.5	0	1.1	0.000449806	0.062857143	0
2019	22	3	20	46	16	736	16	0	18	3.5	0	0	1			22.5	2.5	1.022727273	0.001389575	0.051136364	0.113636364
2018	22	0	20	43	12	516	8	2	14	4	1.5	0.5	0	0.5	0.2	22.7	2.7	1.031818182	0.001999648	0.051590909	0.122727273
2018	22	1	36	41	12	492	11	1	33	4.5	1	0.5	2	2	0	44	8	2	0.004065041	0.055555556	0.363636364
2018	22	3	27	35	15	525	6.5	0.5	19	5	1	0.5	0	0.5	0	26.5	0	1.204545455	0.002294372	0.044612795	0
2018	22	0	19.5	33.5	18.5	619.75	6.5	1	17.5	1.5	1	0	0.5	0	0	21.5	2	0.977272727	0.001576882	0.05011655	0.090909091
2018	22	1	21.5	24.5	16	392	-1	0.5	20	1.5	0.5	0.5	0	0	0	23	1.5	1.045454545	0.002666976	0.048625793	0.068181818
2018	22	3	6.5	33.5	14	469	2.5	0.75	11	1	0.5	0.5	0	0	0	13.75	7.25	0.625	0.001332623	0.096153846	0.329545455
2018	22	0	28.5	43	11	473	13	0	20.5	0	0	0	0	0	0	20.5	0	0.931818182	0.001970017	0.032695375	0
2018	22	1	22.5	42	12.5	525	10	0	28.5	3.5	0.5	0	0	0	0	32.5	10	1.477272727	0.002813853	0.065656566	0.454545455
2018	22	3	18.5	34	11	374	10.5	0	18	0.5	0	0	0	0	0	18.5	0	0.840909091	0.00224842	0.045454545	0
2018	22	0	17	51	17	867	2	5.5	14	3	3	0.5	0	0	0	26	9	1.181818182	0.001363112	0.069518717	0.409090909
2018	15	1	25	61	23	1403	10	3	11	4	2	1.5	0	0	0	21.5	0	1.433333333	0.00102162	0.057333333	0
2018	15	3	8	56	24	1344	3	0	5	3	1	0	0	0	0	9	1	0.6	0.000446429	0.075	0.066666667
2017	14	0	11	50	16	800	1	1.5	6.5	2	1	0	0	0	0	11	0	0.785714286	0.000982143	0.071428571	0
2017	14	1	13.5	39.5	14	553	5.5	0.5	6	1	3	2.5	0	0	0	13	0	0.928571429	0.001679153	0.068783069	0
2017	14	3	14	46	13	598	7	0.5	3.5	0.5	0	0	0	0	0	4.5	0	0.321428571	0.000537506	0.022959184	0
2017	14	0	16	61	21.5	1311.5	7	1	12.8	5	2.3	1.5	0.25	0	0	22.85	6.85	1.632142857	0.001244486	0.102008929	0.489285714
2017	14	1	16.5	51	26	1326	7.7	0	11	5.5	1.5	1	0.5	0	0	19.5	3	1.392857143	0.00105042	0.084415584	0.214285714
2017	14	3	14.5	62	23	1426	5.5	0.5	8.5	4.75	2	0.75	0.5	0	0	17	2.5	1.214285714	0.000851533	0.083743842	0.178571429
2017	14	0	23.5	78.5	36.5	2865.25	14.5	0.5	8.5	8	3	4	1	1	1	27	3.5	1.928571429	0.00067309	0.082066869	0.25
2017	14	1	-23.5	124.5	27	3361.5	1	0	7	7	4	1	0.5	0.5	0.5	20.5	44	1.464285714	0.000435605	-0.06231003	3.142857143
2017	14	3	14.5	72.5	41	2972.5	6	0	2	6.5	4	3	1	0.5	0.5	17.5	3	1.25	0.000420521	0.086206897	0.214285714
2017	14	0	-14	46	24	1104	8	-3.5	3.5	0.8	0	0.5	0.5	0	0	5.3	19.3	0.378571429	0.000342909	-0.027040816	1.378571429
2017	14	1	1	50	25	1250	2	-3.5	2.5	2	0.5	1.5	0	0	0	6.5	5.5	0.464285714	0.000371429	0.464285714	0.392857143
2017	14	3	20.5	48	22	1056	9.9	-2.3	6	1.5	1.8	1	0	0	0	10.3	0	0.735714286	0.000696699	0.035888502	0
2017	14	0	10	58	26.5	1537	6	-0.5	9.5	1.5	1	1.5	1	1	1	16.5	6.5	1.178571429	0.0007668	0.117857143	0.464285714
2017	14	1	5.5	56	18	1008	2.5	-1	3	0	1	0	0	0	2	6	0.5	0.428571429	0.00042517	0.077922078	0.035714286
2017	14	3	11	57	28.5	1624.5	4.5	0	5	2	1	1	1	1	1	12	1	0.857142857	0.000527635	0.077922078	0.071428571
2016	28	0	-5	83	80	6640	-5	31	1	1	5.5	0.5	0.5	0	0	39.5	44.5	1.410714286	0.000212457	-0.282142857	1.589285714
2016	28	0	33.5	62	58.5	3627	31	7	23	20.5	11	3	2.3	4.4	0	71.2	37.7	2.542857143	0.000701091	0.075906183	1.346428571
2016	28	0	6.4	55.5	55.5	3080.25	4.3	-1.6	9.6	7.5	9	1.6	1.5	0.2	0	29.4	23	1.05	0.000340881	0.1640625	0.821428571
2016	28	0	24	49	44	2156	27	-21	19	22	6.5	3	0	0	0	50.5	26.5	1.803571429	0.000836536	0.07514881	0.946428571
2016	14	0	62.5	0		0	58	0	19	14.5	2.5	1	0	0	0	37	0	2.642857143	#DIV/0!	0.042285714	0
2016	28	0	28.5	49	49	2401	22	38.5	43	36.5	3	0	0	0.5	0	121.5	93	4.339285714	0.001807283	0.152255639	3.321428571
2016	28	1	21.5	57	54	3078	21.5	37	10.5	10.5	8	1.5	2	2	0	71.5	50	2.553571429	0.00082962	0.118770764	1.785714286
2016	28	1	28	61	59	3599	26	0.75	23	21	11	8	1	0	0	64.75	36.75	2.3125	0.00064254	0.082589286	1.3125
2016	28	1	45.5	57	57	3249	41	11.5	15.5	11	32	5.5	2.2	1	0	78.7	33.2	2.810714286	0.000865101	0.06177394	1.185714286
2016	28	1	21	48	45	2160	20	-23	21	20	5	0	0	0	0	46	25	1.642857143	0.000760582	0.078231293	0.892857143
2016	28	1	91.5	0		0	85.5	39	46	40	4	1	0.5	0	0	130.5	39	4.660714286	#DIV/0!	0.050936768	1.392857143
2016	14	1	37.5	72	72	5184	37.5	0	26	0	0	0	1	0	0	27	0	1.928571429	0.000372024	0.051428571	0
2016	28	3	7	55	52	2860	7	34	12.5	12.5	9.5	1	0	0	0	69.5	62.5	2.482142857	0.000867882	0.354591837	2.232142857
2016	28	3	38.8	62.2	58.5	3638.7	36	13	26.8	24	12	4	1.5	1.5	0	82.8	44	2.957142857	0.000812692	0.076215022	1.571428571
2016	28	3	6.9	35	35	1225	4.5	4.5	17.7	15.3	0.5	0.5	0.3	1.5	0	40.3	33.4	1.439285714	0.001174927	0.208592133	1.192857143
2016	28	3	22	48	45	2160	23	-25	20	21	3	0	0	0	0	44	22	1.571428571	0.000727513	0.071428571	0.785714286
2016	14	3	28	48	41.5	1992	29.5	23	12.5	14	2	0.5	0	0	0	52	24	3.714285714	0.001864601	0.132653061	1.714285714
2015	21	0	13	73	26	1898	4	1	8	16.5	3.5	1.8				30.8	17.8	1.466666667	0.000772743	0.112820513	0.847619048
2015	20	0	22.5	47.5	19	902.5	11	0	22	3	1	0				26	3.5	1.3	0.001440443	0.057777778	0.175
2015	41	0	58.2	31.8	13	413.4	27	2.8	41	6	1.5	1				52.3	0	1.275609756	0.003085655	0.021917693	0
2015	41	0	52	52	27	1404	30	0	34.75	26	9	5				74.75	22.75	1.823170732	0.001298555	0.035060976	0.554878049
2015	41	0	31	32	14	448	21	0	24	10	0.8	0				34.8	3.8	0.848780488	0.001894599	0.027380016	0.092682927
2015	41	0	34.5	34	13	442	8	0.5	11	11	7	6				35.5	1	0.865853659	0.001958945	0.025097207	0.024390244
2015	41	1	28	46	20	920	22	-2	17	14.5	0	8				39.5	11.5	0.963414634	0.00104719	0.034407666	0.280487805
2015	20	1	17	49	24	1176	17	-1	13.5	12	1.5	0.5				27.5	10.5	1.375	0.001169218	0.080882353	0.525
2015	21	1	31	50.5	22.2	1121.1	9.8	0	23	5.5	1.5	0				30	0	1.428571429	0.001274259	0.046082949	0
2015	41	1	37.5	30	17	510	20	0.5	22.5	11	1.5	1				36.5	0	0.890243902	0.001745576	0.023739837	0
2015	41	1	47.5	29	13	377	17	0.5	25.5	12	1	0				39	0	0.951219512	0.002523129	0.020025674	0
2015	41	3	-20	57	22	1254	2	-2	5	10.5	2	0				17.5	37.5	0.426829268	0.000340374	-0.021341463	0.914634146
2015	41	3	41.5	44	19.8	871.2	14.2	0.5	46	12	1	0				59.5	18	1.451219512	0.001665771	0.034969145	0.43902439
2015	41	3	18	52	32	1664	25	0	6.5	17	1	1				25.5	7.5	0.62195122	0.000373769	0.034552846	0.182926829
2015	41	3	51	29.5	12.5	368.75	20.5	1	23.5	1.5	0	0				26	0	0.634146341	0.001719719	0.012434242	0
2015	41	3	10	42	25	1050	3	0	18	13	1	0				32	22	0.780487805	0.000743322	0.07804878	0.536585366
2015	41	0	42	33	16	528	23	1	22.7	8	0	0				31.7	0	0.773170732	0.001464339	0.018408827	0
2015	20	0	16.5	31	16	496	16	-0.5	13	0	0	0				13	0	0.65	0.001310484	0.039393939	0
2015	41	0	65.5	49.5	27	1336.5	14	0.5	51.5	15	96	3				166	100.5	4.048780488	0.003029391	0.061813443	2.451219512
2015	41	0	25	27	7.5	202.5	14.5	1	32.5	0	0	0				33.5	8.5	0.817073171	0.004034929	0.032682927	0.207317073
2015	41	0	75.5	32	13	416	19	3.5	16	20.2	0	0				39.7	0	0.968292683	0.002327627	0.012825069	0
2015	41	0	-8	44	29	1276	-6.5	0	18	0	0	0				18	26	0.43902439	0.000344063	-0.054878049	0.634146341
2015	41	1	57.5	32.5	24	780	14	2.5	29.5	7	8.5	21				68.5	11	1.670731707	0.002141964	0.029056204	0.268292683
2015	20	1	25	90.5	31.5	2850.75	14.5	0	23	14	1	0.5				38.5	13.5	1.925	0.000675261	0.077	0.675

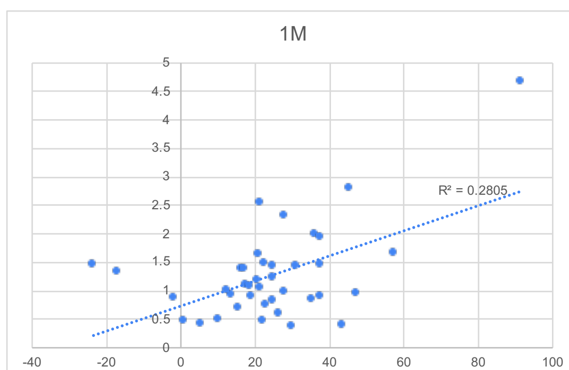
2015	41	1	35.5	52.5	34.5	1811.25	16.5	0.5	28	15	4	2.5	50	14.5	1.219512195	0.000673299	0.034352456	0.353658537
2015	41	1	30	29	15	435	15	-0.5	20.5	12	1.5	1	35	5	0.853658537	0.001962433	0.028455285	0.12195122
2015	41	1	12.5	32	16	512	13	0.5	6	6	2.5	0	15	2.5	0.365853659	0.000714558	0.029268293	0.06097561
2015	41	1	37.5	47	25	1175	15	-0.5	24	15	2	0	41	3.5	1	0.000851064	0.026666667	0.085365854
2015	41	3	86.5	28.5	17	484.5	17.5	0.5	13.5	34.5	5.5	2	56	0	1.365853659	0.002819099	0.015790216	0
2015	20	3	32.3	109.7	29.5	3236.15	6.5	-0.2	15.5	21	1	0.5	38	5.7	1.9	0.000587117	0.058823529	0.285
2015	41	3	32.2	30.8	2.3	70.84	35.7	0.2	20	9.5	2	0	31.7	0	0.773170732	0.010914324	0.024011513	0
2015	41	3	-2	59	19	1121	18	0	19.5	17	2	1	39.5	41.5	0.963414634	0.000859424	-0.481707317	1.012195122
2015	41	3	34.5	23.5	28	658	19	0.5	7.5	12	0.5	0.7	21.2	0	0.517073171	0.000785825	0.014987628	0
2015	21	3	2.5	48.5	18	873	5	0	15	4	1.5	1	21.5	19	1.023809524	0.001172749	0.40952381	0.904761905
2014	24	0	2.5	42	23	966	16	1.5	0	12	2.5	0	16	13.5	0.666666667	0.000690131	0.266666667	0.5625
2014	24	1	43.5	41	20	820	17	0.5	2.6	32	0	0	35.1	0	1.4625	0.001783537	0.03362069	0
2014	24	0	8	56	17	952	3	0	0	3	2	0	5	0	0.208333333	0.000218838	0.026041667	0
2014	24	1	10	44.5	30.8	1370.6	4.2	1	0	7.5	1	0	9.5	0	0.395833333	0.000288803	0.039583333	0
2014	24	0	16	47	24	1128	12	0	5	17	0	0	22	6	0.916666667	0.000812648	0.057291667	0.25
2014	24	1	-17	53	21	1113	1	-1	5	2	4	1	12	29	0.5	0.000449236	-0.029411765	1.208333333
2014	24	3	22.5	43.5	22	957	10	0.5	8.5	14	3.5	0.5	27	4.5	1.125	0.001175549	0.05	0.1875
2014	24	1	22	39.5	11.5	454.25	11	1	9.8	20	1.05	0	31.85	9.85	1.327083333	0.002921482	0.06032197	0.410416667
2014	24	3	27.25	38	16.5	627	16	1	20.8	10.8	1.4	0	34	6.75	1.416666667	0.002259436	0.051987768	0.28125
2014	24	0	28.1	29.9	12.4	370.76	14.6	1.1	6.2	19.8	1.3	0	28.4	0.3	1.183333333	0.003191642	0.042111507	0.0125
2014	24	1	15.6	19.4	8.2	159.08	7.05	1.1	10	0	0	0	11.1	0	0.4625	0.002907342	0.029647436	0
2014	24	3	20.3	19.7	7.7	151.69	9.3	0.8	10.5	13	0.4	0	24.7	4.4	1.029166667	0.00678467	0.050697865	0.183333333
2014	24	0	-1.8	39.3	16.1	632.73	1.9	0.2	0	10	4.3	0	14.5	16.3	0.604166667	0.000954857	-0.335648148	0.679166667
2014	24	1	19	25.5	11	280.5	9.5	0	1	15	0.5	0	16.5	0	0.6875	0.00245098	0.036184211	0
2014	24	3	28.2	34.3	11	377.3	11	0.7	10.25	14.5	7	0	32.45	4.25	1.352083333	0.003583576	0.047946217	0.177083333
2014	24	0	10.1	33.9	11.6	393.24	3.4	-0.5	3.1	9	1	0	13.1	3	0.545833333	0.001388041	0.054042904	0.125
2014	24	1	24.8	27.5	7	192.5	7	-1.7	5.53	15	1	0	21.53	0	0.897083333	0.004660173	0.036172715	0
2014	24	3	21.9	32.6	5.5	179.3	5.5	-0.3	6	13	1.5	0	20.5	0	0.854166667	0.004763897	0.039003044	0
2014	24	0	12.5	42.5	7.5	318.75	3.5	0.5	2	12.5	2.5	0	17.5	5	0.729166667	0.002287582	0.058333333	0.208333333
2014	24	1	26.5	27.5	9	247.5	11	1.5	5.5	17	1	-5	20	0	0.833333333	0.003367003	0.031446541	0
2014	24	3	18.5	36.5	7	255.5	5	0.5	1.5	14.5	3	-5	14.5	0	0.604166667	0.002364644	0.032657658	0
2014	24	0	100.5	33.5	29	971.5	10.5	3.5	3.5	25	14	-5	41	0	1.708333333	0.001758449	0.016998342	0
2014	24	1	18.5	44.5	20	890	5	1.5	2.5	1.5	8.5	0	14	0	0.583333333	0.000655431	0.031531532	0
2014	24	3	9.5	64	27	1728	11	-1.5	0	9	0	2	11	1.5	0.458333333	0.000265239	0.048245614	0.0625
2014	24	0	33	33	3	99	30.5	0	26	2	3	0	31	0	1.291666667	0.013047138	0.039141414	0
2014	24	1	23	31	2.5	77.5	25.5	1	5	17	2	1	26	3	1.083333333	0.013978495	0.047101449	0.125
2014	24	3	15	47	3.5	164.5	28.5	-1	2	12	2	1	17	2	0.708333333	0.004305978	0.047222222	0.083333333
2014	24	0	17	23	2.5	57.5	9.5	-2	2	7	0	1	10	0	0.416666667	0.007246377	0.024509804	0
2014	24	1	18	26	1.5	39	26.5	1	9	7	1	0	18	0	0.75	0.019230769	0.041666667	0
2014	24	3	10	36	5	180	14	0	12	8	3	1	24	14	1	0.005555556	0.1	0.583333333

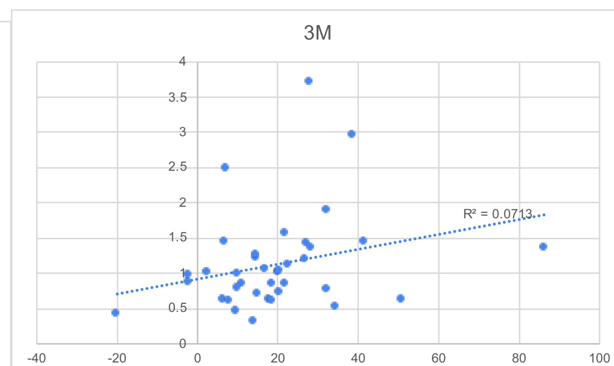
0M	Blade Change	Growth Rate (cm/day)
	7	2.5
	-7	0.818181818
	34	1.454545455
	20	1.031818182
	19.5	0.977272727
	28.5	0.931818182
	17	1.181818182
	11	0.785714286
	16	1.632142857
	23.5	1.928571429
	-14	0.378571429
	10	1.178571429
	-5	1.410714286
	33.5	2.542857143
	6.4	1.05
	24	1.803571429
	62.5	2.642857143
	28.5	4.339285714
	13	1.466666667
	22.5	1.3
	58.2	1.275609756
	52	1.823170732
	31	0.848780488
	34.5	0.865853659
	42	0.773170732
	16.5	0.65
	65.5	4.048780488
	25	0.817073171
	75.5	0.968292683
	-8	0.43902439
	2.5	0.666666667
	8	0.208333333
	16	0.916666667
	28.1	1.183333333
	-1.8	0.604166667
	10.1	0.545833333
	12.5	0.729166667
	100.5	1.708333333
	33	1.291666667
	17	0.416666667

1M	Blade Char	Growth Rate (cm/day)
	20.5	1.181818182
	-2	0.866666667
	17.5	1.1
	36	2
	21.5	1.045454545
	22.5	1.477272727
	25	1.433333333
	13.5	0.928571429
	16.5	1.392857143
	-23.5	1.464285714
	1	0.464285714
	5.5	0.428571429
	21.5	2.553571429
	28	2.3125
	45.5	2.810714286
	21	1.642857143
	91.5	4.660714286
	37.5	1.928571429
	28	0.963414634
	17	1.375
	31	1.428571429
	37.5	0.890243902
	47.5	0.951219512
	57.5	1.670731707
		1.925
	25	1.219512195
	35.5	0.853658537
	30	0.365853659
	12.5	1
	37.5	1.4625
	43.5	0.395833333
	10	0.5
	-17	1.327083333
	22	0.4625
	15.6	0.6875
	19	0.897083333
	24.8	0.833333333
	26.5	0.583333333
	18.5	1.083333333
	23	0.75
	18	

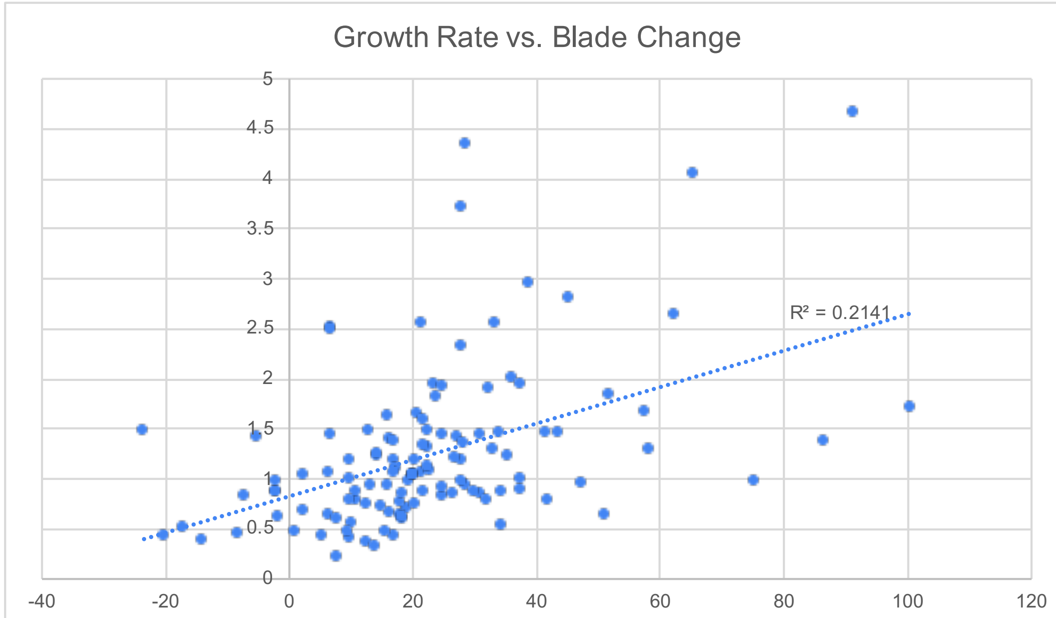
3M	Blade Chang	Growth Rate
	17	1.04545455
	-2	0.86666667
	20	1.02272727
	27	1.20454545
	6.5	0.625
	18.5	0.84090909
	8	0.6
	14	0.32142857
	14.5	1.21428571
	14.5	1.25
	20.5	0.73571429
	11	0.85714286
	7	2.48214286
	38.8	2.95714286
	6.9	1.43928571
	22	1.57142857
	28	3.71428571
	-20	0.42682927
	41.5	1.45121951
	18	0.62195122
	51	0.63414634
	10	0.7804878
	86.5	1.36585366
	32.3	1.9
	32.2	0.77317073
	-2	0.96341463
	34.5	0.51707317
	2.5	1.02380952
	22.5	1.125
	27.25	1.41666667
	20.3	1.02916667
	28.2	1.35208333
	21.9	0.85416667
	18.5	0.60416667
	9.5	0.45833333
	15	0.70833333
	10	1







Blade Change	Growth Rate (cm/day)
7	2.5
-7	0.818181818
34	1.454545455
20	1.031818182
19.5	0.977272727
28.5	0.931818182
17	1.181818182
11	0.785714286
16	1.632142857
23.5	1.928571429
-14	0.378571429
10	1.178571429
-5	1.410714286
33.5	2.542857143
6.4	1.05
24	1.803571429
62.5	2.642857143
28.5	4.339285714
13	1.466666667
22.5	1.3
58.2	1.275609756
52	1.823170732
31	0.848780488
34.5	0.865853659
42	0.773170732
16.5	0.65
65.5	4.048780488
25	0.817073171
75.5	0.968292683
-8	0.43902439
2.5	0.666666667
8	0.208333333
16	0.916666667
28.1	1.183333333
-1.8	0.604166667
10.1	0.545833333
12.5	0.729166667
100.5	1.708333333

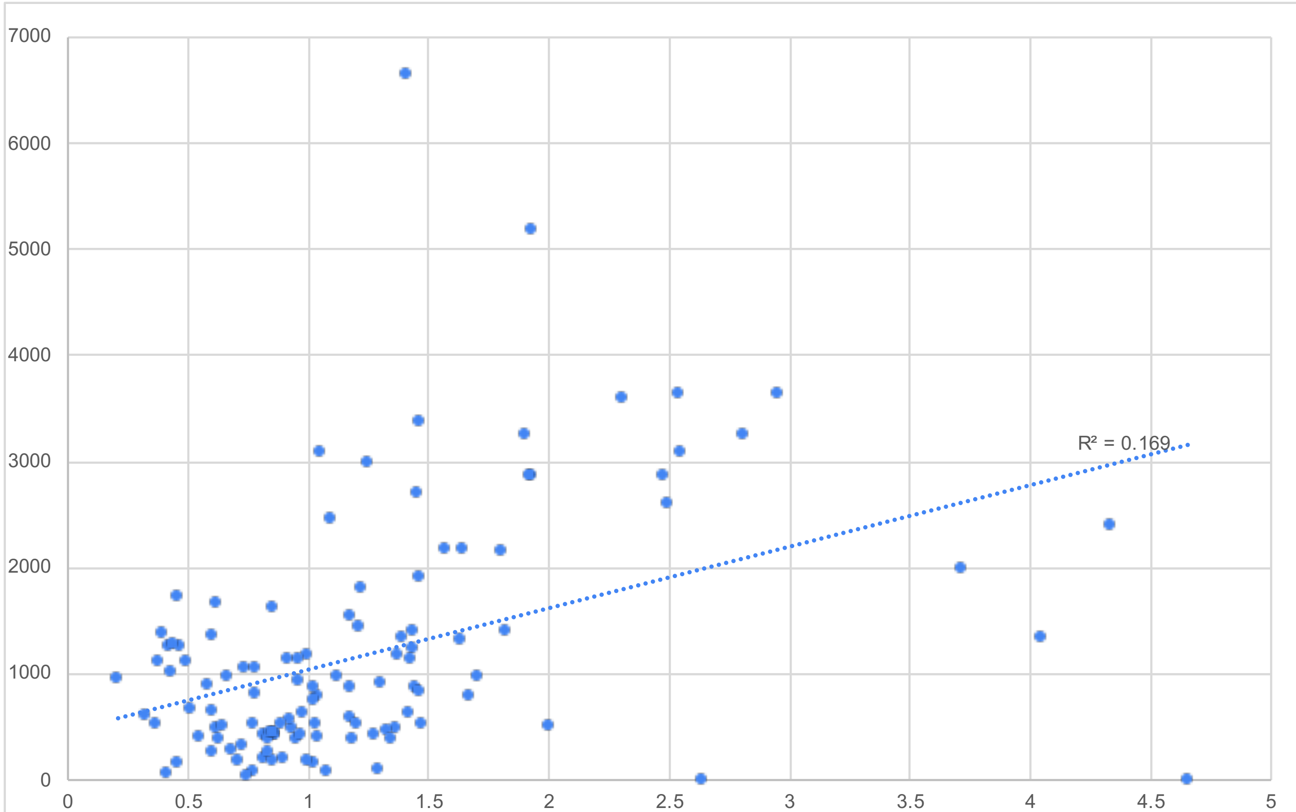


33	1.291666667
17	0.416666667
20.5	1.181818182
-2	0.866666667
17.5	1.1
36	2
21.5	1.045454545
22.5	1.477272727
25	1.433333333
13.5	0.928571429
16.5	1.392857143
-23.5	1.464285714
1	0.464285714
5.5	0.428571429
21.5	2.553571429
28	2.3125
45.5	2.810714286
21	1.642857143
91.5	4.660714286
37.5	1.928571429
28	0.963414634
17	1.375
31	1.428571429
37.5	0.890243902
47.5	0.951219512
57.5	1.670731707
25	1.925
35.5	1.219512195
30	0.853658537
12.5	0.365853659
37.5	1
43.5	1.4625
10	0.395833333
-17	0.5
22	1.327083333
15.6	0.4625
19	0.6875
24.8	0.897083333
26.5	0.833333333

18.5	0.583333333
23	1.083333333
18	0.75
17	1.045454545
-2	0.866666667
20	1.022727273
27	1.204545455
6.5	0.625
18.5	0.840909091
8	0.6
14	0.321428571
14.5	1.214285714
14.5	1.25
20.5	0.735714286
11	0.857142857
7	2.482142857
38.8	2.957142857
6.9	1.439285714
22	1.571428571
28	3.714285714
-20	0.426829268
41.5	1.451219512
18	0.62195122
51	0.634146341
10	0.780487805
86.5	1.365853659
32.3	1.9
32.2	0.773170732
-2	0.963414634
34.5	0.517073171
2.5	1.023809524
22.5	1.125
27.25	1.416666667
20.3	1.029166667
28.2	1.352083333
21.9	0.854166667
18.5	0.604166667
9.5	0.458333333
15	0.708333333

10 1

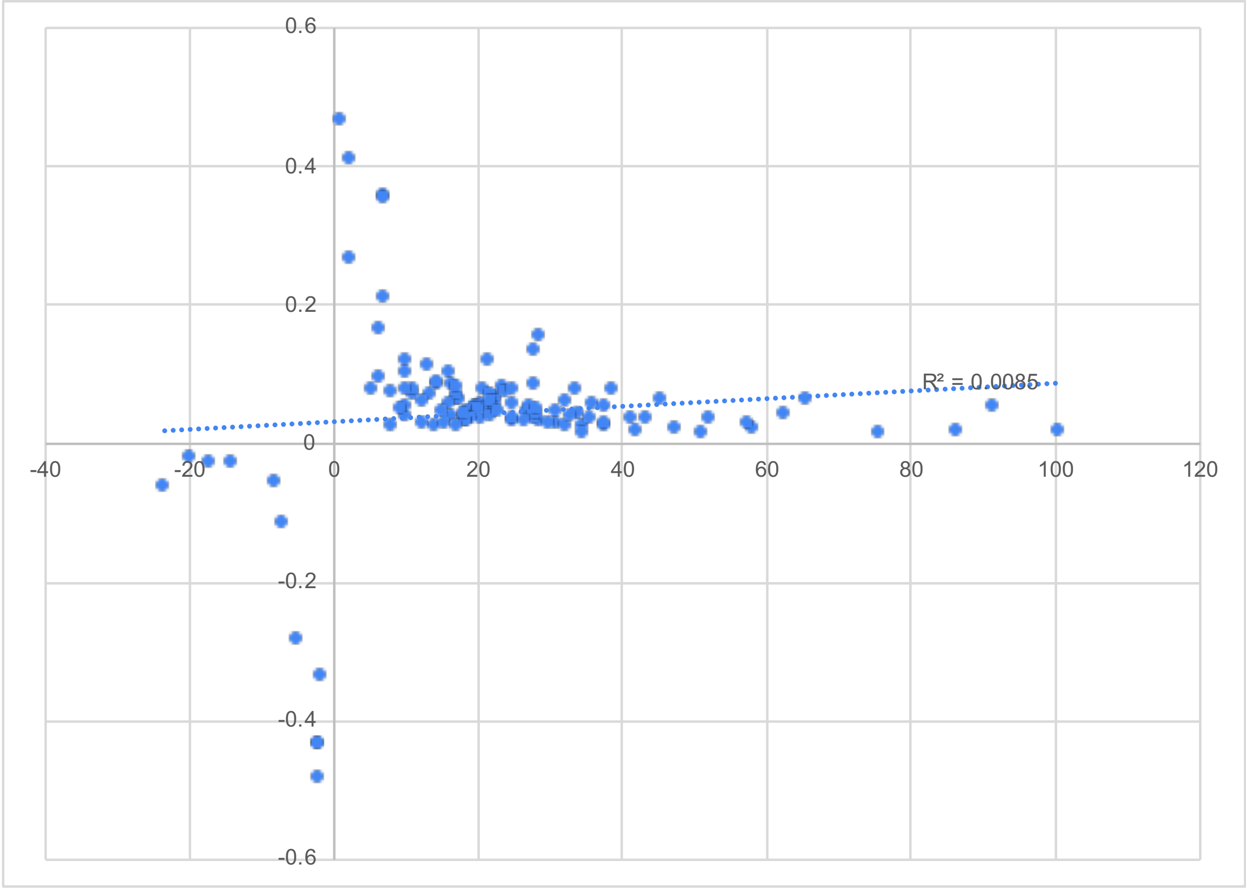
Growth Rate (	Initial Area (cm^2)
2.5	2591.5
1.18181818	585
1.04545455	792
0.81818182	420
0.86666667	420
0.86666667	420
1.45454545	2691
1.1	2445.5
1.02272727	736
1.03181818	516
2	492
1.20454545	525
0.97727273	619.75
1.04545455	392
0.625	469
0.93181818	473
1.47727273	525
0.84090909	374
1.18181818	867
1.43333333	1403
0.6	1344
0.78571429	800
0.92857143	553
0.32142857	598
1.63214286	1311.5
1.39285714	1326
1.21428571	1426
1.92857143	2865.25
1.46428571	3361.5
1.25	2972.5
0.37857143	1104
0.46428571	1250
0.73571429	1056
1.17857143	1537
0.42857143	1008
0.85714286	1624.5
1.41071429	6640
2.54285714	3627
1.05	3080.25
1.80357143	2156
2.64285714	0
4.33928571	2401
2.55357143	3078
2.3125	3599
2.81071429	3249
1.64285714	2160



4.66071429	0
1.92857143	5184
2.48214286	2860
2.95714286	3638.7
1.43928571	1225
1.57142857	2160
3.71428571	1992
1.46666667	1898
1.3	902.5
1.27560976	413.4
1.82317073	1404
0.84878049	448
0.86585366	442
0.96341463	920
1.375	1176
1.42857143	1121.1
0.8902439	510
0.95121951	377
0.42682927	1254
1.45121951	871.2
0.62195122	1664
0.63414634	368.75
0.7804878	1050
0.77317073	528
0.65	496
4.04878049	1336.5
0.81707317	202.5
0.96829268	416
0.43902439	1276
1.67073171	780
1.925	2850.75
1.2195122	1811.25
0.85365854	435
0.36585366	512
1	1175
1.36585366	484.5
1.9	3236.15
0.77317073	70.84
0.96341463	1121
0.51707317	658
1.02380952	873
0.66666667	966
1.4625	820
0.20833333	952
0.39583333	1370.6
0.91666667	1128
0.5	1113

1.125	957
1.32708333	454.25
1.41666667	627
1.18333333	370.76
0.4625	159.08
1.02916667	151.69
0.60416667	632.73
0.6875	280.5
1.35208333	377.3
0.54583333	393.24
0.89708333	192.5
0.85416667	179.3
0.72916667	318.75
0.83333333	247.5
0.60416667	255.5
1.70833333	971.5
0.58333333	890
0.45833333	1728
1.29166667	99
1.08333333	77.5
0.70833333	164.5
0.41666667	57.5
0.75	39
1	180

Blade Change	Relative Growth Rate
7	0.35714286
20.5	0.05764967
17	0.06149733
-7	-0.1168831
-2	-0.4333333
-2	-0.4333333
34	0.04278075
17.5	0.06285714
20	0.05113636
20	0.05159091
36	0.05555556
27	0.04461279
19.5	0.05011655
21.5	0.04862579
6.5	0.09615385
28.5	0.03269537
22.5	0.06565657
18.5	0.04545455
17	0.06951872
25	0.05733333
8	0.075
11	0.07142857
13.5	0.06878307
14	0.02295918
16	0.10200893
16.5	0.08441558
14.5	0.08374384
23.5	0.08206687
-23.5	-0.06231
14.5	0.0862069
-14	-0.0270408
1	0.46428571
20.5	0.0358885

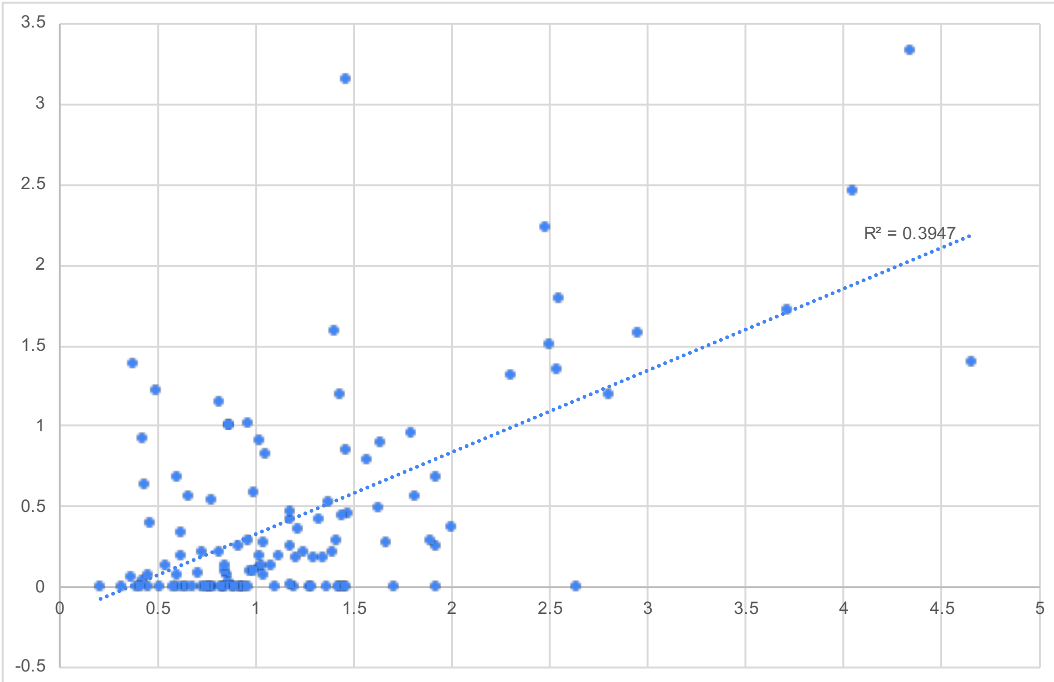


10	0.11785714
5.5	0.07792208
11	0.07792208
-5	-0.2821429
33.5	0.07590618
6.4	0.1640625
24	0.07514881
62.5	0.04228571
28.5	0.15225564
21.5	0.11877076
28	0.08258929
45.5	0.06177394
21	0.07823129
91.5	0.05093677
37.5	0.05142857
7	0.35459184
38.8	0.07621502
6.9	0.20859213
22	0.07142857
28	0.13265306
13	0.11282051
22.5	0.05777778
58.2	0.02191769
52	0.03506098
31	0.02738002
34.5	0.02509721
28	0.03440767
17	0.08088235
31	0.04608295
37.5	0.02373984
47.5	0.02002567
-20	-0.0213415
41.5	0.03496914
18	0.03455285

51	0.01243424
10	0.07804878
42	0.01840883
16.5	0.03939394
65.5	0.06181344
25	0.03268293
75.5	0.01282507
-8	-0.054878
57.5	0.0290562
25	0.077
35.5	0.03435246
30	0.02845528
12.5	0.02926829
37.5	0.02666667
86.5	0.01579022
32.3	0.05882353
32.2	0.02401151
-2	-0.4817073
34.5	0.01498763
2.5	0.40952381
2.5	0.26666667
43.5	0.03362069
8	0.02604167
10	0.03958333
16	0.05729167
-17	-0.0294118
22.5	0.05
22	0.06032197
27.25	0.05198777
28.1	0.04211151
15.6	0.02964744
20.3	0.05069787
-1.8	-0.3356481
19	0.03618421

28.2	0.04794622
10.1	0.0540429
24.8	0.03617272
21.9	0.03900304
12.5	0.05833333
26.5	0.03144654
18.5	0.03265766
100.5	0.01699834
18.5	0.03153153
9.5	0.04824561
33	0.03914141
23	0.04710145
15	0.04722222
17	0.0245098
18	0.04166667
10	0.1

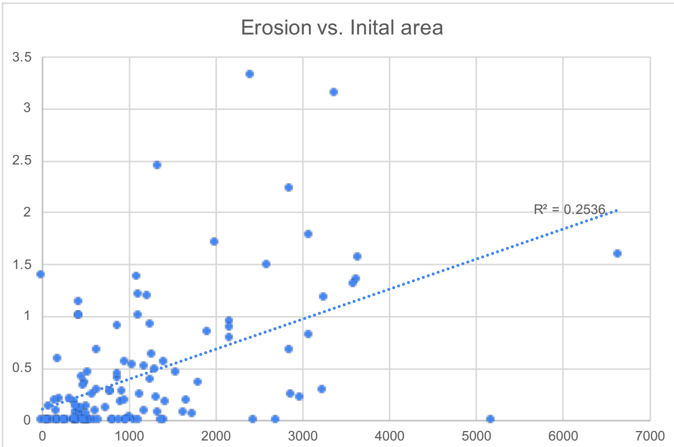
Growth Rate (cm/day)	Erosion Rate (cm/day)
2.5	1.5
1.181818182	0.25
1.045454545	0.27272727
0.818181818	1.13636364
0.866666667	1
0.866666667	1
1.454545455	0
1.1	0
1.022727273	0.11363636
1.031818182	0.12272727
2	0.36363636
1.204545455	0
0.977272727	0.09090909
1.045454545	0.06818182
0.625	0.32954545
0.931818182	0
1.477272727	0.45454545
0.840909091	0
1.181818182	0.40909091
1.433333333	0
0.6	0.06666667
0.785714286	0
0.928571429	0
0.321428571	0
1.632142857	0.48928571
1.392857143	0.21428571
1.214285714	0.17857143
1.928571429	0.25
1.464285714	3.14285714
1.25	0.21428571
0.378571429	1.37857143
0.464285714	0.39285714
0.735714286	0
1.178571429	0.46428571
0.428571429	0.03571429
0.857142857	0.07142857
1.410714286	1.58928571
2.542857143	1.34642857
1.05	0.82142857
1.803571429	0.94642857
2.642857143	0
4.339285714	3.32142857
2.553571429	1.78571429
2.3125	1.3125
2.810714286	1.18571429
1.642857143	0.89285714
4.660714286	1.39285714
1.928571429	0
2.482142857	2.23214286
2.957142857	1.57142857
1.439285714	1.19285714
1.571428571	0.78571429



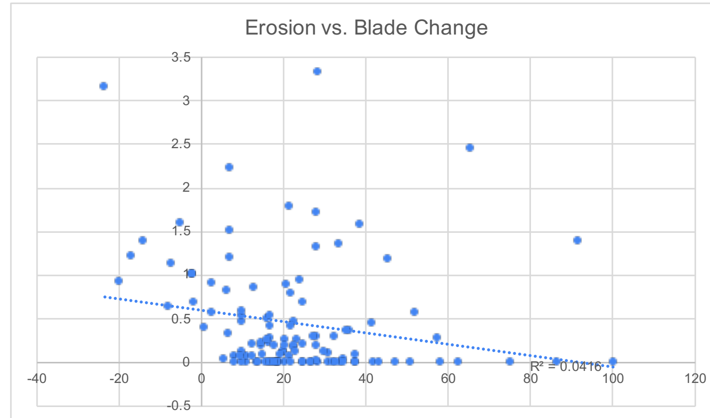
3.714285714	1.71428571
1.466666667	0.84761905
1.3	0.175
1.275609756	0
1.823170732	0.55487805
0.848780488	0.09268293
0.865853659	0.02439024
0.963414634	0.2804878
1.375	0.525
1.428571429	0
0.890243902	0
0.951219512	0
0.426829268	0.91463415
1.451219512	0.43902439
0.62195122	0.18292683
0.634146341	0
0.780487805	0.53658537
0.773170732	0
0.65	0
4.048780488	2.45121951
0.817073171	0.20731707
0.968292683	0
0.43902439	0.63414634
1.670731707	0.26829268
1.925	0.675
1.219512195	0.35365854
0.853658537	0.12195122
0.365853659	0.06097561
1	0.08536585
1.365853659	0
1.9	0.285
0.773170732	0
0.963414634	1.01219512
0.517073171	0
1.023809524	0.9047619
0.666666667	0.5625
1.4625	0
0.208333333	0
0.395833333	0
0.916666667	0.25
0.5	1.20833333
1.125	0.1875
1.327083333	0.41041667
1.416666667	0.28125
1.183333333	0.0125
0.4625	0
1.029166667	0.18333333
0.604166667	0.67916667
0.6875	0
1.352083333	0.17708333
0.545833333	0.125
0.897083333	0
0.854166667	0

0.729166667	0.20833333
0.833333333	0
0.604166667	0
1.708333333	0
0.583333333	0
0.458333333	0.0625
1.291666667	0
1.083333333	0.125
0.708333333	0.08333333
0.416666667	0
0.75	0
1	0.58333333

Initial Area (cr	Erosion Rate (cm/day)
2591.5	1.5
585	0.25
792	0.27272727
420	1.13636364
420	1
420	1
2691	0
2445.5	0
736	0.11363636
516	0.12272727
492	0.36363636
525	0
619.75	0.09090909
392	0.06818182
469	0.32954545
473	0
525	0.45454545
374	0
867	0.40909091
1403	0
1344	0.06666667
800	0
553	0
598	0
1311.5	0.48928571
1326	0.21428571
1426	0.17857143
2865.25	0.25
3361.5	3.14285714
2972.5	0.21428571
1104	1.37857143
1250	0.39285714
1056	0
1537	0.46428571
1008	0.03571429
1624.5	0.07142857
6640	1.58928571
3627	1.34642857
3080.25	0.82142857
2156	0.94642857
0	0
2401	3.32142857
3078	1.78571429
3599	1.3125
3249	1.18571429
2160	0.89285714
0	1.39285714
5184	0
2860	2.23214286
3638.7	1.57142857
1225	1.19285714
2160	0.78571429
1992	1.71428571
1898	0.84761905
902.5	0.175



Blade Change	Erosion Rate (cm/day)
7	1.5
20.5	0.25
17	0.27272727
-7	1.13636364
-2	1
-2	1
34	0
17.5	0
20	0.11363636
20	0.12272727
36	0.36363636
27	0
19.5	0.09090909
21.5	0.06818182
6.5	0.32954545
28.5	0
22.5	0.45454545
18.5	0
17	0.40909091
25	0
8	0.06666667
11	0
13.5	0
14	0
16	0.48928571
16.5	0.21428571
14.5	0.17857143
23.5	0.25
-23.5	3.14285714
14.5	0.21428571
-14	1.37857143
1	0.39285714
20.5	0
10	0.46428571
5.5	0.03571429
11	0.07142857
-5	1.58928571
33.5	1.34642857
6.4	0.82142857
24	0.94642857
62.5	0
28.5	3.32142857
21.5	1.78571429
28	1.3125
45.5	1.18571429
21	0.89285714
91.5	1.39285714
37.5	0
7	2.23214286
38.8	1.57142857
6.9	1.19285714
22	0.78571429
28	1.71428571
13	0.84761905
22.5	0.175



413.4	0	58.2	0
1404	0.55487805	52	0.55487805
448	0.09268293	31	0.09268293
442	0.02439024	34.5	0.02439024
920	0.2804878	28	0.2804878
1176	0.525	17	0.525
1121.1	0	31	0
510	0	37.5	0
377	0	47.5	0
1254	0.91463415	-20	0.91463415
871.2	0.43902439	41.5	0.43902439
1664	0.18292683	18	0.18292683
368.75	0	51	0
1050	0.53658537	10	0.53658537
528	0	42	0
496	0	16.5	0
1336.5	2.45121951	65.5	2.45121951
202.5	0.20731707	25	0.20731707
416	0	75.5	0
1276	0.63414634	-8	0.63414634
780	0.26829268	57.5	0.26829268
2850.75	0.675	25	0.675
1811.25	0.35365854	35.5	0.35365854
435	0.12195122	30	0.12195122
512	0.06097561	12.5	0.06097561
1175	0.08536585	37.5	0.08536585
484.5	0	86.5	0
3236.15	0.285	32.3	0.285
70.84	0	32.2	0
1121	1.01219512	-2	1.01219512
658	0	34.5	0
873	0.9047619	2.5	0.9047619
966	0.5625	2.5	0.5625
820	0	43.5	0
952	0	8	0
1370.6	0	10	0
1128	0.25	16	0.25
1113	1.20833333	-17	1.20833333
957	0.1875	22.5	0.1875
454.25	0.41041667	22	0.41041667
627	0.28125	27.25	0.28125
370.76	0.0125	28.1	0.0125
159.08	0	15.6	0
151.69	0.18333333	20.3	0.18333333
632.73	0.67916667	-1.8	0.67916667
280.5	0	19	0
377.3	0.17708333	28.2	0.17708333
393.24	0.125	10.1	0.125
192.5	0	24.8	0
179.3	0	21.9	0
318.75	0.20833333	12.5	0.20833333
247.5	0	26.5	0
255.5	0	18.5	0
971.5	0	100.5	0
890	0	18.5	0
1728	0.0625	9.5	0.0625

99	0
77.5	0.125
164.5	0.08333333
57.5	0
39	0
180	0.58333333

33	0
23	0.125
15	0.08333333
17	0
18	0
10	0.58333333

GR	ER	RGR
2.5	1.5	0.35714286
1.1818182	0.25	0.05764967
1.0454545	0.27272727	0.06149733
0.8181818	1.13636364	-0.1168831
0.8666667	1	-0.4333333
0.8666667	1	-0.4333333
1.4545455	0	0.04278075
1.1	0	0.06285714
1.0227273	0.11363636	0.05113636
1.0318182	0.12272727	0.05159091
2	0.36363636	0.05555556
1.2045455	0	0.04461279
0.9772727	0.09090909	0.05011655
1.0454545	0.06818182	0.04862579
0.625	0.32954545	0.09615385
0.9318182	0	0.03269537
1.4772727	0.45454545	0.06565657
0.8409091	0	0.04545455
1.1818182	0.40909091	0.06951872
1.4333333	0	0.05733333
0.6	0.06666667	0.075
0.7857143	0	0.07142857
0.9285714	0	0.06878307
0.3214286	0	0.02295918
1.6321429	0.48928571	0.10200893
1.3928571	0.21428571	0.08441558
1.2142857	0.17857143	0.08374384
1.9285714	0.25	0.08206687
1.4642857	3.14285714	-0.06231
1.25	0.21428571	0.0862069
0.3785714	1.37857143	-0.0270408
0.4642857	0.39285714	0.46428571
0.7357143	0	0.0358885
1.1785714	0.46428571	0.11785714
0.4285714	0.03571429	0.07792208
0.8571429	0.07142857	0.07792208
1.4107143	1.58928571	-0.2821429
2.5428571	1.34642857	0.07590618
1.05	0.82142857	0.1640625
1.8035714	0.94642857	0.07514881
2.6428571	0	0.04228571
4.3392857	3.32142857	0.15225564
2.5535714	1.78571429	0.11877076
2.3125	1.3125	0.08258929
2.8107143	1.18571429	0.06177394
1.6428571	0.89285714	0.07823129
4.6607143	1.39285714	0.05093677
1.9285714	0	0.05142857
2.4821429	2.23214286	0.35459184
2.9571429	1.57142857	0.07621502
1.4392857	1.19285714	0.20859213
1.5714286	0.78571429	0.07142857
3.7142857	1.71428571	0.13265306
1.4666667	0.84761905	0.11282051
1.3	0.175	0.05777778
1.2756098	0	0.02191769
1.8231707	0.55487805	0.03506098
0.8487805	0.09268293	0.02738002
0.8658537	0.02439024	0.02509721
0.9634146	0.2804878	0.03440767
1.375	0.525	0.08088235
1.4285714	0	0.04608295
0.8902439	0	0.02373984
0.9512195	0	0.02002567
1.195122	10.6829268	-0.0030723
0.4268293	0.91463415	-0.0213415
1.4512195	0.43902439	0.03496914
0.6219512	0.18292683	0.03455285
0.6341463	0	0.01243424
0.7804878	0.53658537	0.07804878
0.7731707	0	0.01840883
0.65	0	0.03939394
4.0487805	2.45121951	0.06181344
0.8170732	0.20731707	0.03268293
0.9682927	0	0.01282507
0.4390244	0.63414634	-0.054878
1.6707317	0.26829268	0.0290562

cm/day		cm/day		cm/day/cm^2	
GR		*ER*		*RGR*	
Mean	1.24069893	Mean	0.53861752	Mean	0.044195473
Standard Erro	0.07309529	Standard Erroi	0.10497489	Standard Error	0.011174389
Median	1.03049242	Median	0.18541667	Median	0.04758422
Mode	1.18181818	Mode	0	Mode	-0.433333333
Standard Dev	0.79401811	Standard Devi	1.14031922	Standard Deviation	0.121384934
Sample Varia	0.63046476	Sample Varian	1.30032792	Sample Variance	0.014734302
Kurtosis	5.30242503	Kurtosis	54.02385	Kurtosis	8.739861933
Skewness	2.05059055	Skewness	6.43527197	Skewness	-1.242206182
Range	4.45238095	Range	10.6829268	Range	0.945993031
Minimum	0.20833333	Minimum	0	Minimum	-0.481707317
Maximum	4.66071429	Maximum	10.6829268	Maximum	0.464285714
Sum	146.402473	Sum	63.5568674	Sum	5.215065834
Count	118	Count	118	Count	118

	Growth Rate	*Erosion Rate*	*Relative Growth Rate*

	Growth Rate (cm/day)	*Erosion Rate (cm/day)*	*Relative Growth Rate (cm/day/cm^2*
Mean	1.24	0.54	0.04
Standard Dev	0.79	1.14	0.12
Minimum	0.21	0.00	-0.48
Maximum	4.66	10.68	0.46
Sum	146.4024735	63.55686741	5.215065834

1.925	0.675	0.077
1.2195122	0.35365854	0.03435246
0.8536585	0.12195122	0.02845528
0.3658537	0.06097561	0.02926829
1	0.08536585	0.02666667
1.3658537	0	0.01579022
1.9	0.285	0.05882353
0.7731707	0	0.02401151
0.9634146	1.01219512	-0.4817073
0.5170732	0	0.01498763
1.0238095	0.9047619	0.40952381
0.6666667	0.5625	0.26666667
1.4625	0	0.03362069
0.2083333	0	0.02604167
0.3958333	0	0.03958333
0.9166667	0.25	0.05729167
0.5	1.20833333	-0.0294118
1.125	0.1875	0.05
1.3270833	0.41041667	0.06032197
1.4166667	0.28125	0.05198777
1.1833333	0.0125	0.04211151
0.4625	0	0.02964744
1.0291667	0.18333333	0.05069787
0.6041667	0.67916667	-0.3356481
0.6875	0	0.03618421
1.3520833	0.17708333	0.04794622
0.5458333	0.125	0.0540429
0.8970833	0	0.03617272
0.8541667	0	0.03900304
0.7291667	0.20833333	0.05833333
0.8333333	0	0.03144654
0.6041667	0	0.03265766
1.7083333	0	0.01699834
0.5833333	0	0.03153153
0.4583333	0.0625	0.04824561
1.2916667	0	0.03914141
1.0833333	0.125	0.04710145
0.7083333	0.08333333	0.04722222
0.4166667	0	0.0245098
0.75	0	0.04166667
1	0.58333333	0.1