QUANTIFYING VEGETATION RECOVERY ON SANTA ROSA ISLAND

Elizabeth Rentschlar

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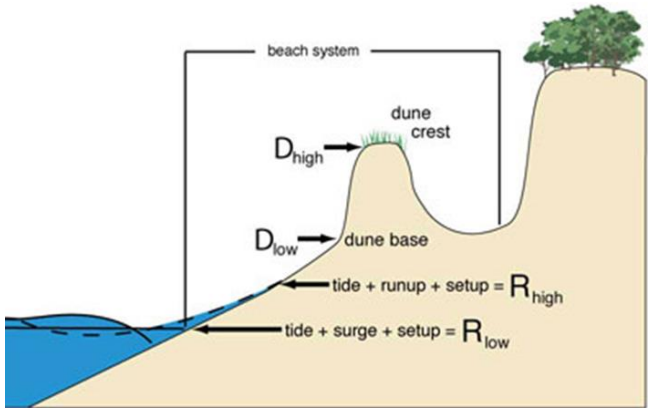
Introduction

- Impact of a hurricane depends on the height and extent of dunes
- Dune development is dependent on vegetation recovery since last storm
- Island resiliency depends on the re-establishment of vegetation and the rate of regrowth
- Vegetation recovery rates are not well understood in barrier island environments

Storm Response

- Collision Regime
  - Scarping of beach and dune
  - Transfers sand offshore
  - Burial or removal of the vegetation
- Overwash and breaching of dune
  - Transfers sand to the back barrier
  - Burial and loss of vegetation



Vegetation Recovery

- Recovery Mechanisms:
  - Reemergence of buried plants
  - Roots and Rhizomes
  - Seed banks
  - Colonization from other parts of the island
- Previous Studies of barrier island vegetation recovery
  - Miller et al. (2010)

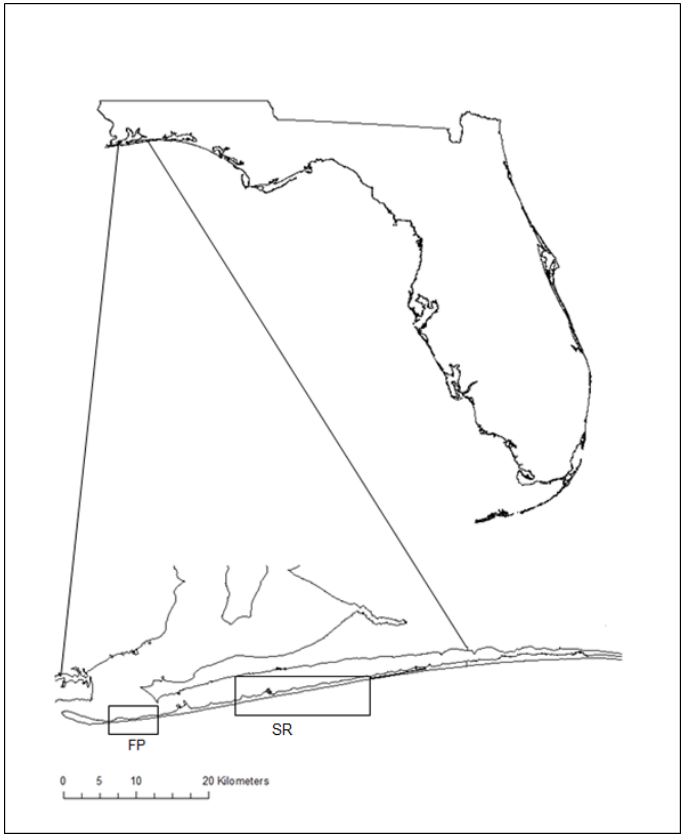
    Used vegetation census, happened to have a hurricane during the study period
  - Snyder and Boss (2002)

    Proxy island used to measure pre-storm vegetation

Santa Rosa Island

- Located in the Florida panhandle

- Hurricane Opal (4) – 10/1995
- Hurricane Danny (1) – 07/1997
- Hurricane Georges (4) – 09/1998
- Hurricane Ivan (5) – 09/2004
- Hurricane Dennis (4) – 07/2005



Pre-Ivan (May 2004)

Collision-Overwash

Overwash-
Breaching

Collision-Overwash

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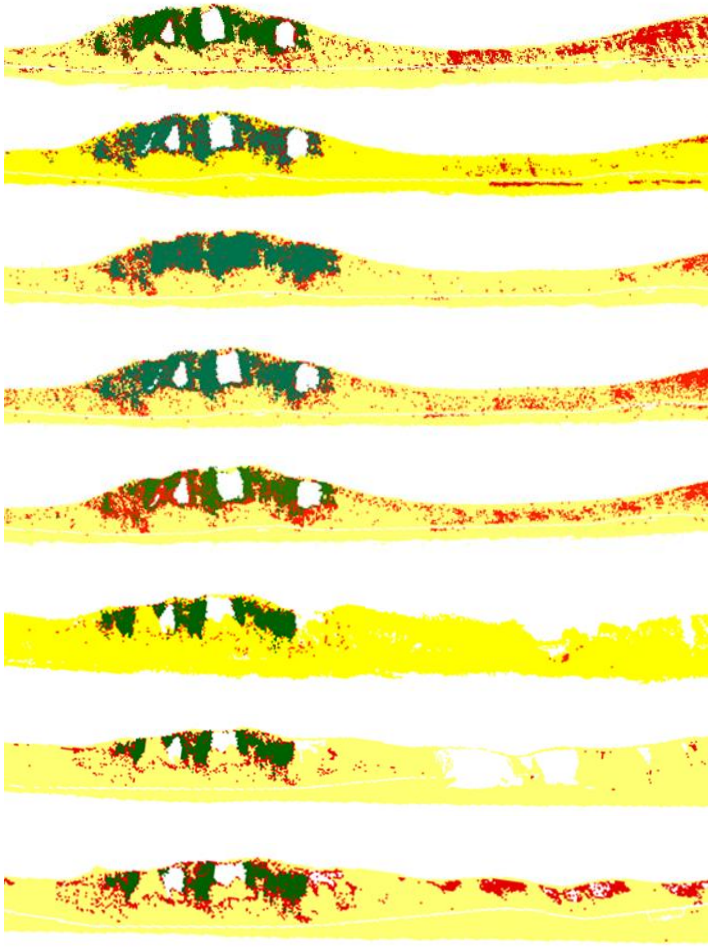
Research Questions

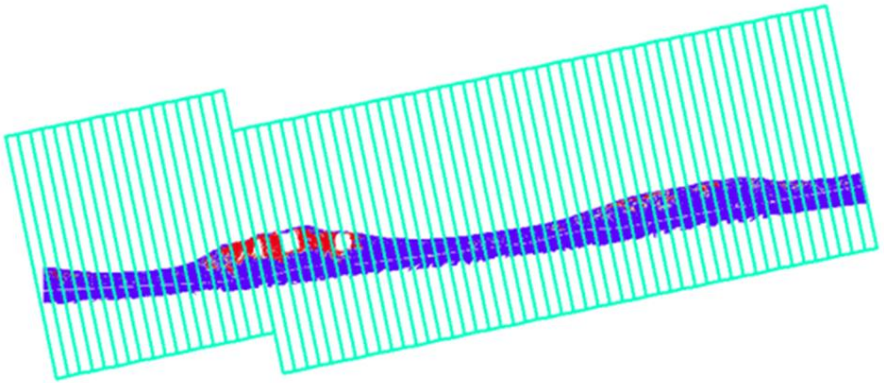
- What is the rate of dune vegetation recovery?
- How does it vary spatially along the island?

Methodology

- Run ISODATA Classification on 1994, 1997, 1999, 2000, 2004, 2005, 2007, and 2010 images
- Perform accuracy assessments
- Convert rasters into polygons
- Measure area of sand, trees, and non tree vegetation in each transect
- Model Vegetation Change with the Verhulst Model
- Perform Spectral analysis to determine frequency of repeated vegetation growth patterns

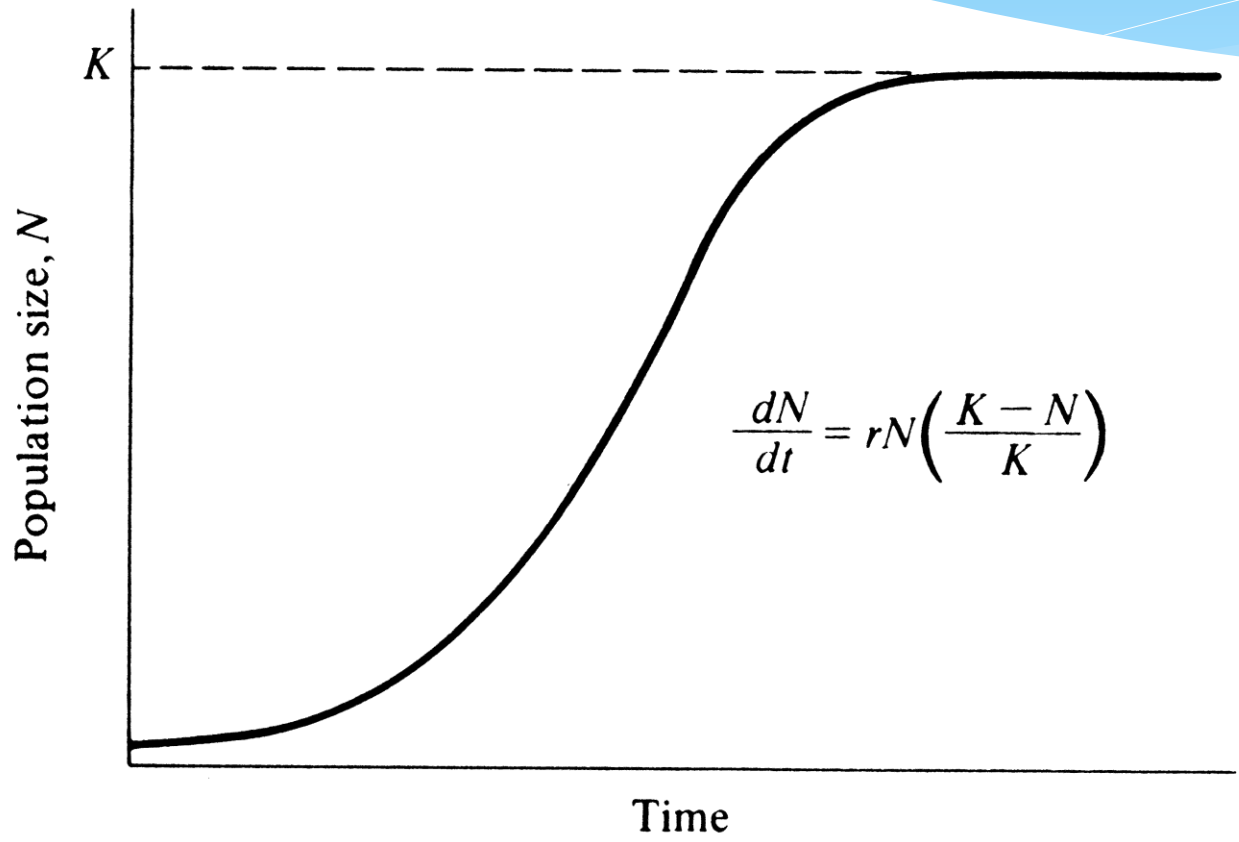
Methodology: Classification and Segmentation





- Transects are each 100m wide and 2km long.
- Polyline → COGO tool

Verhulst Model (1838)



r: population growth rate

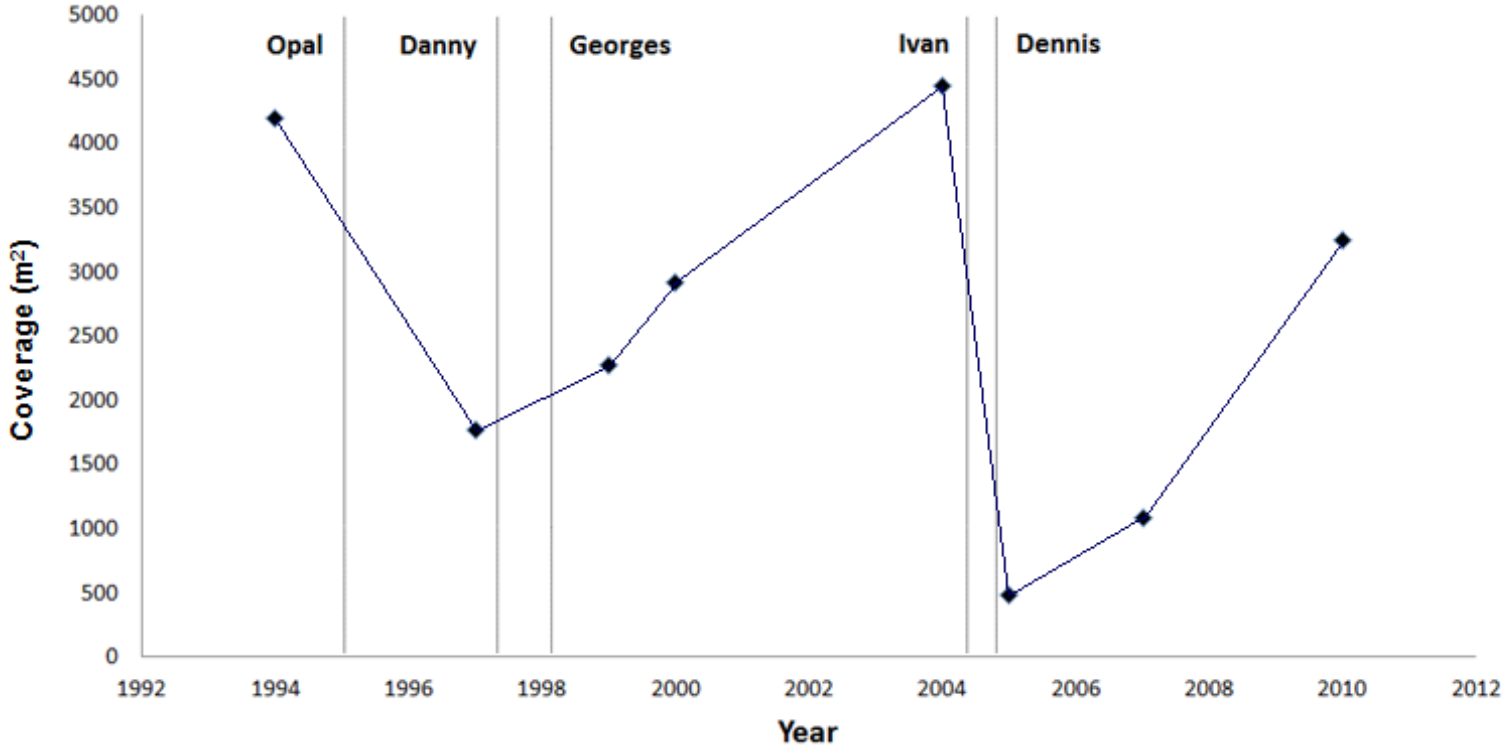
N: time 0

K: area that is available for plant growth

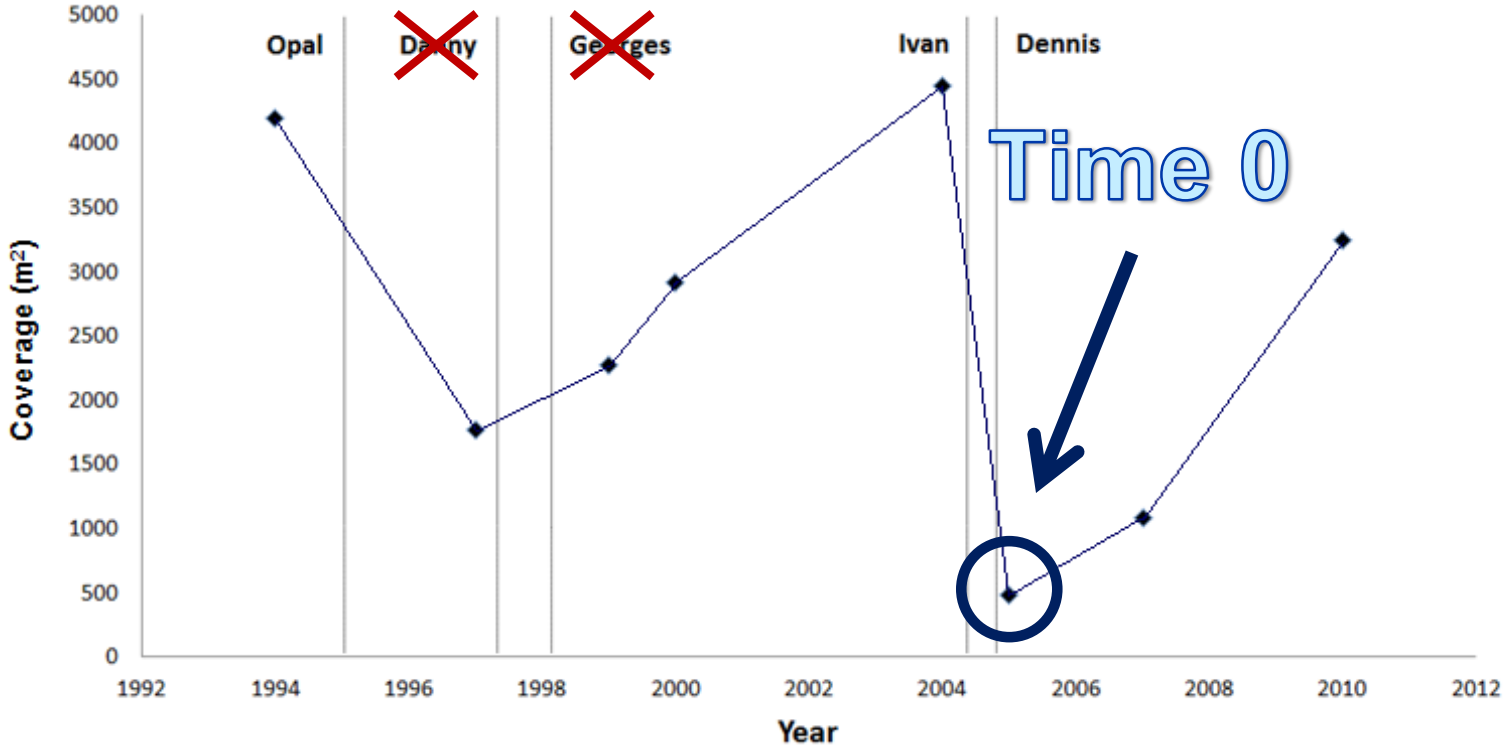
- pre-storm vegetation
- different percentages of the land mass

Fort Pickens

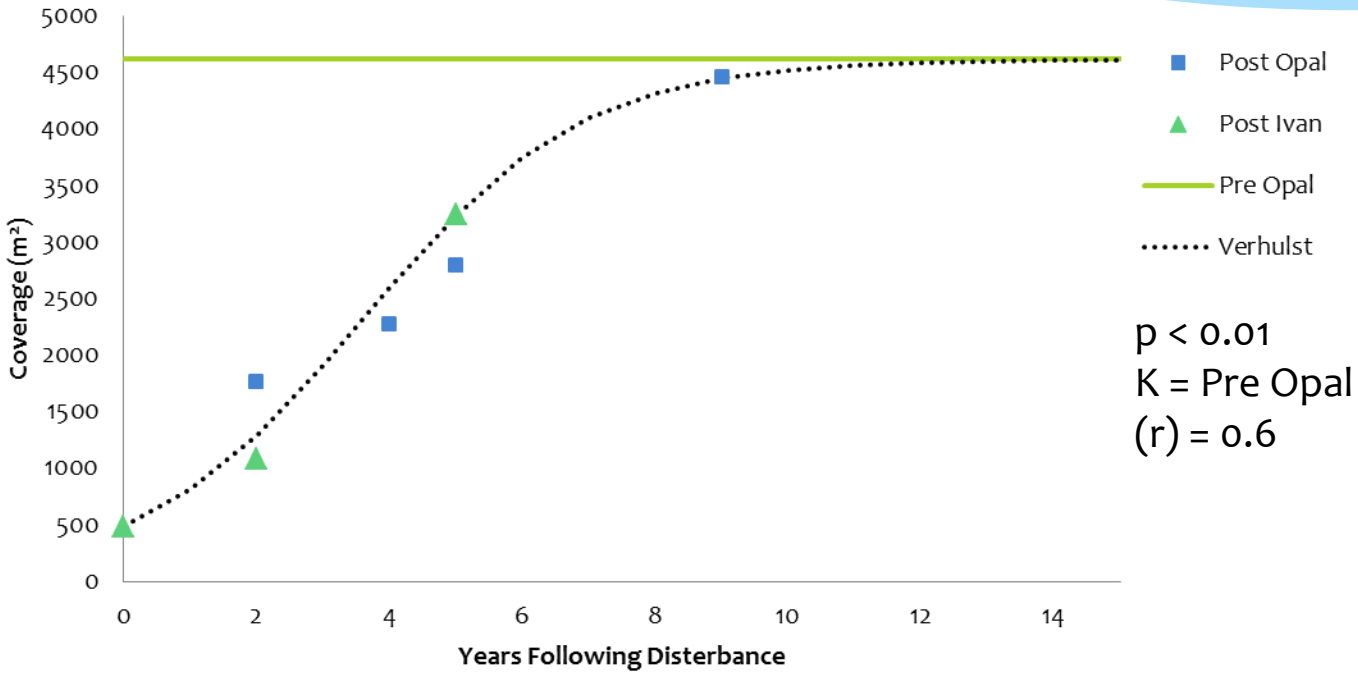
Average Vegetation Area FP



Average Vegetation Area FP

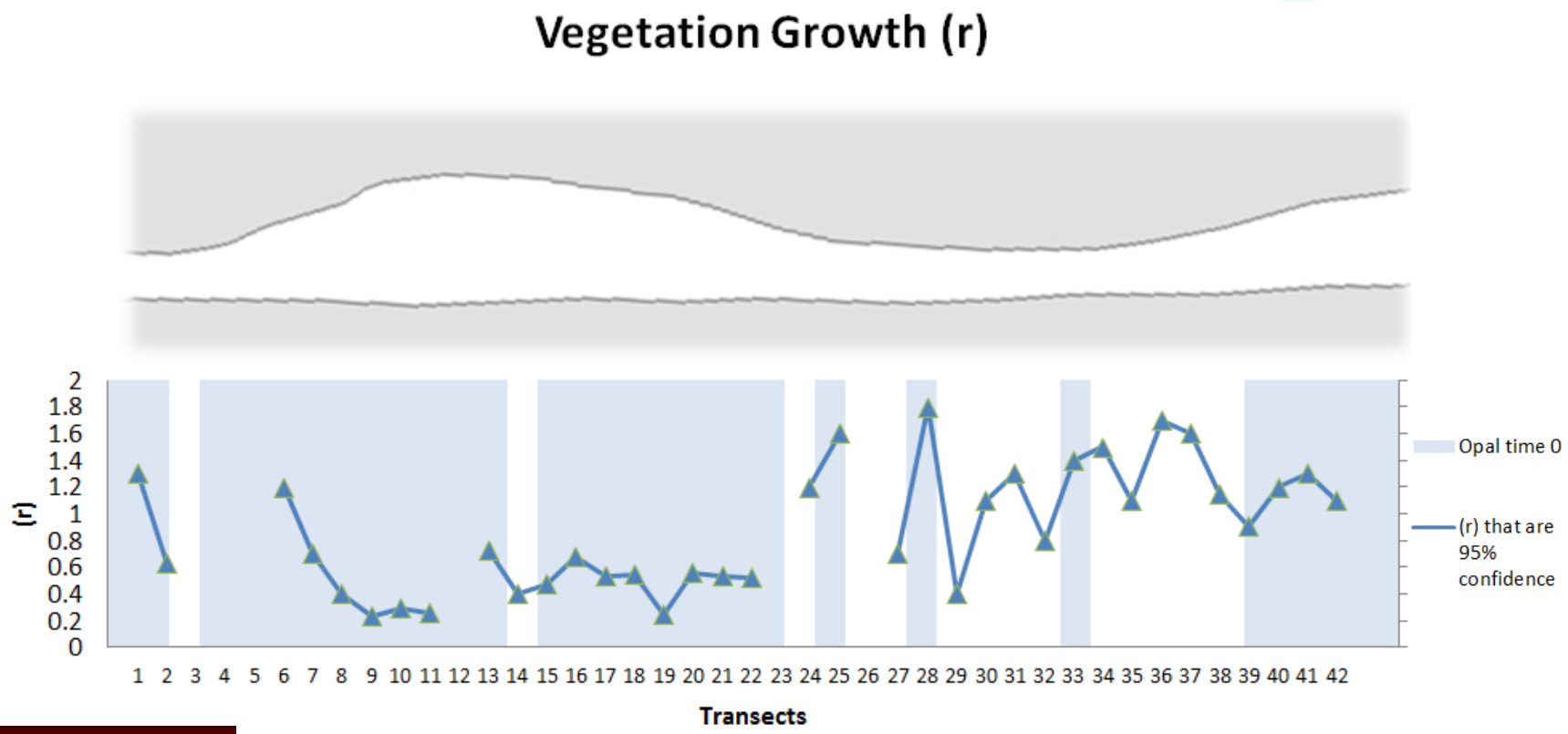


Average Vegetation Recovery FP



$p < 0.01$
K = Pre Opal
(r) = 0.6

Spatial Distribution of Vegetation Growth Rate FP



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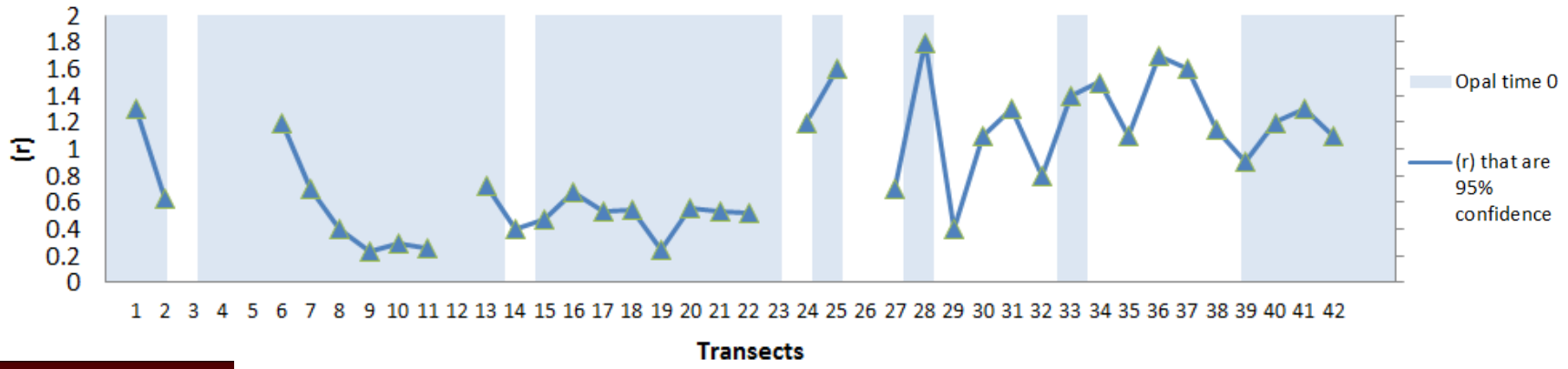
Spatial Distribution of Vegetation Growth Rate FP

Vegetation Growth



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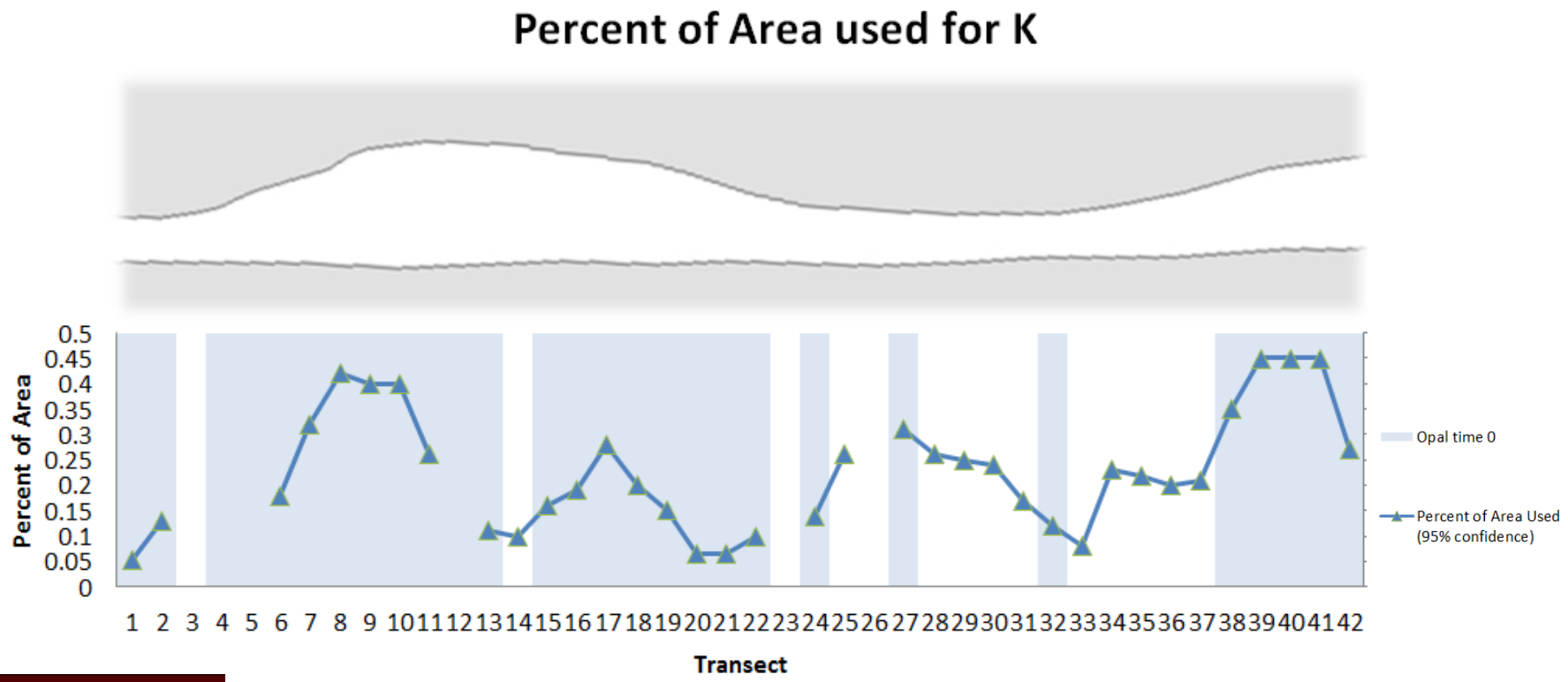
Spatial Distribution of K at FP



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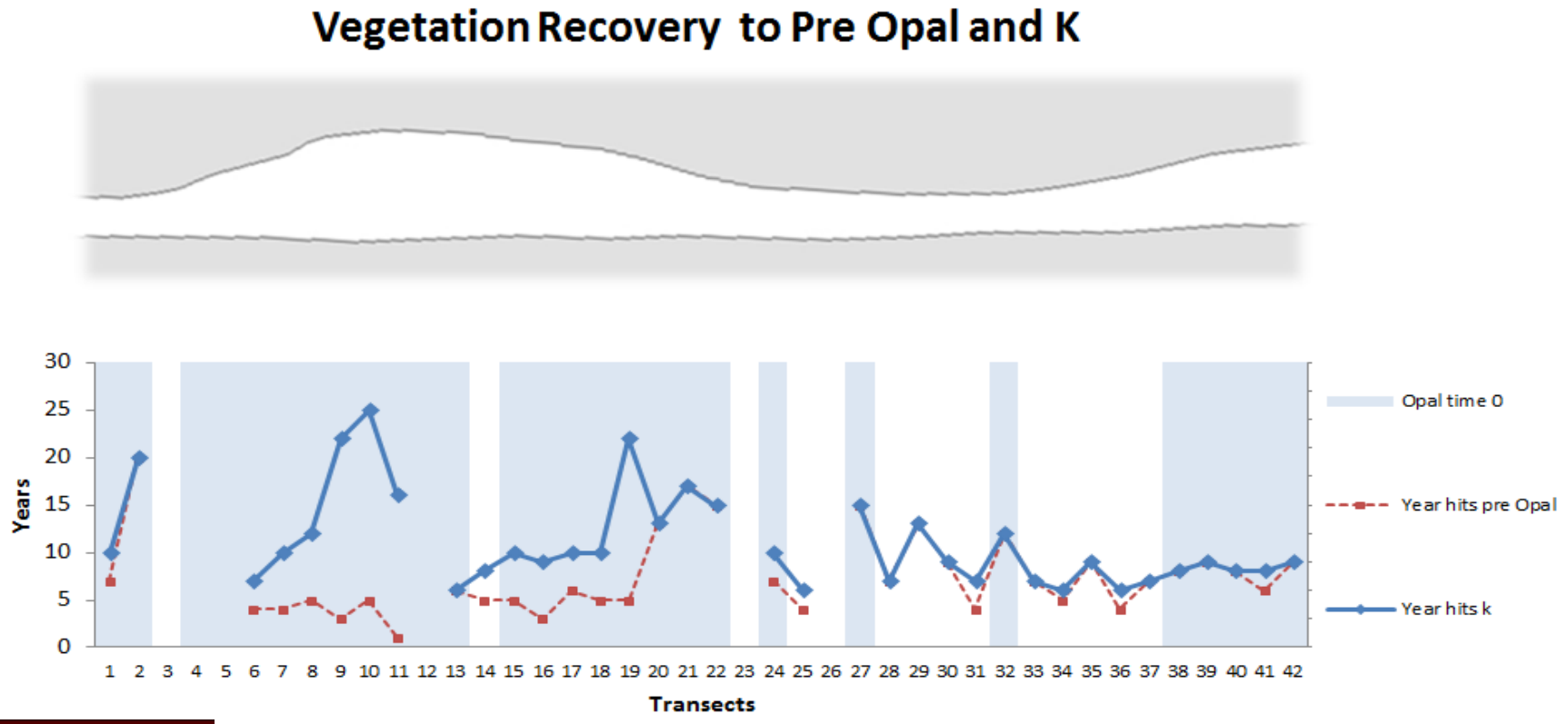
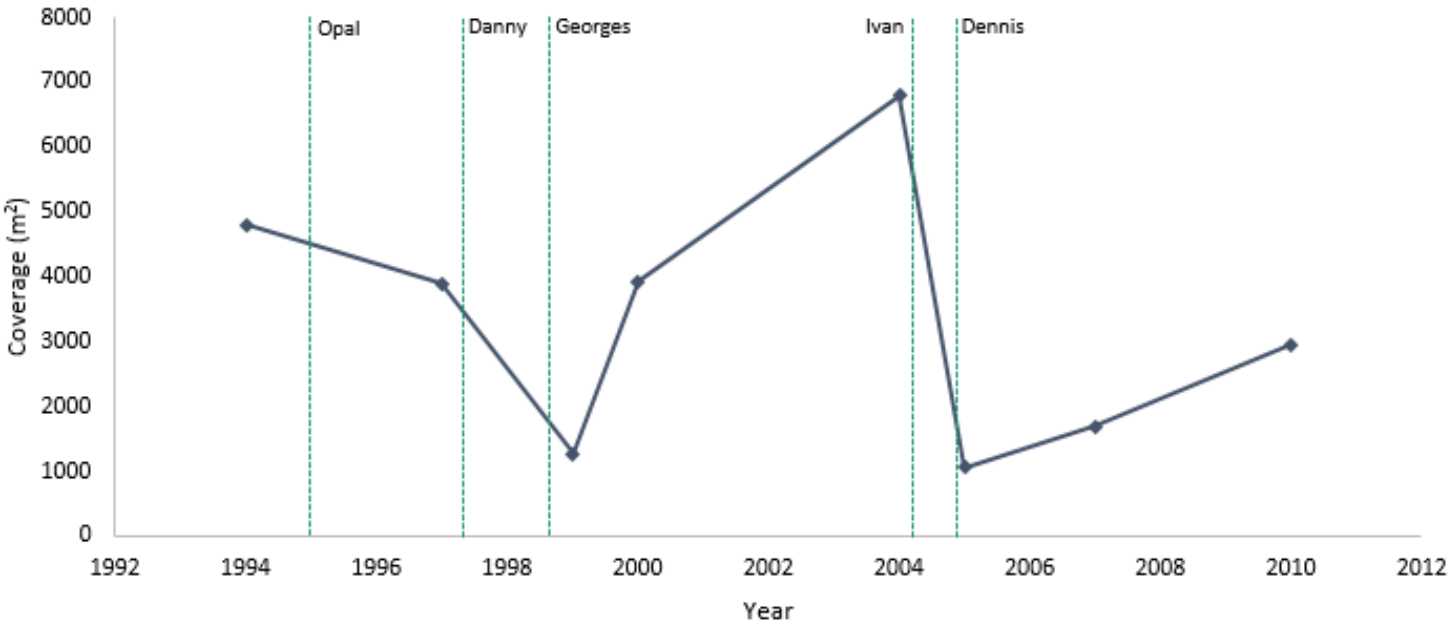
Recovery time along FP

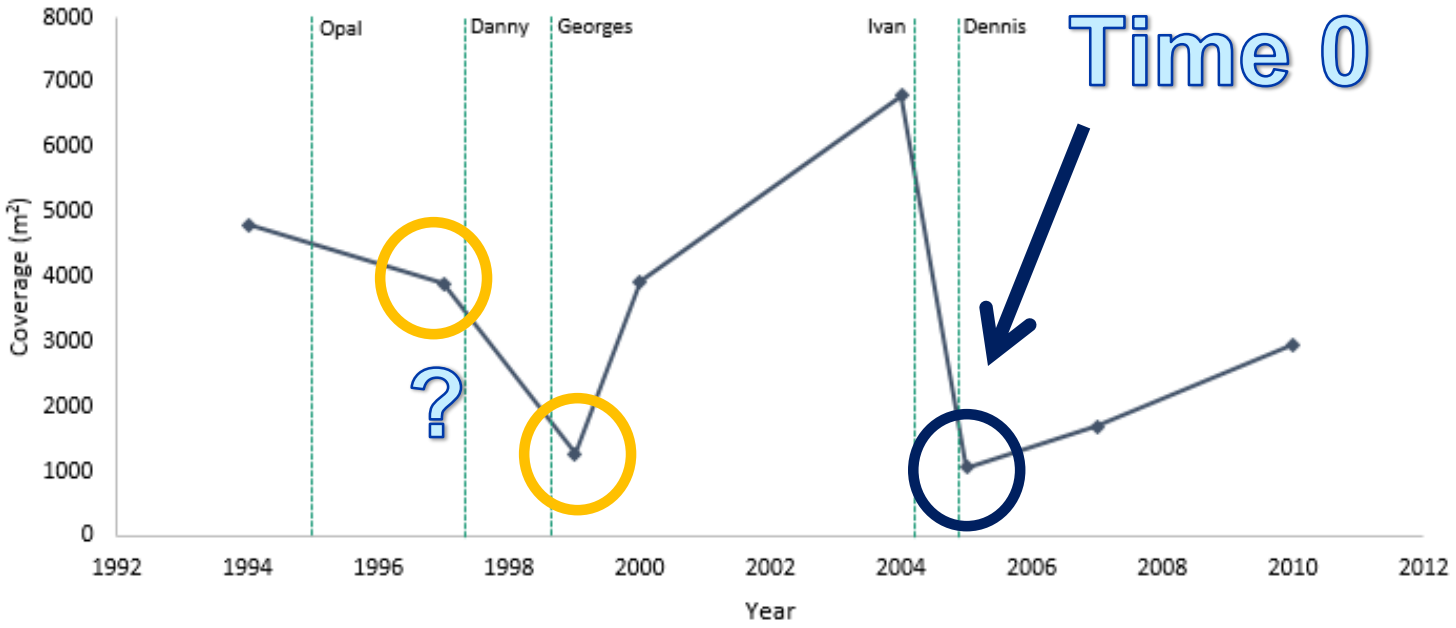


Santa Rosa

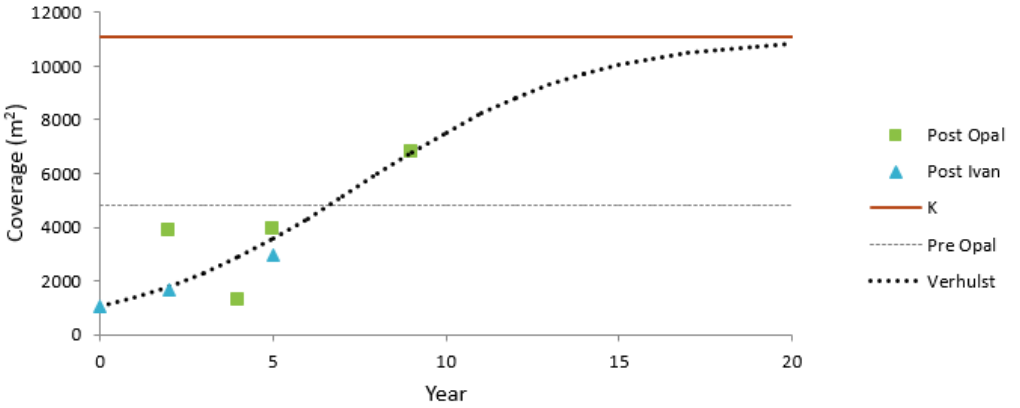
Average Vegetation Area SR



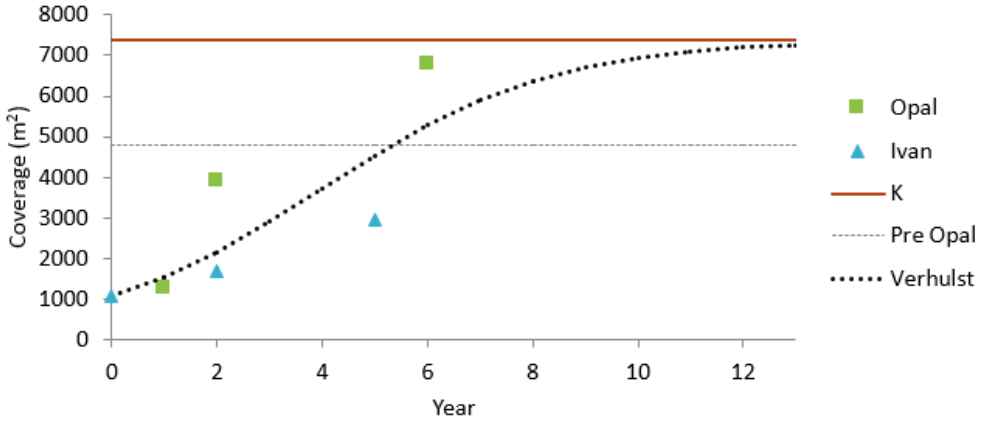
Average Vegetation Area SR



Average Vegetation Recovery SR Opal as N_0 vs Georges as N_0



Opal
$p < 0.02$
K = 30% area
(r) = 0.3



Georges
$p < 0.05$
K = 20% area
(r) = 0.45

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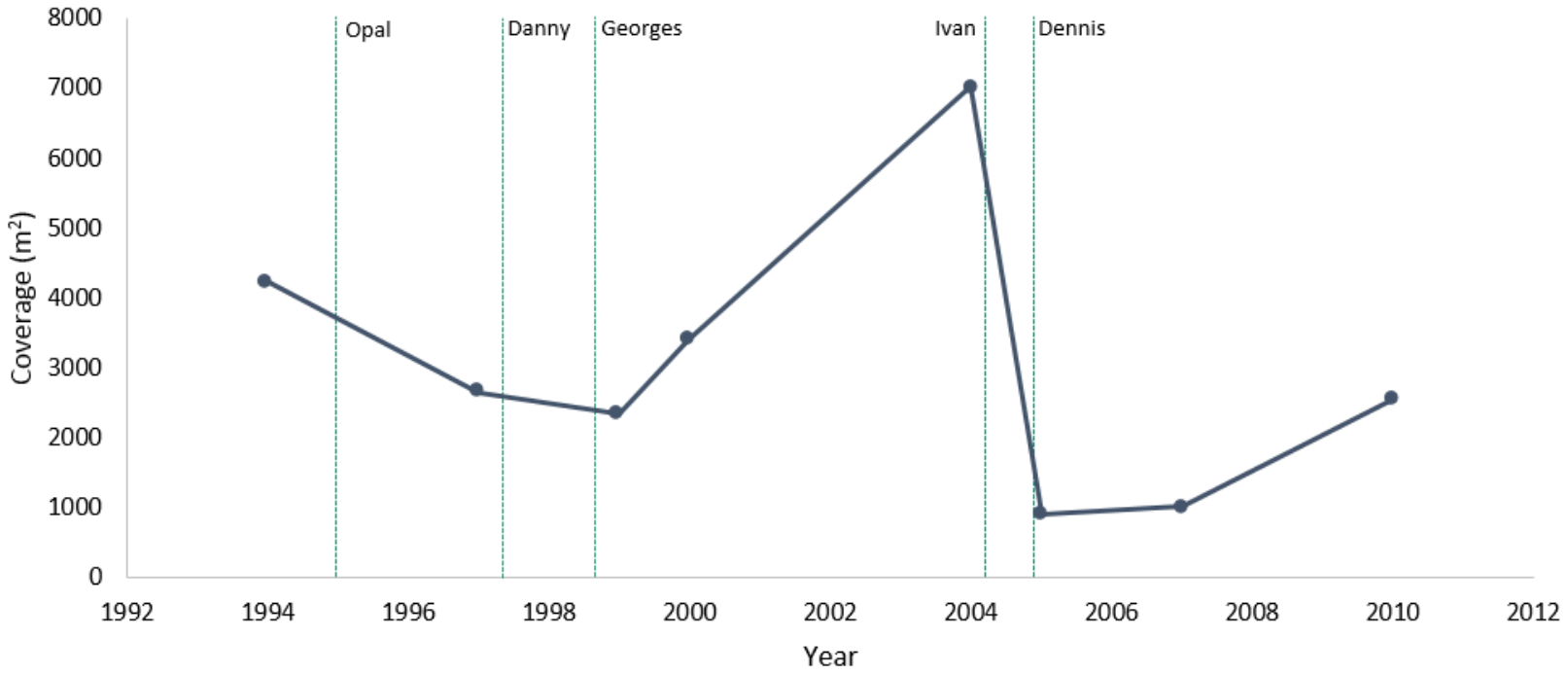
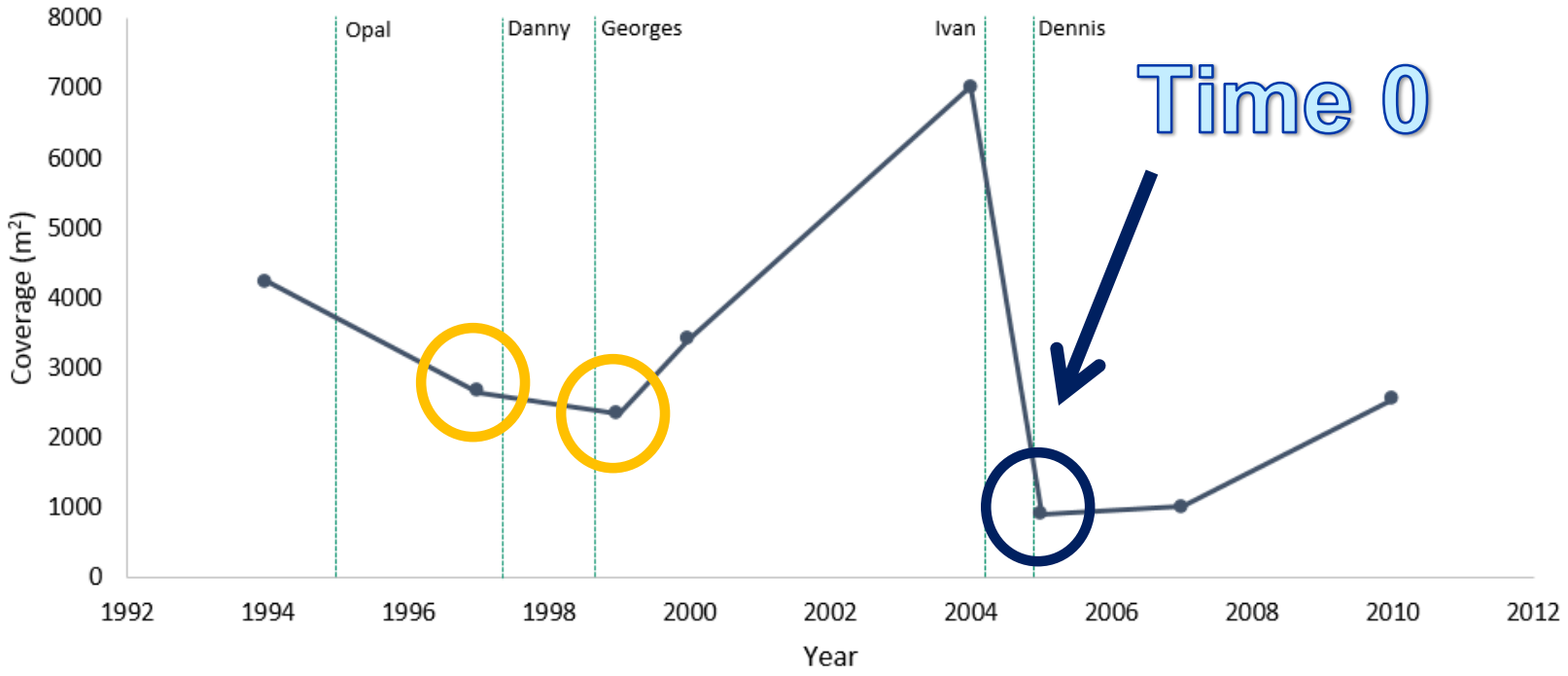
Santa Rosa 37-155

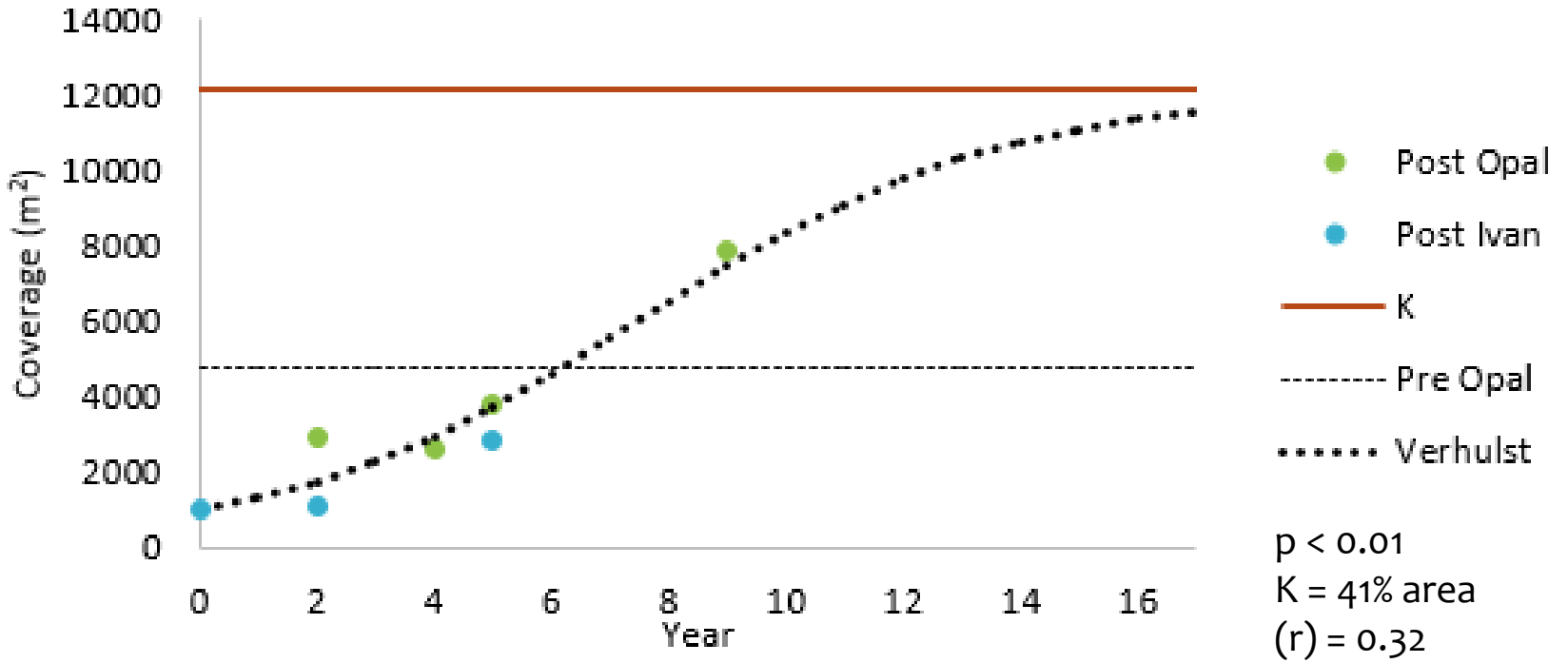
Average Vegetation Area SR 37-153



Average Vegetation Area SR 37-153

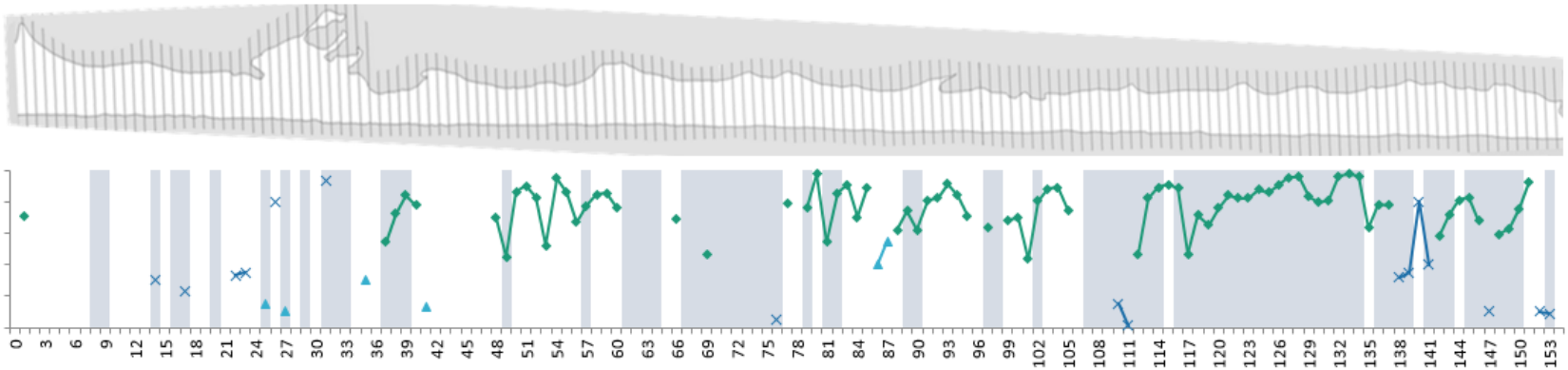


Average Vegetation Recovery SR

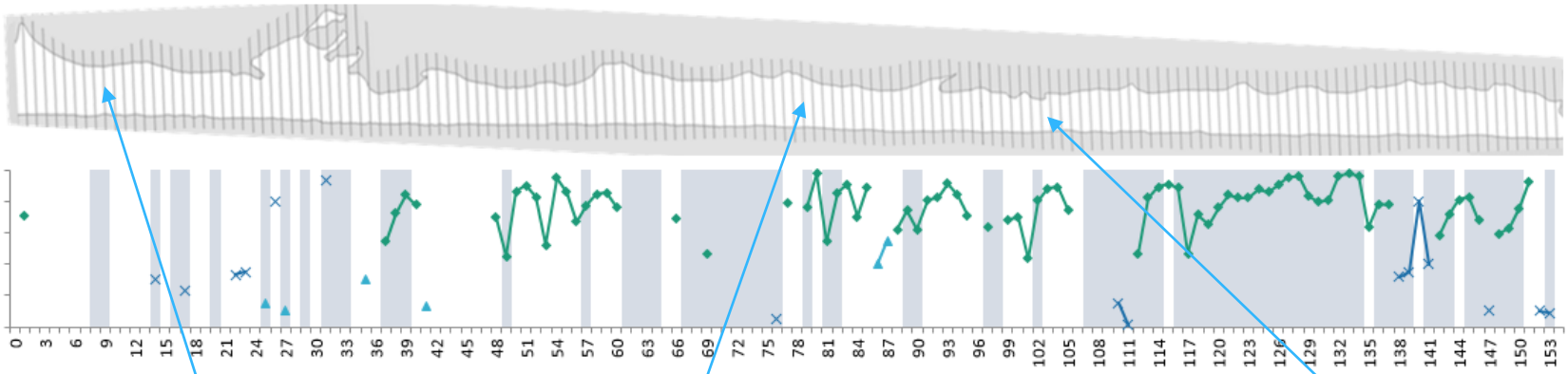


$p < 0.01$
K = 41% area
(r) = 0.32

Spatial Distribution of Vegetation Growth Rate SR



Spatial Distribution of Vegetation Growth Rate SR



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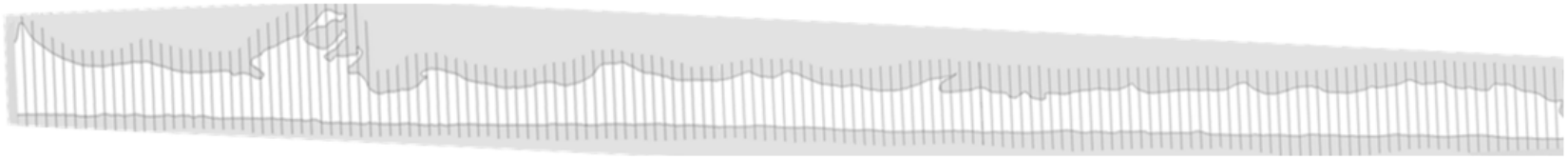
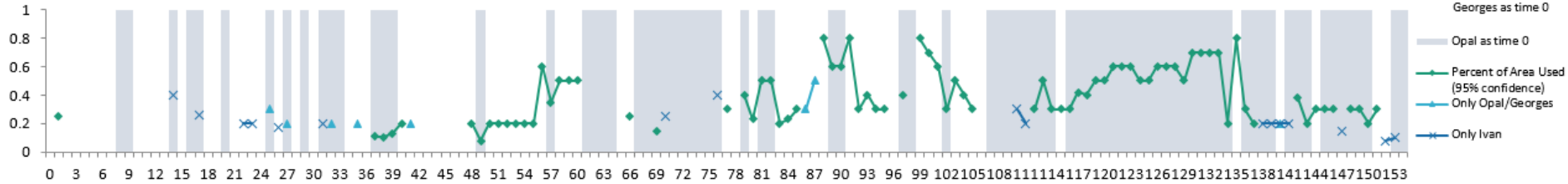
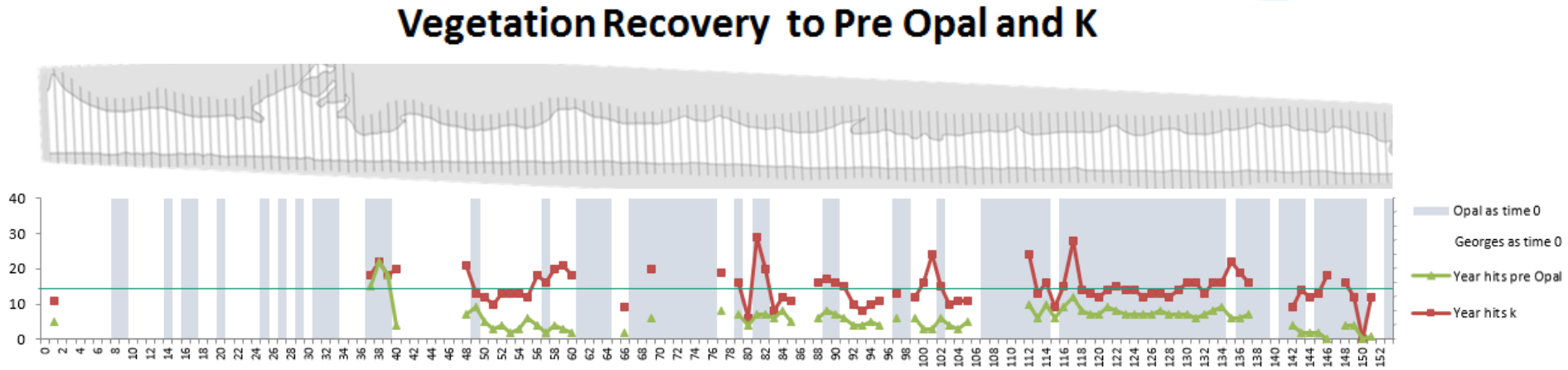
Spatial Distribution of K at SR

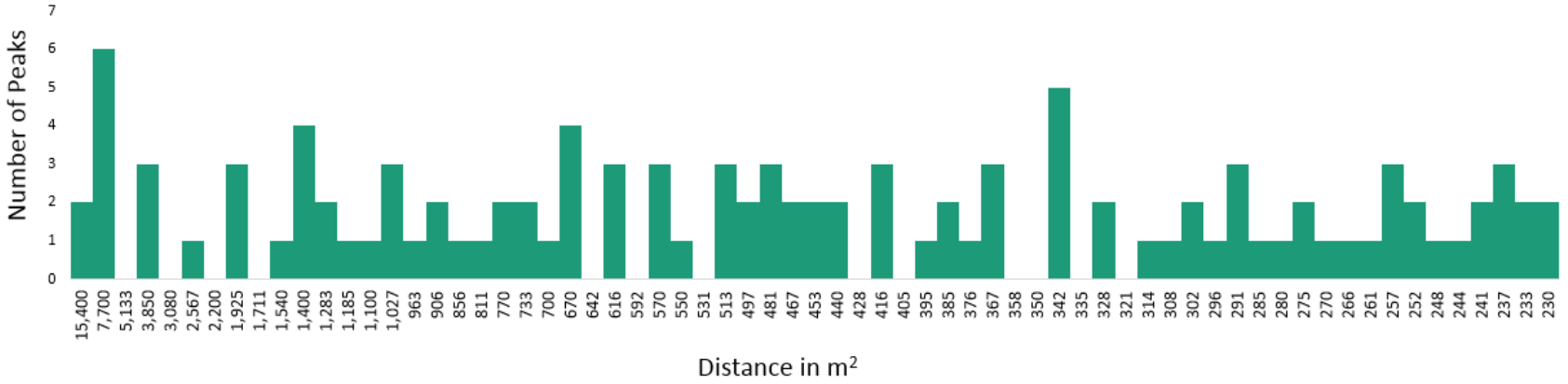


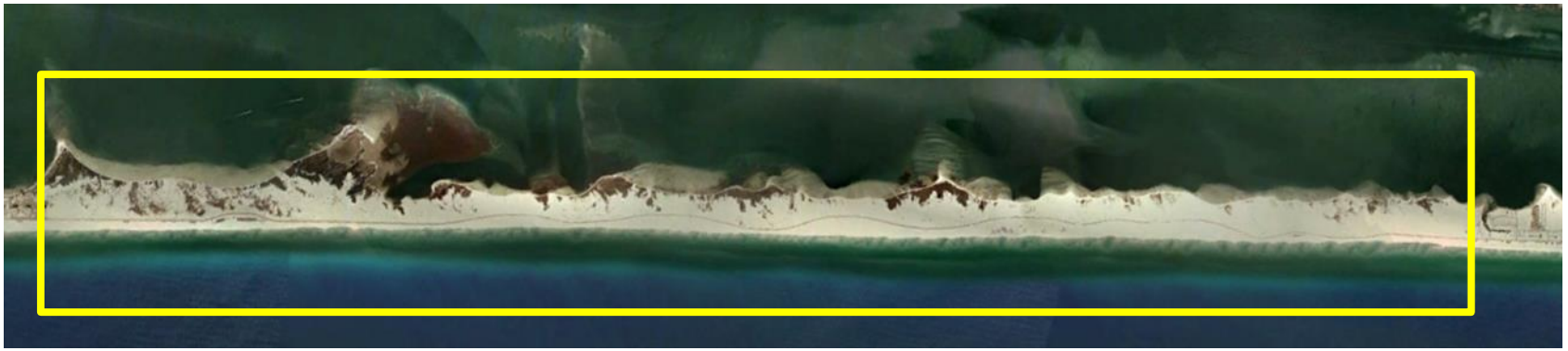


Recovery time along SR

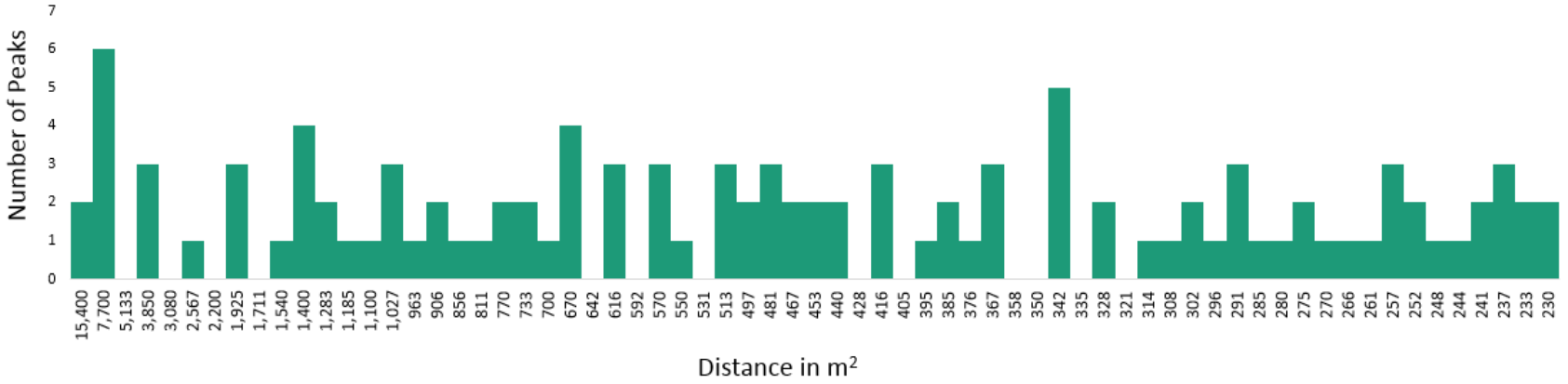


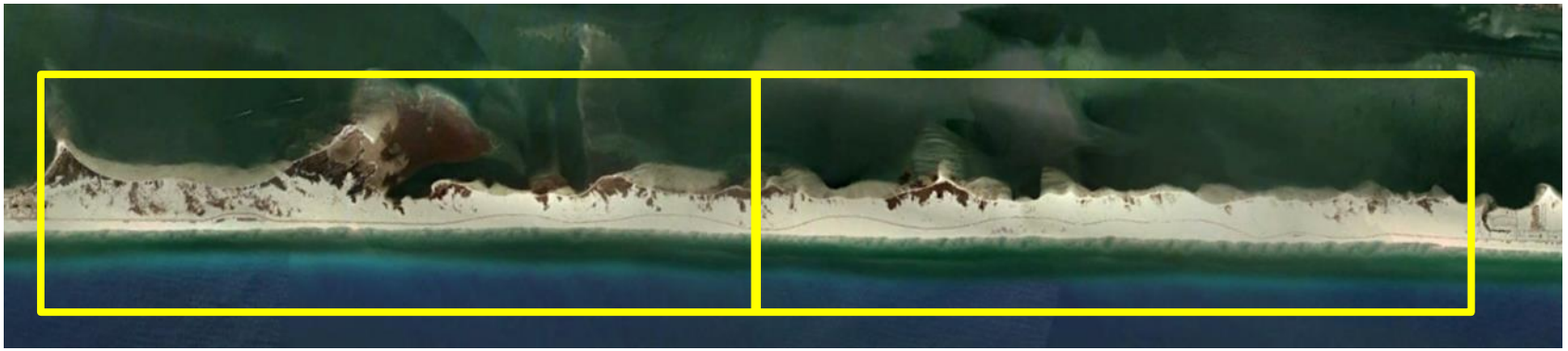
Fourier Transformation



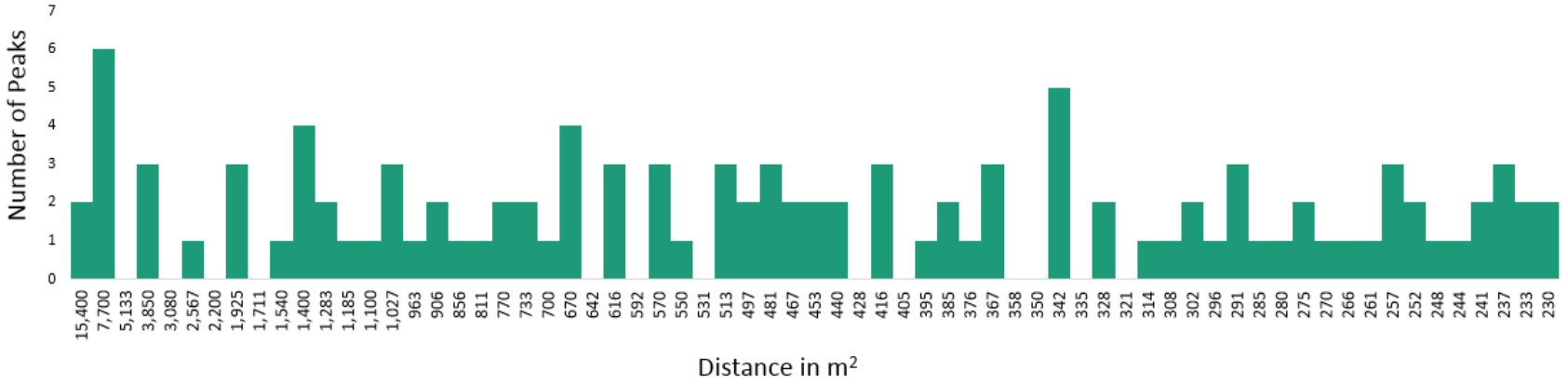


Fourier Transformation

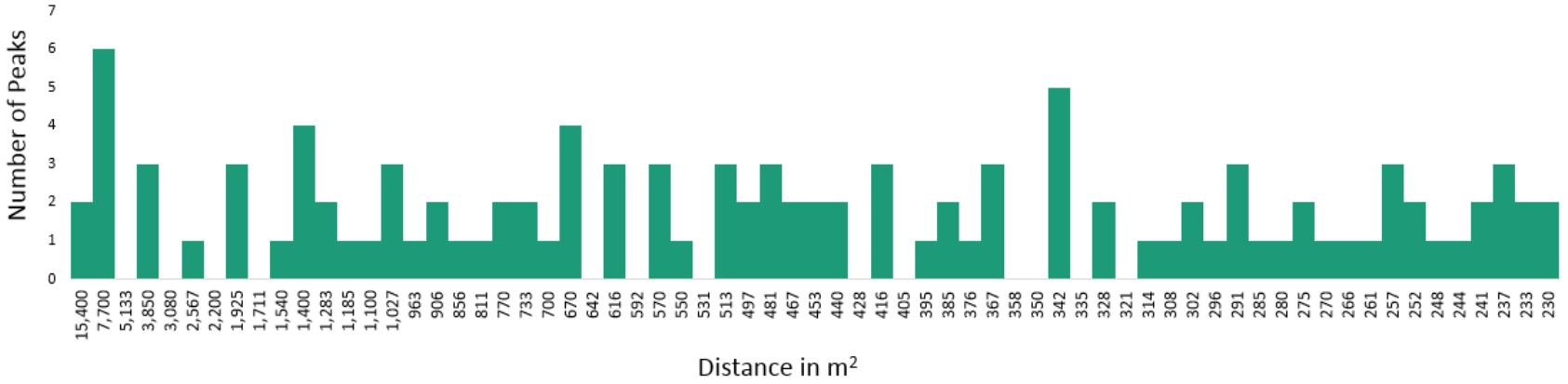


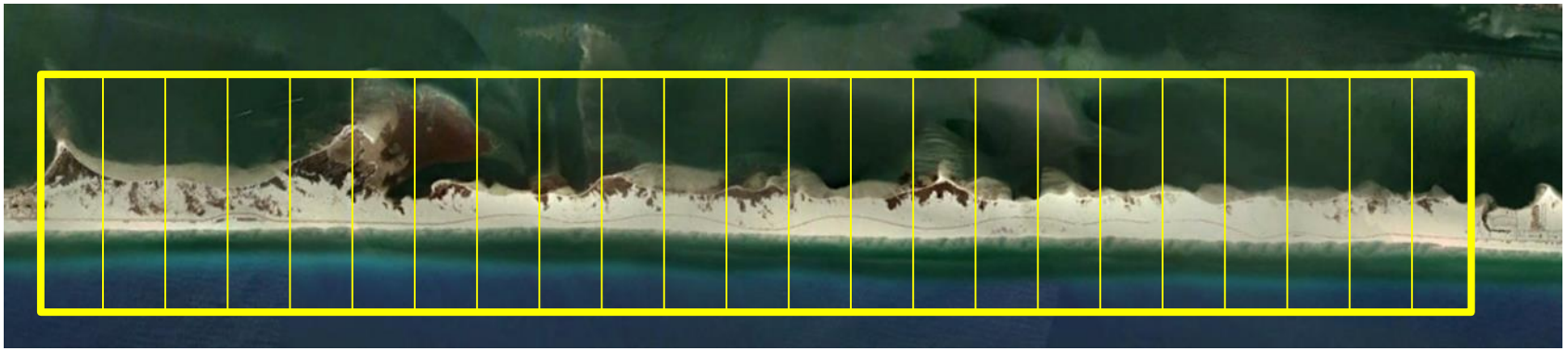


Fourier Transformation



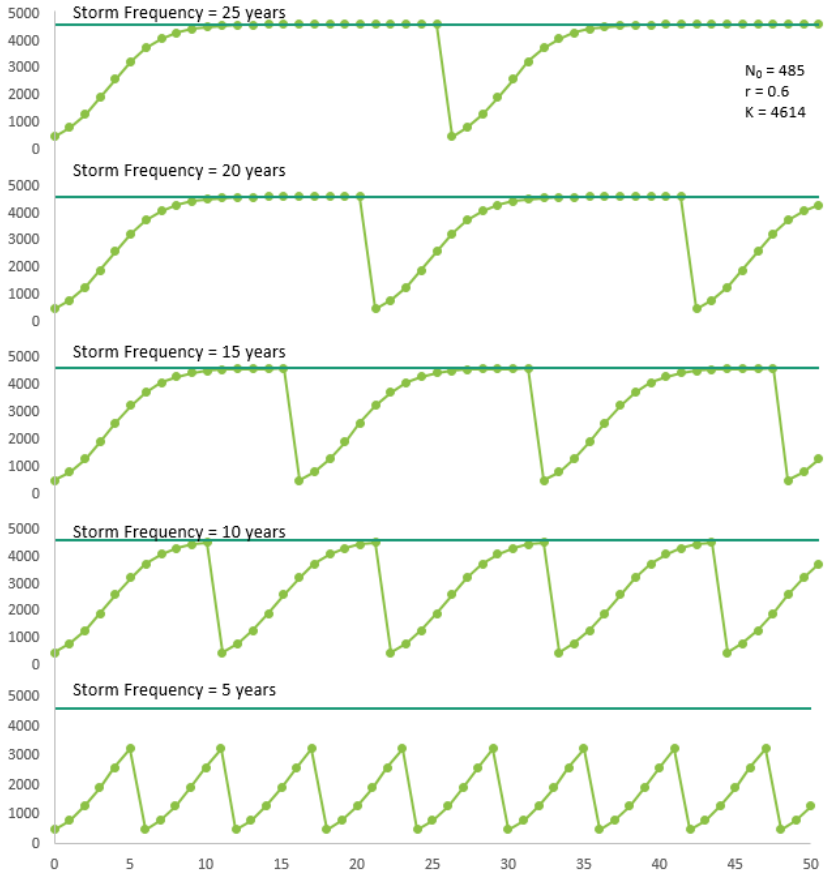
Fourier Transformation



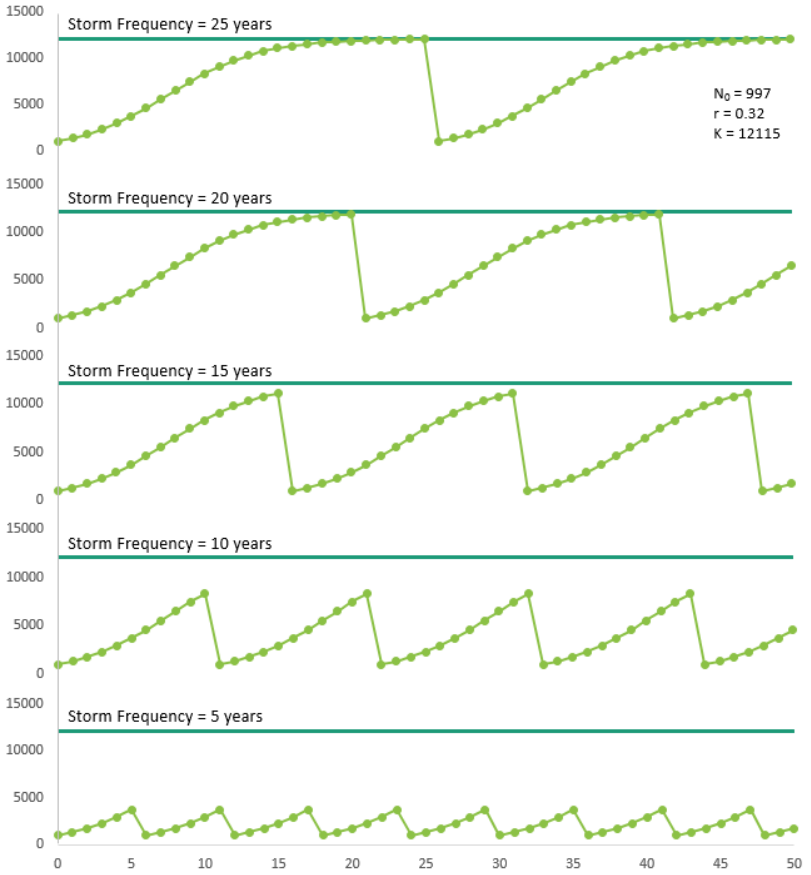


Changing Storm Frequencies

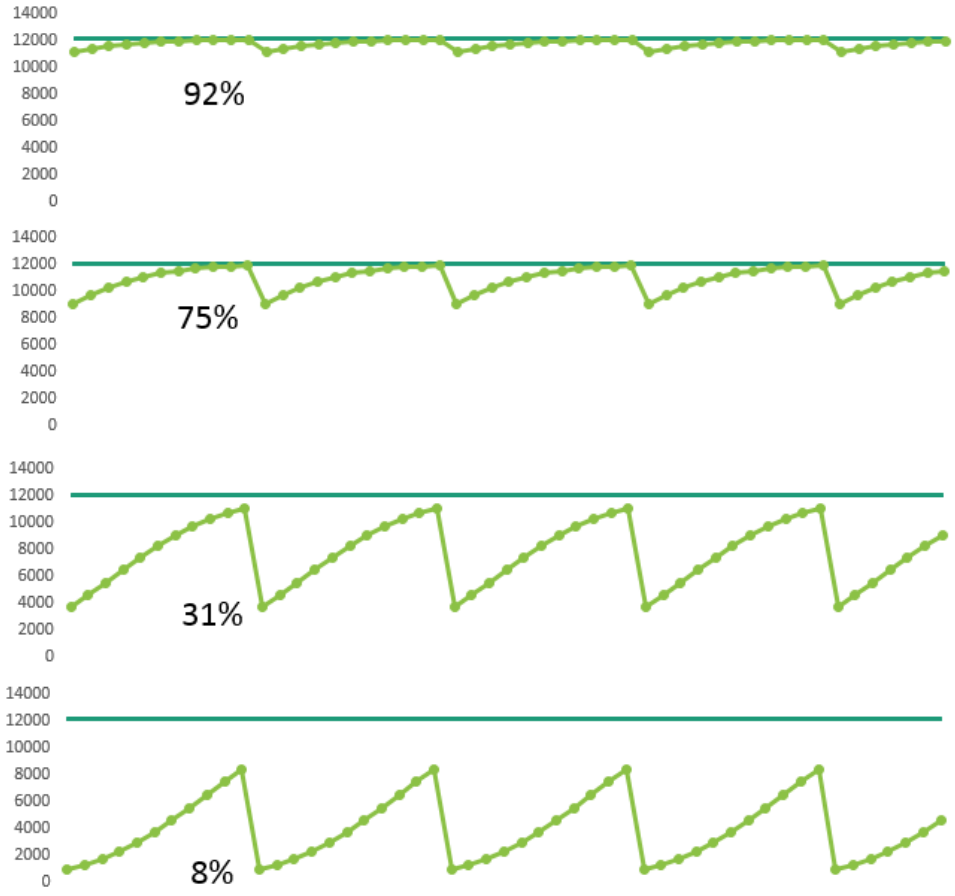
FP



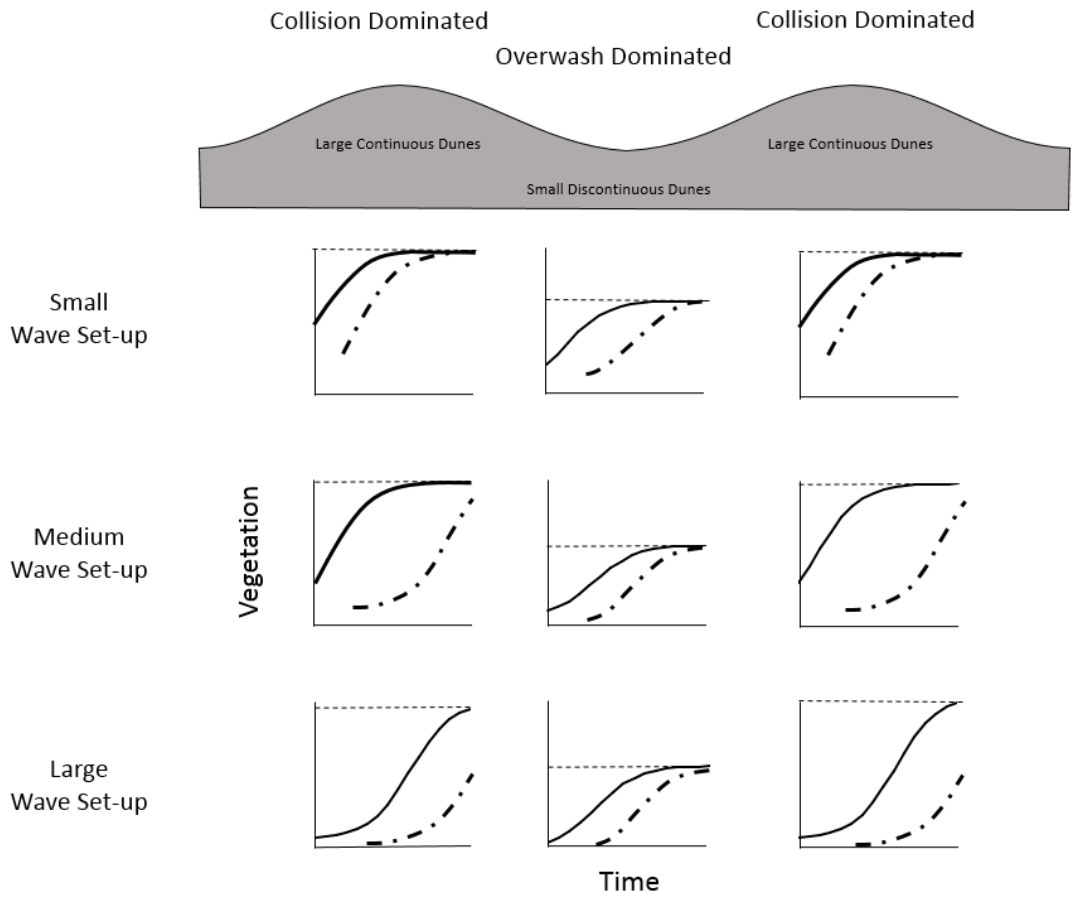
SR

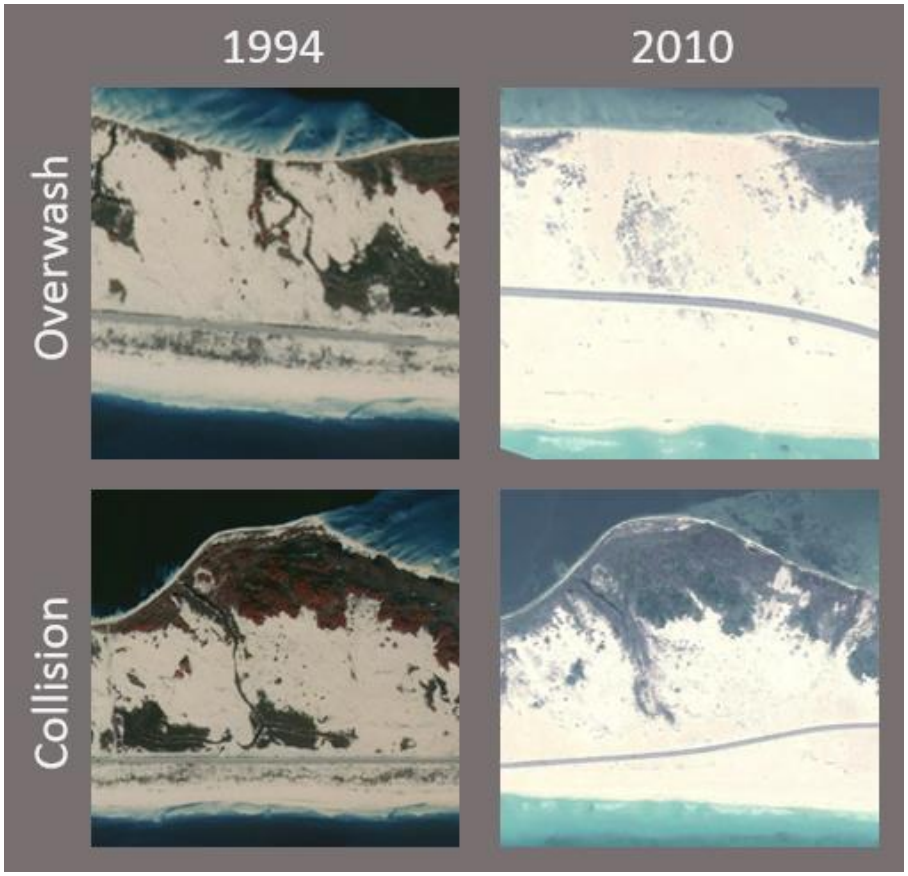


Changing Storm Magnitudes



Response and Recovery




1994
2010
Overwash
Collision

Future Directions

- Does the recovery occur in the same location and the same rate or is there an offset between vegetation and dune recovery?
  - Use LiDAR data to determine the location of dunes and recovery of dunes

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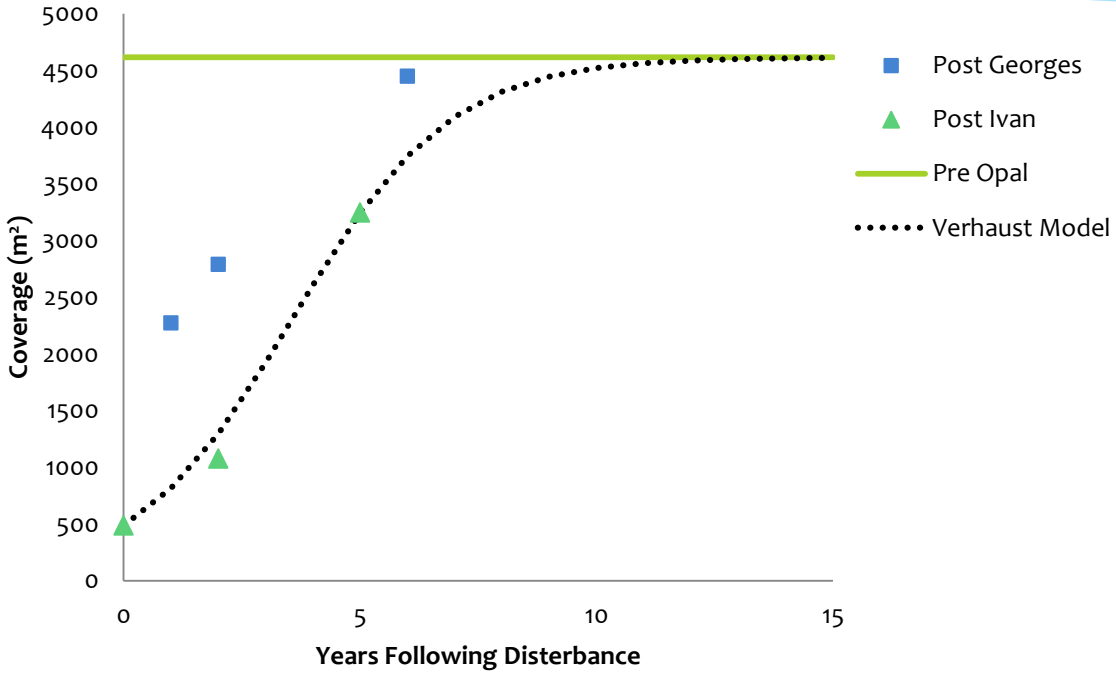
Accuracy Assessments

	FP		
	Overall	**Kappa**	**Veg**
1994	99.05	0.99	100.00
1997	95.22	0.95	88.75
1999	98.10	0.98	97.50
2000	91.43	0.91	83.75
2004	94.76	0.94	92.50
2005	93.33	0.93	82.00
2007	91.43	0.90	77.50
2010	91.87	0.91	81.25

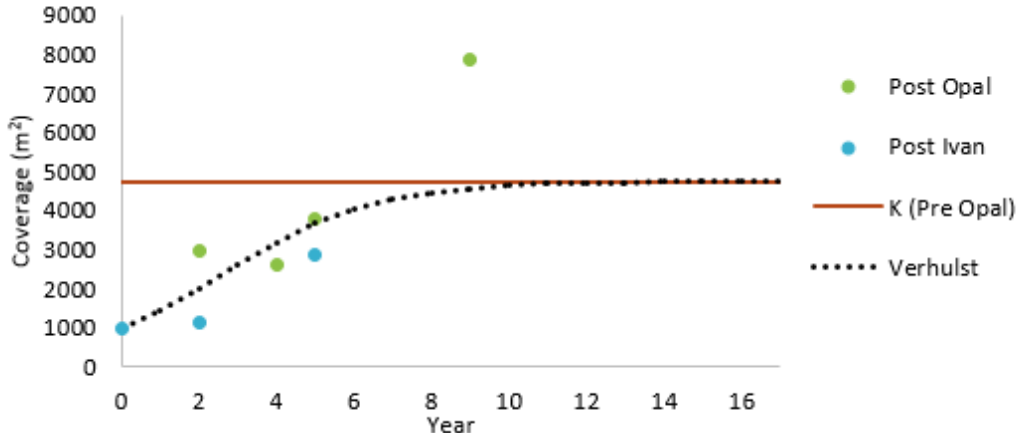
Imagery Specs

Year	Source	Type	Resolution
1994, Jan 31	USGS/NAPP	DOQ- 3.75-MIN CIR	1-meter
Opal October 4 1995			
1997, Feb 15	FDOT	B/W	0.33-meter
Danny July 19 1997			
Georges September 28 1998			
1999, Nov 27	USGS /NAPP	DOQ- 3.75-MIN CIR	1-meter
2000, Feb 15	FDOT	B/W	0.33-meter
2004, Jan	NAIP	DOQQ- CIR and visible	1-meter
Ivan September 16 2004			
Dennis July10 2005			
2005, July	NOAA	Aerial	0.33-meter
2007, Jan 9	NAIP	DOQQ-	1-meter
2010, Jan 10	NAIP	DOQQ-	1-meter

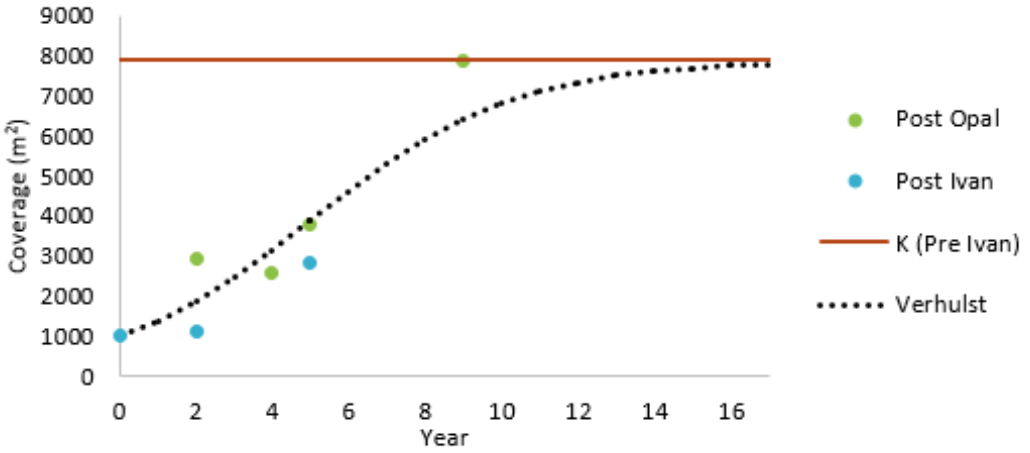
If Danny and Georges were not removed



K not Pre Opal or Ivan

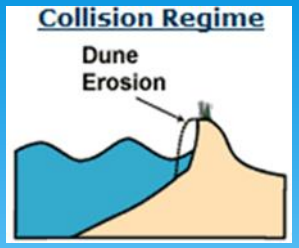


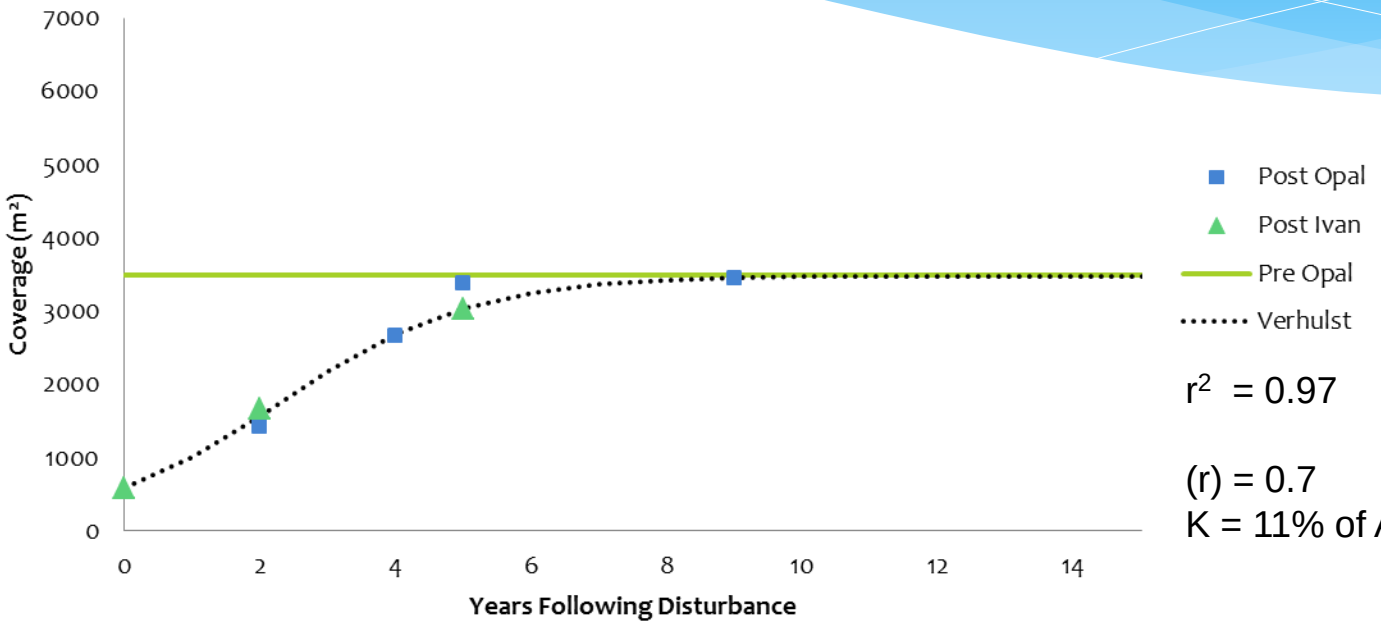
37 to 153 SR
$p < 0.02$
K = Pre Opal Vegetation
(r) = 0.51



37 to 153 SR
$p < 0.01$
K = Pre Ivan Vegetation
(r) = 0.38

Collision

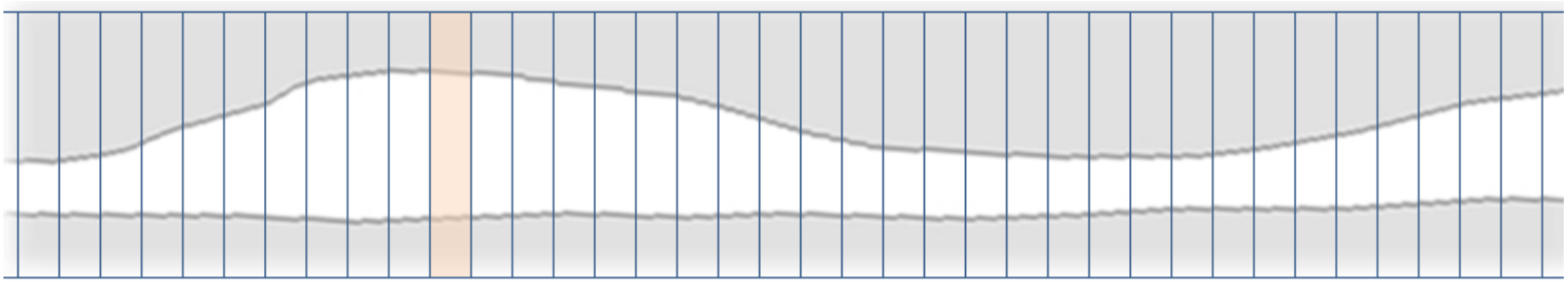




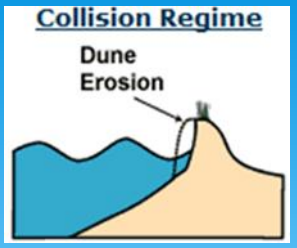
r^2 = 0.97

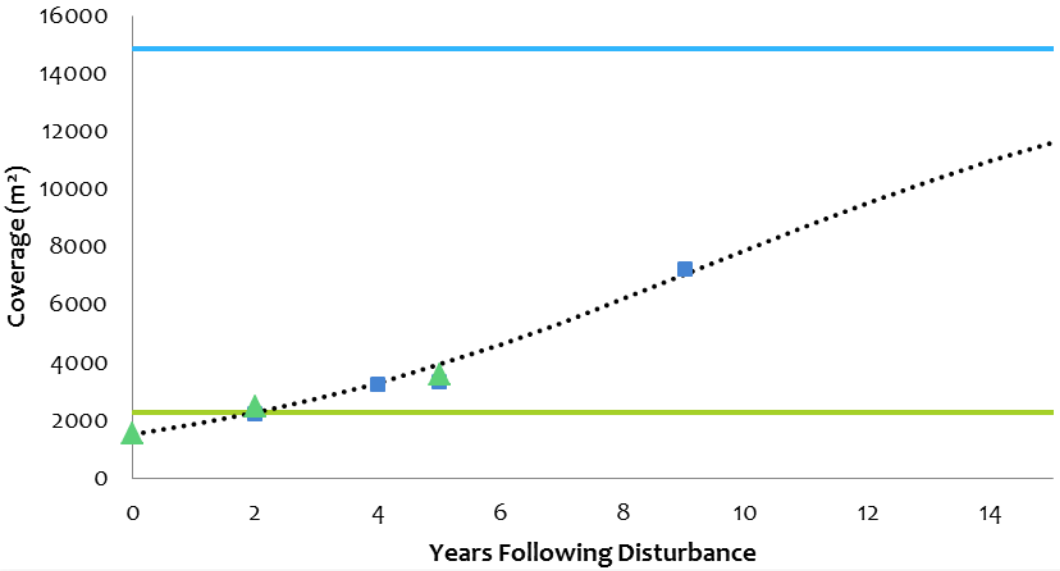
(r) = 0.7

K = 11% of Available Area



Collision

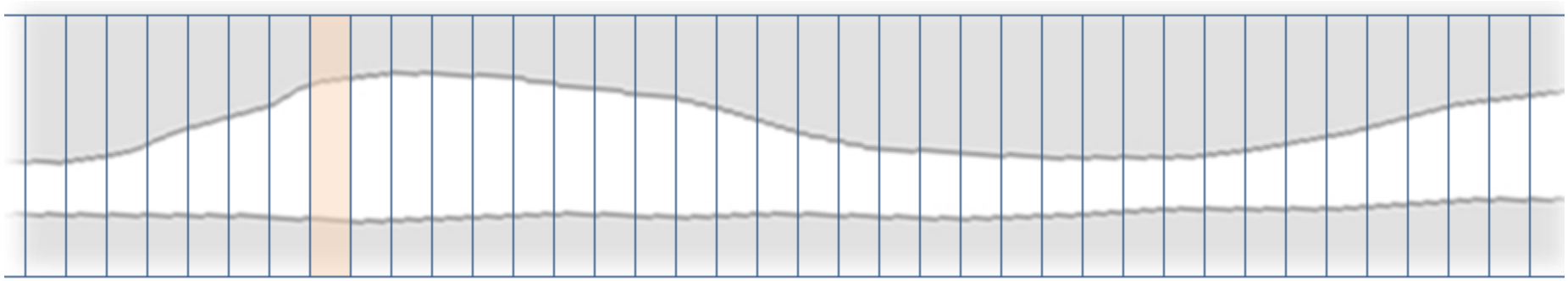




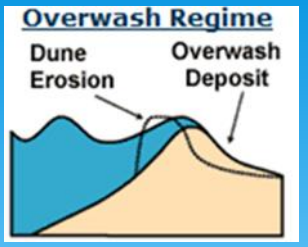
Post Opal
Post Ivan
k
Pre Opal
Verhulst

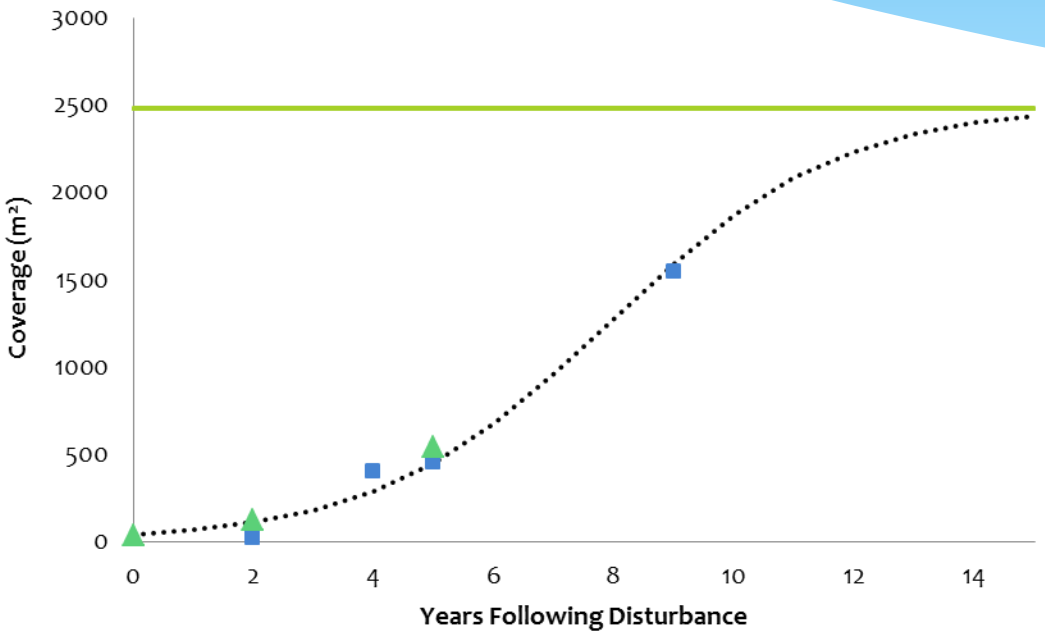
r^2 = 0.97

(r) = 0.23
K = 40% of Available Area



Overwash





Post Opal
Post Ivan
Pre Opal
Verhulst

R^2 = 0.98

(r) = 0.52
K = 10% of Available Area