Projecting Effects of Climate Change on Pests

REACCH (Regional Approaches to Climate Change)

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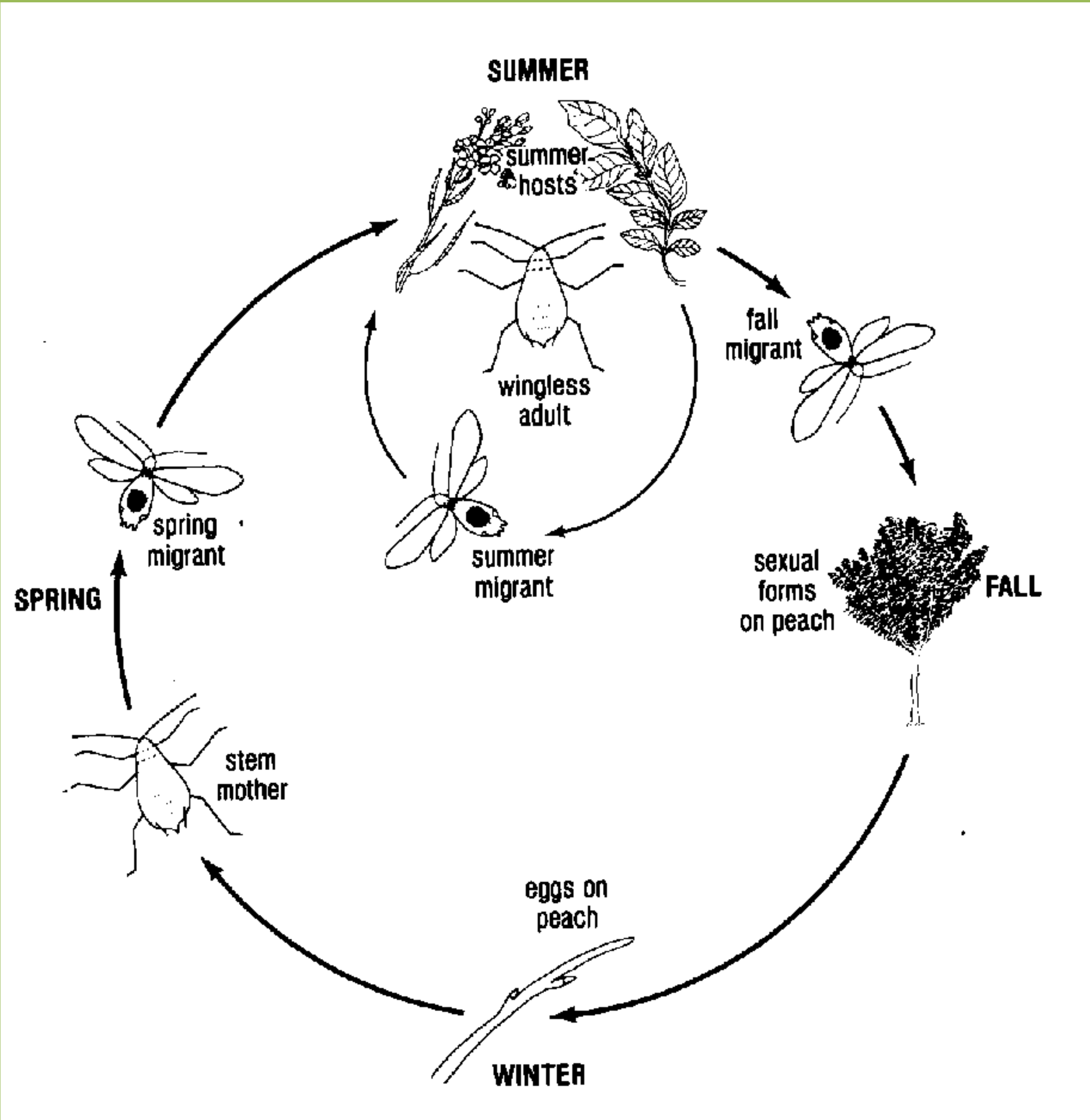
Summary:

1. Background
   - Aphid life cycle
   - *R. Padi* and *S. Avenae*
   - Suction traps
   - El Niño and La Niña weather patterns
2. Hypothesis
   - *R. Padi and S. Avenae* abundances will be different in El Niño, La Niña and La Nada years and these differences will be caused by climactic differences
3. Results
   - Graphical analysis
   - Statistical analysis
   - Analysis of temperature and precipitation data

Aphid Life Cycle



3 flight periods of aphids per year

1) Spring: Leave primary host and migrate to the secondary host
2) Summer: 1 or more migrations when resources run out.
3) Fall: Return to primary host to overwinter

Sitobion avenae (*S. Avenae*: English Grain Aphid)

- Arrive later in the season
- Feeding: Prefers ears and upper leaves of plant

Rhopalosiphum padi (*R. Padi*: Birdcherry-Oat Aphid)

- Arrive earlier in the season
- Feeding: Prefers stem and lower leaves

Suction Traps

- Winged aphids movement accounts for the distribution of aphids throughout this region and drives the colonization of crops between within growing seasons.

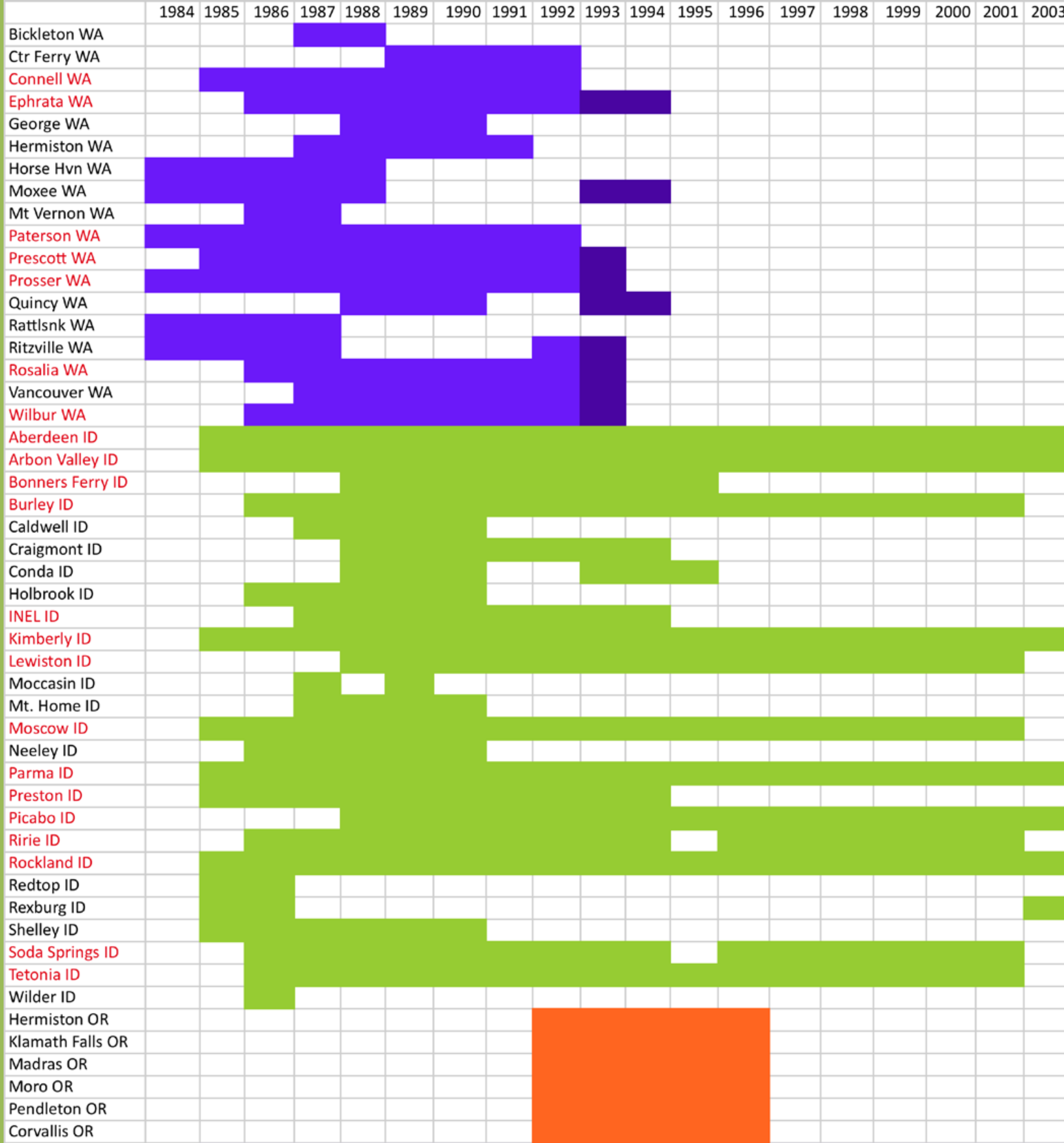
Suction Trap use around the world:

- **AGRAPHID – France**
  - Using data to study aphid flight phenologies and their vairance in space and time.
  - Focus on *R. padi* which are extremely economically important in France
- **Rothamsted – UK**
- **Illinois Natural History Survey – United States Midwest**
  - Use Aphid fall aphid counts to predict aphid severity for the following year.

Looking at past studies

- **Finlay and Luck- How climate change will effect aphid populations, Klueken- Connecting aphid data to various meteorological variables**
  - o Increases in temperature and sunlight duration → increases in aphid abundances
  - oIncreases precipitation, humidity and wind speed → decreases in aphid abundances
  - o CO_2 and precipitation changes effect crops in different ways → effect aphid abundances in different ways

Data Set


1984
1985
1986
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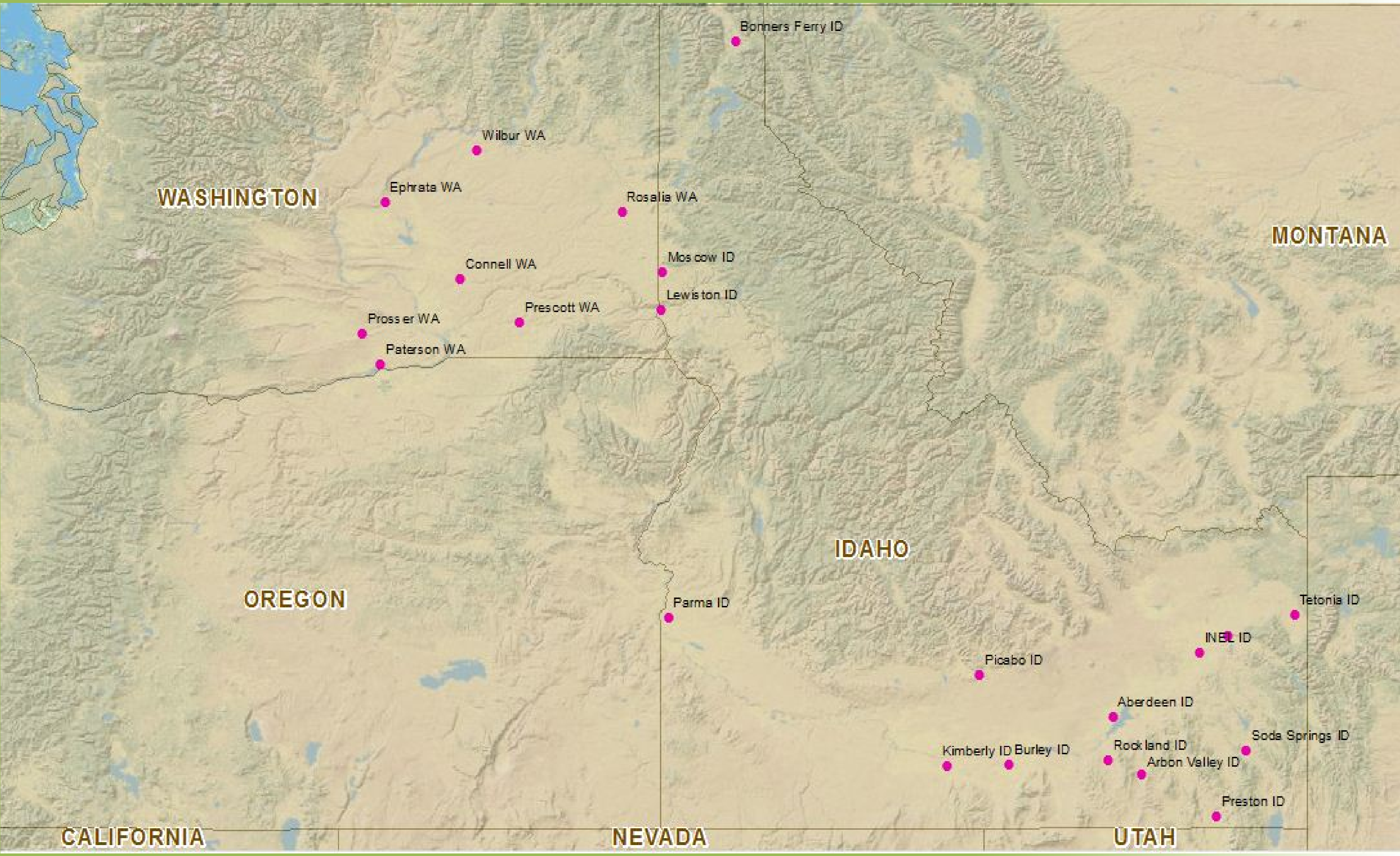
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2003
Bickleton WA
Ctr Ferry WA
Connell WA
Ephrata WA
George WA
Hermiston WA
Horse Hvn WA
Moxee WA
Mt Vernon WA
Paterson WA
Prescott WA
Prosser WA
Quincy WA
Rattlsnk WA
Ritzville WA
Rosalia WA
Vancouver WA
Wilbur WA
Aberdeen ID
Arbon Valley ID
Bonners Ferry ID
Burley ID
Caldwell ID
Craigmont ID
Conda ID
Holbrook ID
INEL ID
Kimberly ID
Lewiston ID
Moccasin ID
Mt. Home ID
Moscow ID
Neeley ID
Parma ID
Preston ID
Picabo ID
Ririe ID
Rockland ID
Redtop ID
Rexburg ID
Shelley ID
Soda Springs ID
Tetonia ID
Wilder ID
Hermiston OR
Klamath Falls OR
Madras OR
Moro OR
Pendleton OR
Corvallis OR

Sites Used In Data Analysis



Hypothesis:

R. Padi and S. Avenae abundance patterns will be different in El Niño, La Niña and La Nada years.

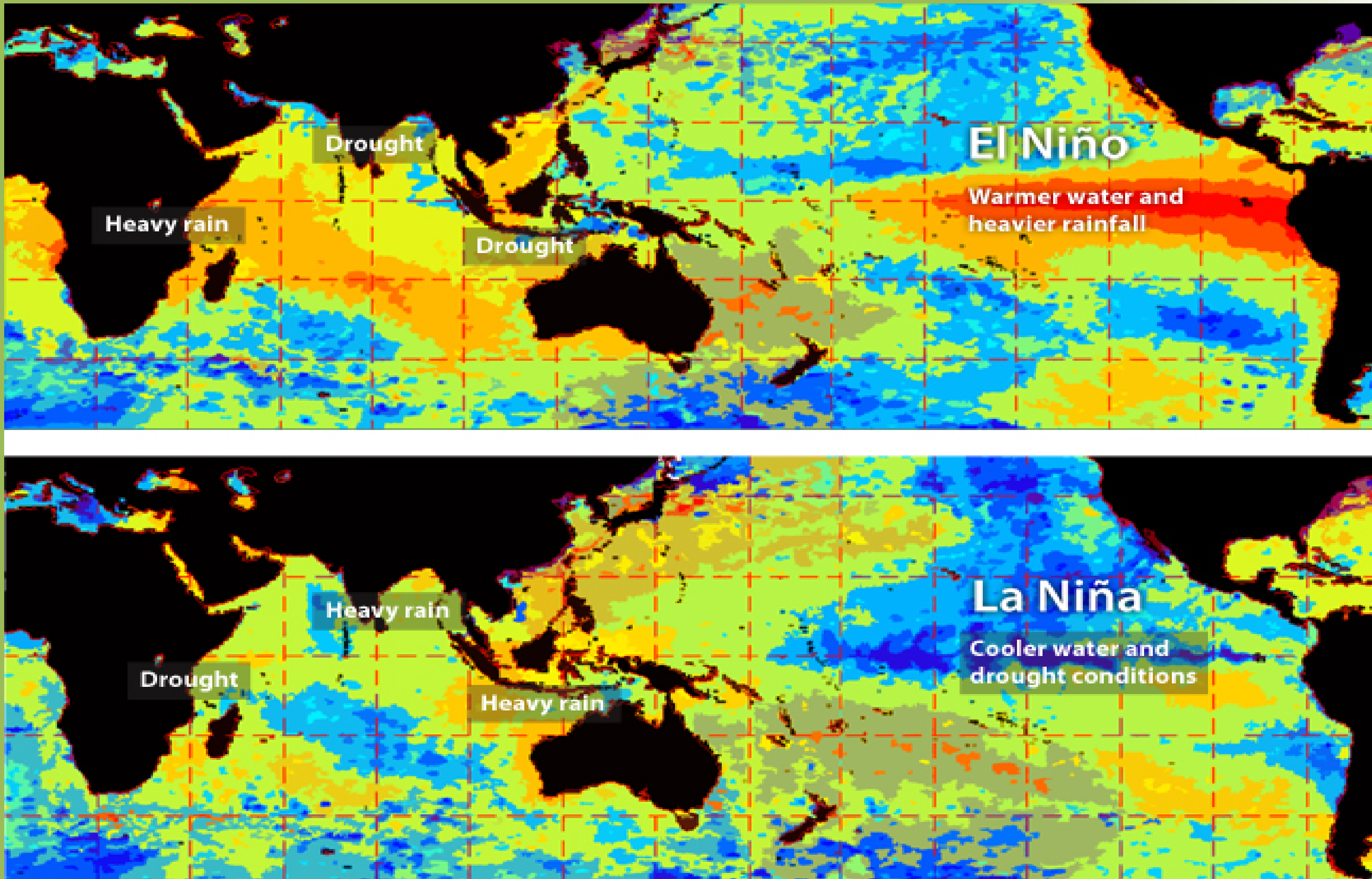
El Niño years: 1987, 1992, 1995, 1998

La Niña years: 1989, 1999, 2000

La Nada years: 1984, 1985, 1986, 1988, 1990, 1991, 1993, 1994, 1996, 1998, 2001, 2003

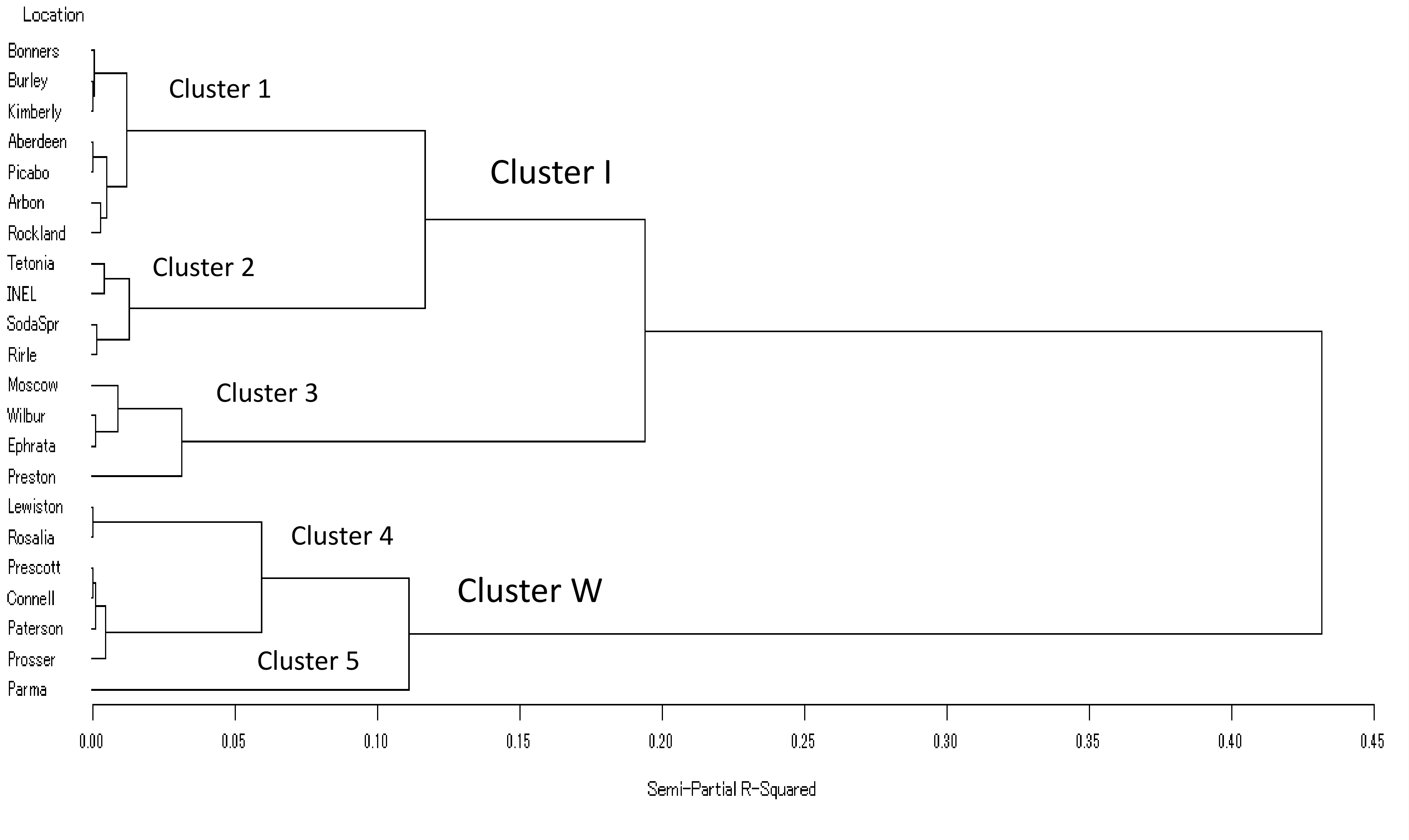
Methods

1. **Cluster Creation:**
   - Compiled a table of yearly totals for each location (1984-1991)
   - Created a correlation matrix between all locations
   - Created a distance matrix between all locations (distance = 1 – correlation coefficient)
   - SAS creates clusters from this Data
2. **Examined clusters for relationships with El Niño and La Niña**
3. **Examined data for other climate and weather associations**
4. **Analysis was completed for both *R. padi* and *S. avenae***


El Niño
Warmer water and heavier rainfall
Drought
Heavy rain
Drought
La Niña
Cooler water and drought conditions
Heavy rain
Drought
Heavy rain

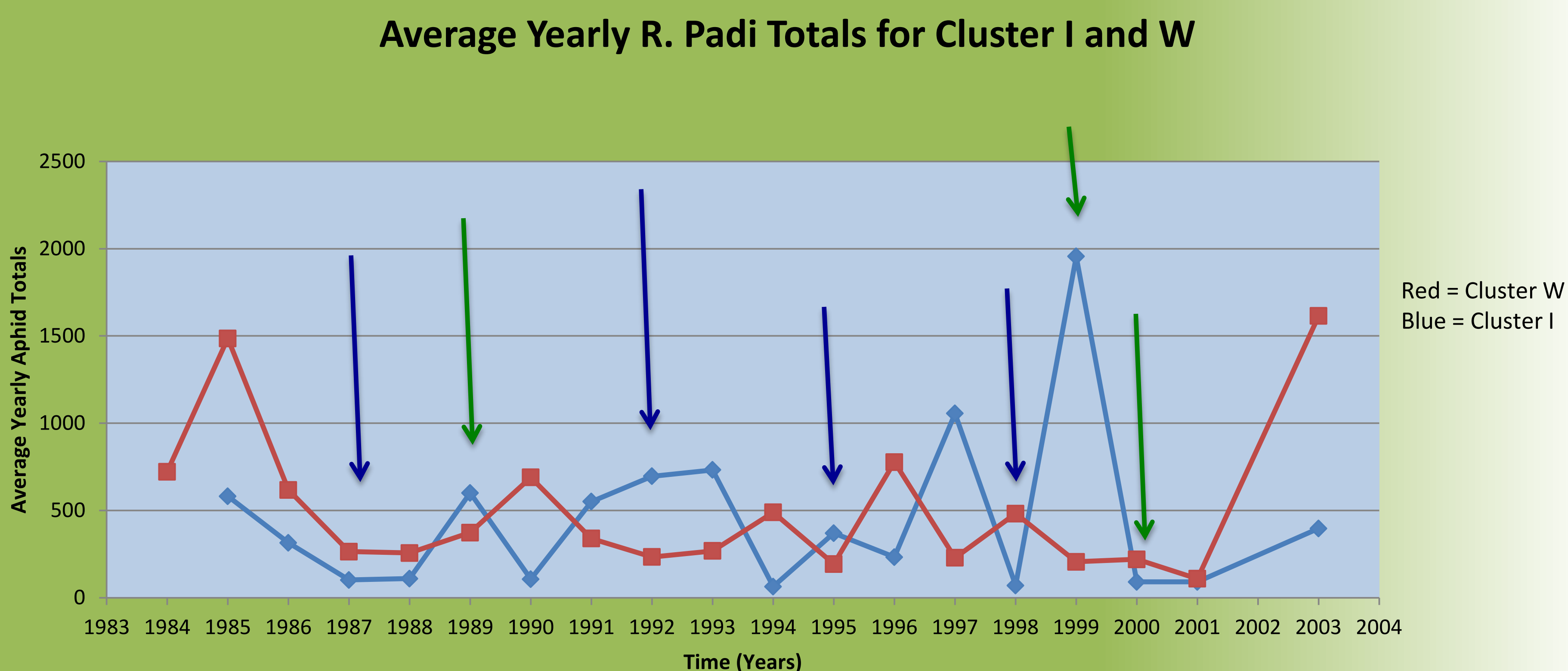
Broad effects of El Niño and La Niña on North America

Cluster Analysis: *R. padi*



Analyzing Yearly *R. padi* Total Abundances for El Niño or La Niña Effects

Blue arrow= El Niño Green Arrow= La Niña



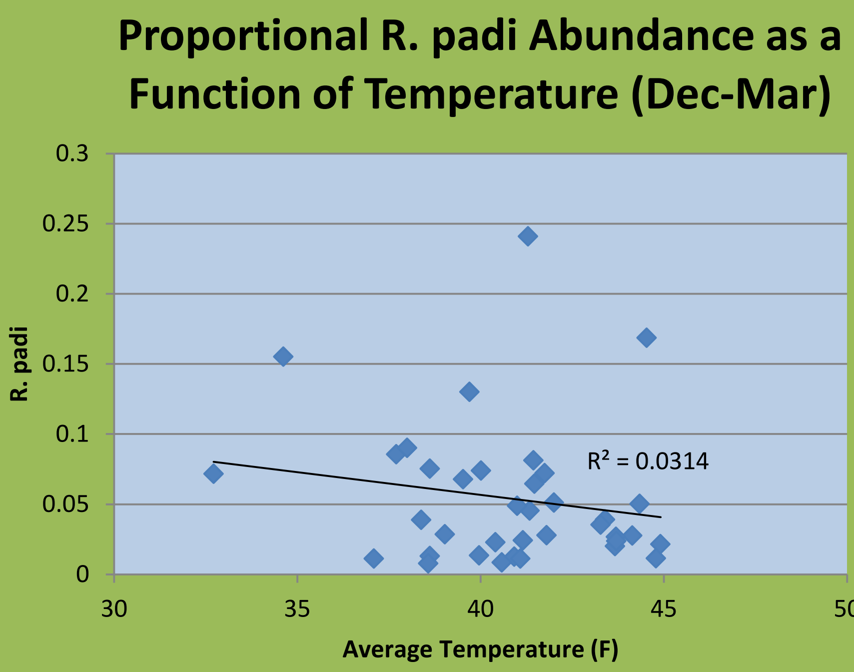
Statistically Significant Results

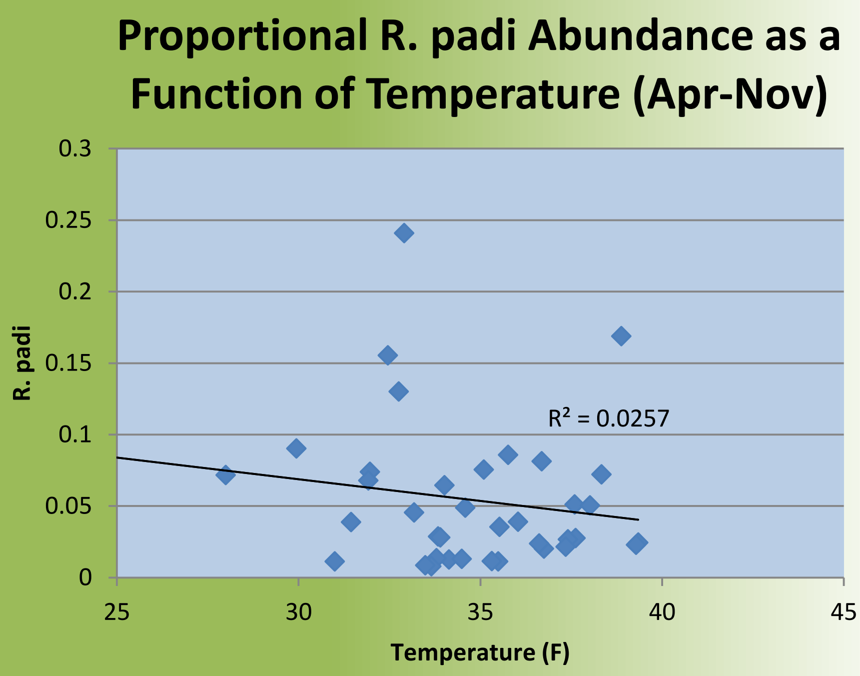
	I: (1984-2003)	Apr-Nov Tem	Dec-Mar Tem	Precipitation
El Niño	5.21	34.14	40.133125	61.5725
La Niña	5.889	32.7833333	39.4633333	63.9133333
La Nada	5.26	31.5225	38.5364583	61.9214583

	I: (1984-1991)	Apr-Nov Tem	Dec-Mar Tem	Precipitation
El Niño	4.5117	34.135	40.9175	61.4625
La Niña	6.3593	31.965	40.0125	53.5325
La Nada	5.1418	30.4175	37.5091667	62.25

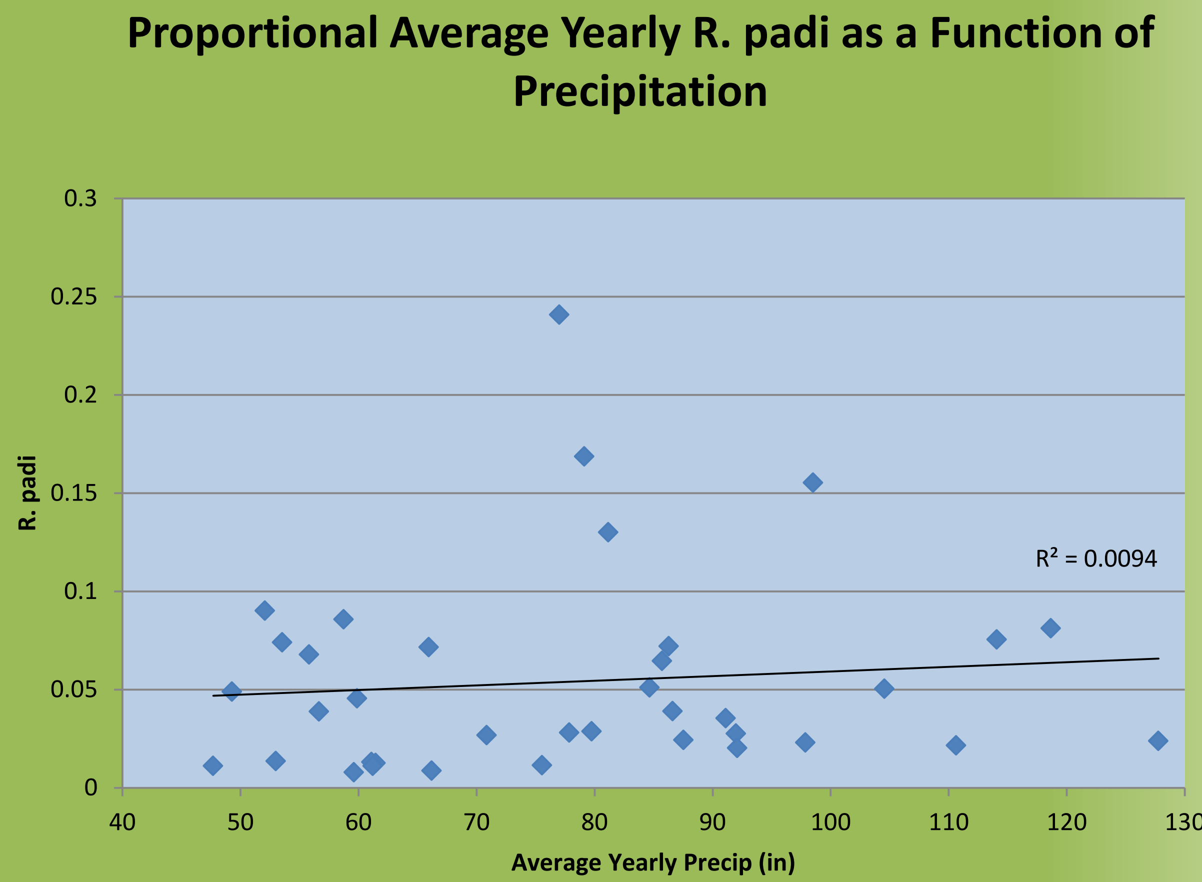
	I/W: (1984-1991)	Apr-Nov Tem	Dec-Mar Tem	Precipitation
El Niño	4.7815	35.5525	42.52625	76.72
La Niña	6.1611	34.00125	41.645	70.075
La Nada	5.26	33.04125	42.205625	83.215

Analysis Of *R. padi:* Temperature

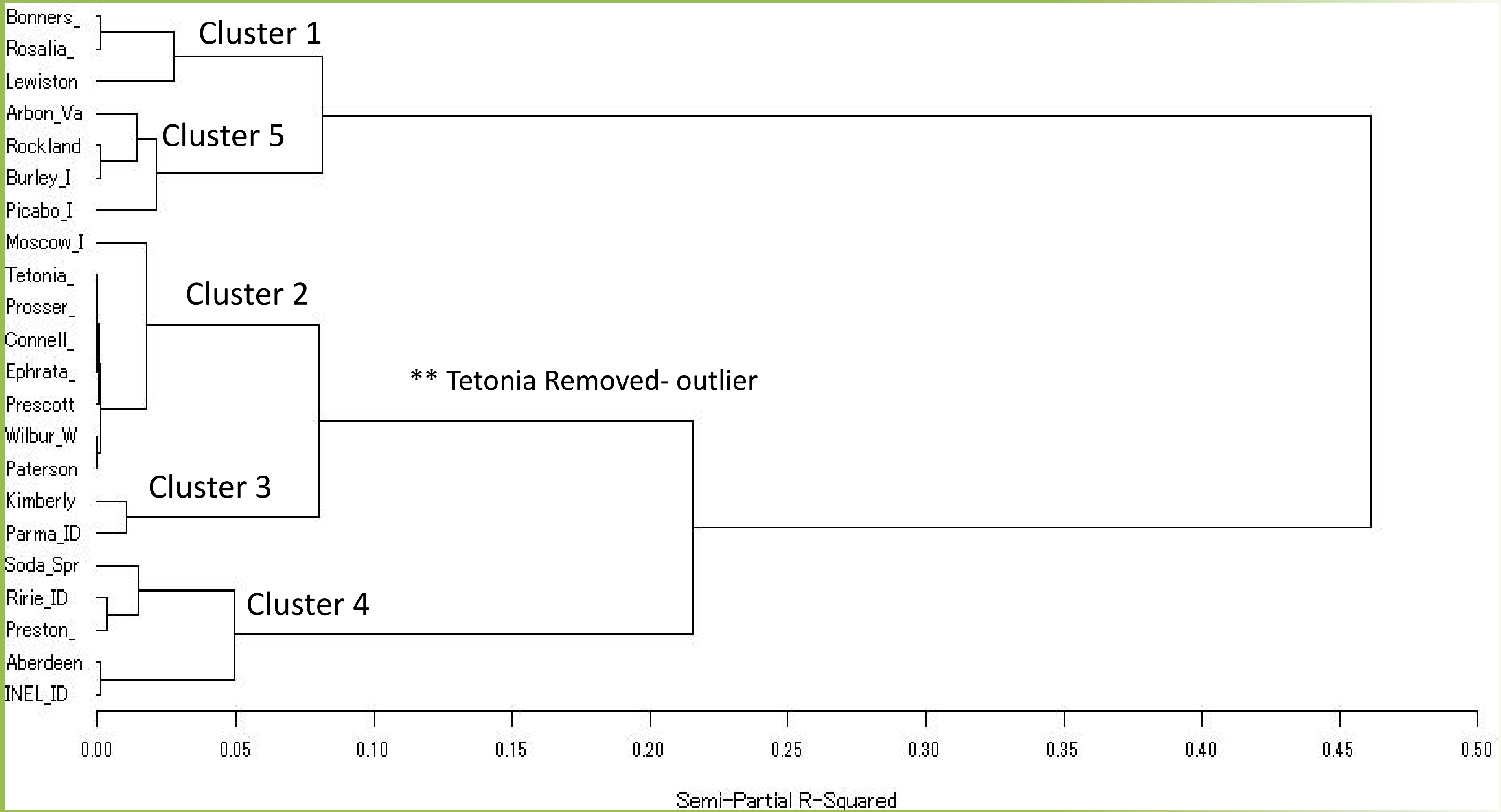




Analysis Of *R. padi:* Precipitation

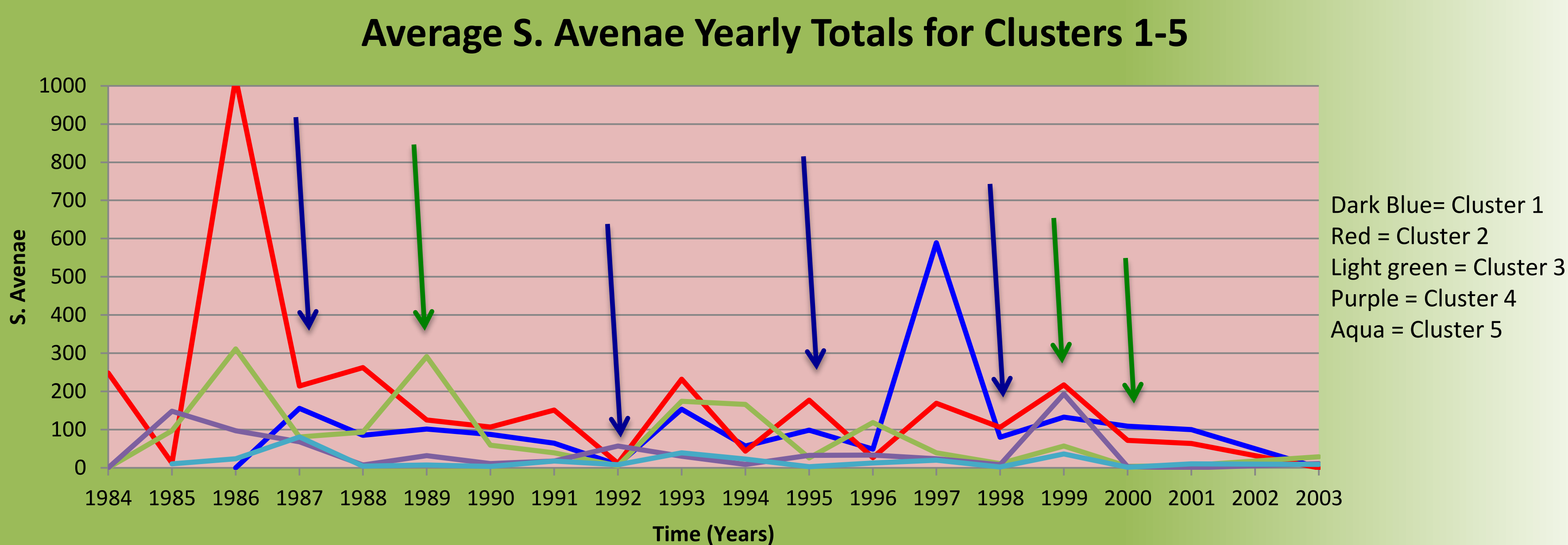


Cluster Analysis: S. Avenae



Analyzing Yearly *S. avenae* Total Abundances for El Niño or La Niña Effects

Blue arrow= El Niño   Green Arrow= La Niña

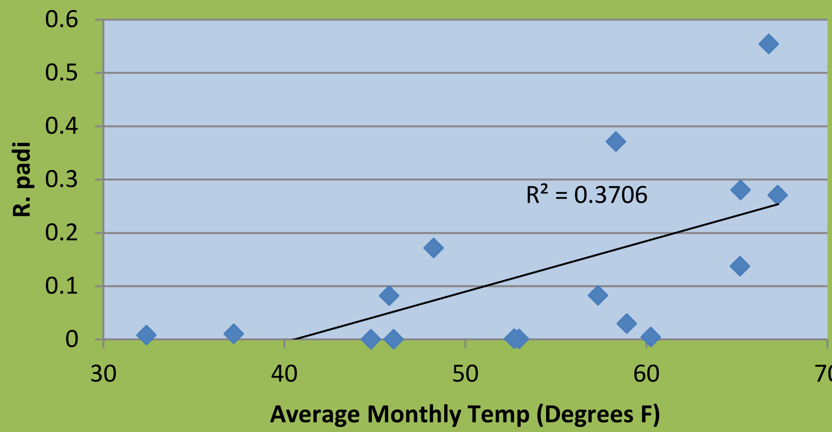


Statistically Significant Results

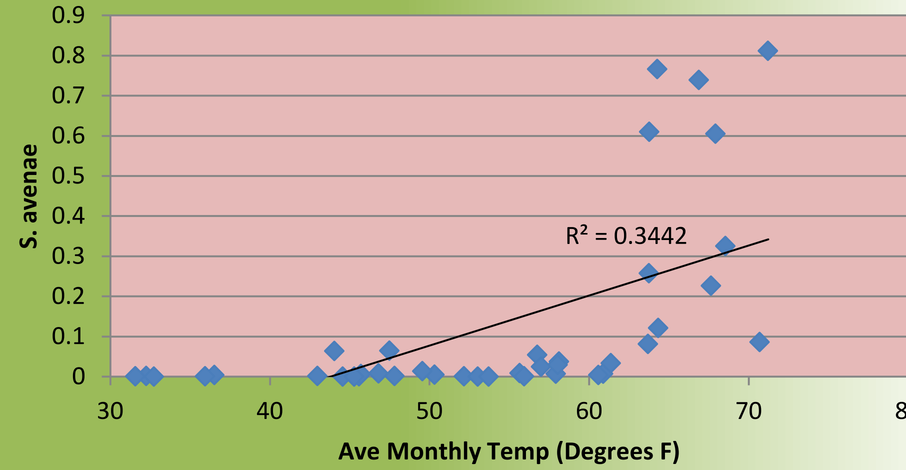
	5: (1984-1991)	Apr-Nov Tem	Dec-Mar Tem	Precipitation
El Niño	4.0968	33.8166667	41.1566667	36.6833333
La Niña	1.1938	31.6133333	39.93	26.02
La Nada	1.9258	31.2544444	37.5411111	34.4516667

Monthly Analysis Of Temperature And Precipitation

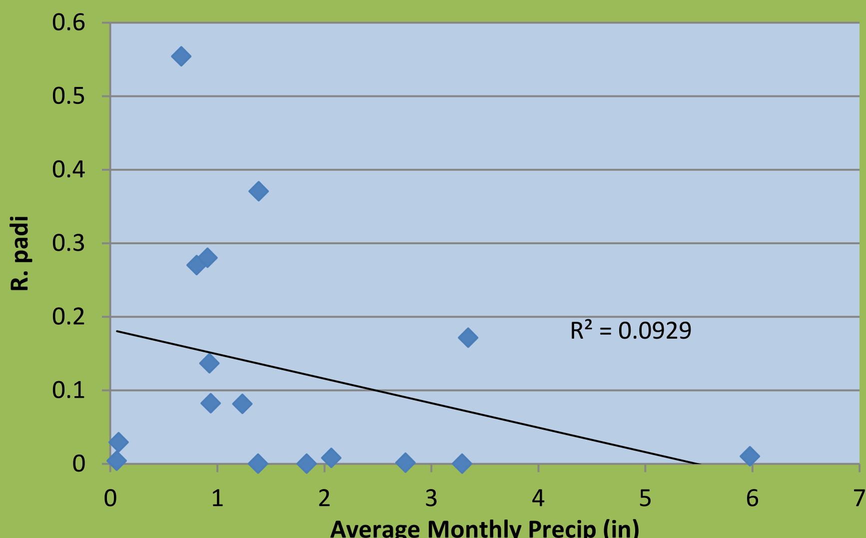
Proportional R. padi Monthly Averages as a Function of Average Monthly Temp



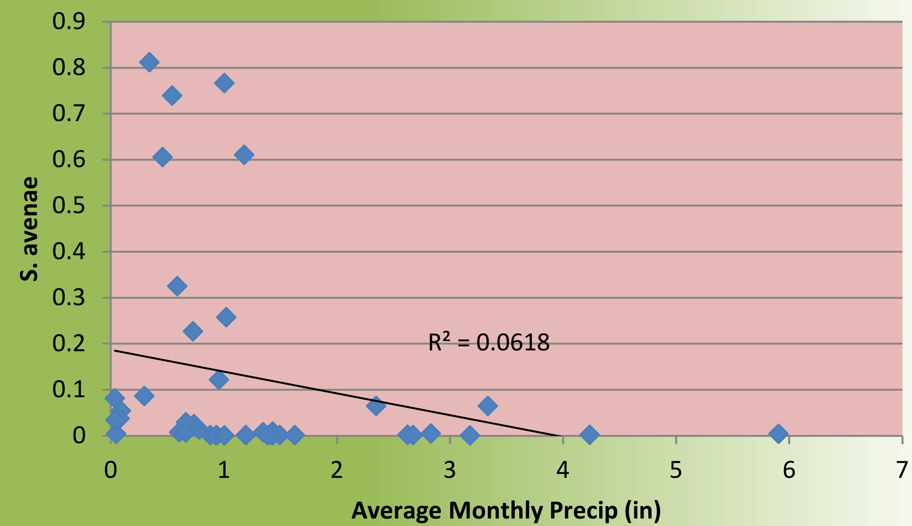
Proportional S. avenae Monthly Averages as a Function of Average Monthly Temp



Proportional R. padi Monthly Averages as a Function of Average Monthly Precipitation



Proportional S. avenae Averages as a Function of Average Monthly Precipitation



Summary Of Patterns Found:

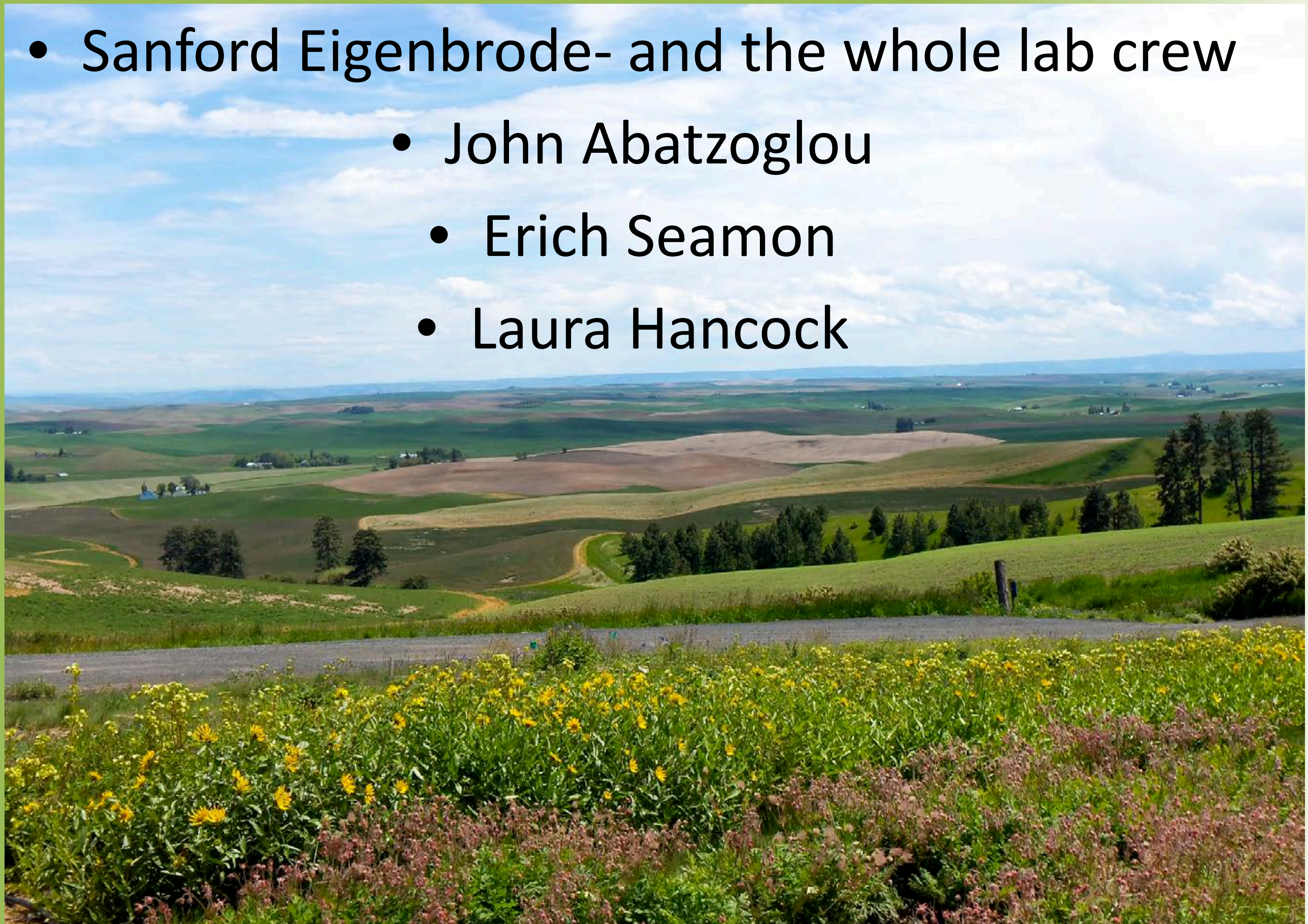
- Temperature and Precipitation yearly averages showed no correlation to average yearly totals of *R. padi* or *S. avenae* captured within each cluster.
- Climate data didn't explain the significant results obtained from analyzing El Niño, La Niña and La Nada years for total aphid abundance
- A larger proportion of yearly *R. padi* and *S. avenae* were captured during warmer months
- A smaller proportion of yearly *R. padi* and *S. avenae* were captured during wetter months

Future Explorations

- More in depth statistical analysis to find if there is significance with climate data
- Look at wind patterns and other climatic variables
- Explore other species
- Better understand the varying effects of climate change patterns on the Pacific Northwest and different locations within the REACCH region
- Develop a way to predict future years aphid abundance by the last years abundance patterns.

Acknowledgements

- Sanford Eigenbrode- and the whole lab crew
- John Abatzoglou
- Erich Seamon
- Laura Hancock



Resources Used

Finlay, K.J., Luck, J.E. 2011. Response of the bird cherry-oat aphid (*Rhopalosiphum padi)* to climate change in relation to its pest status, vectoring potential and function in a crop-vector-virus pathosystem. Agriculture, Ecosystems and Environment 144: 405-421.

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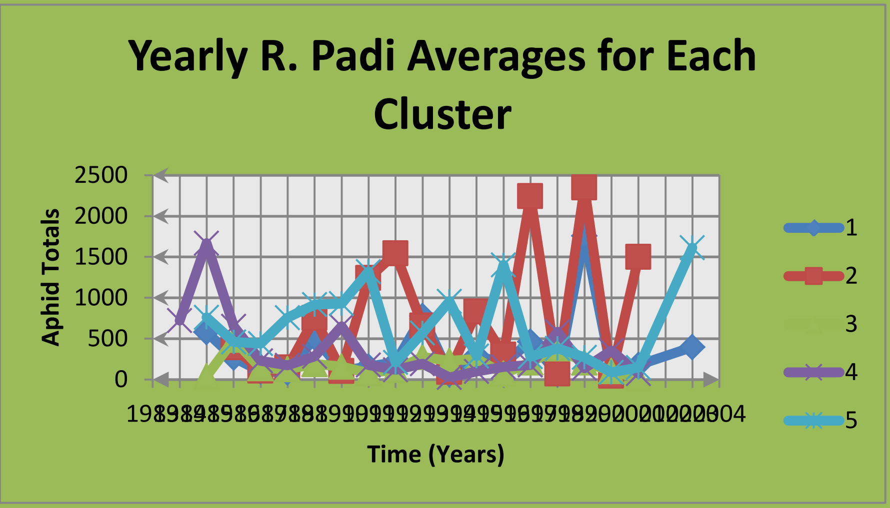
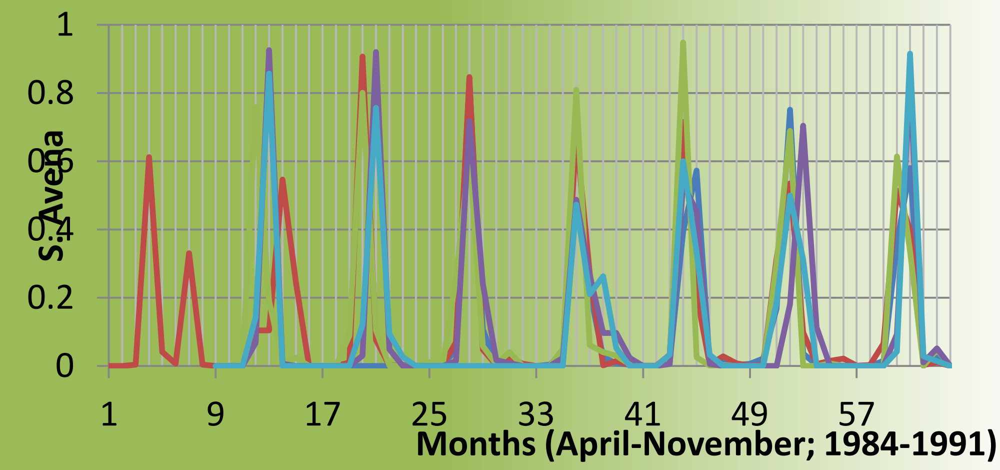
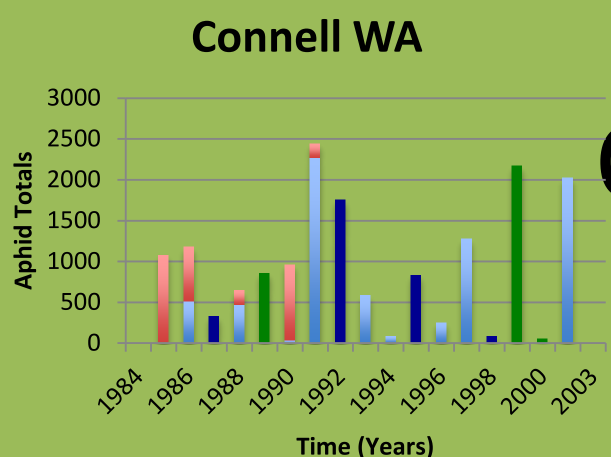
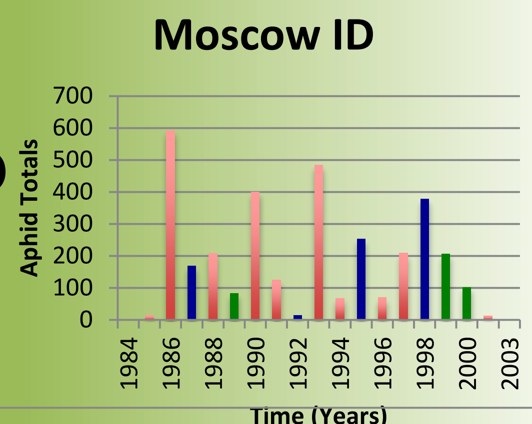
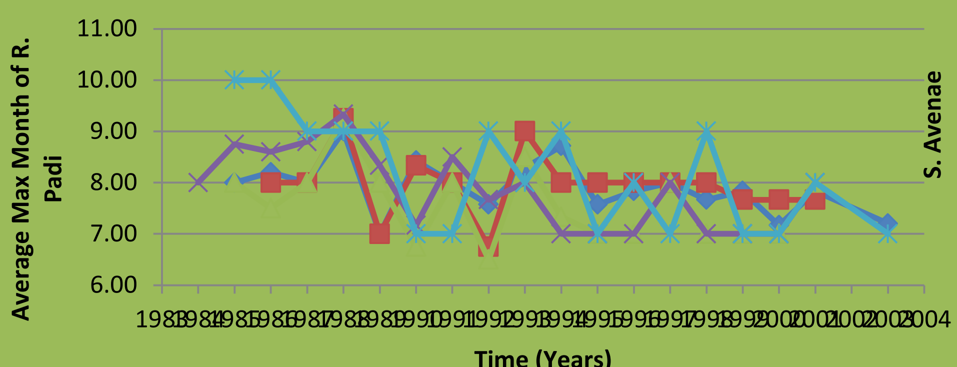

Yearly R. Padi Averages for Each Cluster
Aphid Totals
Time (Years)
1
2
3
4
5

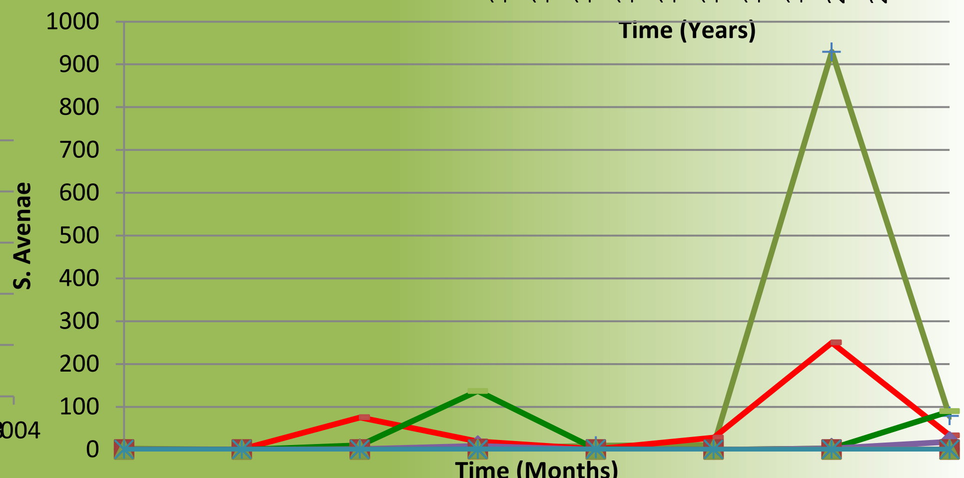

S. Avena
Months (April-November; 1984-1991)


Connell WA
Aphid Totals
Time (Years)

QUESTIONS???


Moscow ID
Aphid Totals
Time (Years)


Average Max Month of R. Padi
Time (Years)


S. Avenae
Time (Months)