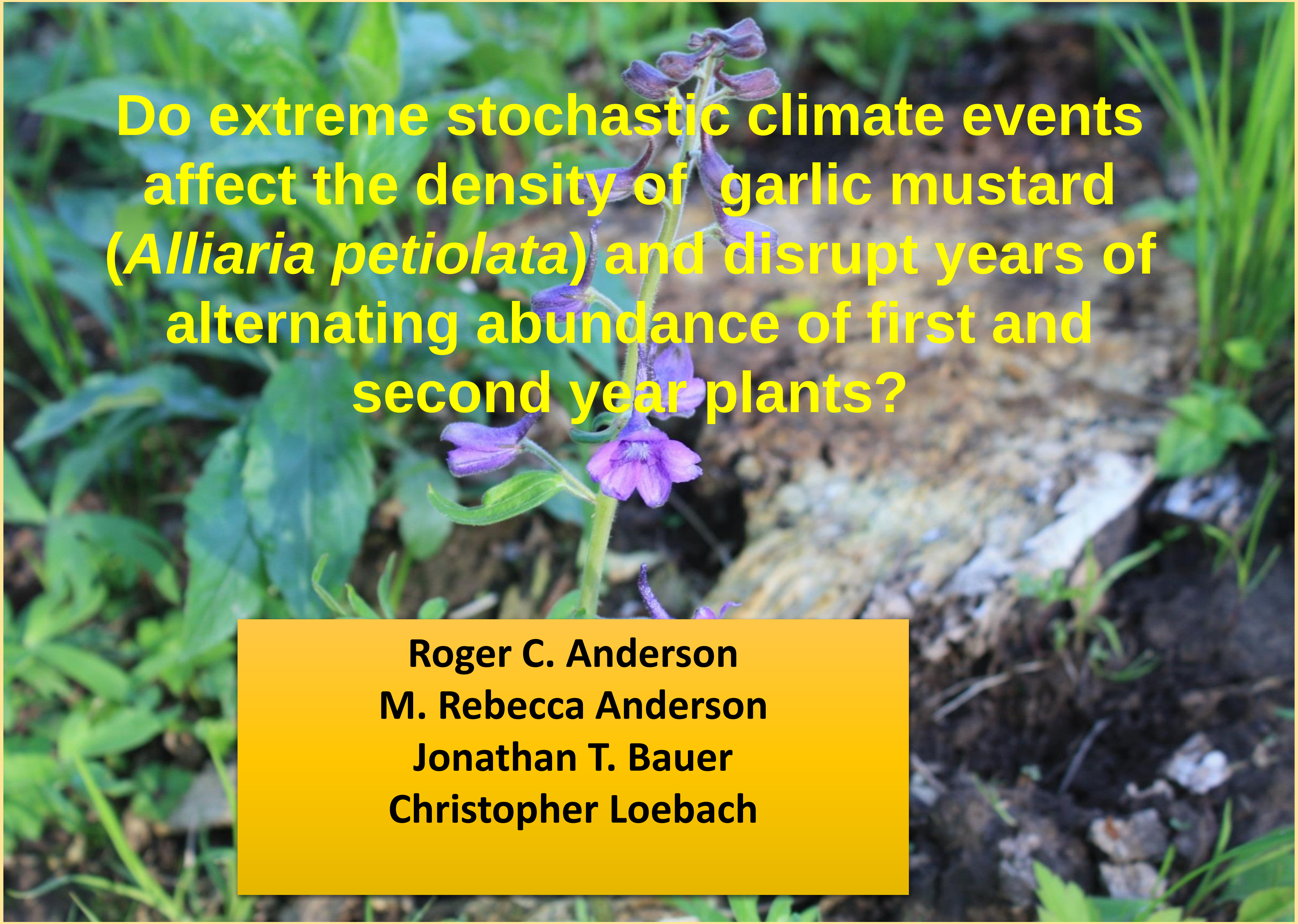


Do extreme stochastic climate events affect the density of garlic mustard (*Alliaria petiolata*) and disrupt years of alternating abundance of first and second year plants?

Roger C. Anderson
M. Rebecca Anderson
Jonathan T. Bauer
Christopher Loebach

Biennial – 2 Stage Life cycle

1st-year "**Rosette**" → 2nd-Year "A**dult**"

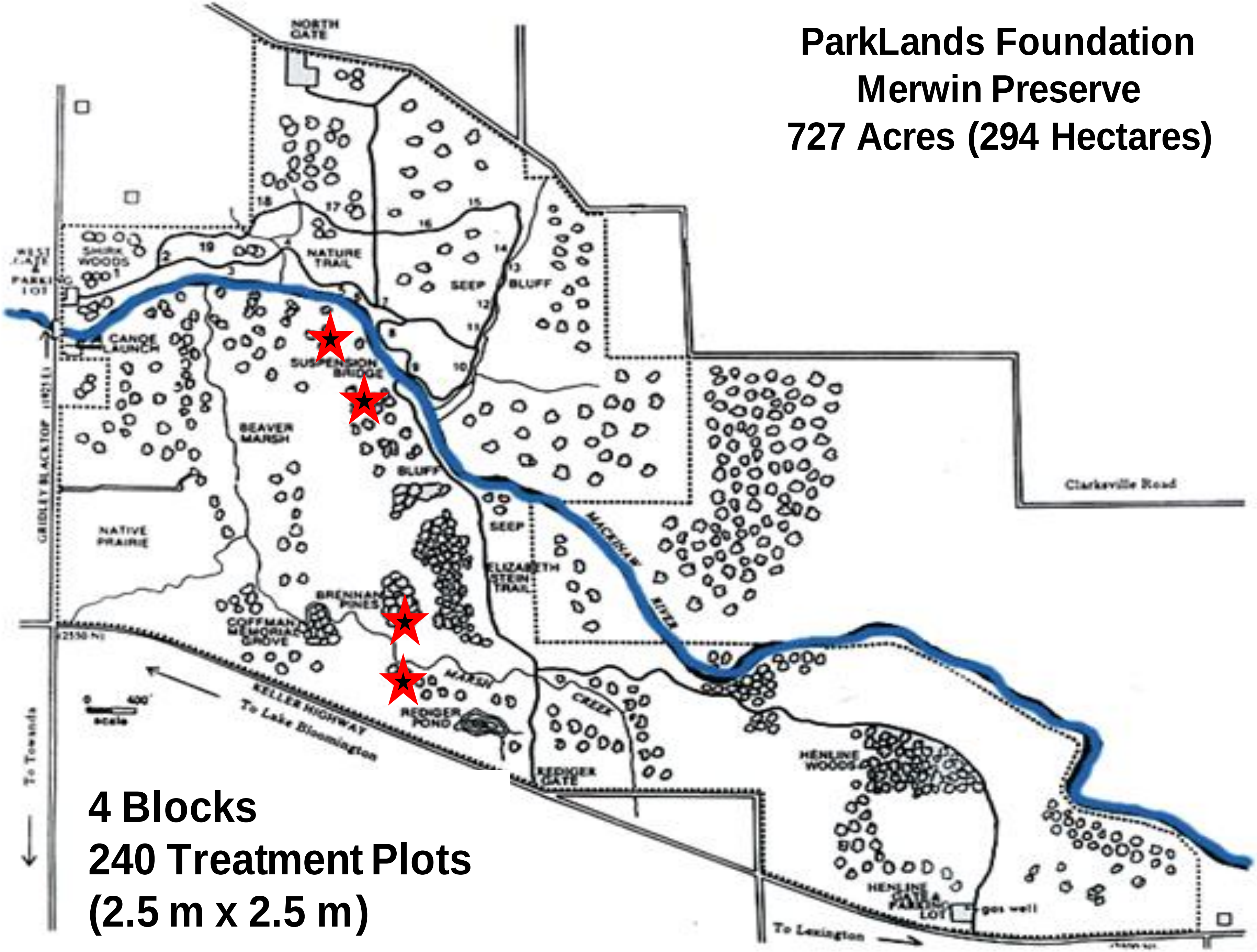
Questions asked in this Study

Do extreme climate events cause:

(1) a reduction in the abundance of the garlic mustard species and

(2) the collapse of the alternating abundance of 1st and 2nd year plants?

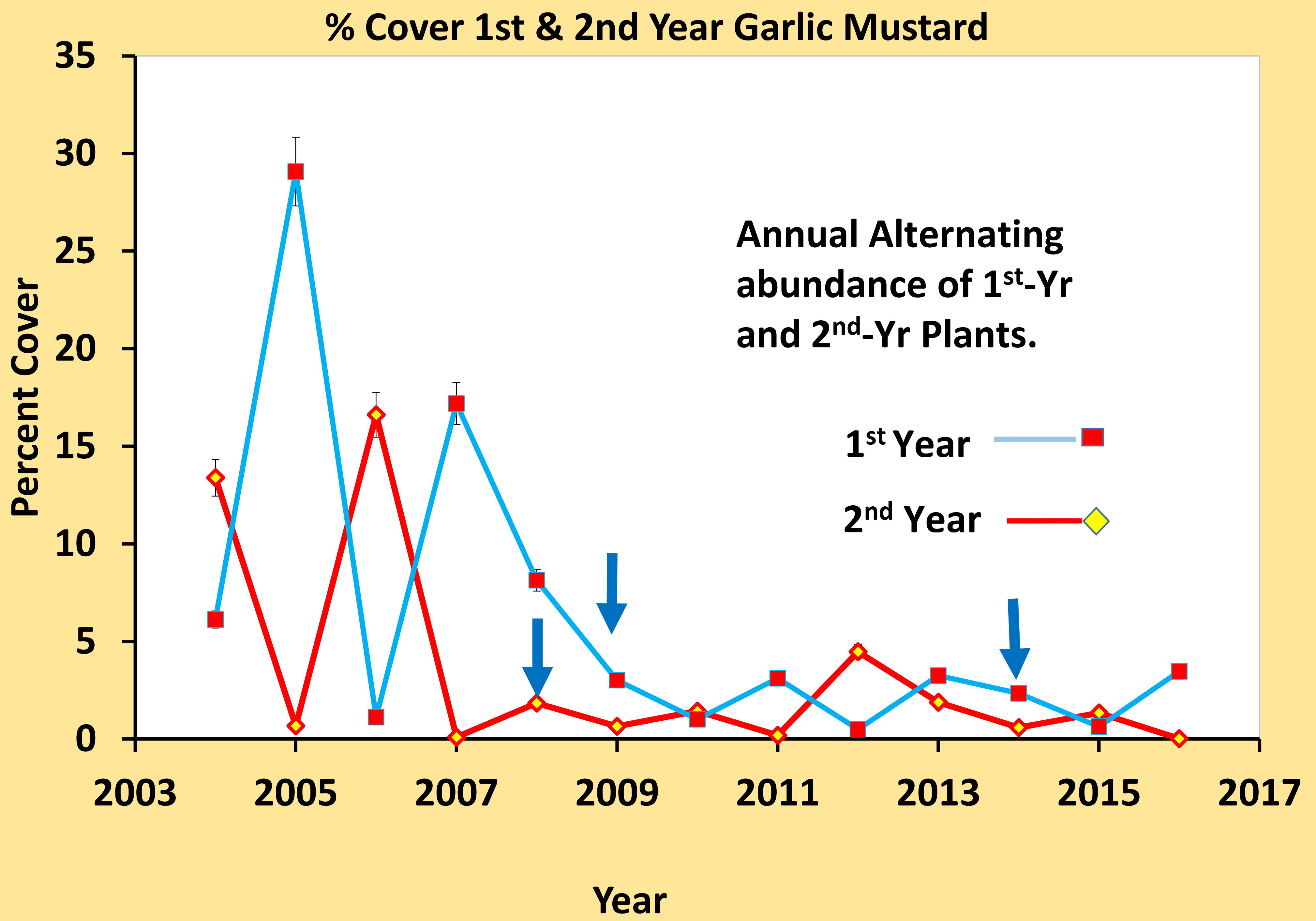
ParkLands Foundation
Merwin Preserve
727 Acres (294 Hectares)



4 Blocks
240 Treatment Plots
(2.5 m x 2.5 m)

Experimental Design

- Each Block has 60 Treatment Plots
  - 20 Plots were randomly assigned to each of three treatments
    - Early Pull 2nd-yr GM (Early to Mid-March)
    - Late Pull 2nd-yr GM (Early May)
    - Control
- Data collected in (50 cm x 50 cm Sampling Quadrat)
  - % Cover herbs & Woody (< 50 cm tall) estimated by species
  - Cover and Counts of 1st and 2nd yr GM plant

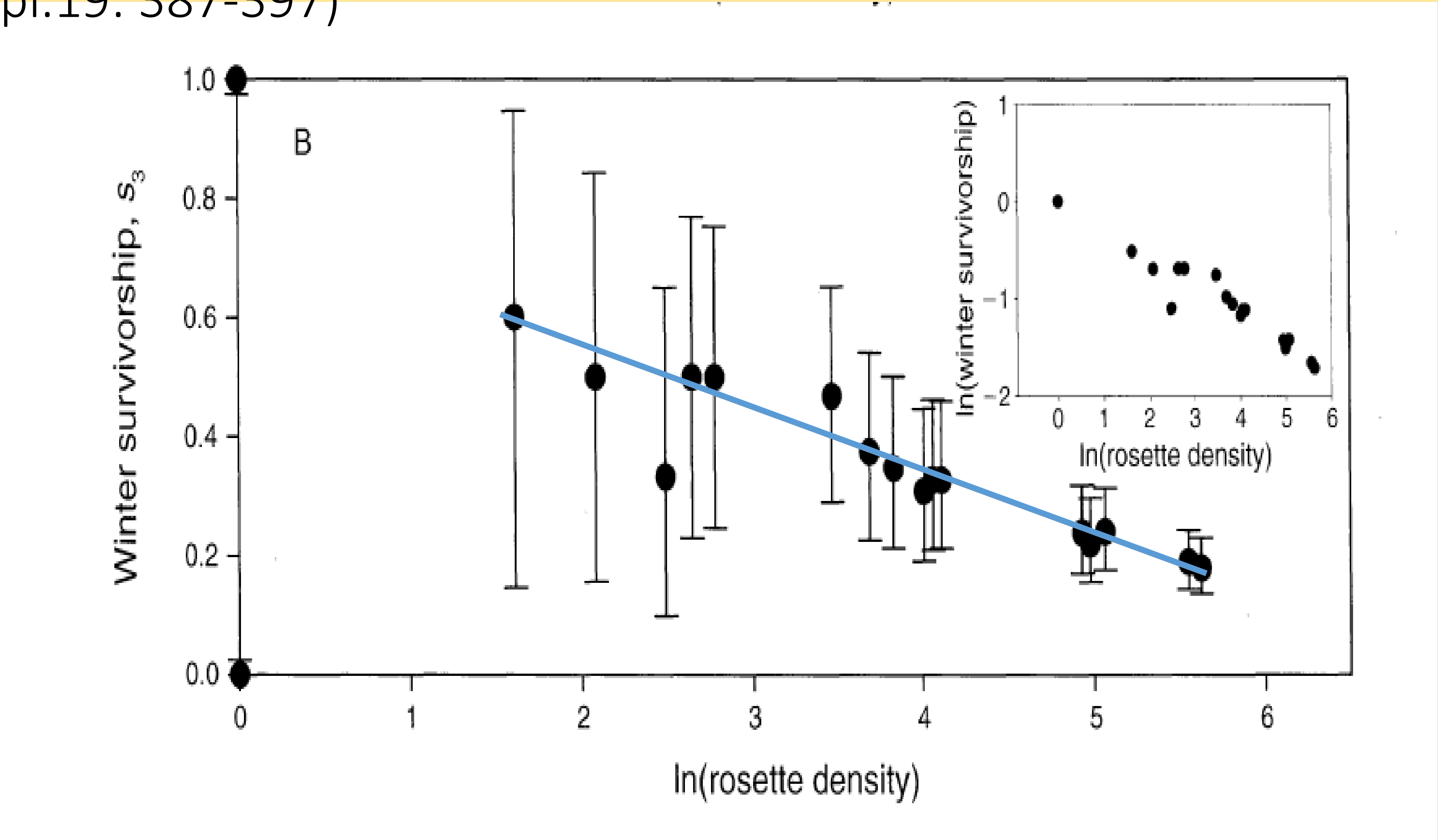

% Cover 1st & 2nd Year Garlic Mustard
Percent Cover
0
5
10
15
20
25
30
35
2003
2005
2007
2009
2011
2013
2015
2017
Year
Annual Alternating abundance of 1st-Yr and 2nd-Yr Plants.
1st Year
2nd Year

Method of Data Collection & Analysis for 2007-2008

(Pardini et al. 2009. Ecol. Appl.19: 387-397)

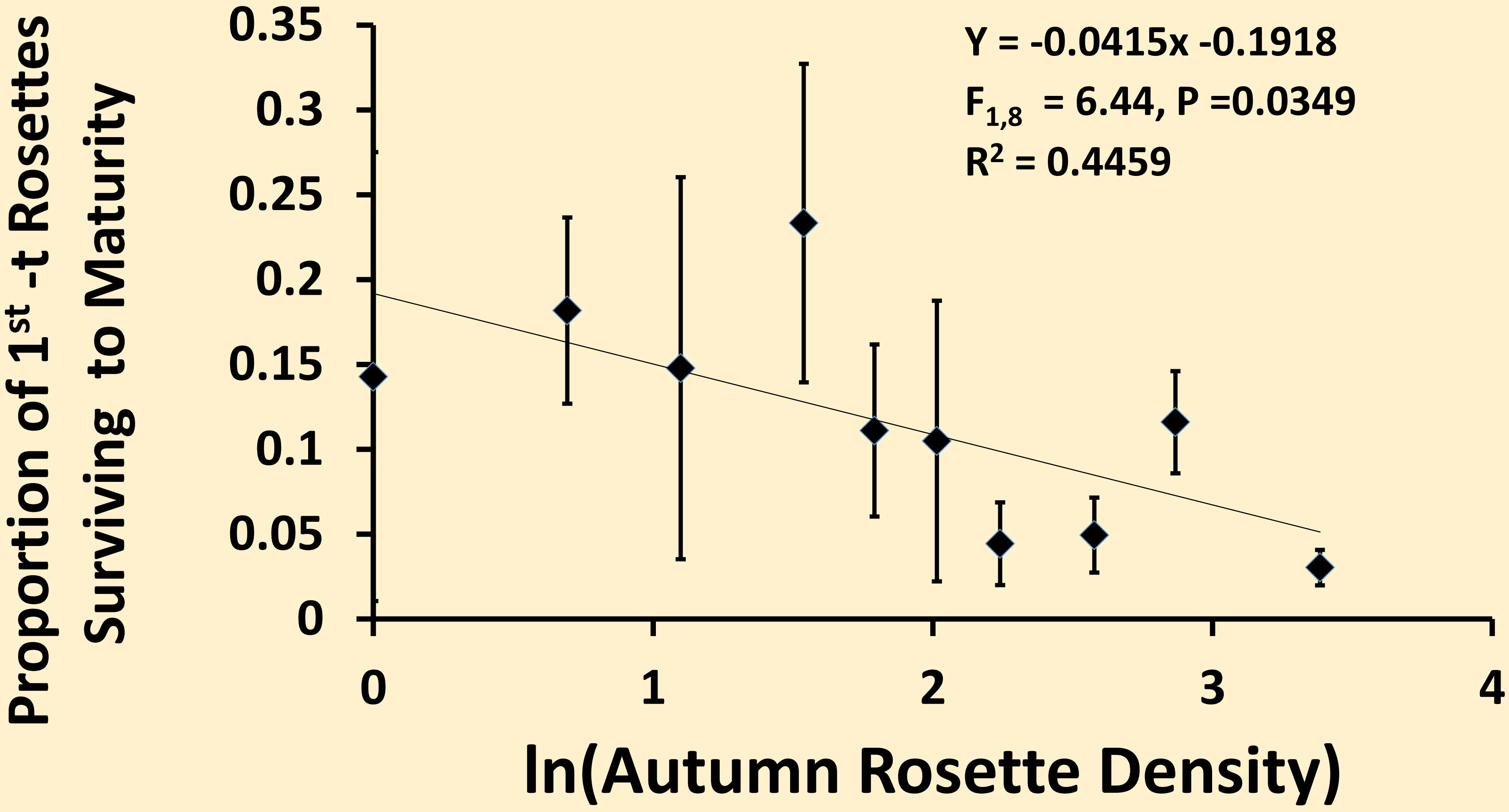
I. Counts of 1st-yr rosettes in mid-late July 2007 and mature plants in May 2008
II. 1st-yr rosettes were grouped by quadrats with similar densities
III. Proportion of 1st-yr rosettes surviving to maturity was plotted over the grouped data of 1st-year counts
IV. Portion of surviving 1st-yr plant was regressed against grouped data
V. Regression coefficient becomes more negative as density and intraspecific competition increases among 1st-year rosettes

Transition of 1st-year rosettes to mature plants (Pardini et al. 2009. Ecol. Appl.19: 387-397)



Regression coefficient = -0.2890

Survival of Rosettes to maturity as a function of ln(1st-YrRosette Density)



What does differences in regression coeffficients mean?

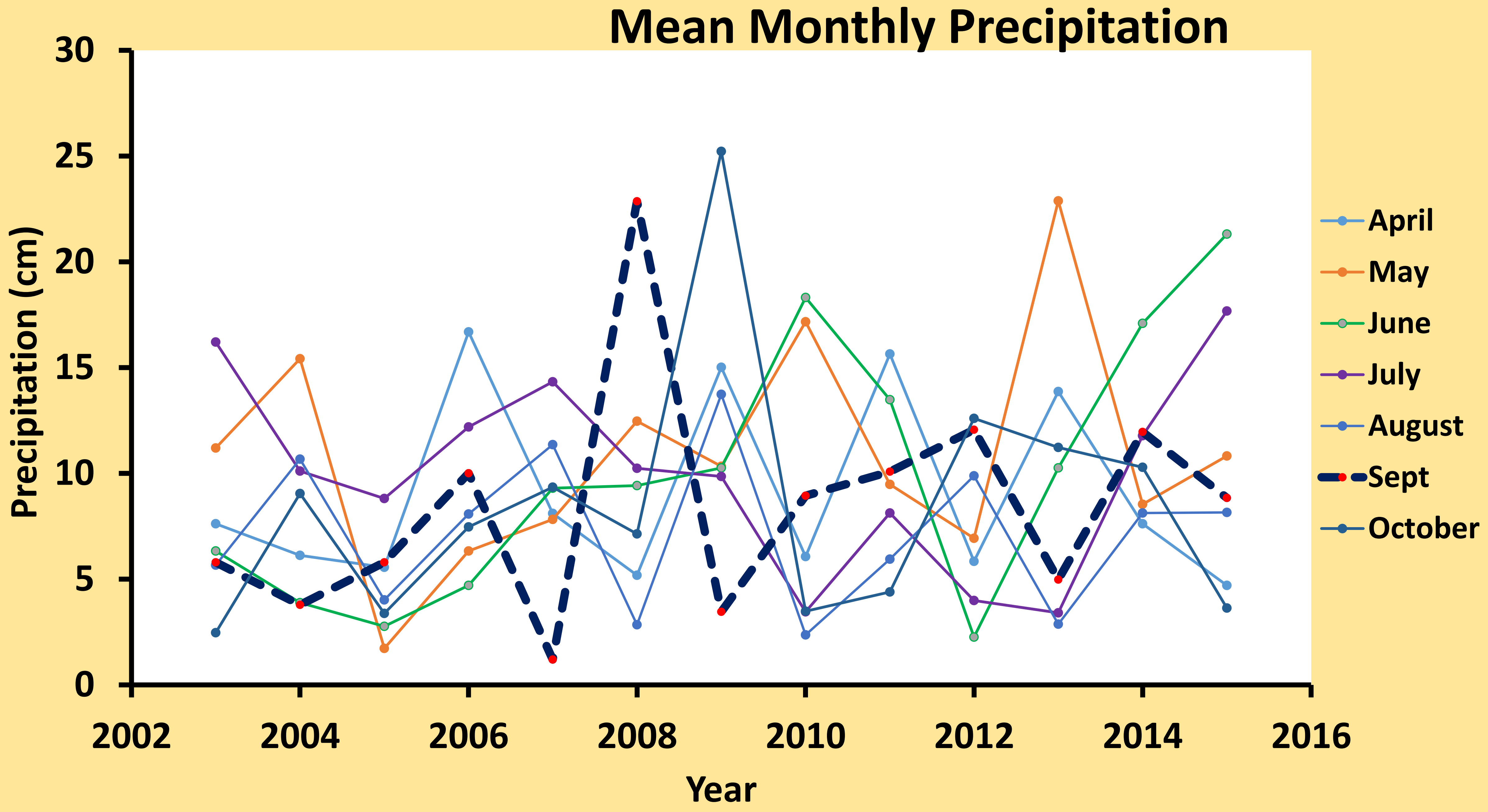
A. Pardini et al. (2009) study was conducted in years (2003-2004) and 1st-yr rosette mortality was more strongly due to intraspecific competition than in our study (2007–2008)

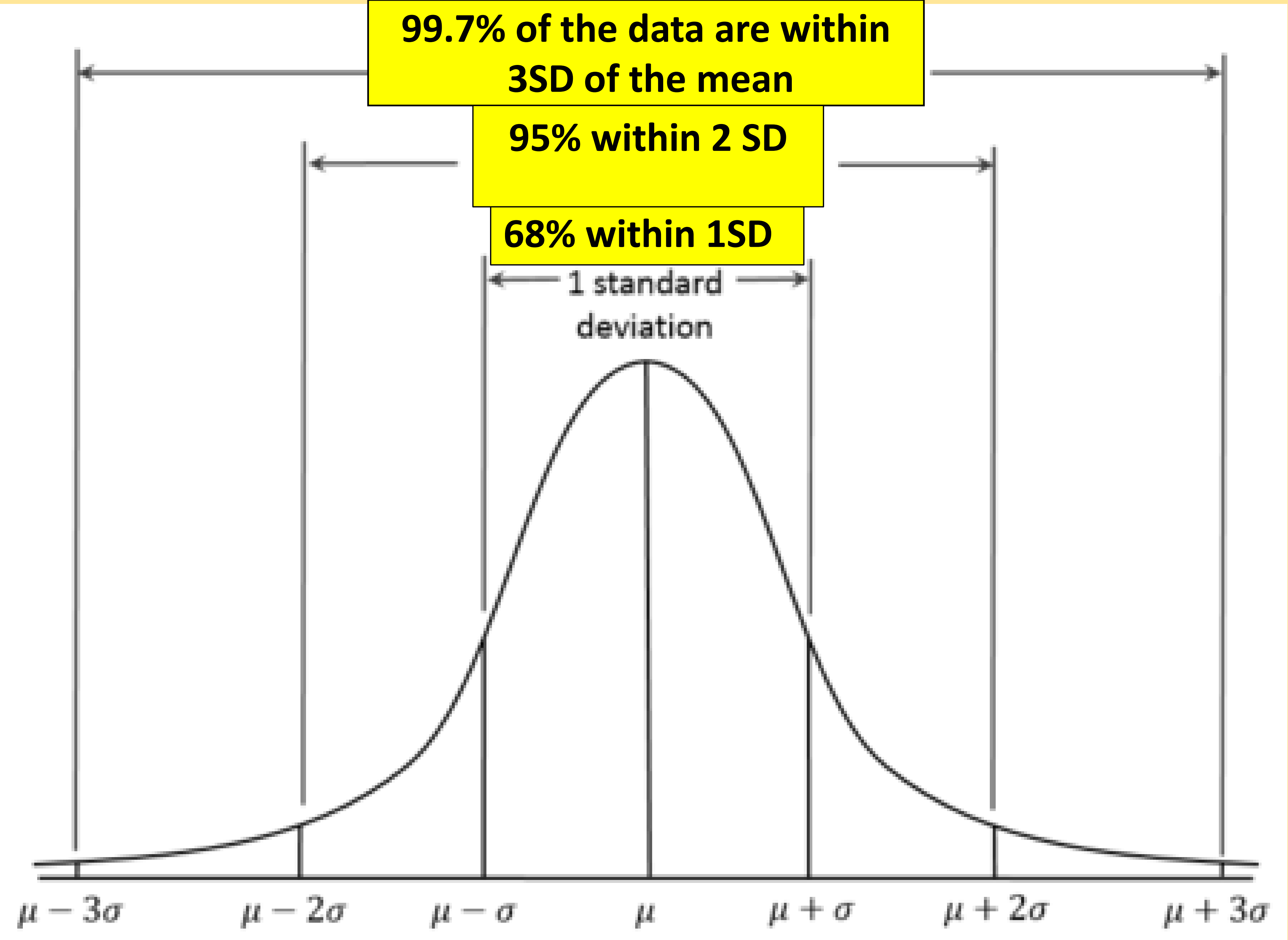
B. In our study, stochastic event (s) in 2007 likely reduced proportion of 1st yr rosettes that transitioned to mature plants causing:

   a. Low abundance of 2nd-yr plants in 2008 and

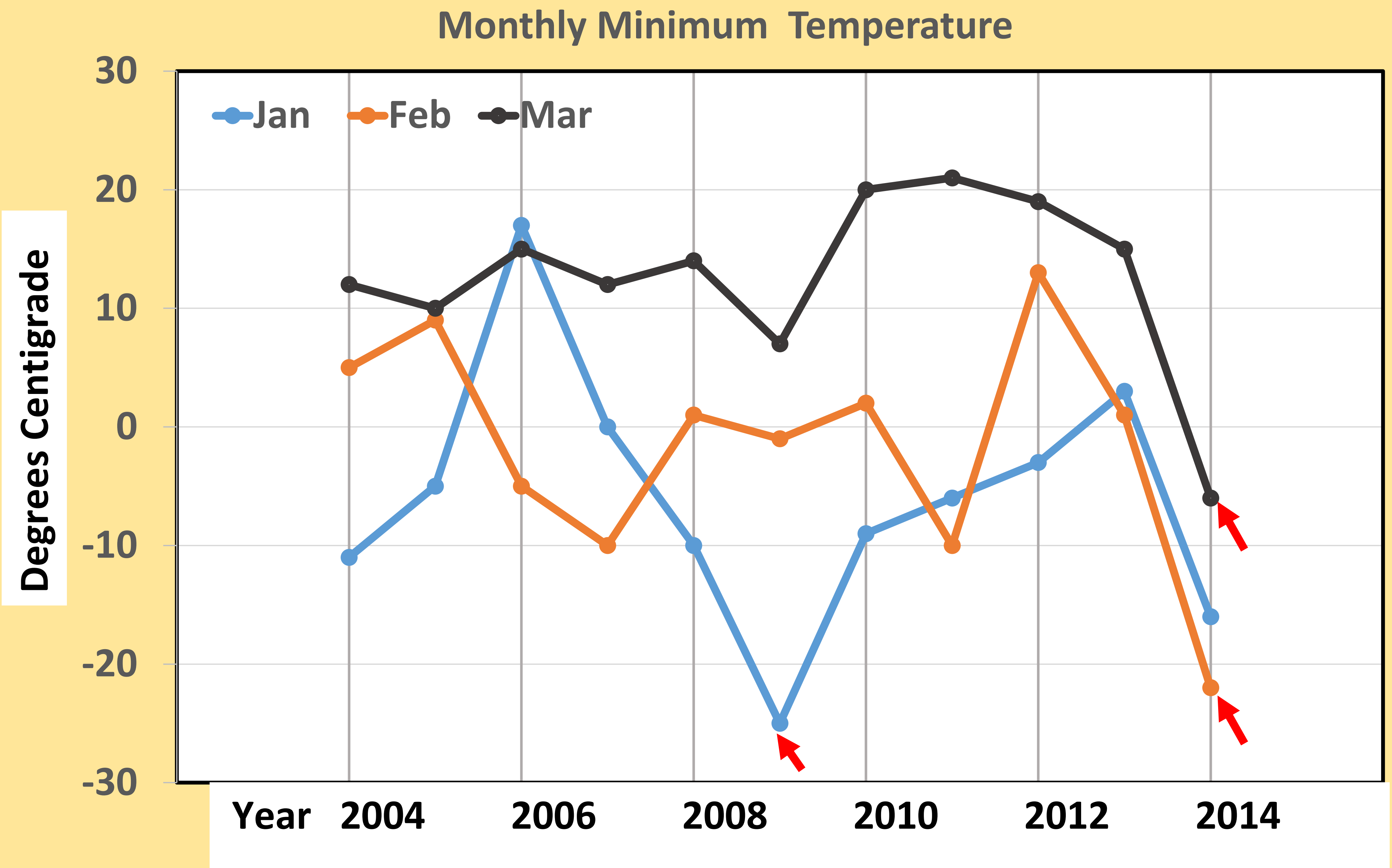
   b. High abundance of 1st-yr plant resulting from

      1. Reduced competition from 2nd-yr plants
      2. Germination of seed from the seed bank


Mean Monthly Precipitation
Precipitation (cm)
30
25
20
15
10
5
0
2002
2004
2006
2008
2010
2012
2014
2016
Year
April
May
June
July
August
Sept
October


99.7% of the data are within 3SD of the mean
95% within 2 SD
68% within 1SD
1 standard deviation
μ − 3σ
μ − 2σ
μ − σ
μ
μ + σ
μ + 2σ
μ + 3σ

Factors influencing Moisture Stress in Plants					
Year	Total Ppt. (cm)	Days w/ Ppt.	Contig. Days w/o Ppt.	Days > 30º C	Mean Temp. ºC
2004	3.8	1	15	1	19.6
2005	5.8	7	15	14	21.8
2006	10	9	7	0	17.6
2008	2.9	11	12	3	19.3
2009	3.5	7	13	0	18.5
2010	8.9	11	7	7	19.4
2011	10.1	11	4	3	16.9
2012	12.1	5	9	4	18.2
2013	5	6	8	7	20.4
2014	12	5	14	2	17.8
Mean	7.4	7.3	10.4	4.1	19
SD	-3.4	-3.1	3.7	4.1	1.4
μ+SD	4.0	4.2	14.1	8.2	20.4
μ+2SD	0.6	1.1	17.8	12.3	21.8
μ+3SD	-2.8	-2	21.5	16.4	23.2
Yr. 2007	1.2*	2*	22***	13**	21*



Monthly Minimum Temperature
Jan
Feb
Mar
Degrees Centigrade
30
20
10
0
-10
-20
-30
Year
2004
2006
2008
2010
2012
2014

Minimum Monthly Temp. °C			
Year	Jan	Feb	Mar
2004	-23.9	-15.0	-11.1
2005	-20.6	-12.8	-12.2
2006	-8.3	-20.0	-9.4
2007	-17.8	-23.3	-11.1
2008	-23.3	-17.2	-10.0
2009	-31.7**	-31.7	-13.9
2010	-22.8	-16.7	-6.7
2011	-21.1	-23.3	-6.1
2012	-19.4	-10.6	-7.2
2013	-16.1	-17.2	-9.4
2014	-26.7	-30.0***	-21.1**
2015	-24.4	-21.7	-20.6
Mean	-20.4	-17.8	-10.7
1SD	4.9	3.9	3.8
μ-1SD	-25.3	-21.7	-14.6
μ-2SD	-30.2	-25.7	-18.4
μ-3SD	-35.1	-29.6	-22.3

Coldest on Record 1950 -2015
January 2009
February and March 2014

Daily Minimum Temp. Data (1951-2016)

Coldest Daily Record			Monthly Long-term Daily Record				
Year	Month	Min.	Mean	SD	μ-1SD	μ-2SD	μ-3SD
2009	Jan	-31.7**	-22.0	4.7	-26.7	-31.5	-36.2
2014	Feb	-30.0**	-19.0	4.8	-23.8	-28.6	-33.4
2014	Mar	-21.1**	-11.8	3.9	-15.7	-19.6	-23.5