Long term fruiting response to climate in the mid-elevation evergreen forests of southern Western Ghats, India

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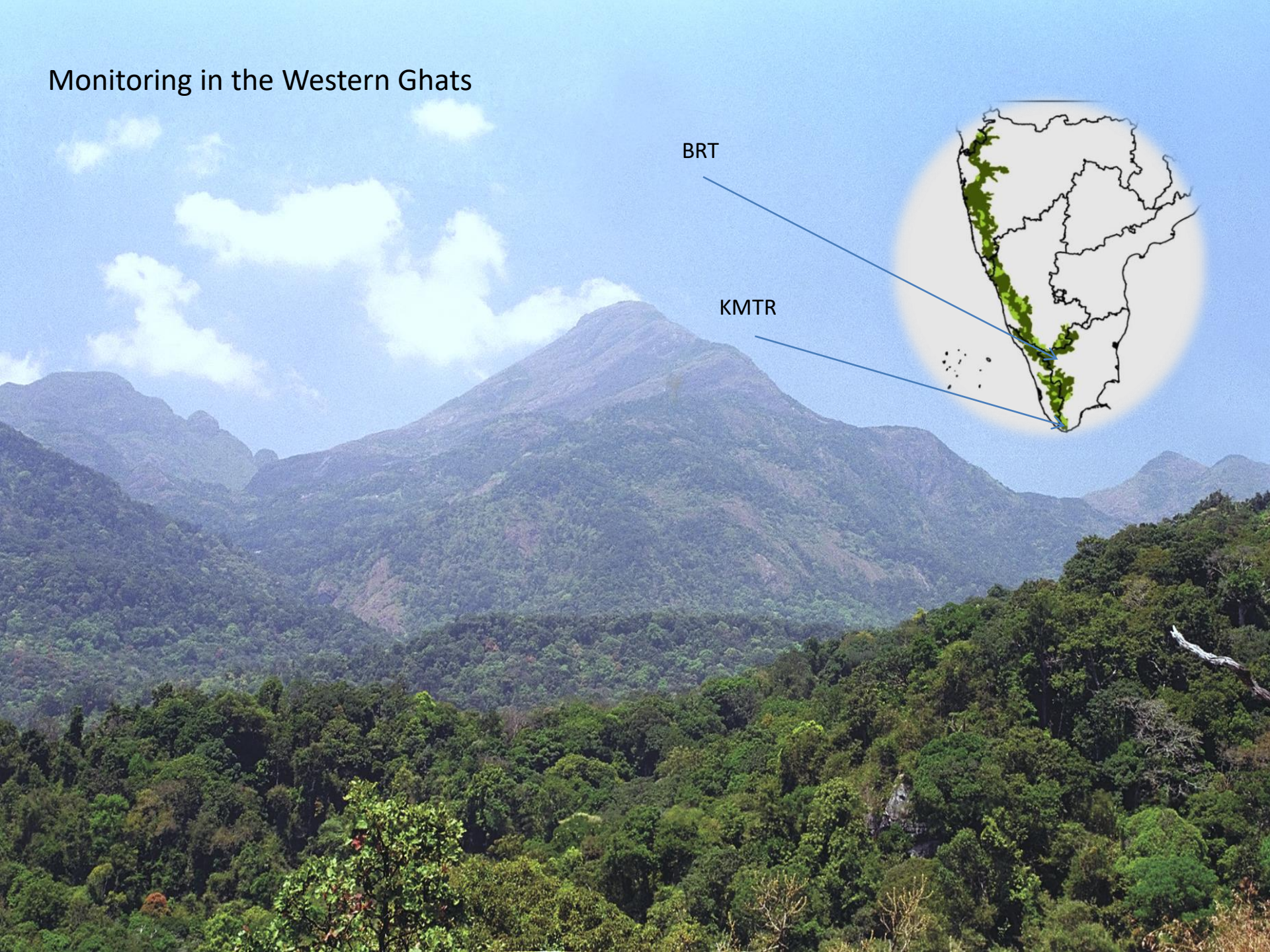
Phenological monitoring in India

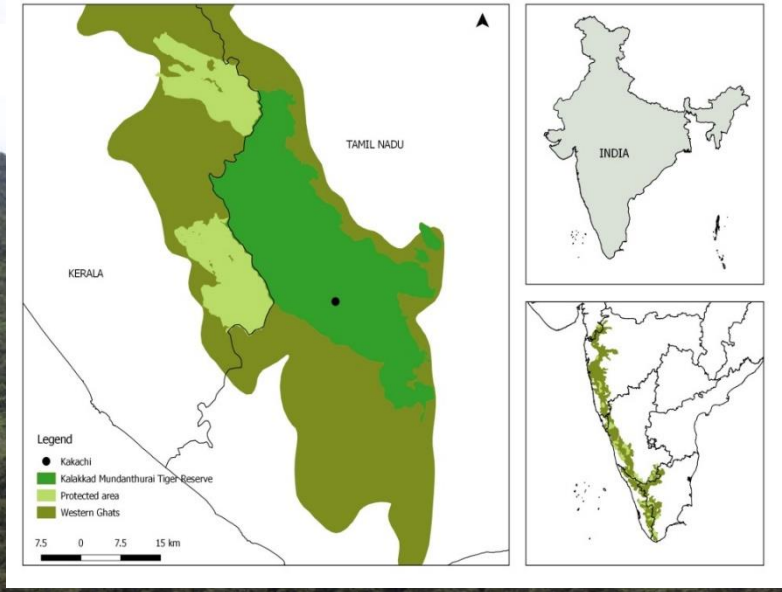
- Tropical phenology monitoring has been limited to short-term studies in India*
- Very few long-term efforts have been carried out but not from the evergreen forests of Western Ghats.
- India is experiencing climate change effects but we have very little information on how it affects our biota.

*Geetha et al 2018

Monitoring in the Western Ghats



Kalakad Mundanthurai Tiger Reserve



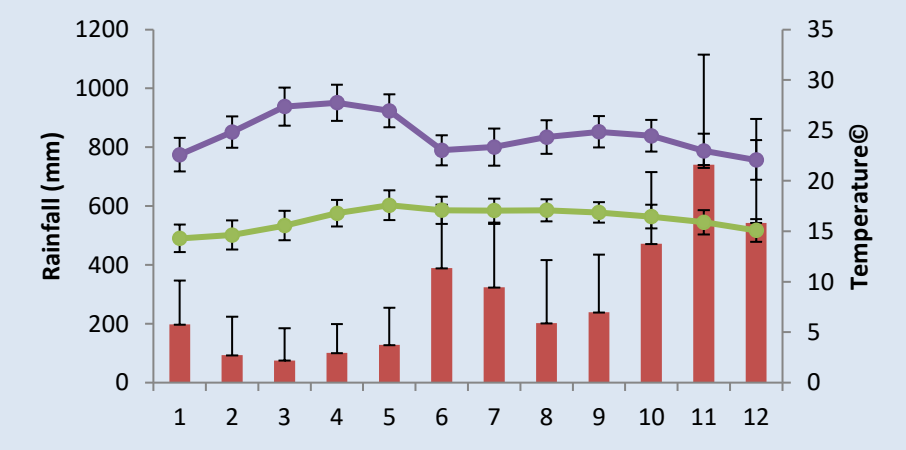
Largest stretch of undisturbed wet evergreen forests in southern Western Ghats.

Kalakad Mundanthurai Tiger Reserve

High annual rainfall (3000-5000mm) spread over 6-7 months with a break of 30-40days in between

Temperatures: 14 – 28 C

Severe rainfall events are rare



High level of Endemism – 48% tree species and several animal species are endemic to WG

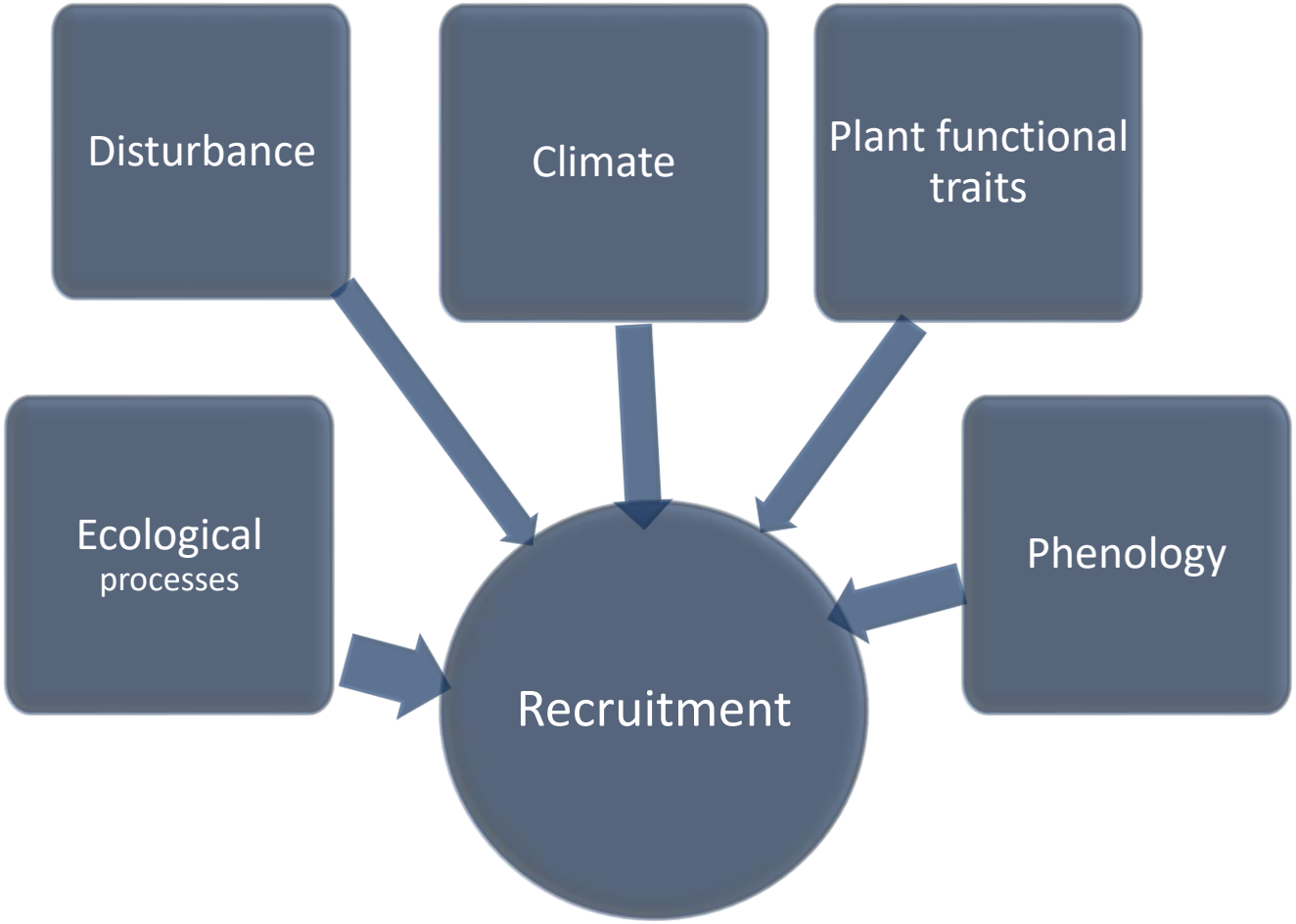
Lion tailed macaque

Grey langur

Palaquium elipticum **(Sapotaceae)**
Central & S.W.G

Cullenia exarillata **(Bombacaceae) –**
Central & S.W.G

Long term monitoring 1990



Broad Objectives

- Long-term trends in fruiting (1991-2021)
  - Trends in fruiting differ between species that occupy different strata in the evergreen forest.

- Global vs regional effects
  - Minimum temperature is positively related to fruiting.
  - Elnino effects will vary between species.

Tutin & Fernandez (1993), Chapman et al 2005, Babweteera et al 2018

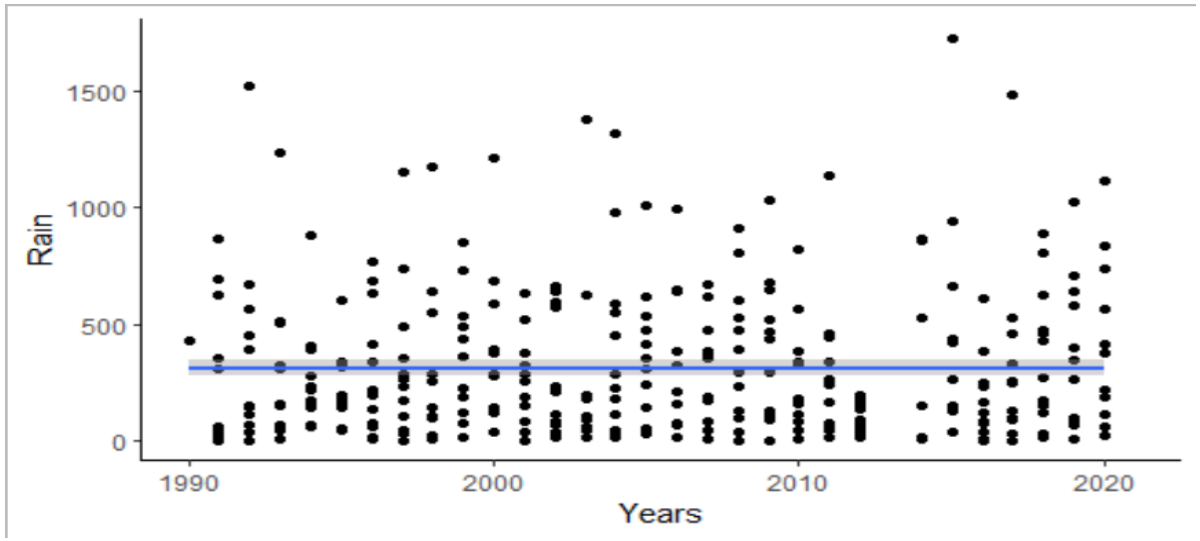
Methods

- Trees were first marked in 1990-91 along trails in the forests.
- We also tagged 15-30 individuals of species that were numerically abundant in the forests.
- Flushing, senescence, flowering, fruiting, herbivory
- This was done once a month.
- We calculate the proportion of trees in fruit in this analysis

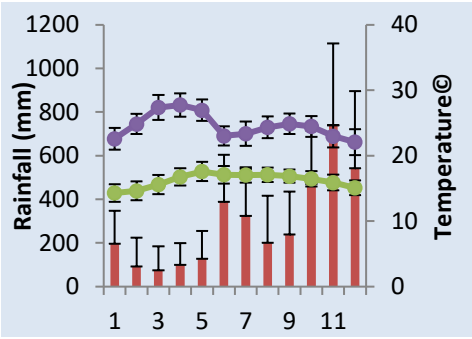
Monitoring profile – phenology and climate

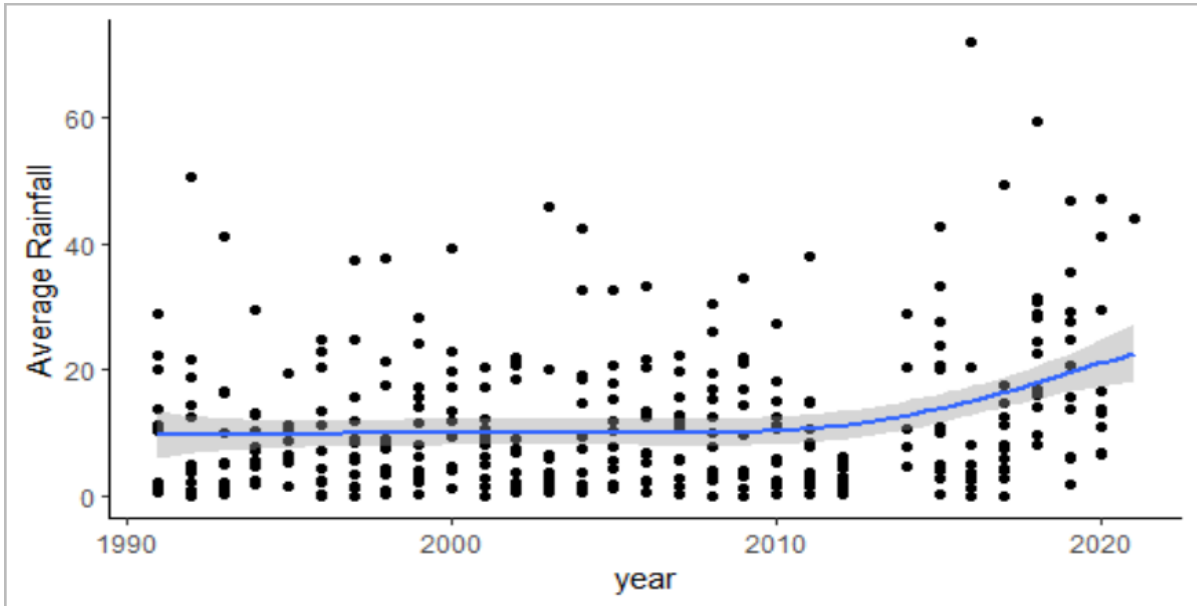
Site	No. sp	No. individuals (approx)	No. years	Parameters (5)	climate
KMTR	70 +/-	800+/-	30	Flushing, senescence, flowering, fruiting, herbivory	30 y of rainfall and temperature

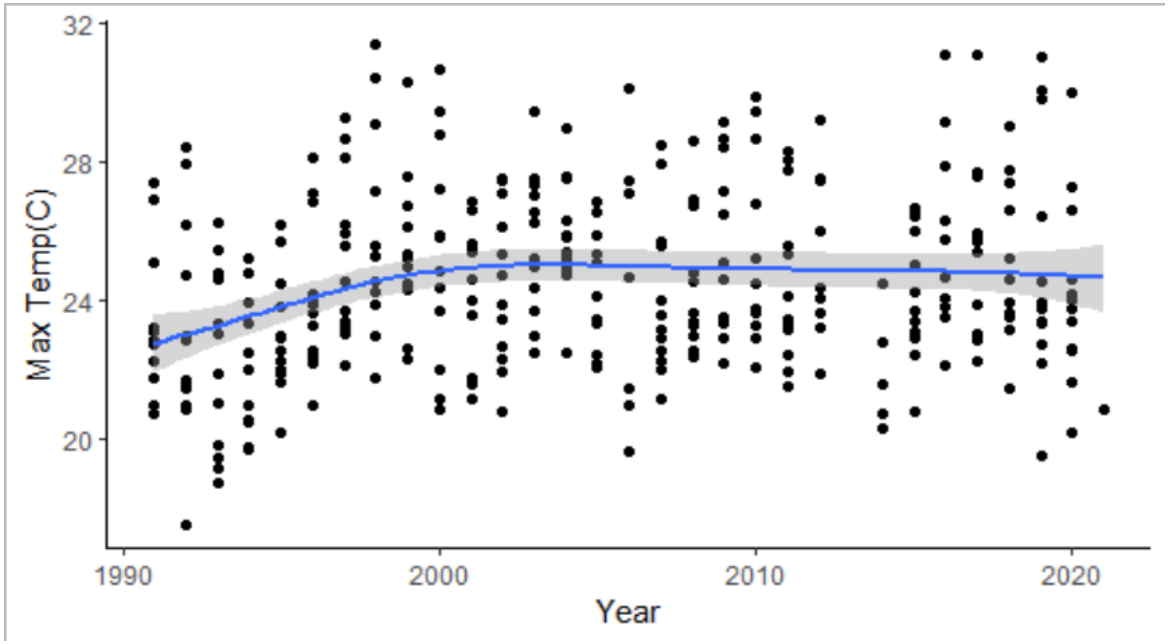
CLIMATIC TRENDS


Rain
1500
1000
500
0
1990
2000
2010
2020
Years

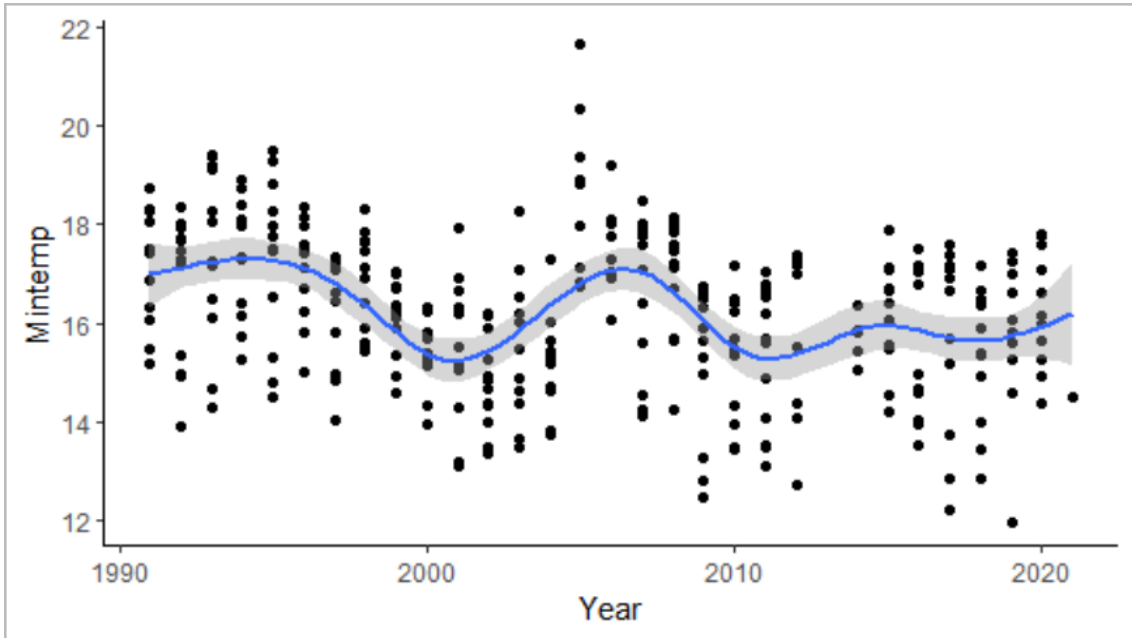
R^2= 0.001, p=ns


Rainfall (mm)
1200
1000
800
600
400
200
0
40
30
20
10
0
Temperature©
1
3
5
7
9
11

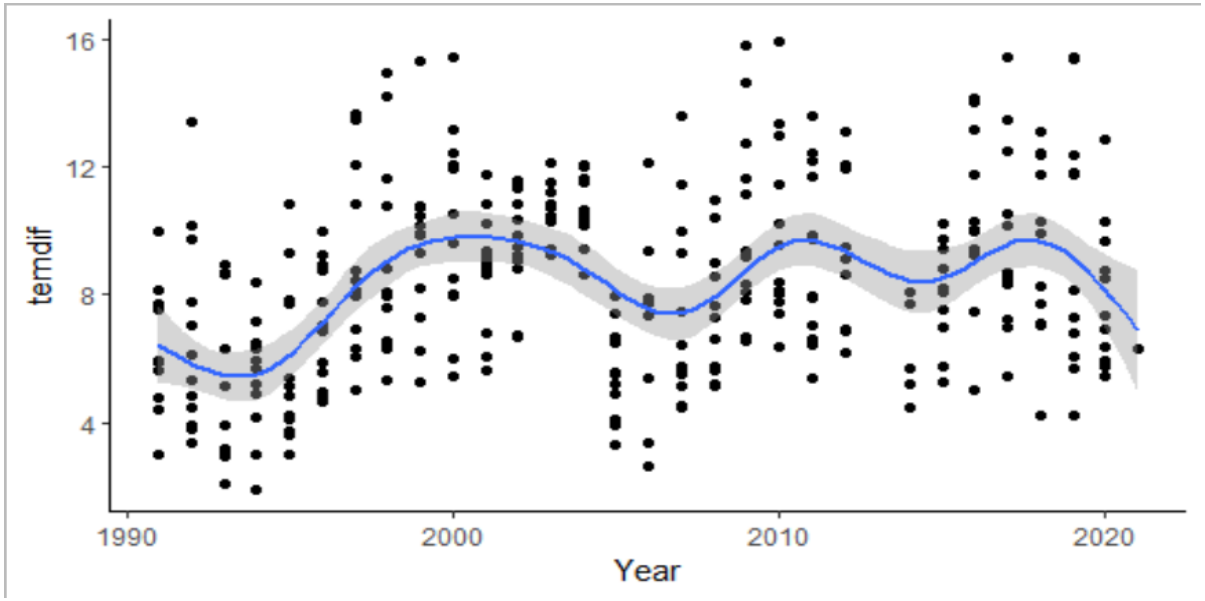

Average Rainfall
60
40
20
0
1990
2000
2010
2020
year



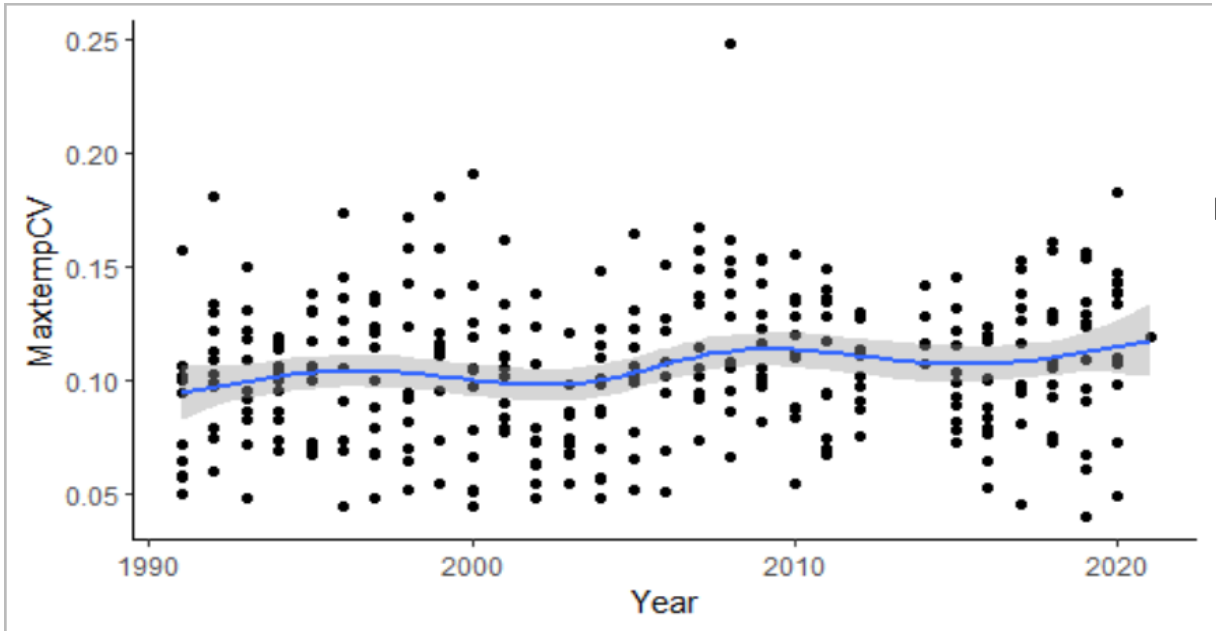
R^2= 0.03, p<0.001



R^2= - 0.06, p<0.00001



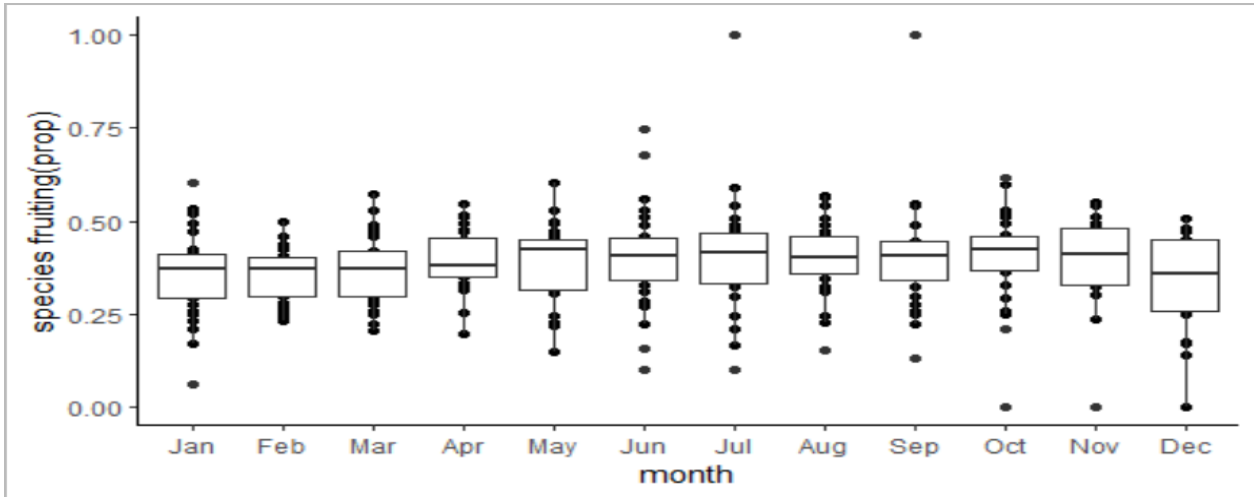
R^2= 0.070, p<0.00001

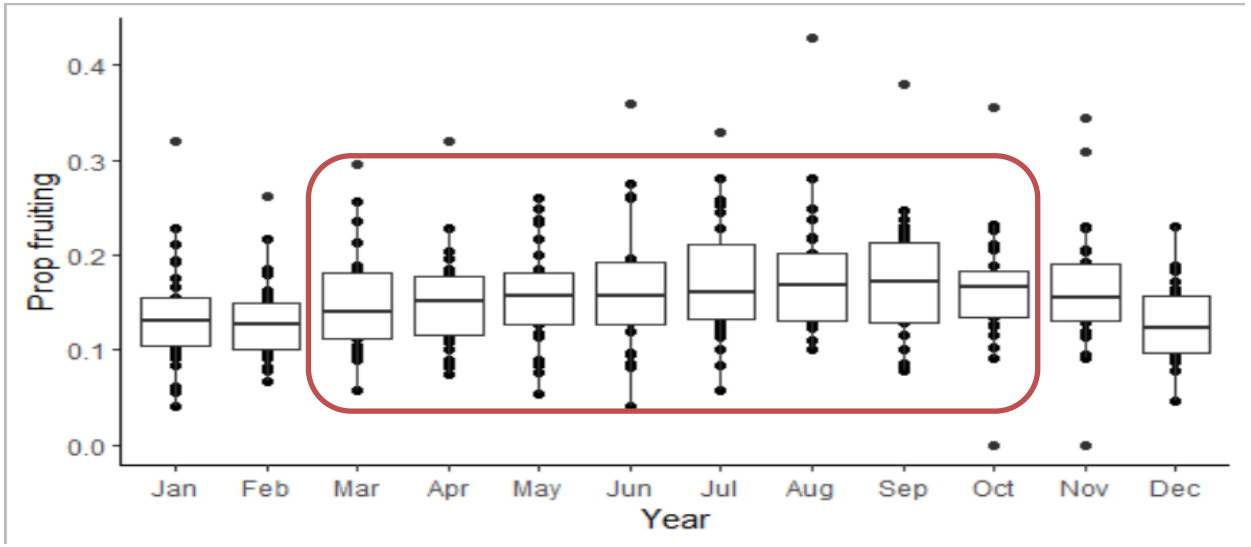


R^2= 0.024, p<0.0001

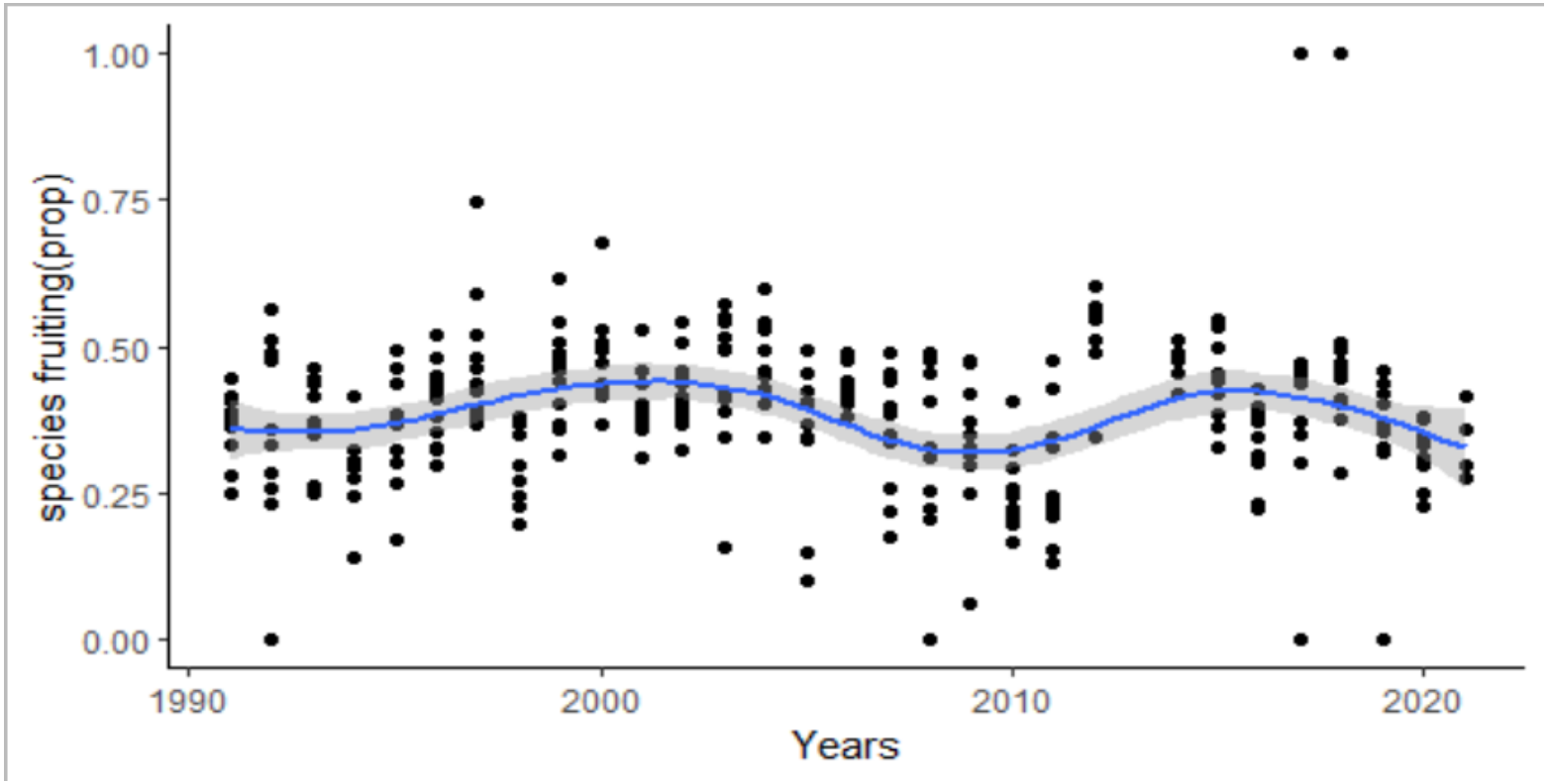
PHENOLOGICAL TRENDS

Community-level patterns

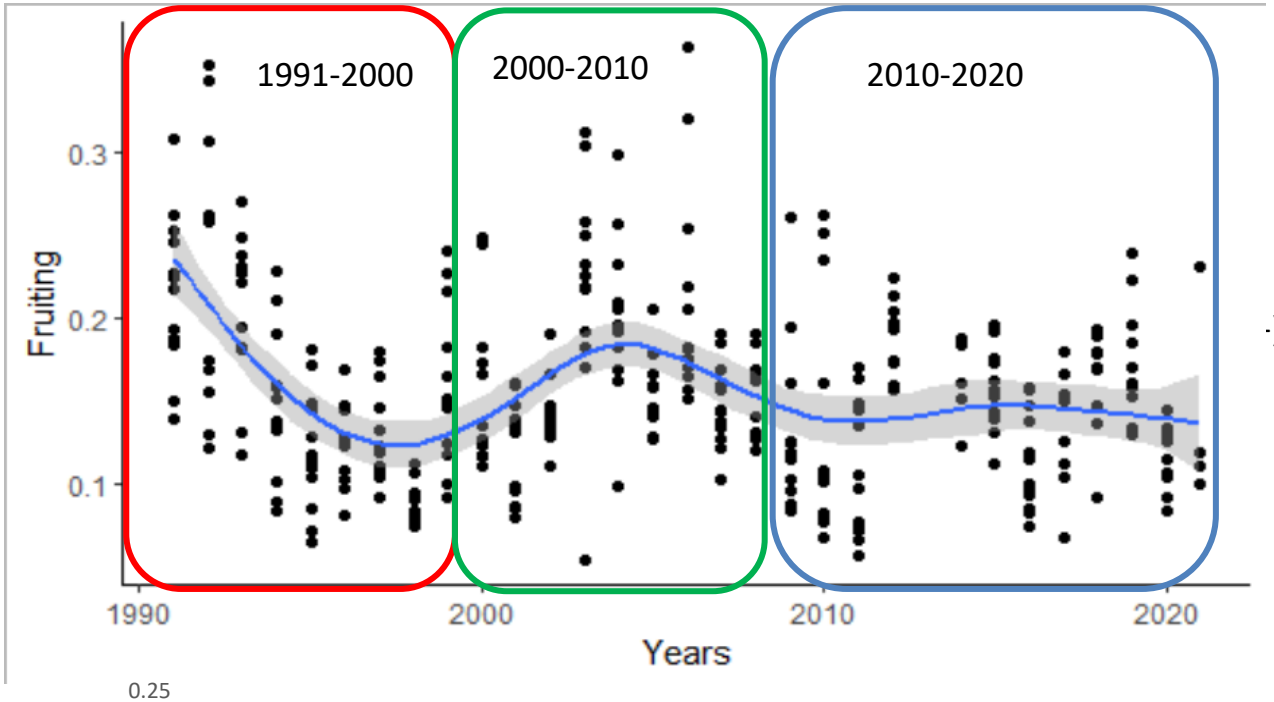




Species trend



Trees in fruit



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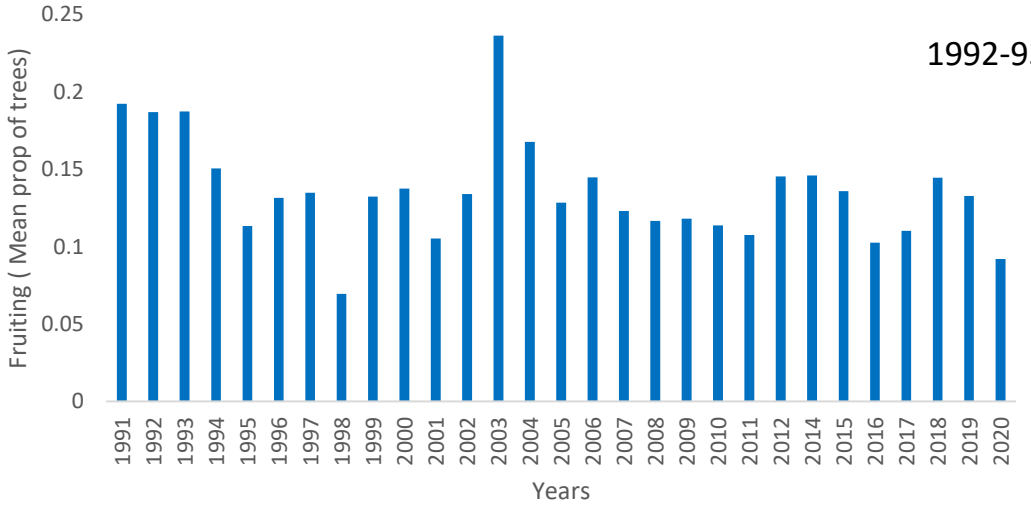
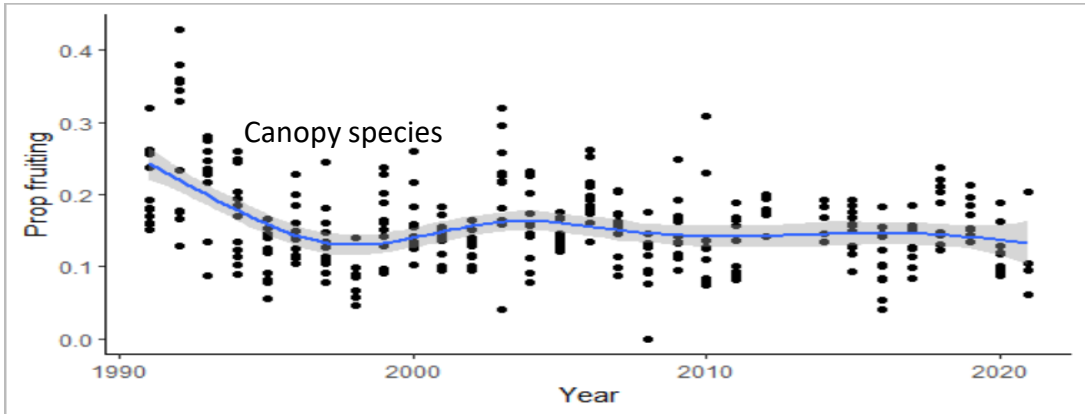
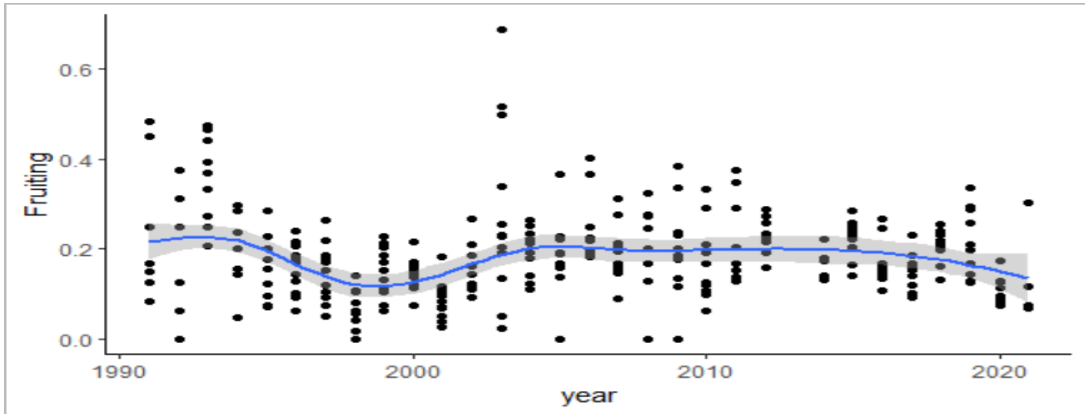


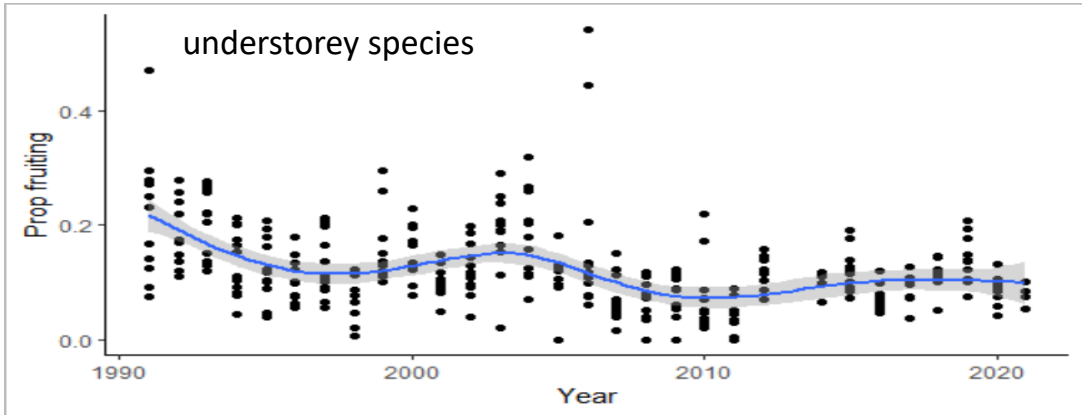
1992-93, 2003 were major fruiting years



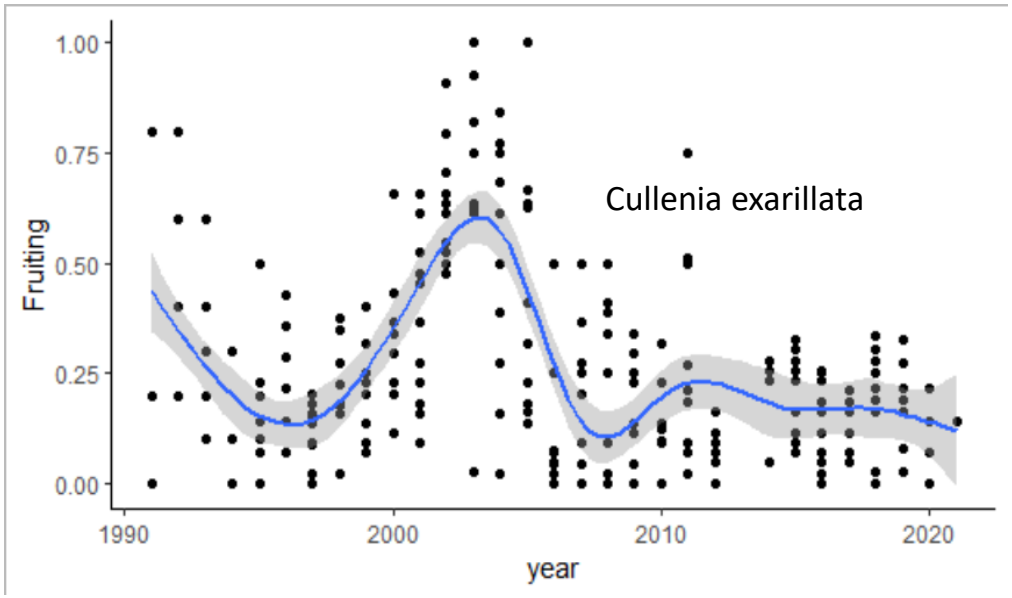
R^2= 0.034(-), p<0.0001

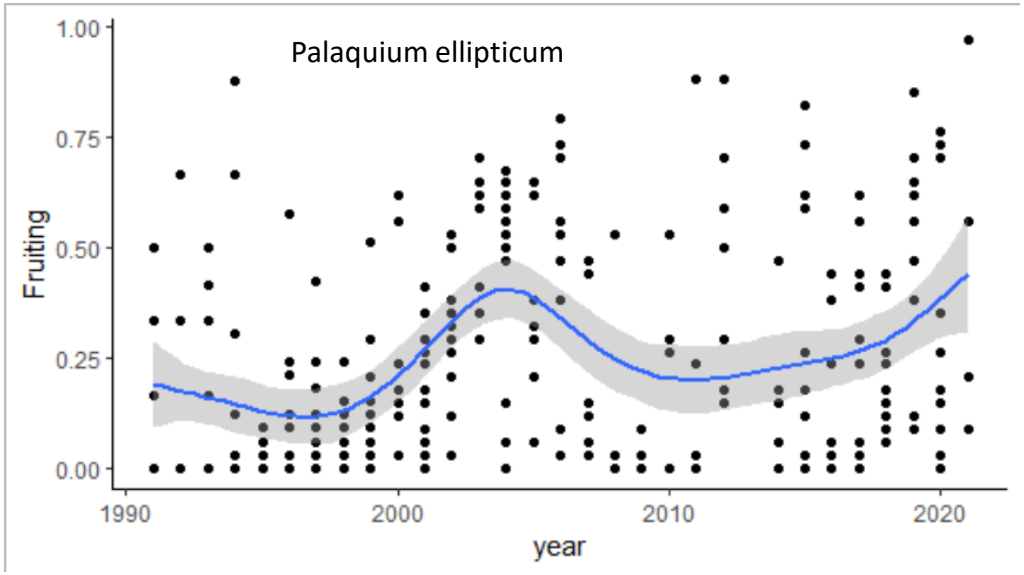


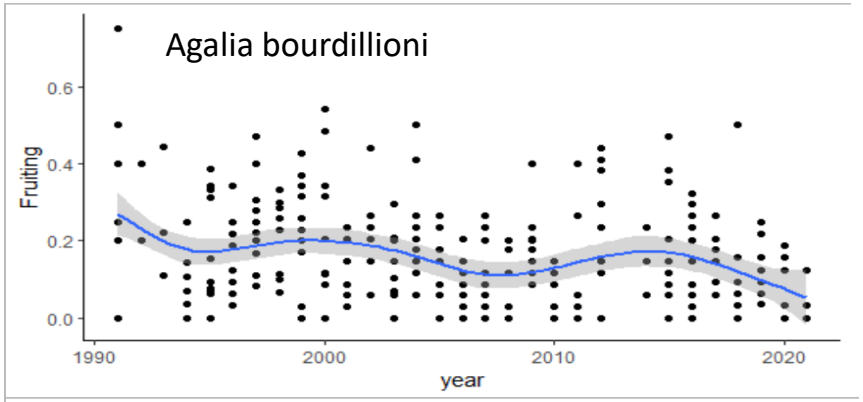
R^2= 0.031(-), p ns

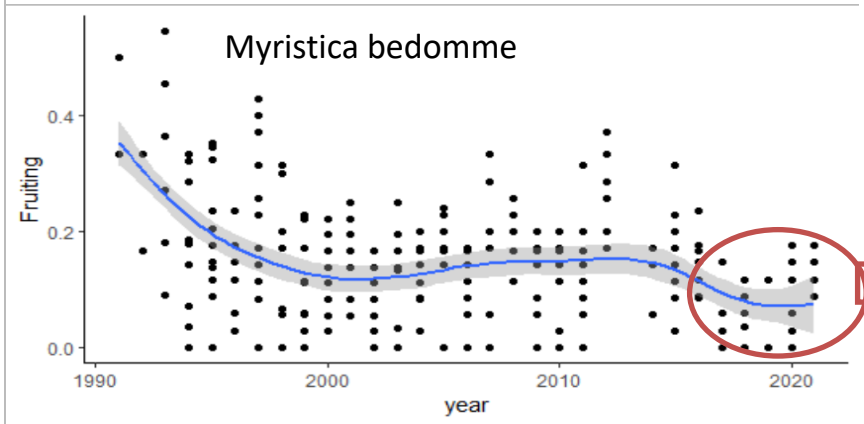


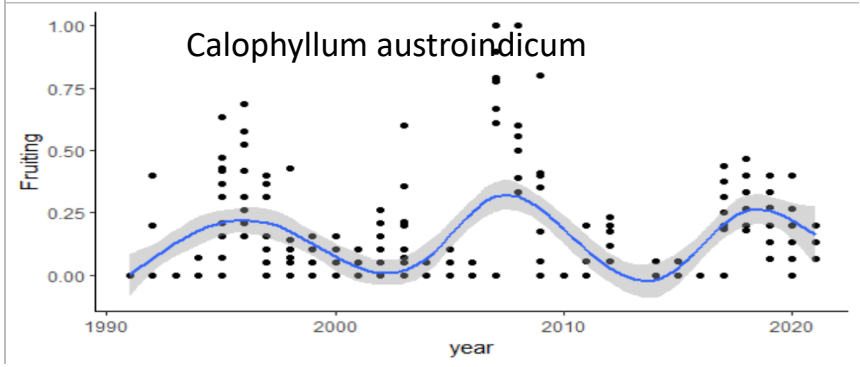
R^2= 0.134(-), p<0.002


Cullenia exarillata
Fruiting
1.00
0.75
0.50
0.25
0.00
1990
2000
2010
2020
year

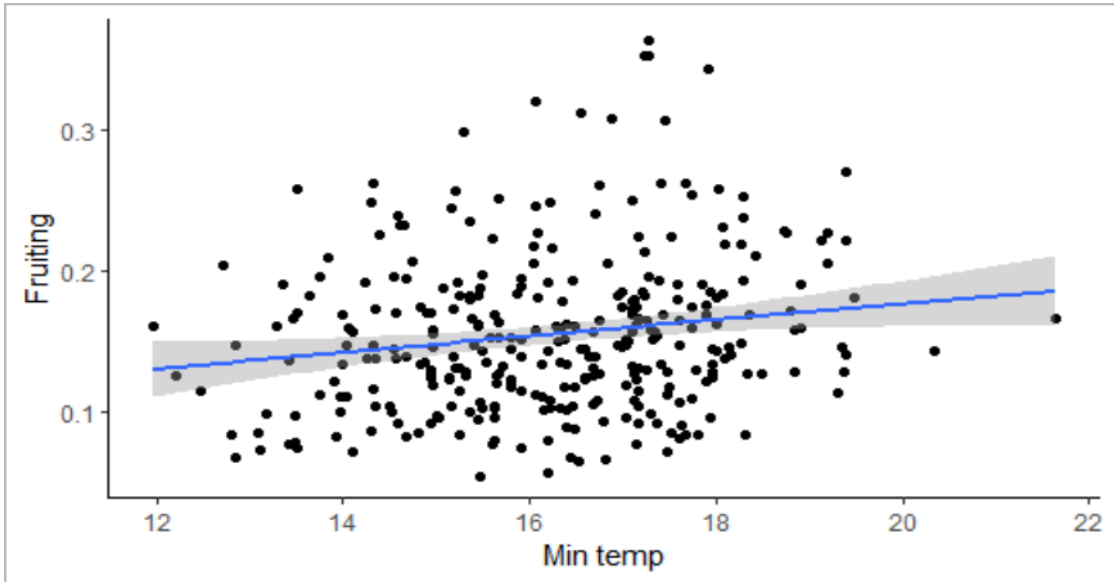

Palaquium ellipticum
Fruiting
1.00
0.75
0.50
0.25
0.00
1990
2000
2010
2020
year


Agalia bourdillioni
Fruiting
0.6
0.4
0.2
0.0
1990
2000
2010
2020
year

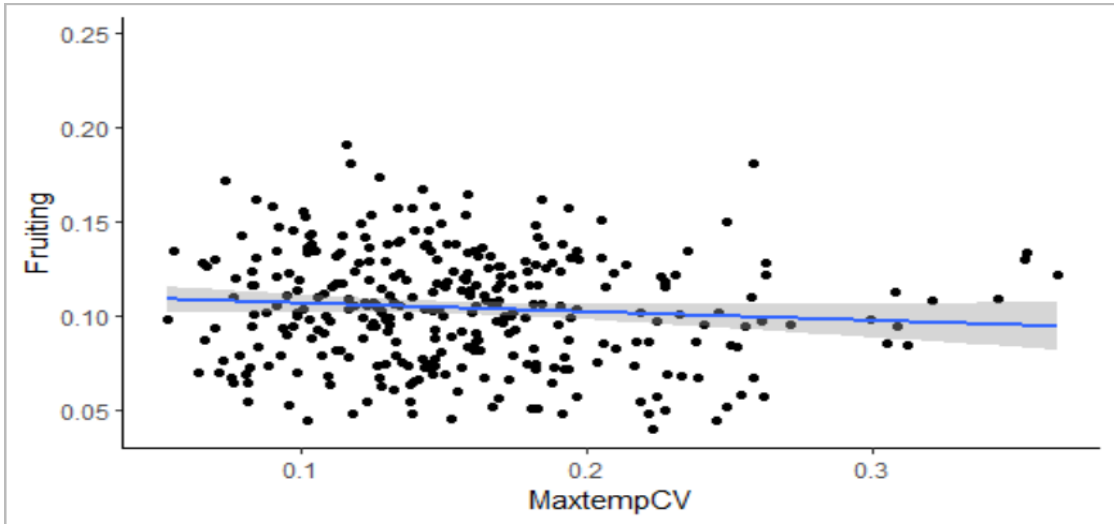

Myristica bedomme
Fruiting
0.4
0.2
0.0
1990
2000
2010
2020
year


Calophyllum austroindicum
Fruiting
1.00
0.75
0.50
0.25
0.00
1990
2000
2010
2020
year

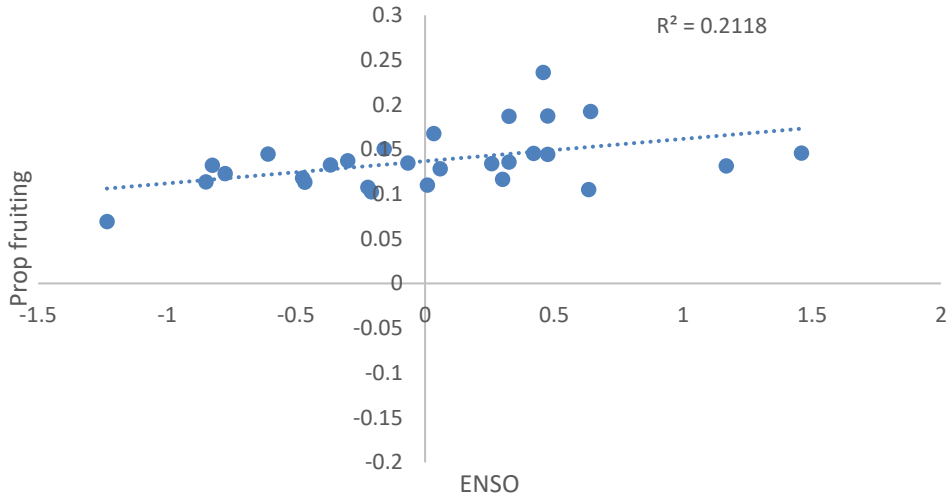
CLIMATIC FACTORS AFFECTING FRUITING

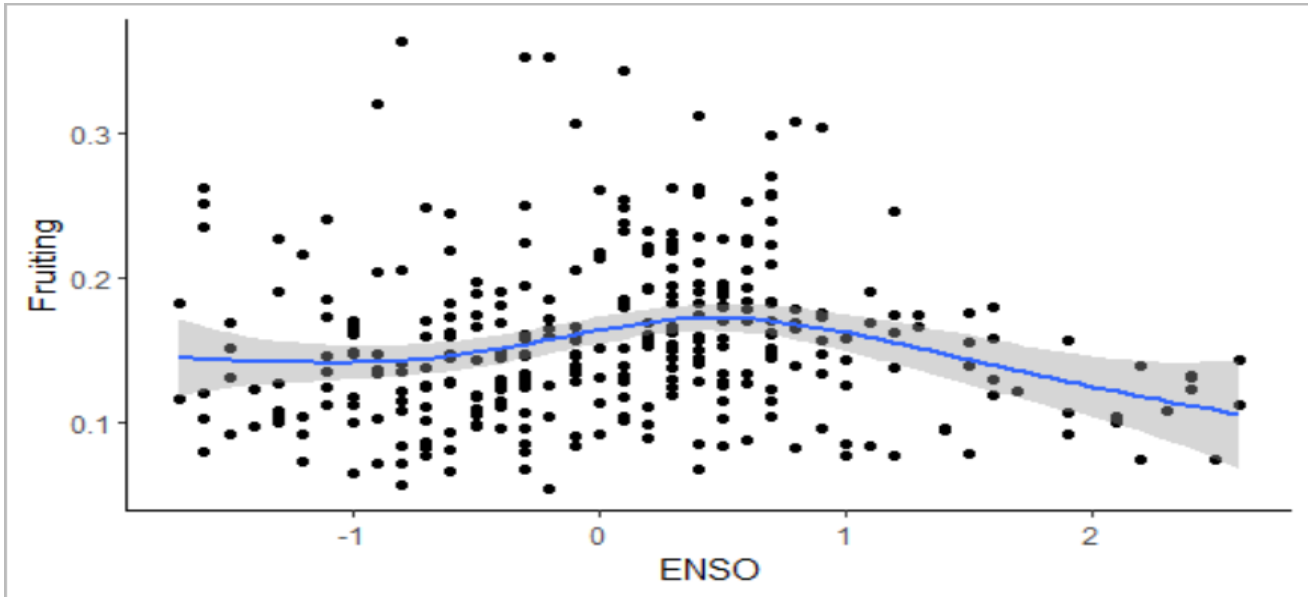


R^2= 0.064,
p<0.002, n=322

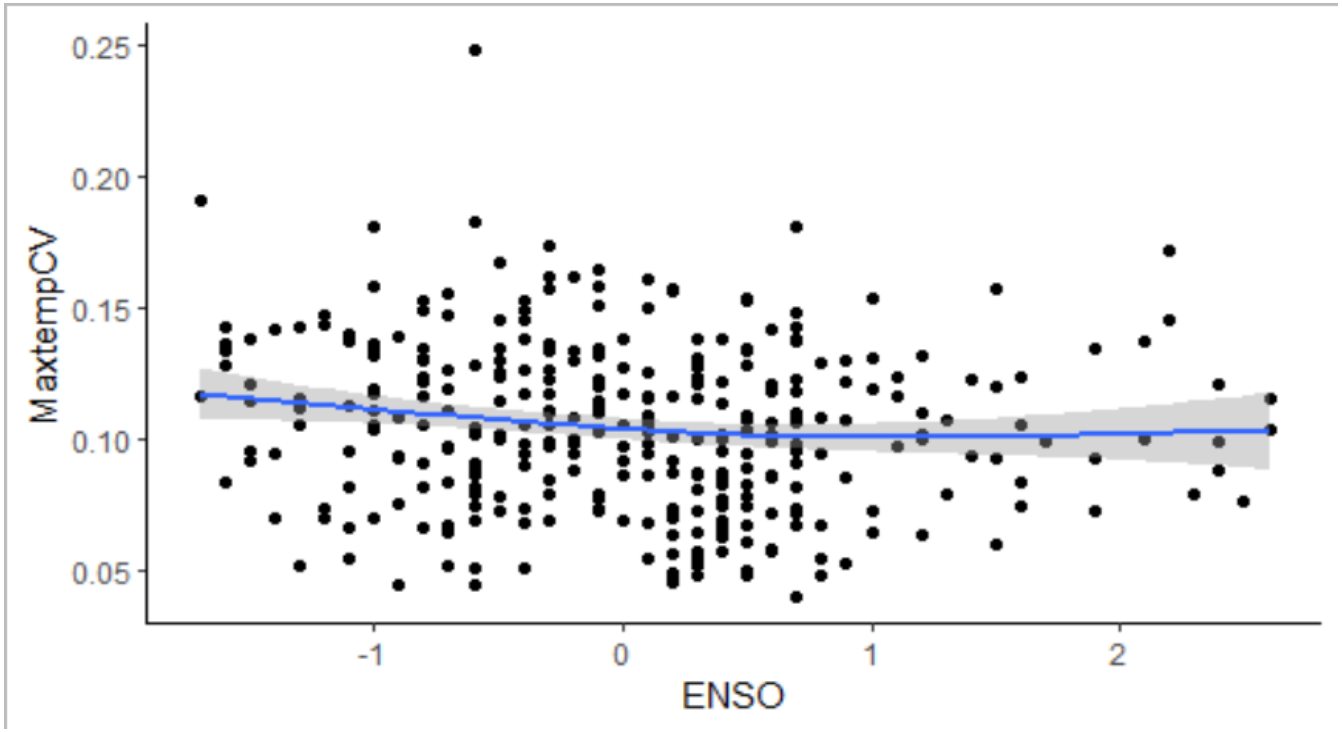


R^2= 0.036 (-),
p<0.01, n=322

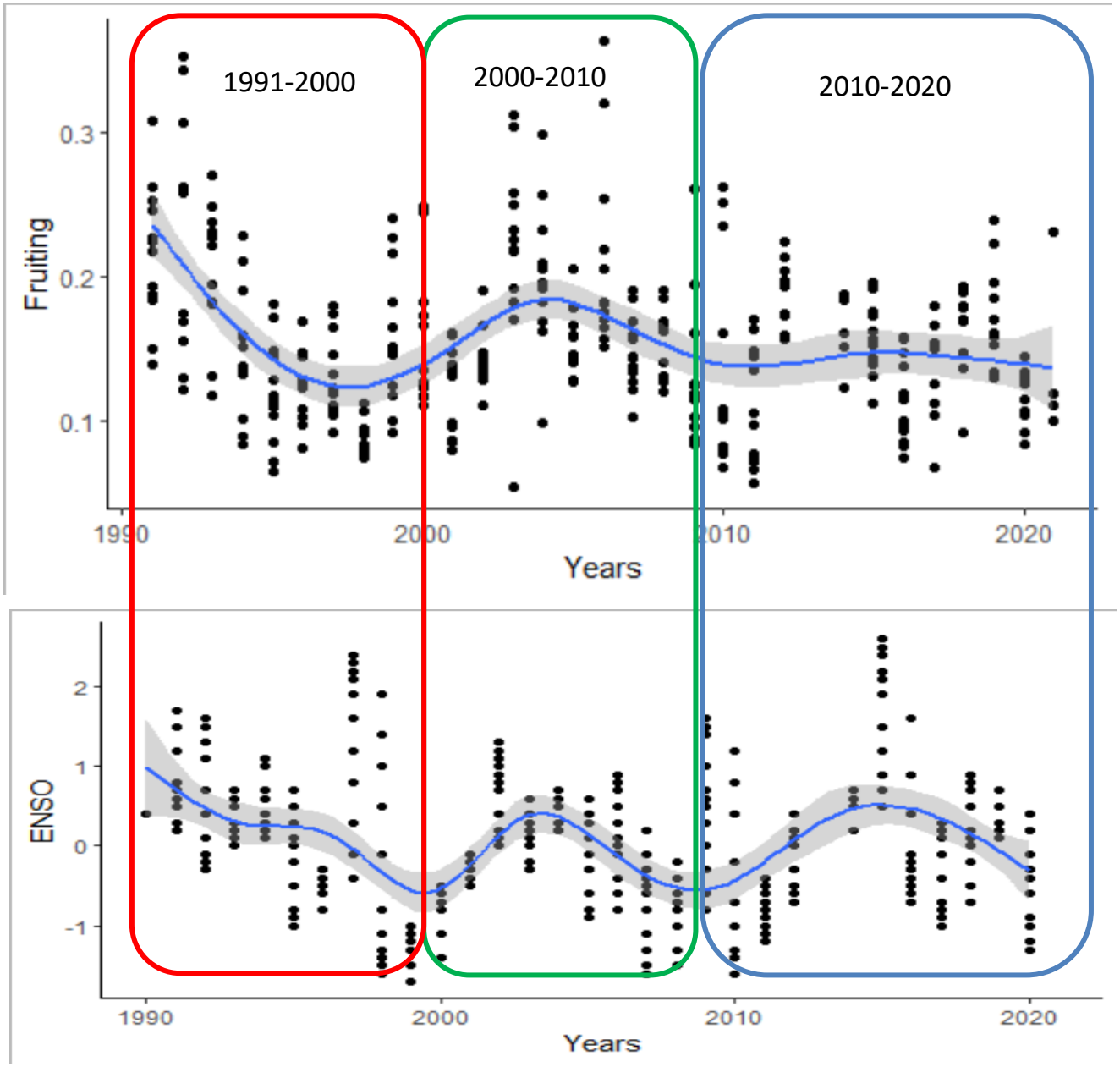


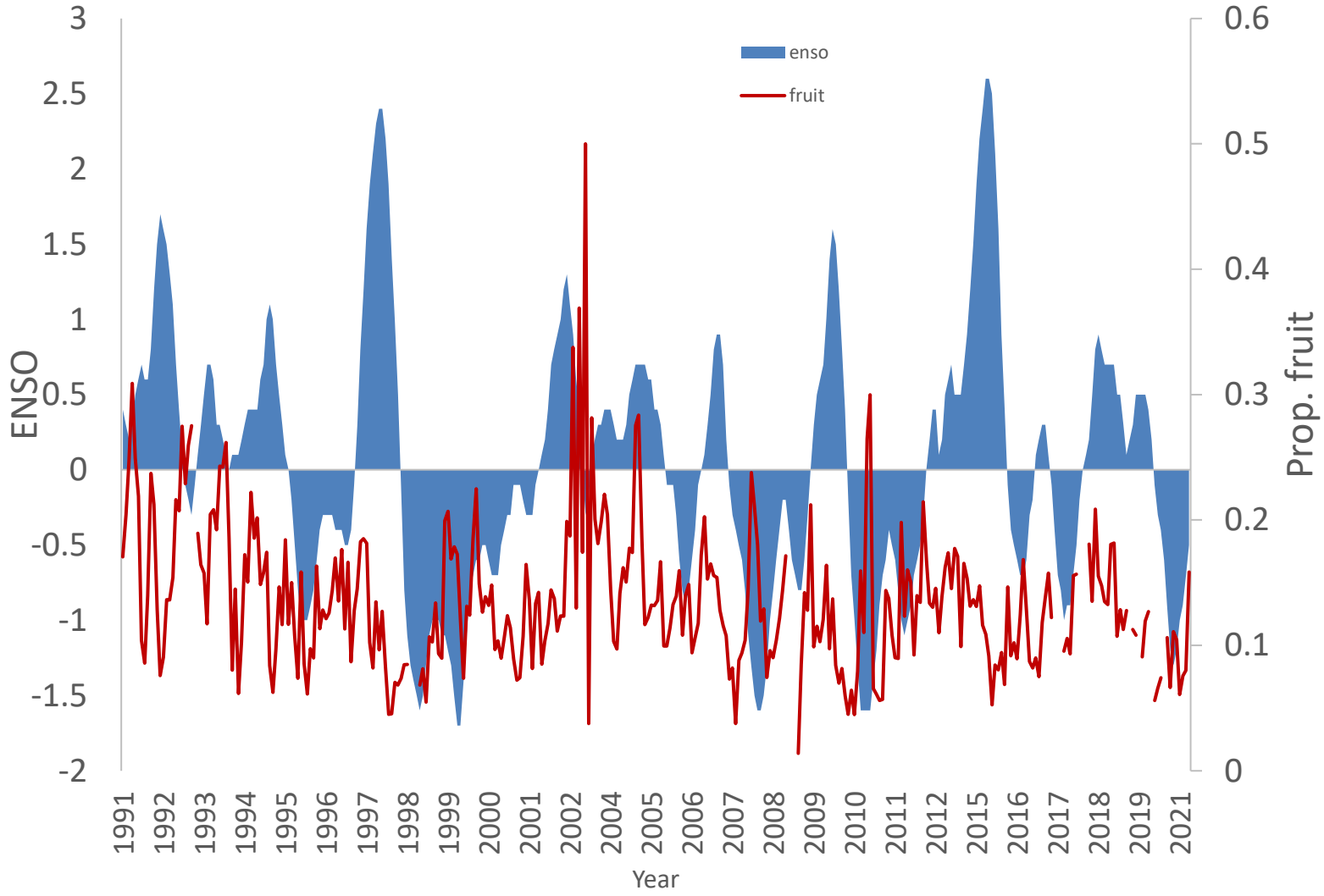


R^2= 0.028,
p=0.001, n=322



R^2= 0.023 (-),
p=0.002, n=322


1991-2000
2000-2010
2010-2020
Fruiting
0.3
0.2
0.1
1990
2000
2010
2020
Years
ENSO
2
1
0
-1
1990
2000
2010
2020
Years


enso
fruit
ENSO
Prop. fruit
Year
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0.6
0.5
0.4
0.3
0.2
0.1
0
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2004
2005
2006
2007
2008
2009
2010
2011
2012
2015
2016
2017
2018
2019
2021

Conclusion

- Fruiting has shown a decline across all groups of species in the 1st decade of sampling but has been stable thereafter.

- The effects of climate on fruiting are marginal. Minimum temperature has a positive effect on fruiting and it is also decreasing over the years but it's not clear if this is a reason for the decline in fruiting.

- Elnino has a positive influence at low levels and not at high levels but is not conclusive.

- Climatic factors mentioned here probably have a limited direct role to play in fruiting but there could be other factors like solar insolation that may explain the decline in fruiting

- There could also be eco-physiological factors that may be important at the site.

Acknowledgment

- Ministry of Environment and Forests, India
- MacArthur foundation, USA
- Department of Science and Technology, India.
- Rufford small grants
- International Foundation for Science
- Tata trust, India
- Royal Norwegian Embassy
- Tamil Nadu Forest Departments
- Tamil Nadu Electricity Board
- Brakes India CSR grant
- Sundaram Finance, India CSR grant
- **Organizers of Pheno2022**

- Thank you