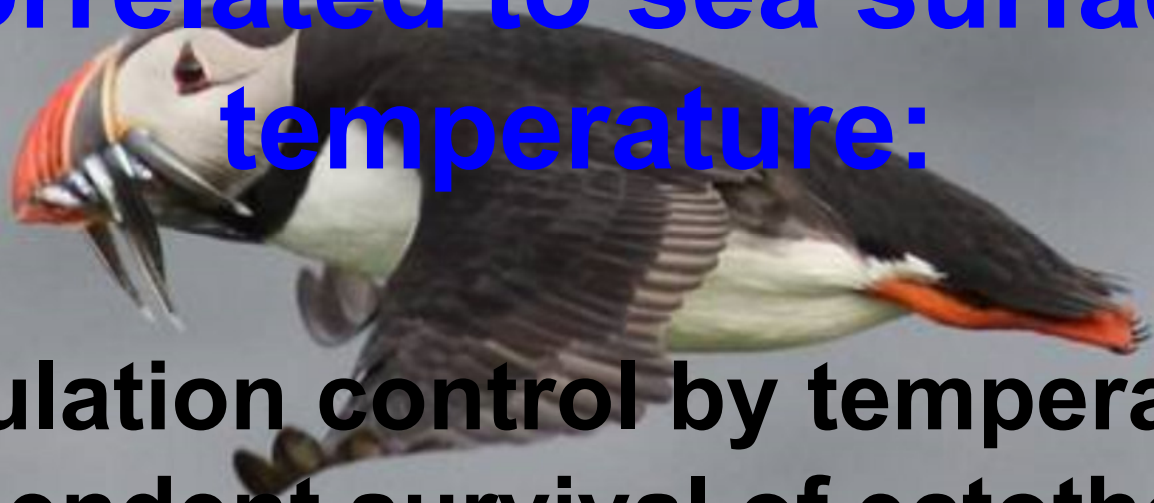
135-year time series of Atlantic Puffin production is negatively correlated to sea surface temperature:



Population control by temperature dependent survival of ectotherm sandeel prey?

NÁTTÚRUSTOFA SUÐURLANDS

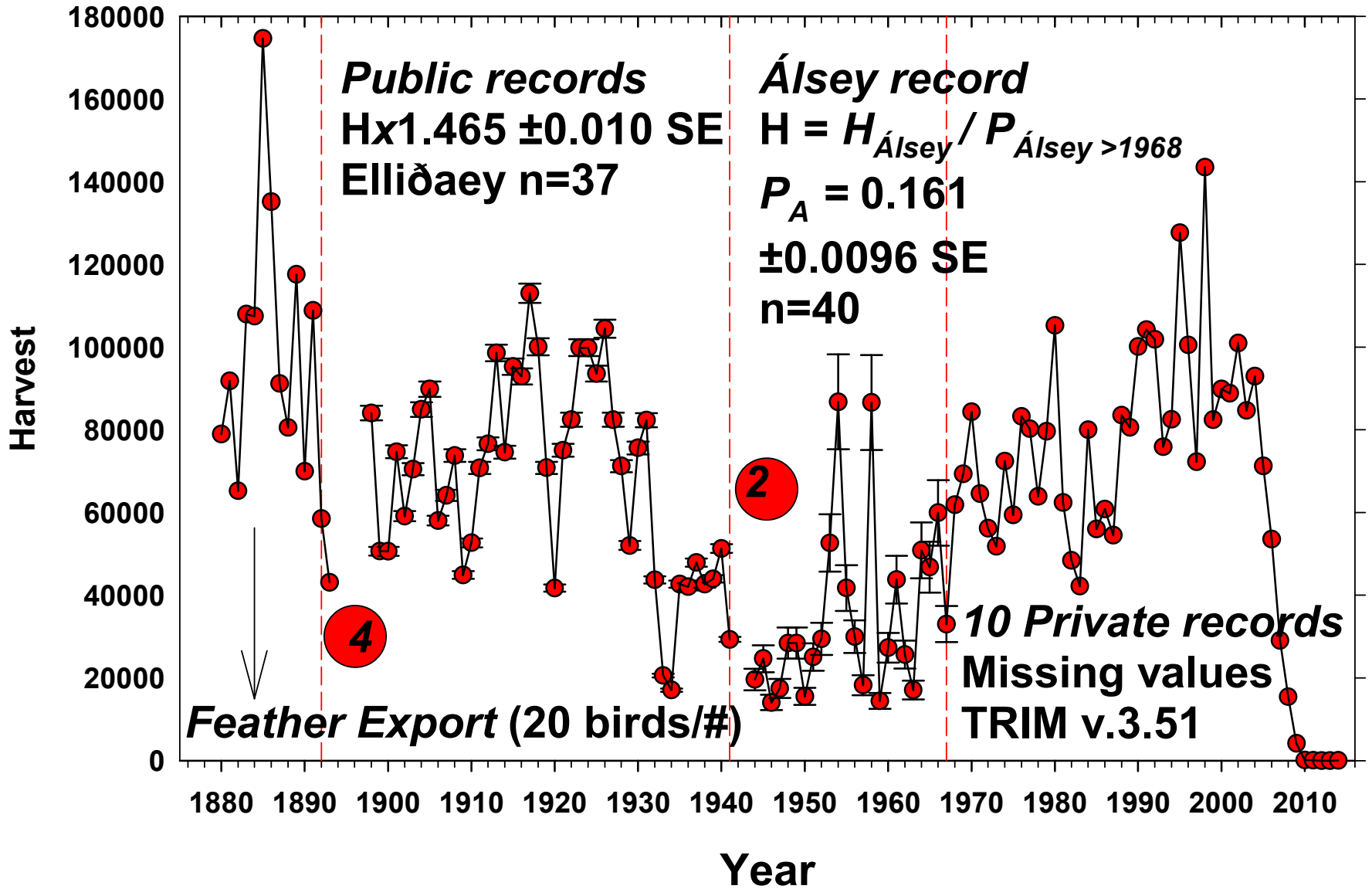
Erpur Snær Hansen et alia

Collaborative project

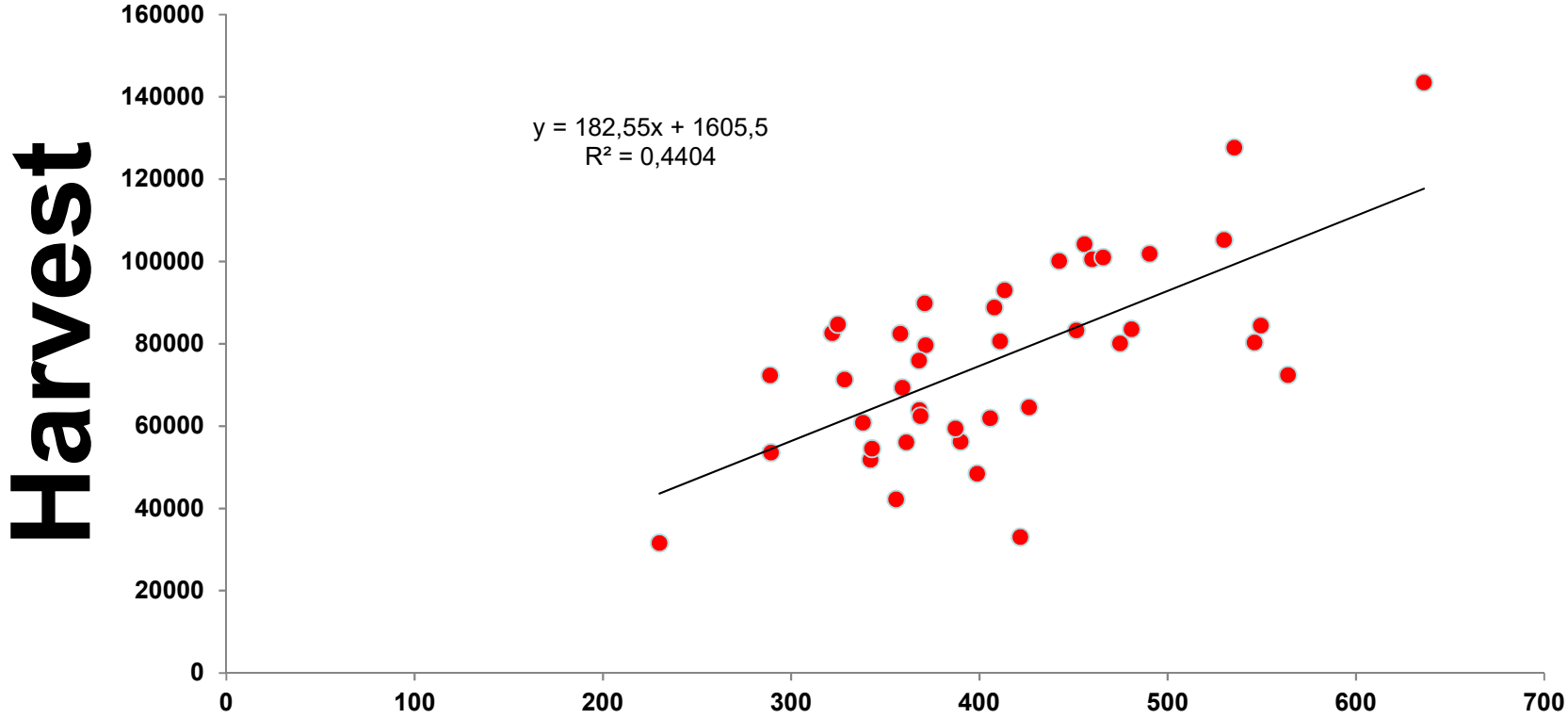
- **Erpur S. Hansen** (South Iceland Nature Res. Centre).
- **Hanno Sandvik** (NTNU).
- **Kjell Einar Erikstad** (NINA Tromsø).

- **Tycho Anker-Nielsen** (NINA Trondheim).
- **Jürgen Bader** (Max-Planck Institute).
- **Sébastien Descamps** (Norwegian Polar Institute).
- **Kevin Hodges** (Univ. of Reading).
- **Michel d. S. Mesquita** (Uni Res. Climate & Bjerknes Centre).
- **Nigel Yoccoz** (Univ. of Tromsø).

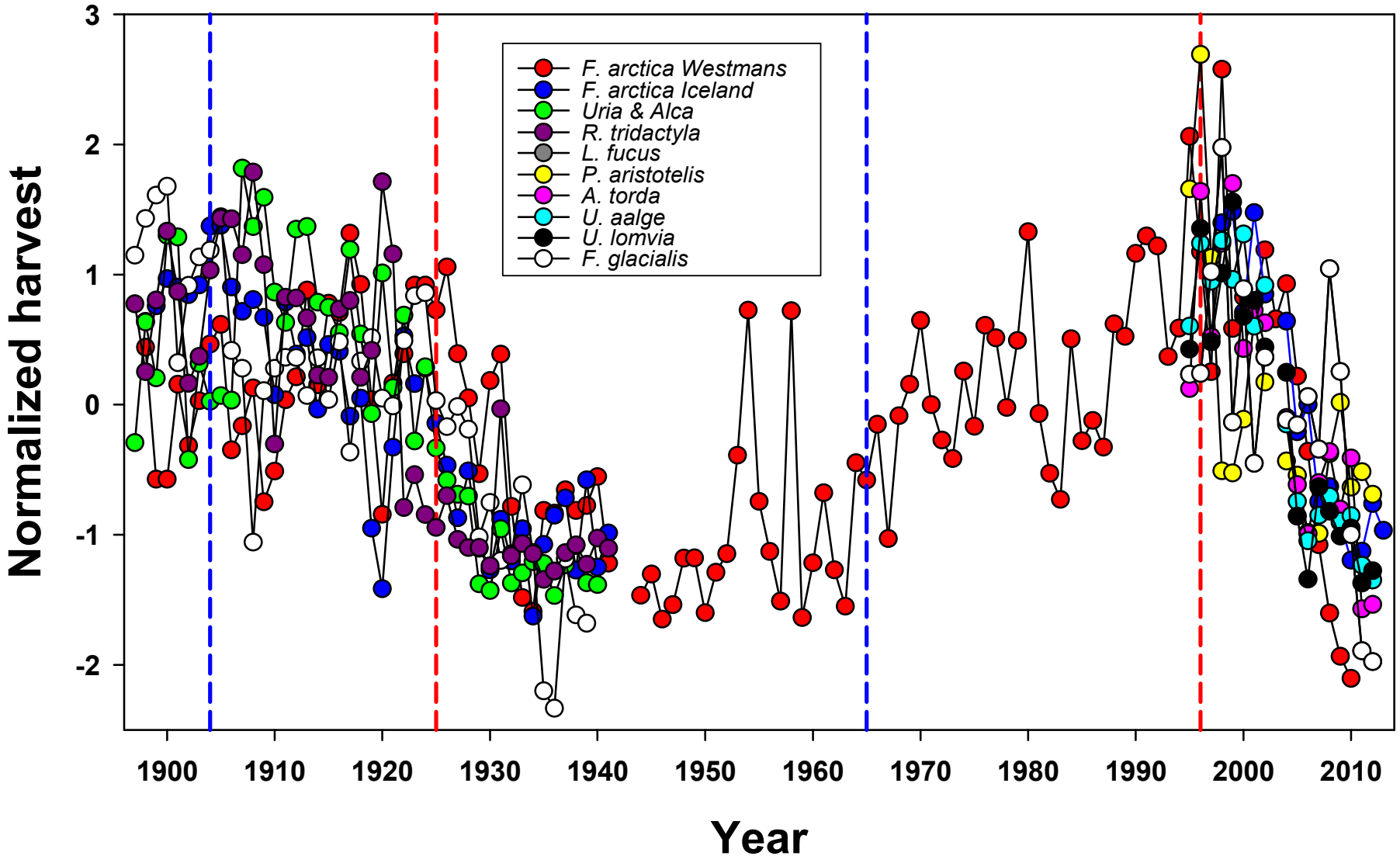
The Westman 1880-2018 Puffin harvest series



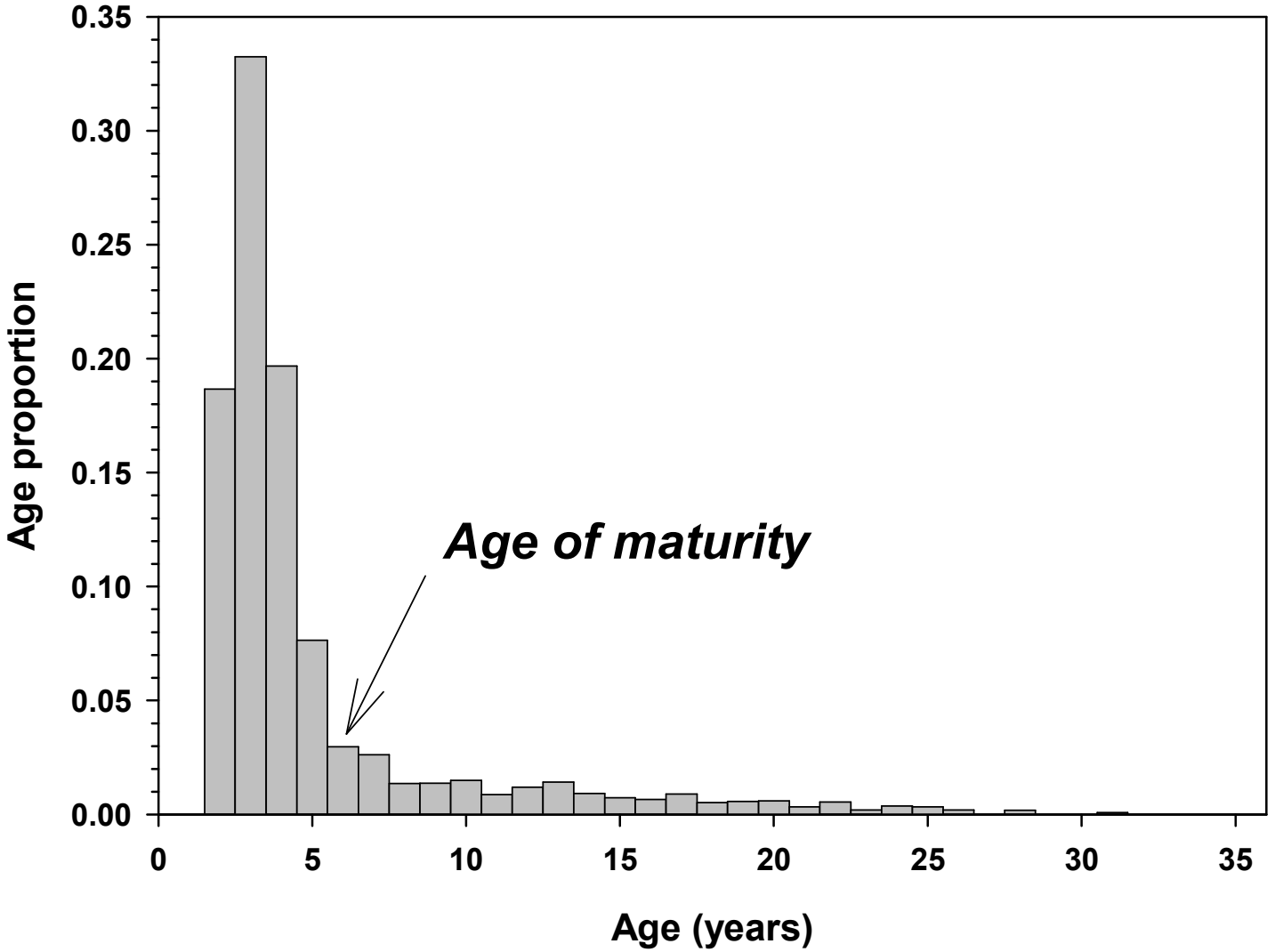
CPUE explains (R^2) 44% of the harvest variation (r = 0.66)



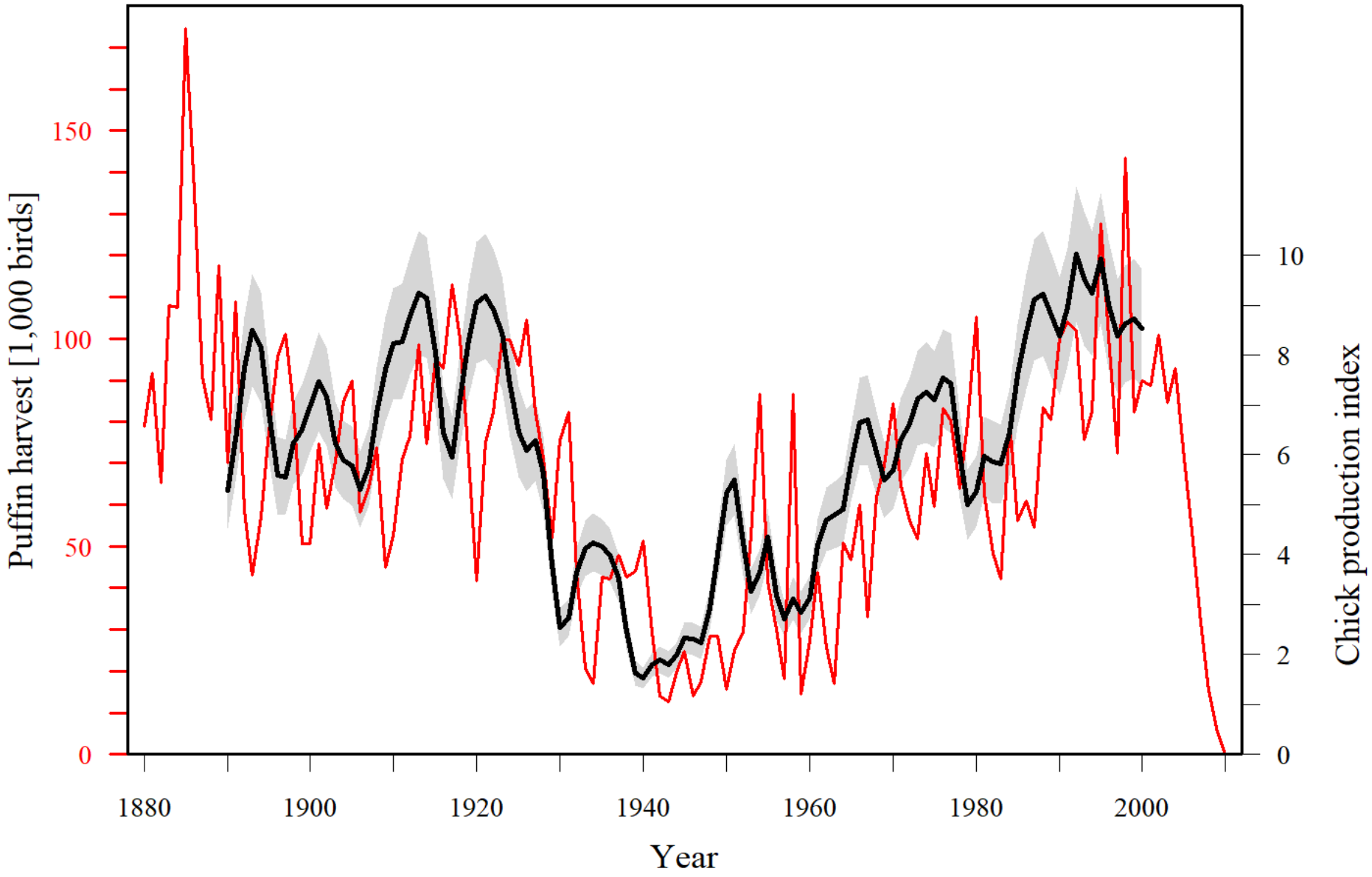
Icelandic seabird harvest 1898-2013



Age distribution of 4340 recaptures from harvesting 22 cohorts (1961-1982), each hunted ≥25 years

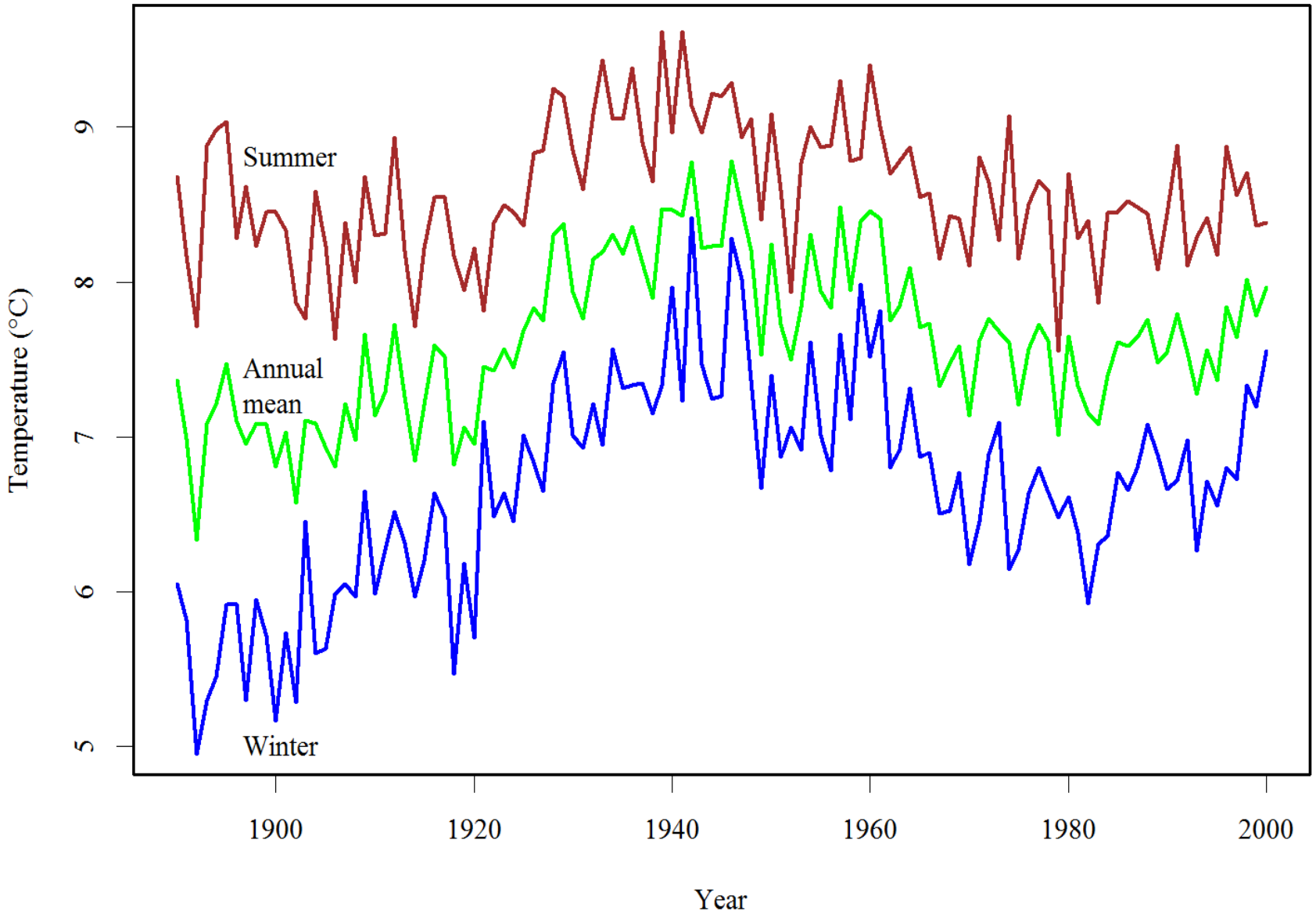


Harvest & chick production index (black, with grey 95% C.I.)

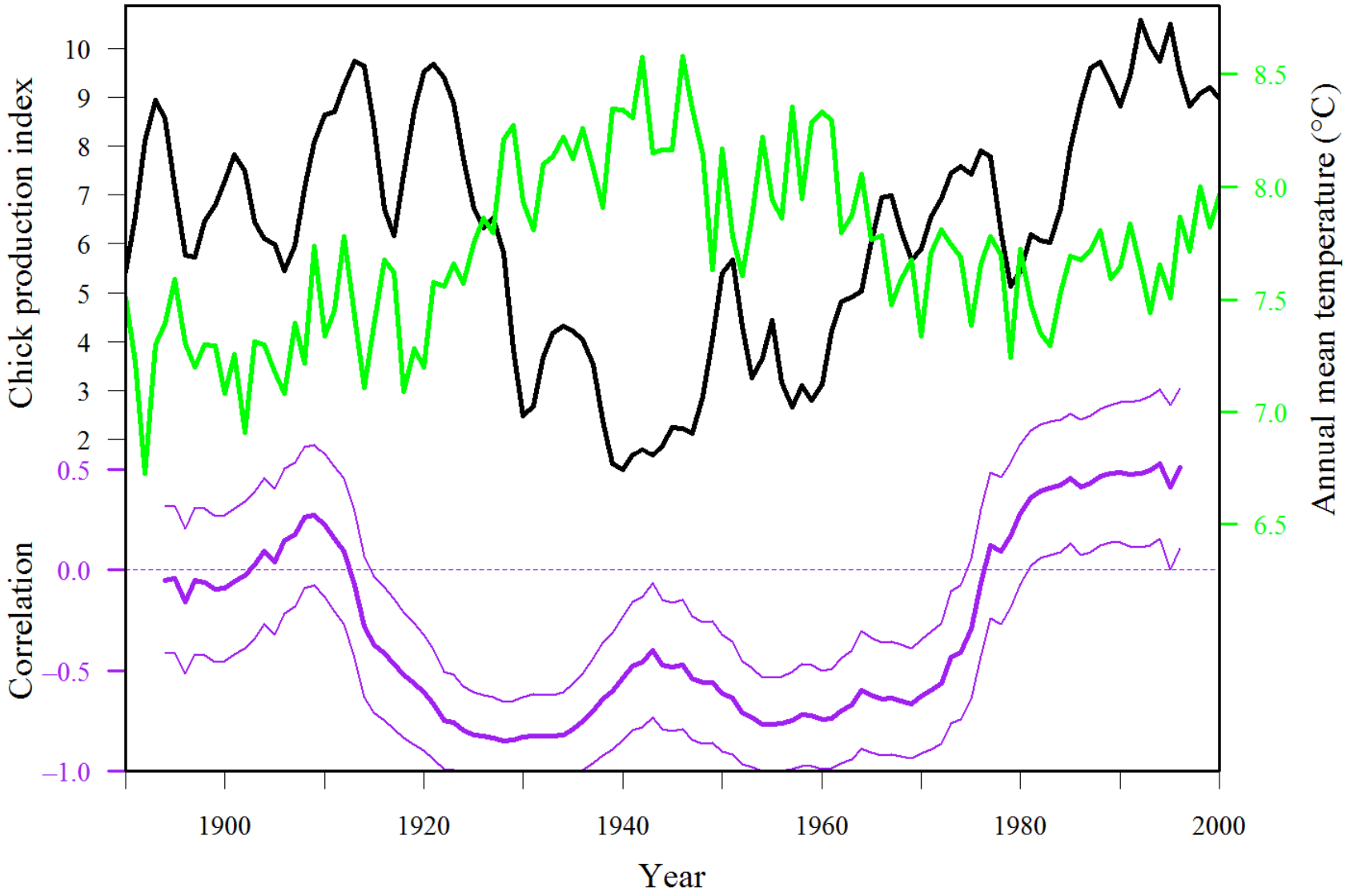


Sea Surface Temperature (SST) in Westmans

Summer, annual mean, & winter



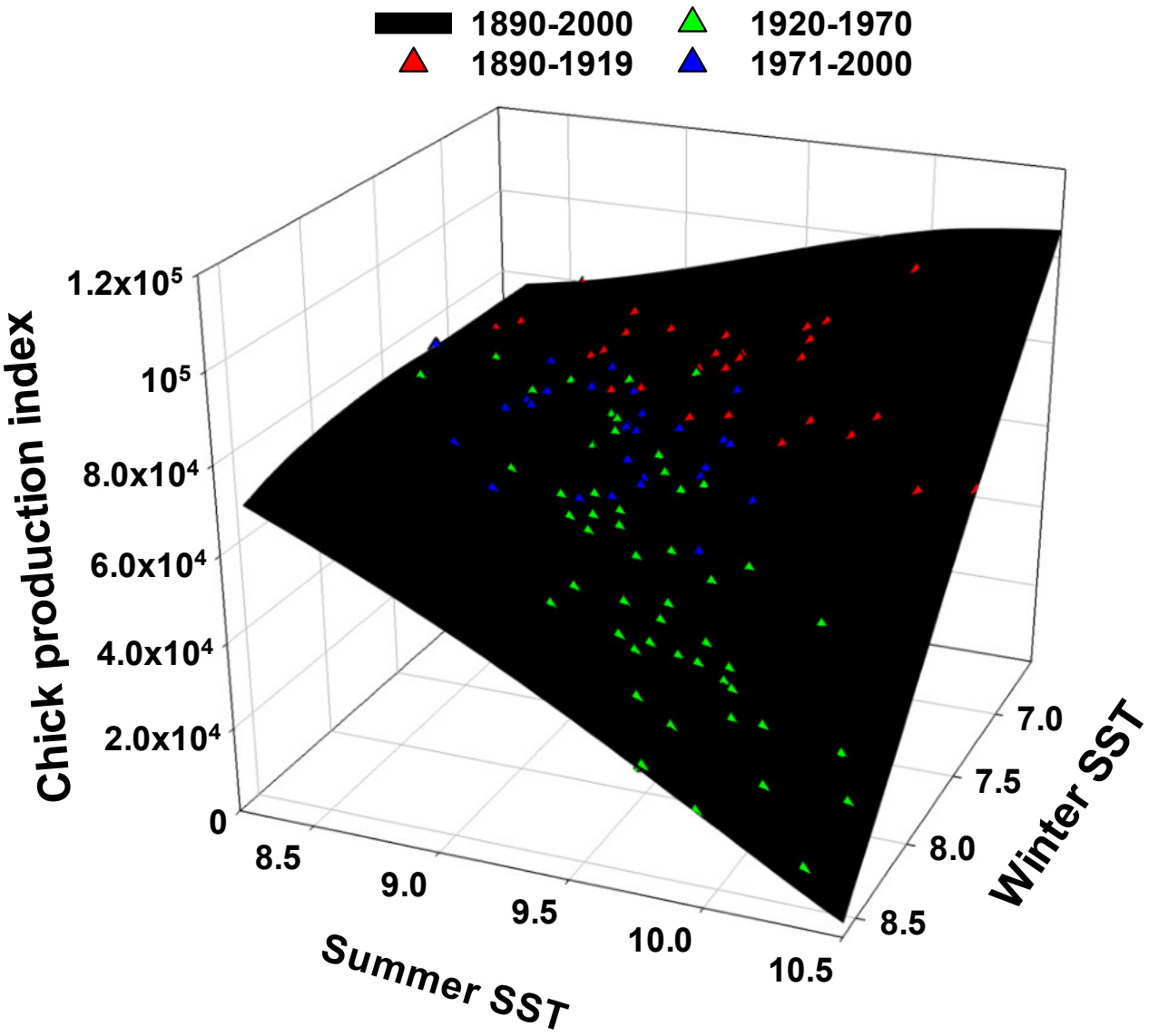
Chick production (black), annual mean SST, & their correlation (with 95% C.I.). Correlations are estimated from 31-year sliding windows.



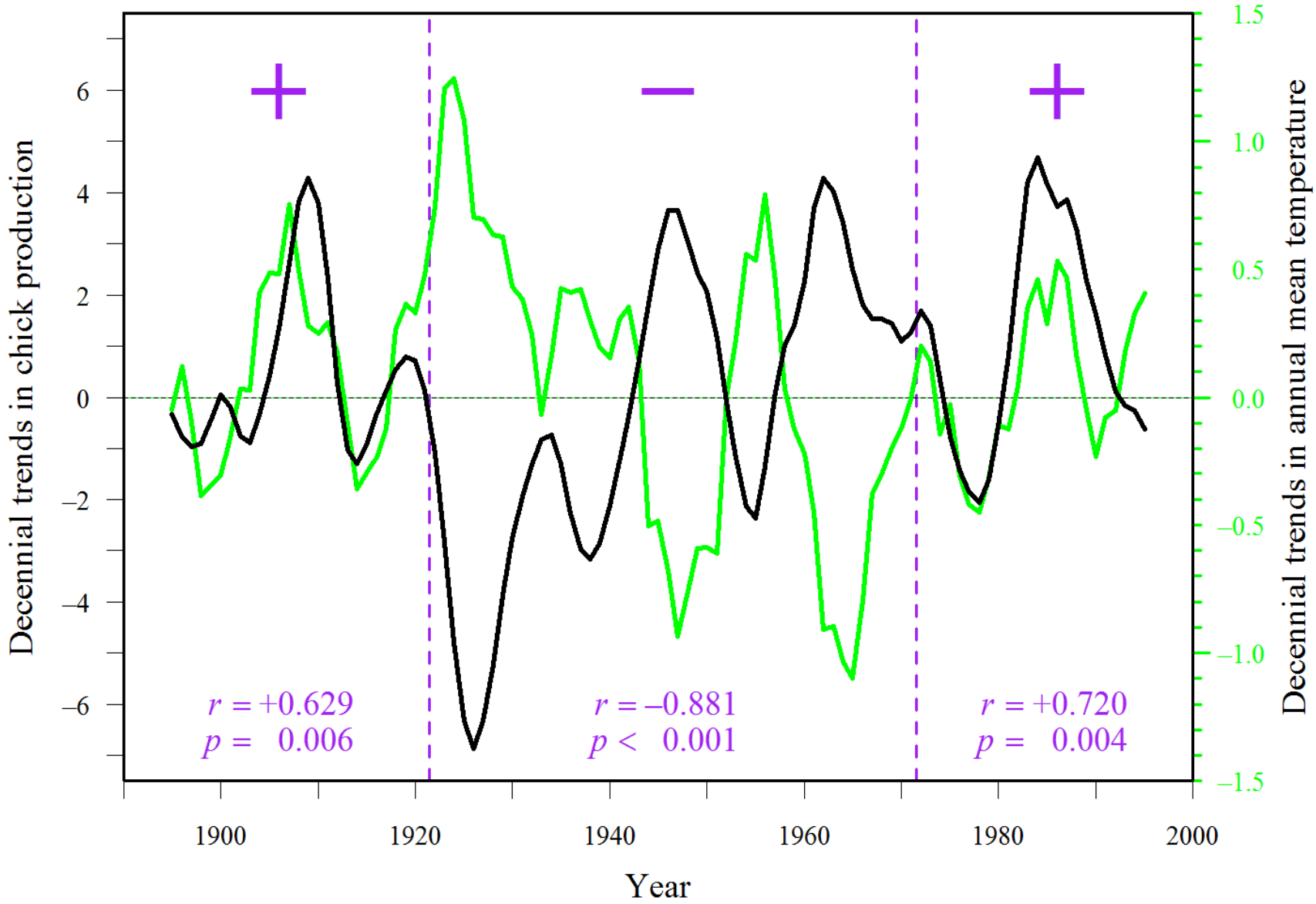
Chick production is affected by an interaction betwen summer & winter SST.

High winter SST is always negatively related to production.

High summer SST is negatively related to production only when winters are warm.



11-year trends in chick production (black) & annual mean SST

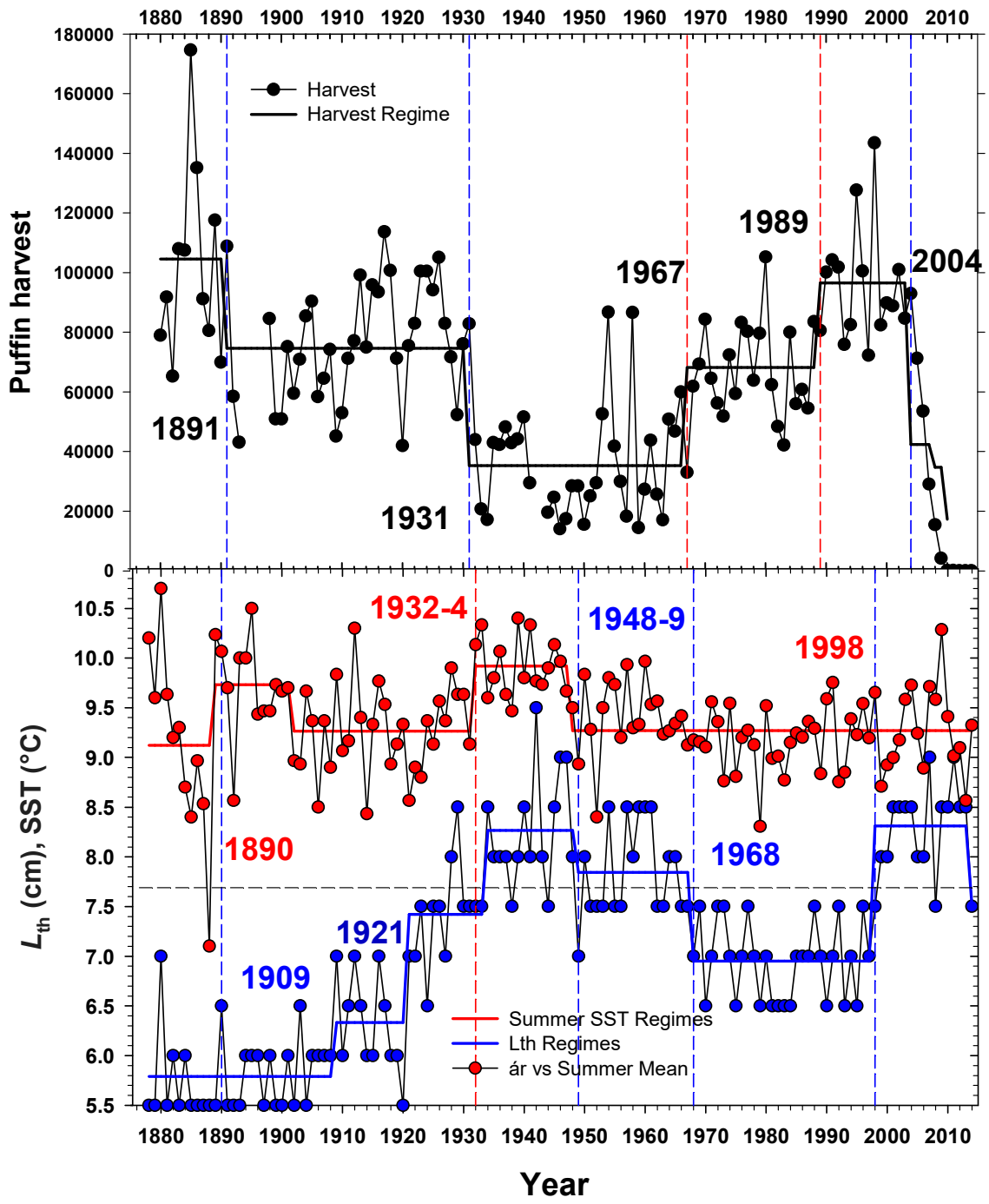


Sandeel length threshold (L_{th}) for wintering

- Fish metabolic rate are proportional to size and increase with temperature which together determine a threshold for winterering, but fish under the threshold experience reduced survival without feeding.

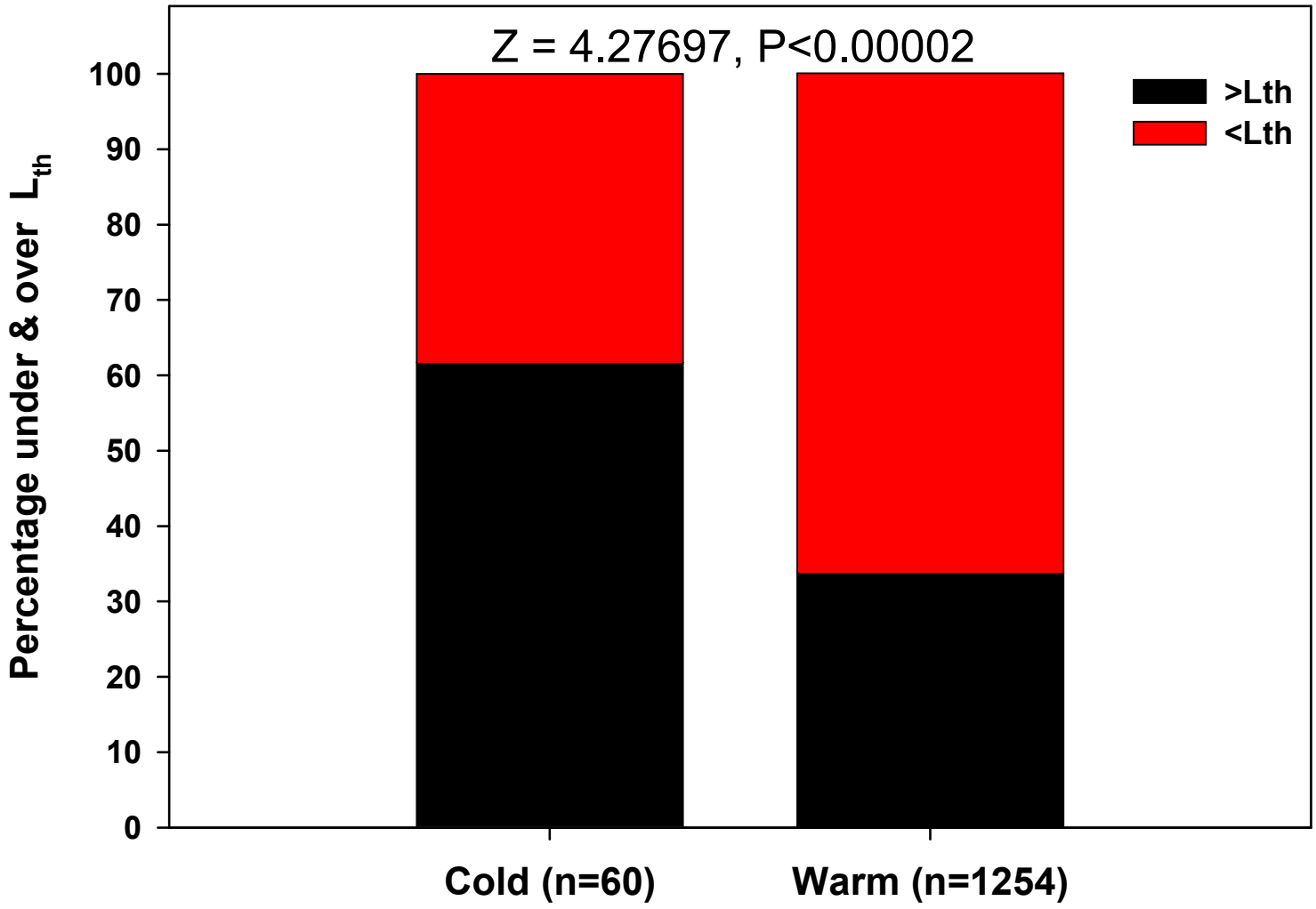
  van Deurs, Hartvig & Steffensen (2011)

- Annual L_{th} is calculated for August-April 1880-2014.


Puffin harvest
Harvest
Harvest Regime
1891
1931
1967
1989
2004
L_{th} (cm), SST (°C)
1890
1909
1921
1932-4
1948-9
1968
1998
Summer SST Regimes
Lth Regimes
ár vs Summer Mean
Year

Sandeel proportion <L_{th}> warm & cold periods

Eyjólfur Friðgeirsson (1983), Valur Bogason (2014)



Conclusions

- Hunting effort stable from 1880, biological signal real.
- Key demographic: Productivity, highly variable.
- Productivity is highly SST dependent with a seasonal interaction.
- Puffin SST dependence possibly connected to sandeel ecophysiology.

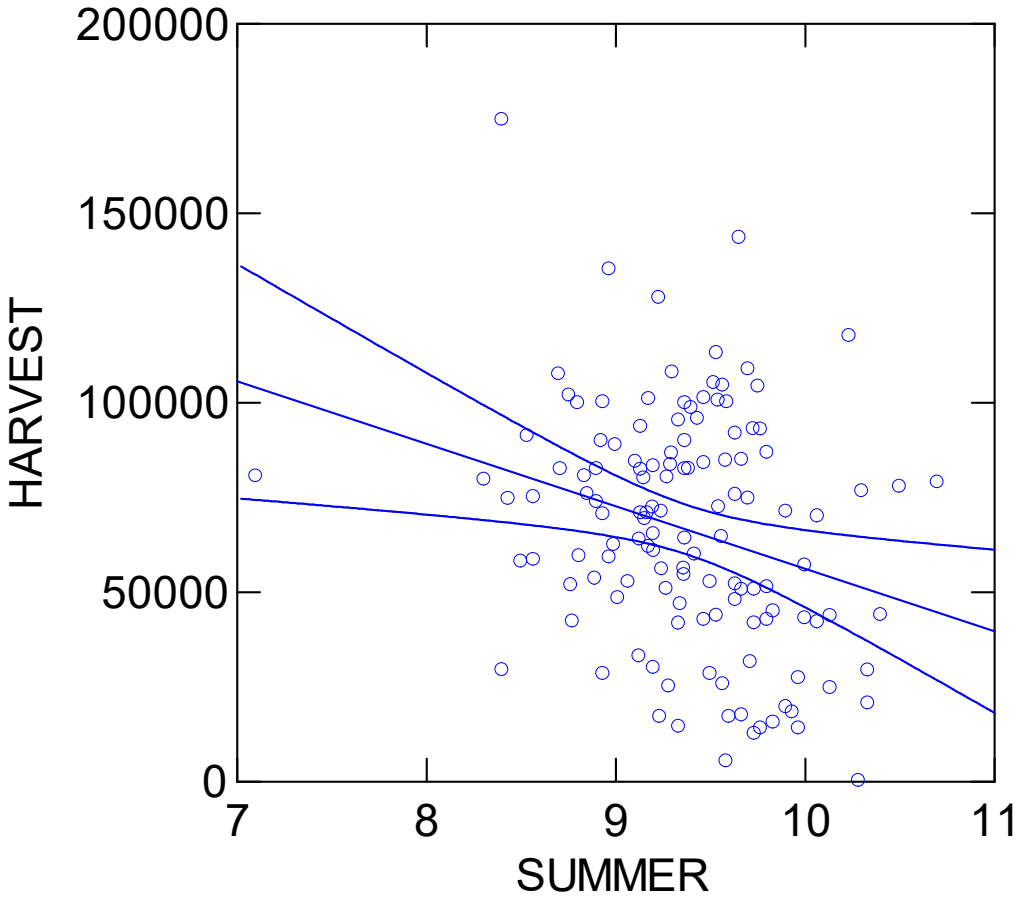
Acknowledgements

Anthony R. Ives, Arnþór Garðarsson,
Bjargveiðifélög Vestmannaeyja,
Freydís Vigfúsdóttir, Hafrannsóknastofnun,
Ingvar A. Sigurðsson, Jónas P. Jónasson,
Kristinn H. Skarphéðinsson, Trausti Jónsson,
Veðurstofa Íslands, Yann Kolbeinsson

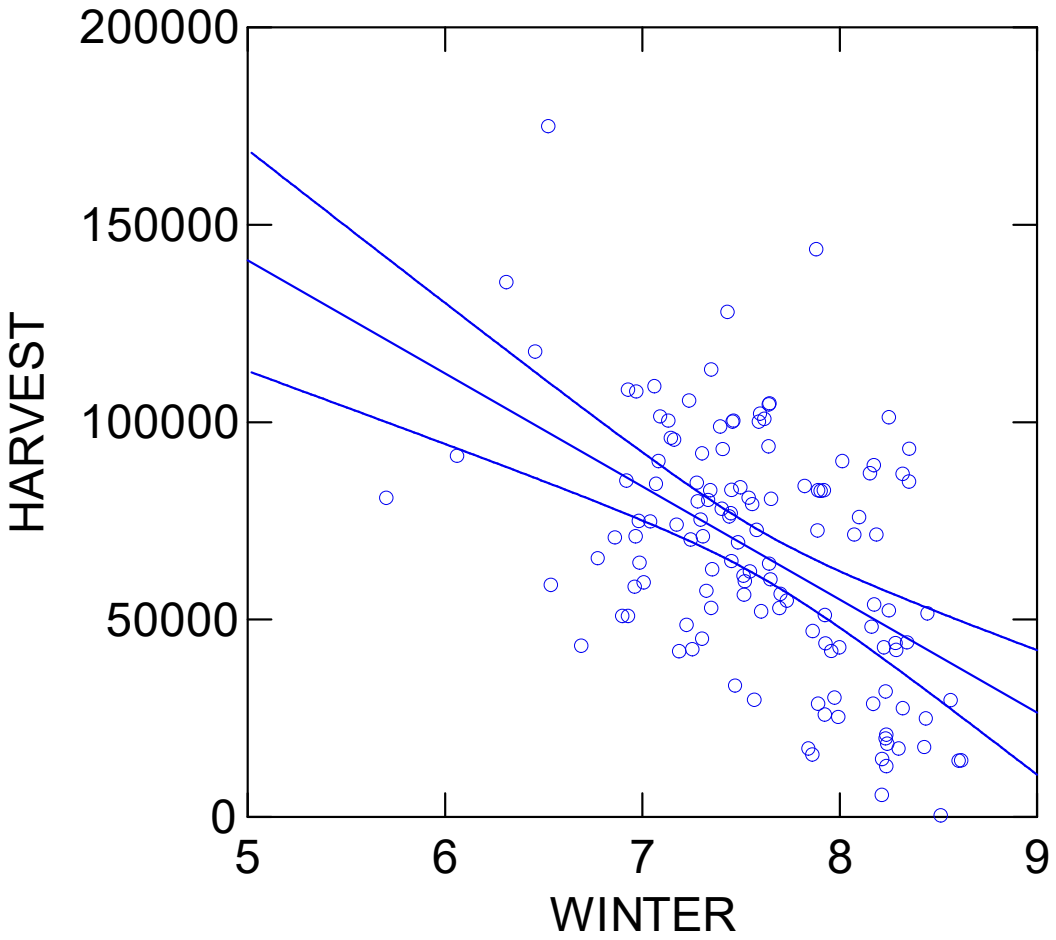
Financially supported by:
Framsenteret, CAFF, Rannsóknasjóður, Veiðikortasjóður,


Thanks for listening!

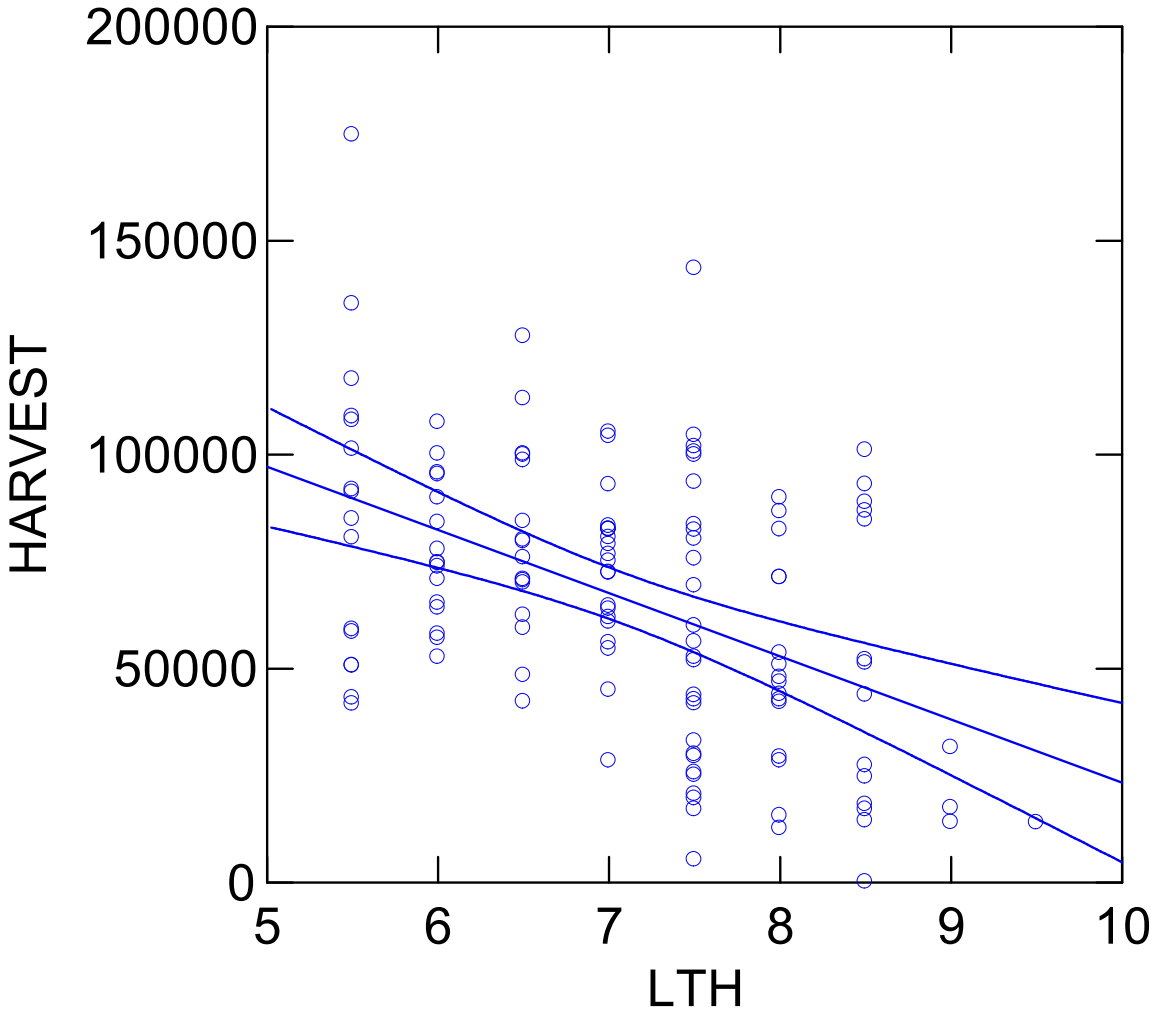
Correlation btw harvest & summer SST: *r* = -0.27 (N.S., N*=16).

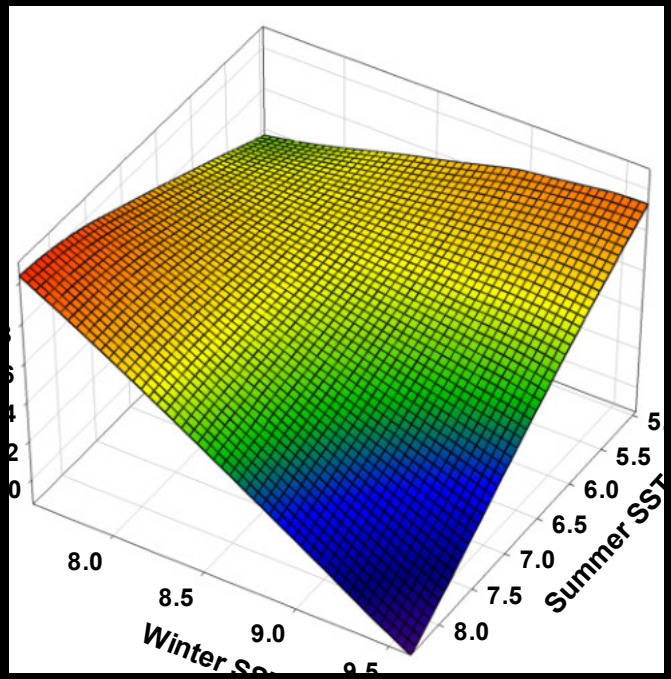


Correlation btw harvest & winter SST: r = -0.51 (P<0.05, N*=16).



Correlation btw harvest & L_{th}: r = -0.47 (P<0.05, N*=16).




8.0
8.5
9.0
Summer SST
5.5
6.0
6.5
7.0
7.5
8.0

Winter & summer SST vs harvest