Climate change effects on terrestrial and marine birds: Consequences for reproduction

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Two Indicators of Climate Change Effects on Birds

Long-term studies by Point Blue Conservation Science reveal sensitivity of many species that breed in California to climate conditions.

- Cassin's Auklet, a marine bird. Gulf of the Farallones.
  - Index of Reproductive Success (Updated).
- Song Sparrow, a terrestrial bird. Variety of habitats: Coastal scrub and tidal marsh (estuarine) habitat in San Francisco Bay region.
- Proposed: New Indicator:
  - Timing of breeding
  - Length of breeding season
  - Reproductive Success

Not only are these 2 species sensitive to climate variation, but modeling indicates are vulnerable to effects of climate change.

Point Blue Conservation Science

- Founded in 1965 as Point Reyes Bird Observatory
- 140 staff, seasonal and full time 2015 budget: $10 million
- Work to conserve birds, other wildlife and ecosystems through science, partnerships and outreach.

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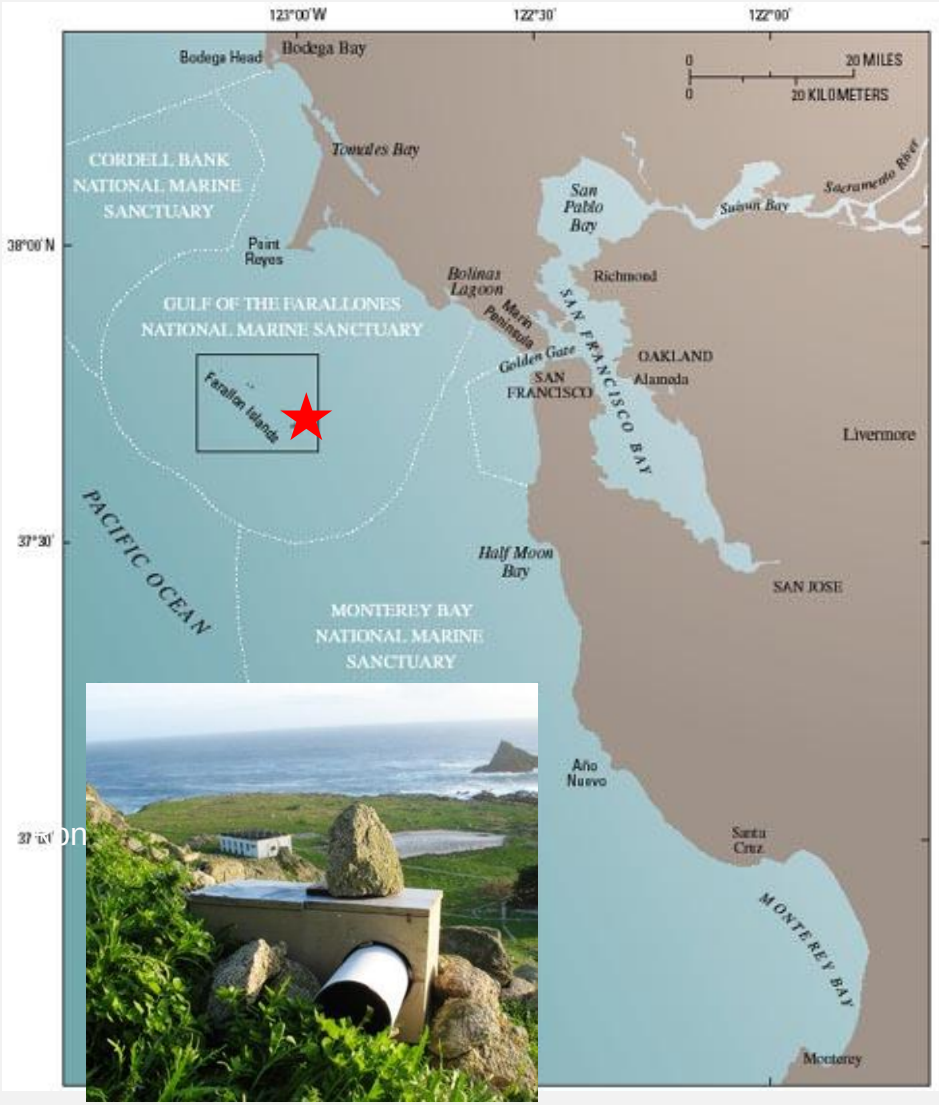
Cassin's Auklets on the Farallon Islands

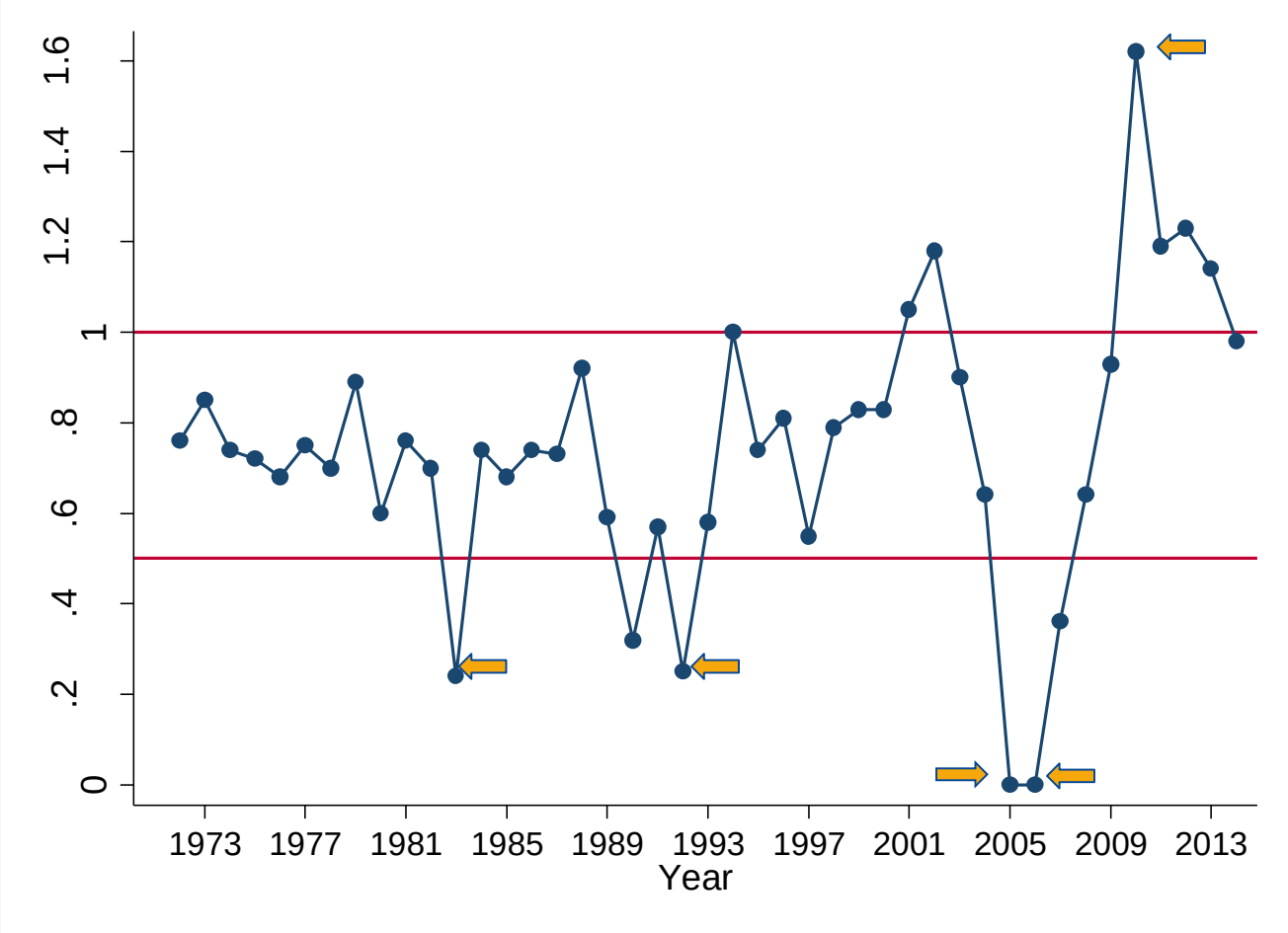
- Planktivorous (especially krill)
- Strongly responsive to ocean climate:
  - Reproductive success,
  - Adult survival, and
  - Survival to breeding age

Reproductive success important determinant of population growth, viability



Climate Change Indicator: Cassin's Auklet Reproductive Success

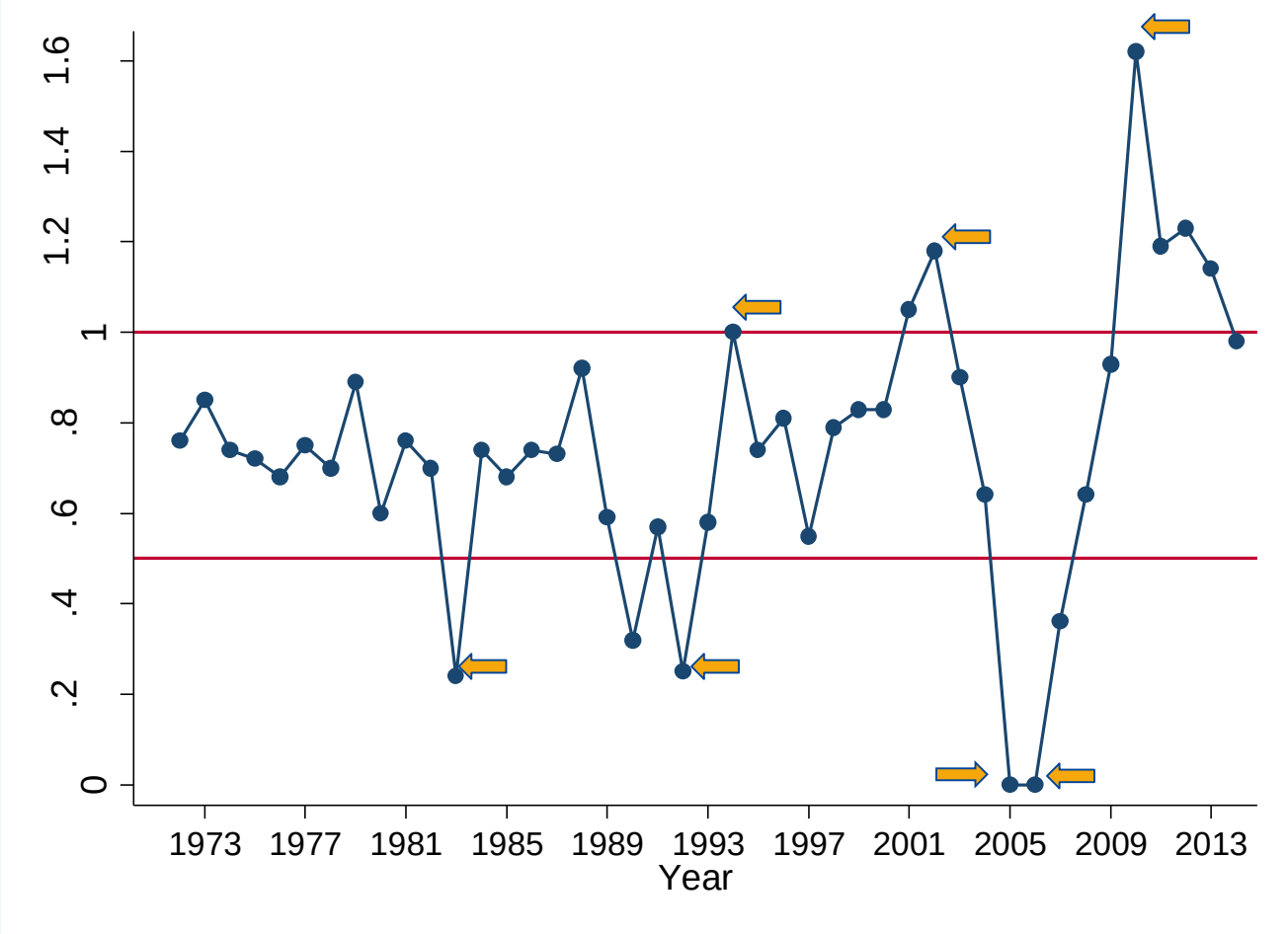
Reproductive Success Very Low in 1983 and 1992 (Major El Niño years)
But lowest ever in 2005 and 2006 (Anomalous, but not El Niño years)
Highest ever in 2010 (2011, 2012)



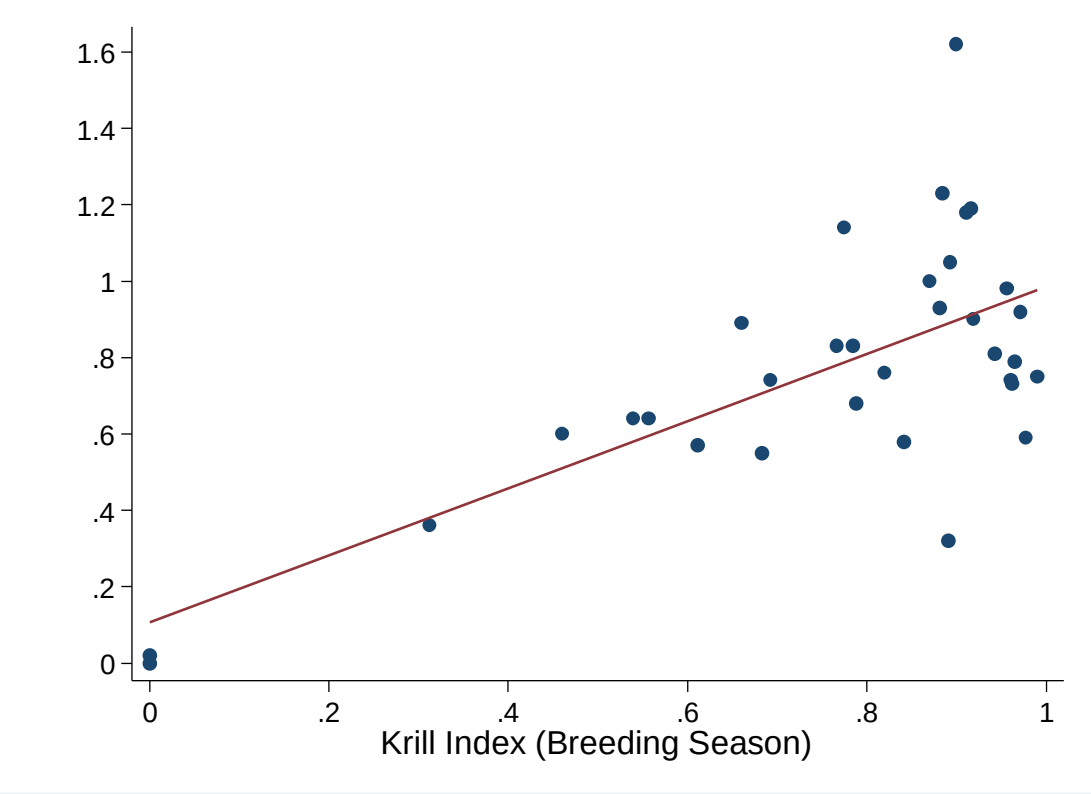
Cassin's Auklets respond to ocean conditions:

Climate Change Models Predict Increased Climate Variability

Increased Variability in Response: 70's, 80's-90's, 2000's – present



Cassin's Auklets Reproductive Success:
Importance of Prey
Annual Reproductive Success Reflects Prey, Reflects Oceanic Conditions

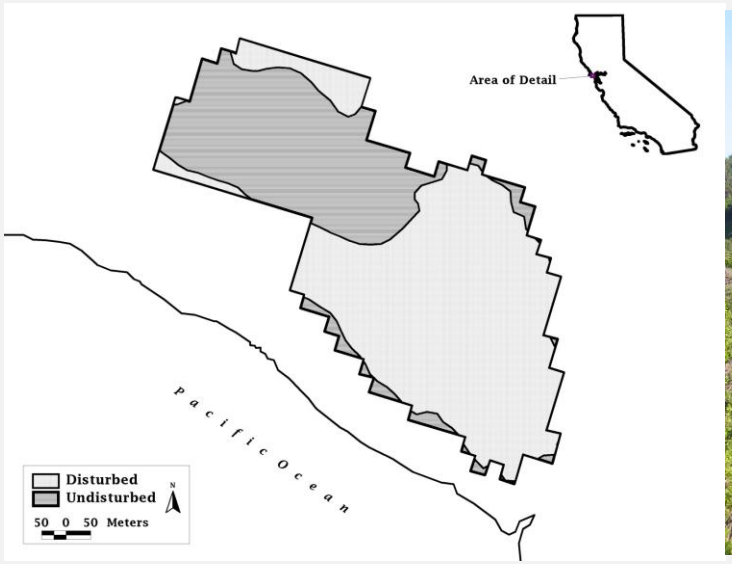


Summary: Cassin's Auklet Climate Change Indicator

- Cassin's Auklet Respond to Alterations in Food Web, reflected in warm-water events (e.g., 2005), delay in Upwelling (2006), major El Niño events.
- Such disturbances have been predicted to increase in frequency and/or magnitude due to climate change
- Cassin's Auklets have displayed increased variability in their response from 1970's to the present. Both extreme positive and negative deviations seen recently.

Proposed Climate Change Indicator:
Timing (and Success) of Song Sparrow Reproduction

- Song Sparrows studied intensively at Palomarin Field Station, 1980 – 2014. Coastal scrub habitat.
- Present year-round. Territorial.
- Parallel study of Tidal Marsh Song Sparrows, 1996-2007.



- Song Sparrows have long breeding season. Lay March – July.
- Are multi-brooded. Can rear a second brood after successfully rearing a first brood.
- Rearing a second brood, or a replacement if first brood fails, is adaptive. More breeding attempts require a longer breeding season, which may be affected by climate.

Investigated

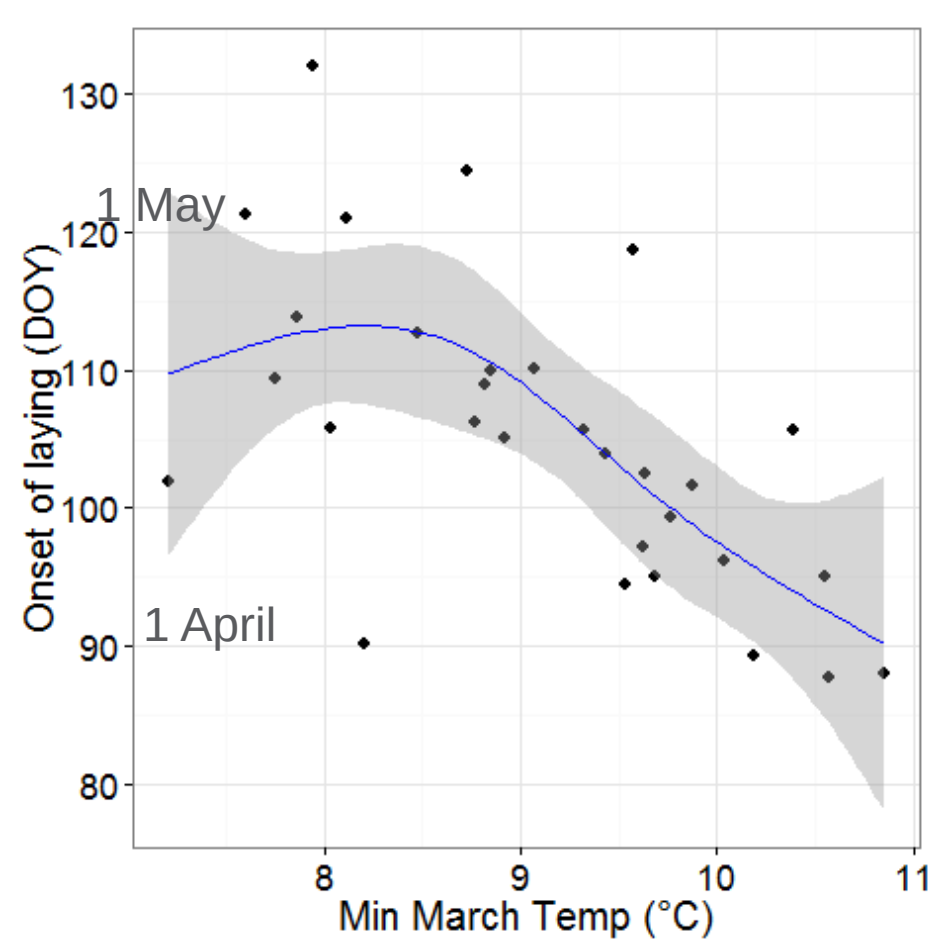
- “onset” of clutch completion (first 10 percentile),
- “cessation” (last 10 percentile of all nests) and
- duration of breeding season.

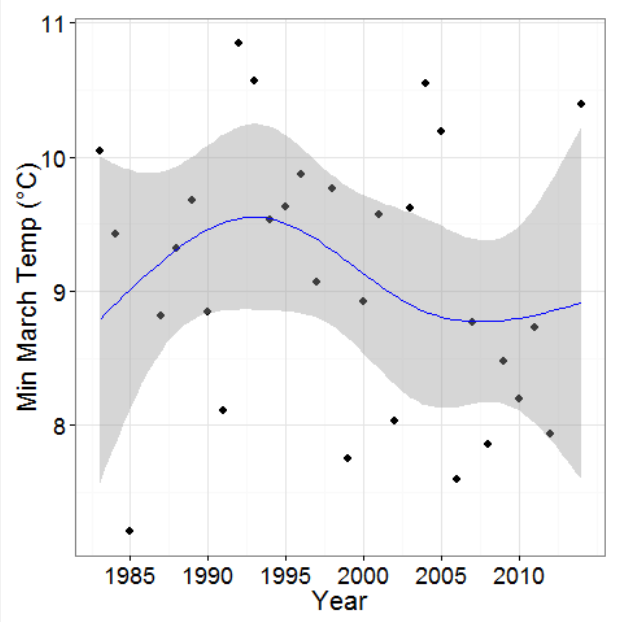
In relation to

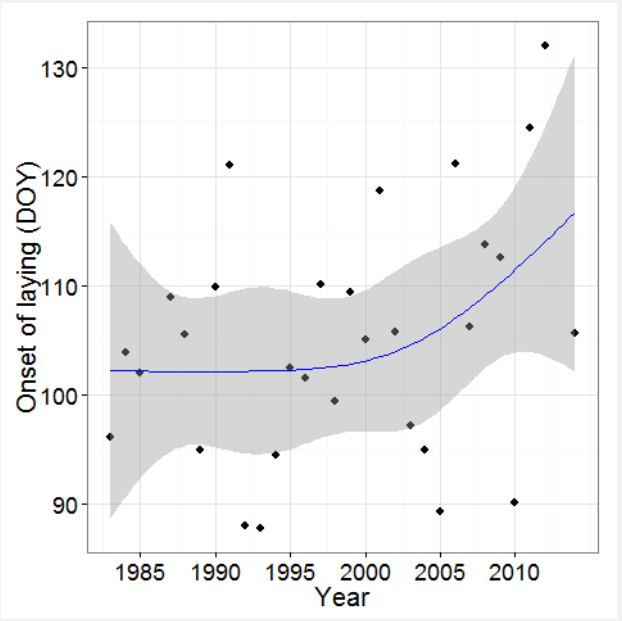
- temperature (winter, spring);
- precipitation (fall, winter, spring).

- Temperature and precipitation have been shown to influence reproduction in this species.
- Climate models predict changes in temperature and precipitation

Onset of Breeding





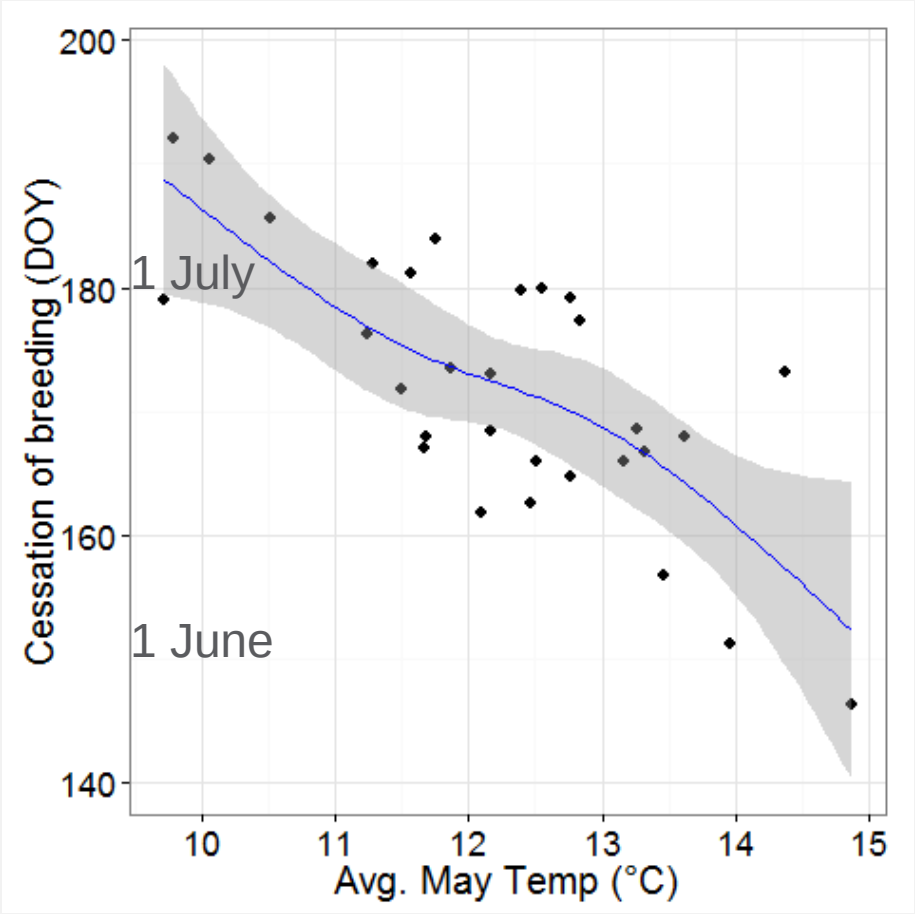


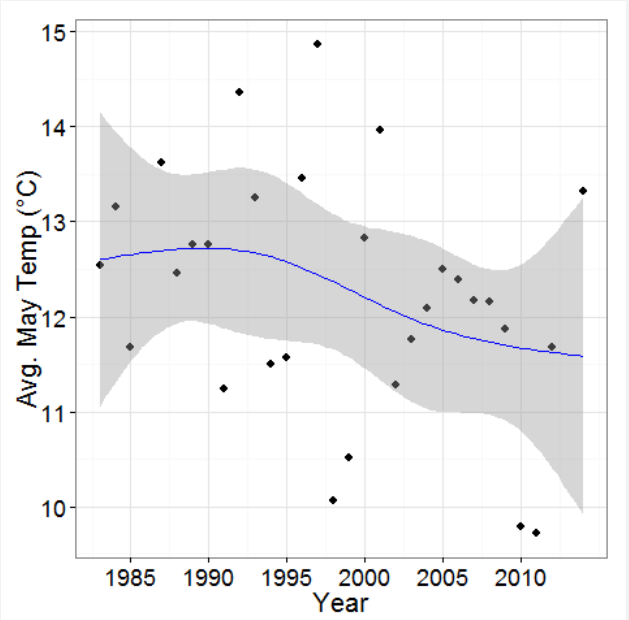
Breeding is earlier as March Temp increases.

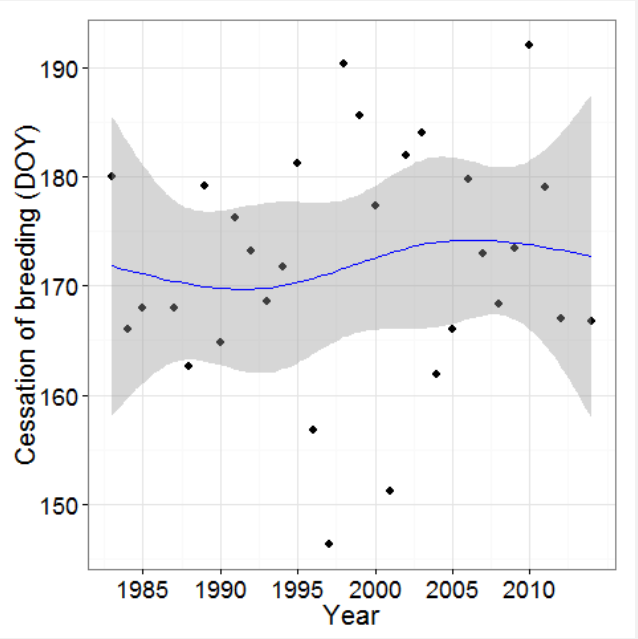
$P < 0.001$. $R^2 = 0.37$. About 20 d difference.

No significant trend in date with year (later initiation in recent years?).

Cessation of Breeding







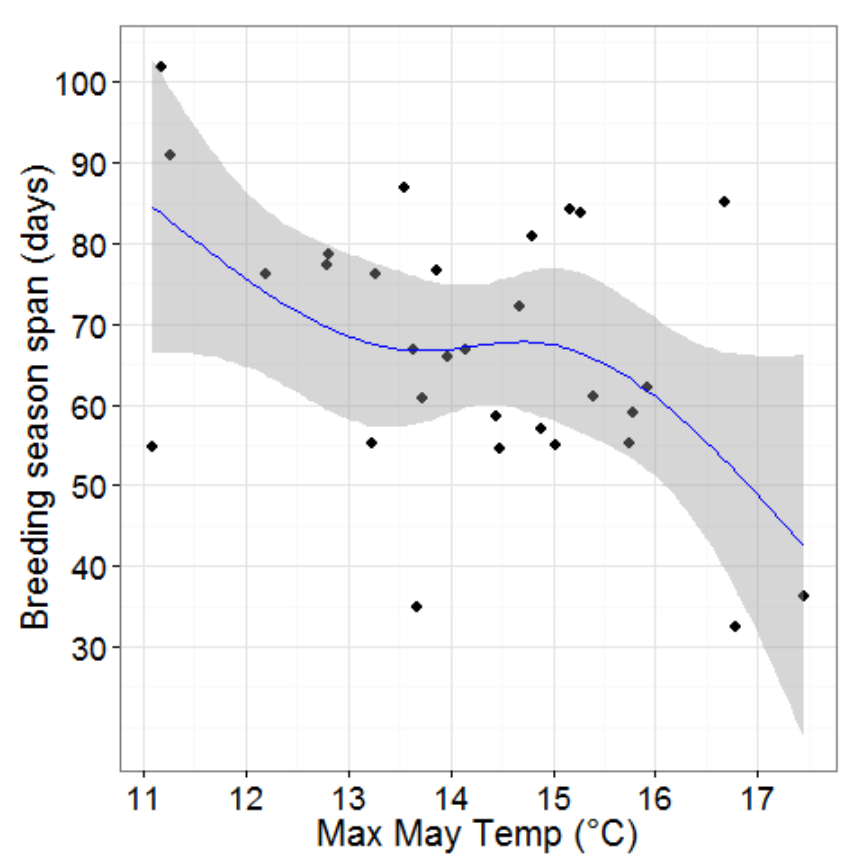
Breeding stops earlier as May Temp increases.

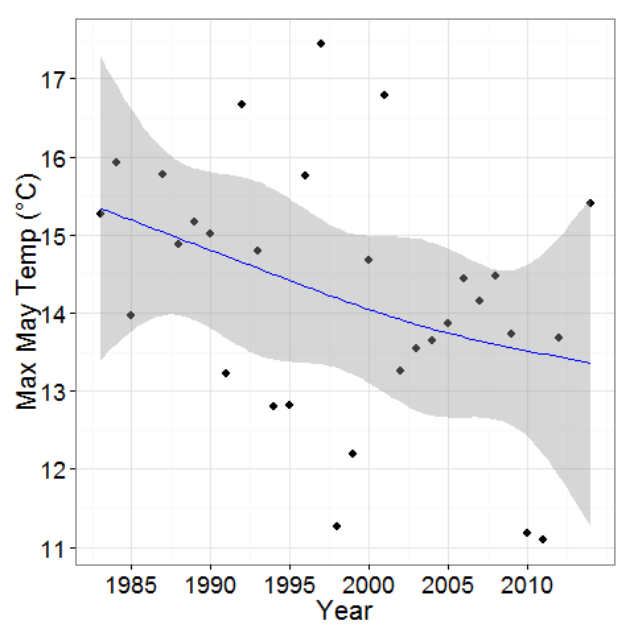
$P < 0.0001$; $R^2 = 0.54$.

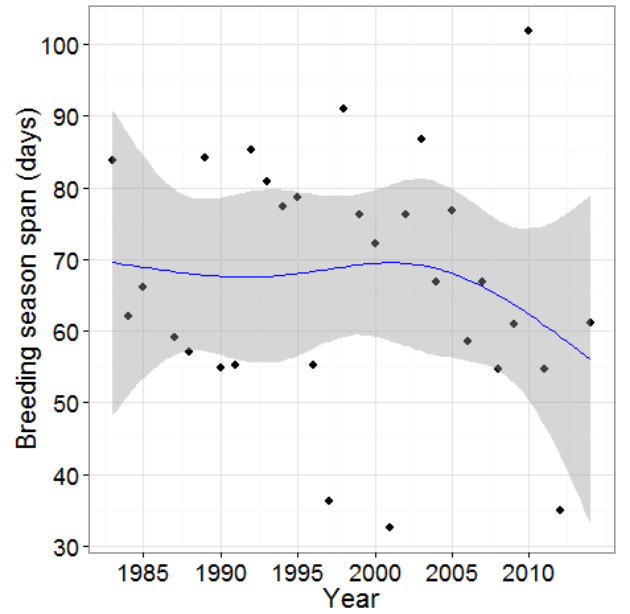
Strong effect: About 40 d difference.

Weak (NS) trend for temp vs year; no trend for cessation vs yea

Duration of Breeding Season







Duration of breeding season decreases as May Temp increases. $P < 0.01$. $R^2 = 0.22$.

Trend for Maximum May Temp to decrease vs year, $P = 0.03$

No significant trend for duration to change over time.

Summary: Song Sparrow Timing of Breeding Indicator

- Temperature in March-May best predictive variable. Precipitation in spring also predictive. Wetter spring -> longer breeding season.
- Warmer temperatures lead to earlier onset, earlier termination of laying.
- Warmer temperature leads to shorter breeding period (fewer attempts).
- **Mechanism:** Warm, dry conditions affects vegetation (and prey?).
- Similar findings for tidal marsh Song Sparrows (earlier cessation, fewer attempts, under warm, dry conditions).
- How does this impact reproductive success?
- Proposed Next step!

Conclusions

- Timing and duration of breeding are potentially effective indicators of climate change for terrestrial and marine bird species.
- Important to combine indicators of timing with measures of reproductive success, such as survival of nests (affected by vegetation, predators).
- Value of long-term studies as basis for climate change indicators
- Demographic models of climate change impacts indicate potential for significant long-term effects for Song Sparrows, Cassin's Auklets .
- Adverse impacts of climate change not observed, in the short-term, for Song Sparrows. Important to monitor in the long term.
- Information from climate change indicators can inform management, with regard to vulnerability and resilience to climate change.

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