Regionalizing seabirds as indicators of forage fish in Alaska

Sarah Ann Thompson, William J. Sydeman, Heather Renner, and John F. Piatt

Seabirds

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- Monitored at sea and in colonies

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- Indicators
  - population parameters track environmental variability and forage fish abundance

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  - relates well with prey abundance

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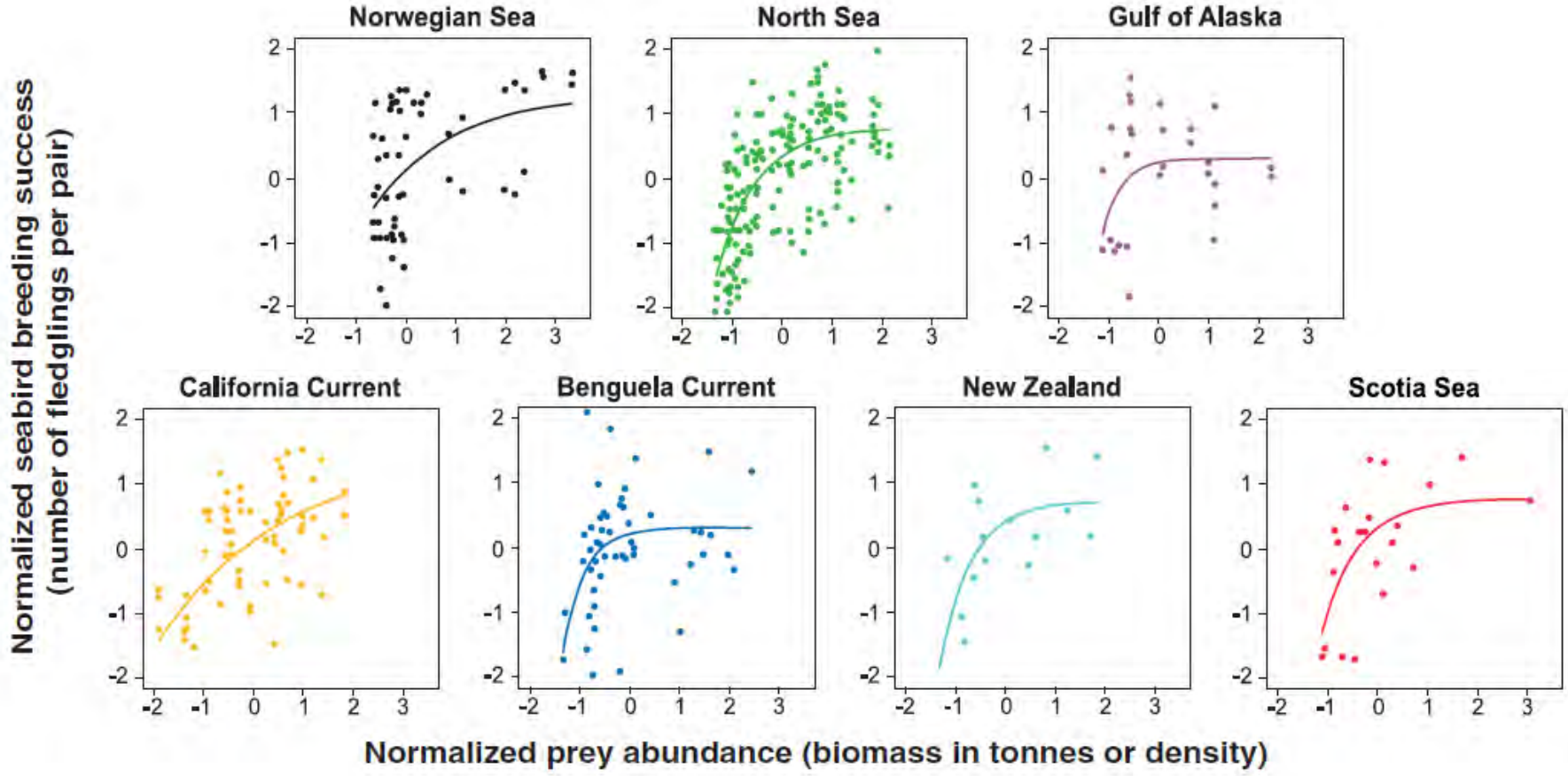
  - = productivity
  - easily measured
  - relates well with prey abundance
- Phenology (timing) of breeding
  - sensitive indicator of seasonal timing of local prey abundance
  - mean hatching date

Seabird Success Global Analysis



Cury et al. 2011 *Science*

Research Question

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- 4 piscivorous species
- 2 response variables
  - productivity and phenology
- 14 sites
- principal component analysis (PCA)

Seabird Study Species

Diving birds: *Uria*

Common Murre
COMU

Thick-billed Murre
TBMU

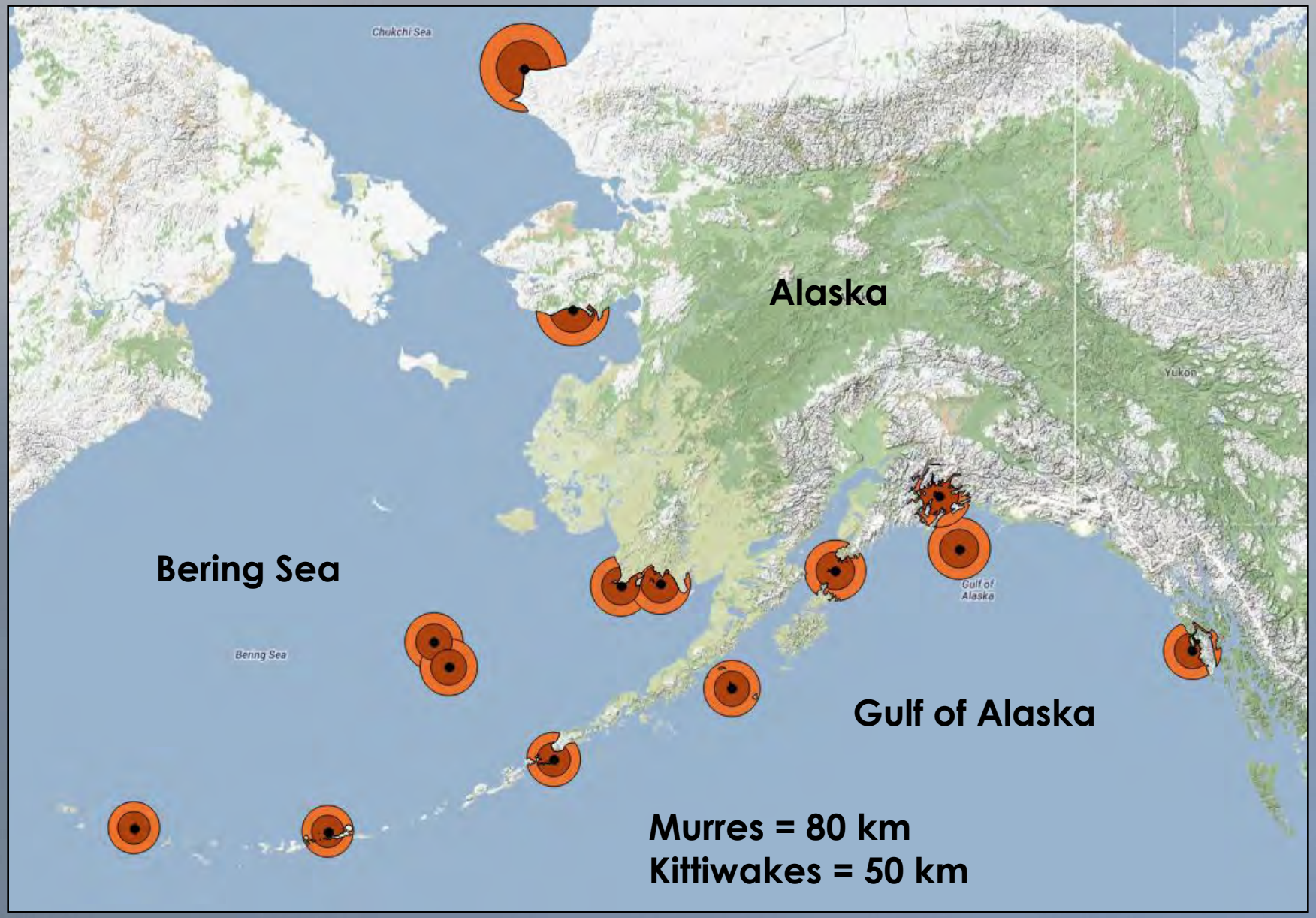
Seabird Study Species

Surface feeders: *Rissa*

Black-legged Kittiwake
BLKI

Red-legged Kittiwake
RLKI

Seabird Colony Sampling Domain



Data Selection

Species-sites for each response

- not all species at each site

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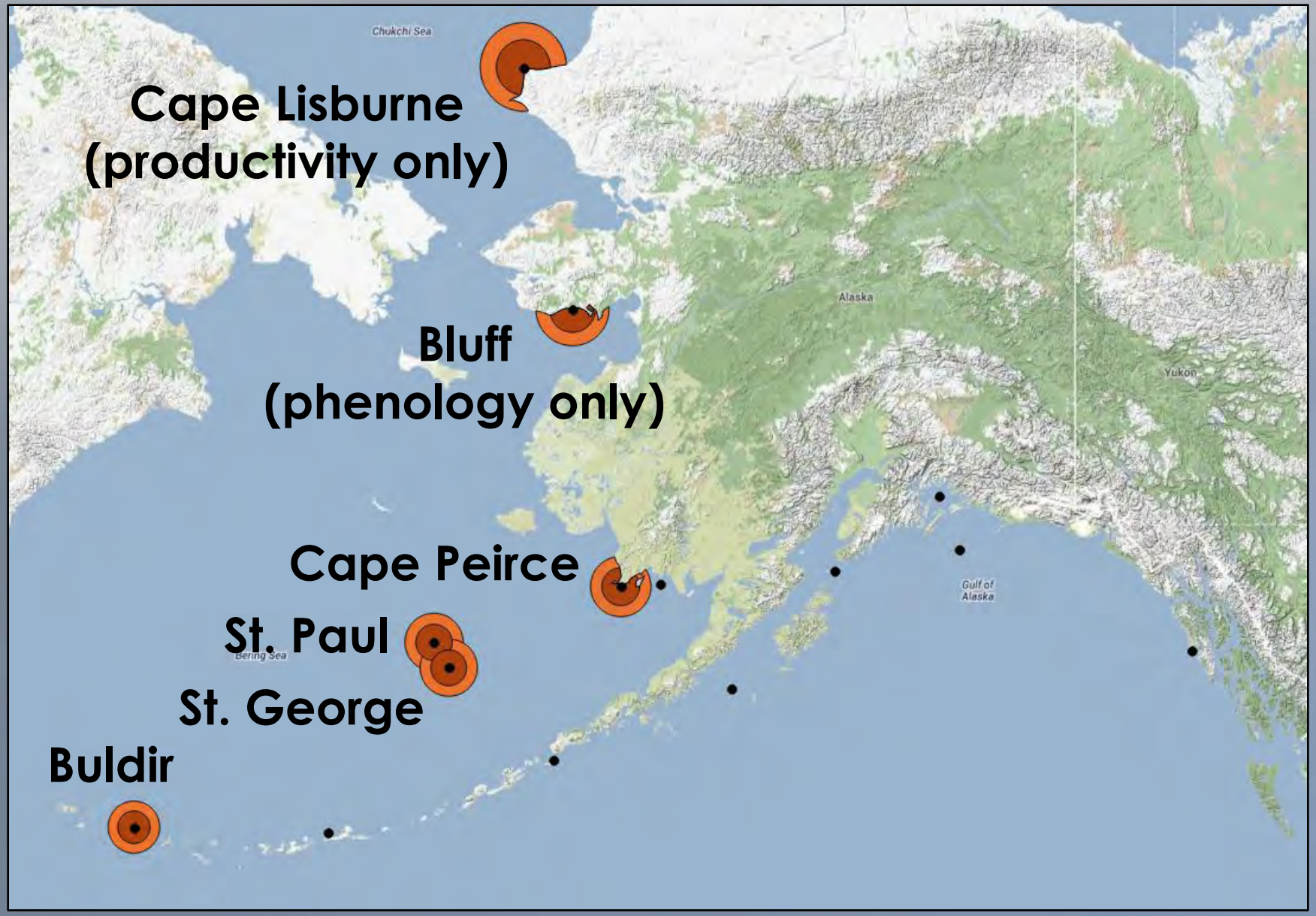
2. truncate time series
3. fill in missing values

Selected Seabird Colonies



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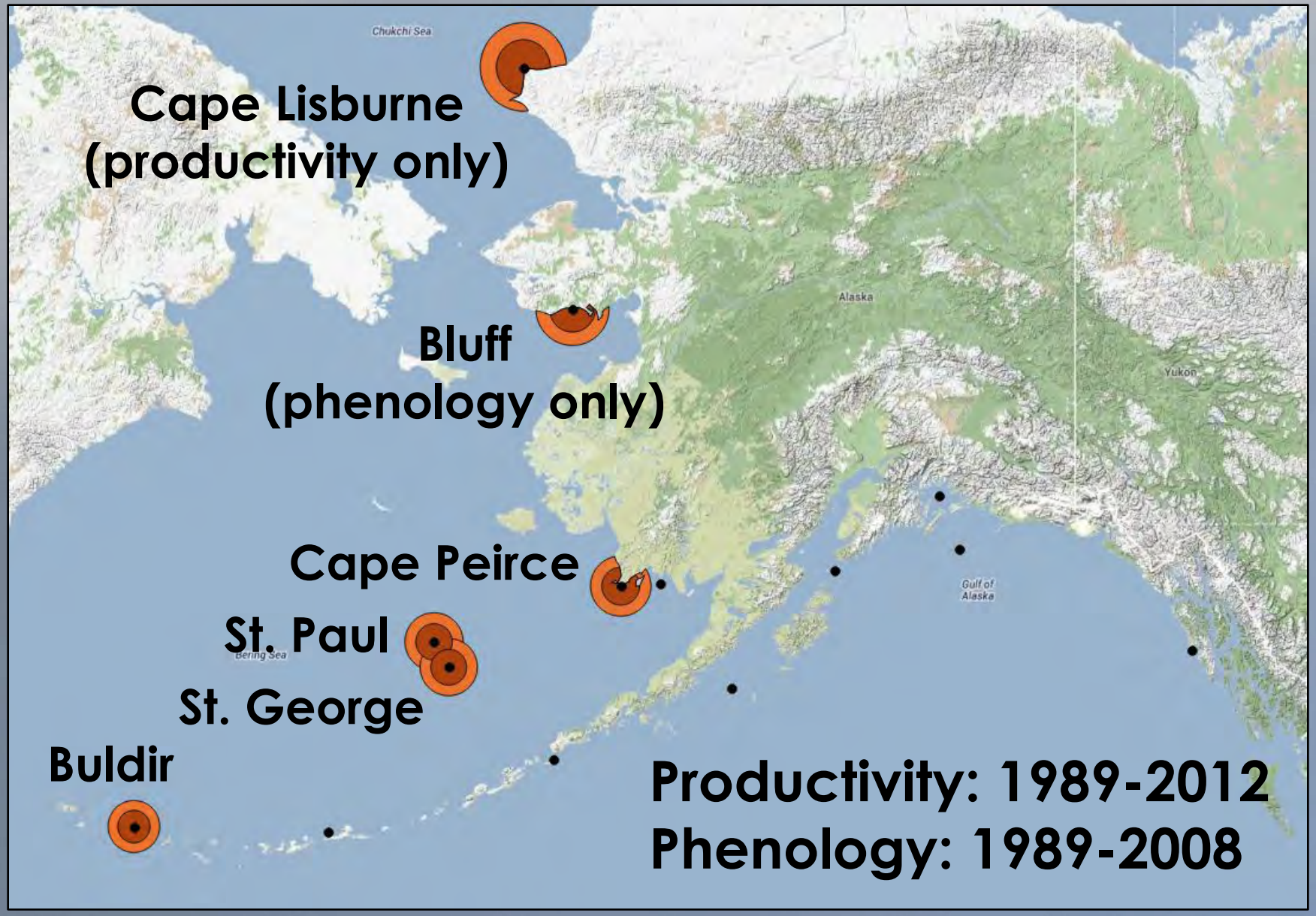

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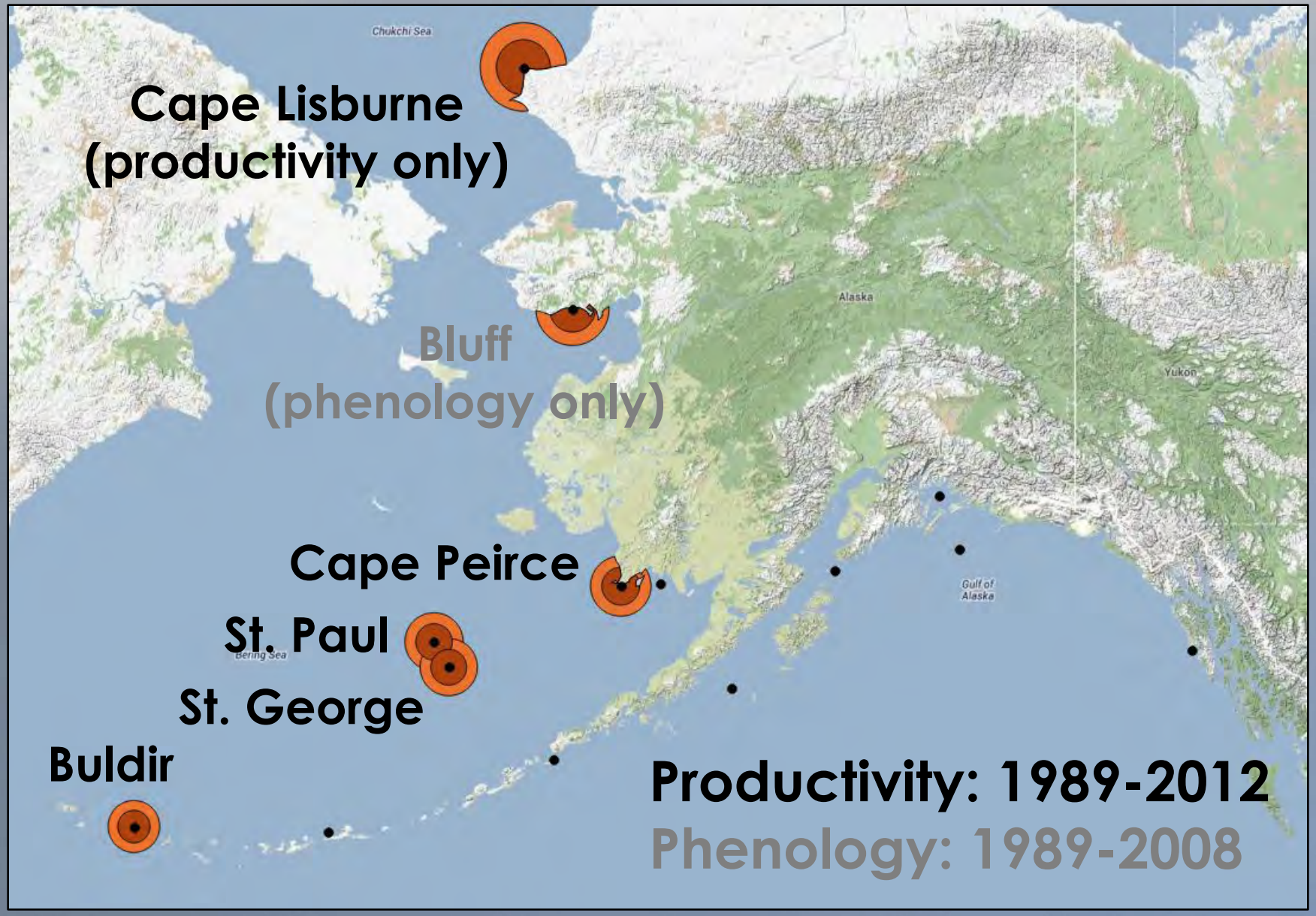

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- Produces values for missing data points by estimation

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Multiple Imputation

- Produces values for missing data points by estimation
  - 5% productivity data (10% phenology)
  - maximum 5 years/species-site, maximum 3 consecutive years
- Generated 10 imputations
- Averaged the 10 imputed values, used this average for the missing data point

  = full data matrix

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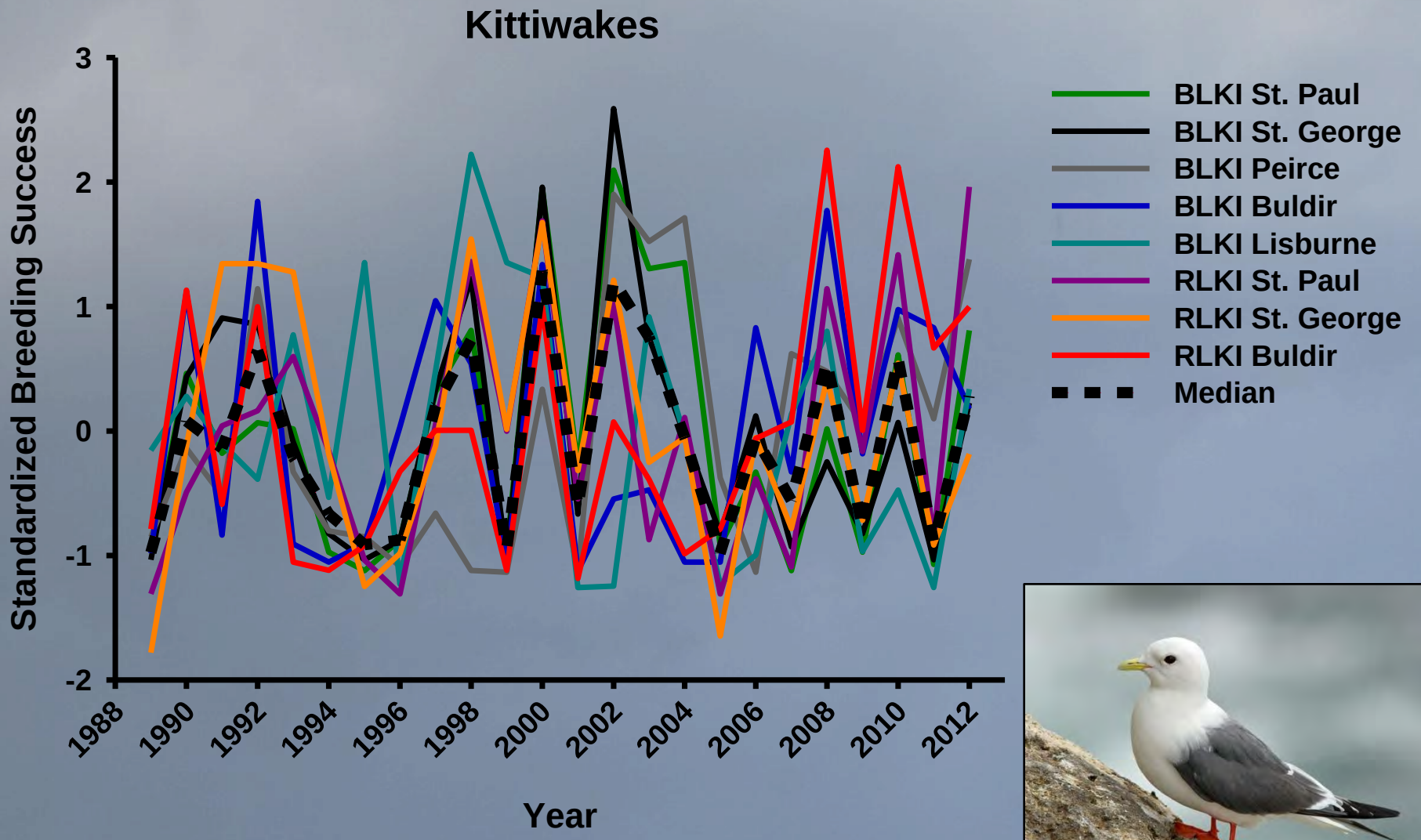
Can sites or taxa be combined to produce regional indicators in Alaska?

→ Do they co-vary?

Species-site covariation



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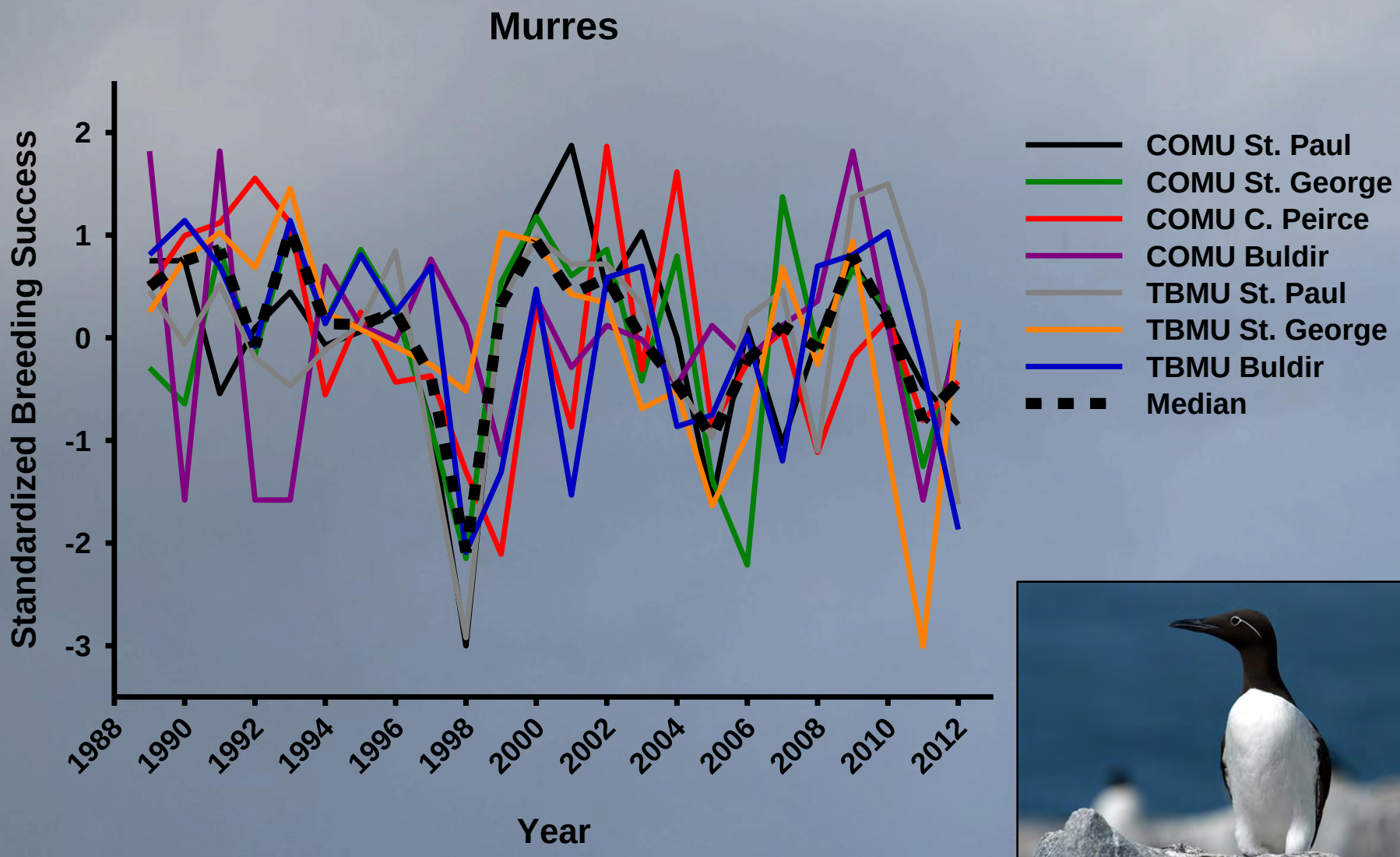


UCSC Natural Reserves

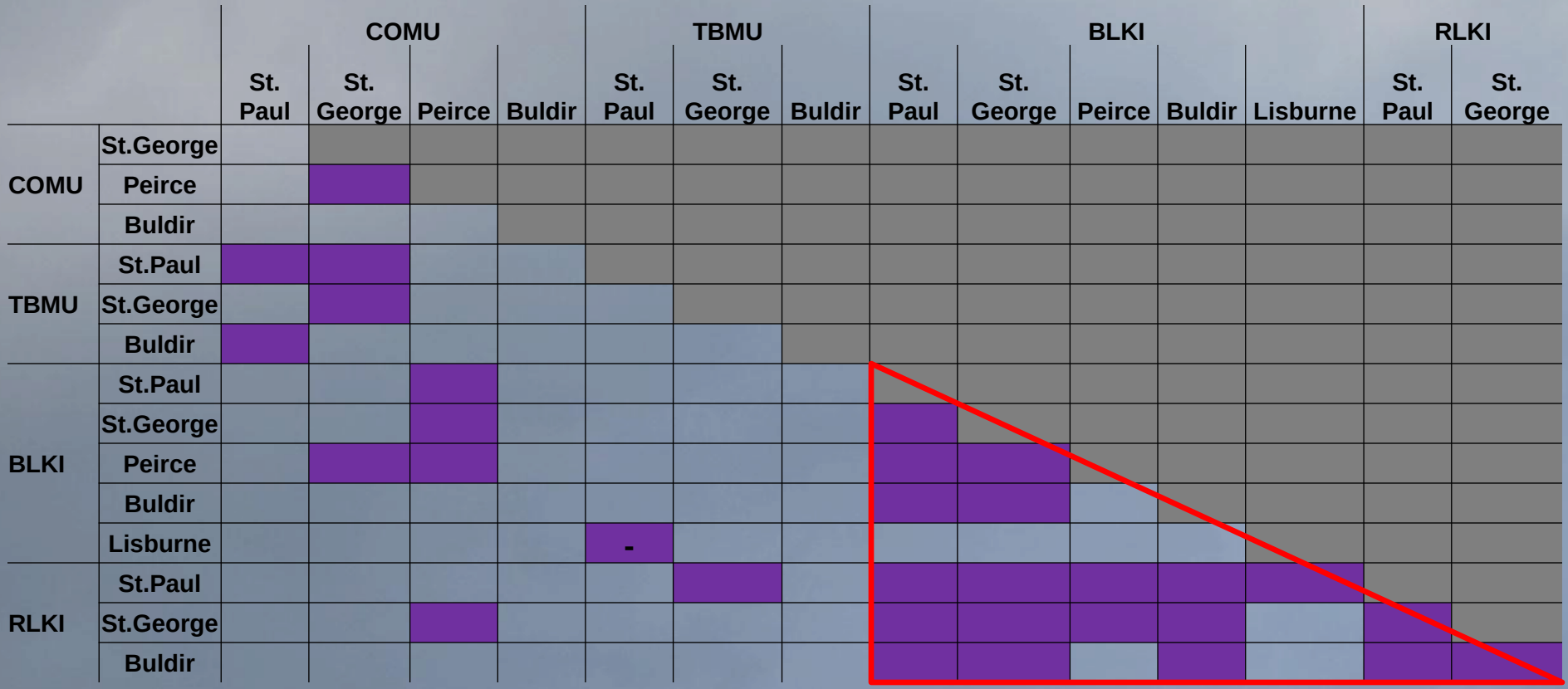
Research Question

Can sites or taxa be combined to produce regional indicators in Alaska?

→ Do they co-vary?

- Spearman cross-correlation

Productivity Cross-correlation



Significance: p < 0.1; 97% correlations +

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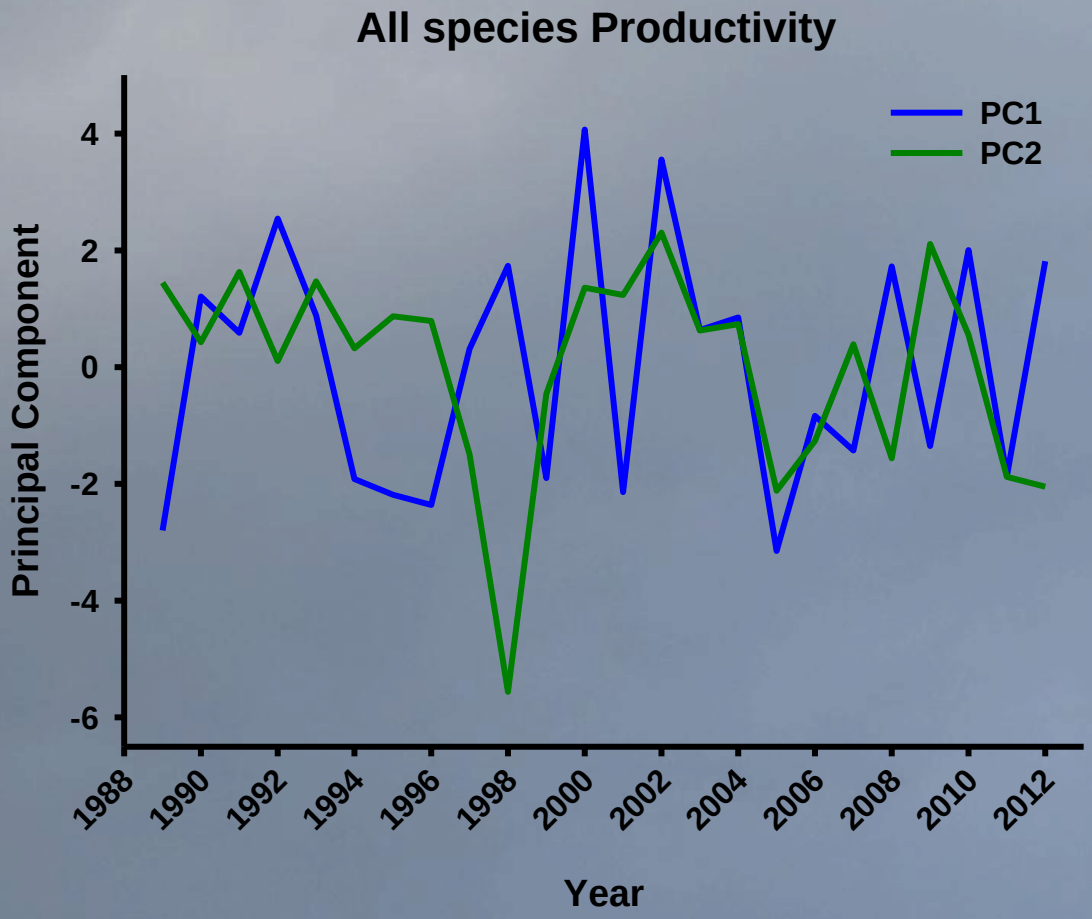
Yes. Proceed with PCA

Principal Component Analysis

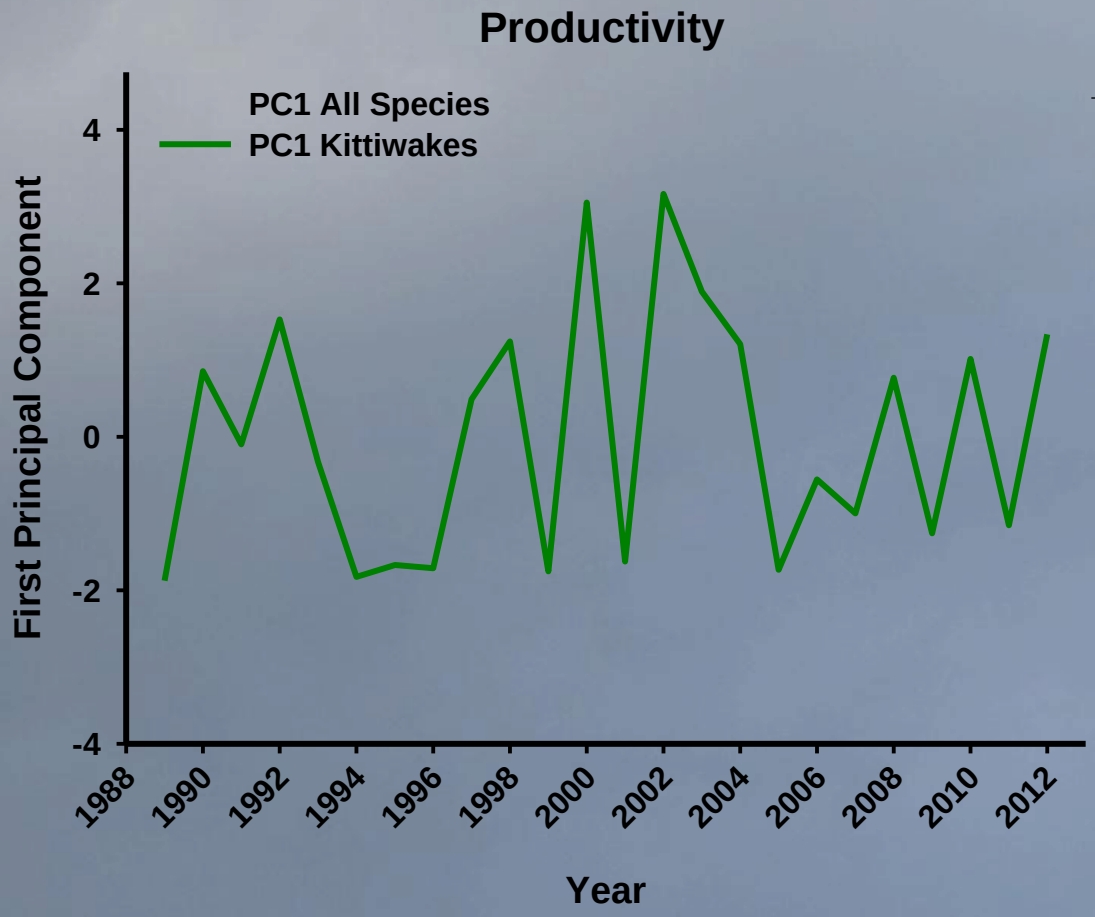


Component	Eigenvalue	Proportion	Cumulative
PC1	4.38	0.29	0.29
PC2	3.16	0.21	0.50

Variable	PC1	PC2
COMU St. Paul	0.007	0.441
COMU St. George	0.061	0.431
COMU C. Peirce	0.216	0.328
COMU Buldir	-0.069	0.107
TBMU St. Paul	-0.075	0.452
TBMU St. George	0.105	0.292
TBMU Buldir	0.071	0.319
BLKI St. Paul	0.415	0.021
BLKI St. George	0.419	0.015
BLKI C. Peirce	0.294	0.115
BLKI Buldir	0.263	-0.193
BLKI C. Lisburne	0.157	-0.179
RLKI St. Paul	0.392	-0.112
RLKI St. George	0.300	-0.011
RLKI Buldir	0.286	-0.121

Little co-variation across genera

PCA Kittiwakes



Component	Eigenvalue	Proportion	Cumulative
PC1	4.14	0.52	0.52
PC2	1.40	0.18	0.69

Variable	PC1	PC2
BLKI St. Paul	0.423	-0.231
BLKI St. George	0.423	-0.228
BLKI C. Peirce	0.289	0.114
BLKI Buldir	0.300	0.562
BLKI C. Lisburne	0.167	-0.357
RLKI St. Paul	0.419	-0.088
RLKI St. George	0.403	-0.261
RLKI Buldir	0.322	0.602

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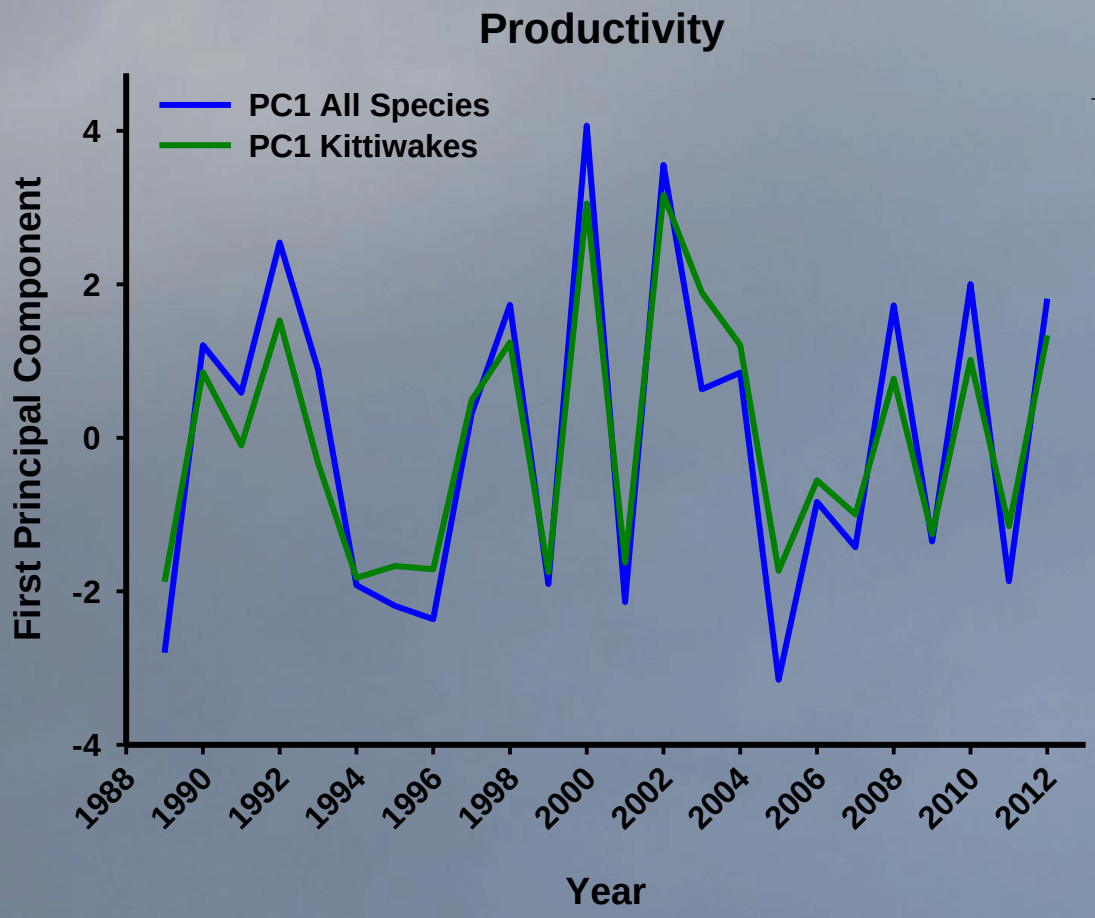

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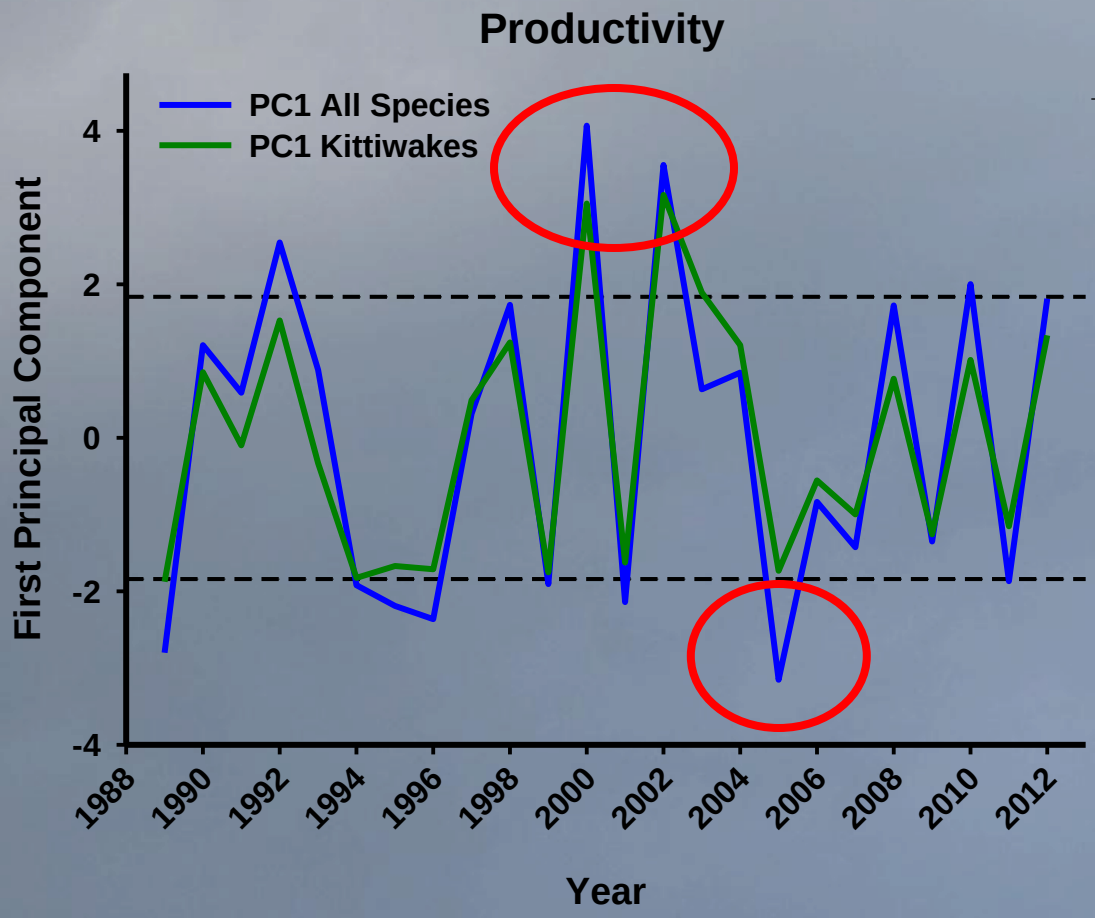

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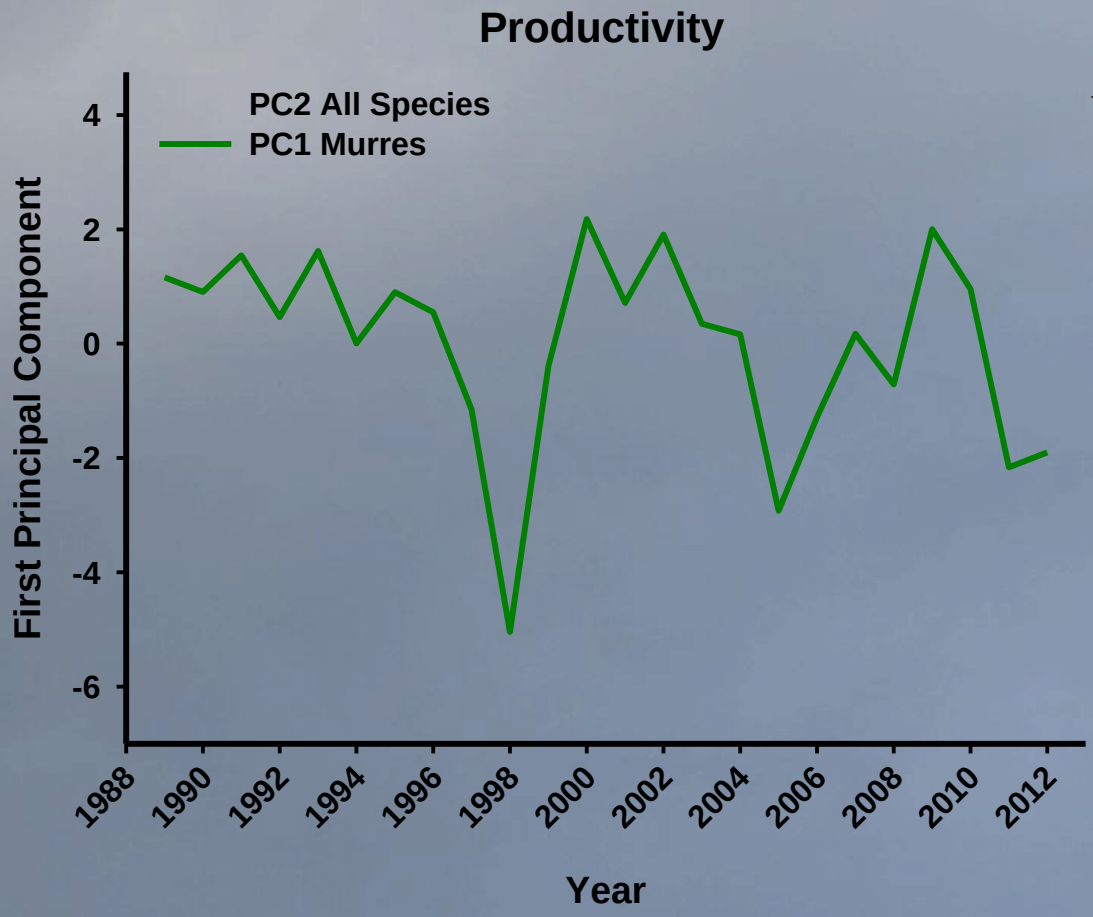
PCA Murres



Component	Eigenvalue	Proportion	Cumulative
PC1	2.98	0.43	0.43
PC2	1.15	0.16	0.59

Variable	PC1	PC2
COMU St. Paul	0.461	-0.271
COMU St. George	0.450	0.395
COMU C. Peirce	0.341	0.000
COMU Buldir	0.099	0.295
TBMU St. Paul	0.448	-0.345
TBMU St. George	0.347	0.636
TBMU Buldir	0.371	-0.400

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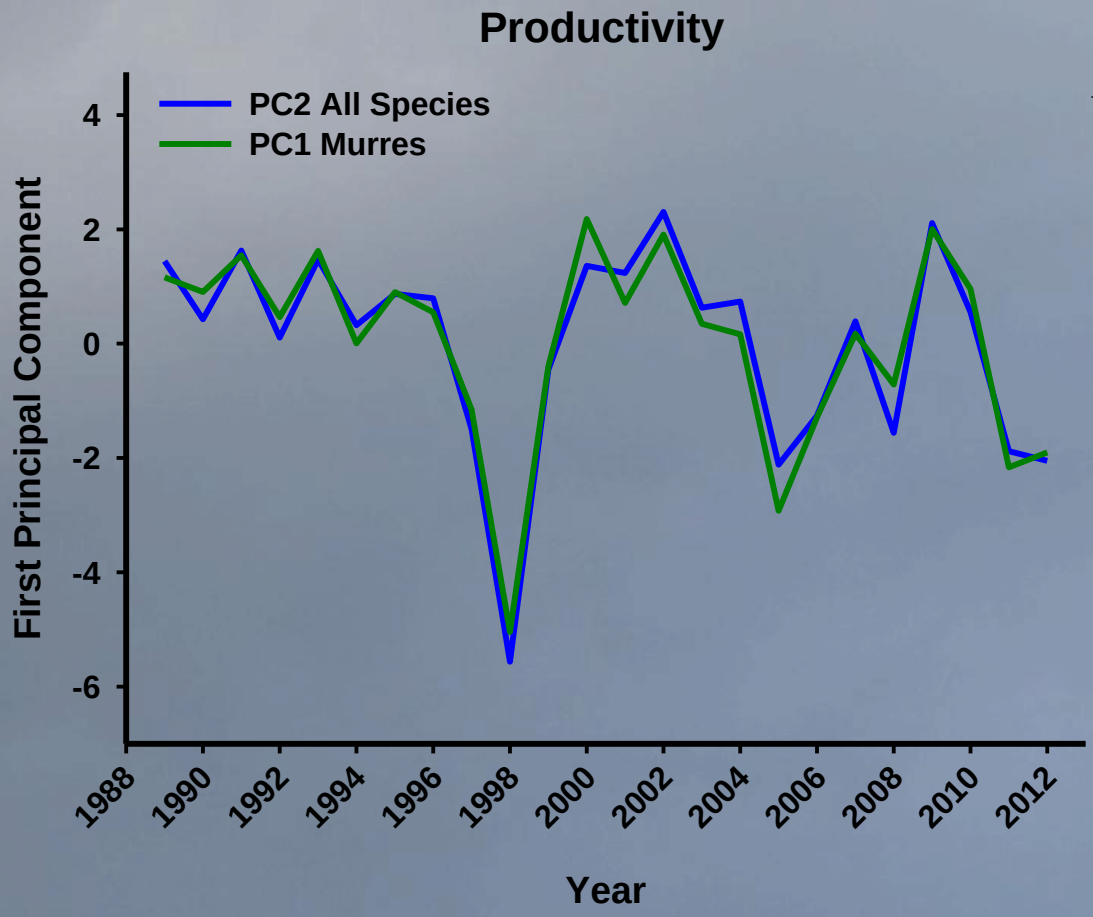

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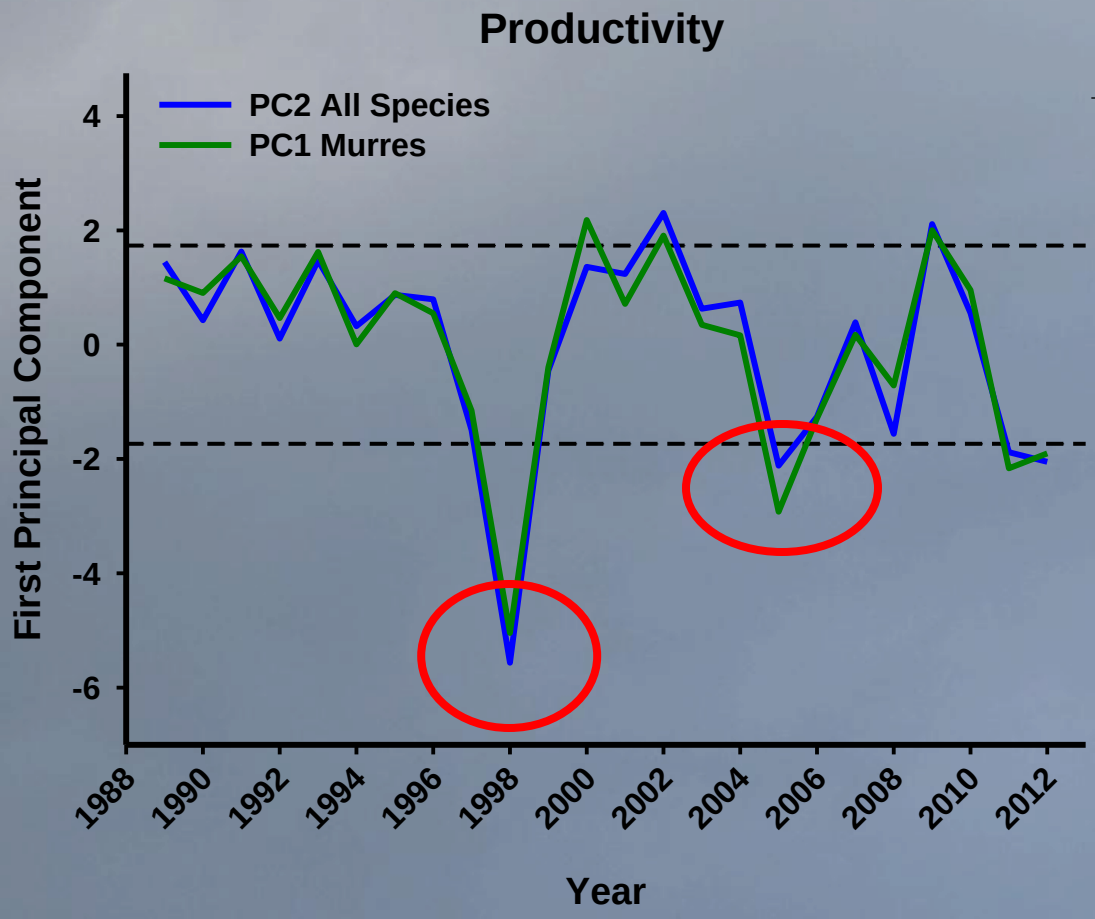

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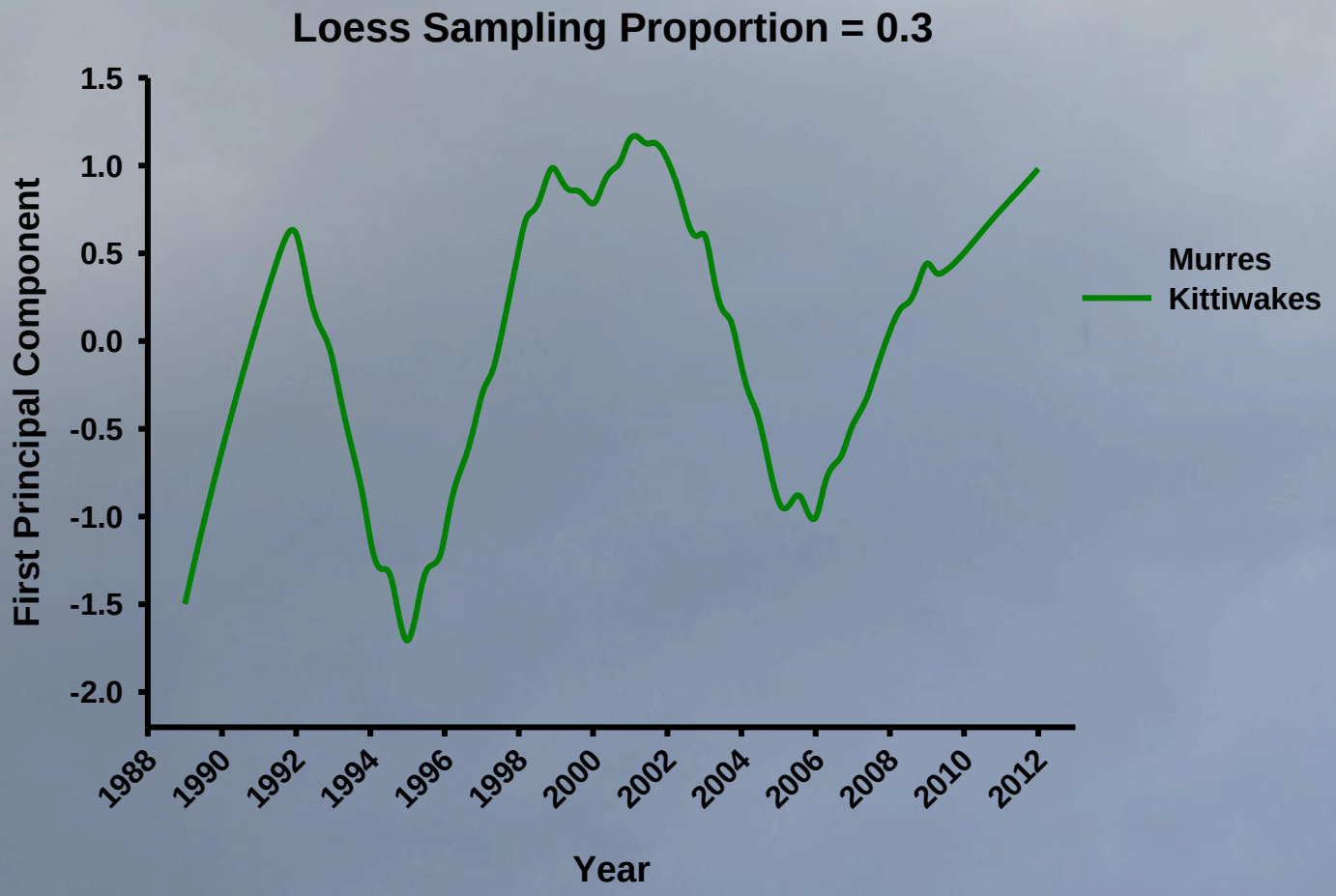
Seabird Interannual Variability



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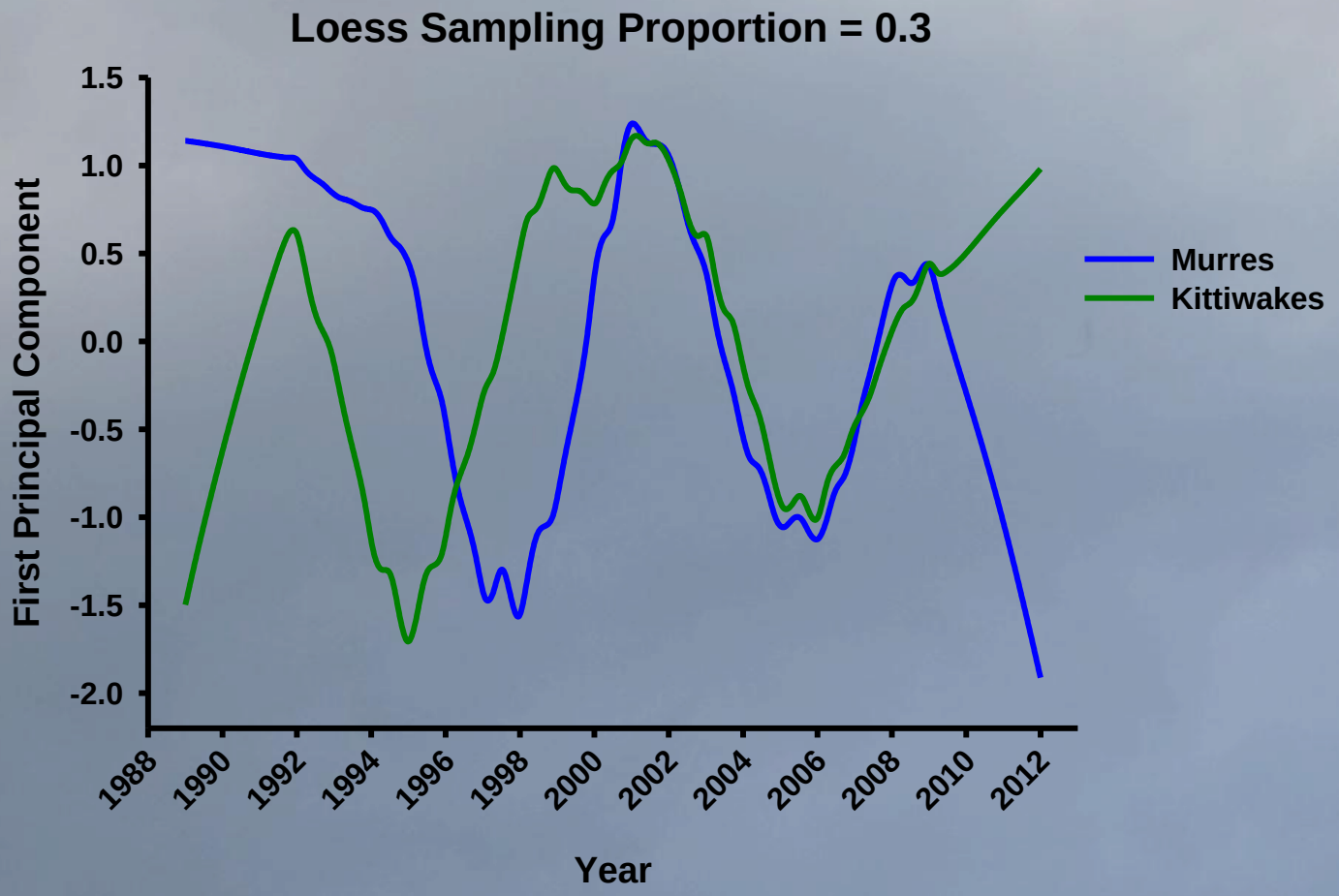

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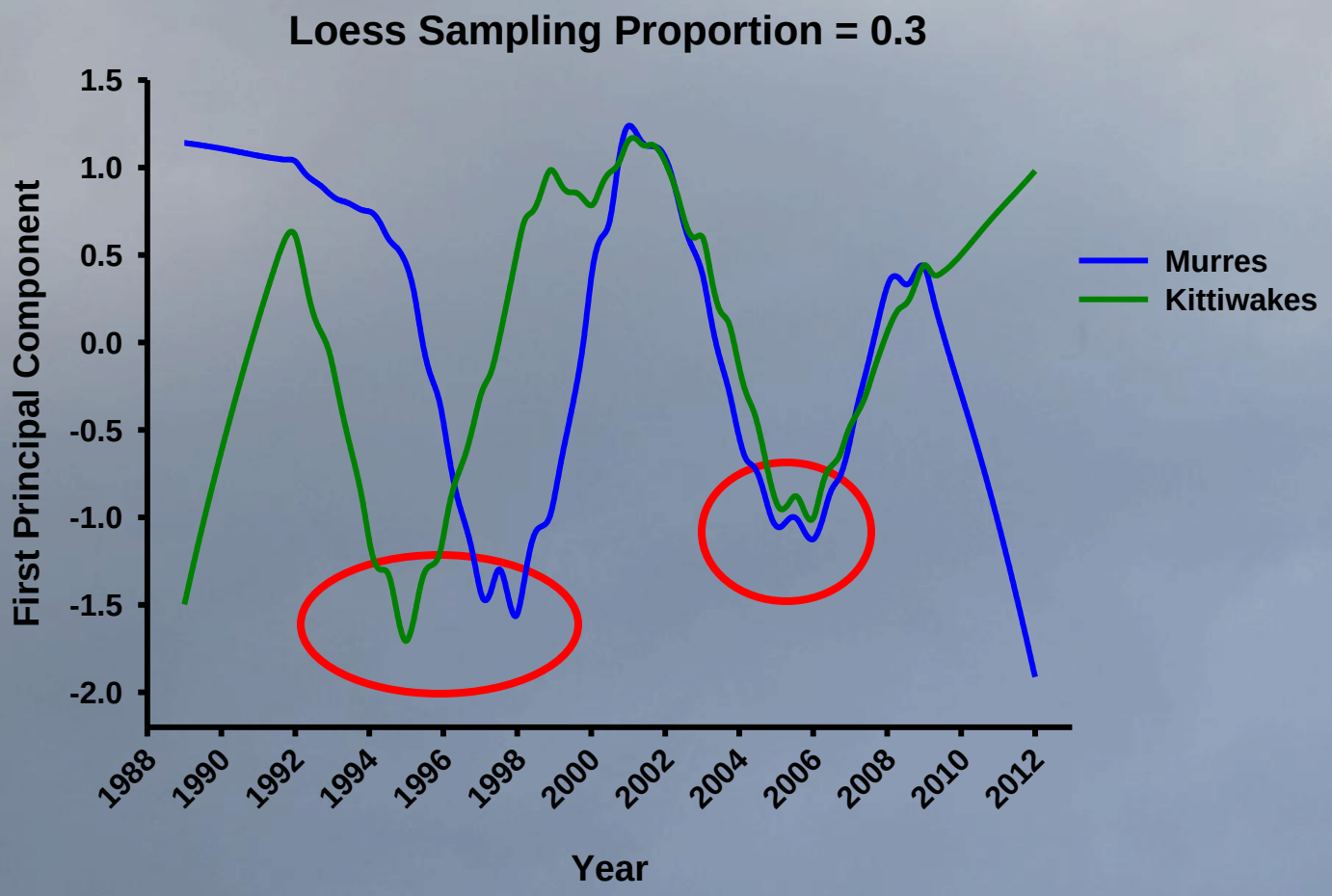

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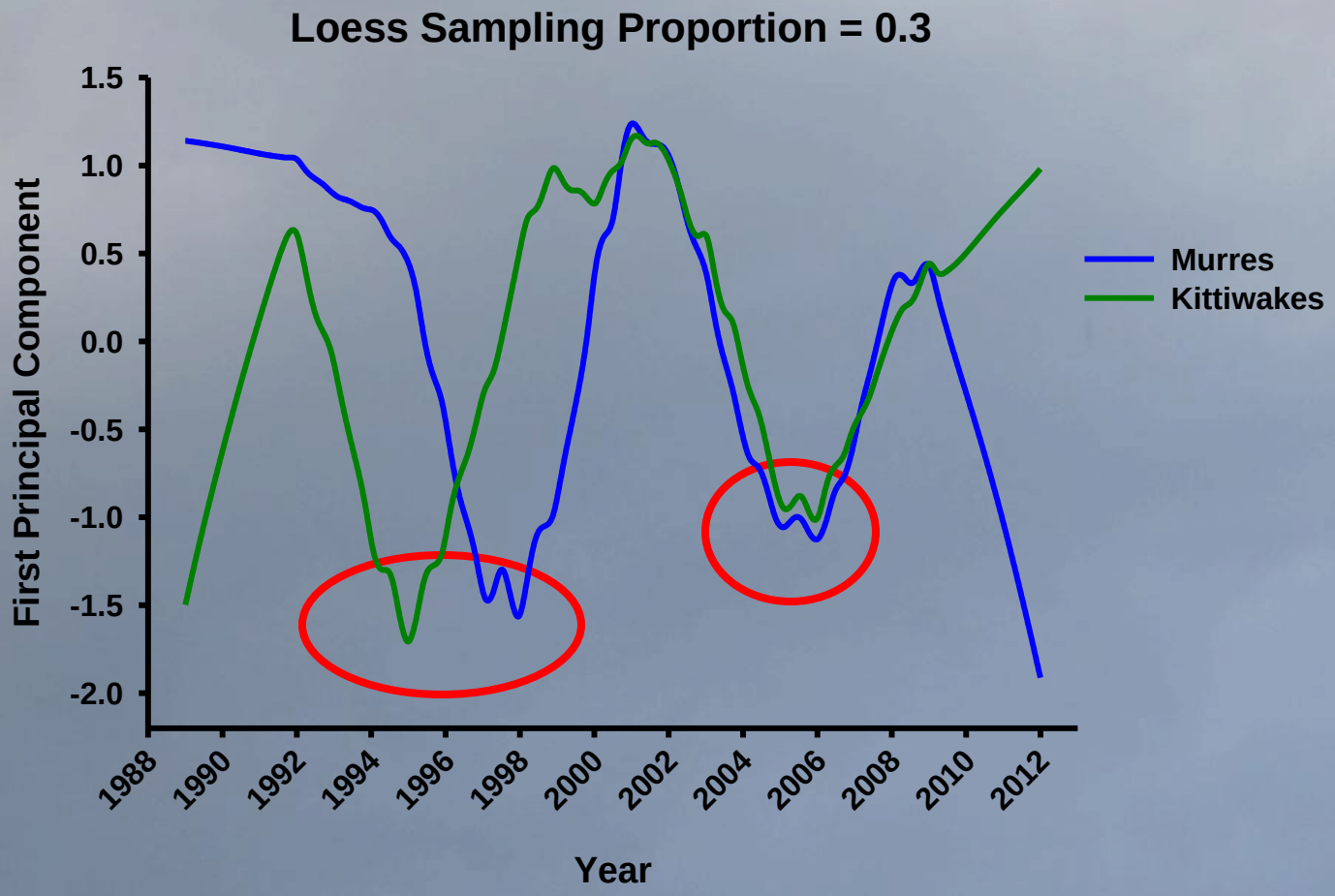

- May be due to differing foraging ecology/ prey base

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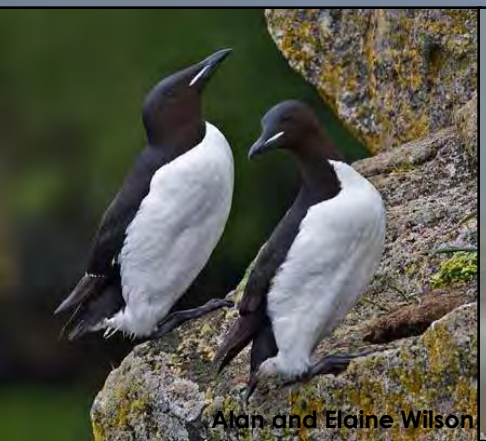
  = indicate differences in forage fish communities by reverse inference

Thank you!

North Pacific Research Board
Alaska Maritime National Wildlife Refuge staff
Mike Litzow
Marcel Losekoot
Spencer Wood
Jarrod Santora


Alan and Elaine Wilson


Hannu Jannes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