

# Associations among mortality events, seabird demography, and ocean climate trends in central California

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# Seabird Mass Mortality Events

## Aka Seabird Wrecks

- Regular occurrence for many species
- Several major seabird die-offs along CA coast and west coast wide in last 20 years
  - Brandt's cormorants – 2009, 2015, 2020
  - Cassin's auklets – 2005, 2014
  - Common murre – 2007, 2008, 2015, 2019
  - Northern fulmar – 2003, 2010, 2020



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# Research questions

1. What drives unusual mortality events?
2. What is impact on local populations?
3. Can we identify thresholds for concern?



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# Specific research activities

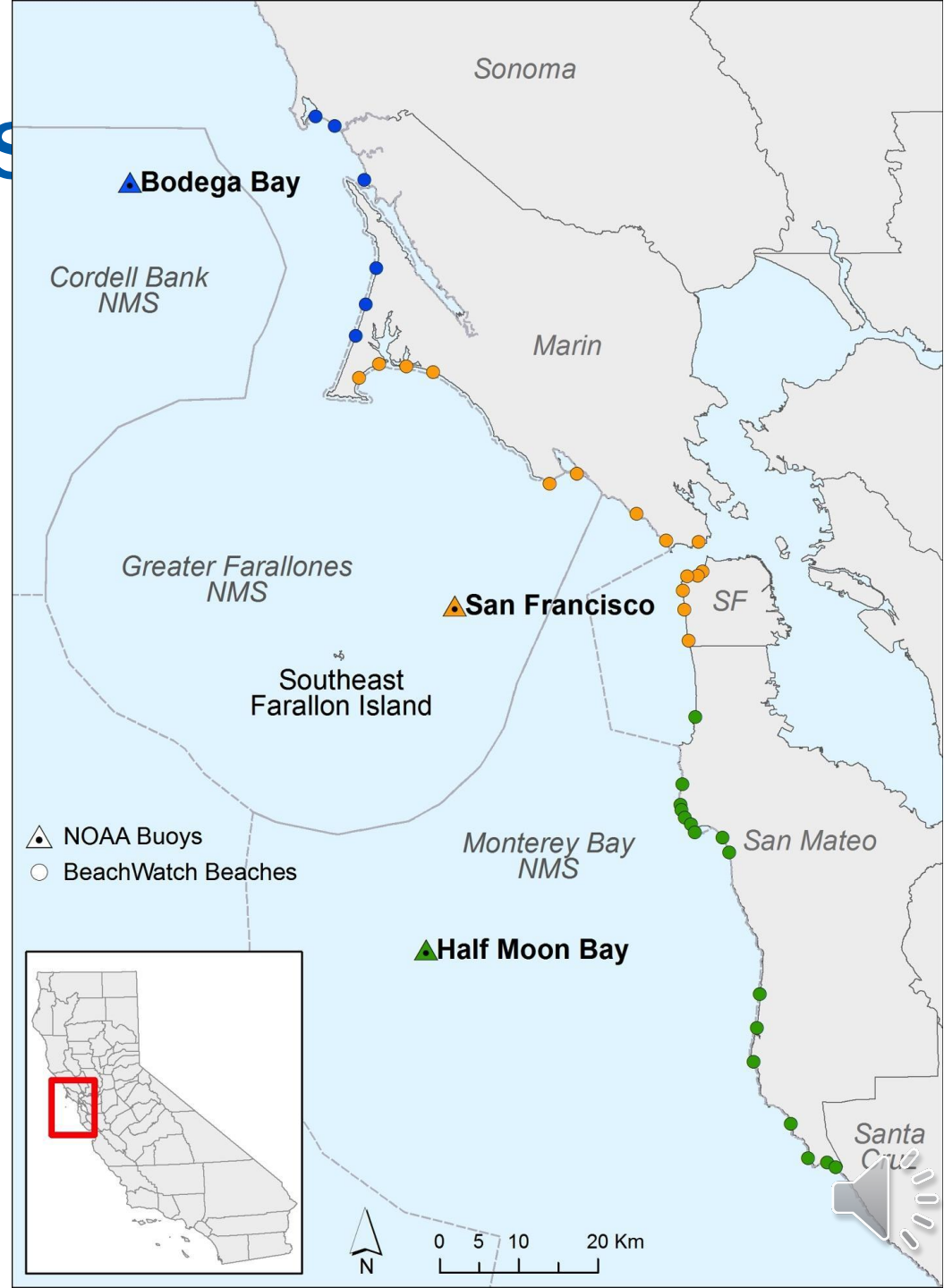
1. Compile long-term data on beached carcass records from Beach Watch and local seabird demographics
2. Identify patterns relating ocean climate indices to beached carcass data, seabird demography, population and prey availability



# Study area and Datasets

## Bodega Head to Point Año

- Focused on Beach Watch survey region
- Seabird population data from Farallon Islands and regional colonies
- Reproductive success data from Farallon Islands
- Oceanographic data available from NOAA buoys or locally collected at Farallon Islands
- Six species examined - BRAC, CAAU, COMU, WEGU, WE/CLGR, NOFU



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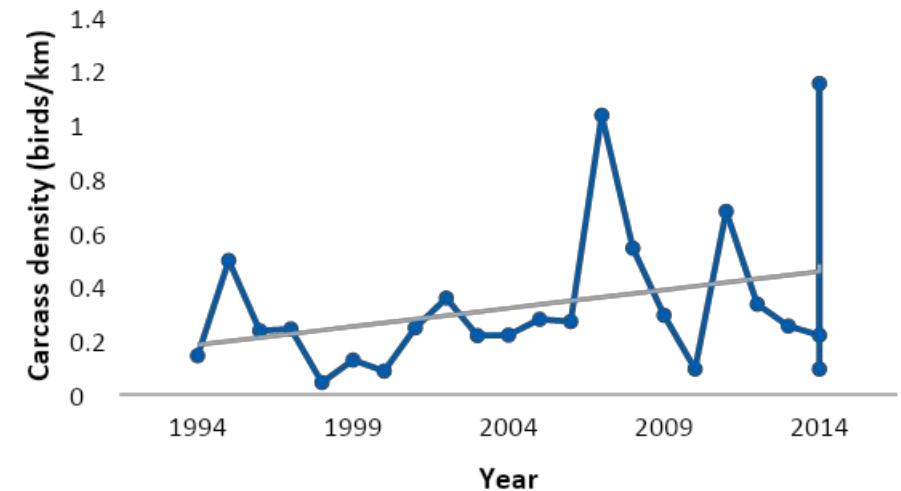
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# Methods

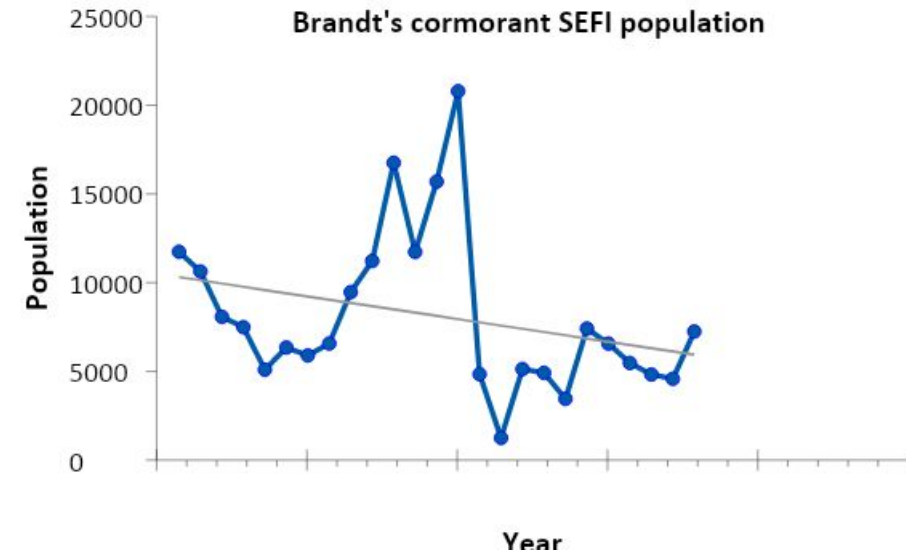
## Data acquisition

- Carcass deposition and demographic data from Beach Watch surveys 1994-2016
  - Standardized carcass rate by km of beach surveyed
  - We binned data by species and by age (immature or adult), month, and season
- Compiled seabird breeding data from South East Farallon Island 1994-2016
- Compiled data for ocean climate variables
  - local and basin scale

Brandt's cormorant fall deposition



Brandt's cormorant SEFI population



# Methods

## Relate climate indices to carcass data &

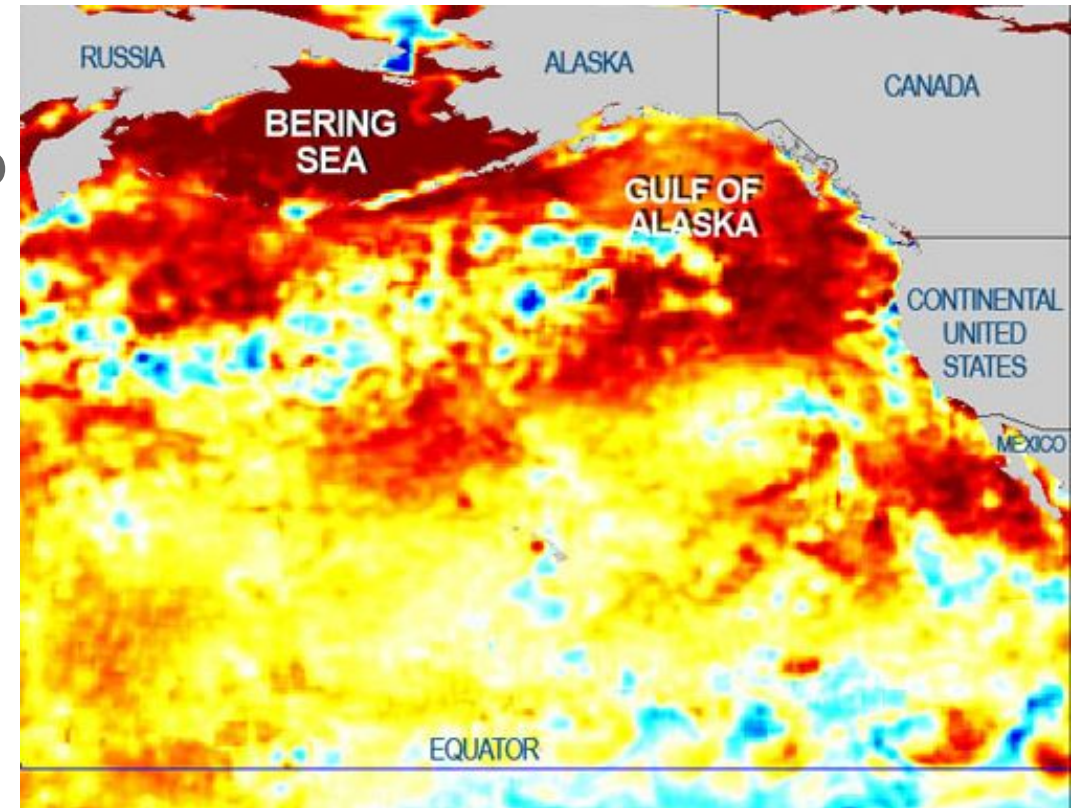
- Determine associations between carcass density grouping and:
  - oceanographic variables – SST, UI, Spring Transition
  - climate indices – SOI, PDO, NPGO
  - prey availability – Rockfish cruise prey abundance, seabird diet
  - seabird demography – RS, phenology
  - seabird population size
- Negative binomial regression
- Hierarchical approach, separate partial models for each group of explanatory variables
- Combined significant variables from partial





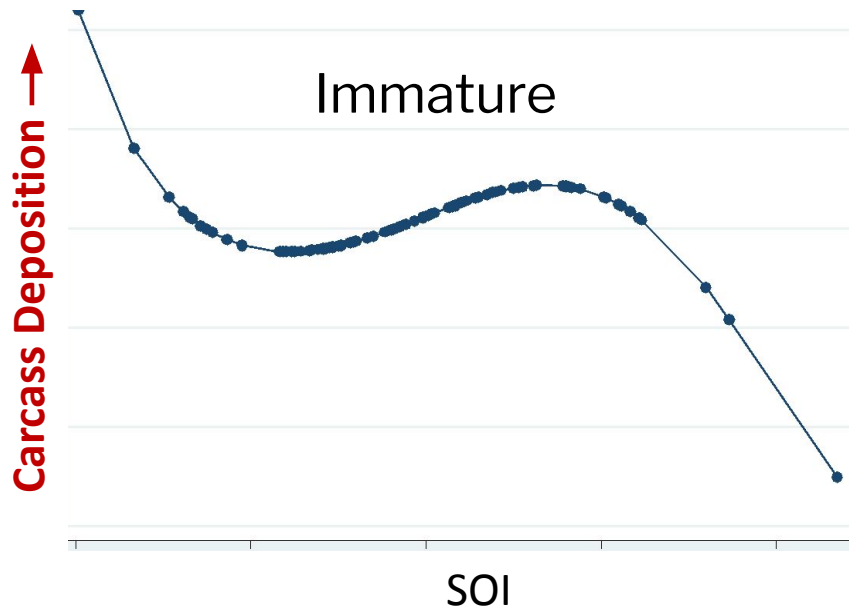
# Overall results

- Significant associations with prey and demographic variables were found (e.g. reduced prey availability or high RS)
- Once all significant variables were added to the final model, prey and breeding demography were swamped by oceanographic and climate variables
- Increased carcass deposition was found when decreased or delayed upwelling and warm ocean temperatures existed (e.g. El Niño)
- Specific predictors varied among species and age classes

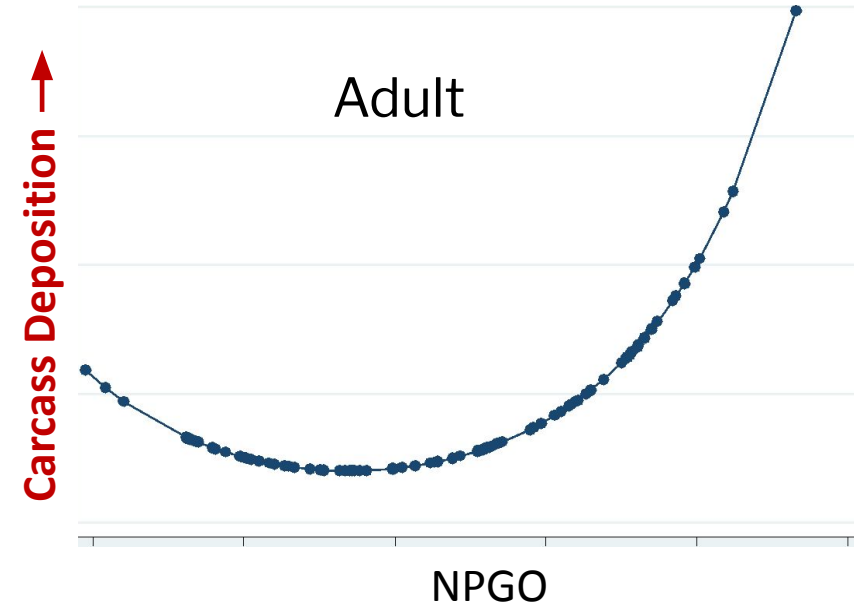


# Brandt's cormorant model

Decreased upwelling and warm ocean temperatures associated with El Niño



Carcass Deposition increases with -2 or lower SOI, and decreases with +2 or higher



Both anomalously warm or cold conditions increase adult deposition after 7-9 months.



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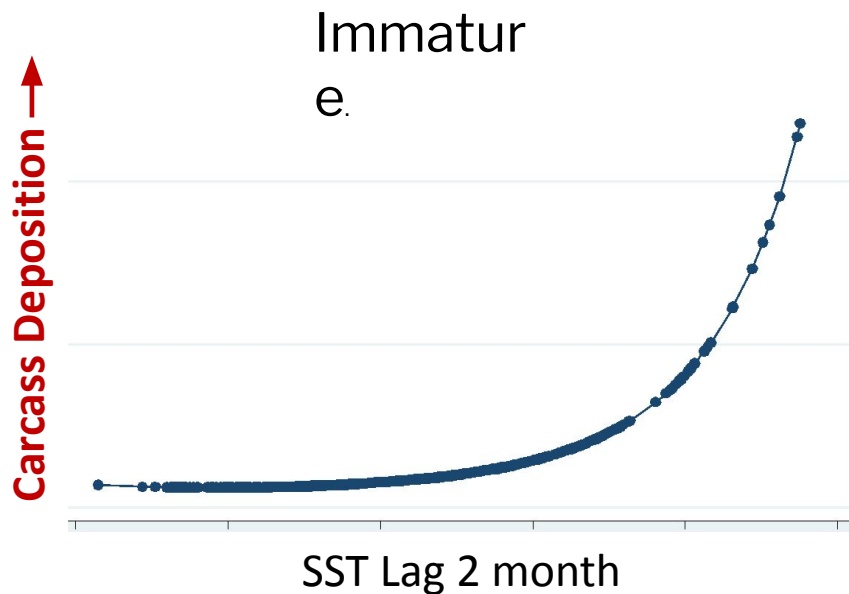
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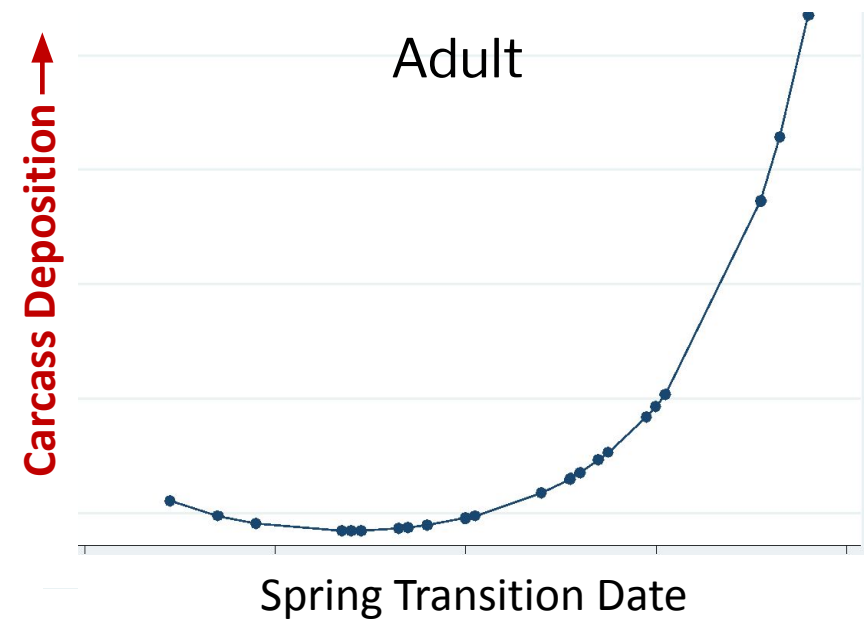
# Cassin's auklet model

Warm water and late spring transition

Also higher in poor breeding years



Carcass deposition increases 2 month after very high SST increase.



Carcass deposition increases with later spring transition. Deposition highest during late breeding years.



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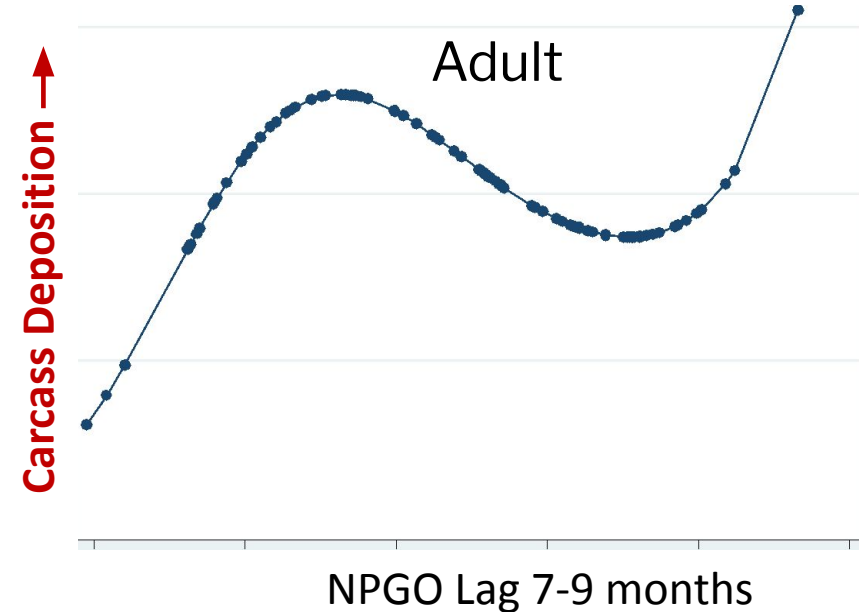
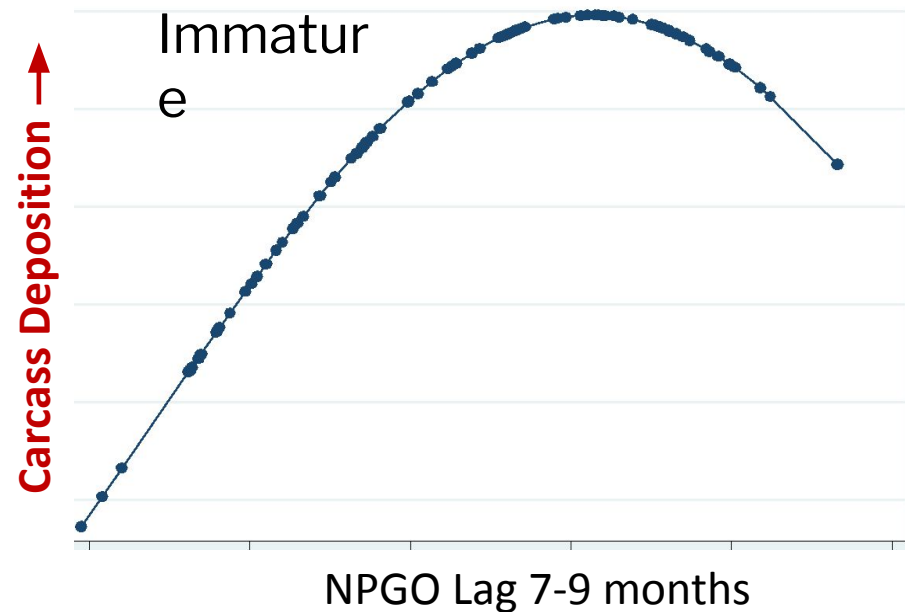


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# Common murre model

Warm water and decreased upwelling



Higher carcass deposition 7-9 months after a positive NPGO for both immatures and adults



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# Other species



Western gull

Access to human food resources



Northern fulmar

Breeding season conditions in north pacific



Clark's/Western grebe

Breeding season conditions interior lakes



# Conclusions

- Oceanographic conditions as drivers of carcass deposition
- Seabird mass mortality events more likely 6-9 months after warm ocean conditions with weak upwelling and reduced prey availability
- Specific oceanographic drivers vary among species and time of year
- Few strong associations between carcass deposition and local population trends
- Seabird populations adapted to occasional MME but frequency and magnitude can have long-term negative impacts
- Great value in multi-decadal datasets: Colony data and Beach Watch and similar programs for providing context and identifying significant events



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# Thank You

- Greater Farallones National Marine Sanctuary
- Beach Watch staff and volunteers
- Farallon Islands National Wildlife Refuge
- Point Blue Staff, Interns, and Volunteers
- National Fish and Wildlife Foundation
- Greater Farallones Association and Point Blue Funders and Anonymous Donors

