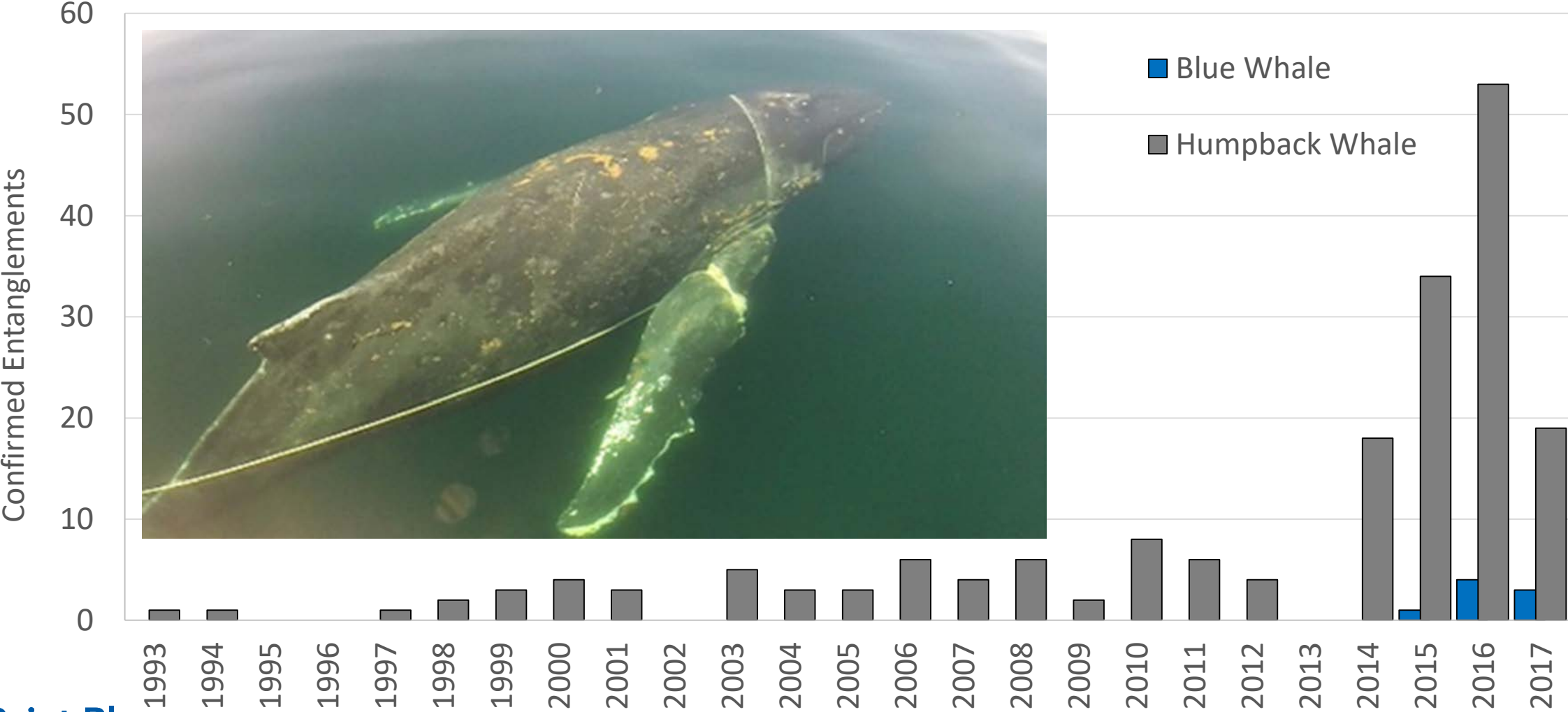


Changes in abundance and timing of migration of whales in central California

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August 2020

Confirmed whale entanglements

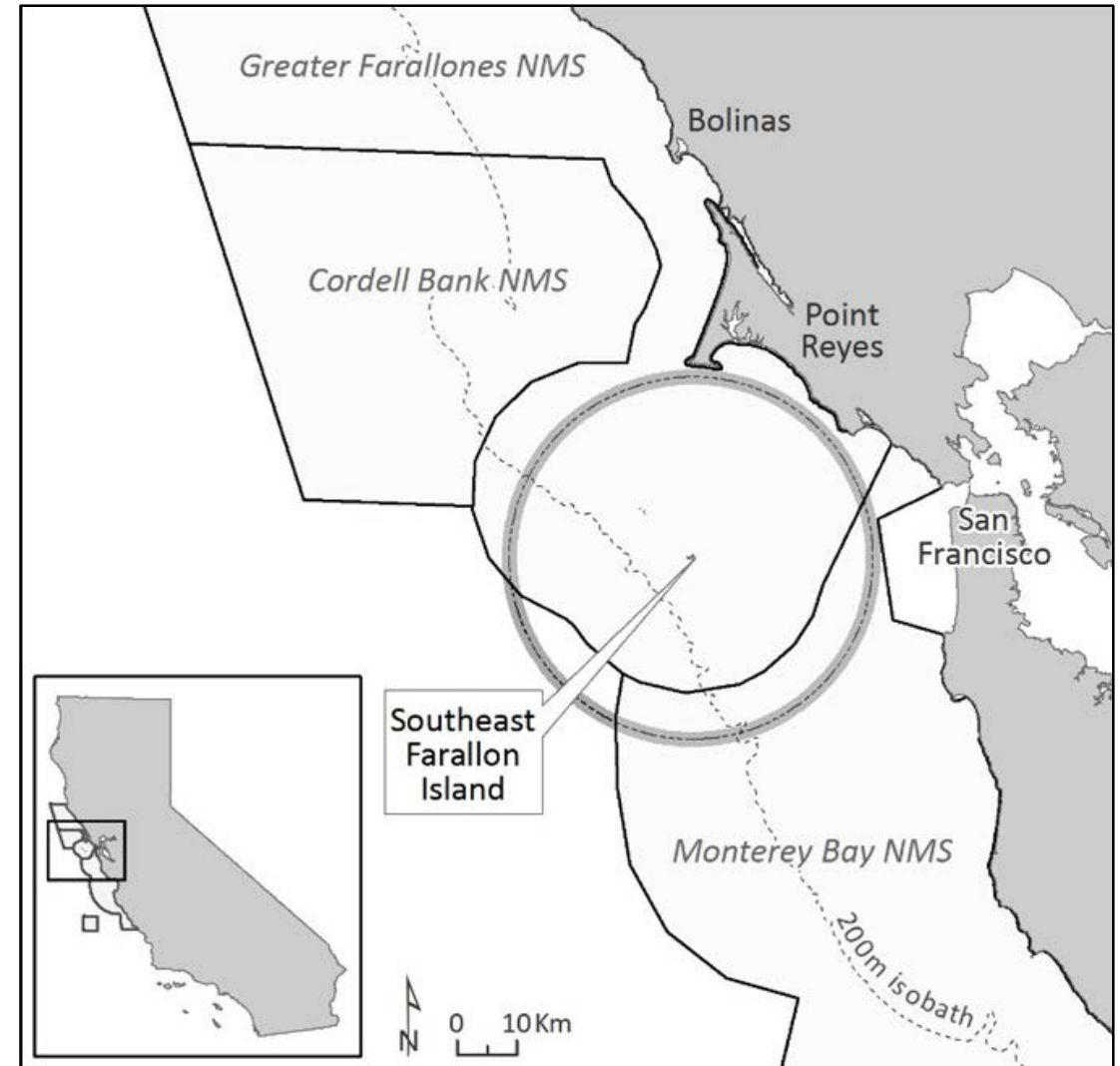


Purpose

Track changes in sightings and timing of migration of humpback and blue whales around the Farallon Islands.

Whales were observed migrating into the area in summer and out of the area in late fall.

We hypothesized that changes in timing of migration off central California were driven by environmental conditions



Counts from Southeast Farallon Island



Whale **Alert** West Coast

Methods

We used 24 years of daily whale counts collected from 1993 to 2017.

We developed negative binomial regression models to evaluate trends over time.

We then used linear models to assess trends in the timing of migration and to identify environmental drivers.

Covariates | Drivers

SST (island based; °C)

SSS (island based; PSU)

Front index (°C/km)

Upwelling index (m³/s/100m)

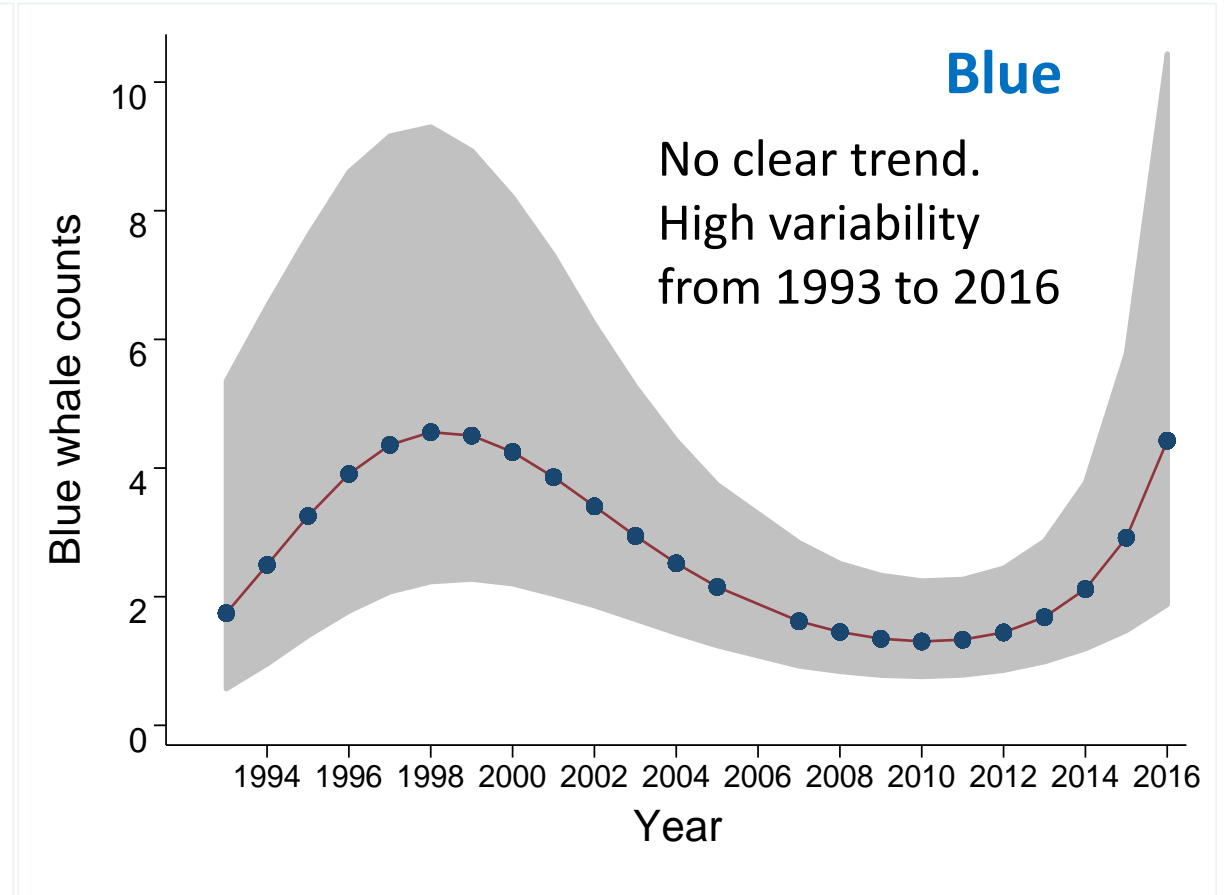
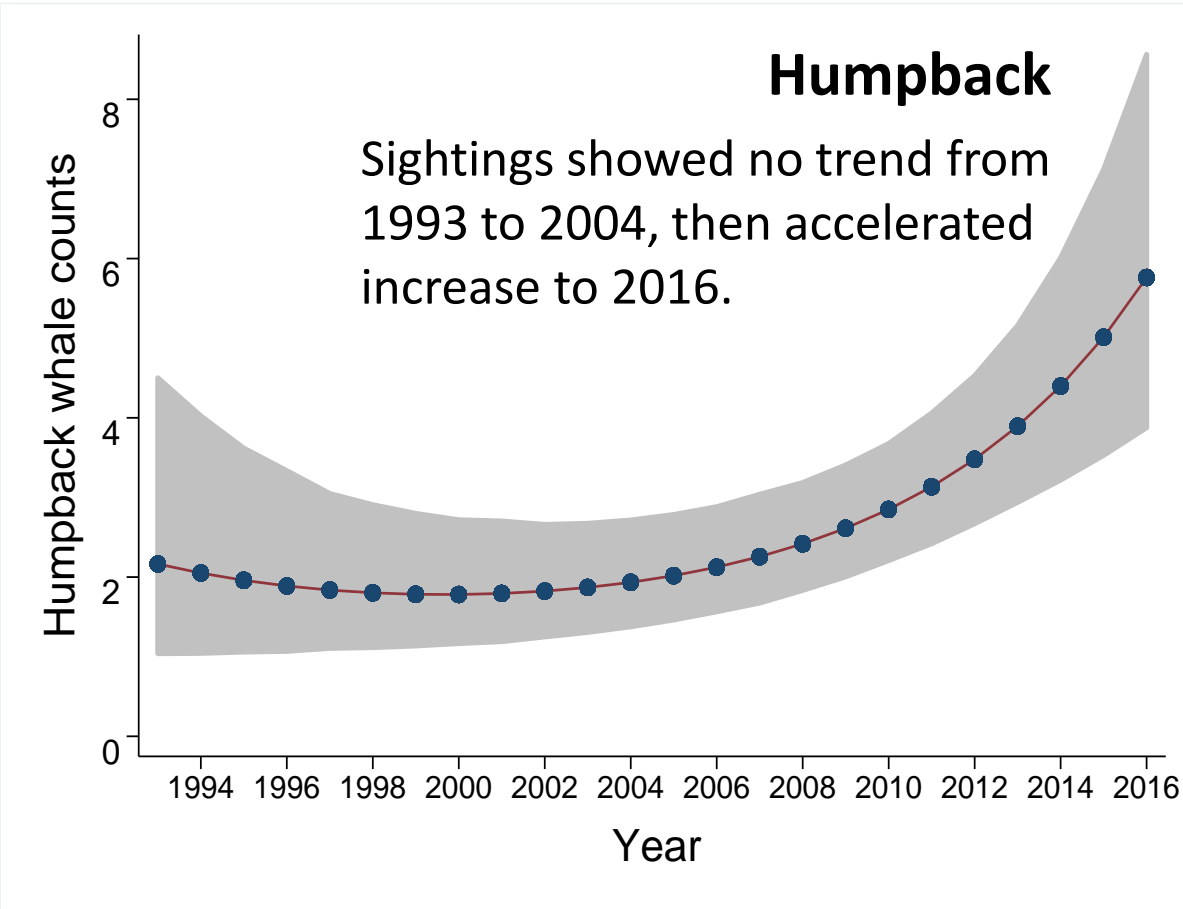
Spring transition (anomaly; days)

Southern Oscillation Index

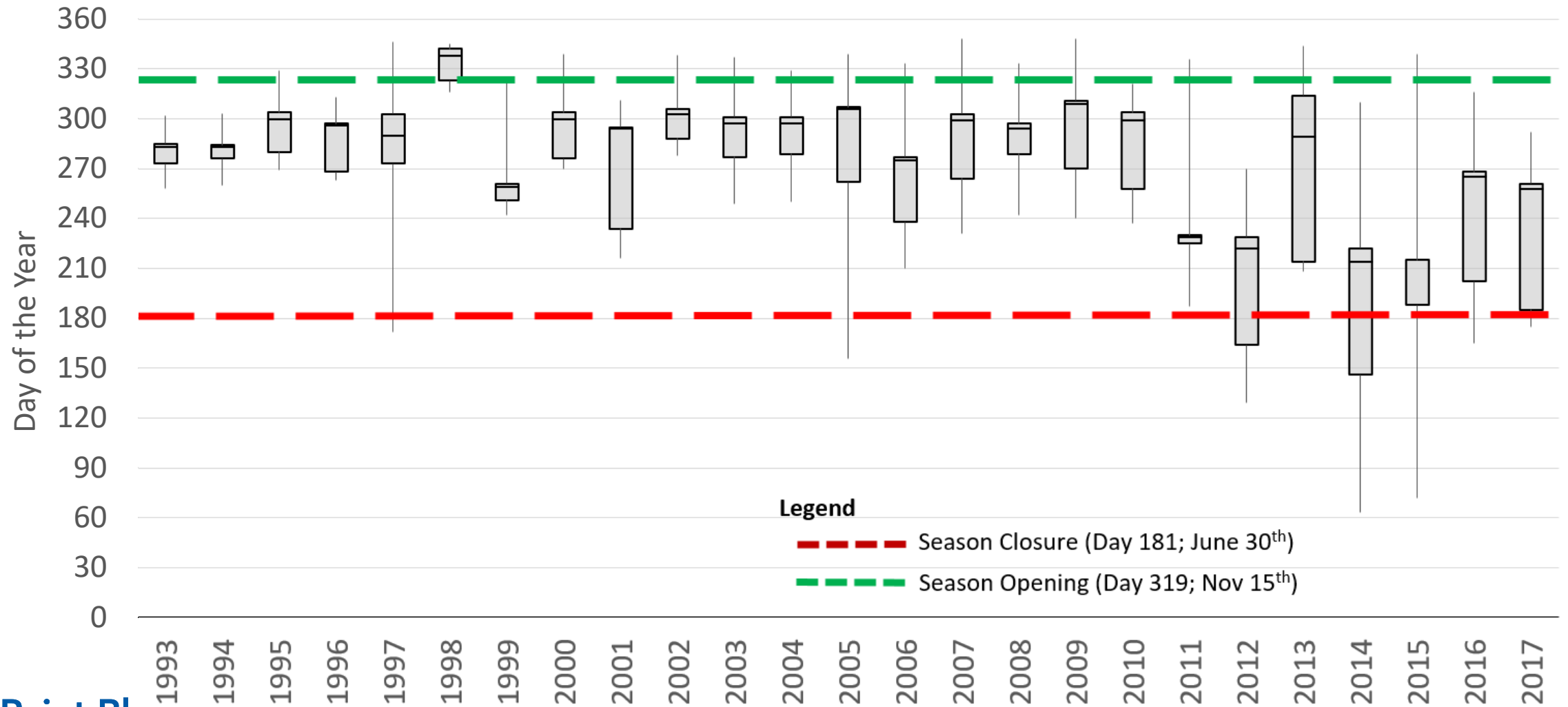
Pacific Decadal Oscillation

North Pacific Gyre Oscillation

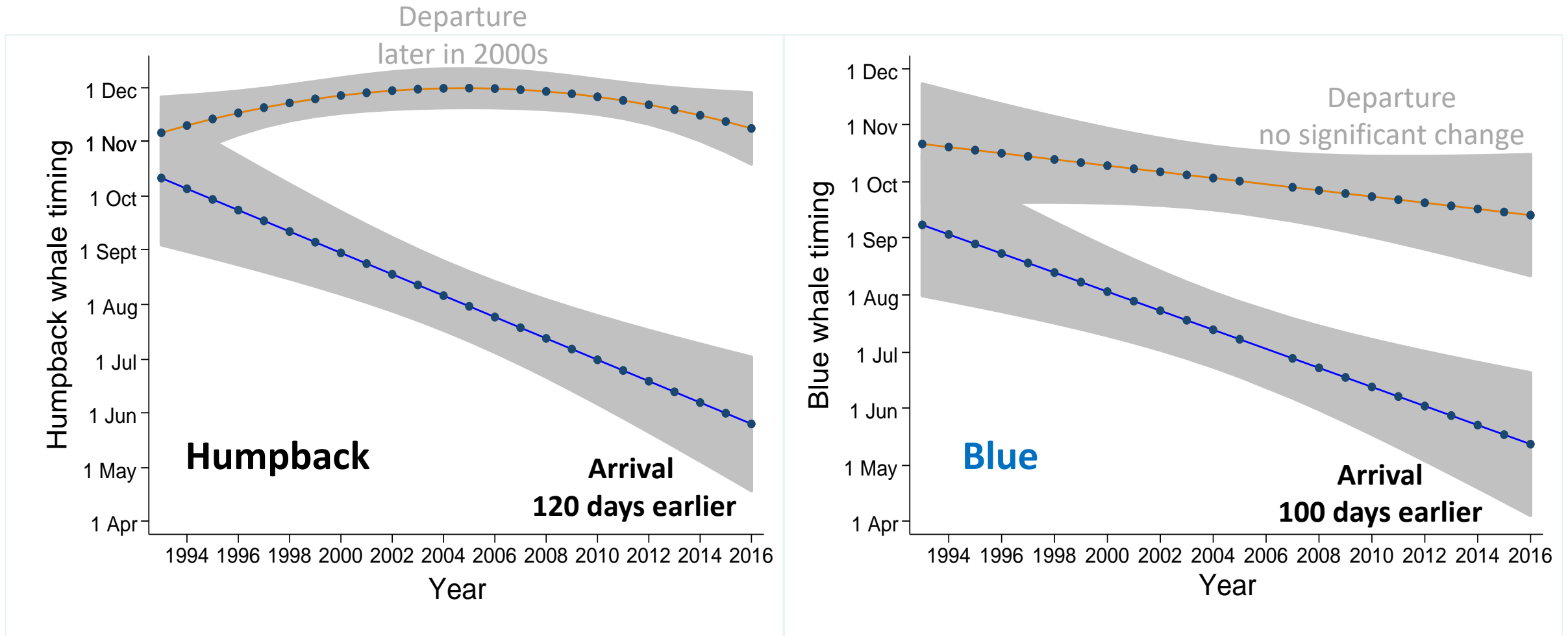
Interannual trends in whale counts (per week)



Are humpback whales arriving earlier?



Interannual trends in timing of migration



Drivers of humpback whale early arrival

The most dominant predictor of arrival was **SST**, with all climate indices contributing to the model.

Early arrival occurred during **warm, non-productive years** (indicated by winter PDO and NPGO values) ***following* a productive year** (indicated by SOI in the previous year; $p < 0.01$, $R^2 = 0.66$).



Drivers of humpback whale entanglements

Monthly entanglements increased as counts of humpbacks increased.

Monthly entanglements increased in years with earlier arrival.

While the ecological effect of count and arrival are strong, the predictability of the model is low ($p < 0.01$, $R^2 = 0.16$).



Summary

- Humpback whale sightings increased over the study period, but blue whales did not.
- Feeding migration (arrival time) occurred earlier for humpback and blue whales.
- Timing was influenced by warmer waters and non-productive ocean conditions.
- Earlier arrival leads to longer periods of time when whales are exposed to fishing gear, elevating the risk of entanglements.
- Actions to decrease overlap between whales and fisheries during Spring in warm years are encouraged.

Thank You

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Thelma Doelger Trust for Animals

United States Fish and Wildlife Service

Volgenau Foundation

and Point Blue Staff,
Interns and Volunteers



Suggested prompts

What observational data streams are included in your model?

Farallon Islands daily whale counts (Point Blue's whale observations)

How does your research support more targeted management decisions?

Research support reduced crab fishing effort during spring particularly during early whale arrival years (El Niño years)

What are the opportunities and limitations for leveraging these models in management?

Point Blue whale data is available in near real time (2hr delay)

What are the near-term opportunities to refine/combine/expand these models (e.g., what capabilities might we have in the next 1-2 years)?

How many whales should trigger a management action? We can use Point Blue's whale data to create a metric that helps streamline the RAMP process