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Shifting phenology of an apex/specialist predator tracks changes in its favored prey

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Shifting phenology of an endangered apex predator tracks changes in its favored prey

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Shifting phenology of an endangered apex predator tracks changes in its favored prey

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Southern resident killer whales (*Orcinus orca*) are an endangered population

Killer whales are widespread, with different populations

Resident killer whales = fish-eating

Southern residents (SRKWs) listed as endangered in 2005

3 pods: J,K,L

Current threats include lack of food, vessel noise, pollution, small population size



Southern resident killer whales may be shifting their activity in the Salish Sea

Where are the southern resident orcas? Researchers see longest absence ever from summer waters

July 3, 2019 at 4:22 pm | Updated July 4, 2019 at 3:00 pm



1 of 3 | This 26-year-old female transient orca tosses around the pelt of a Stellar sea lion after the kill. Taken May... (Jeff Friedman / Pacific Whale Watch Association) [More](#)

Where are the salmon and the orcas? Tribe, scientists grapple with unprecedented disappearance in Washington waters

Aug. 6, 2019 at 6:00 am | Updated Aug. 6, 2019 at 3:46 pm



1 of 13 | Lummi Nation spiritualist Richard Solomon offers a prayer for the southern-resident orcas on a private beach in the San Juan... (Alan Berner / The Seattle Times) [More](#)

By Lynda V. Mapes

Seattle Times environment reporter

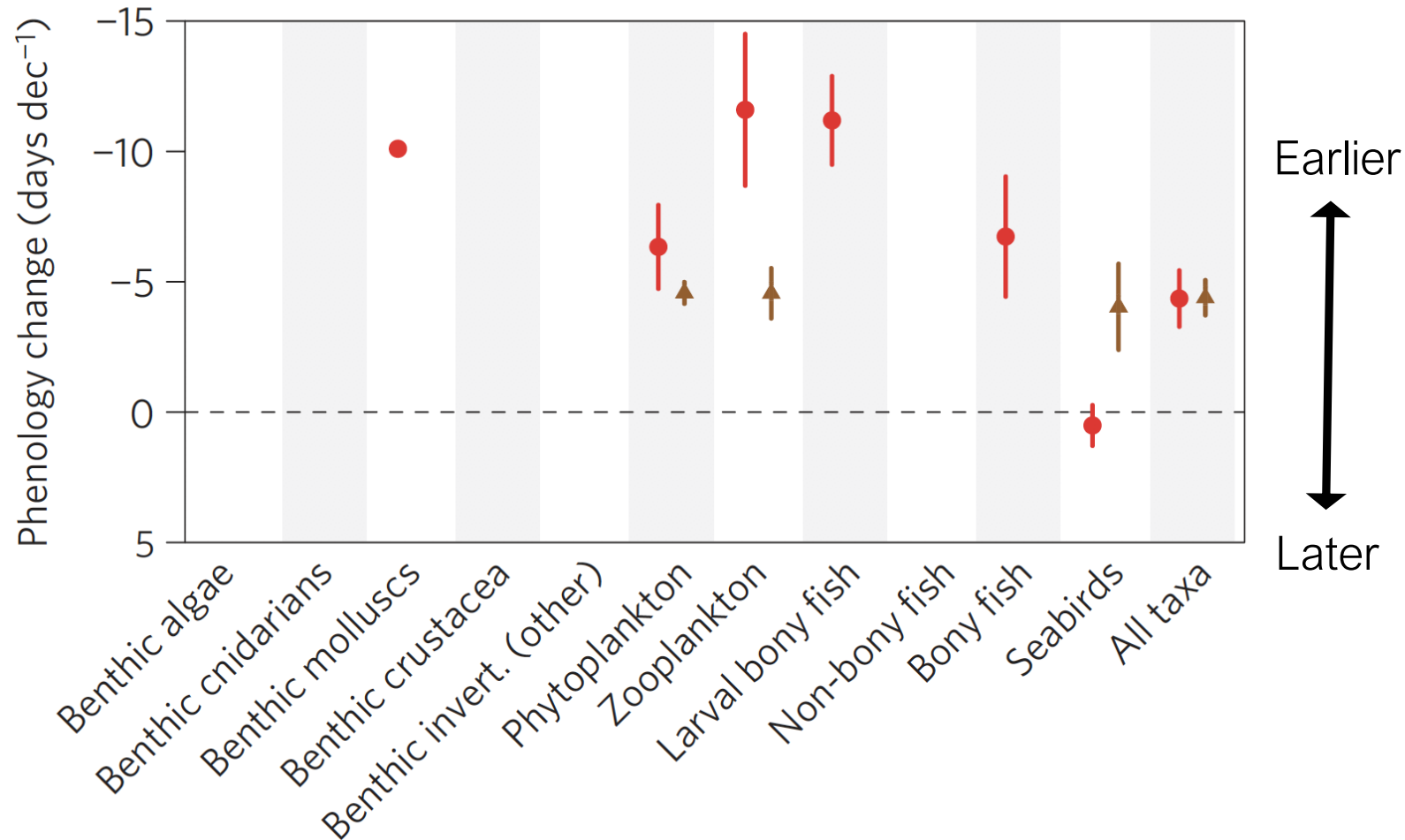
ABOARD THE LENGESOT IN THE SALISH SEA — The tote was loaded and full of water, the cedar boughs cut and stacked on deck. But as Lummi tribal members headed out on their traditional waters to offer a ceremonial feeding of live chinook salmon to the endangered southern-resident killer whales, neither whale nor fish was anywhere to be found.

In this historic summer of unthinkables, day after day is passing without the orcas and fish that normally enliven the waters of the inland Salish Sea.

Are these recent events part of long-term phenological shifts?

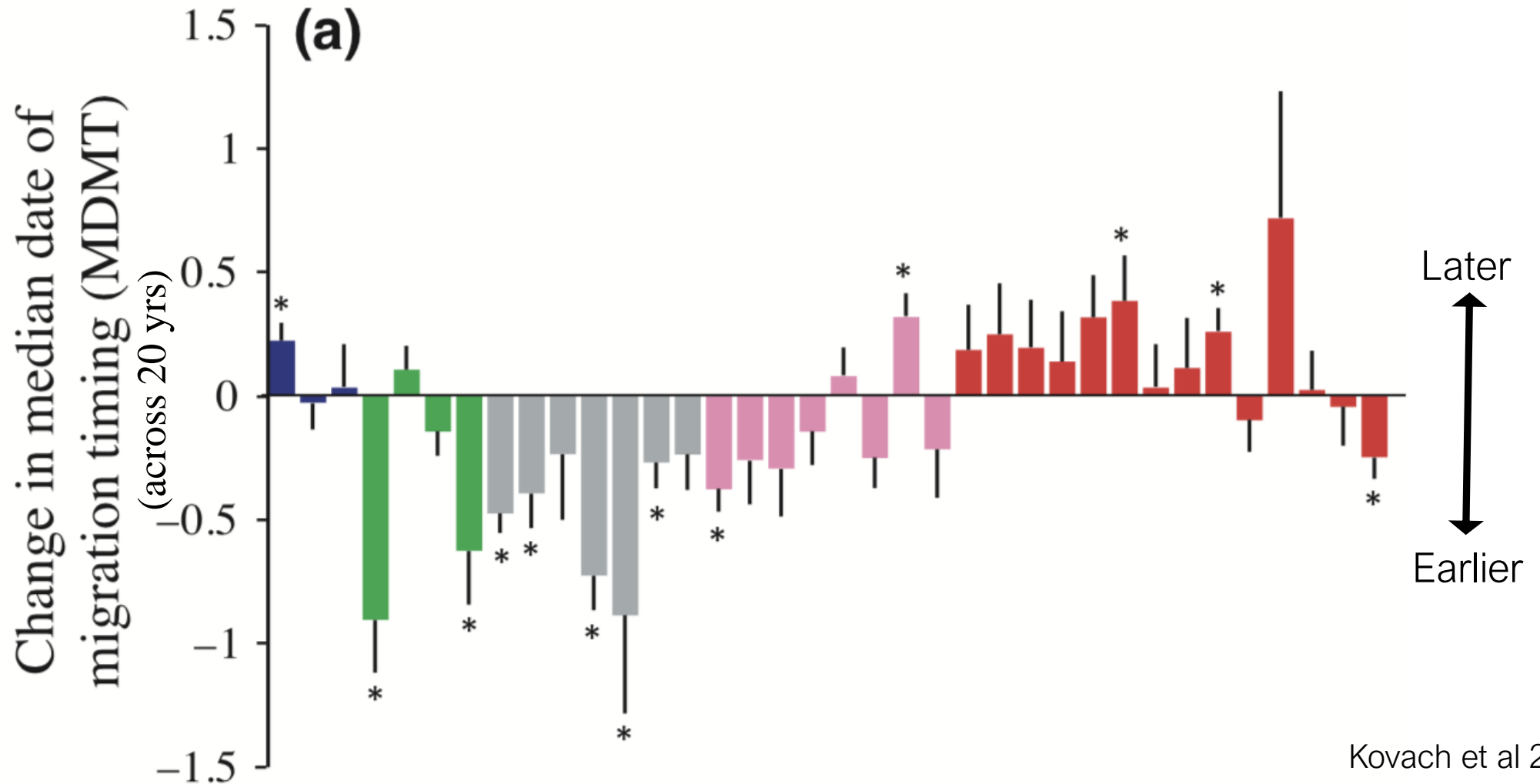
Are these recent events part of long-term phenological shifts?

Many marine organisms are shifting phenology

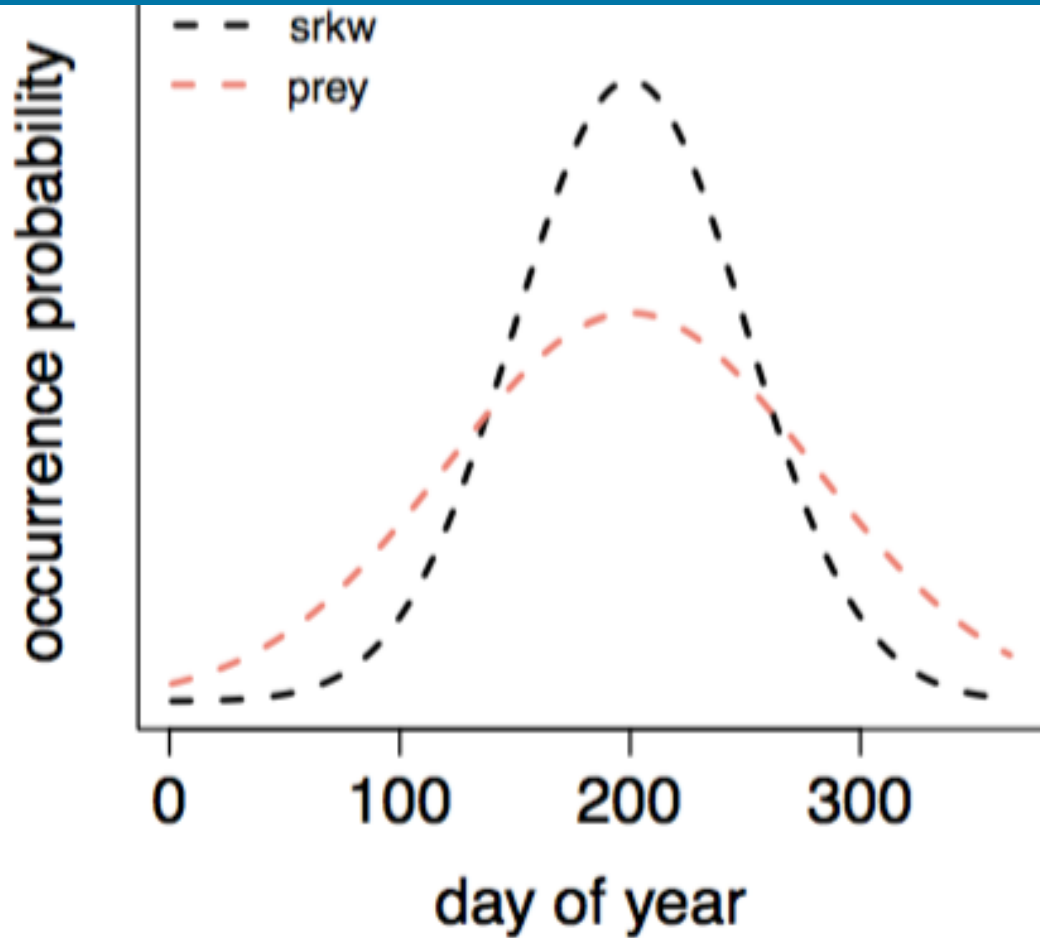


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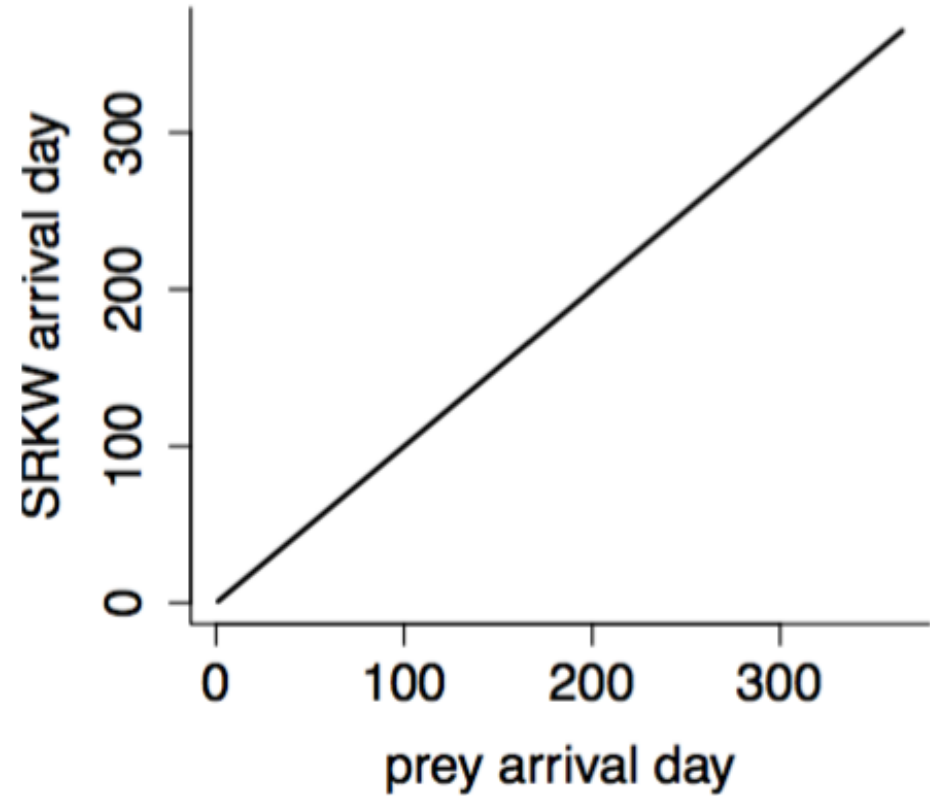
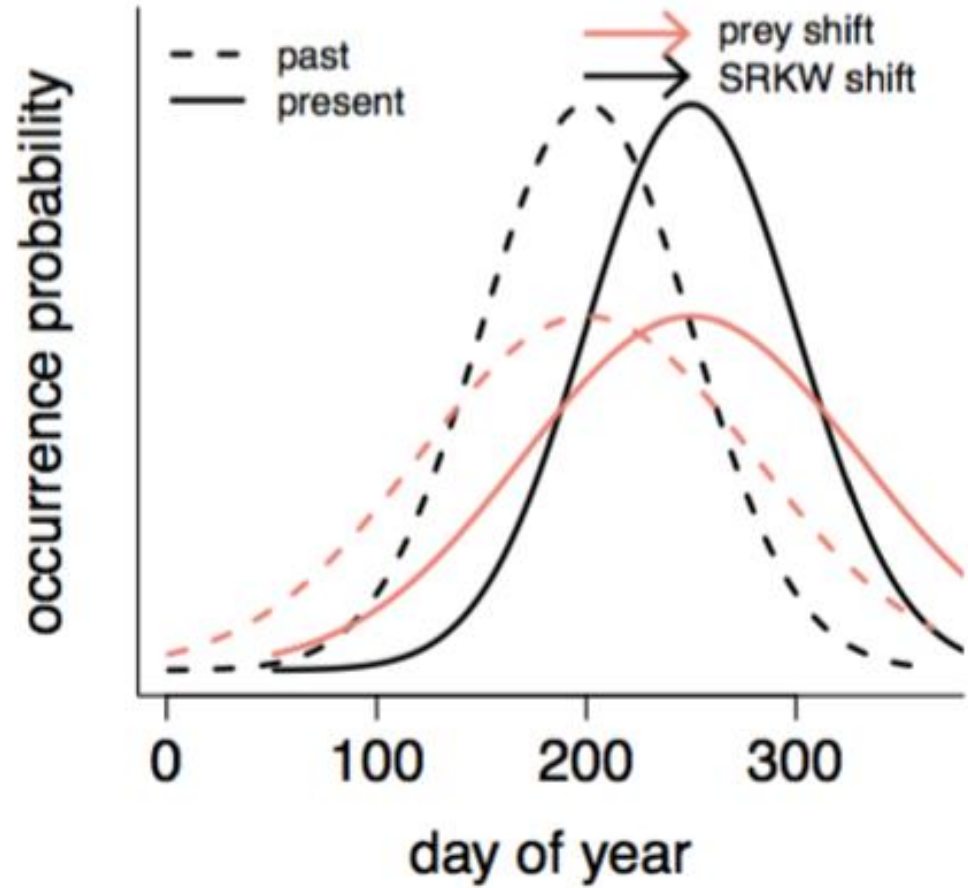
Many salmon species are shifting phenology



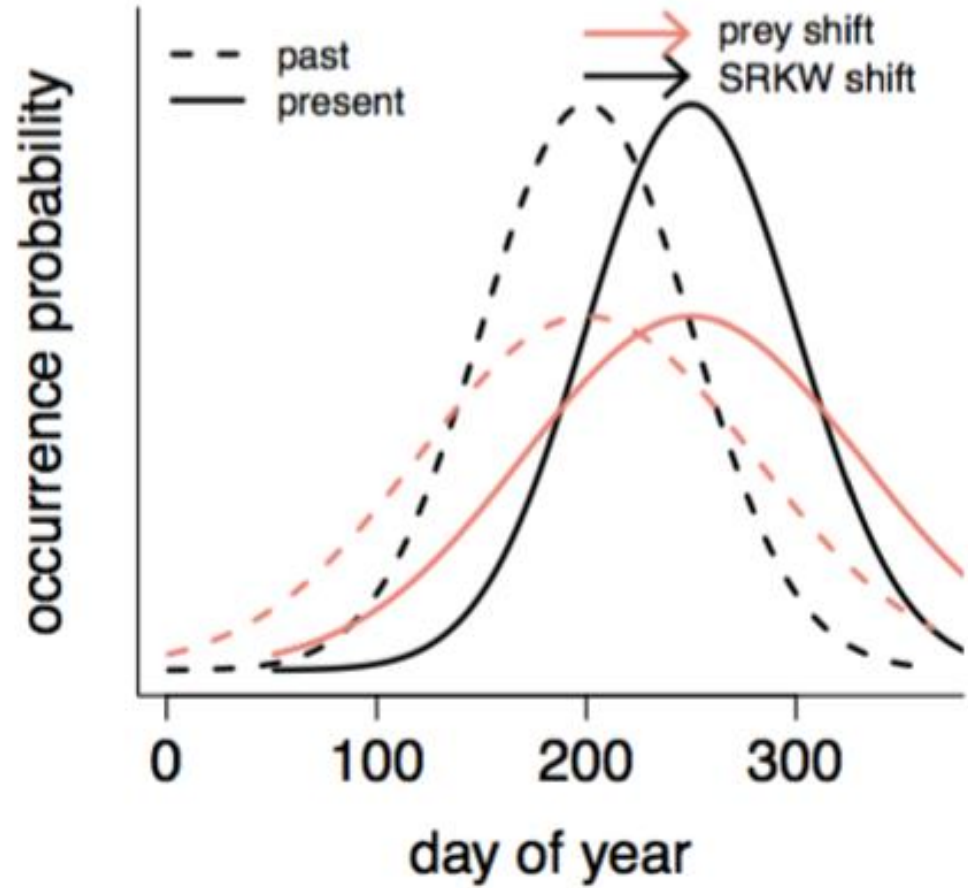
Asynchronous shifts between SRKWs and their prey could reduce prey availability (“phenological mismatch”)



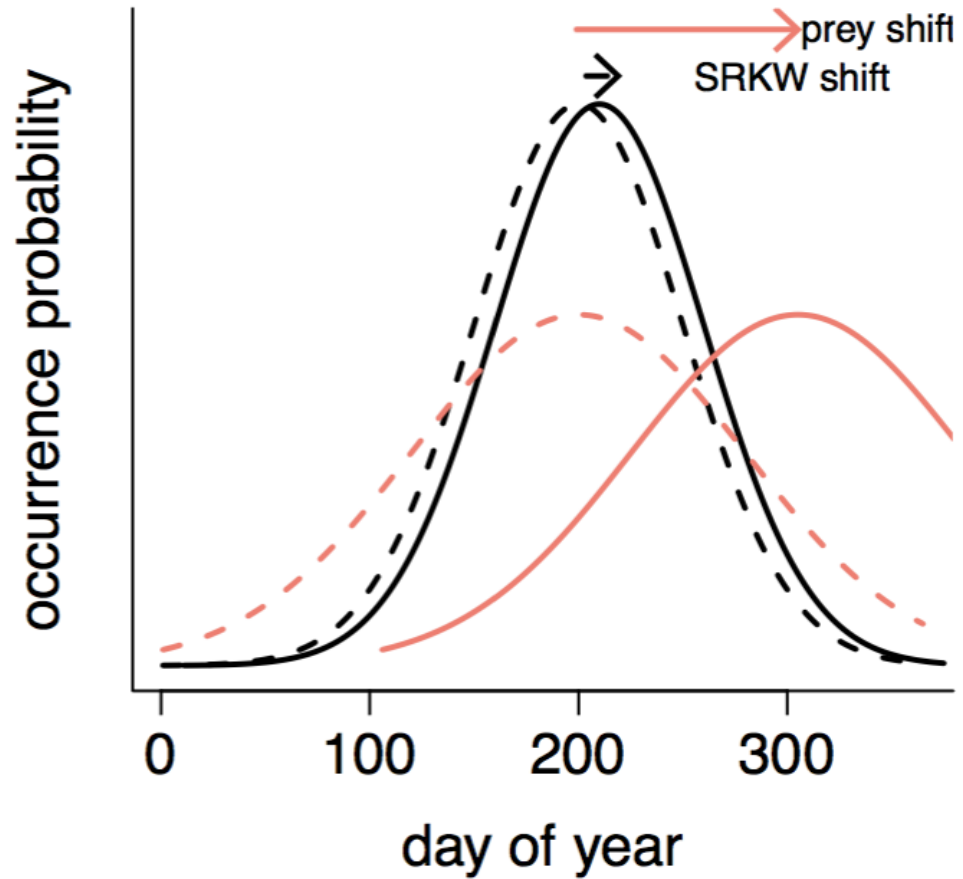
If phenological shifts are similar, the amount of matching will not change:



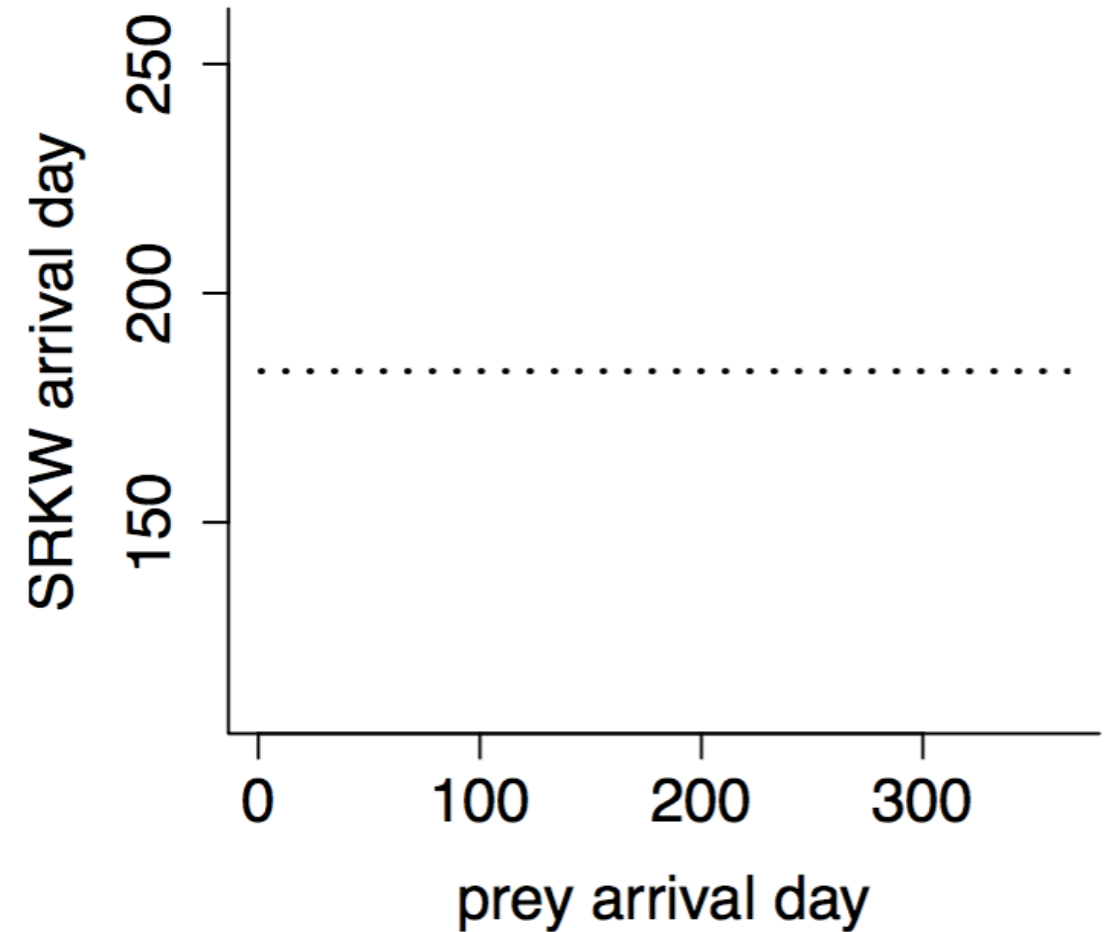
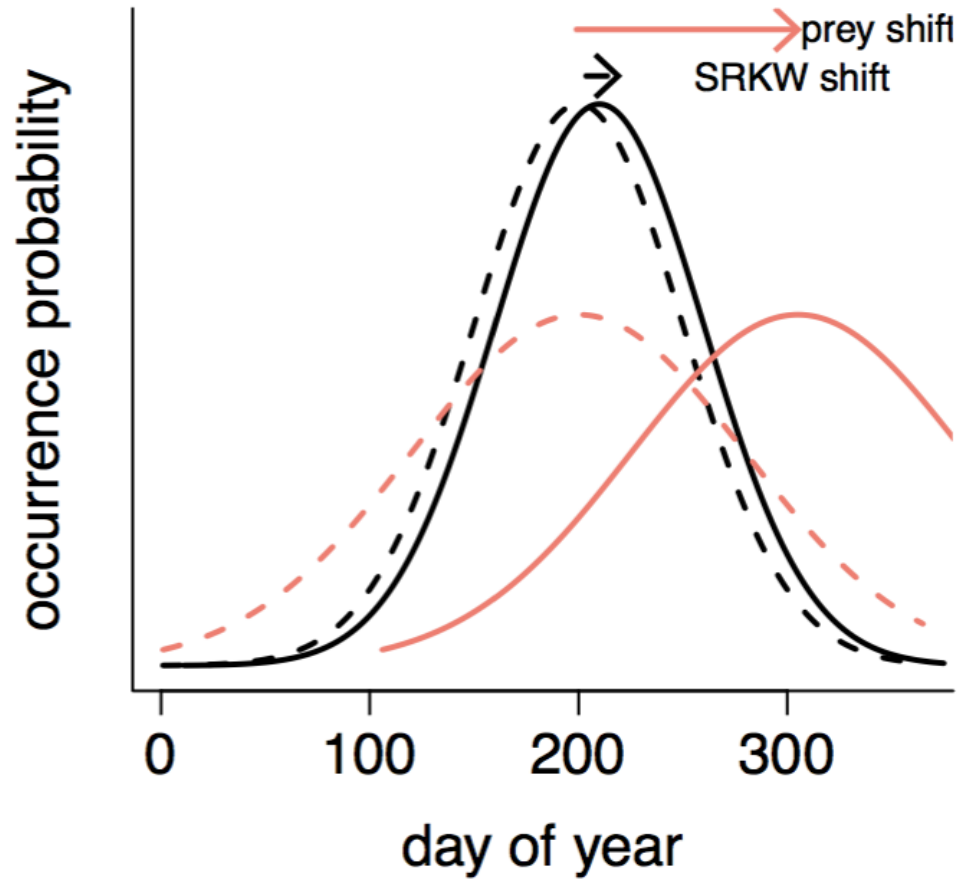
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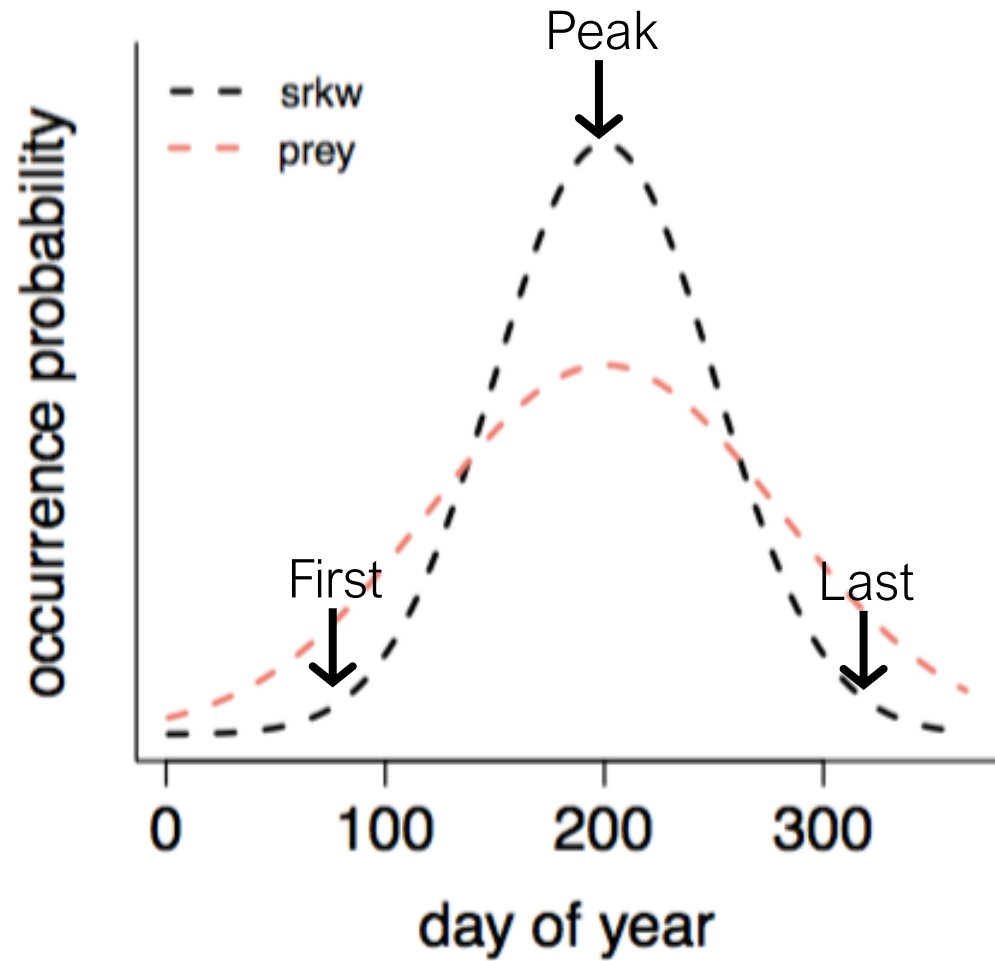
Asynchronous shifts between SRKWs and their prey could reduce prey availability (“phenological mismatch”)



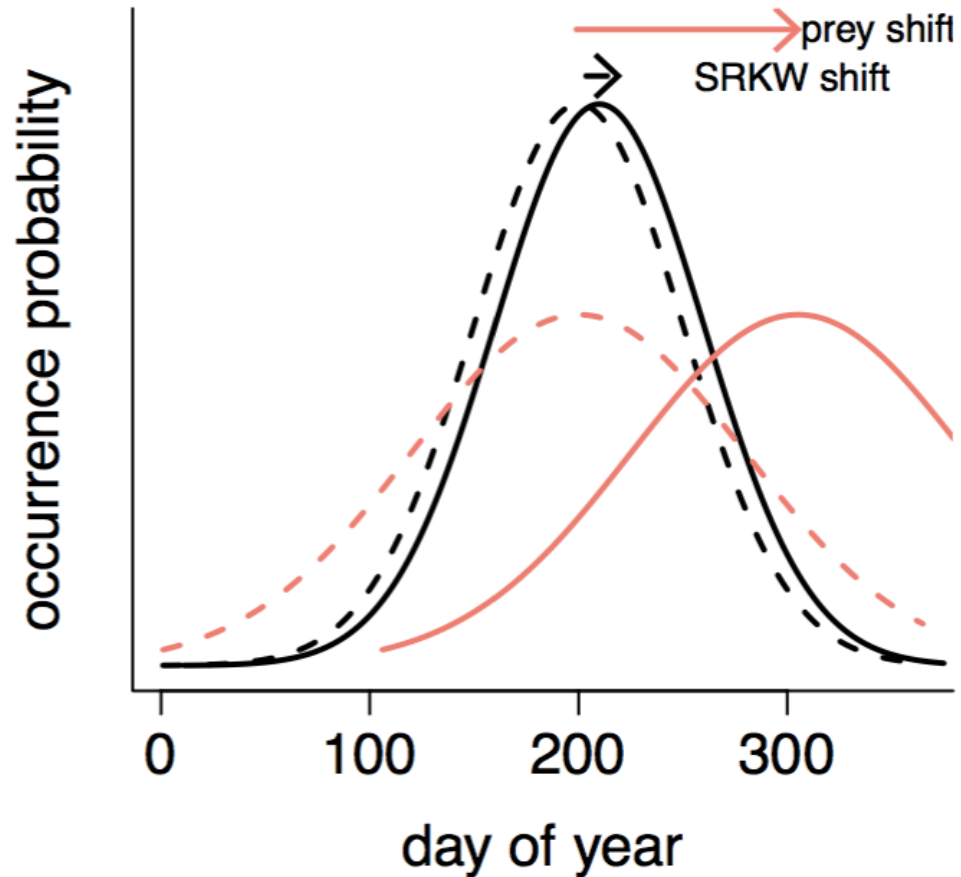
Asynchronous shifts between SRKW and their prey could reduce prey availability (“phenological mismatch”)



Shifts could be occurring in first, peak, last occurrence probability



Asynchronous shifts between SRKWs and their prey could reduce prey availability (“phenological mismatch”)



Study Questions

1. Has the timing of SRKW activity shifted in the Salish Sea?
2. Do shifts coincide with shifts in phenology of salmon?

The Orca Master Database

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ENDANGERED SPECIES RESEARCH
Endang Species Res

Published October 10



Sightings of southern resident killer whales in the Salish Sea 1976–2014: the importance of a long-term opportunistic dataset

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Shawn Larson¹

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ABSTRACT: Southern resident killer whales (SRKW) *Orcinus orca* may be present year round in the Salish Sea, i.e. the inland waterways of Washington State (USA) and southern British Columbia (Canada). SRKW were listed as endangered in 2005 under the US Endangered Species Act. The Whale Museum (Washington, USA) has been collecting opportunistic sightings reports on SRKW since 1976 with a goal of providing managers and regulatory agencies with reliable spatial and temporal data on this population. Information in this dataset comes from 5 classes of killer whale sighting sources and is systematically evaluated for accuracy before integration into the dataset. From 1976 to 2014, The Whale Museum's Orca Master dataset documented a total of 82 447 SRKW sightings in the Salish Sea. Sightings were concentrated in a few key hot spots, with an overall pattern of consistent presence in the Central Salish Sea during the summer months and a presence in Puget Sound proper during the fall and early winter months. A shift in SRKW presence in Puget Sound was documented in the late 1990s, possibly driven by increased foraging on fall chum salmon *Oncorhynchus keta* by 2 pods ('K' and 'L'), and is consistent with the hypothesis that the movement patterns of these whales may be driven by prey availability. The Whale Museum's dataset highlights the importance of long-term monitoring to document shifts that may take decades, and shows how opportunistic datasets can be valuable tools for illuminating spatial and temporal trends.



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Sightings



Recent whale sightings in the Salish Sea

(Puget Sound, Northwest Straits, Gulf Islands and Georgia Strait)

[Sightings Summaries Archives](#)

[Sighting Report Archives](#)

 [Click here for the most Recent Sightings](#) 

[Sign up for Whale Sightings Alerts and updates!](#)

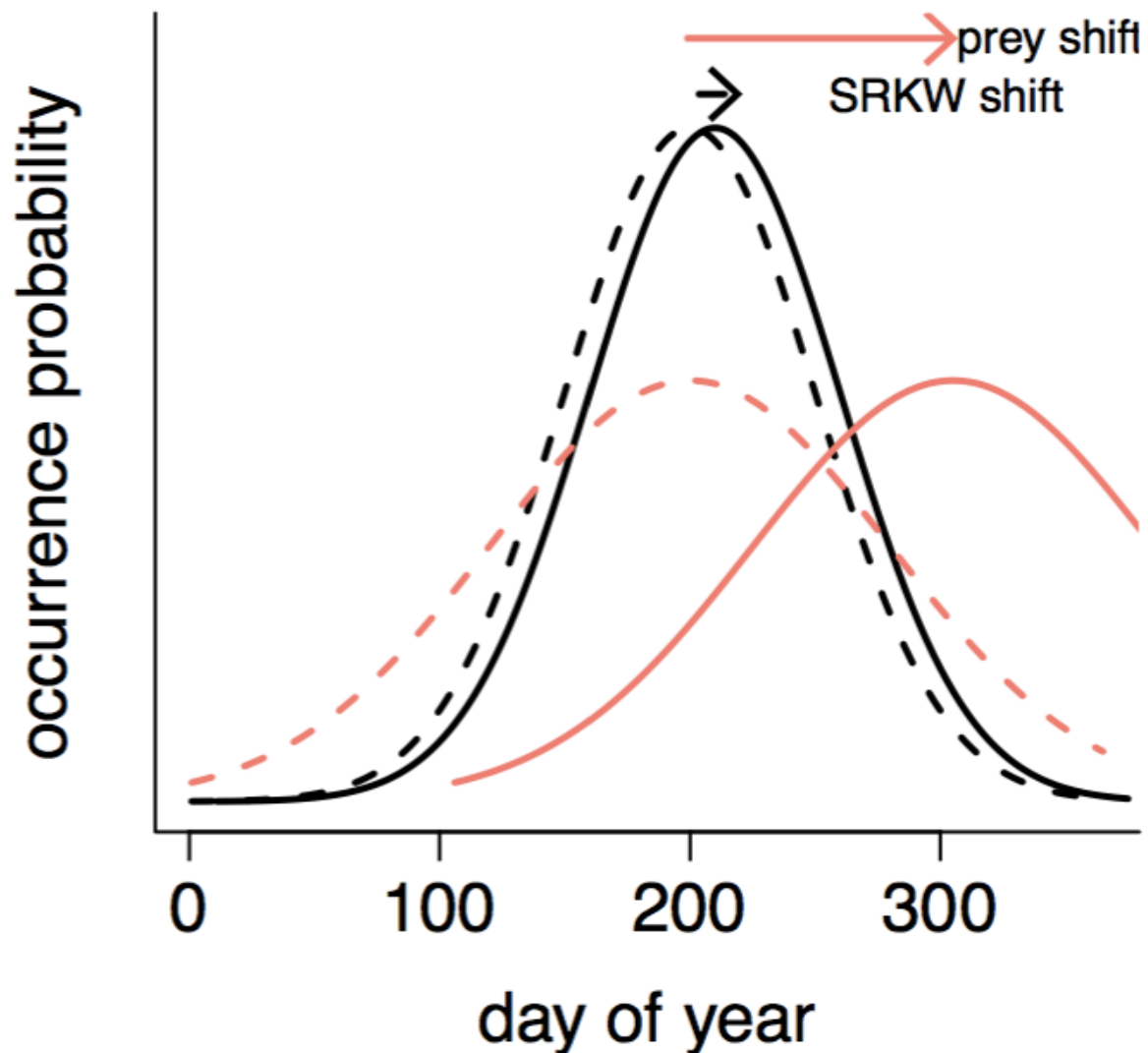
To find viewpoints along shorelines from Deception Pass to Olympia, go to:
[Whale Sightings Viewpoints Map Page](#)

To report whales please go to the [Orca Network Sightings Report Page](#).

The purpose of Orca Network's Whale Sighting Network and Education Project is to encourage observation and increase awareness and knowledge about the Southern Resident Community of orcas (J, K and L pods), and foster a stewardship ethic to motivate a diverse audience to take action to protect and restore these orcas' critical habitat.

The orcas' steep population decline of 20% from 1995 to 2001 is a reflection of the problems and issues facing the greater Puget Sound marine and watershed ecosystems: *declining salmon runs, PCB contamination, and the effects of a rapidly increasing human population including habitat loss and resource depletion*. Through a volunteer Whale Sighting Network, sightings and observations of this orca community are gathered and disseminated to researchers and volunteers, and posted on our website.

Asynchronous shifts between SRKWs and their prey could reduce prey availability (“phenological mismatch”)



Study Questions

1. Has the timing of SRKW activity shifted in the Salish Sea?
2. Do shifts coincide with shifts in phenology of salmon?

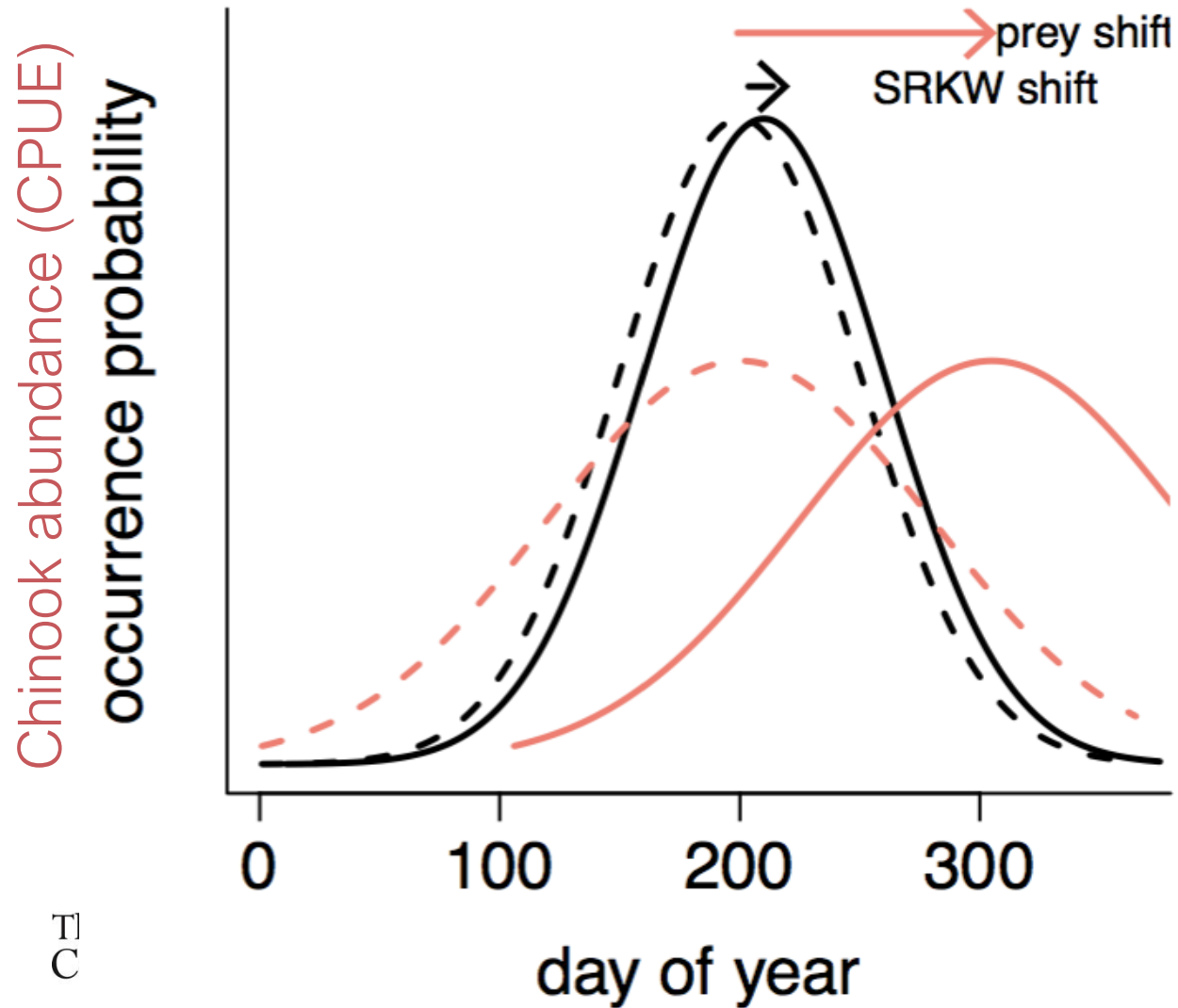
Approach:

- Explore for one location with consistent data for SRKWs & salmon
- Expand to broader geographic region

One location with consistent data: Lime Kiln Point State Park



Approach



Fit 2 models

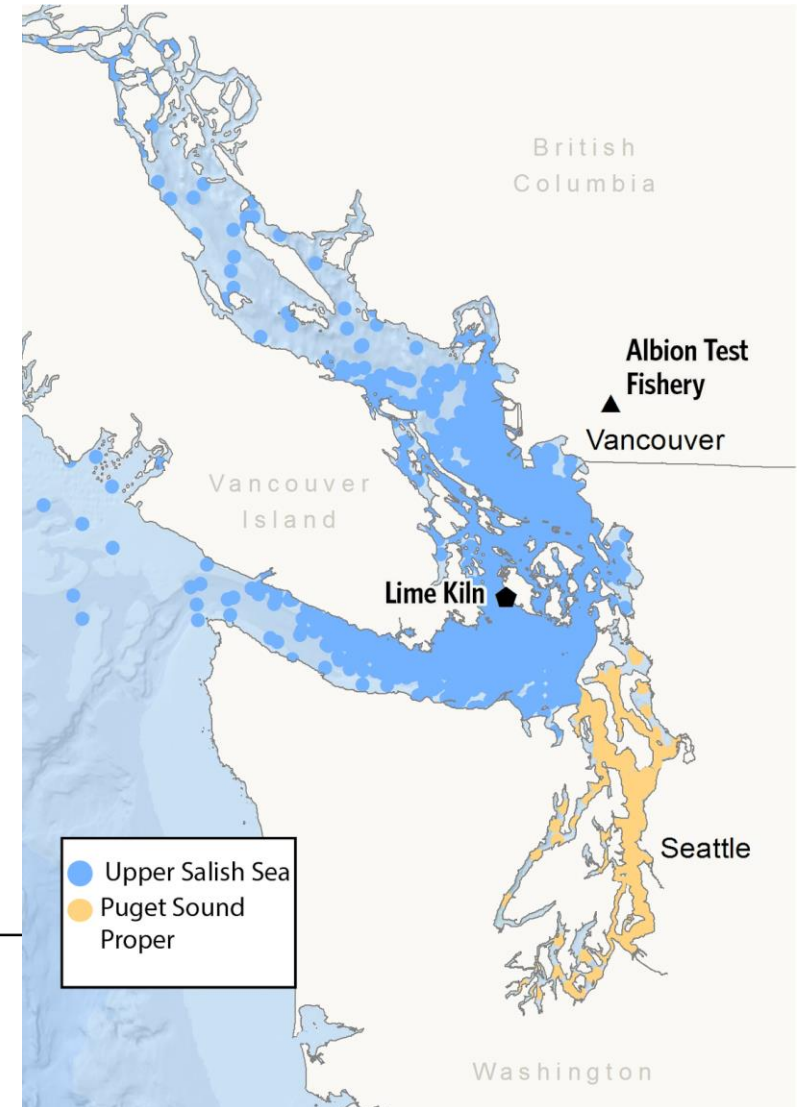
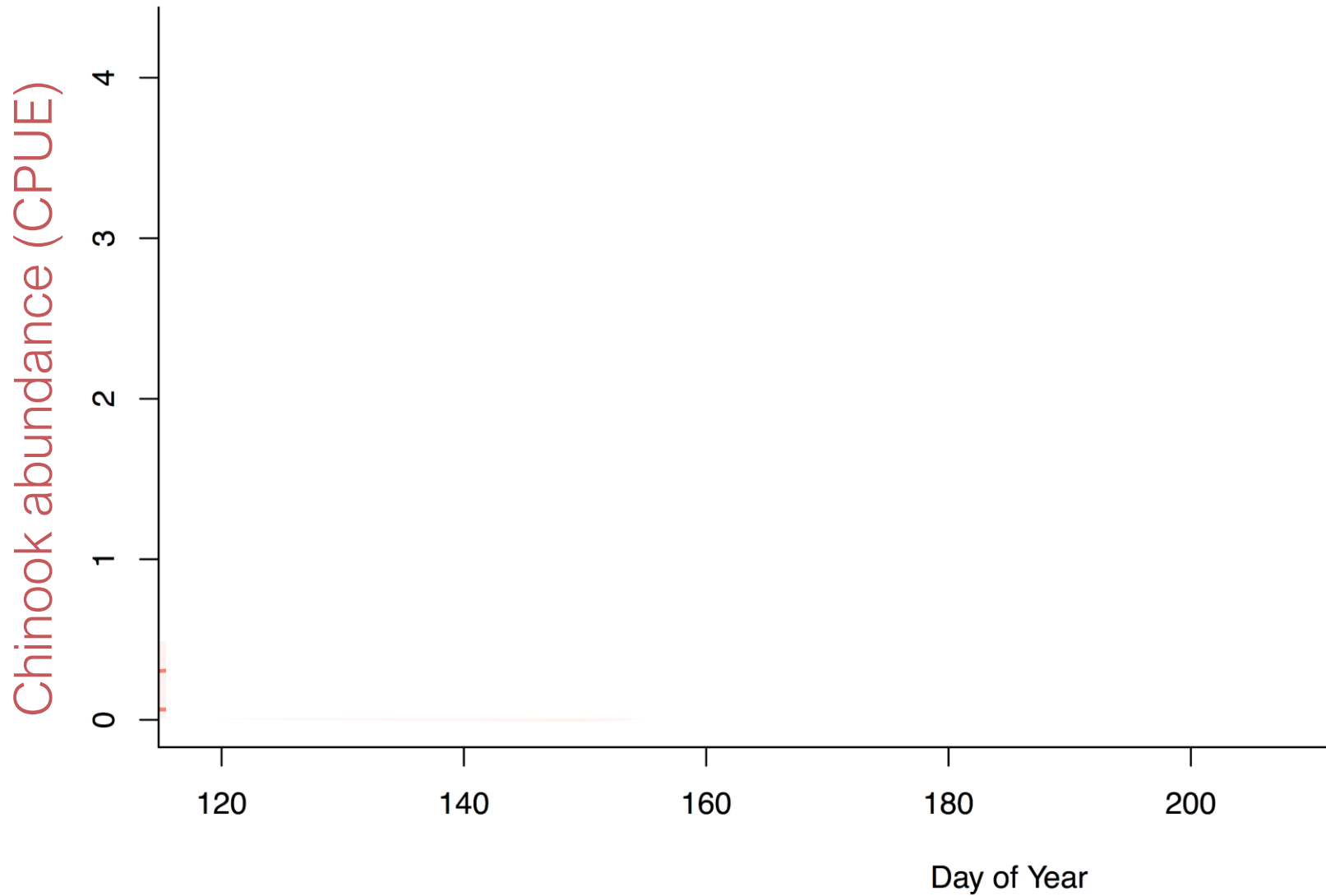
Response variables:

- Presence/absence of SRKW
- Abundance for chinook

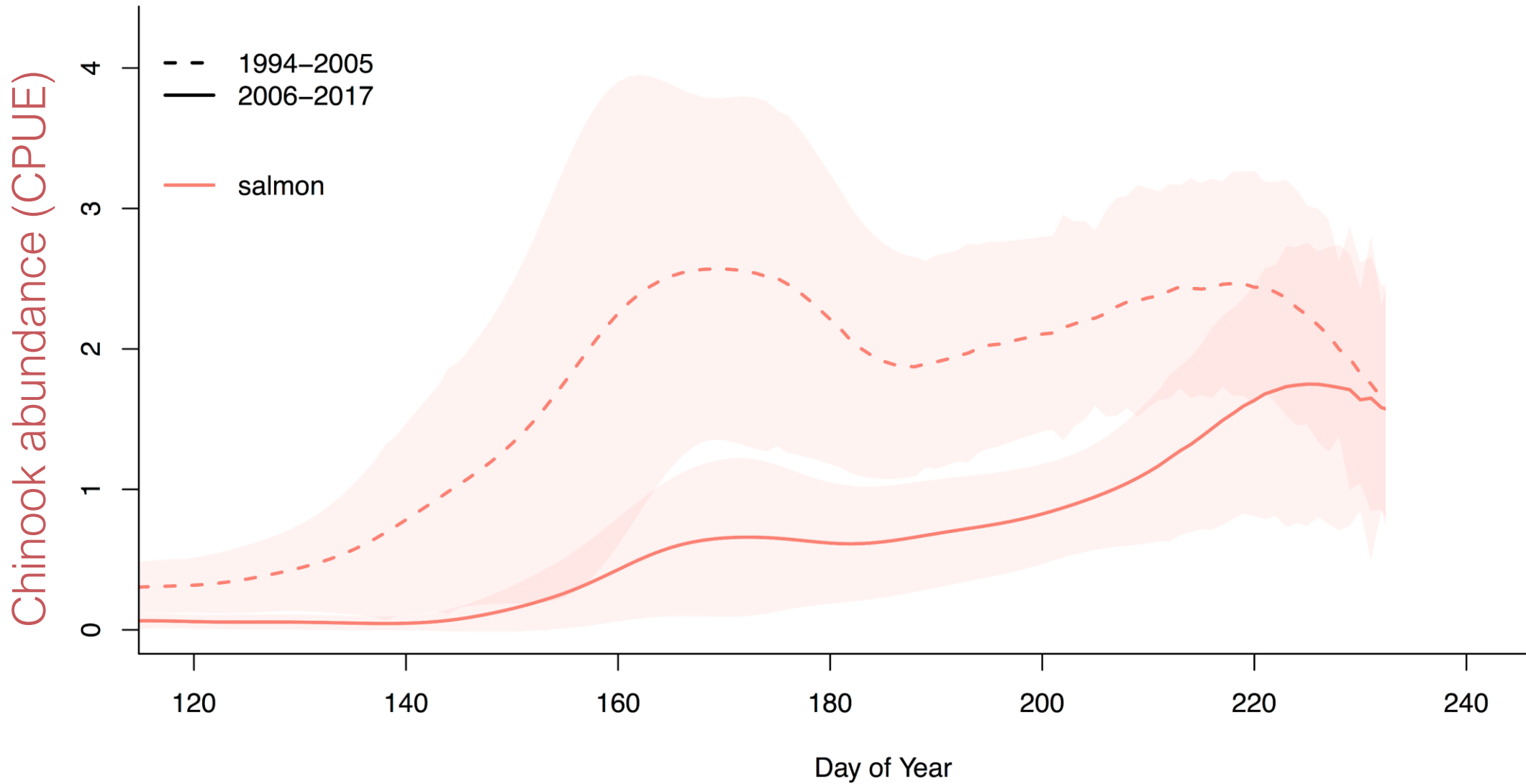
Predictors:

- Day of year (spline)
- Year (random effect)

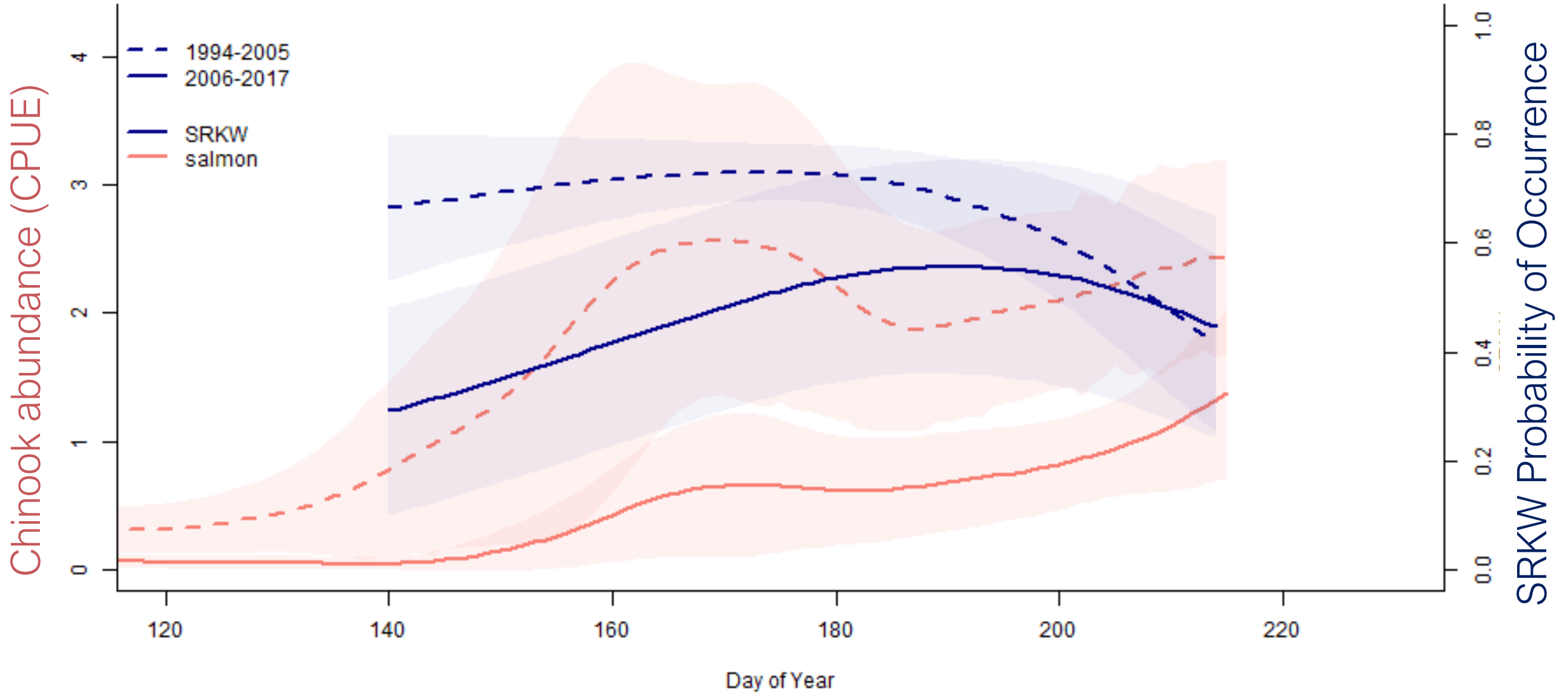
At Lime Kiln:



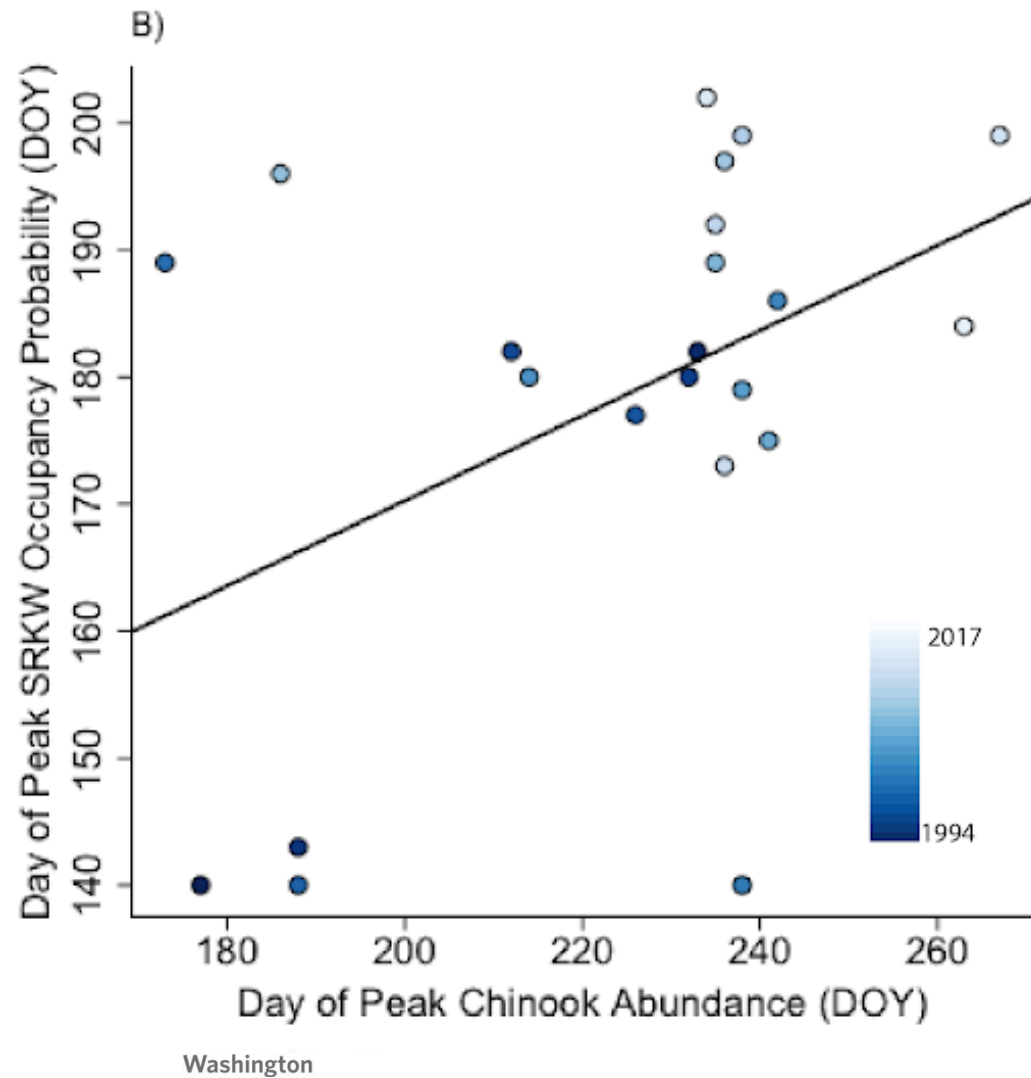
Chinook abundance and timing have shifted in the Fraser River:



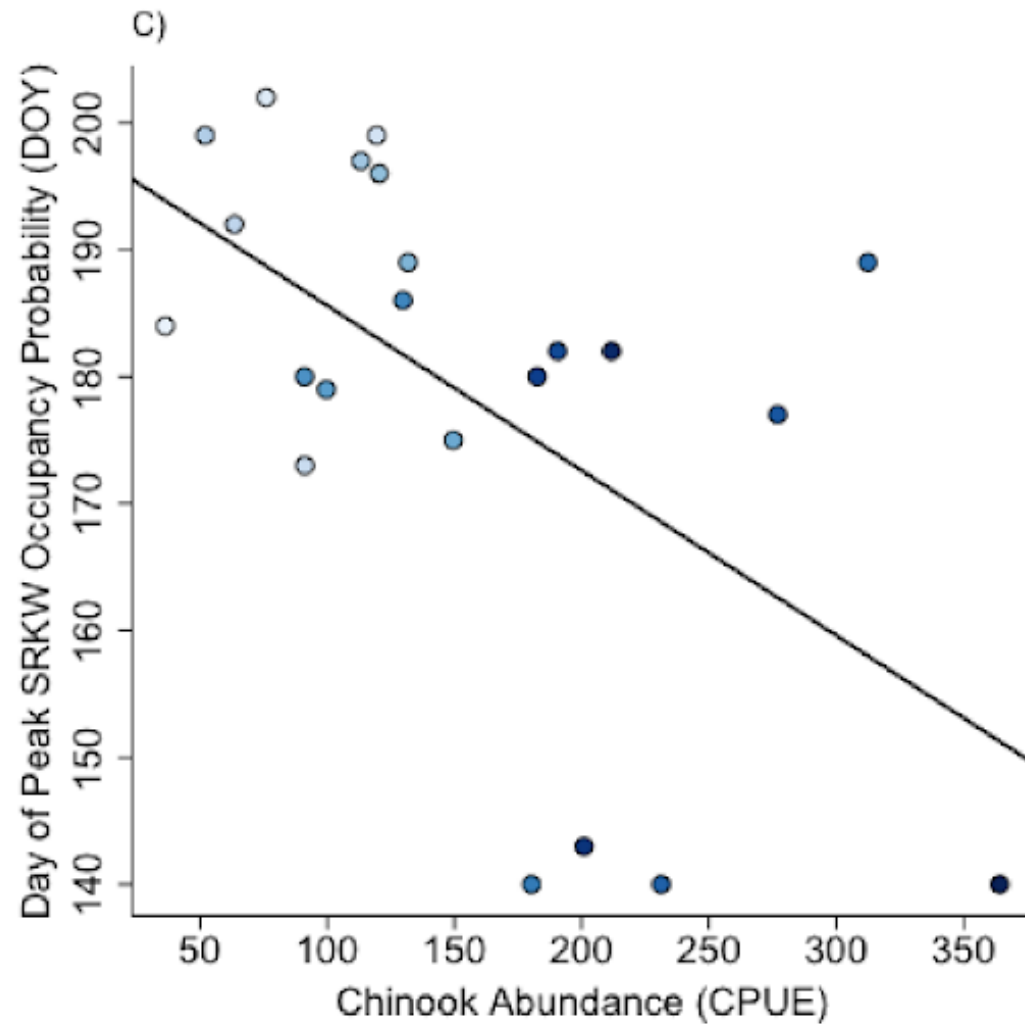
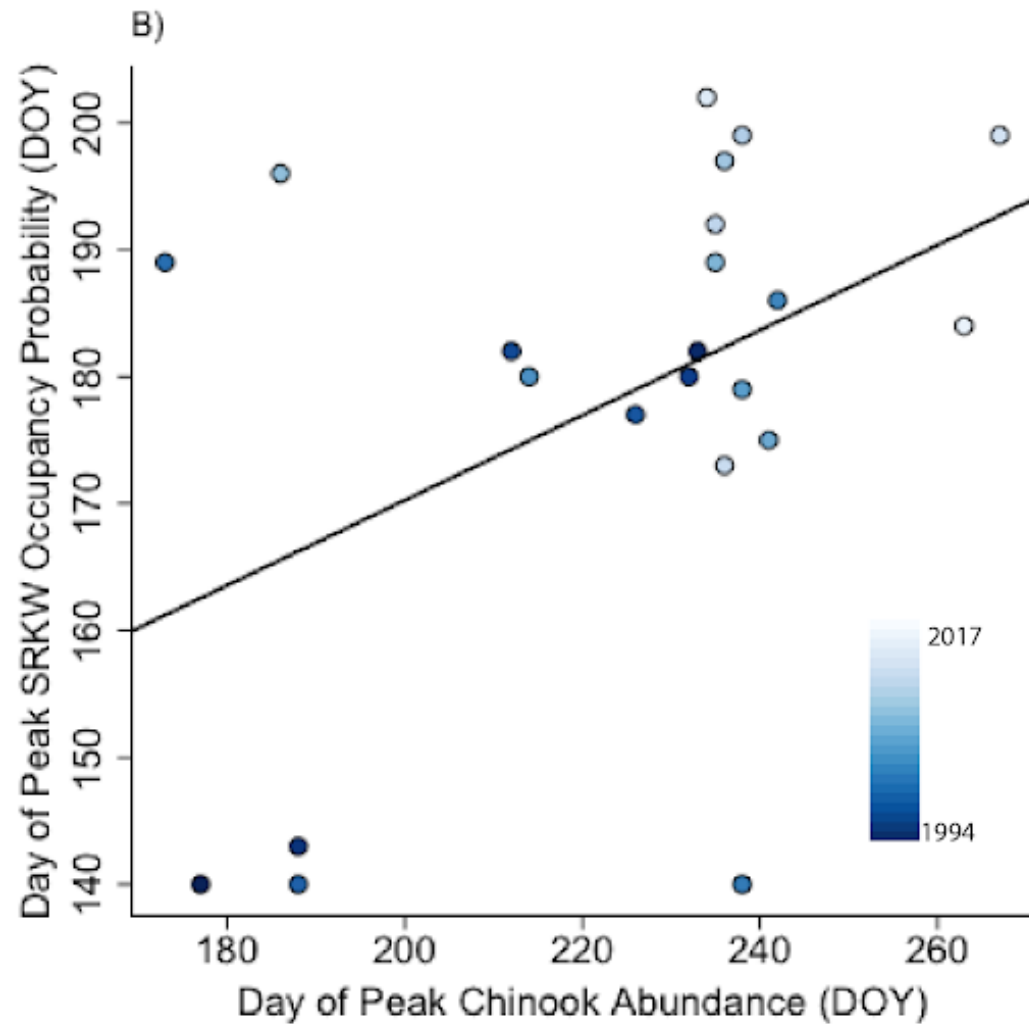
The timing of SRKW activity has shifted at Lime Kiln



SRKW phenology is correlated with chinook peak phenology



More Chinook = earlier SRKW activity



Broader geographic scope



Approach

Fit pod-specific occupancy models to 2 regions

Response variables:

SRKW sightings

Predictors:

Day of year (spline)

Year, marine area (random effects)

Broader geographic scope



Approach

Fit pod-specific occupancy models to 2 regions

Response variables:

SRKW sightings

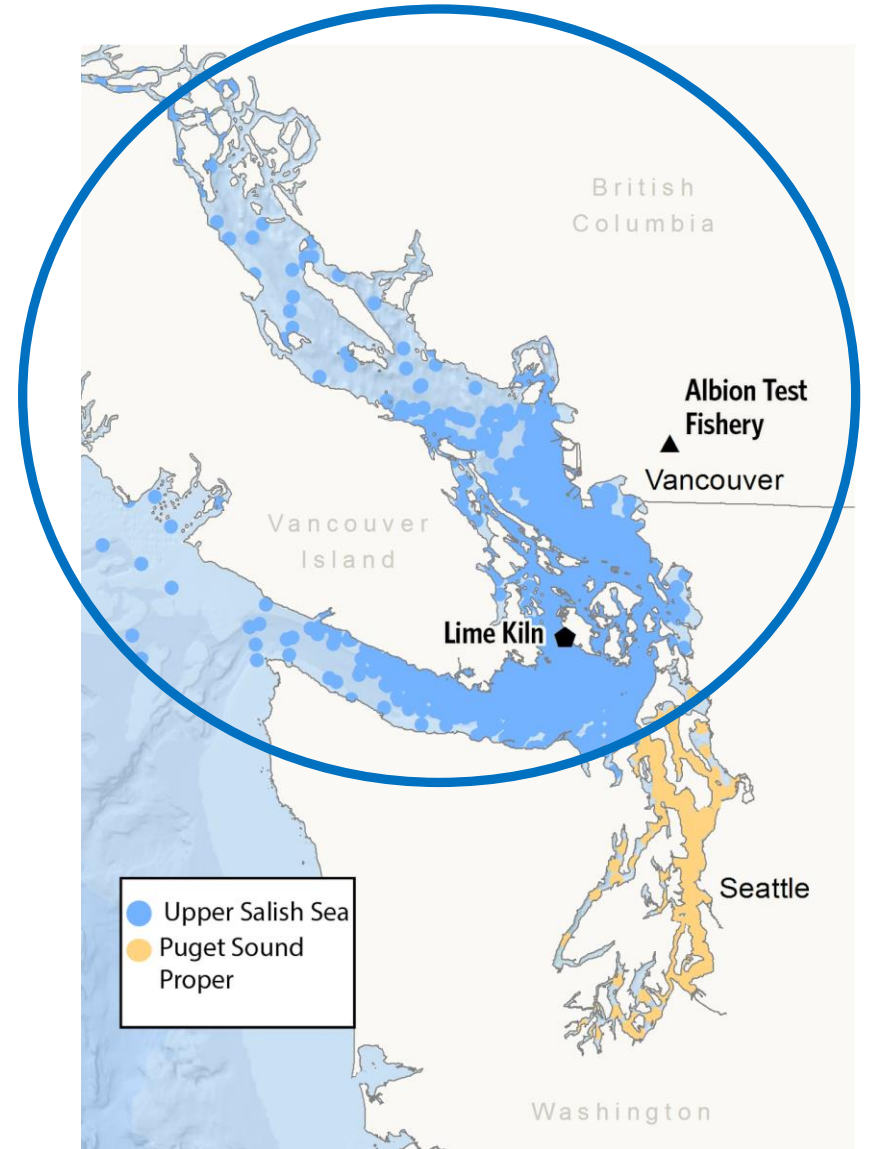
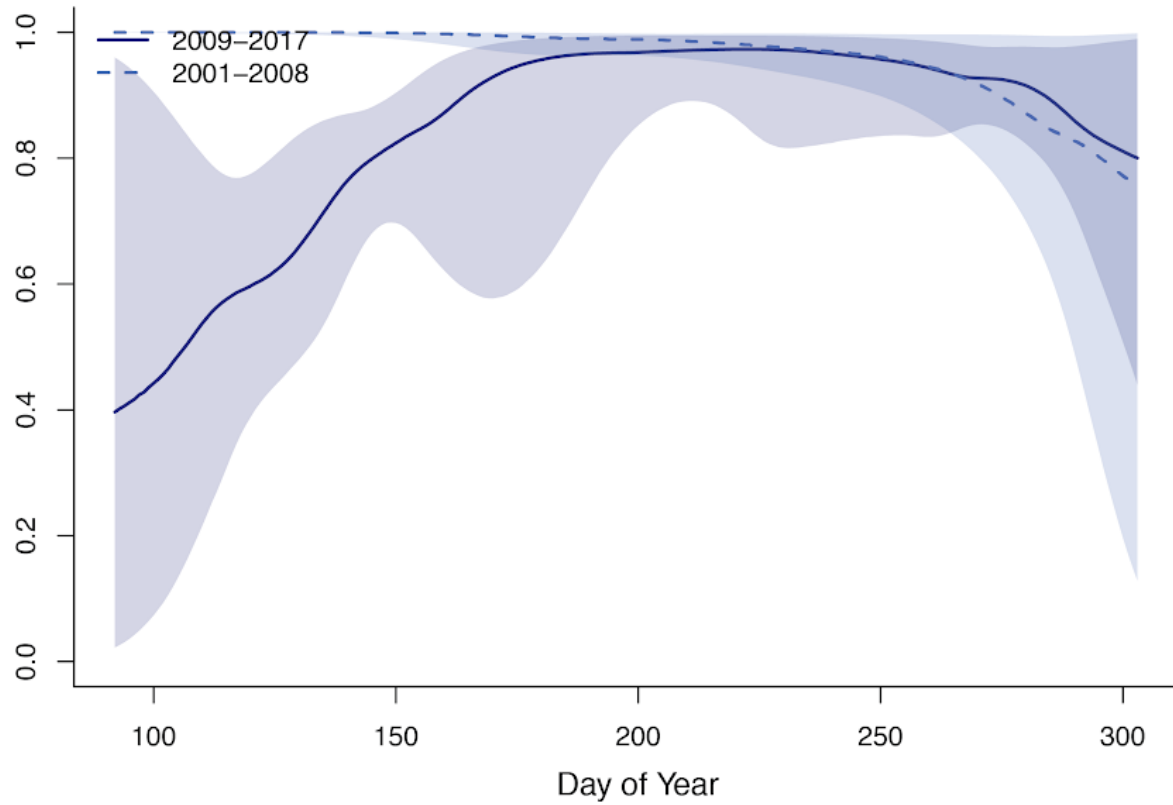
Predictors:

Day of year (spline)

Year, marine area (random effects)

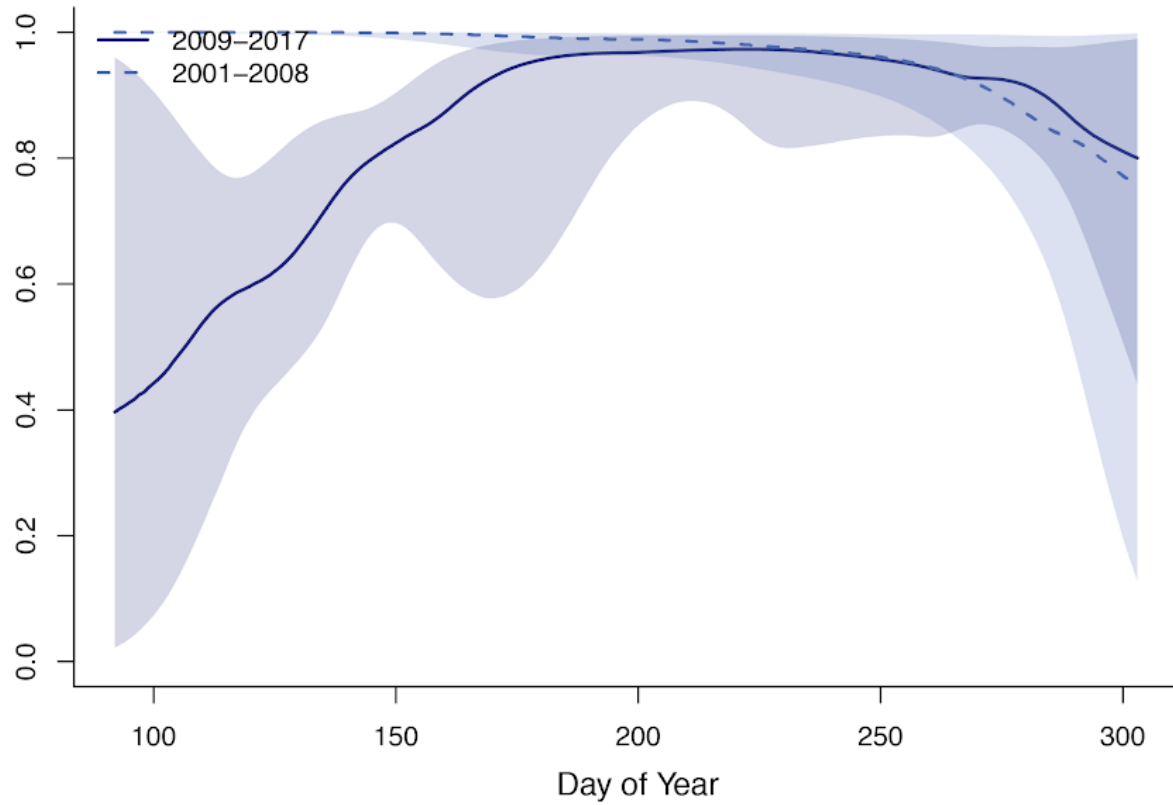
SRKW's are arriving later in the Central Salish Sea

J Pod Probability of Occurrence

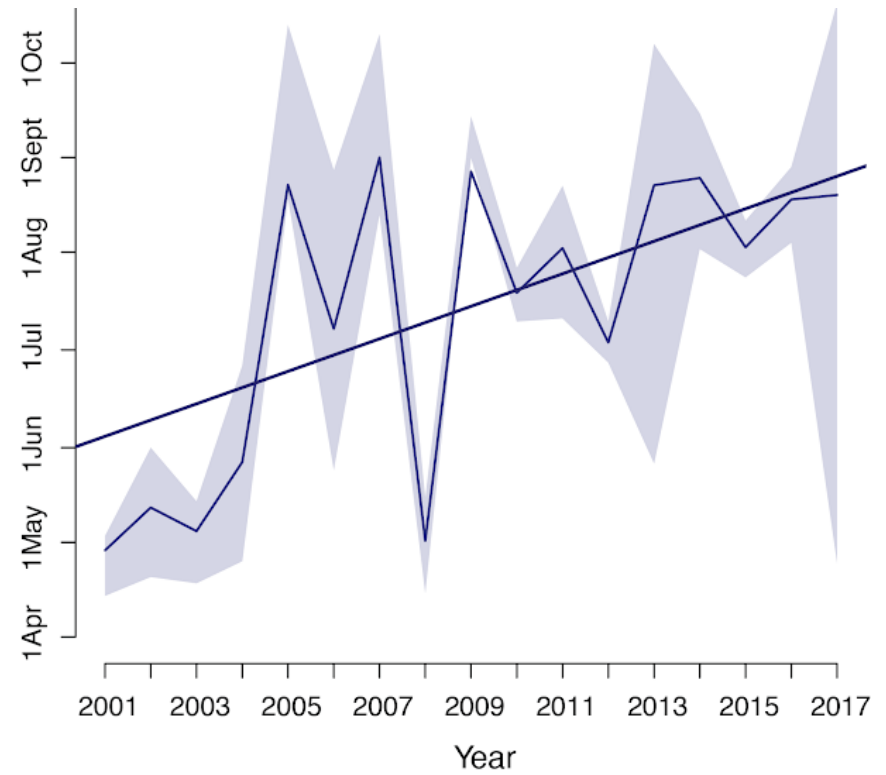


SRKW's are arriving later in the Central Salish Sea

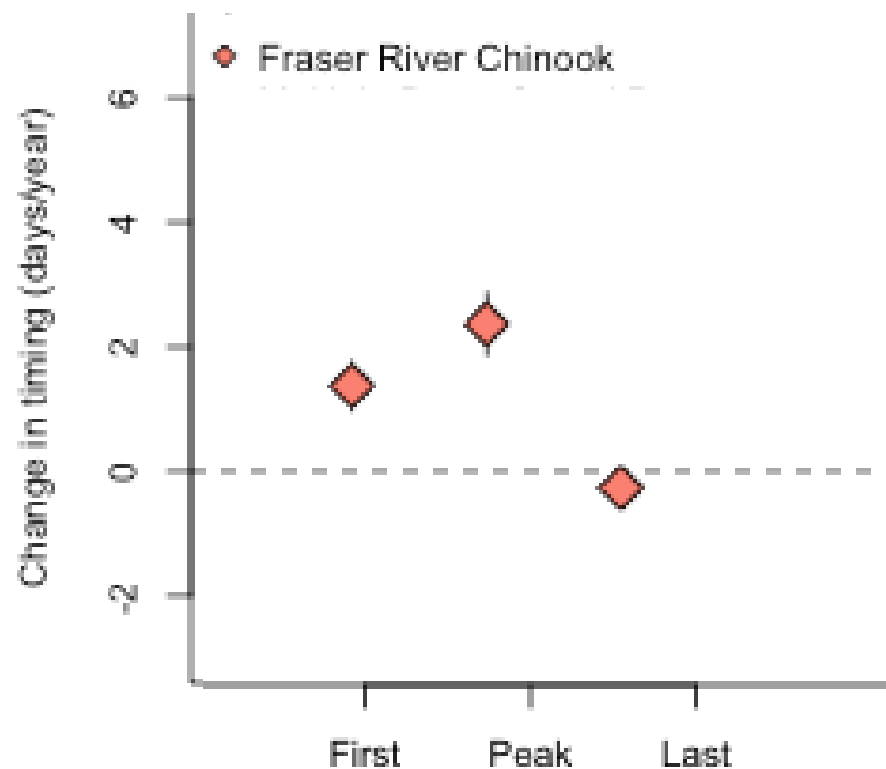
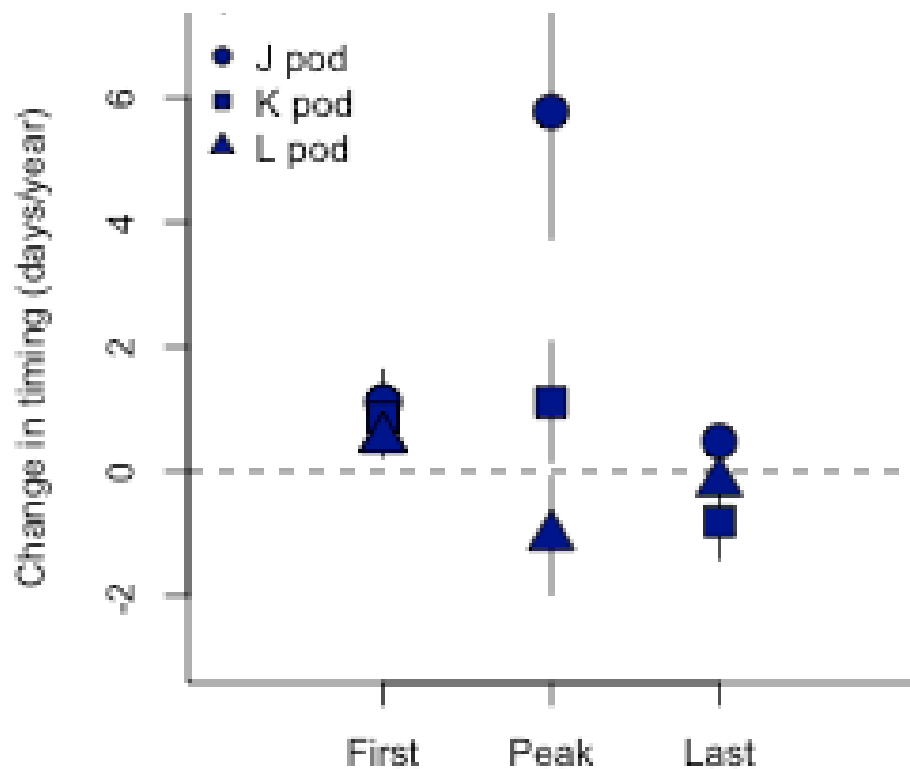
J Pod Probability of Occurrence



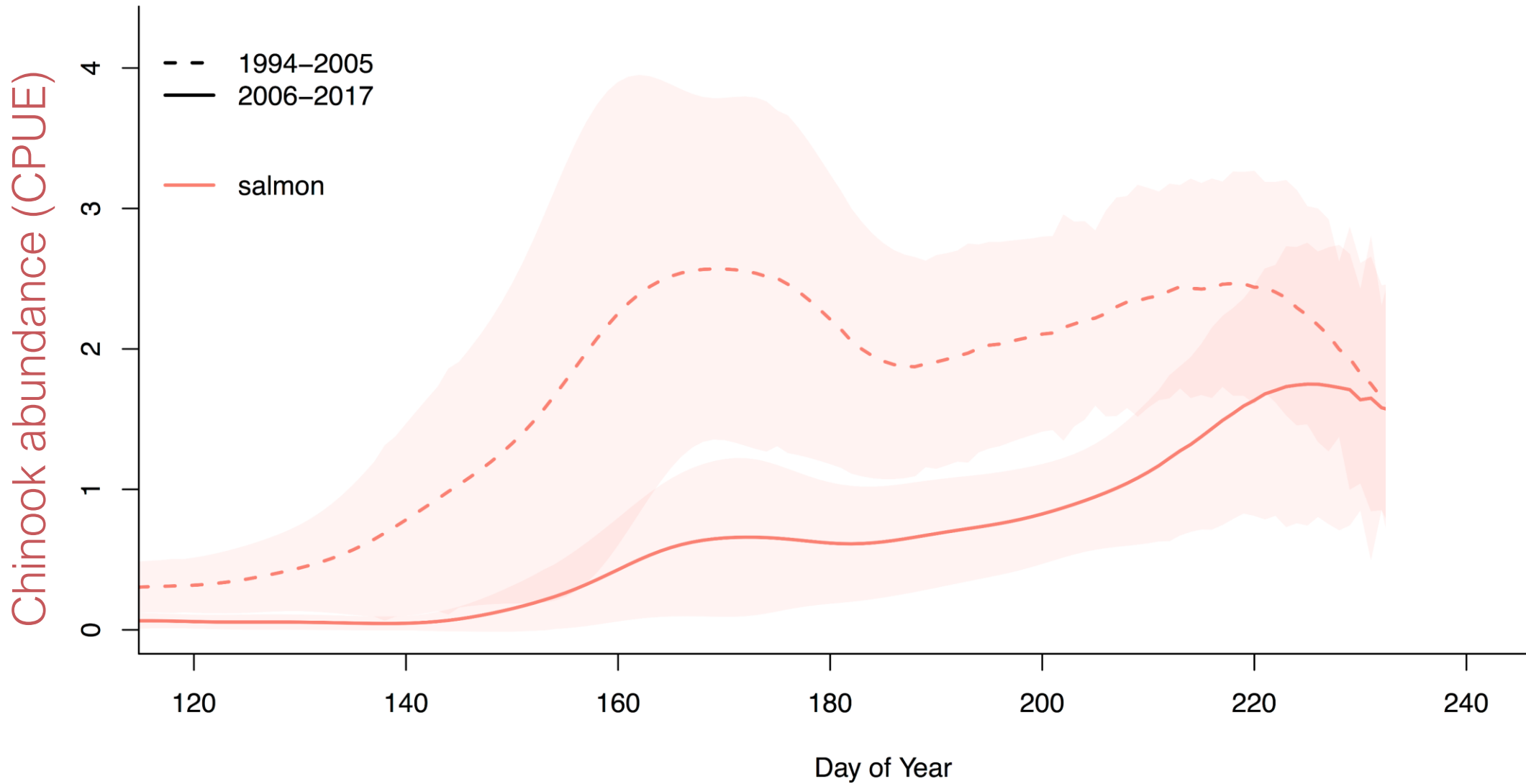
Trend in Day of Year with Peak Probability of Occurrence



SRKWs are arriving later in the Central Salish Sea



Chinook abundance and timing have shifted in the Fraser River:



SRKW activity is affected by other things

- Ecosystem changes
- Behavioral/social changes
- Vessel traffic and noise



Summary and implications

- SRKW activity has shifted later at Lime Kiln Point State Park and the broader Central Salish Sea Region
- These shifts are consistent with shifts in their prey (Fraser River Chinook), and vary across pods
- SRKWs appear able to track shifts in their prey
- Proposed management to help SRKWs should incorporate phenology



Thank you!

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Quantitative Ecologist

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