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## Divergent trends in migration timing of shorebirds along the Pacific flyway

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Hope, David; Buchanan, Joseph; Bishop, Mary Anne; Matz, George; Lemon, Moira; and Drever, Mark, "Divergent trends in migration timing of shorebirds along the Pacific flyway" (2018). *Salish Sea Ecosystem Conference*. 102.

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**Speaker**

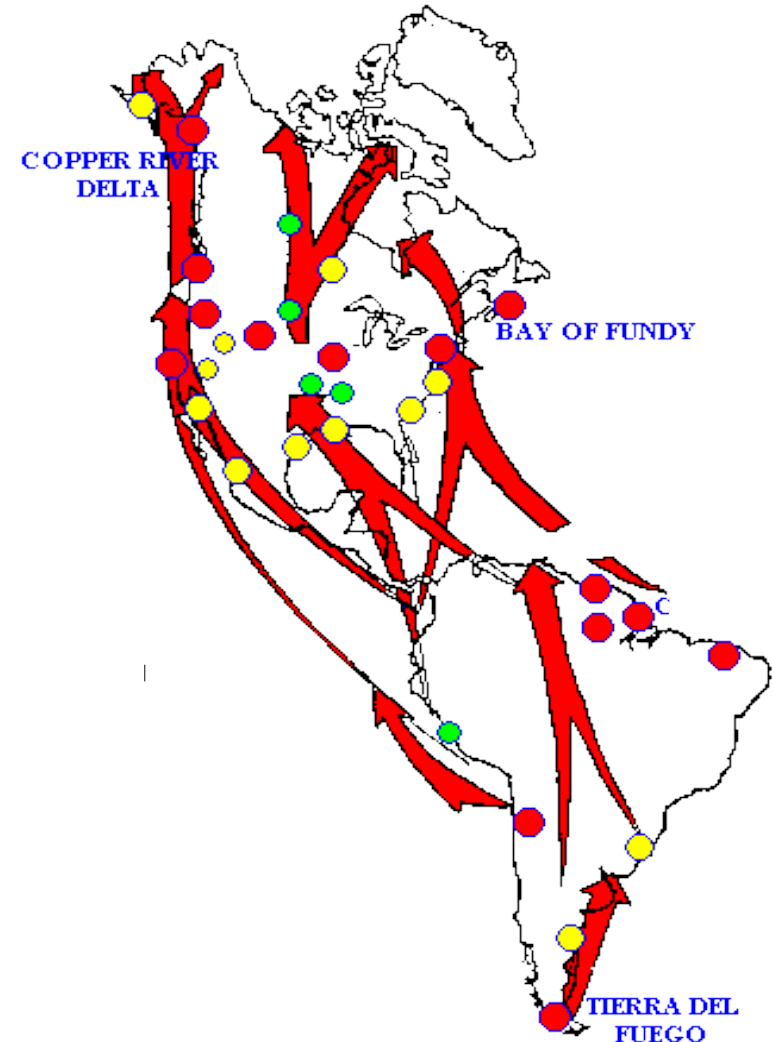
David Hope, Joseph Buchanan, Mary Anne Bishop, George Matz, Moira Lemon, and Mark Drever

# Divergent trends in migration timing of shorebirds along the Pacific flyway

David D. Hope, Mark C. Drever, Joseph B. Buchanan, Mary Anne Bishop, George Matz, and Moira J. F. Lemon

# Northward migration along the Pacific Flyway

- | Short time window
- | Timing of arrival at breeding location must tradeoff with survival on migration
- | Changes in conditions on migration and at breeding ground should result in changes in timing on migration
- | Shorebirds can be counted easily at large stopover sites on migration



Source: Alaska Fish and Game

# Project aims

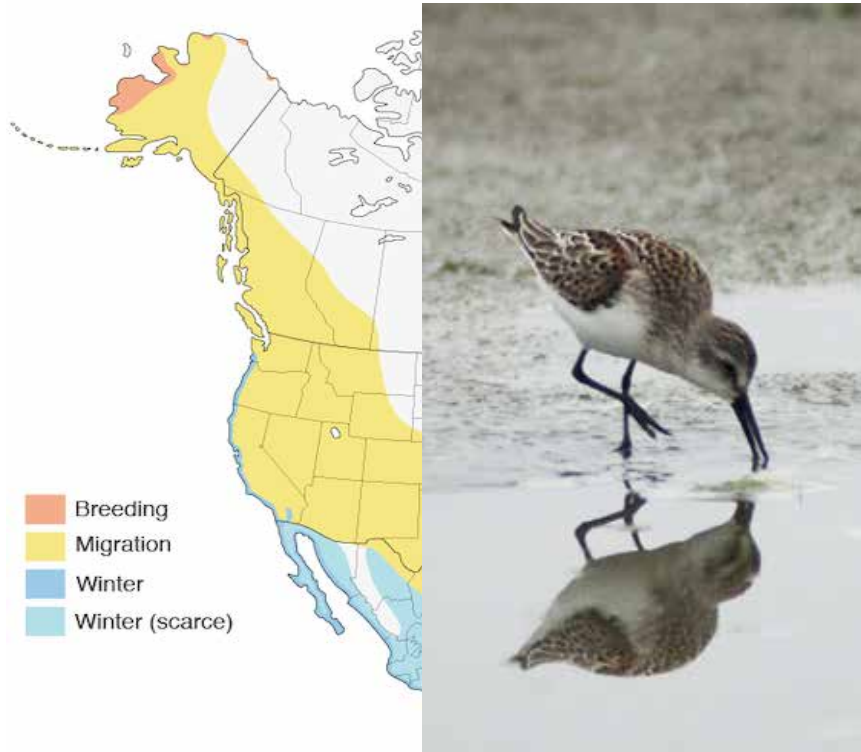
Has the timing of migration changed along the flyway?

- Climate change
- Predator recovery

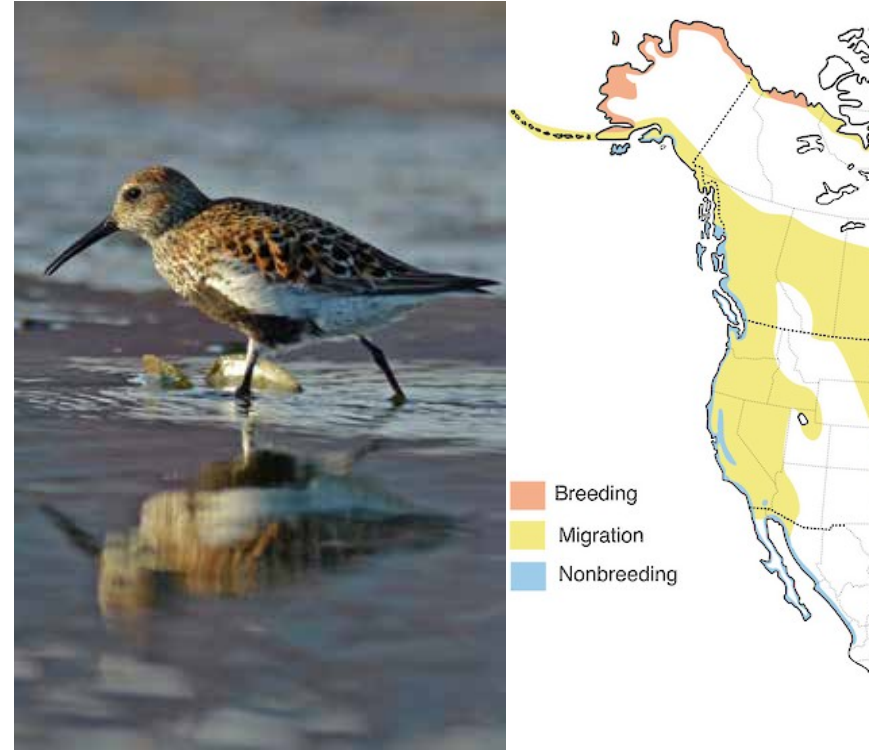
Is an observed change consistent across the flyway?



# Western sandpipers and dunlin



*Calidris mauri*



[www.flickr.com/photos/katechka](http://www.flickr.com/photos/katechka)

*Calidris alpina*

# Flyway sites with years and sample sizes



Kachemak Bay

Copper River Delta

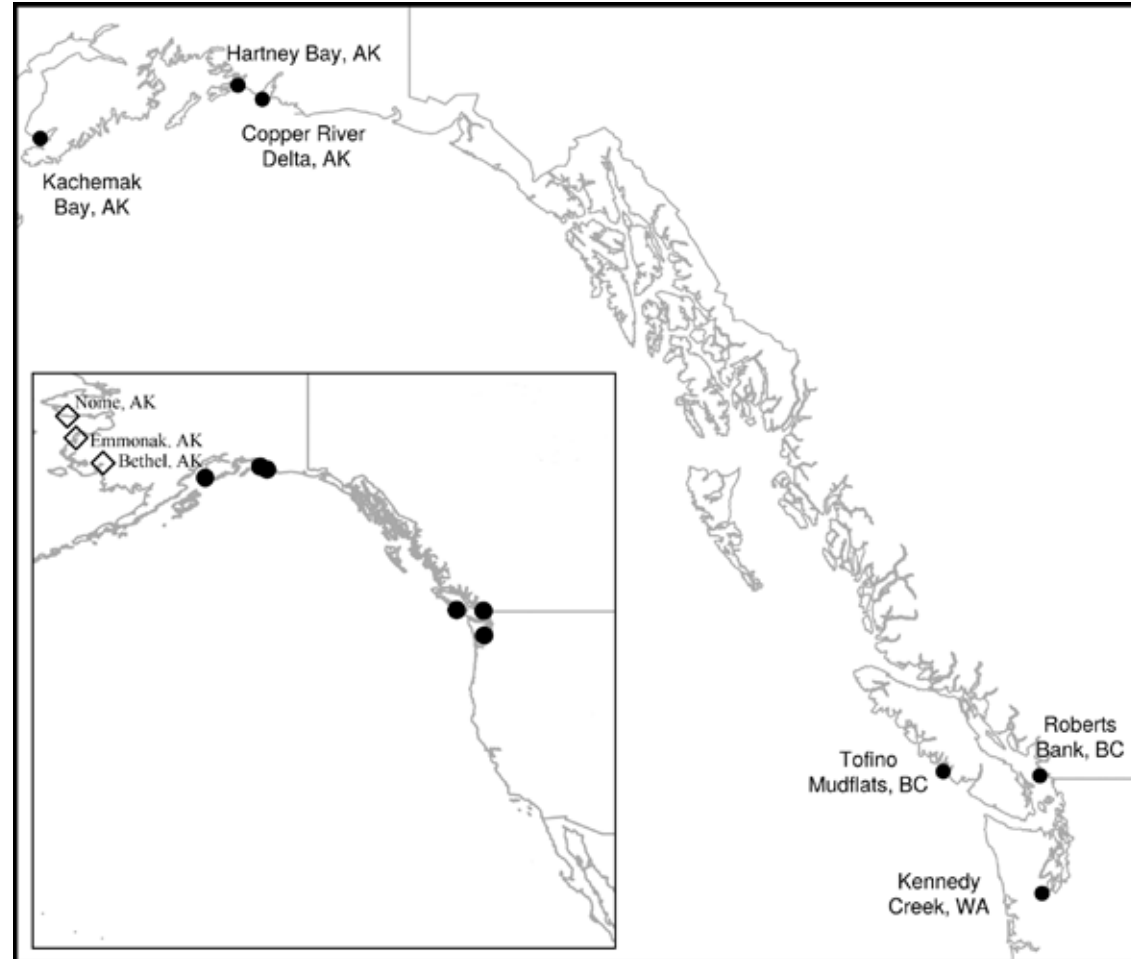


Roberts Bank



Tofino Mudflats

Kennedy Creek



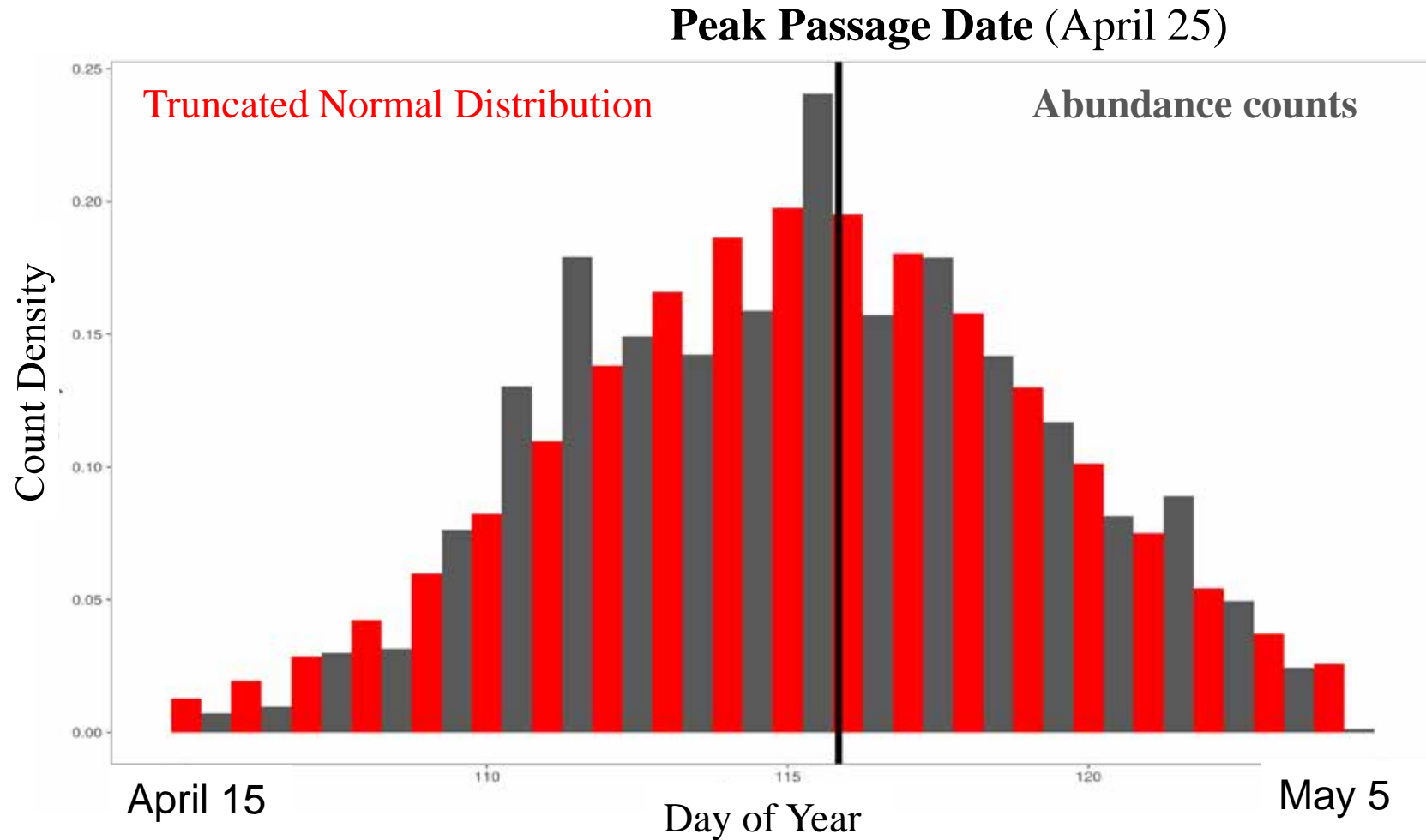
# Collaborators

- | Joe Buchanan - Kennedy Creek, WA
- | Mark Drever and Moira Lemon - Roberts Bank and Tofino Mudflats, BC
- | Mary Anne Bishop - Copper River Delta, AK
- | Environment for the Americas – Hartney Bay, AK
- | George Matz and Kachemak Bay Birders - Kachemak Bay, AK

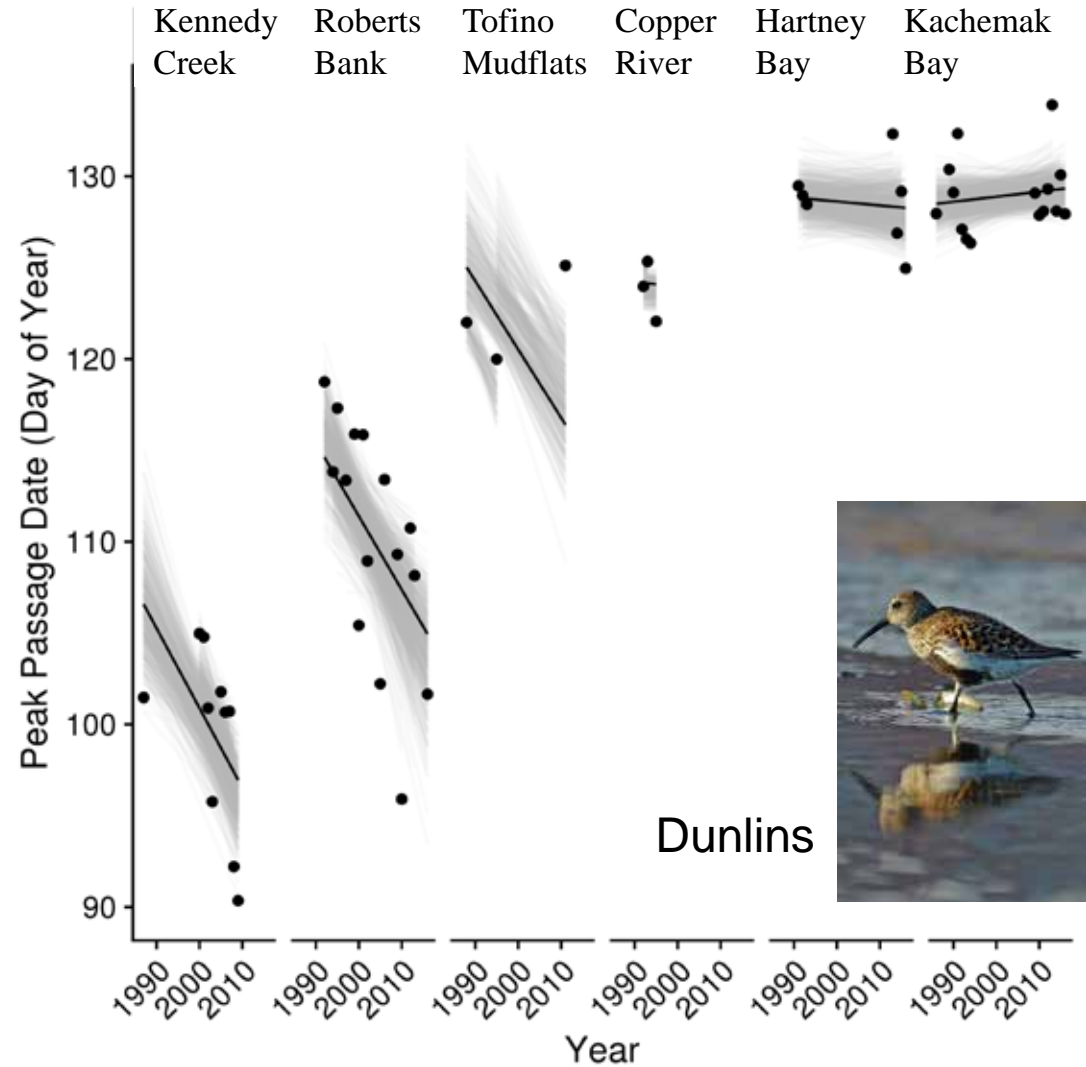
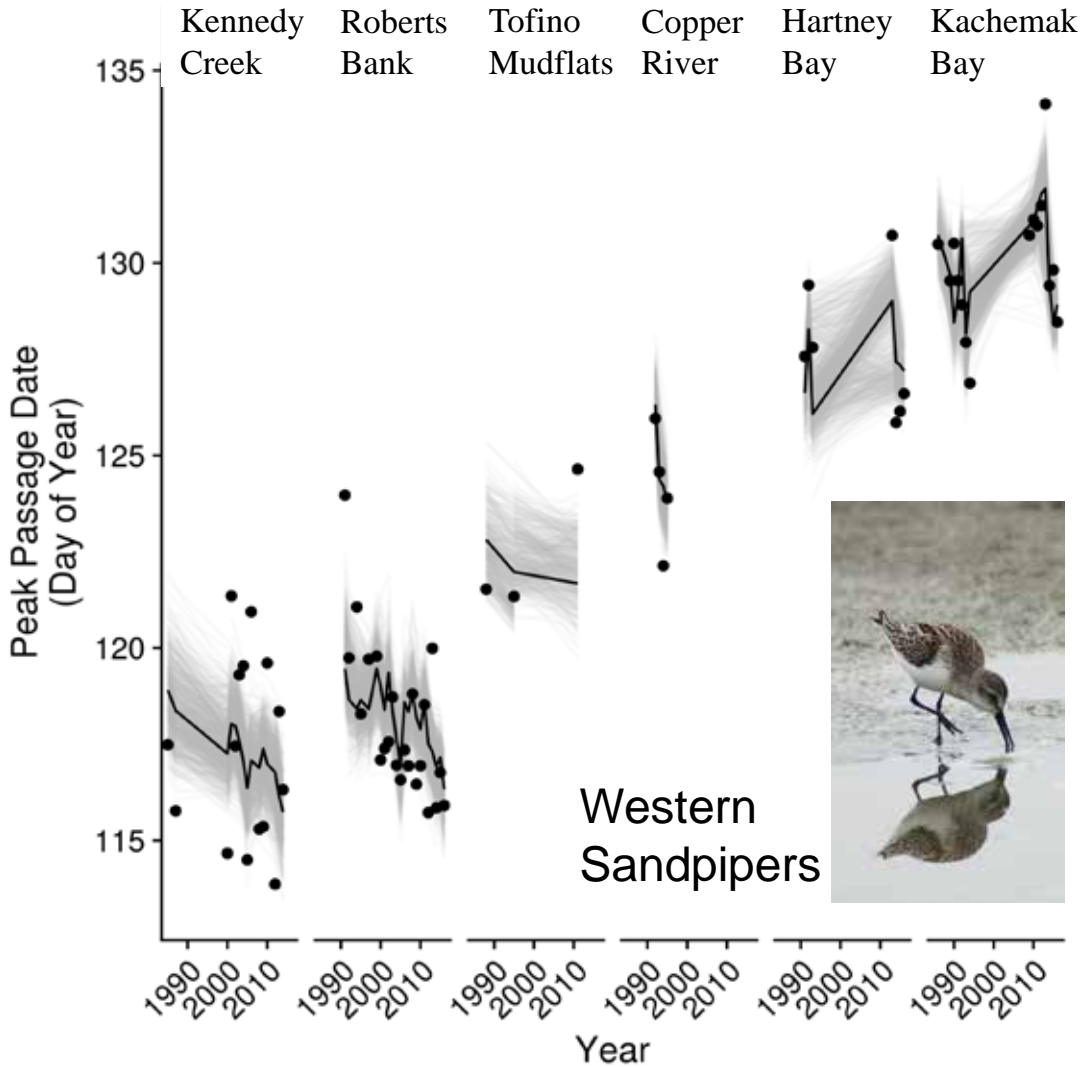




# Quantifying passage through a stopover

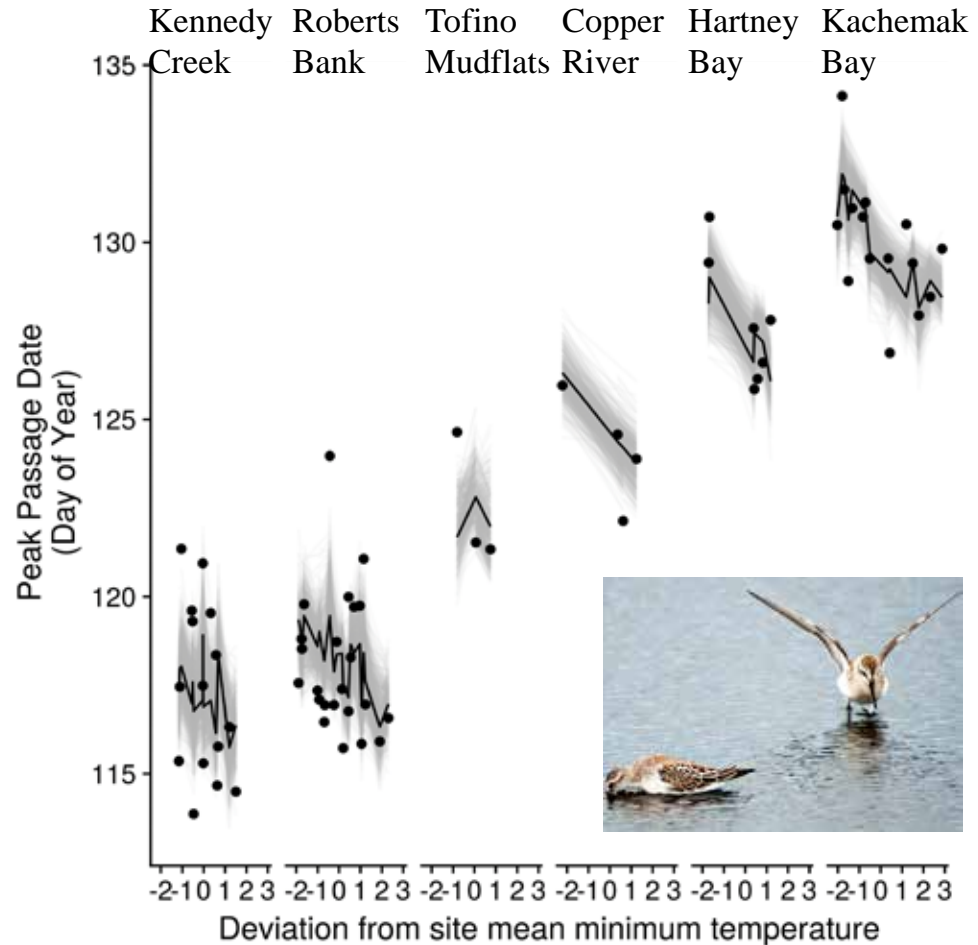
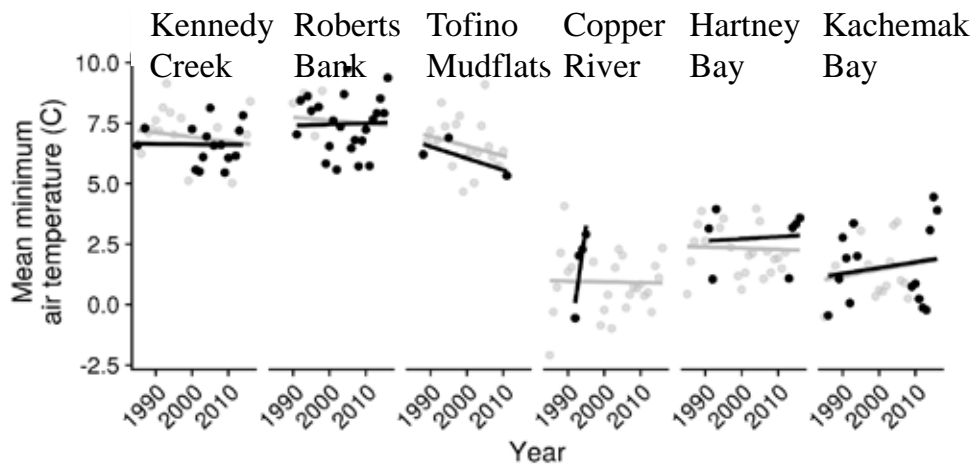


# Timing of passage has changed in both species



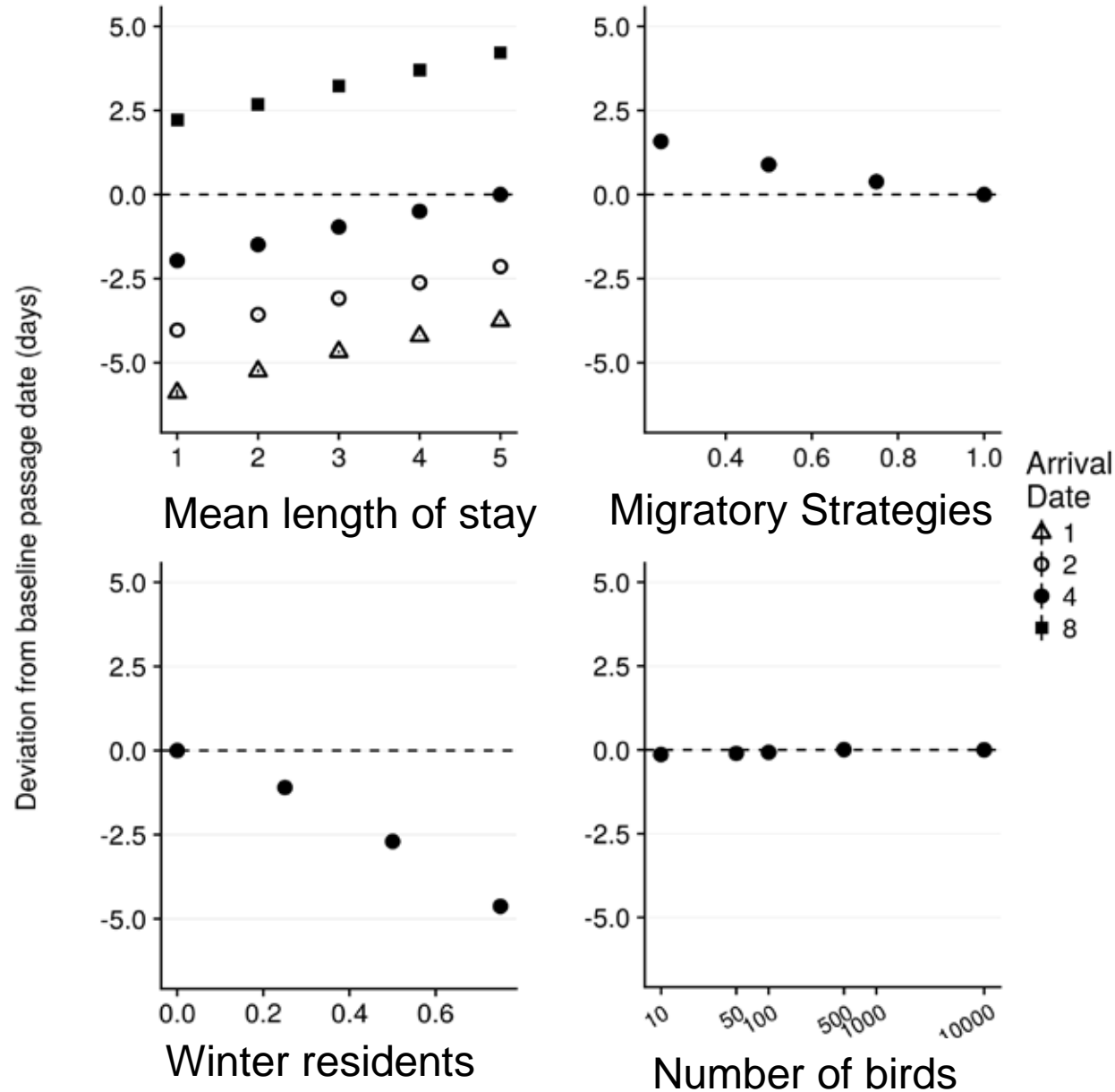
# Role of Local Temperature

- Mean local minimum temperature affected passage dates
- Temperature did not explain interannual trend



# Behavioural mechanisms

- | Length of stay and arrival date influence peak passage estimate
- | Small impact from number of birds and migratory strategies
- | Winter resident population has strong impact



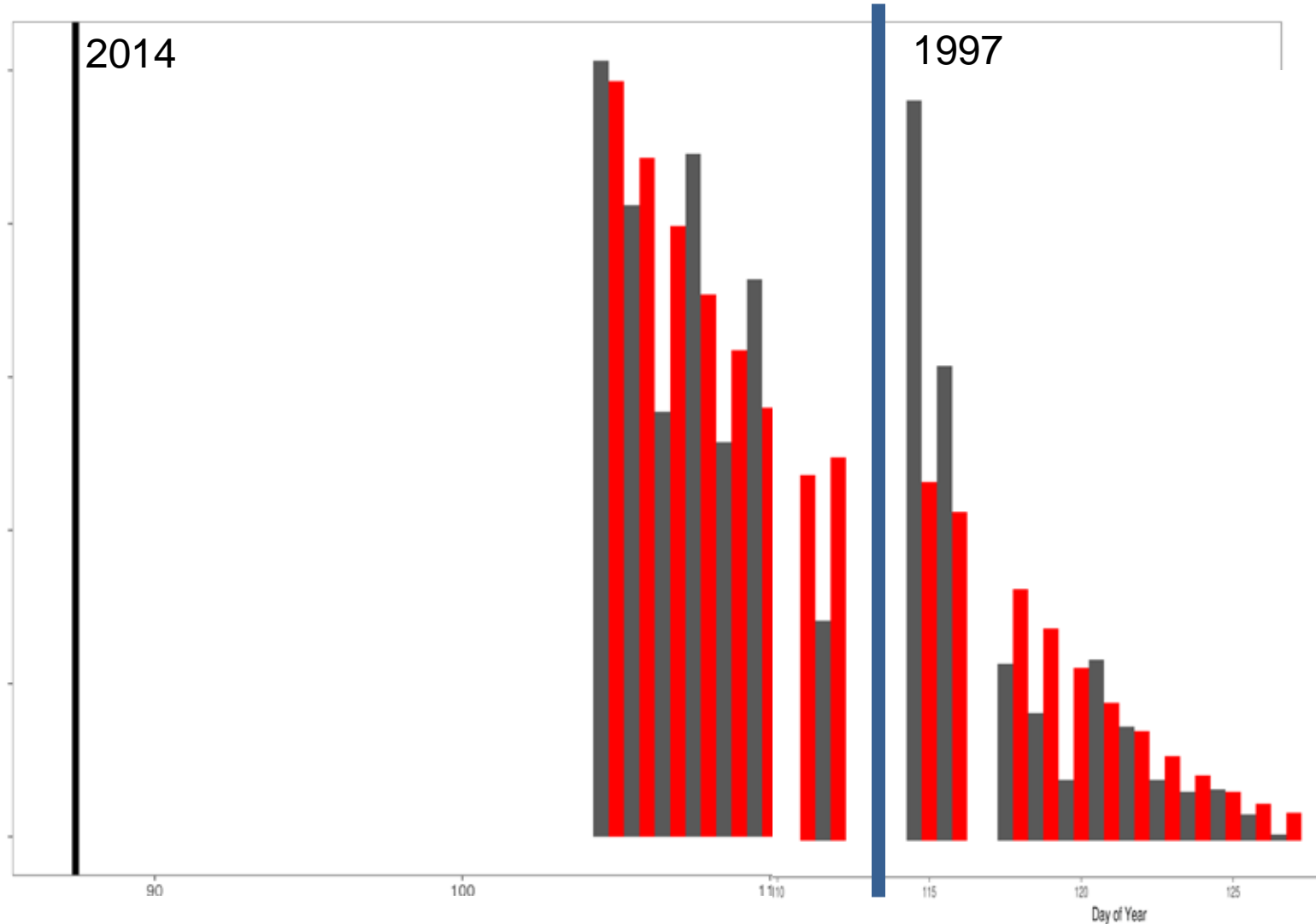
# Divergent trends, divergent process?

- | Western Sandpiper migratory passage now 3 days earlier in Salish Sea (0.085 days/year earlier)
- | Passage shifted by 2 days later at northern sites
- | Early arrival at southern sites
- | Spending longer at northern sites



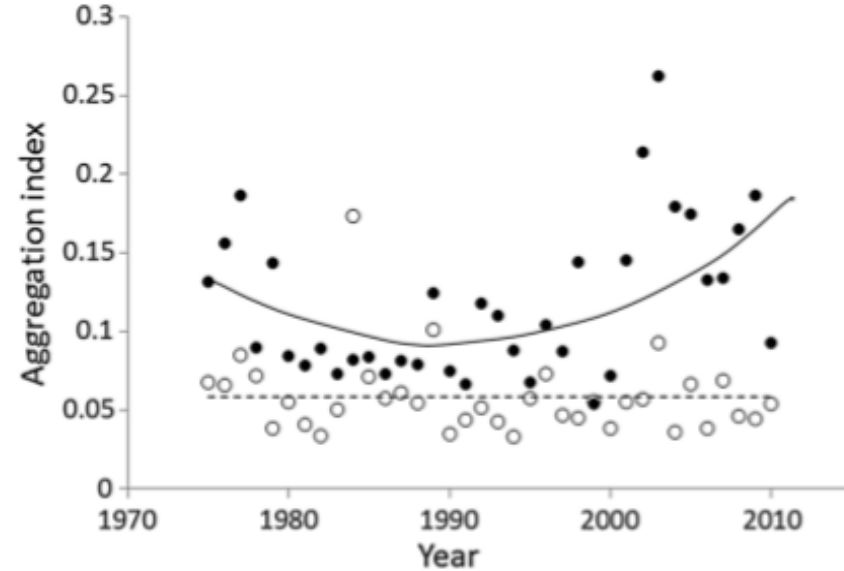
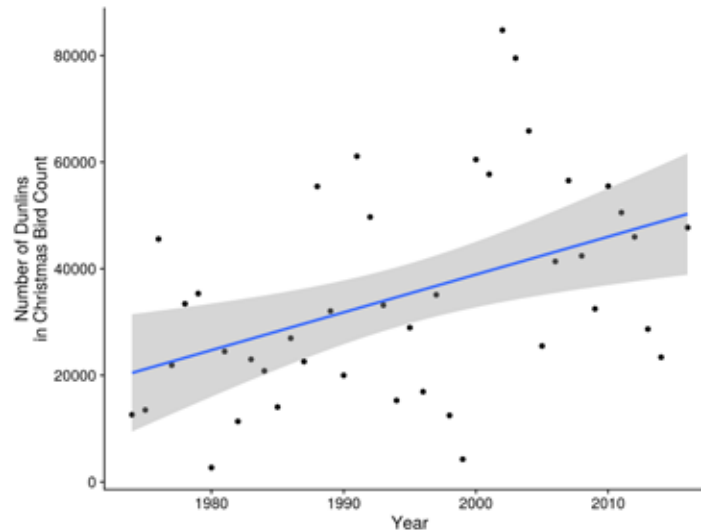
# Non-breeding Dunlins

- More Dunlin at start of surveys
- Increased aggregation at large sites
- Predator and population impacts



# Role of Wintering Dunlins

- More Dunlin at start of surveys
- Increased aggregation at large sites
- Predator and population impacts



# Conclusions

- | Western Sandpipers appear to be arriving earlier to the Salish Sea each spring
- | Dunlins may be increasingly using large Salish Sea sites during winter.
- | Long term monitoring can be useful when combined with simulation modelling.





# Project affiliations and funding

Tofino Mudflats and Roberts Bank surveys funded by:



Environment and Climate Change Canada



Hartney Bay, 2013-2016 made available through:



Copper River Delta and Hartney Bay, 1992-95 funded by:



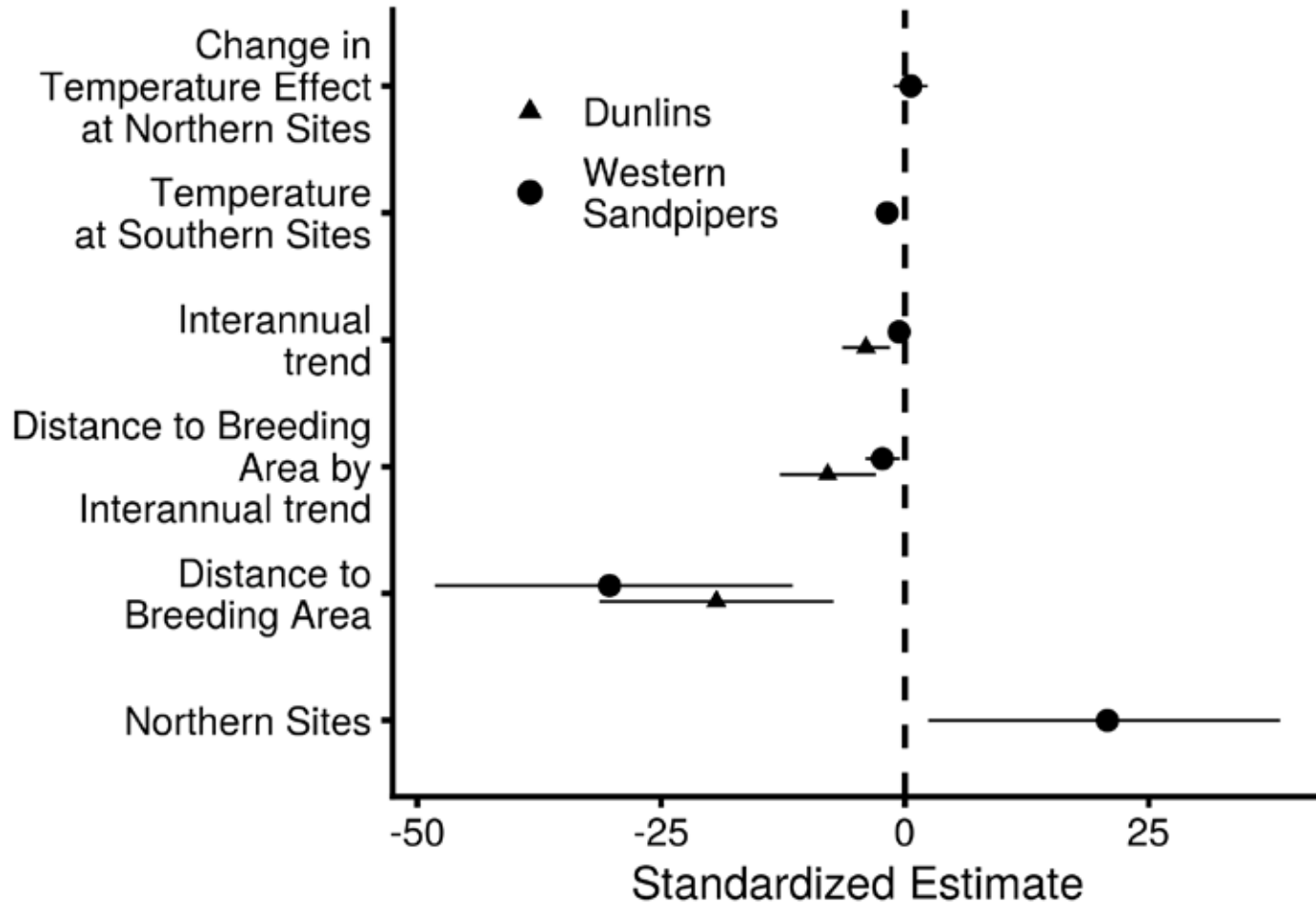
Environment and Climate Change Canada

SFU



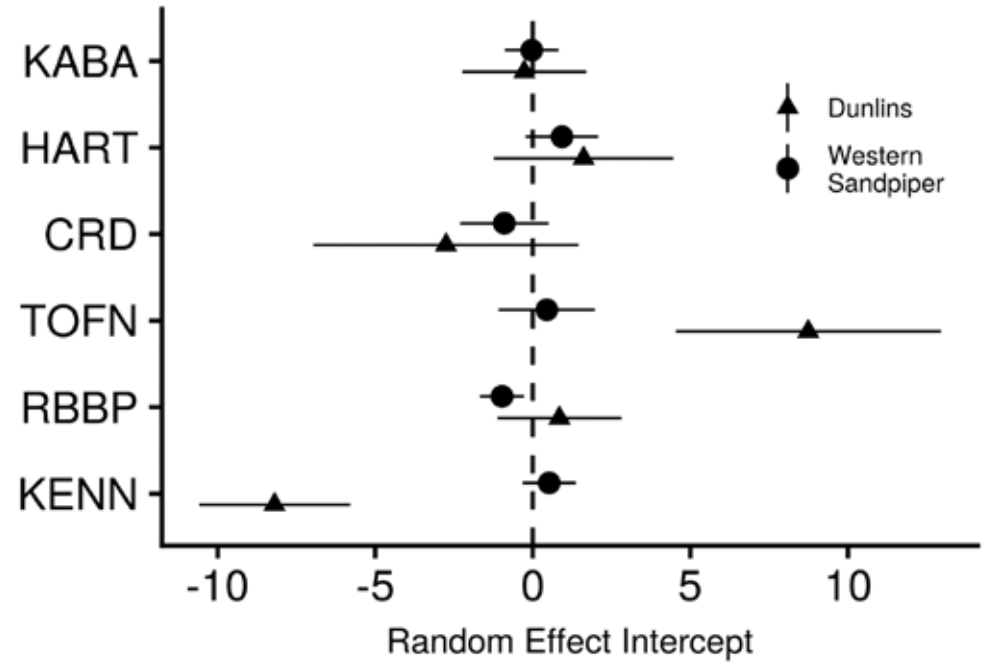
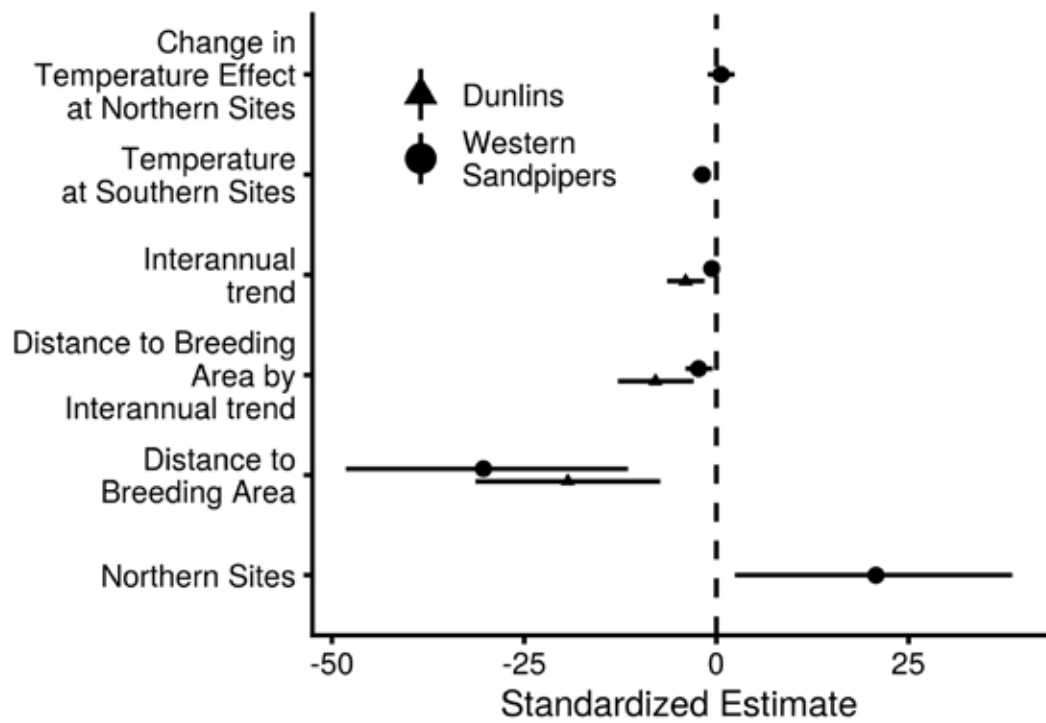
Hope et al. (In Press). Trends in timing of spring migration along the Pacific Flyway by Western Sandpipers and Dunlins. *The Condor: Ornithological Applications*

# Model effects



- Migratory passage now 3 days earlier in Salish Sea (0.085 days/year earlier)
- Passage shifted by 2 days later at northern sites
- Strong effects in Dunlins

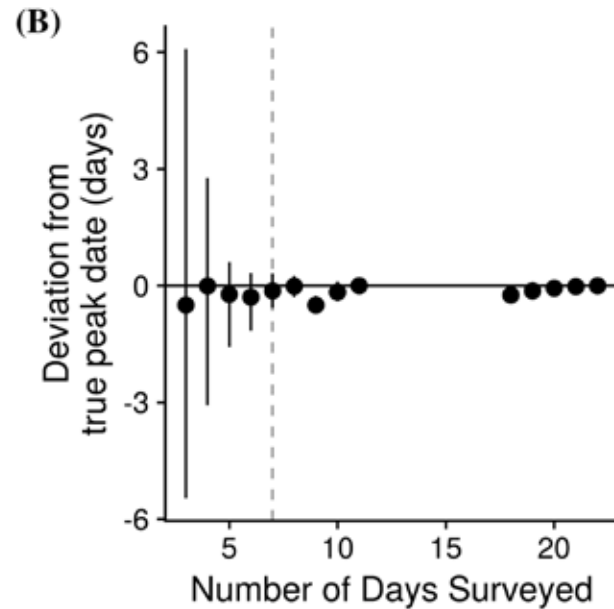
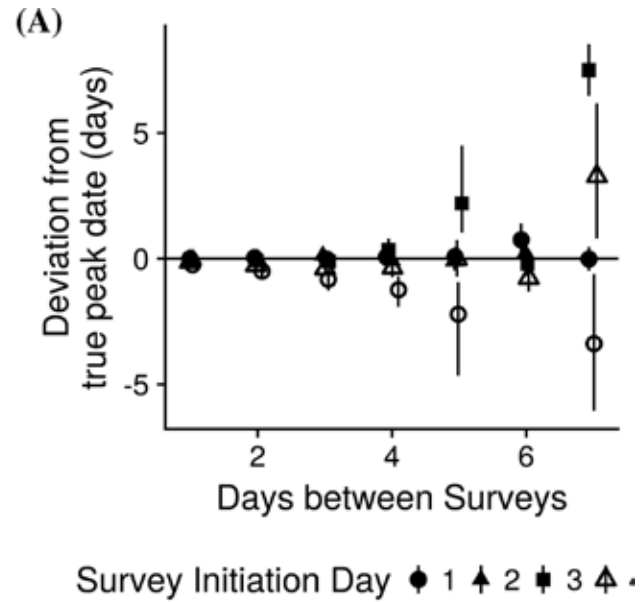
# Model effects



$$\mu_{ij} = \alpha_j + \beta_1 \cdot year_i + \beta_2 \cdot \varphi_j + \beta_3 \cdot \varphi_j \cdot year_i + \beta_4 \cdot \tau_{ij} \cdot \eta_j + \beta_5 \cdot \tau_{ij} + \beta_6 \cdot \eta_j + \varepsilon_{ij}$$

$$\alpha_j = N(\mu_\alpha, \sigma_\alpha^2)$$

# Power analysis



# Survey sites

Site	Years (n)	Survey Days
Kennedy Creek, WA	15	13.9 ± 0.9
Roberts Bank, BC	23	20.6 ± 1.3
Tofino Mudflats, BC	3	17.3 ± 4.1
Copper River Delta, AK	4	10.0 ± 0.9
Hartney Bay, AK	7	19.0 ± 2.5
Kachemak Bay, AK	15	20.5 ± 1.5