

Size and abundance of resident Chinook salmon in the Salish Sea: Insights from a culturally unique recreational fishery

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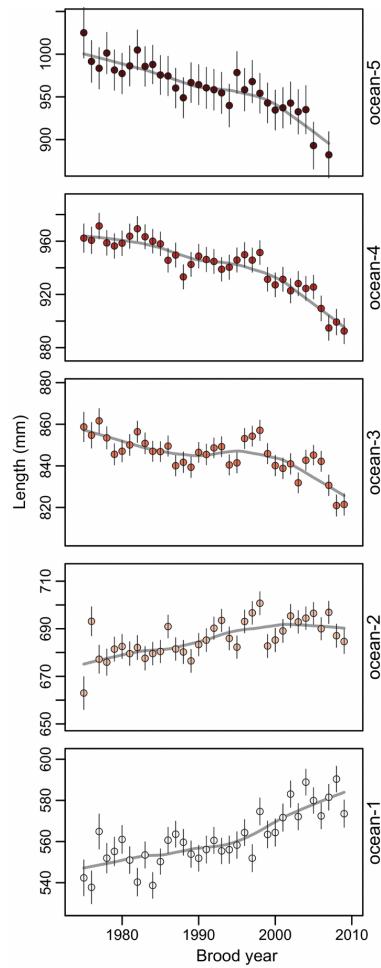
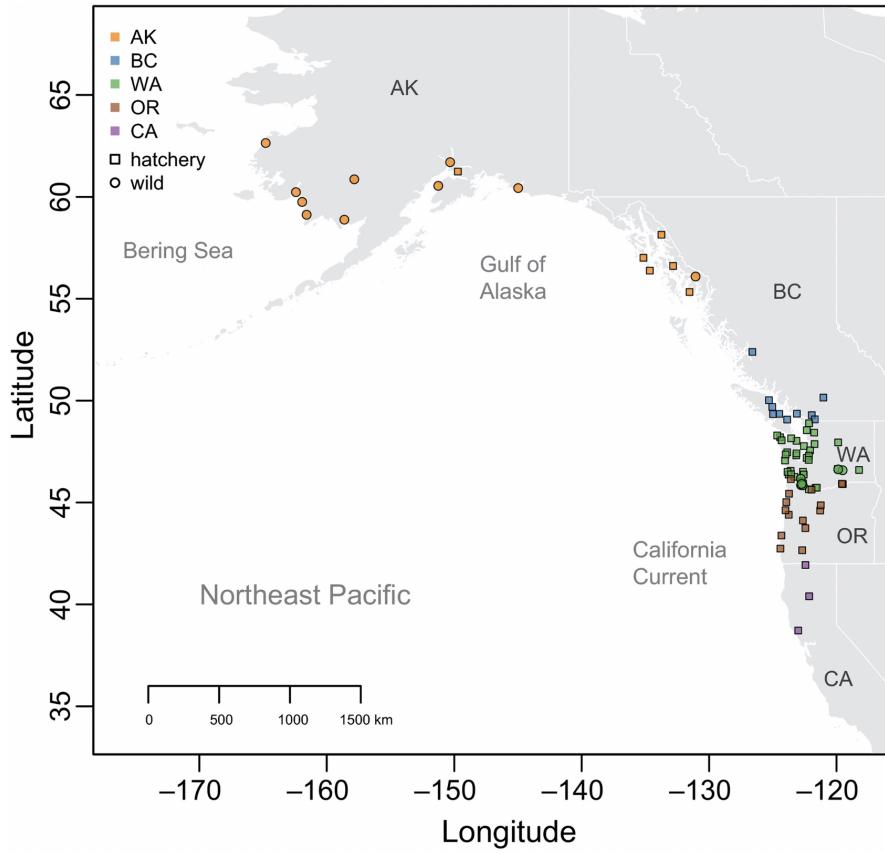
Collaborators

Tom Quinn (U Washington)

James Losee (WA Dept Fish Wildlife)

Doug Hanada (Tengu Club)

Older Chinook salmon are getting smaller



Ohlberger et al. (2018) *Fish and Fisheries*

Size of salmon matters because...

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smaller fish may signal problems with habitat



Camp Harmony in 1942



DEDICATED TO
THE TENGU CLUB

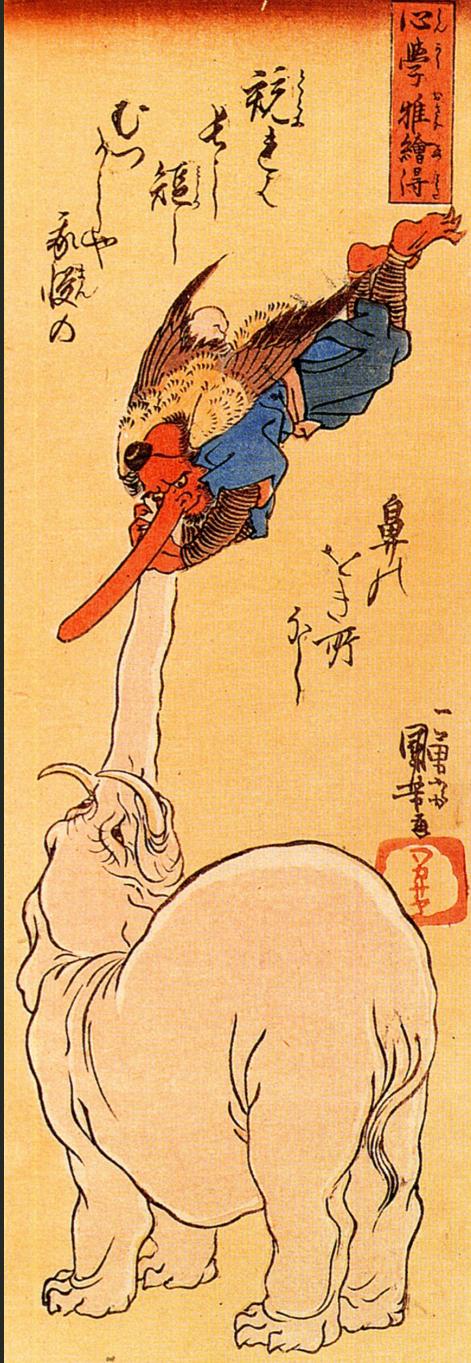
THE TENGU CLUB OF SEATTLE, FORMED IN THE 1930S BY JAPANESE AMERICANS, HELD ITS FIRST TENGU BLACKMOUTH SALMON FUN DERBY IN 1946. ARGUABLY THE LONGEST CONTINUALLY RUNNING SALMON DERBY IN NORTH AMERICA, IT CONTINUES TO BE HELD EACH WINTER IN ELLIOTT BAY. THE DERBY ORIGINALLY OPERATED OUT OF THE HARBOR ISLAND BOATHOUSE AND LATER MOVED TO LLOYD'S BOATHOUSE. IT NOW RUNS OUT OF THE CITY OF SEATTLE'S SACREST BOATHOUSE.

CLUB MEMBERS, RETURNING FROM WARTIME INTERNMENT CAMPS, WERE DENIED ENTRY INTO LOCAL SALMON DERBIES SO THEY ORGANIZED THE FIRST TENGU DERBY IN DECEMBER OF 1946. MORE THAN 170 PEOPLE, INCLUDING ABOUT A DOZEN NON-JAPANESE, FISHED IN THE FIRST FOUR-SUNDAYS-LONG COMPETITION SINCE THEN, THE DERBY HAS VARIED IN LENGTH UP TO 13 SUNDAYS.

THE TECHNIQUE OF "MOOCHING" WAS INVENTED IN ELLIOTT BAY BY THESE FISHERS, WHO PERFECTED A WAY TO ENCISE SALMON BY WORKING BAIT IN AN UP-AND-DOWN MOTION WHILE DRIFTING. THIS METHOD PROVED TO BE SO EFFECTIVE THAT NON-JAPANESE WOULD "MOOCH" HERRING FROM THEM. THE TENGU CLUB RECOGNIZED THE HISTORICAL SIGNIFICANCE OF MOOCHING AND ADHERES TO THIS "PURIST" WAY OF SALMON FISHING TO THIS DAY.

THE NAME "TENGU" IS FROM JAPANESE FOLKLORE THAT DESCRIBES MYTHICAL CREATURES THAT WERE MISCHIEVOS BRAGGARTS. THEIR LONG NOSES ARE SYMBOLIC OF EXAGGERATING THE TRUTH, WHICH IS TYPICAL OF FISH STORIES.

The name 'Tengu' is from Japanese folklore that describes mythical creatures that were mischievous braggarts. Their long noses are symbolic of exaggerating the truth, which is typical of fish stories.

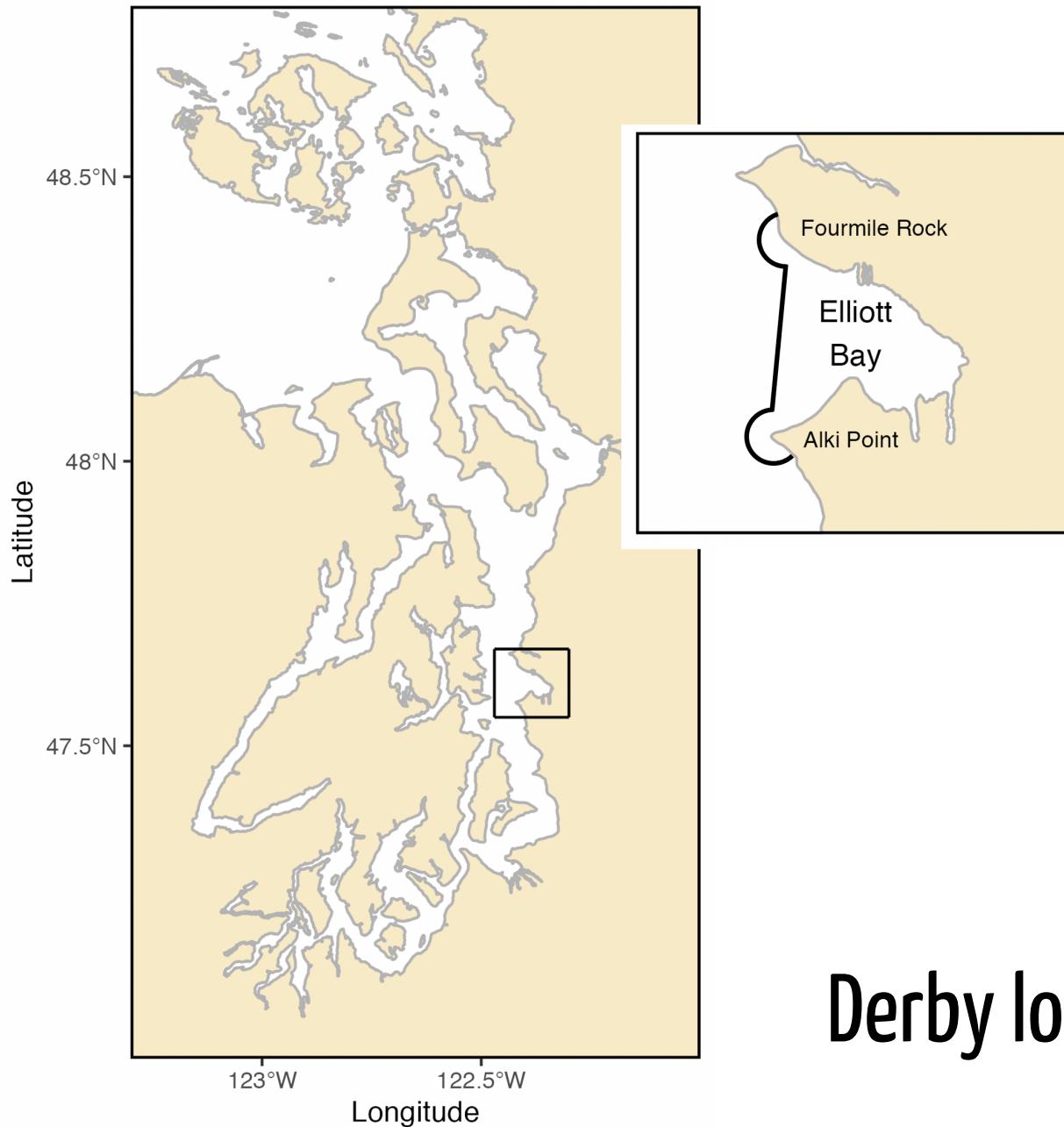


"Blackmouth" Chinook salmon

Feed in the Salish Sea year-round until they mature & return to rivers to spawn

Targeted by anglers in fall and winter





Derby location

Salmon mooching rig





Catch is carefully scrutinized and recorded

Questions

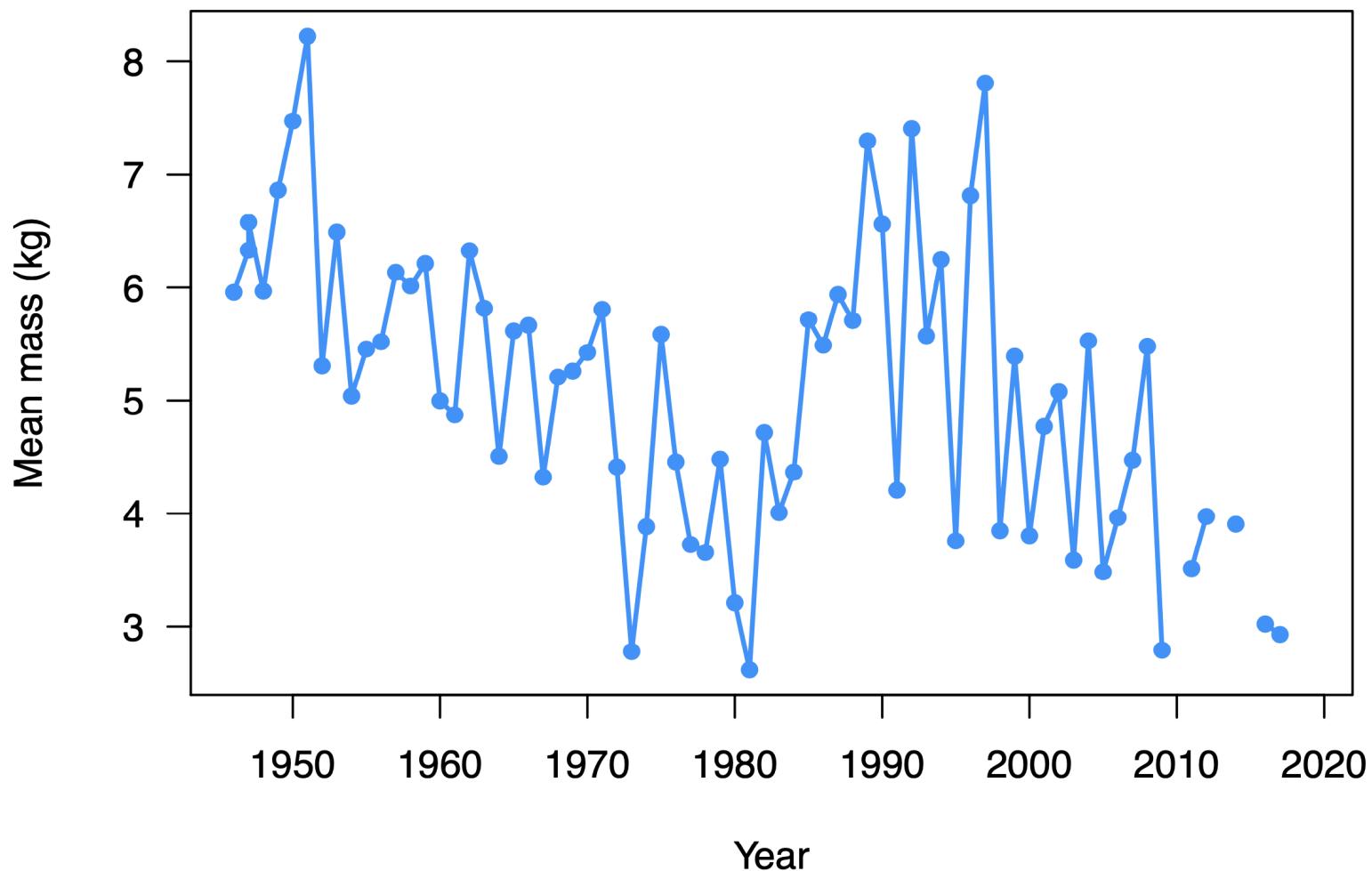
Has fish mass changed systematically over the past 70 years?

Questions

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Do changes in Tengu fish mirror patterns of Puget Sound Chinook salmon as a whole?

Mean mass of 5 largest fish



Analyzing changes in fish mass via two-part *state-space* models

- 1) State (process) model
- 2) Observation (data) model

Possible state models

Random walk

$$x_t = x_{t-1} + w_t$$

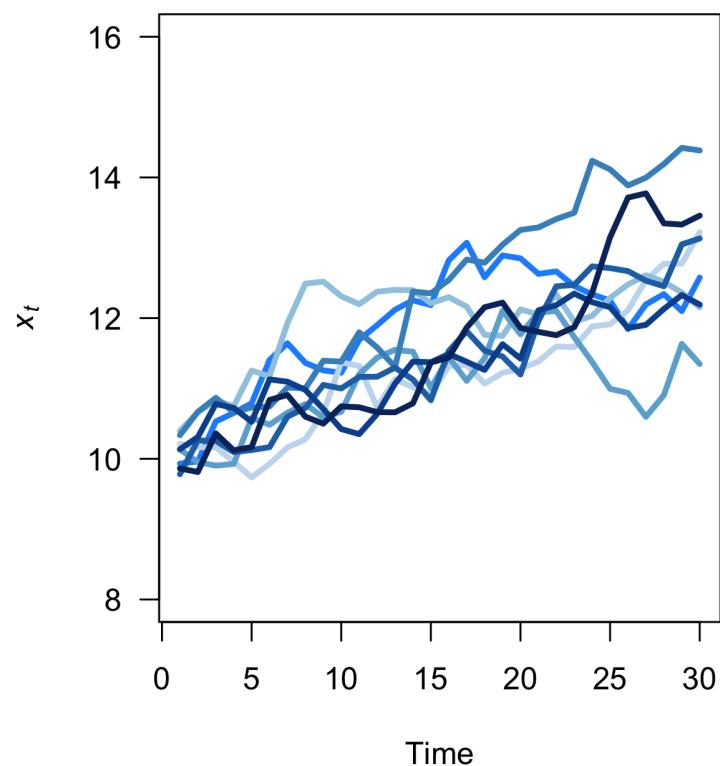
Biased random walk

$$x_t = x_{t-1} + u + w_t$$

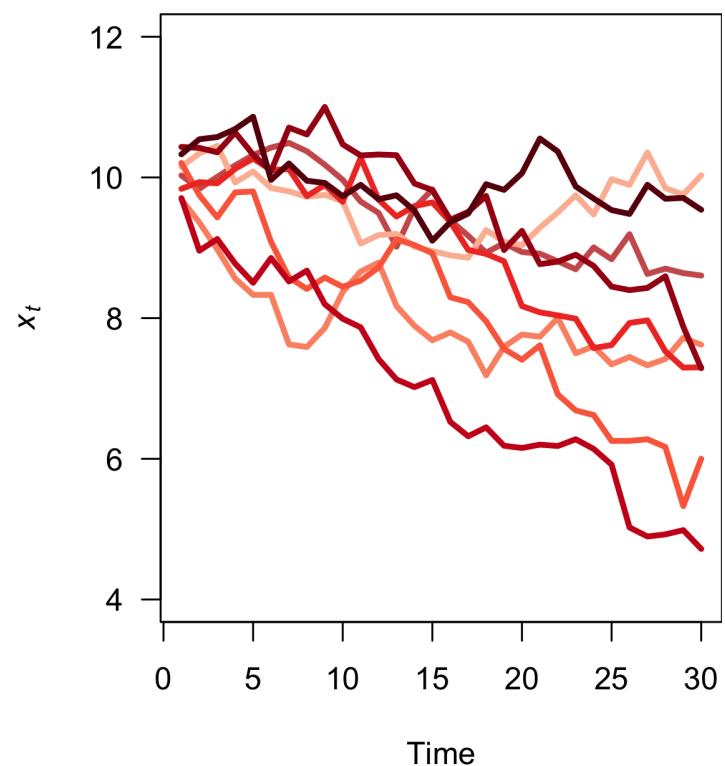
where $x_t = \log(mass_t)$

Examples of biased random walks

Positive bias



Negative bias

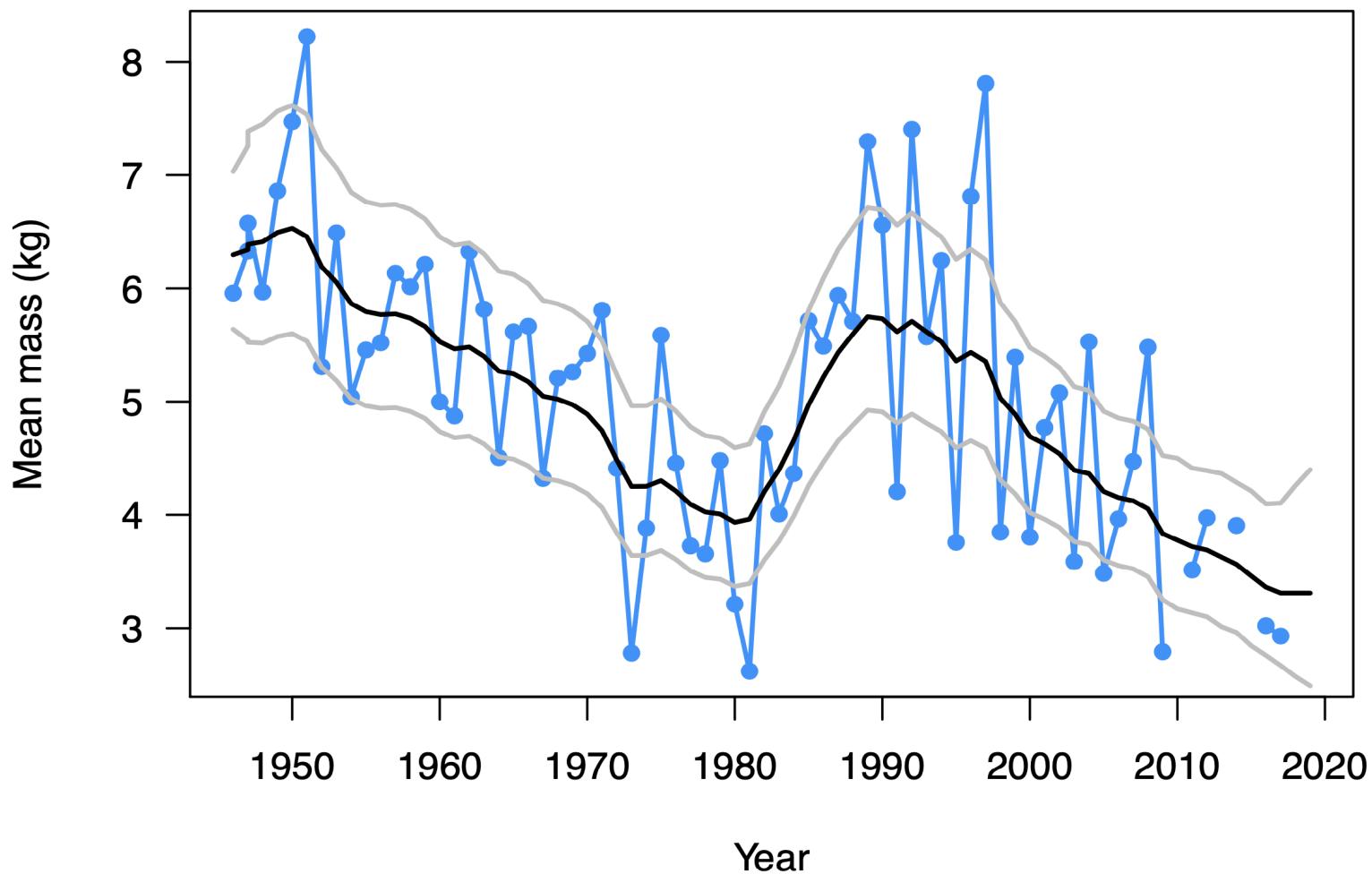


Observation model

Imperfect sampling means we are unsure of the true size

Observed size = **true size + error**

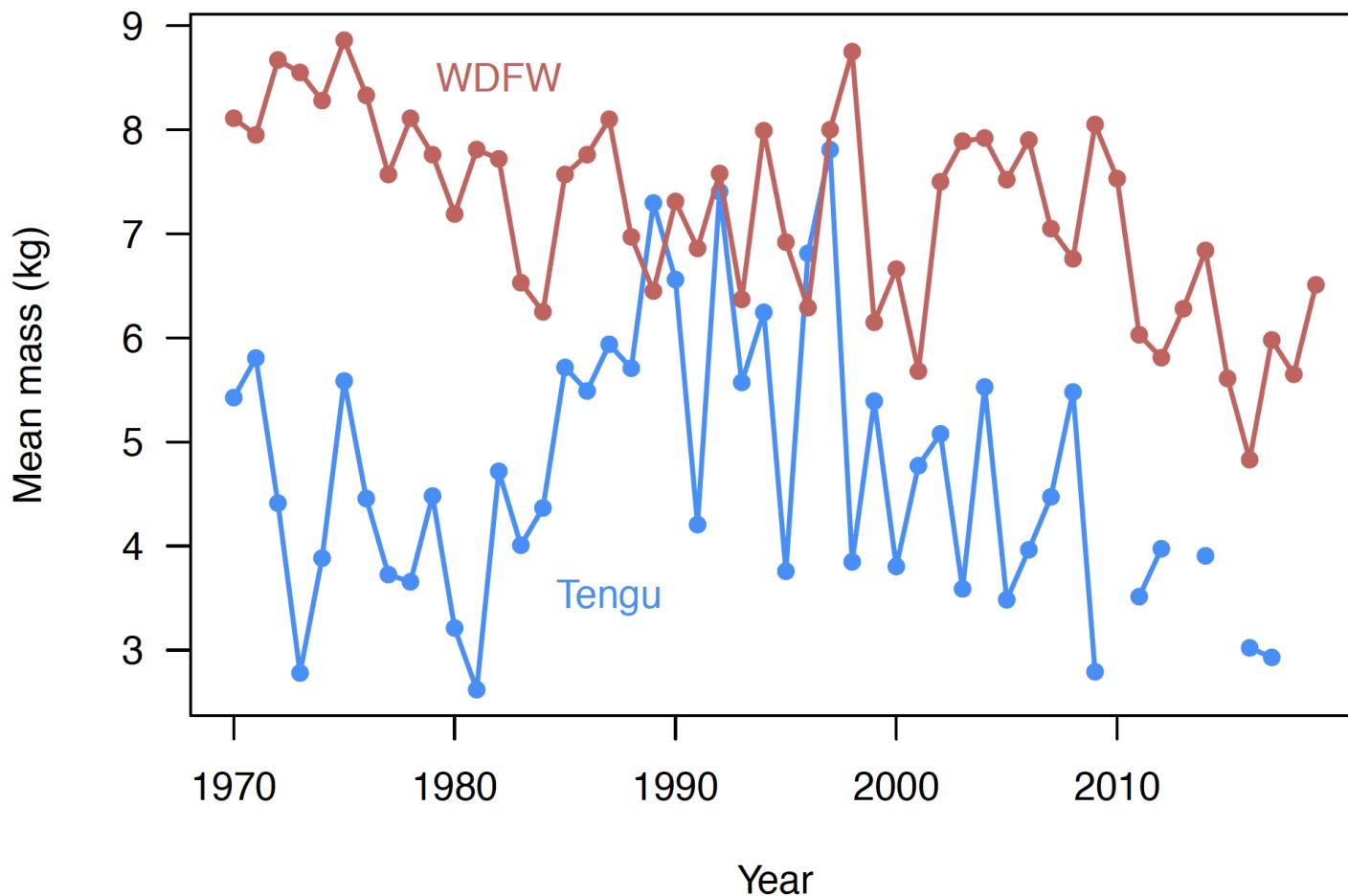
True size follows a random walk



Comparison of derby & WDFW size data



Sizes from derby & purse seine fishery



Model forms

One common state

$$x_t = x_{t-1} + u + w_t$$

Two unique states

$$\begin{bmatrix} x_{\text{Tengu}} \\ x_{\text{WDFW}} \end{bmatrix}_t = \begin{bmatrix} x_{\text{Tengu}} \\ x_{\text{WDFW}} \end{bmatrix}_{t-1} + \begin{bmatrix} u_{\text{Tengu}} \\ u_{\text{WDFW}} \end{bmatrix} + \begin{bmatrix} w_{\text{Tengu}} \\ w_{\text{WDFW}} \end{bmatrix}_t$$

Model forms

One common state

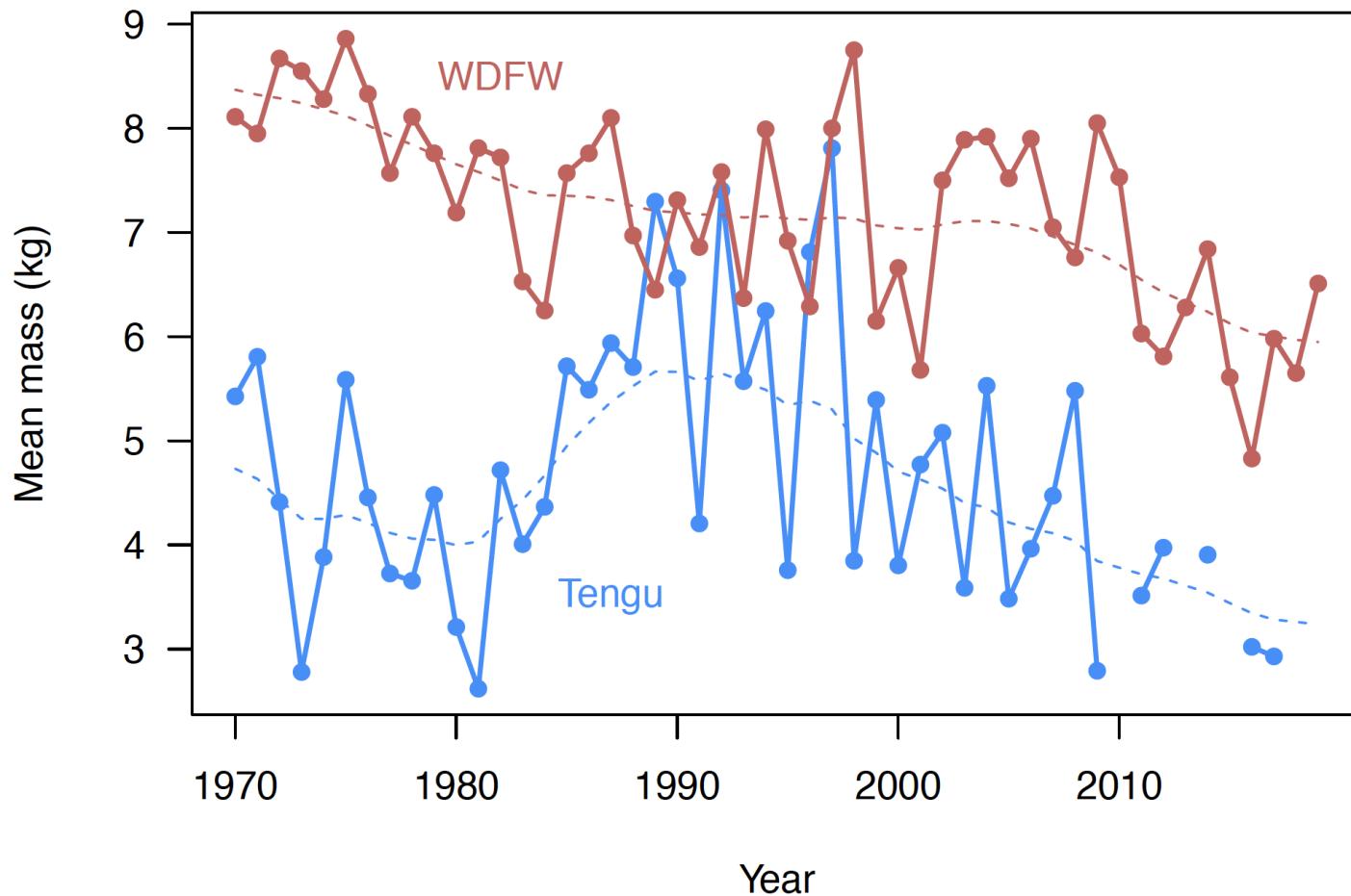
$$x_t = x_{t-1} + u + w_t$$

Two unique states

$$\begin{bmatrix} x_{\text{Tengu}} \\ x_{\text{WDFW}} \end{bmatrix}_t = \begin{bmatrix} x_{\text{Tengu}} \\ x_{\text{WDFW}} \end{bmatrix}_{t-1} + \begin{bmatrix} u \\ u \end{bmatrix} + \begin{bmatrix} w_{\text{Tengu}} \\ w_{\text{WDFW}} \end{bmatrix}_t$$

The data support two unique states with a common decline of ~0.4% per year

Estimated trends in sizes



Chinook salmon from common origins with different migration patterns show different patterns in size

Big picture

Differences in size suggest something unique going on in Puget Sound relative to Pacific Ocean

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Differences in size suggest something unique going on in Puget Sound relative to Pacific Ocean

Tengu Club's meticulous record keeping & willingness to collaborate offered unprecedented analysis

Image credits

Camp Harmony: *MOHAI*

Blackmouth: *WDFW*

Tengu artwork: *Utagawa Kuniyoshi*

Mooching setup: *Andrew Moravec*

Tengu derby: *Tom Quinn*

Purse seiner: *Jim Borrow*

Journal article (open access)

<https://doi.org/10.1002/mcf2.10205>

Open science

<https://github.com/mdscheuerell/tengu>

Presentation

<https://github.com/mdscheuerell/tengu/presentation>