SOCKEYE SALMON RETURNS FOR EARLY STEWART STOCK 2023

GROUP 1

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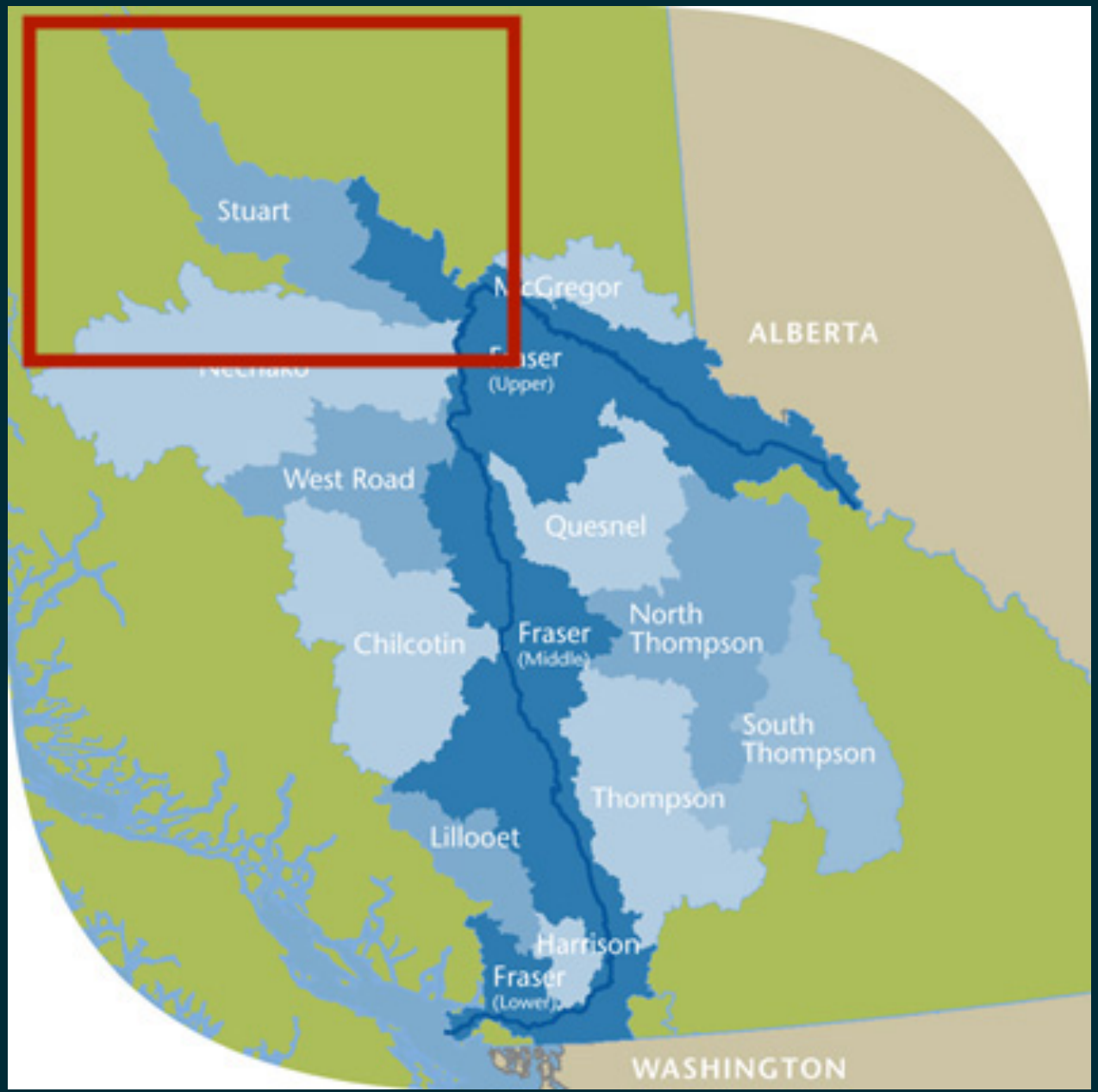
SOCKEYE SALMON

Fraser River Watershed



Early Stuart Stock

1. BASIC RICKER MODEL

Consider the following model:

$$R_i = \alpha S_i e^{-\beta S_i} \qquad (1)$$

population growth (α) and carrying capacity (β)

We can linearize to obtain simpler parameters:

$$\ln(R_i) = \ln(\alpha) + \ln(S_i) - S_i/S_{max} \qquad (2)$$

We place priors on the following:

$$\ln(\alpha) \sim \text{normal}(\mu_\alpha, \tau\alpha) \qquad (3)$$

$$\ln(S\_max) \sim \text{normal}(\mu_{Smax}, \tau_{Smax}) \qquad (4)$$

$$\tau \sim \text{gamma}(\theta, \theta) \qquad (5)$$

2. ALTERNATE MODELS

Power Model

Power Model with environmental covariate

ALTERNATE 1: POWER MODEL

based on the assumption that log(recruiters) depends on log(spawners)

$$R_i = e^A S_i^B \qquad (6)$$

We can linearize equation 10 to the following:

$$\ln(R_i) = A + B * \ln(S_i) \qquad (7)$$

This model form has normal priors for both A and B:

$$\mathrm{A} \sim \mathrm{normal}(\mu_{\mathrm{A}}, \tau_{\mathrm{A}}) \qquad (8)$$

$$\mathrm{B} \sim \mathrm{normal}(\mu_{\mathrm{B}}, \tau_{\mathrm{B}}) \qquad (9)$$

And the same gamma prior on precision as the above models (equation 6).

ALTERNATE 2: POWER MODEL WITH TEMPERATURE COVARIATE

This alternate model is an extension to the previous power model that includes the average sea surface temperatures as an environmental covariate:

$$R_i = e^{A+gEsst_i} S_i \qquad (10)$$

We can linearize this as the following:

$$\ln(R_i) = A + B * \ln(S_i) + gEsst_i \qquad (11)$$

We used the same priors for A, B, as previous above models and a normal (flat) prior for g:

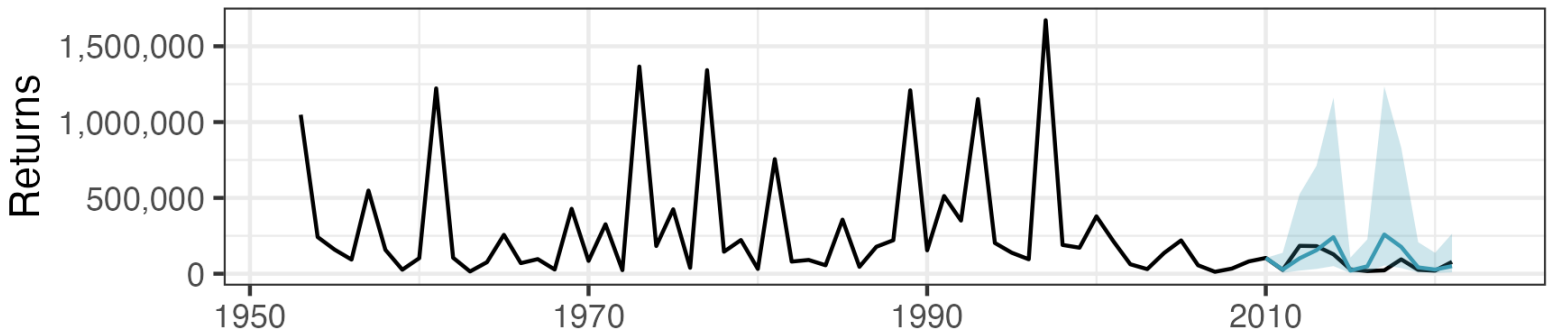
$$g \sim \text{normal}(\mu_g, \tau_g) \qquad (12)$$

3. MODEL COMPARISONS

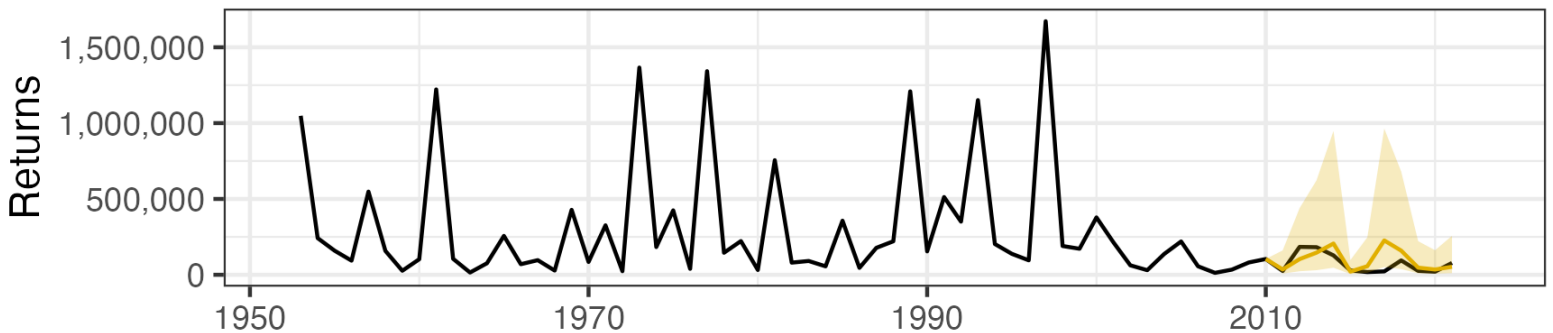
CREATE RETROACTIVE PREDICTIONS

We used our models to predict recruits in years 2011-2021, then check against real data to assess model performance.

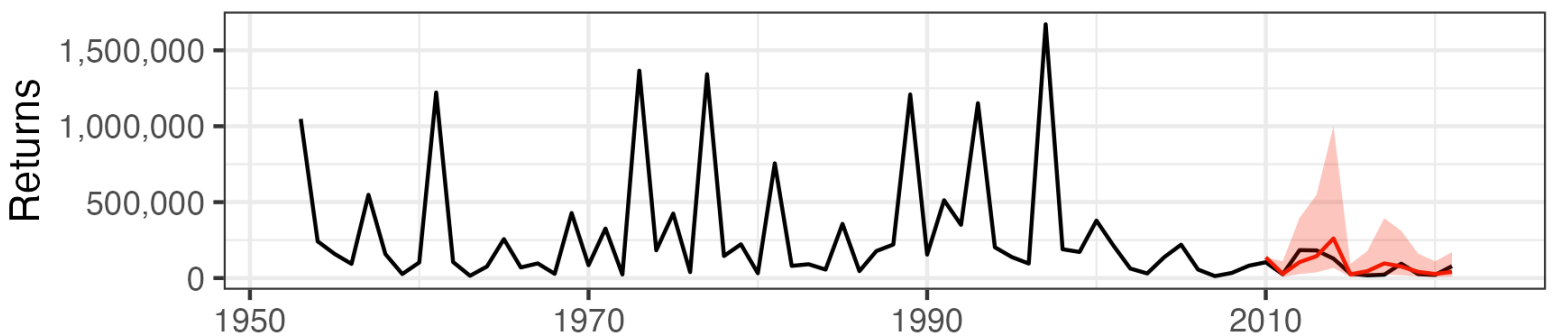
Ricker Model



Power Model

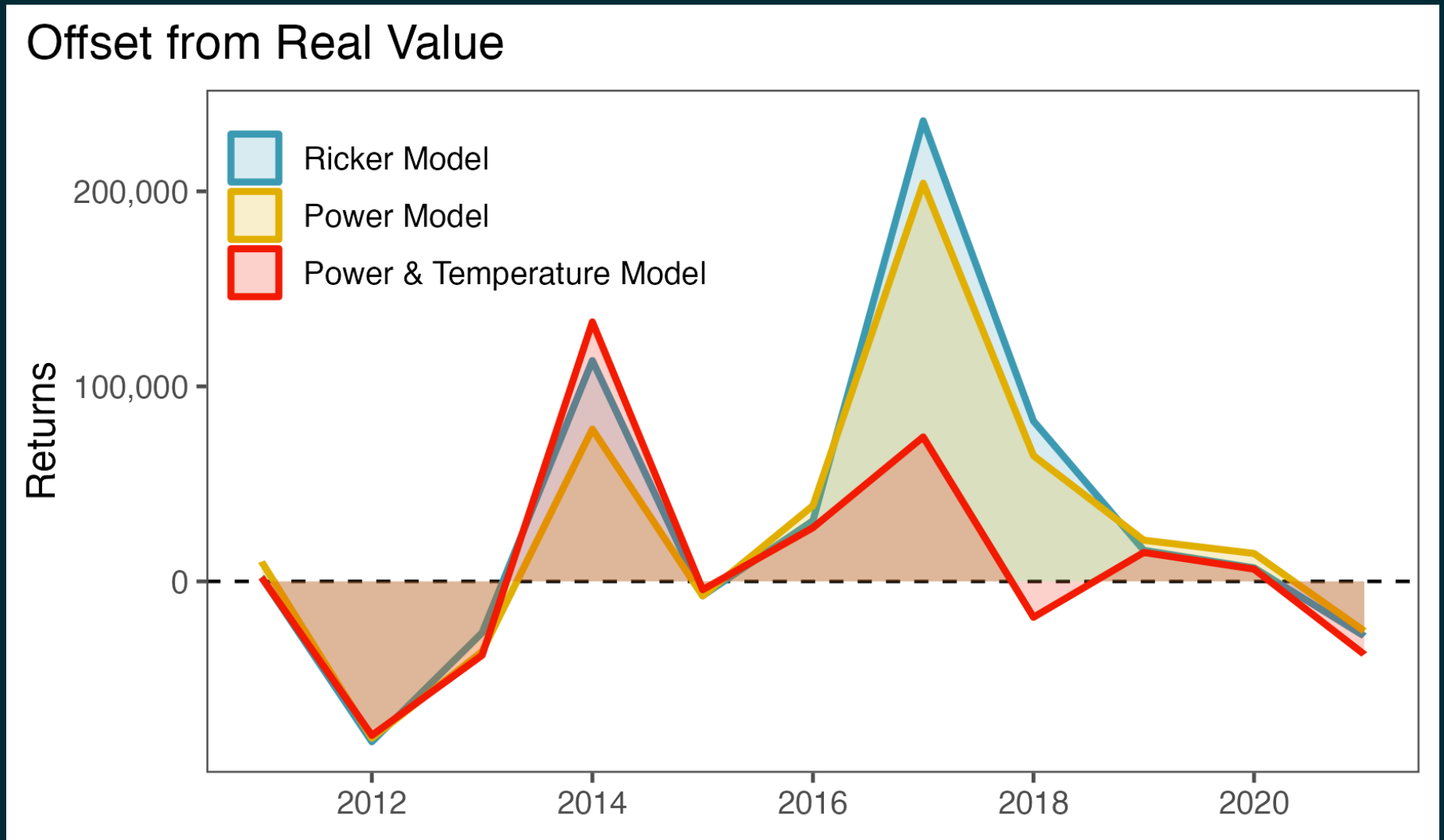


Power & Temperature Model



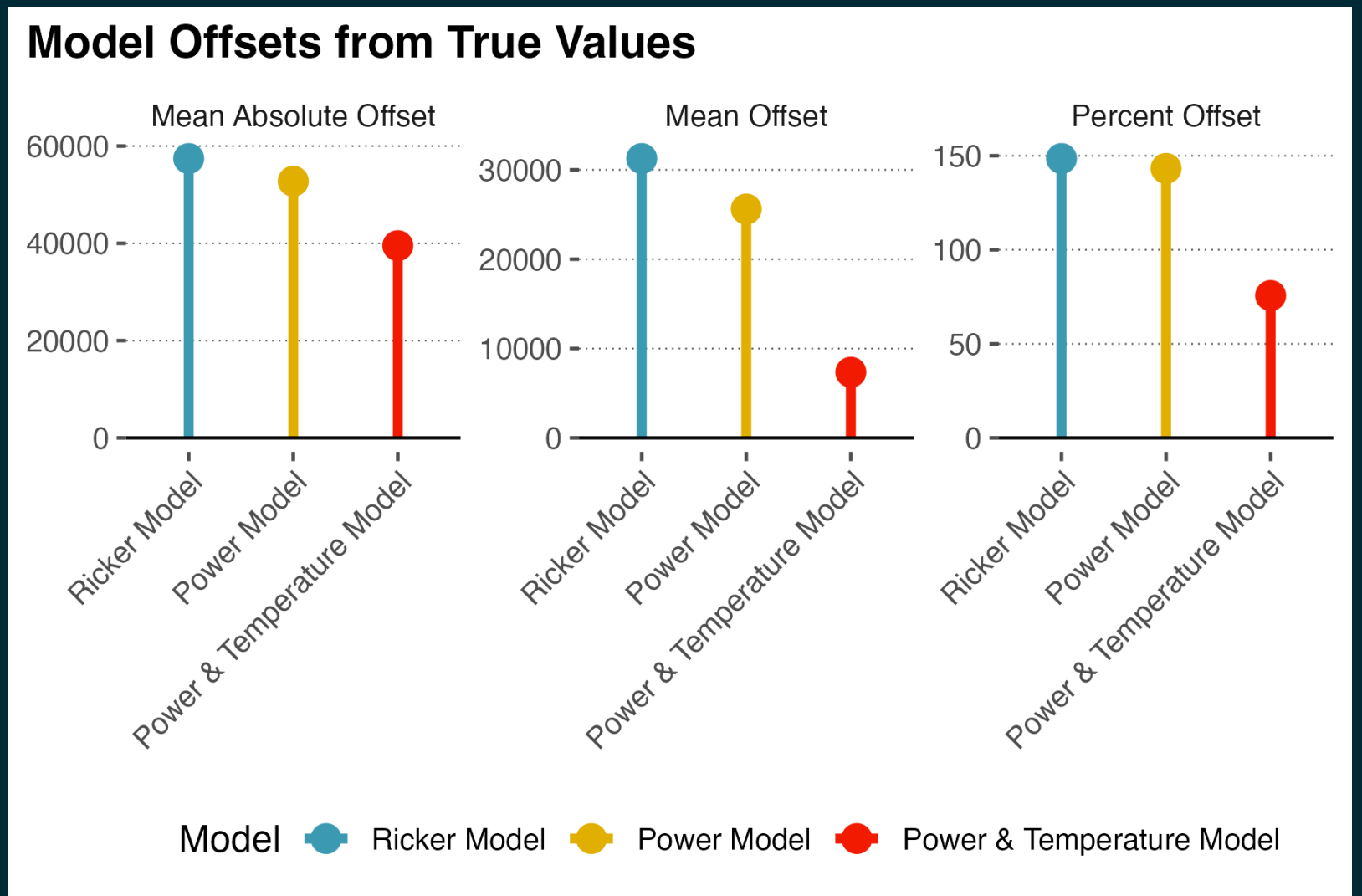
PERFORMANCE METRICS

Metric 1: Offset from true prediction



PERFORMANCE METRICS

Metrics 2, 3, & 4:



4. MODEL SUGGESTION

In all performance metrics, our **Power & Temperature Model** performed best.

5. PRACTICE FORECASTS

We proceeded to apply our three forecast models to predict 2022 recruits.

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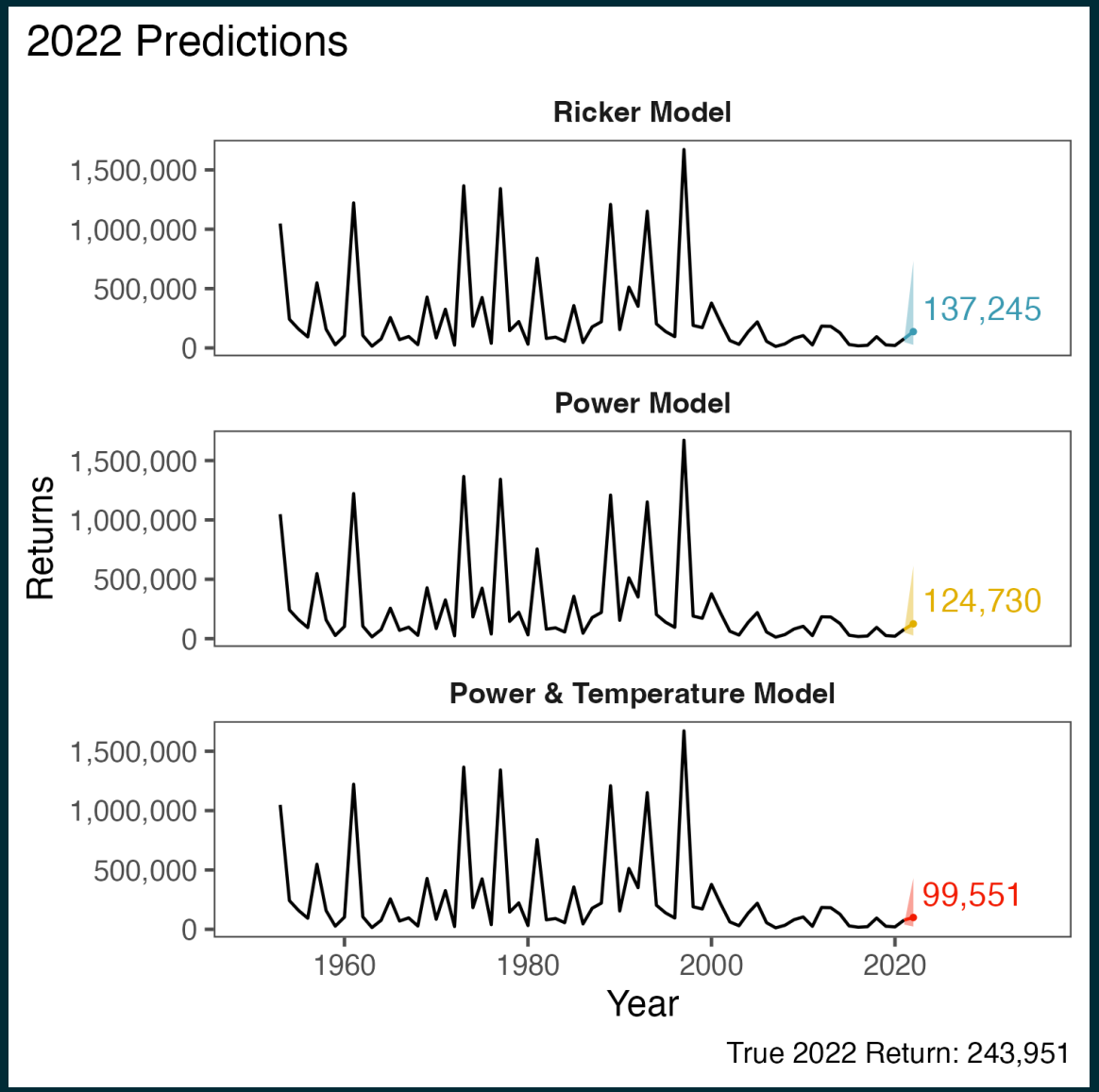
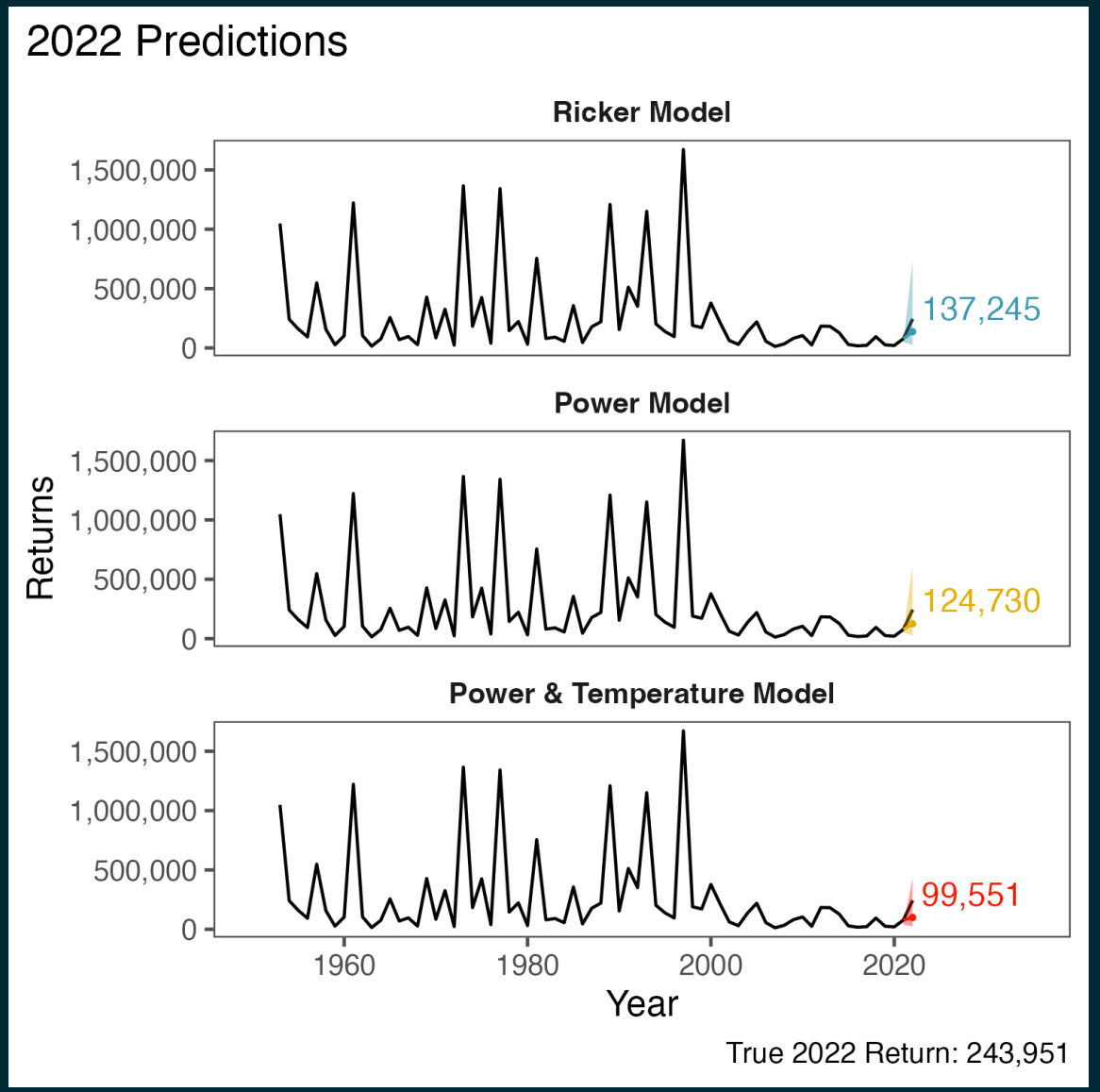


5. PRACTICE FORECASTS



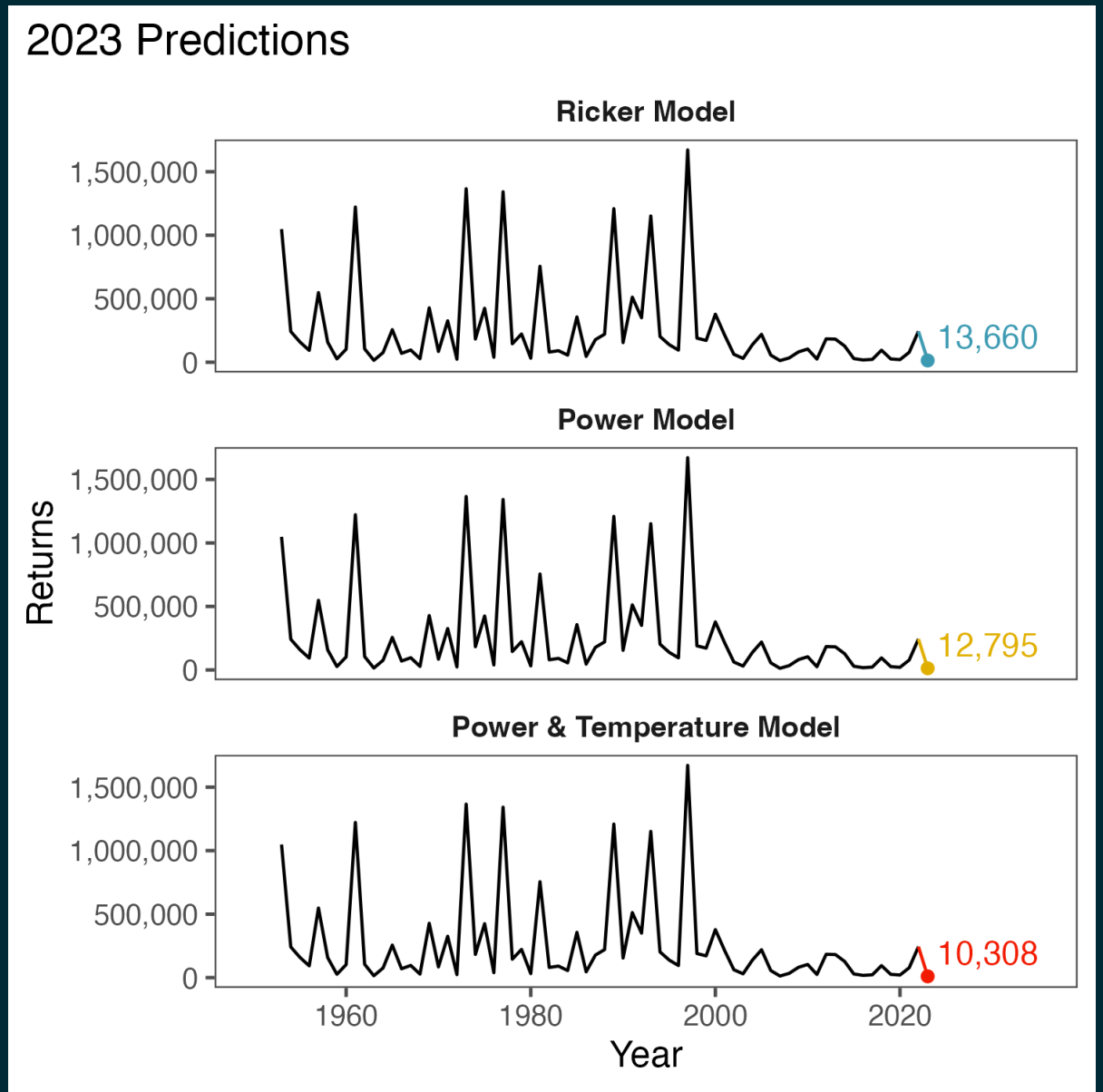
All models slightly under-predicted recruits, but each contained the true value within uncertainty shadow.

i.e., forecasts are *okay*.

6. FORECAST 2023

Seeing that our forecasts were reasonable so far, we used our models to predict recruits in 2023.

6. FORECAST THE FUTURE



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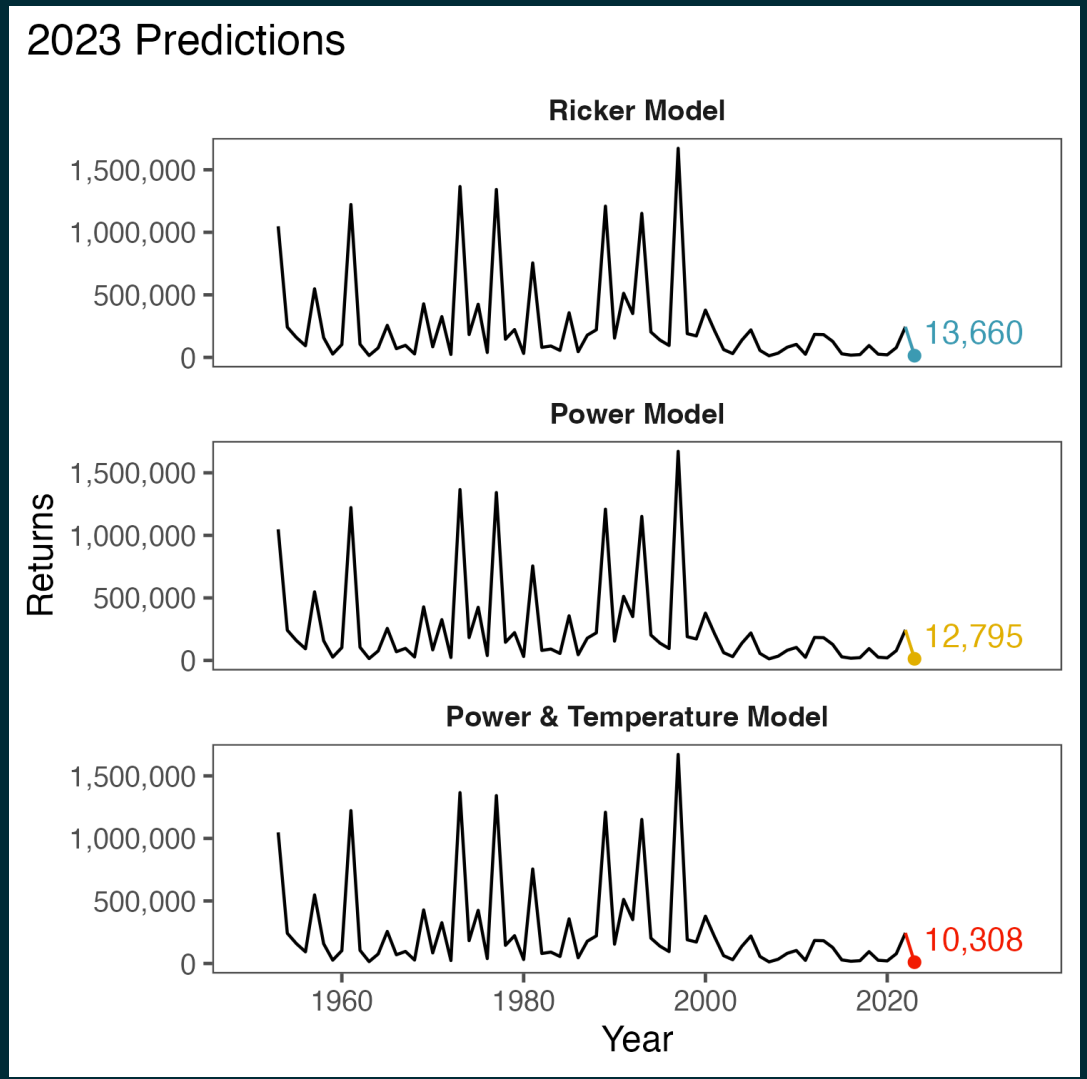
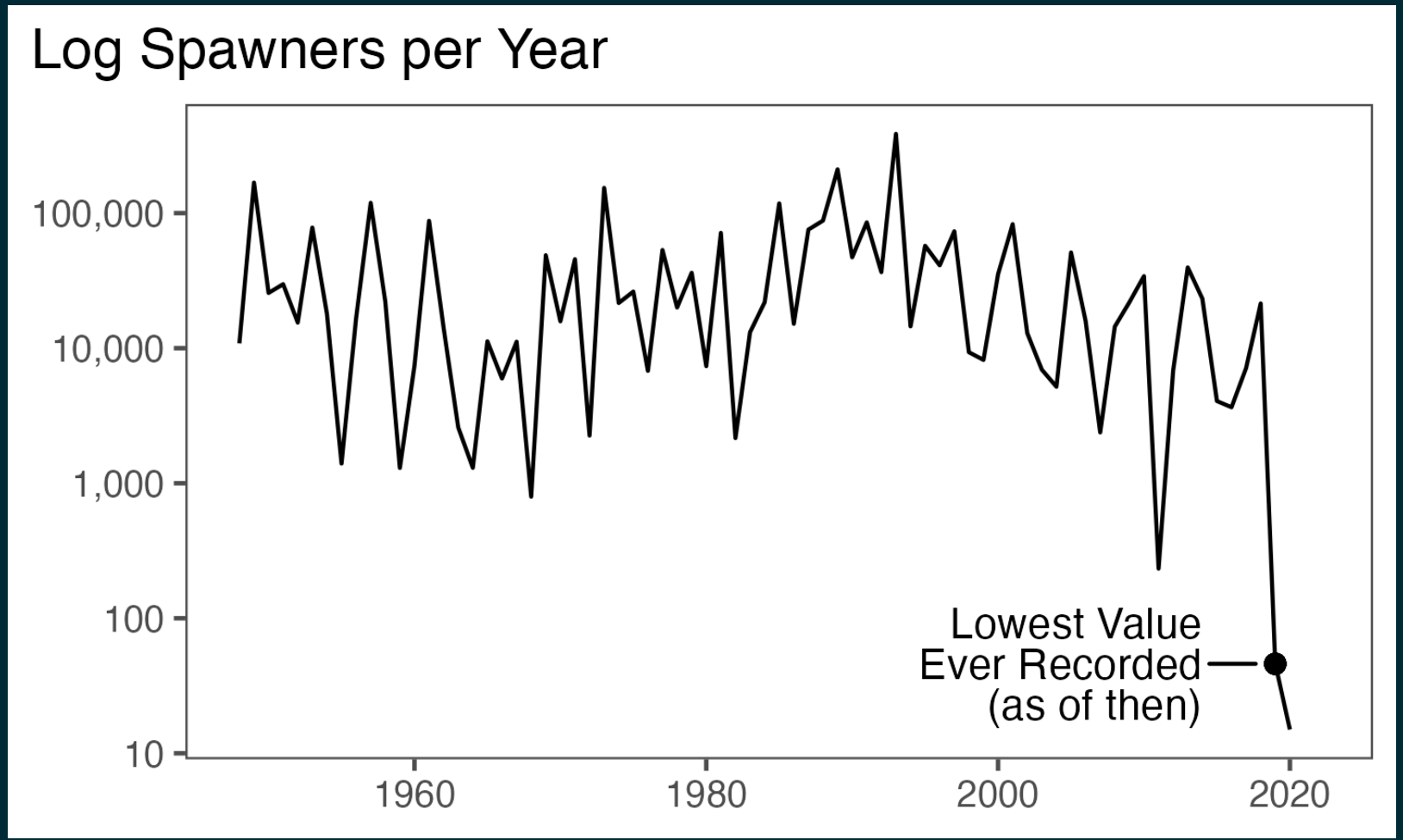


PANIC! - why are predicted values so low??

6.2 INVESTIGATE UNEXPECTED PREDICTIONS

We investigated model parameters to identify reasons our predictions were so low. The temperature covariate model is lowest, but all 3 values are low, indicating a probable *anomaly in the S (spawners) variable*.

6.2 INVESTIGATE UNEXPECTED PREDICTIONS



2019 spawners dip will likely affect 2023 Returns. Could this spawner count really be so low??

6.2 INVESTIGATE UNEXPECTED PREDICTIONS

yes.

Canada.ca › Fisheries and Oceans Canada › Pacific Region › Pacific salmon

Big Bar landslide response

The Big Bar landslide, located on a remote section of the Fraser River, 64 kilometres north of Lillooet, British Columbia, created a barrier to the vital seasonal northward Fraser salmon migration. In partnership with First Nations and the Province of BC, we are working towards restoring sustainable fish passage for future salmon returns.

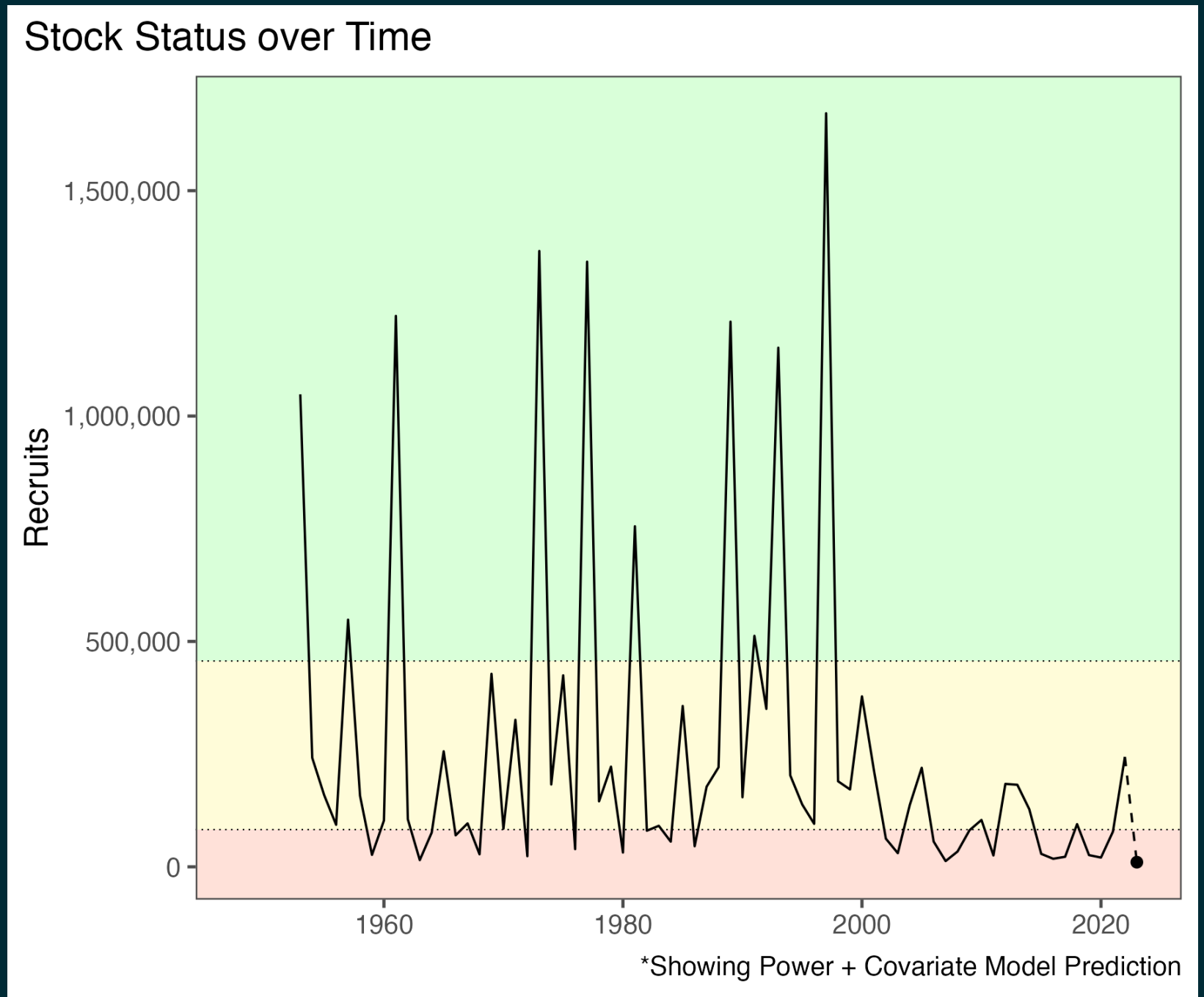
Follow:

Considering this, our projected low values of 2023 recruits are reasonable (read: not an error on our part).

ASSESSMENT OF STOCK

Compared to global historical mean

- **Yellow** = prediction within +/-0.5sd of global historical mean
- **Green** = prediction larger than global historical mean by more than +0.5sd
- **Red** = prediction smaller than global historical mean by more than -0.5sd


Stock Status over Time
Recruits
1,500,000
1,000,000
500,000
0
1960
1980
2000
2020
*Showing Power + Covariate Model Prediction

LIMIT FISHING TO THE EXTENT POSSIBLE