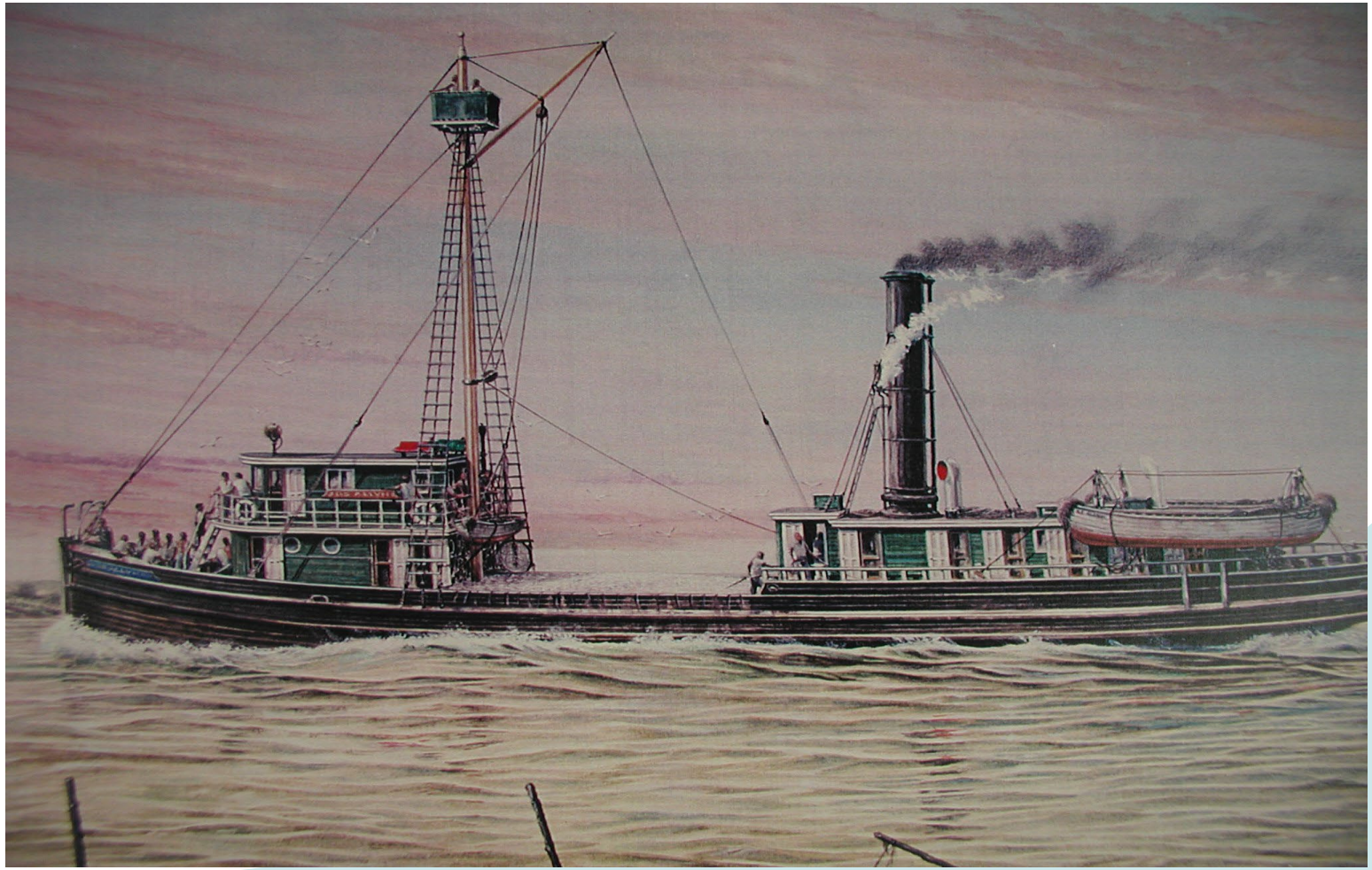
Forecasting Fisheries: Working to Improve the Gulf menhaden Forecast



Ray Mroch
Beaufort Laboratory

GSMFC Annual Meeting
October, 2024

Gulf Menhaden (*Brevoortia patronus*)

- *Pogie, Mossbunker, Bunker, Fatback, Bugfish, Bugmouth*
- Gulf menhaden
  - Maximum: Size 300mmFL, Weight 550g, Age 6y
  - Yucatan Peninsula to Tampa, Florida
- Fishery
  - Not very tasty
  - Not much record of it prior to the 20th Century
  - Harvested for processing to meal, oil, and solubles

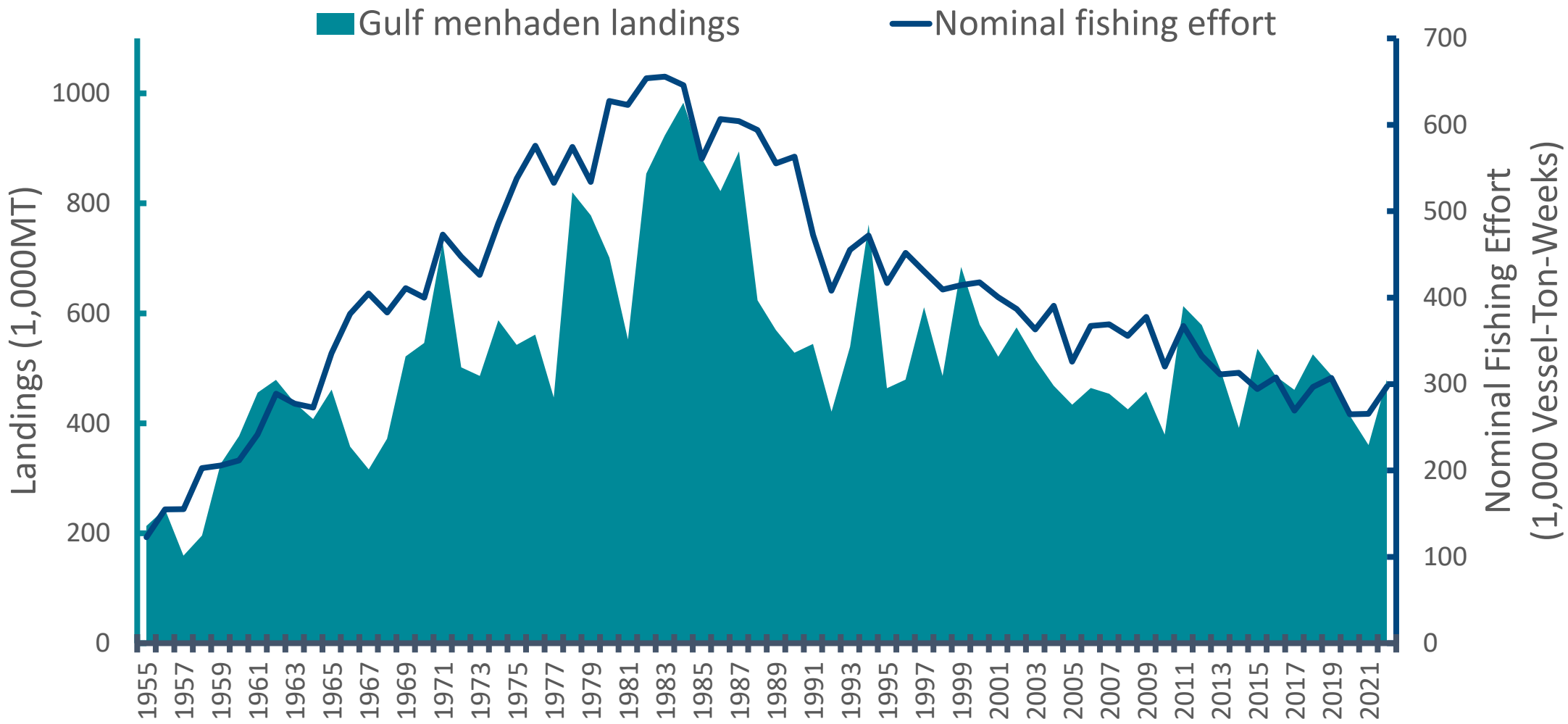
The Fishery

- Gulf menhaden reduction fishery is the second-largest fishery in the United States (by weight)
- Harvested mostly for reduction by purse seine

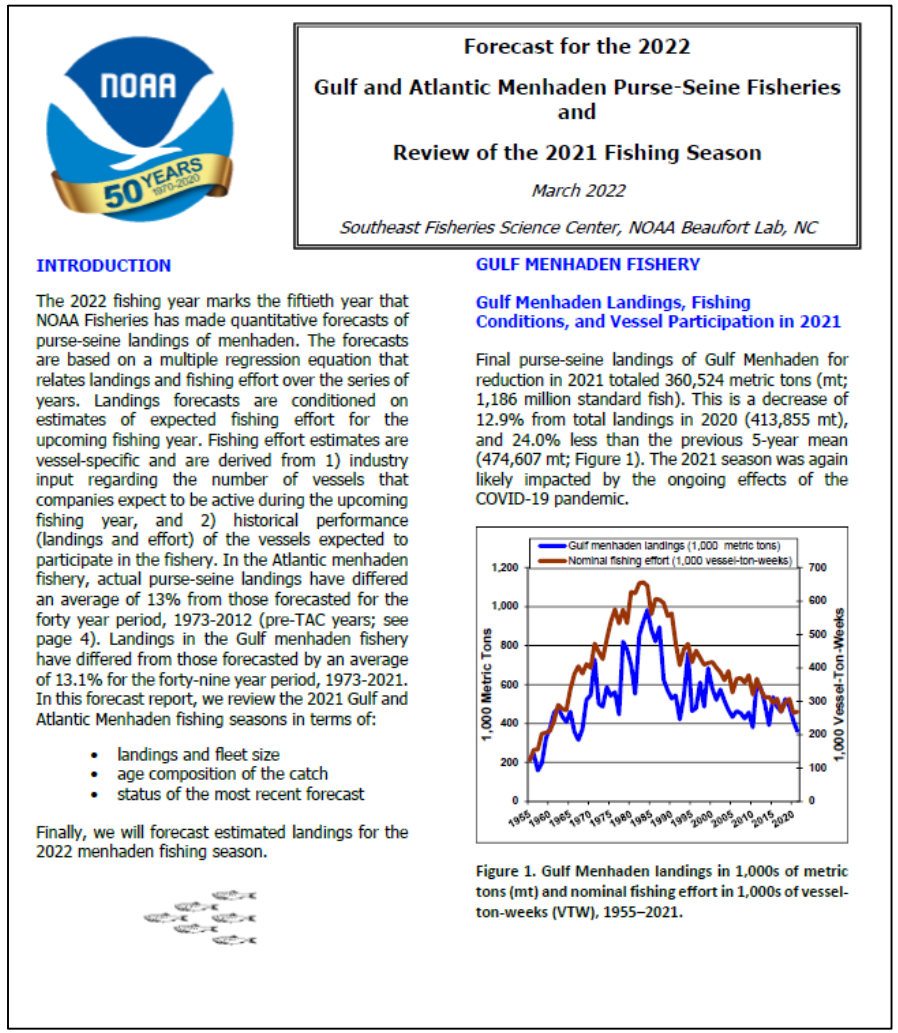
The Fishery, continued

- Menhaden vessels, or “Steamers”
  - 50-60m long, ~14 crew
- Purse boats
  - 9-12m, 4-5 crew

Gulf Menhaden Fishery, continued



Gulf Menhaden Forecast



Forecast for the 2022

Gulf and Atlantic Menhaden Purse-Seine Fisheries and

Review of the 2021 Fishing Season

March 2022

Southeast Fisheries Science Center, NOAA Beaufort Lab, NC

INTRODUCTION

The 2022 fishing year marks the fiftieth year that NOAA Fisheries has made quantitative forecasts of purse-seine landings of menhaden. The forecasts are based on a multiple regression equation that relates landings and fishing effort over the series of years. Landings forecasts are conditioned on estimates of expected fishing effort for the upcoming fishing year. Fishing effort estimates are vessel-specific and are derived from 1) industry input regarding the number of vessels that companies expect to be active during the upcoming fishing year, and 2) historical performance (landings and effort) of the vessels expected to participate in the fishery. In the Atlantic menhaden fishery, actual purse-seine landings have differed an average of 13% from those forecasted for the forty year period, 1973-2012 (pre-TAC years; see page 4). Landings in the Gulf menhaden fishery have differed from those forecasted by an average of 13.1% for the forty-nine year period, 1973-2021. In this forecast report, we review the 2021 Gulf and Atlantic Menhaden fishing seasons in terms of:

- landings and fleet size
- age composition of the catch
- status of the most recent forecast

Finally, we will forecast estimated landings for the 2022 menhaden fishing season.

GULF MENHADEN FISHERY

Gulf Menhaden Landings, Fishing Conditions, and Vessel Participation in 2021

Final purse-seine landings of Gulf Menhaden for reduction in 2021 totaled 360,524 metric tons (mt; 1,186 million standard fish). This is a decrease of 12.9% from total landings in 2020 (413,855 mt), and 24.0% less than the previous 5-year mean (474,607 mt; Figure 1). The 2021 season was again likely impacted by the ongoing effects of the COVID-19 pandemic.

Figure 1. Gulf Menhaden landings in 1,000s of metric tons (mt) and nominal fishing effort in 1,000s of vessel-ton-weeks (VTW), 1955–2021.

- First forecast, 1973
- Published annually
- Multiple regression
  - Current effort estimate
  - Lagged effort
  - Lagged landings

Research Objective

- Improve forecast
- Assess models using RMSE
  - Traditional model variations
  - Moving averages
  - Time series (ARIMA)
    - Univariate
    - Multivariate
    - Effort as input
  - Cobb-Douglas Model

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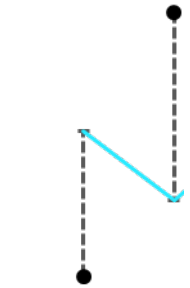

Observed

Predicted

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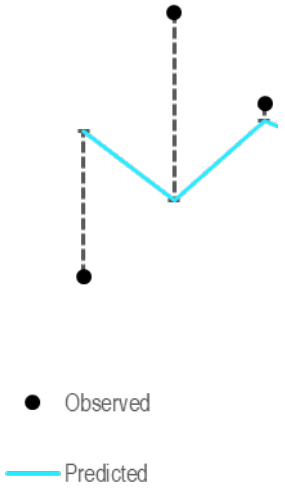

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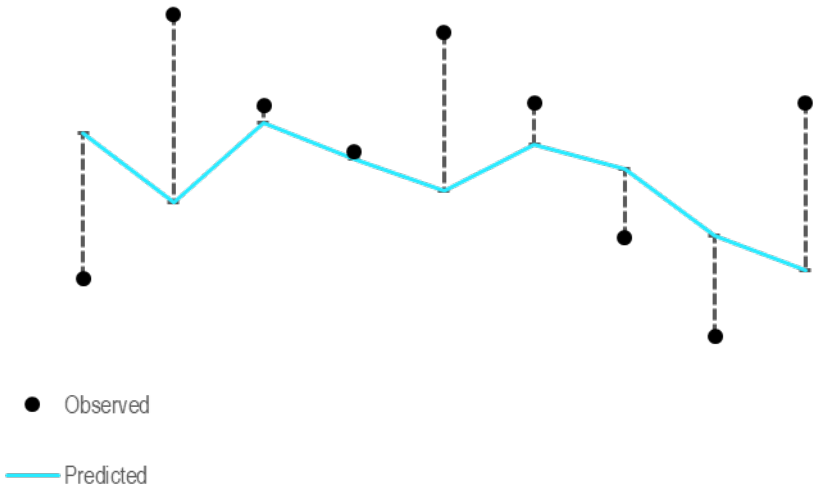

$$RMSE = \sqrt{\frac{\sum(Observed\ -\ Forecasted)^2}{N}}$$

Model

Begin-2015 → 2022

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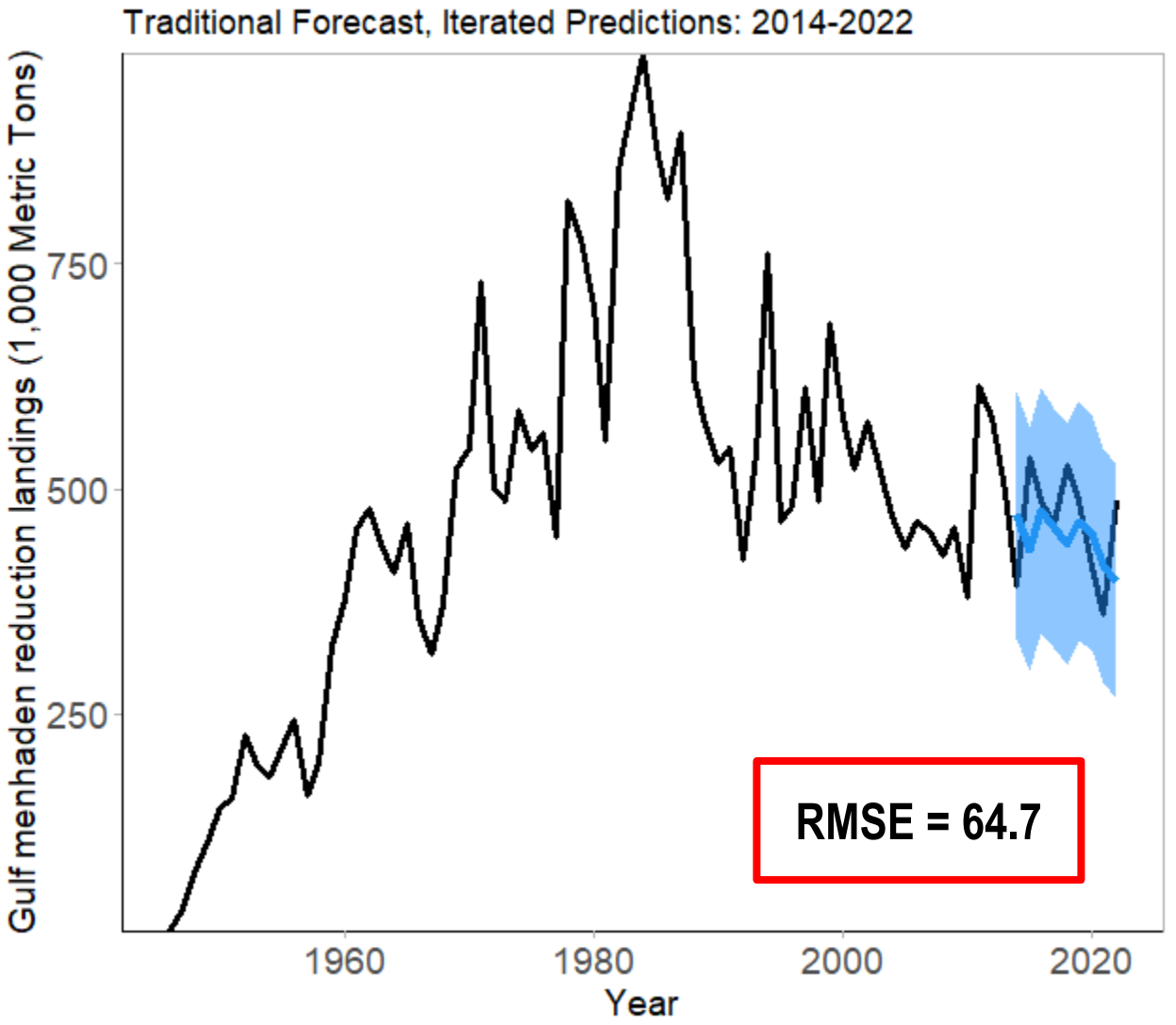

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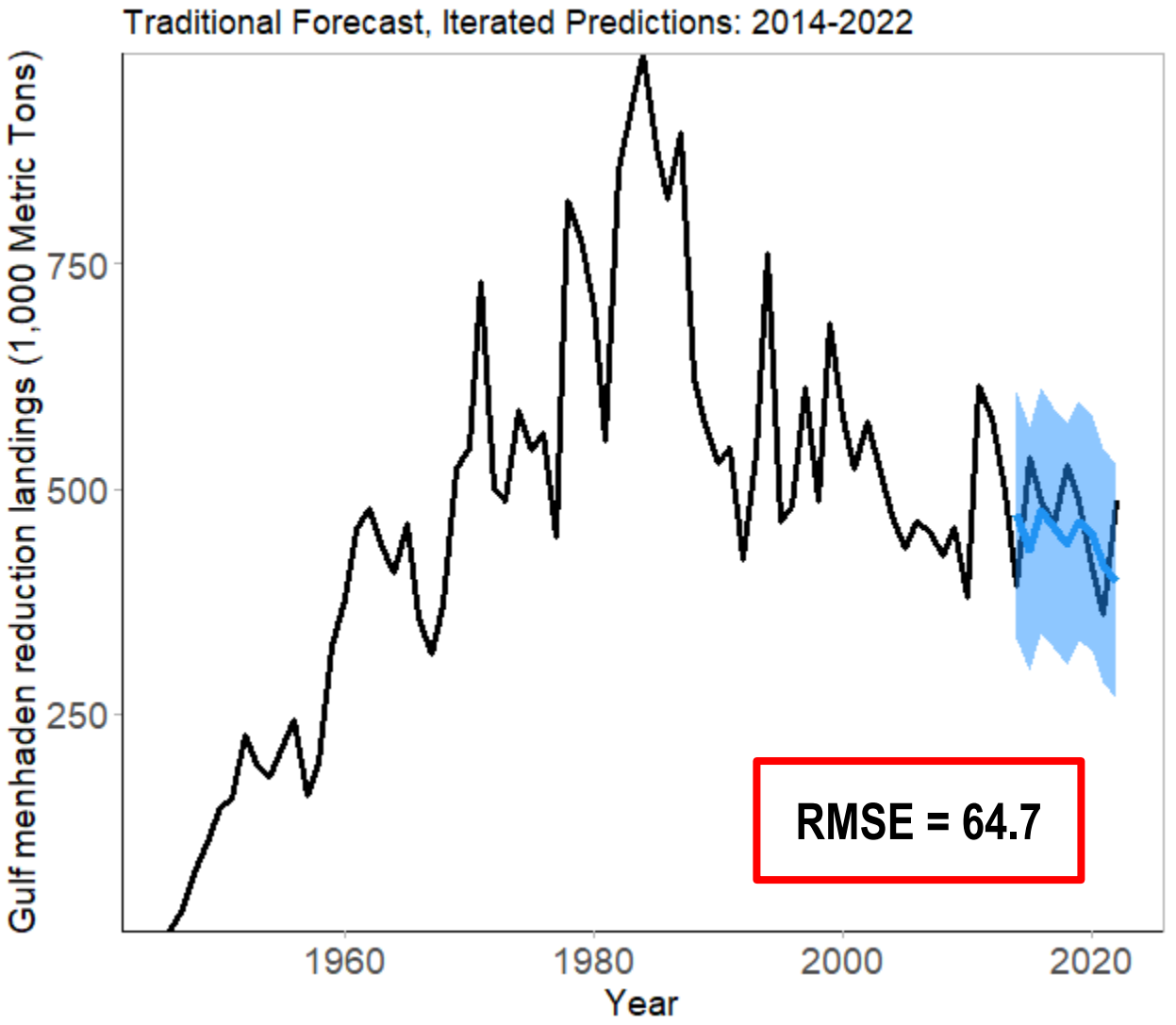

Model Tests

- Improve forecast
- Assess models using RMSE
  - Traditional model [64.7]
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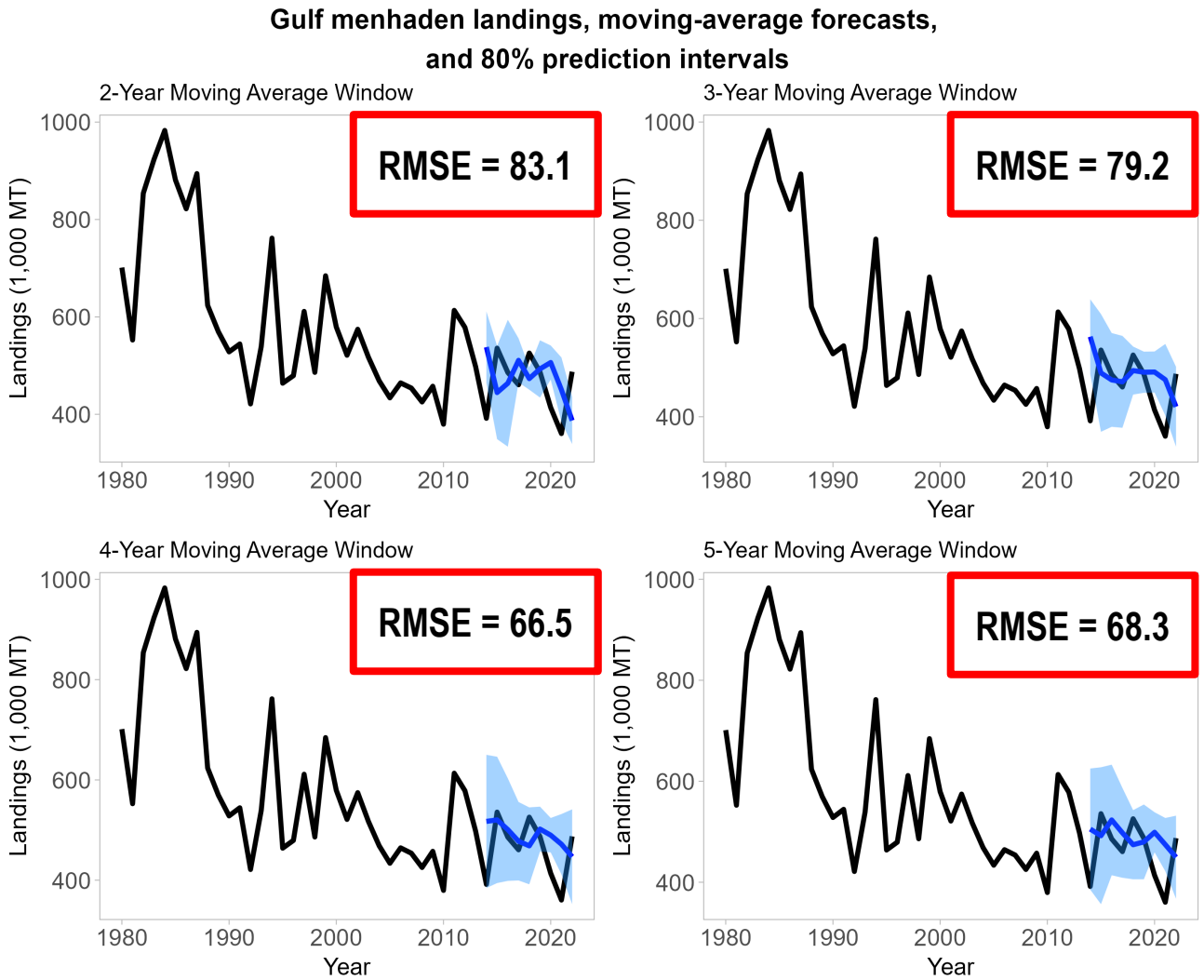

Model Tests

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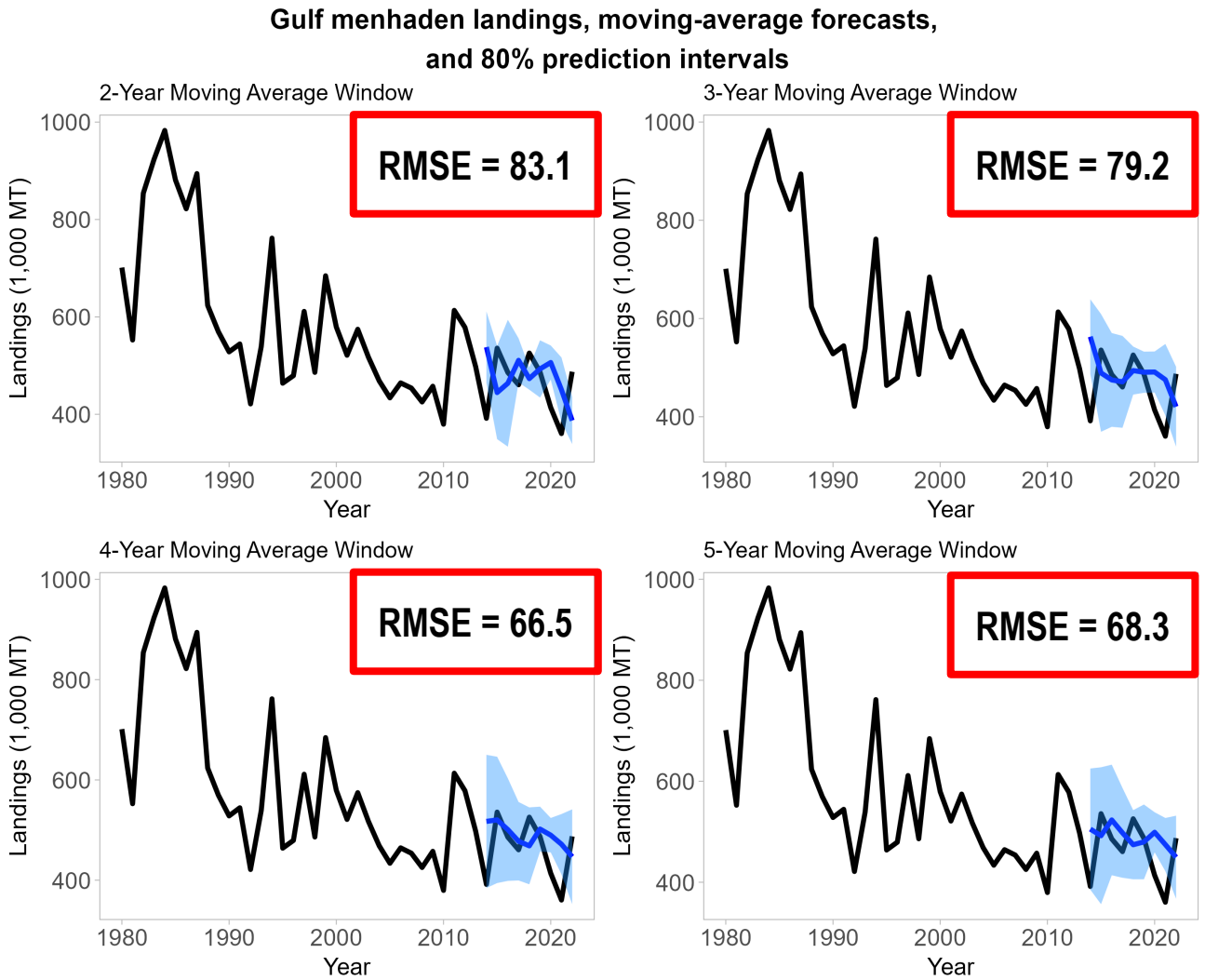

Model Tests

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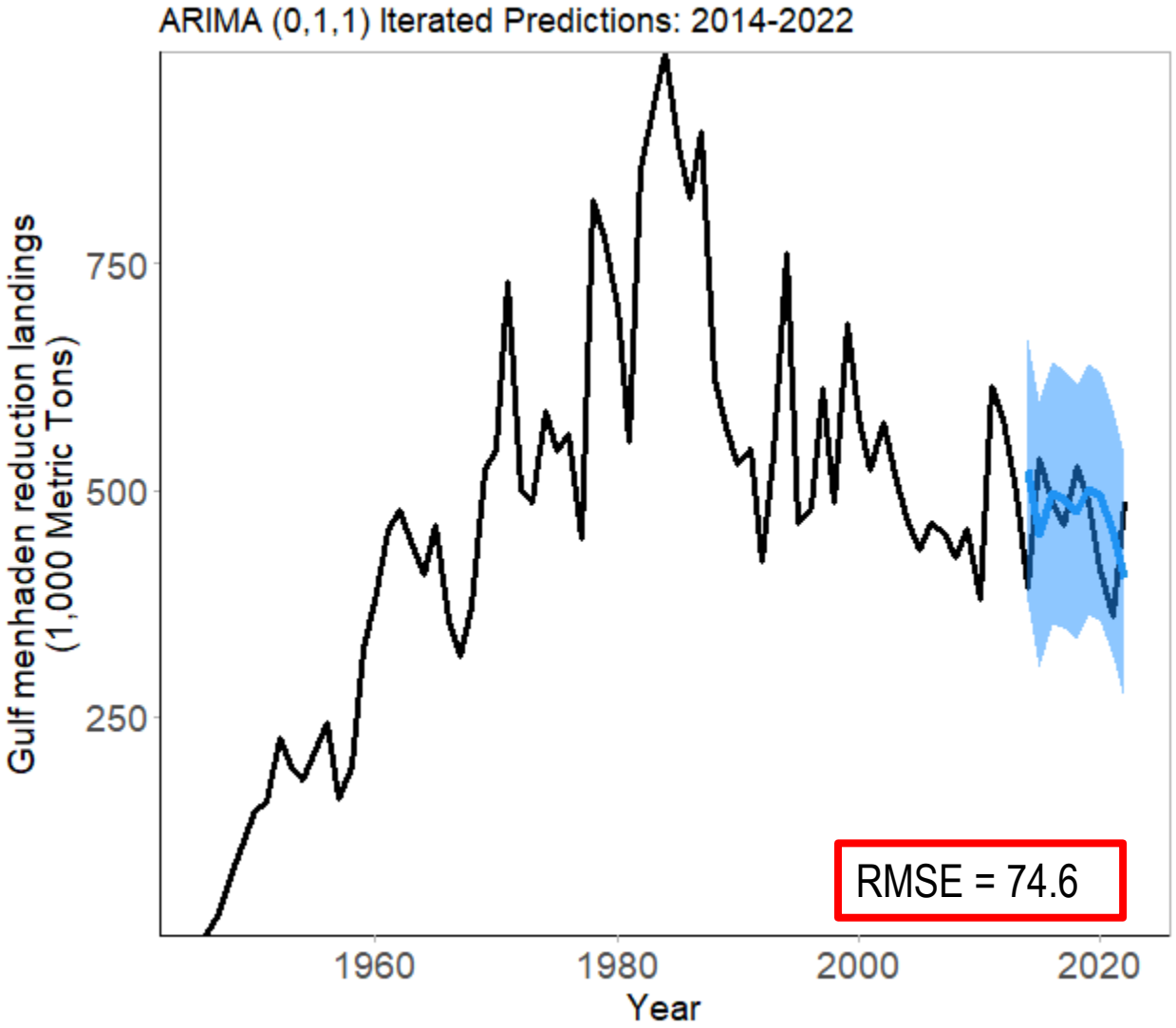

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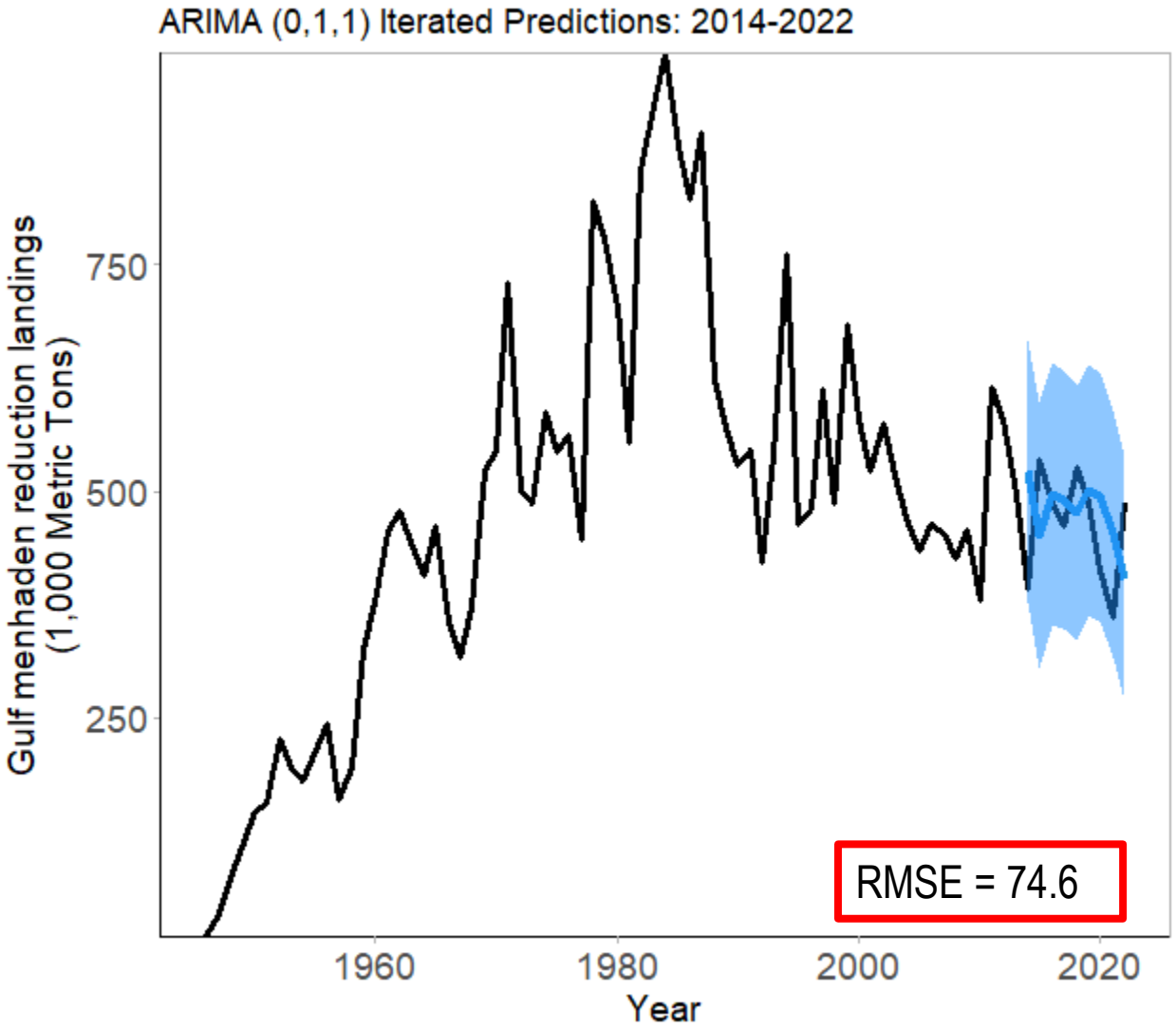
ARIMA Model Order	AIC	RMSE
(1,1,1)	862.3	75.0
(0,1,2)	862.4	75.4
(3,1,2)	863.4	97.3
(2,1,1)	863.4	95.9
(0,1,3)	863.5	85.5
(1,1,2)	864.6	94.4
(3,1,3)	864.8	98.4



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    - Effort as input
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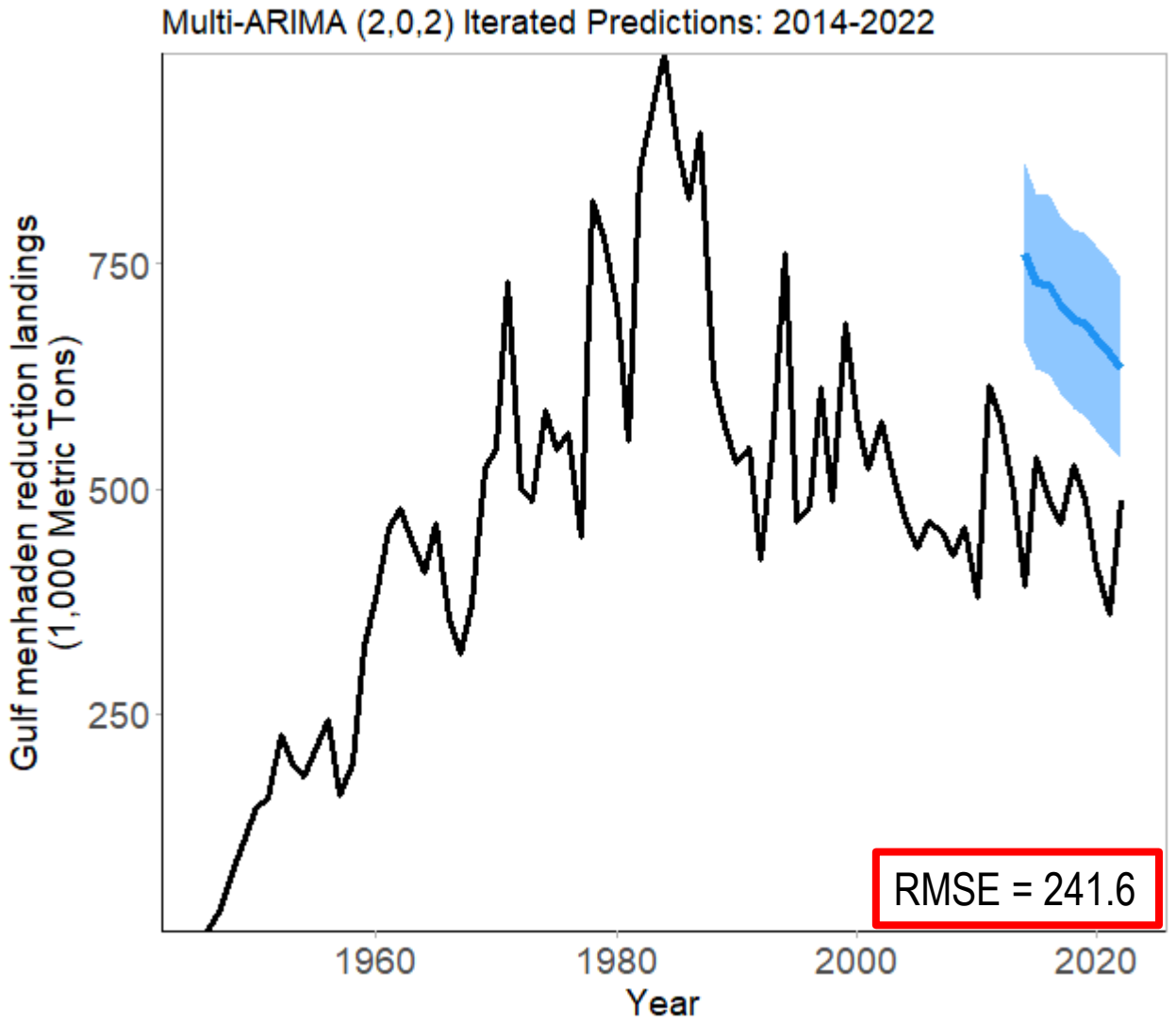

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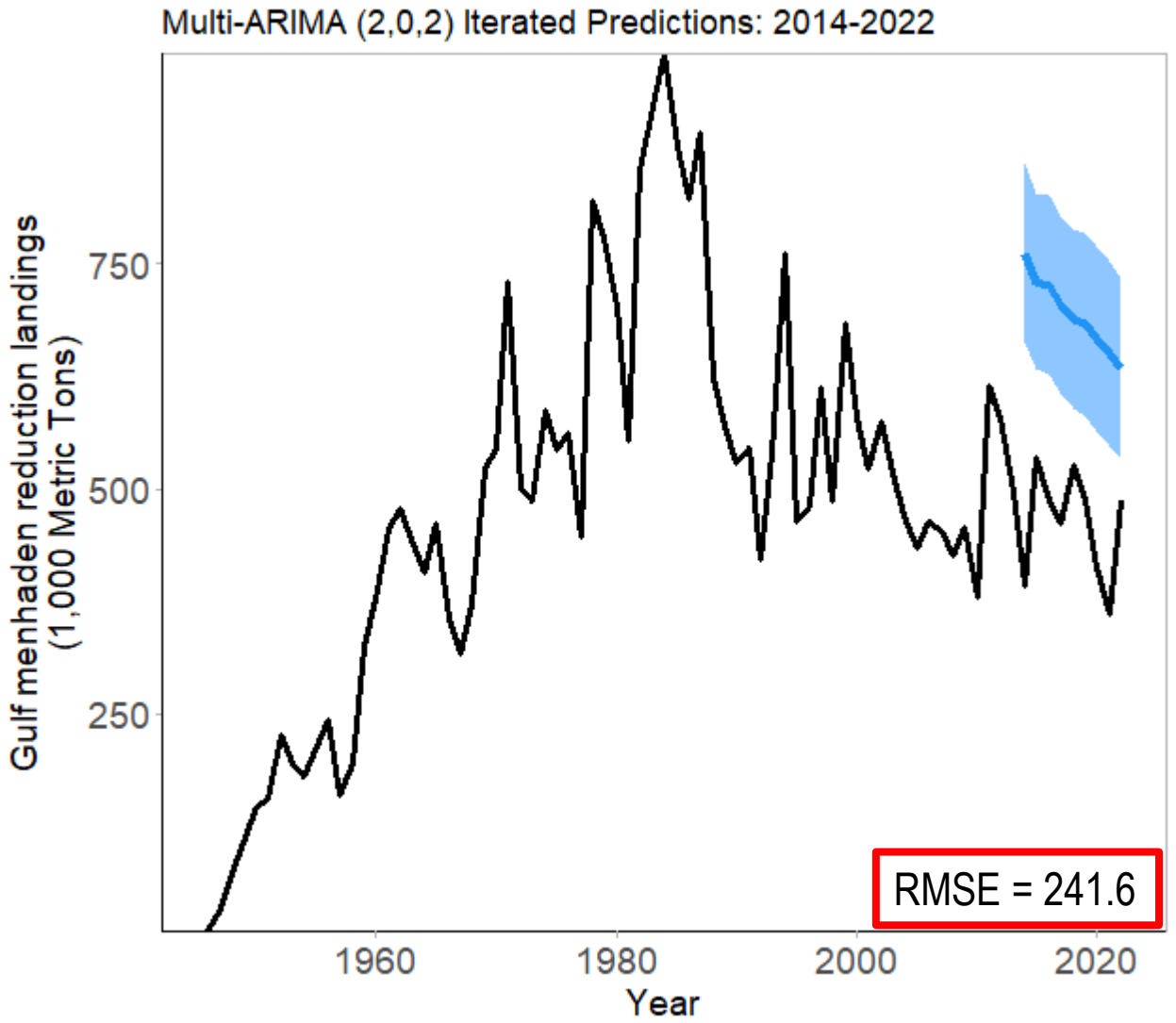

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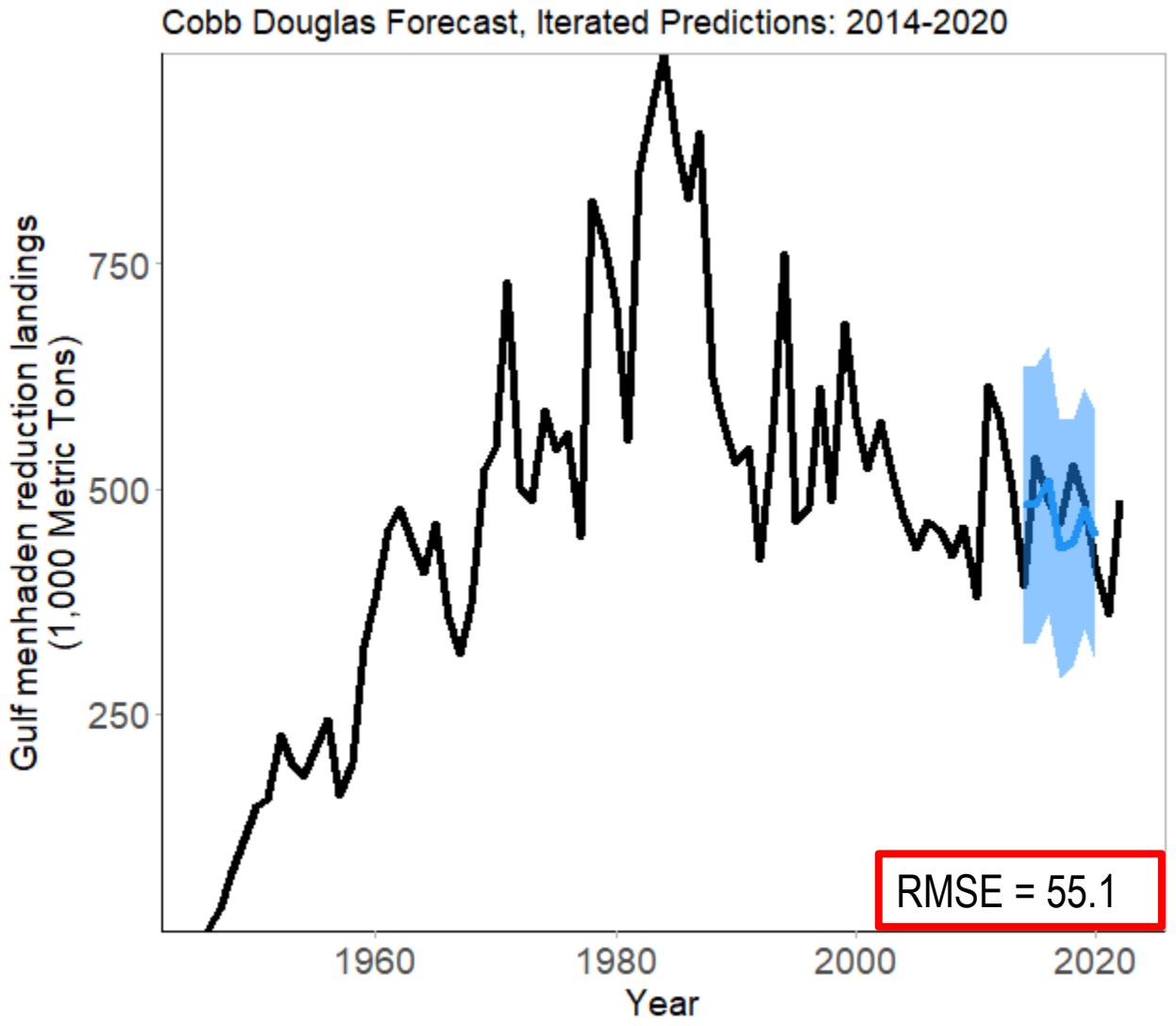
    - Effort as input
  - Cobb-Douglas Model [55.1]
    - Biomass, Effort
    - *E. ringens* landings, Diesel



Cobb-Douglas Model Description

- Cobb-Douglas Model
  - Economics model relating resources (labor, capital, and harvest) to production
  - Used to estimate:
    - How changes to input affect production
    - Efficiency of a process
    - Trade-offs between parameters

$$Y = A * L^{\alpha} * K^{\beta} \ldots$$

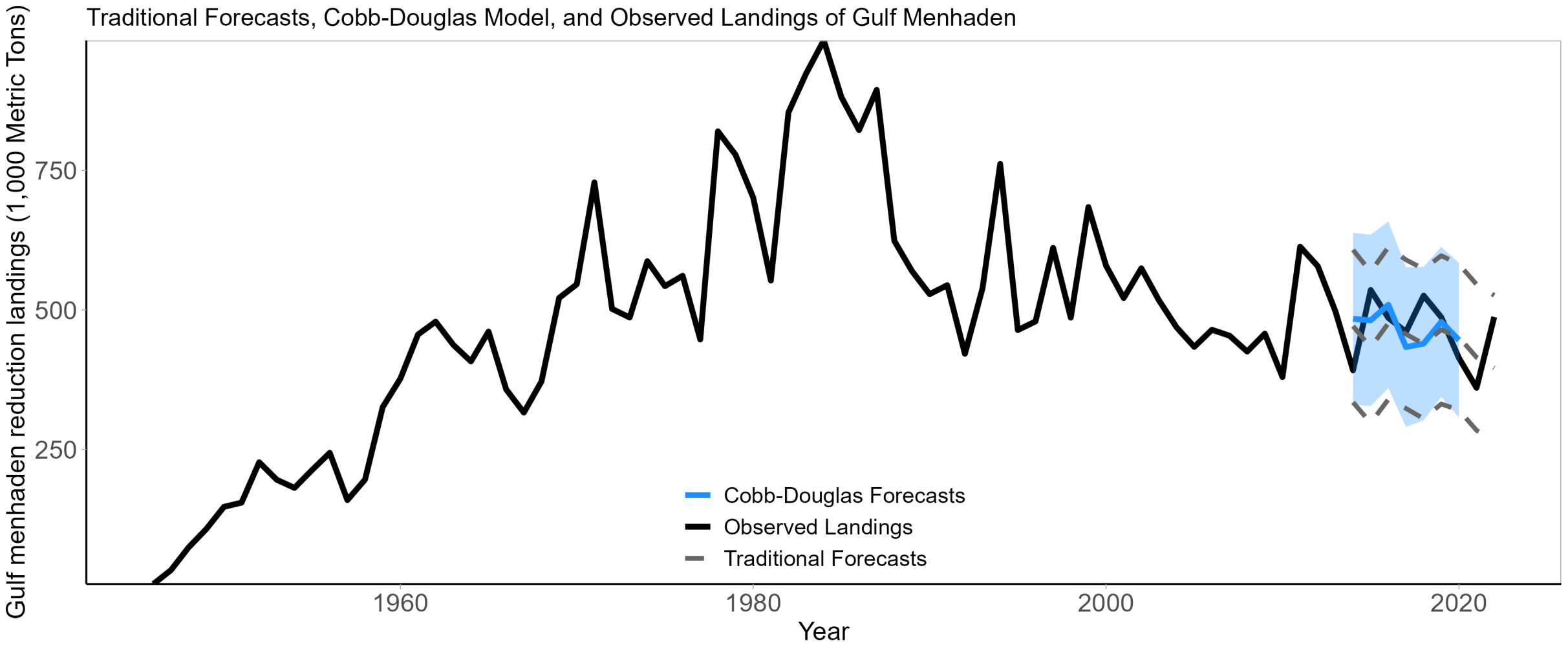
Where:

- Y = Total output
- A = Constant relating to technology (catchability)
- L = Input of first parameter (often Labor)
- K = Input of second parameter (often Capital Investment)
- α and β are output elasticities (the model adjusts these for fit

Cobb-Douglas Model Inputs

- Cobb-Douglas Model Inputs:
  - Gulf menhaden reduction fishing fleet nominal effort in Vessel-Ton-Weeks
  - Gulf menhaden relative spawning stock biomass estimate (GDAR 03)
  - Landings of Peruvian anchovy (*Engraulis ringens, Food and Agriculture Organization of the UN)*
  - Inflation-adjusted diesel fuel prices (US Bureau of Labor and Statistics)

Conclusions

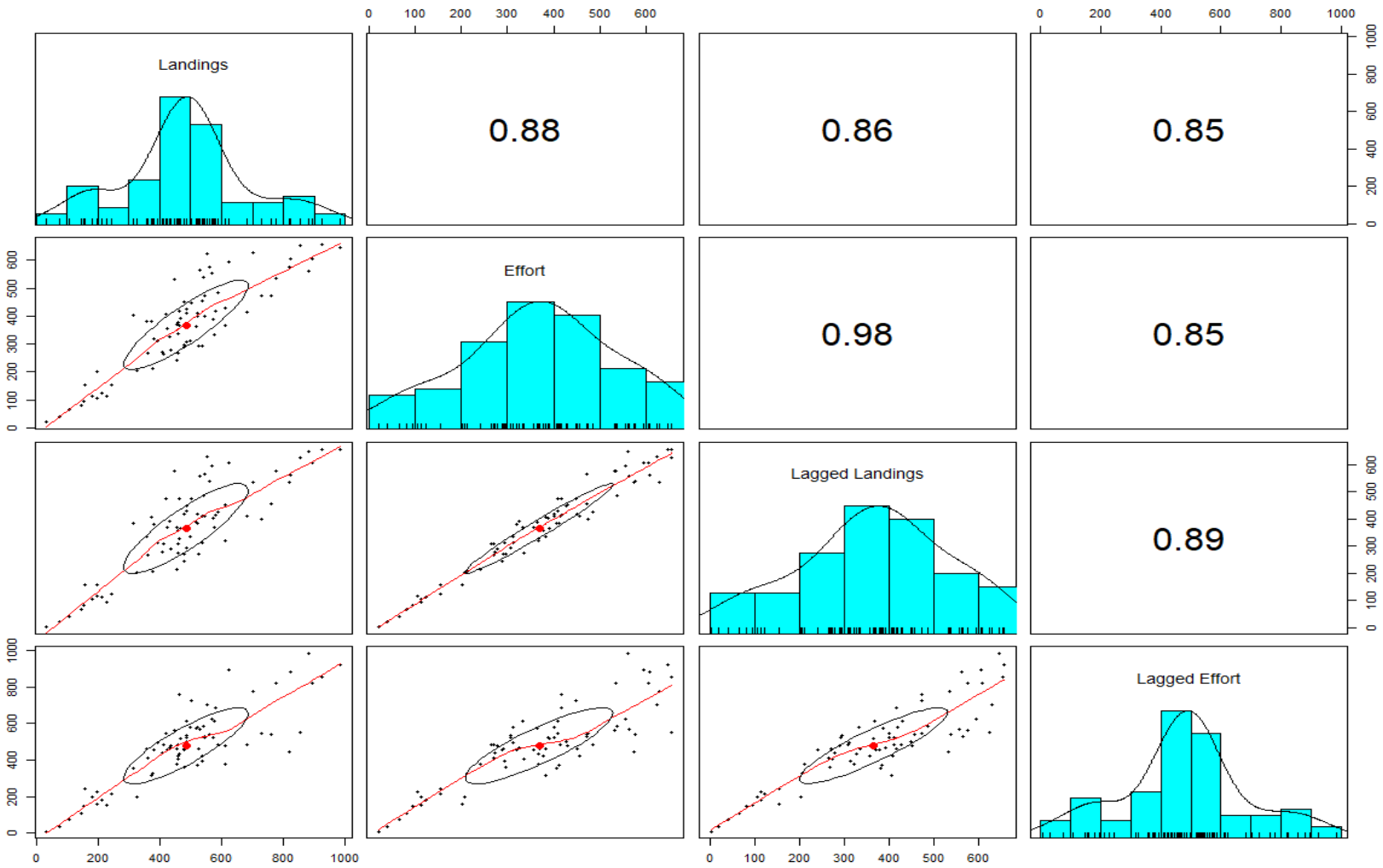


Acknowledgments

- NOAA's Academic Studies Program
- University of Maryland Graduate School
- Wilberg Laboratory
- My Committee
- My Family
- My Friends

Questions?

Forecast Examination and Review



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