

*Science, Service, Stewardship*



# Time Series Analysis of Recreational Catch and Effort

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# Overview

- Data series diagnostics
- ARIMA times series models
- Total effort by state and wave
- Total landings by wave
- Forecasting



# ARIMA Models

- Concept
  - Values in a time series are correlated
  - Correlation is a function of time
- Parameters for ARIMA
  - $p$ : autoregressive (AR),  $q$ : moving average (MA)
  - $d$ : difference (I)
- Highly flexible
  - Parameterization
  - External correlates (tuning series)
- Implementation
  - SAS/ETS, proc arima



## Model Formulations

- ARMA ( $p, q$ ) 
$$X_t = \mu + \sum_{i=1}^p b_i X_{t-i} + e_t + \sum_{i=1}^q a_i e_{t-i}$$

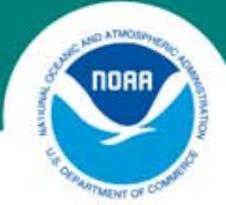
- ARIMA (1,1,1)

$$(X_t - X_{t-1}) = b(X_{t-1} - X_{t-2}) + e_t + a_1 e_{t-1}$$

$$(X_t - X_{t-6}) = b(X_{t-1} - X_{t-6}) + e_t + a_6 e_{t-6}$$

- ARIMA (0,2,3)

$$(X_t - X_{t-1}) - (X_{t-6} - X_{t-7}) = e_t + a_1 e_{t-1} + a_6 e_{t-6} + a_7 e_{t-7}$$



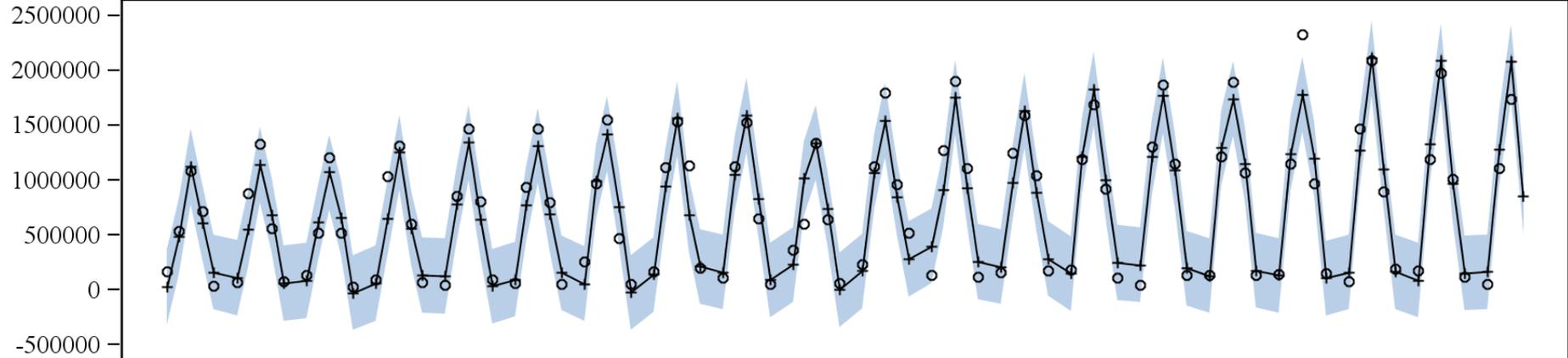
# Effort Models

- Total Effort (angler trips) by Wave, 1990-2009
- Separate models by State: MA, AL, FL
- Untransformed, Log transformed, No correlates

# MASSACHUSETTS

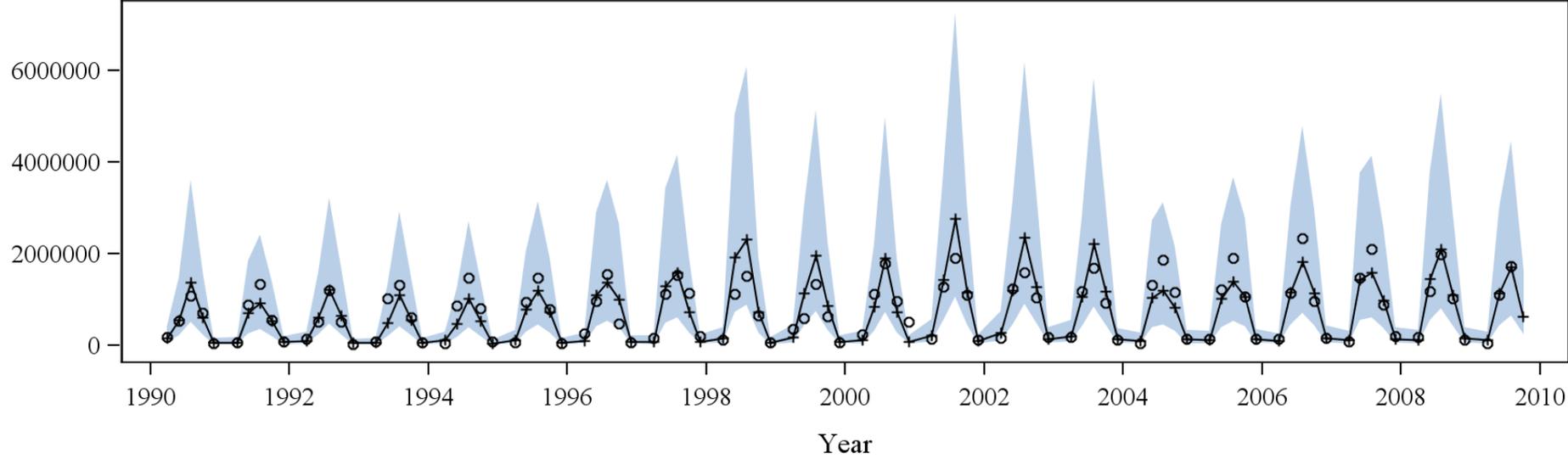
Model Input = BASE

fit = R-squared: 0.91



Model Input = LOG

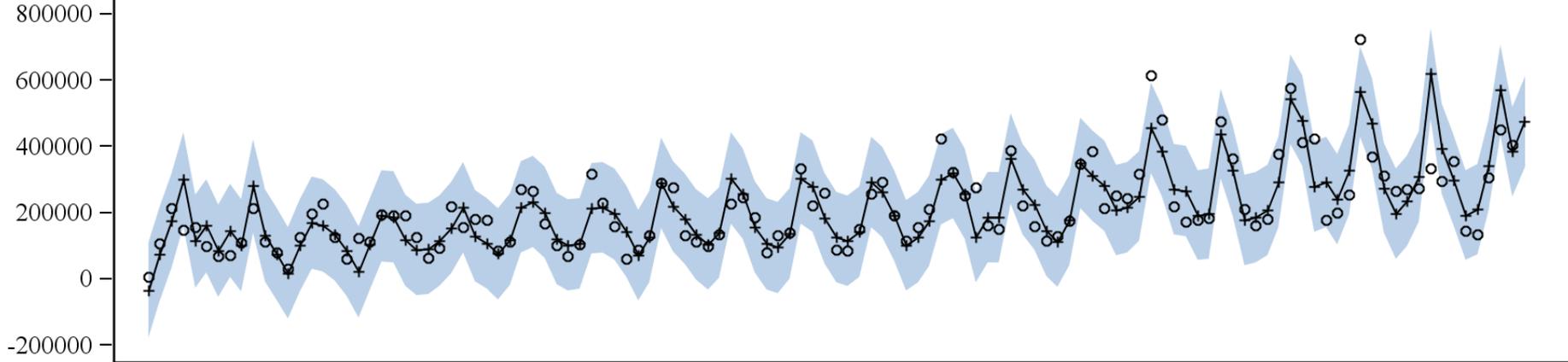
fit = R-squared: 0.84



# ALABAMA

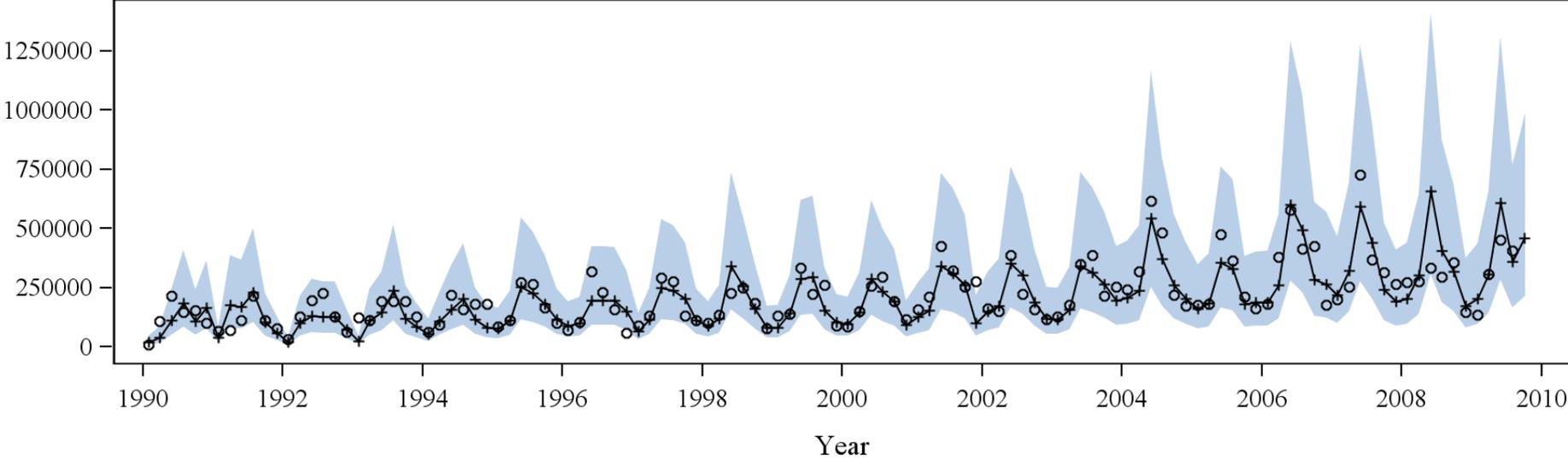
Model Input = BASE

fit = R-squared: 0.69



Model Input = LOG

fit = R-squared: 0.62

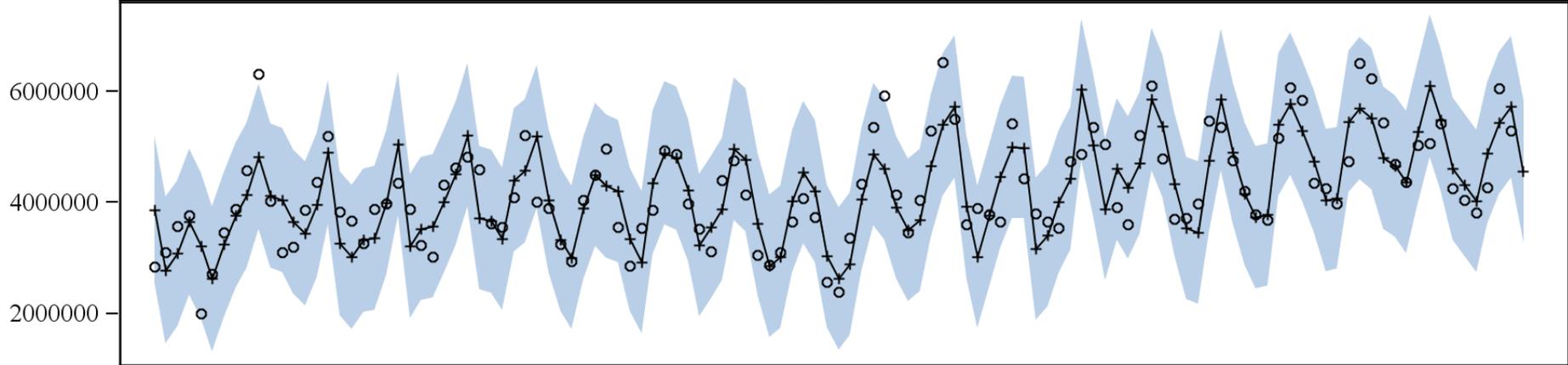


■ 95% Confidence Limits ○ Effort (No. Angler Trips) —+— Predicted Effort

# FLORIDA

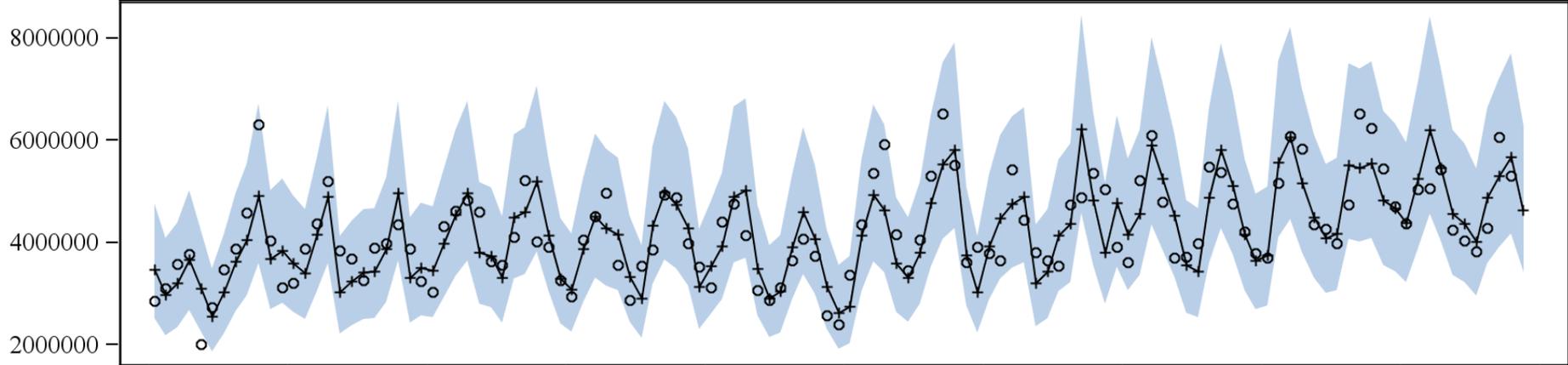
Model Input = BASE

fit = R-squared: 0.45



Model Input = LOG

fit = R-squared: 0.46



■ 95% Confidence Limits ○ Effort (No. Angler Trips) —+— Predicted Effort



# Effort Models

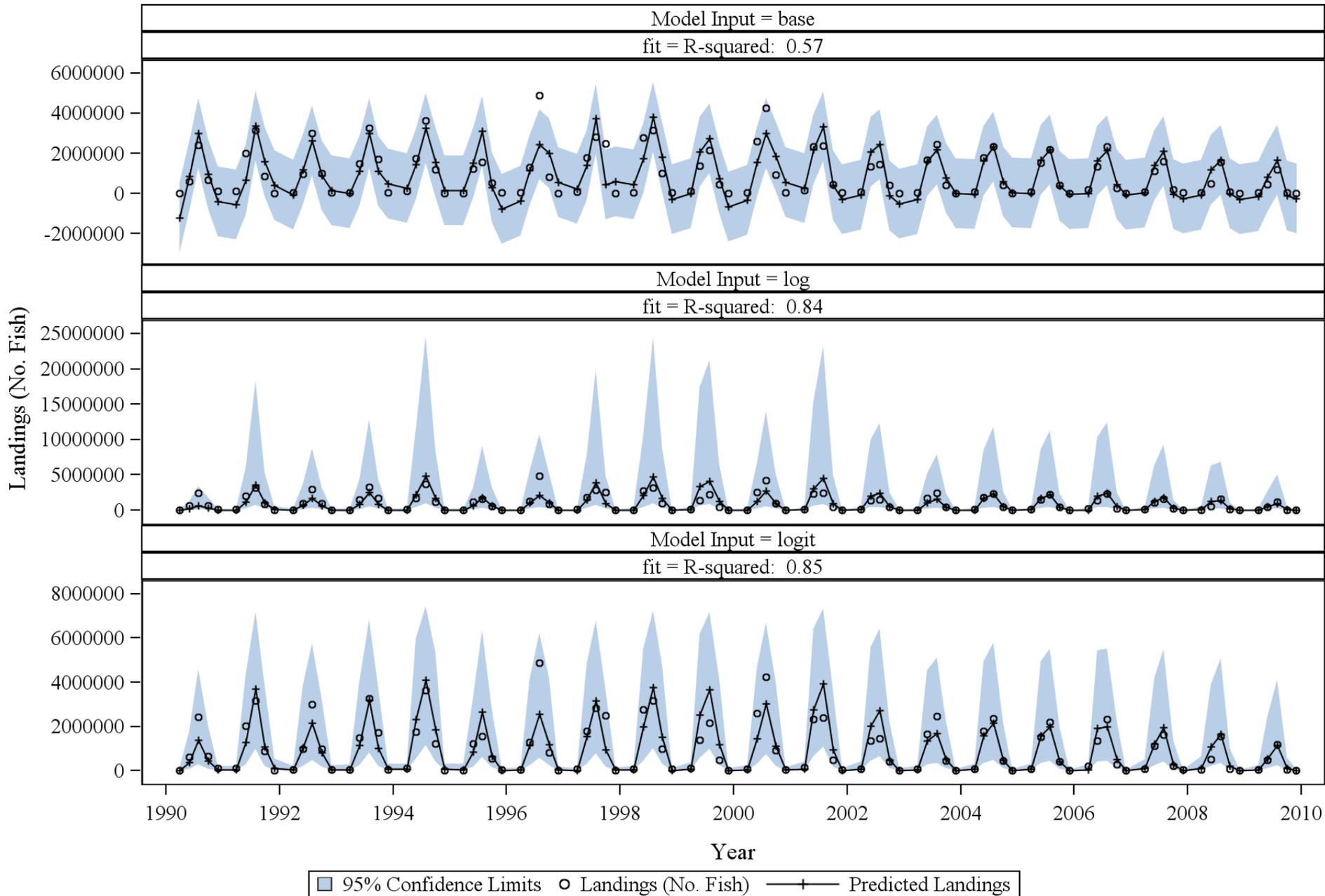
- Model Fit:
  - Large states better than small states
  - Mid Atlantic, NE better than SA, Gulf
  - Short series better than long



# Catch Models

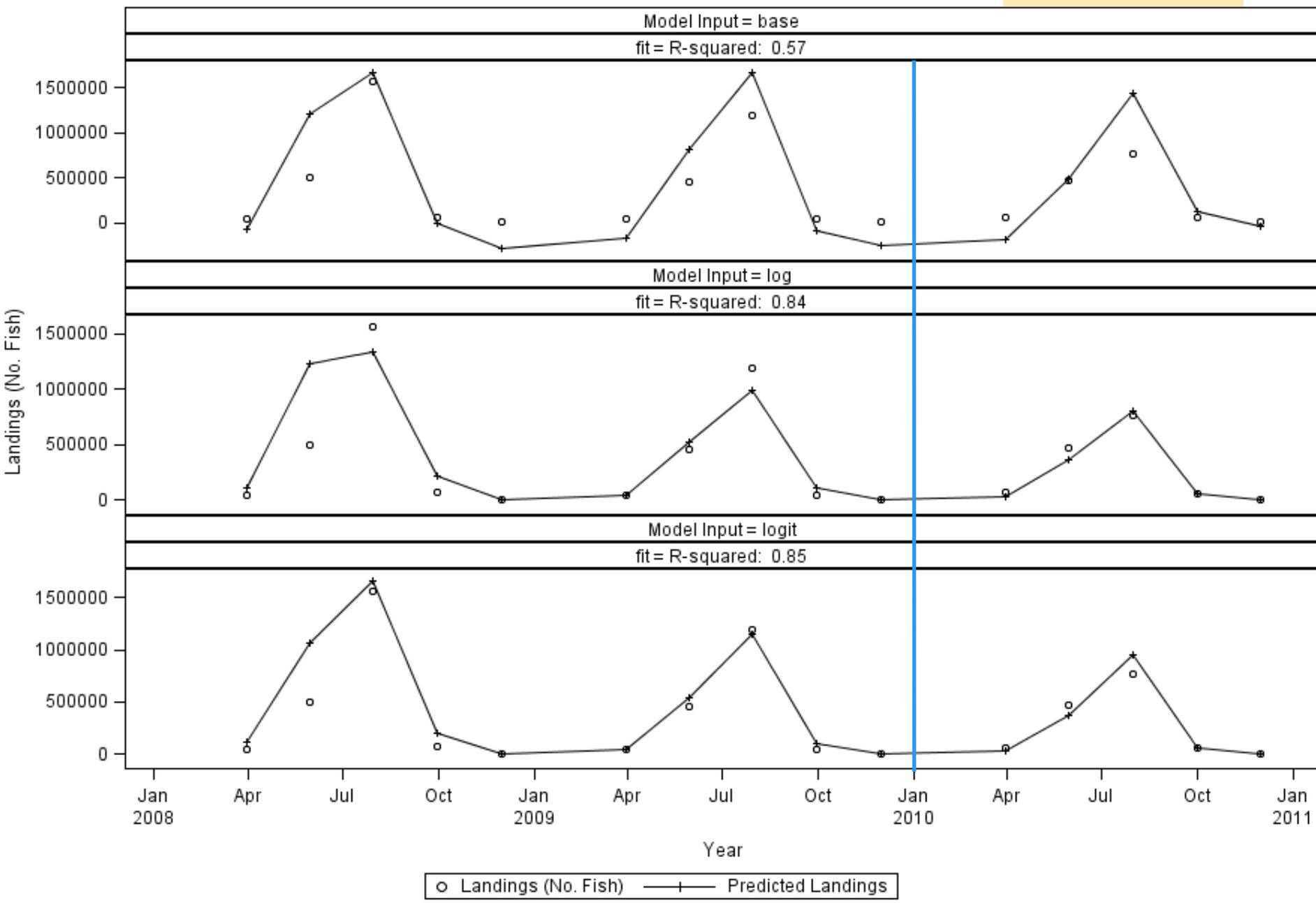
- Total Landings (no. fish) by Wave, 1990-2009
- Coastwide models by species
- Summer flounder, Scup, Striped Bass
- Untransformed, Log and Logit transformed
- No Correlates

# SUMMER FLOUNDER



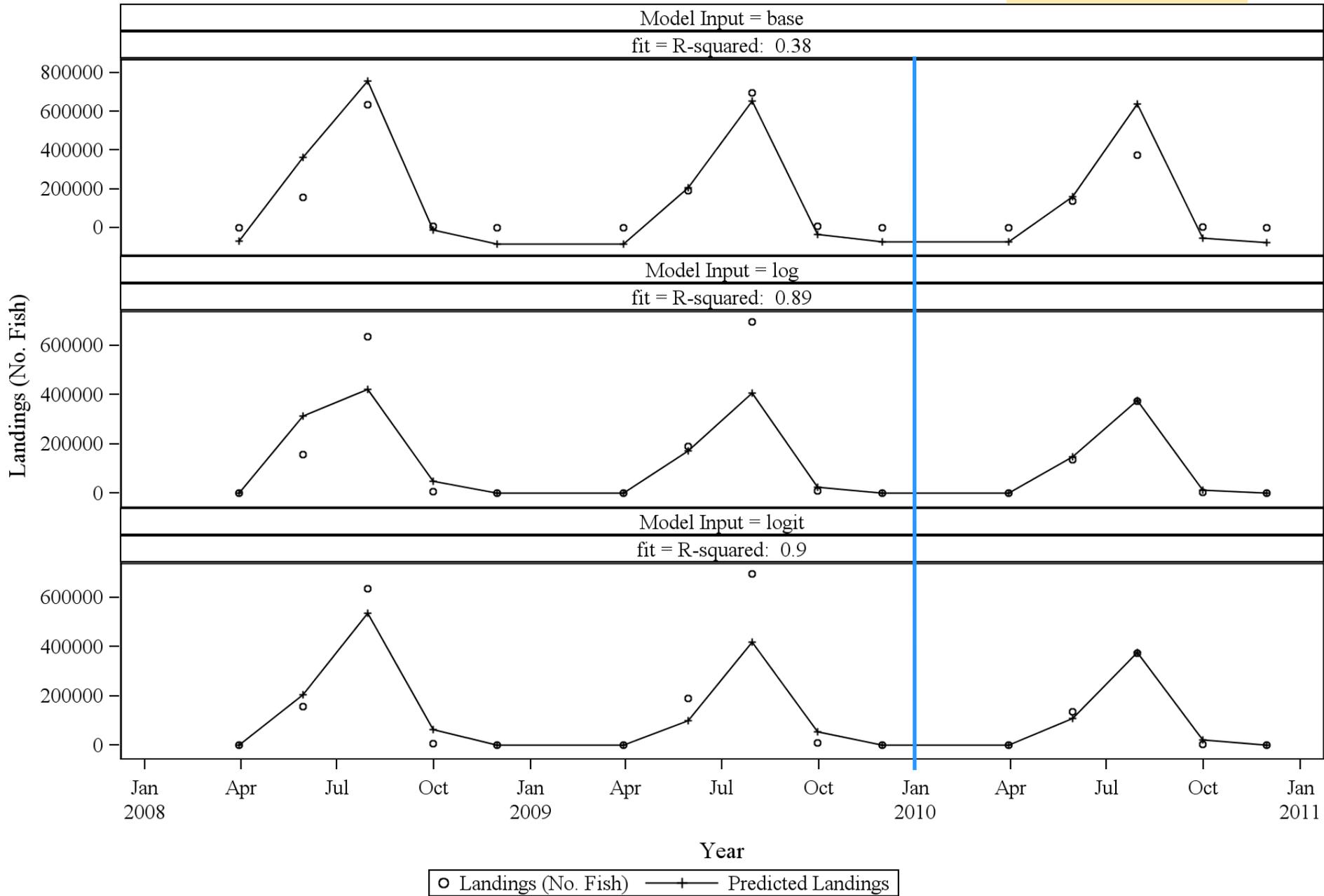
# SUMMER FLOUNDER

Full Year Forecast

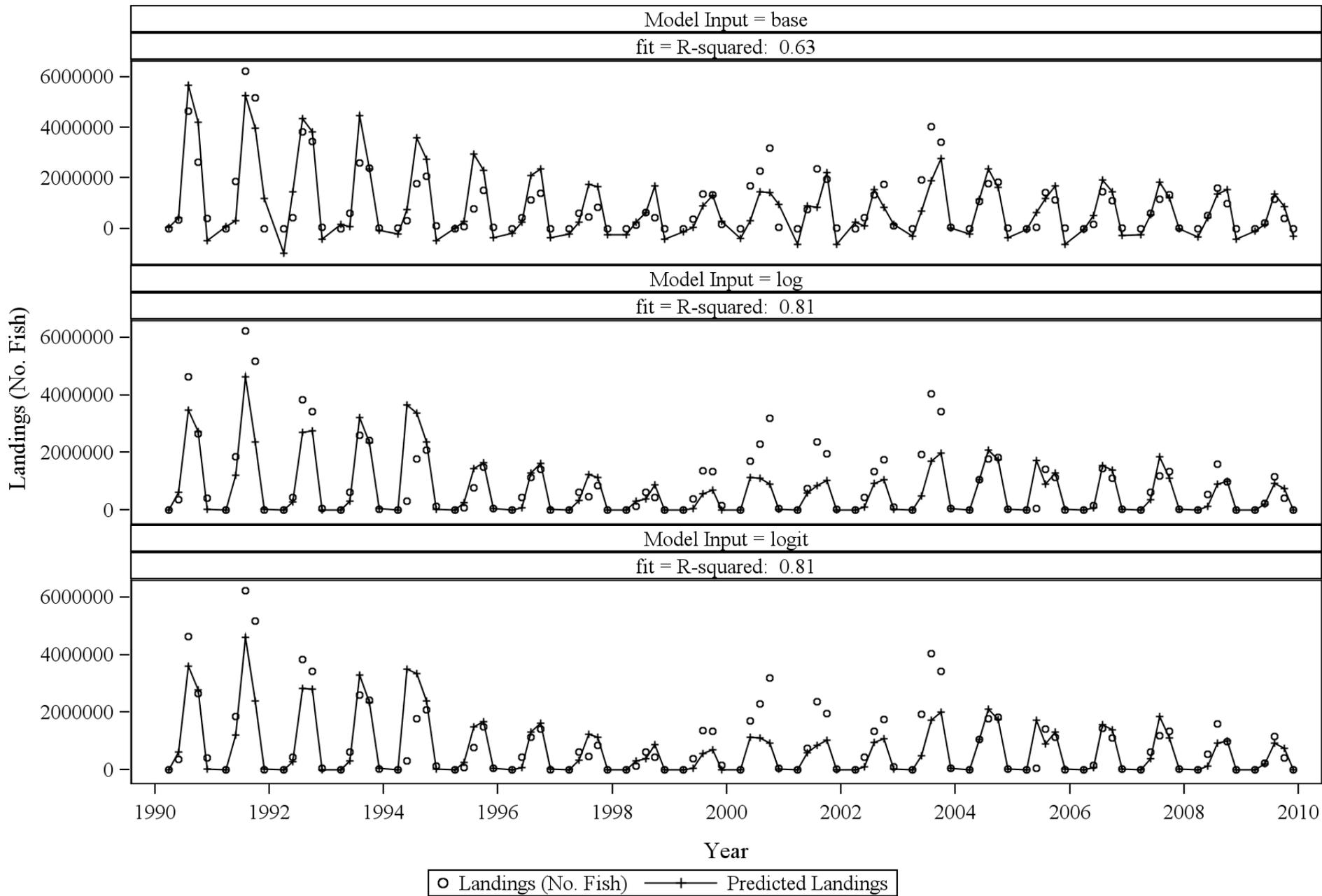


# NEW JERSEY SUMMER FLOUNDER

Full Year Forecast

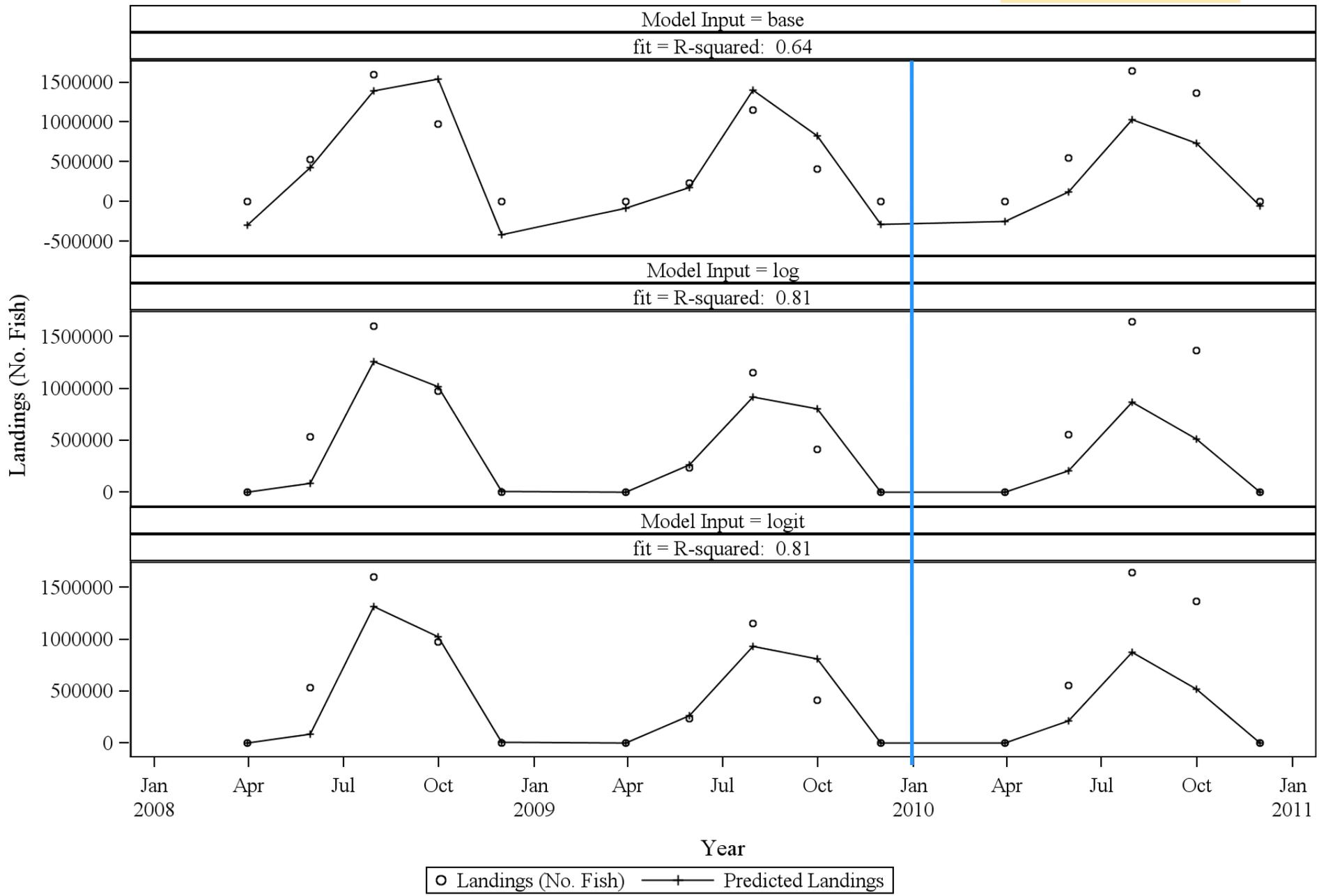


# SCUP



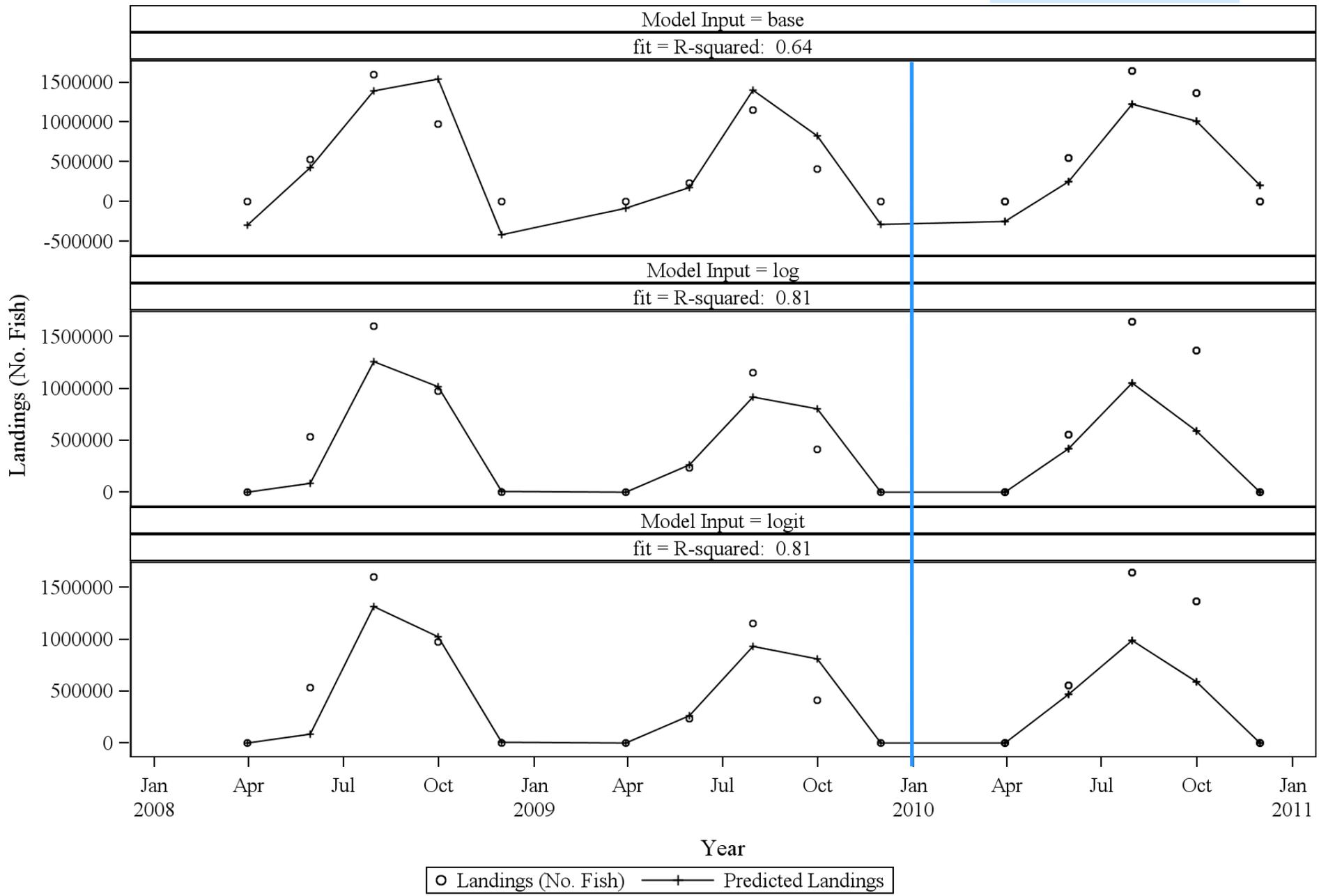
# SCUP

Full Year Forecast



# SCUP

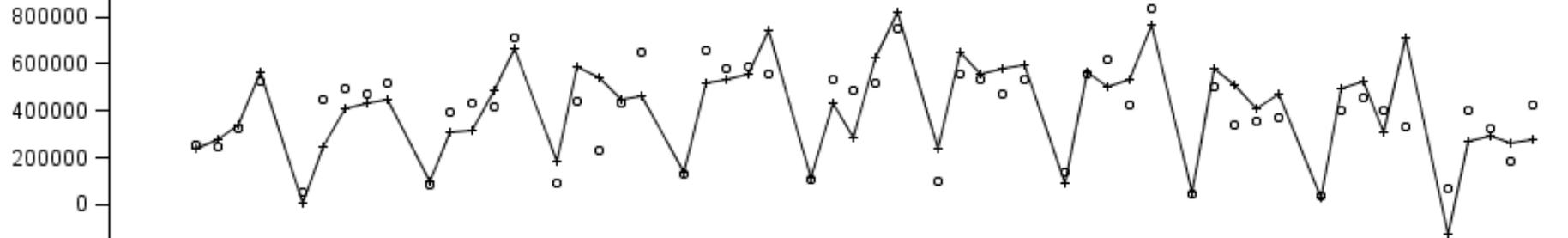
By Wave Forecast



# STRIPED BASS

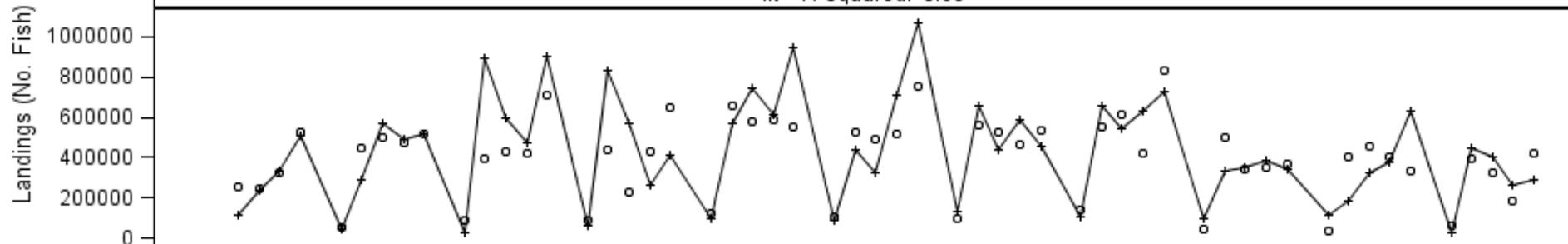
Model Input = base

fit = R-squared: 0.65



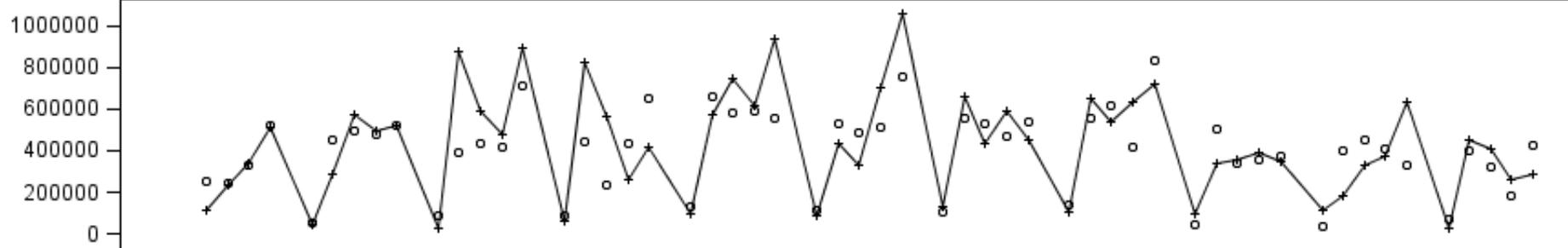
Model Input = log

fit = R-squared: 0.69



Model Input = logit

fit = R-squared: 0.69



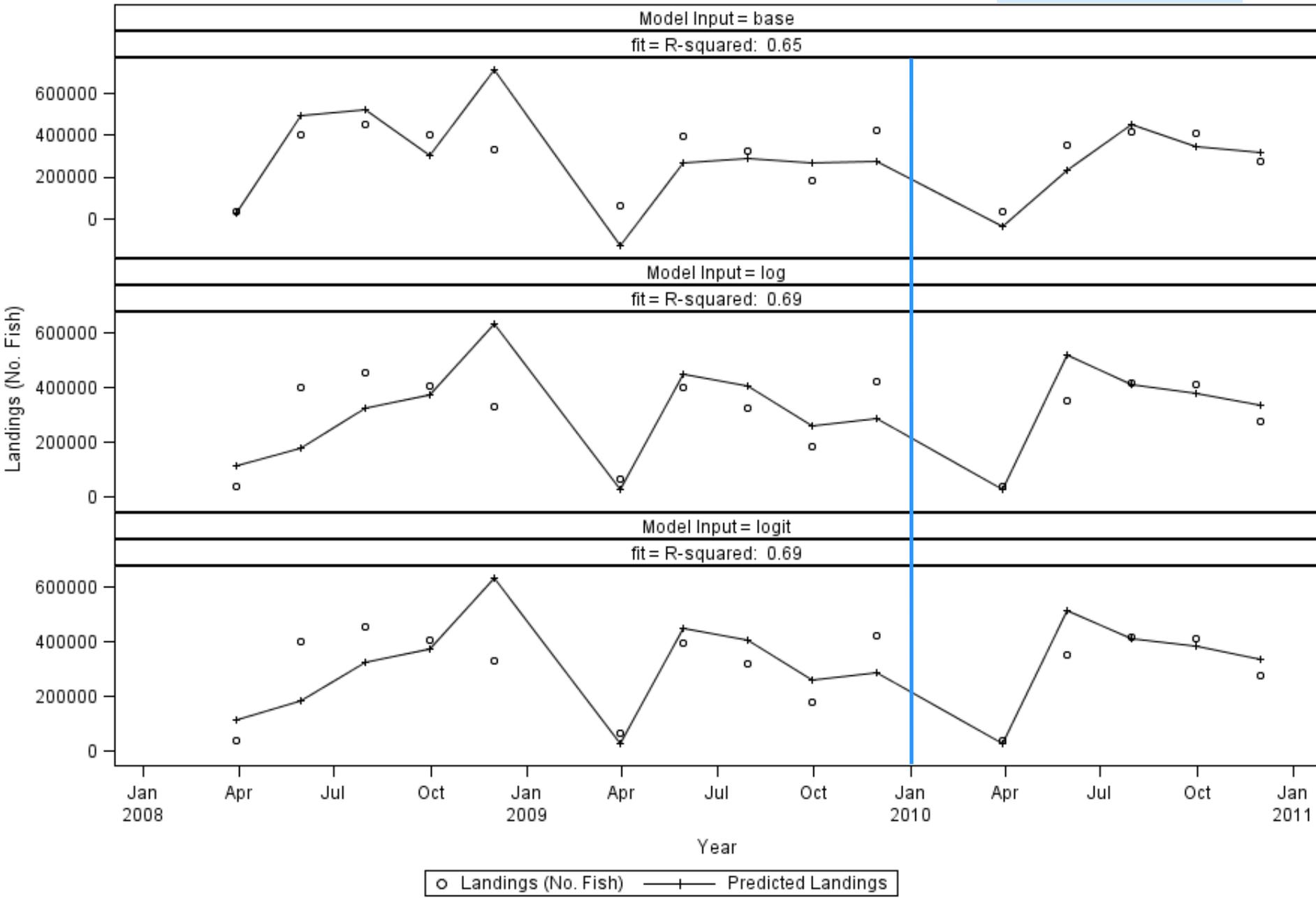
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

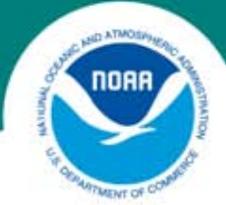
Year

○ Landings (No. Fish) —+— Predicted Landings

# STRIPED BASS

By Wave Forecast





# Future Development

- External correlates
  - Effort
  - Weather data: wind, precipitation, storm series
  - Economic data: fuel prices, state level gdp
  - Management regulations
  - Survey metrics
- Optimizing model specifications

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