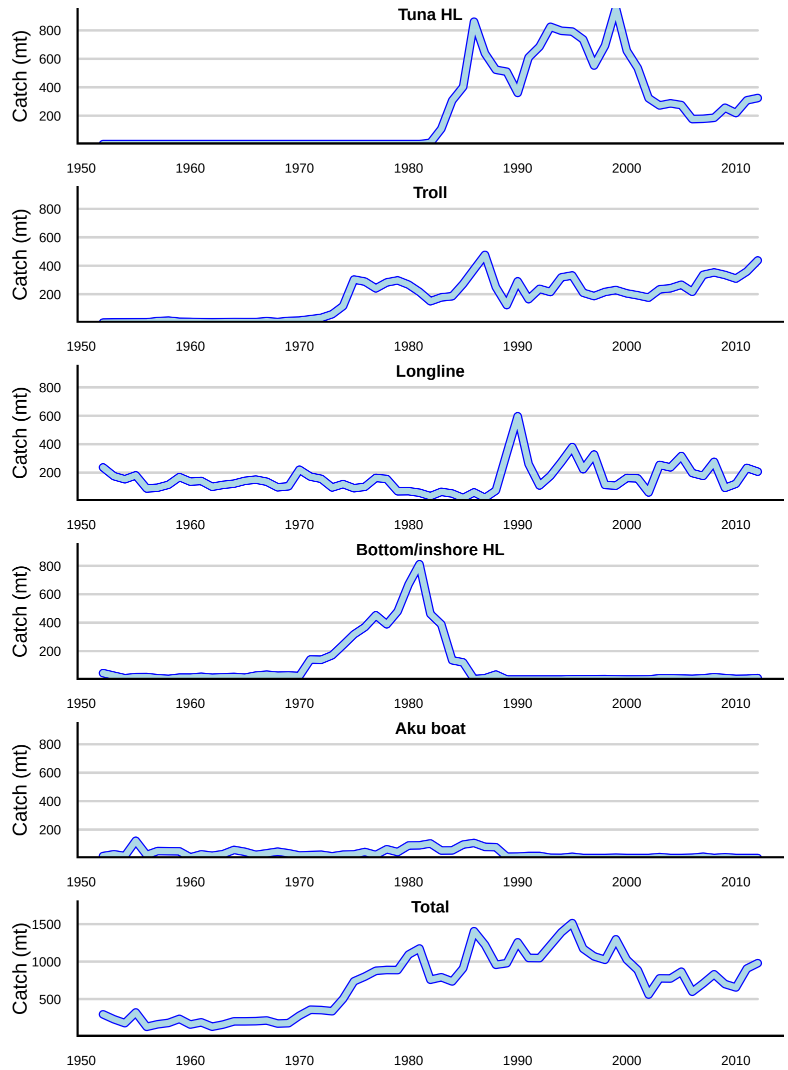
# Feasibility of developing a stock assessment model for Main Hawaiian Islands Yellowfin Tuna Fishery

# Part Deux

John Sibert, Retirement-failure Consulting

sibert@hawaii.edu

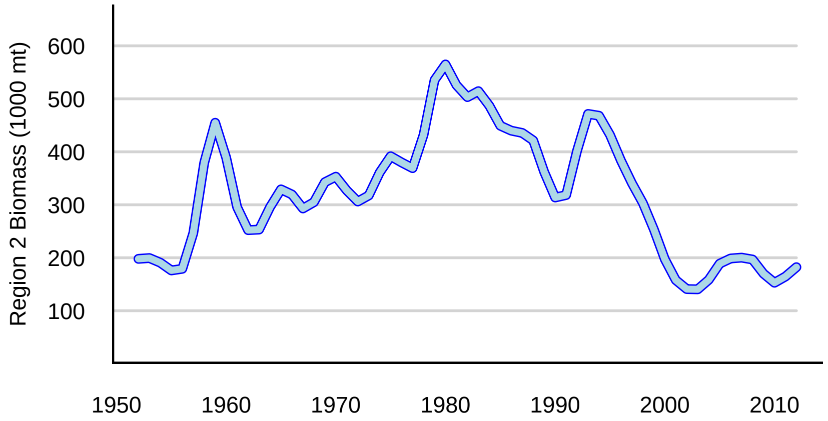
# Combined HDAR and NOAA Catch Time Series



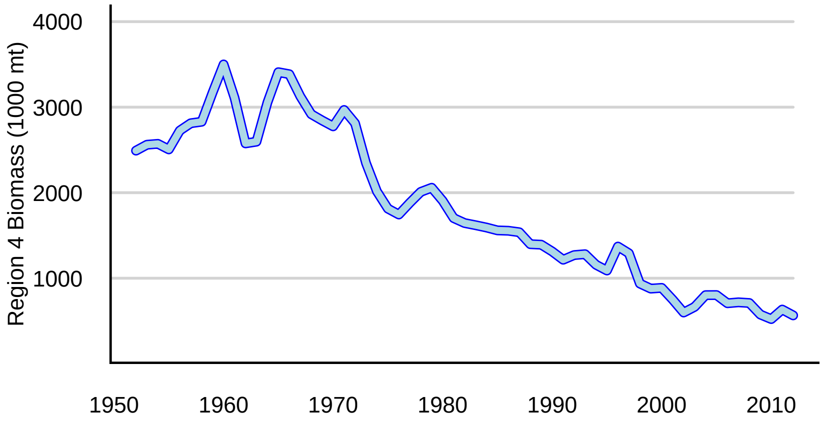

**No Recreational Data**

# WCPFC Stock Assessments

MFCL Region 2




MFCL Region 4



# Feasibility questions

1. Can we contrive a simple model of the MHI YFT population and fishery?
2. Can model parameters be estimated from the data?
3. Are model biomass estimates plausible?
4. Can model results be used in alphabet soup?

# Principle model assumptions

1. The dynamics of the population of YFT in the MHI follows a surplus production (Schaefer) model.
2. Fishing mortality is represented by a random walk.
3. Predicted catch by gear is the product of estimated fishing mortality for each gear and average predicted biomass during a year.
4. Optional use of MFCL biomass estimate as index of abundance so that local abundance is **approximately proportional** to the index biomass.

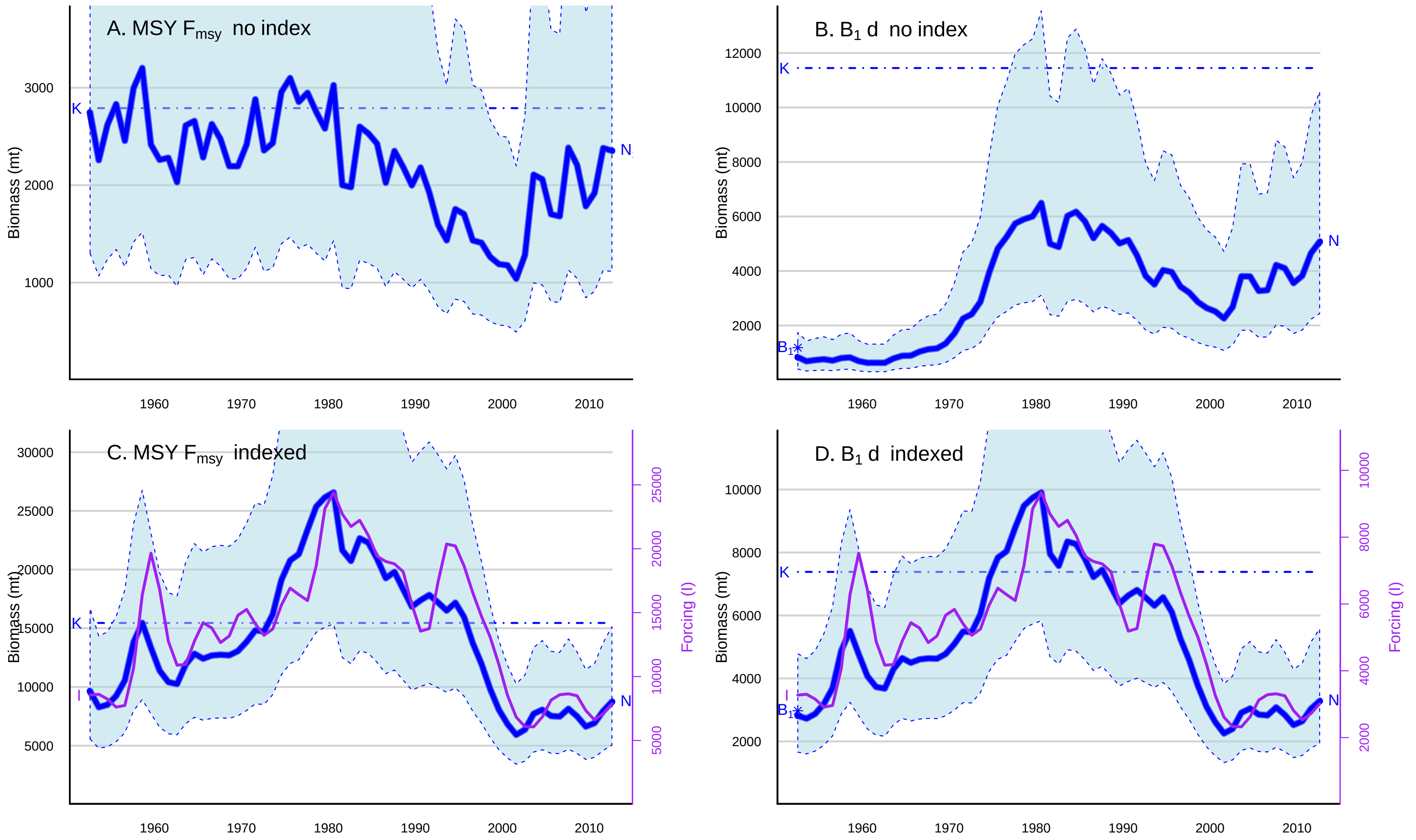
# Technical features

1. Fishing mortality and biomass are random effects.
2. Process errors associated with population growth, fishing mortality random walk, and biomass index proportionality are assumed to be equal and represented by a single parameter ($\sigma_P$).
3. Two alternate logistic model parameterizations:
   a) $K = \frac{4\widetilde{Y}}{r}; \quad r = 2F_{\widetilde{Y}}$
   b) $K = d \cdot B_1$
4. Zero-inflated log-normal catch likelihood.
5. Optional log-normal prior on $r$ with $\tilde{r} = 0.486$ and $\sigma_r = 0.8$,
6. Analytic solution to Schaefer ODE for stable propagation through time.
7. All computer code, data files, and draft reports in support of this analysis can be found at Github: https://github.com/johnrsibert/XSSA.git.

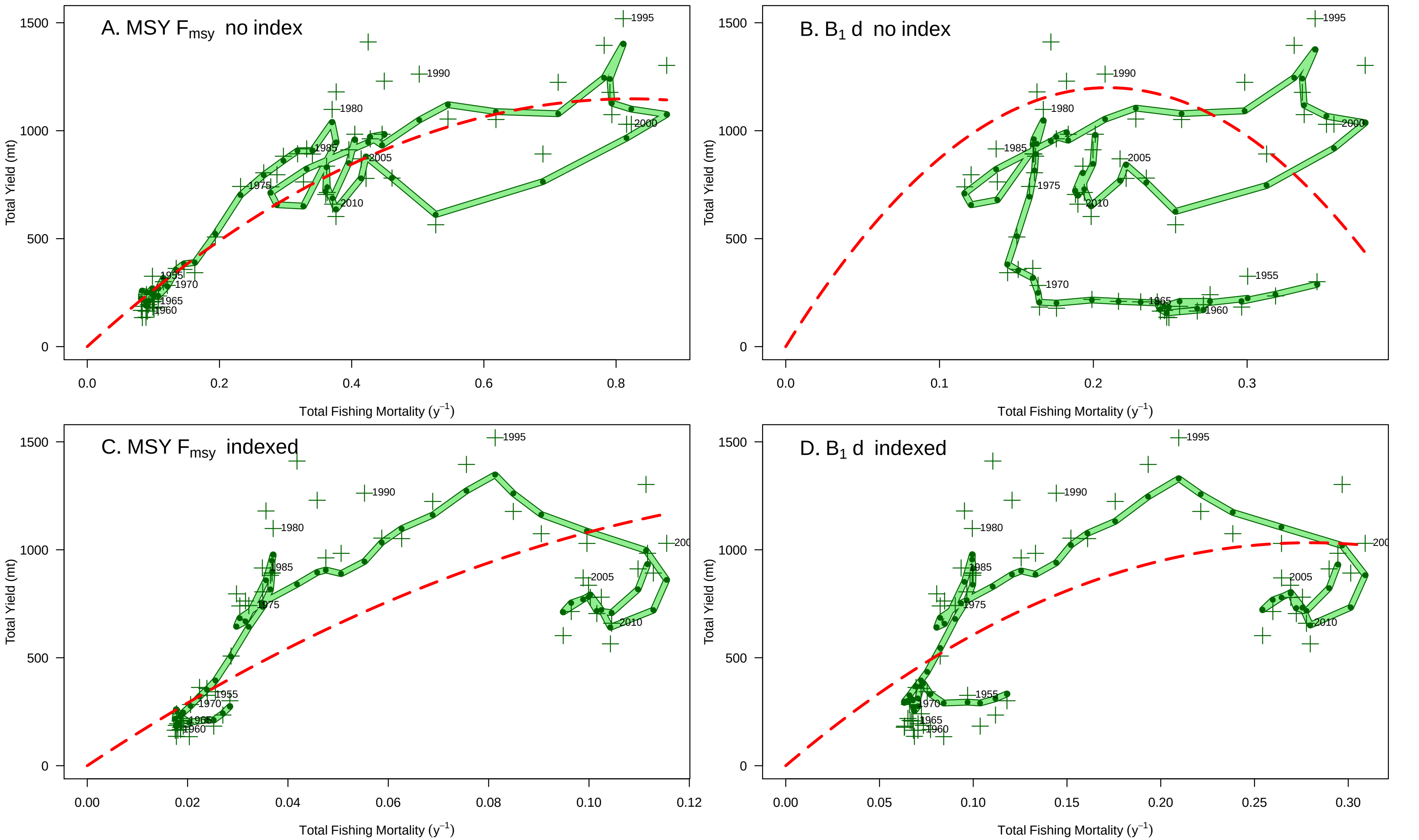
# Estimabilty

| Index | | None | | MFCL 2 | |
|---|---|---|---|---|---|
| | Parameterization | $\widetilde{Y}$ $F_{\widetilde{Y}}$ | $B_1$ $d$ | $\widetilde{Y}$ $F_{\widetilde{Y}}$ | $B_1$ $d$ |
| | Designation | A | B | C | D |
| $n$ | Estimated Parameters | 4 | 5 | 5 | 6 |
| $\|G\|_{max}$ | Gradient at Minimum | 0.0016409 | 33.1289 | 3.51082e-05 | 3.77653 |
| $-\log L$ | Likelihood | -237.238 | -237.968 | -247.175 | -243.343 |
| AIC | Akaike Criterion | -466.476 | -465.936 | -484.35 | -474.686 |
| $B_1$ | Initial Biomass | — | 1184.2 | — | 2802.3 |
| $d$ | $K = dB_1$ | — | 9.6674 | — | 2.6348 |
| $\widetilde{Y}$ | MSY | 1147.5 | (1199.3) | 1288.7 | (1032.6) |
| $F_{\widetilde{Y}}$ | F at MSY | 0.82239 | (0.20952) | 0.1668 | (0.2797) |
| $r$ | Growth Rate | (1.6448) | 0.41904 | (0.3336) | 0.5594 |
| $K$ | Equilibrium Biomass | (2790.8) | (11448) | (15452) | (7383.5) |
| $\sigma_P$ | Process Error | 0.37416 | 0.36757 | 0.2743 | 0.2649 |
| $\sigma_Y$ | Observation Error | 0.41693 | 0.43062 | 0.46924 | 0.47614 |
| $Q$ | Index Proportionality | — | — | 0.04321 | 0.016535 |

# Estimated Biomass Trends



# Production

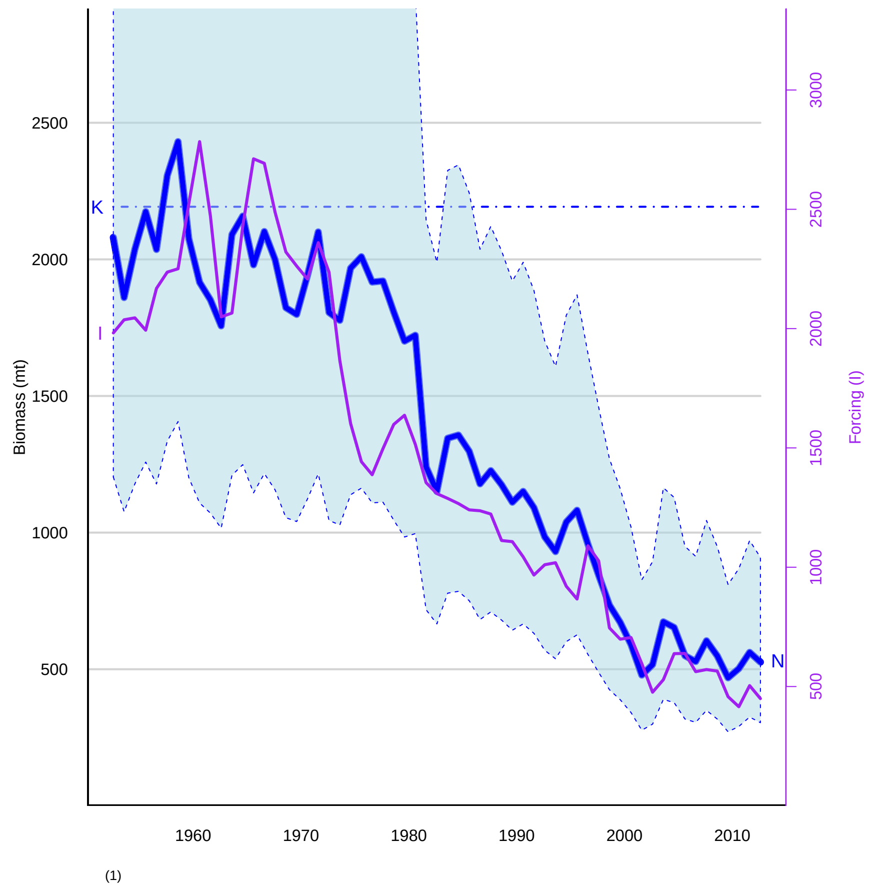


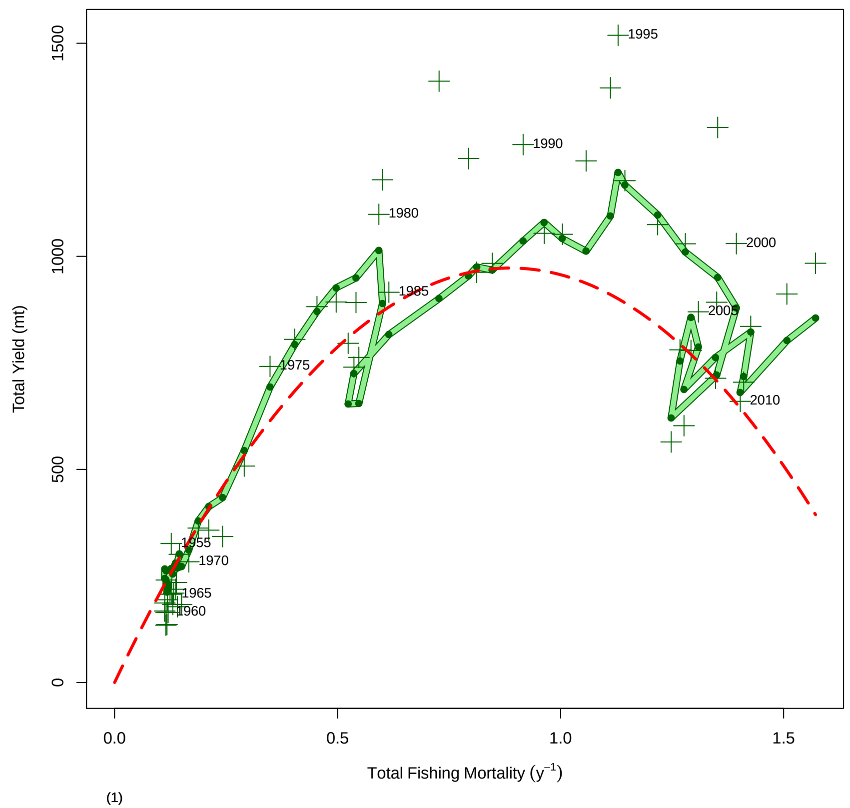
A. MSY $F_{msy}$ no index
B. $B_1$ d no index
C. MSY $F_{msy}$ indexed
D. $B_1$ d indexed
Total Yield (mt)
Total Fishing Mortality ($y^{-1}$)
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

# Omitting $r$ prior

| Index | None | | MFCL 2 | |
|---|---|---|---|---|
| Parameterization | $\widetilde{Y}\ F_{\widetilde{Y}}$ | $B_1\ d$ | $\widetilde{Y}\ F_{\widetilde{Y}}$ | $B_1\ d$ |
| Designation | A | B | C | D |
| $n$ | 4 | 5 | 5 | 6 |
| $-\log L$ | -284.898 | -236.212 | -246.302 | -242.176 |
| $\|G\|_{max}$ | 2.45563 | 151.693 | 1.24795e-05 | 39.9125 |
| $B_1$ | — | 1540.2 | — | — |
| $d$ | — | 12.567 | — | — |
| $\widetilde{Y}$ | — | 1274.9 | 1579.3 | — |
| $F_{\widetilde{Y}}$ | — | 0.13174 | 0.1293 | — |
| $r$ | — | 0.26347 | 0.25859 | — |
| $K$ | — | 19355 | 24430 | — |
| $\sigma_P$ | — | 0.35682 | 0.27044 | — |
| $\sigma_Y$ | — | 0.43481 | 0.47162 | — |
| $Q$ | — | — | 0.073752 | — |

# Alternate forcing: MFCL Region 4



# Conclusions

1. Yellowfin catch data from fleets operating in the Main Hawaiian Islands waters are sufficiently informative to estimate relative biomass trends.

2. An index of abundance is required to estimate absolute biomass, but absolute estimates are sensitive to the choice of index population.

3. Representing trends in fishing mortality as a random walk is a convenient and effective approach to accounting for the removal of biomass from the fish population.

4. The Bayesian prior on $r$ is difficult to assign and probably not required.

# Next Steps?

1. Reevaluate data: Complete? Accurate (yellowfin or bigeye)? Recreational catch?
2. Technical review of model, including statistical assumptions, and computing methods.
3. Run Simulations.
4. Compare results to Catch-MSY analysis.
5. Review previous uses of production models in tuna fisheries.
6. Test alternative biomass indices, including MHI-specific SEAPODYM estimates.
7. Work within WCPFC assessment process to improve applicability of WCPFC stock assessments to local requirements.