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

Part Deux

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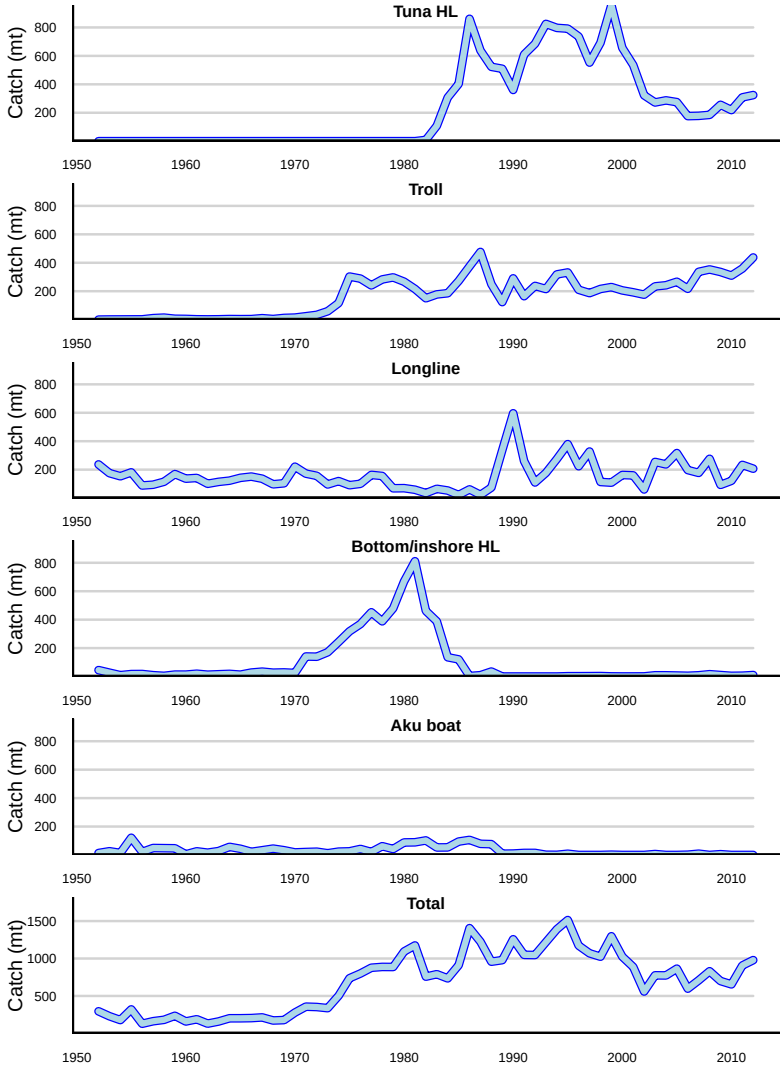
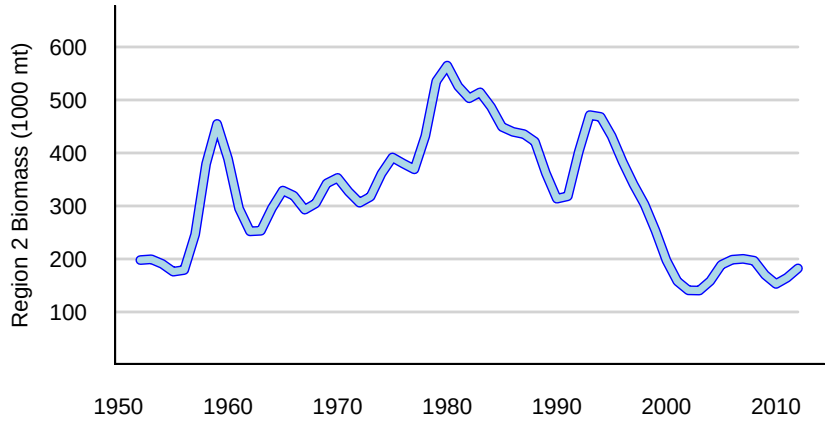
Combined HDAR and NOAA Catch Time Series



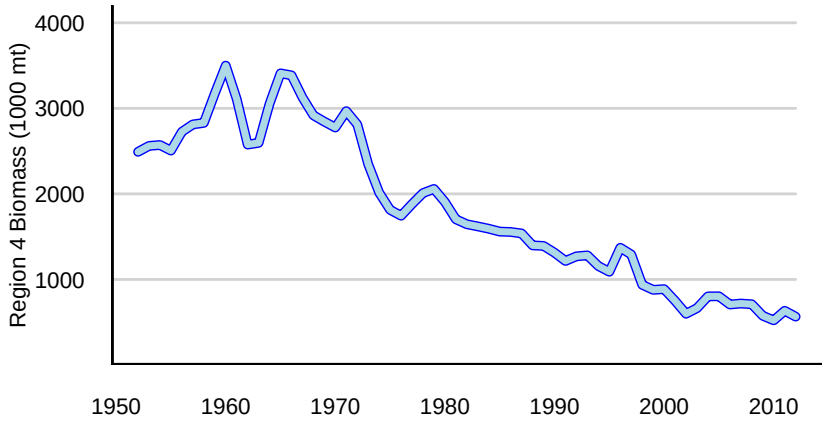
No Recreational Data

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 the model parameters be estimated from the data?
3. Are the model biomass estimates plausible?
4. Can the model results be used in alphabet soup?

Principle model assumptions

1. The dynamics of the population of YFT in the MHI follows a simple 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.

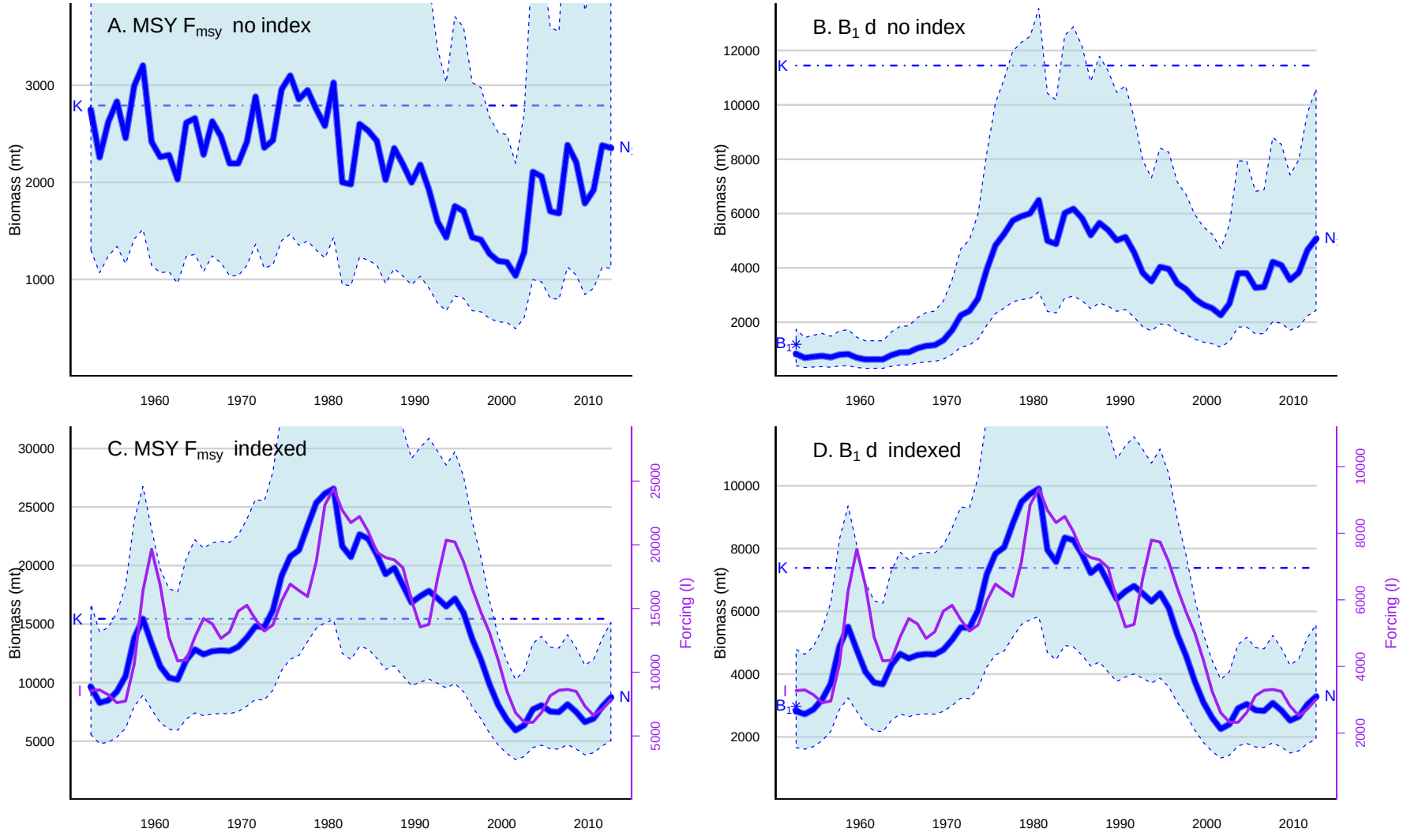
Technical features

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 (σ_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.

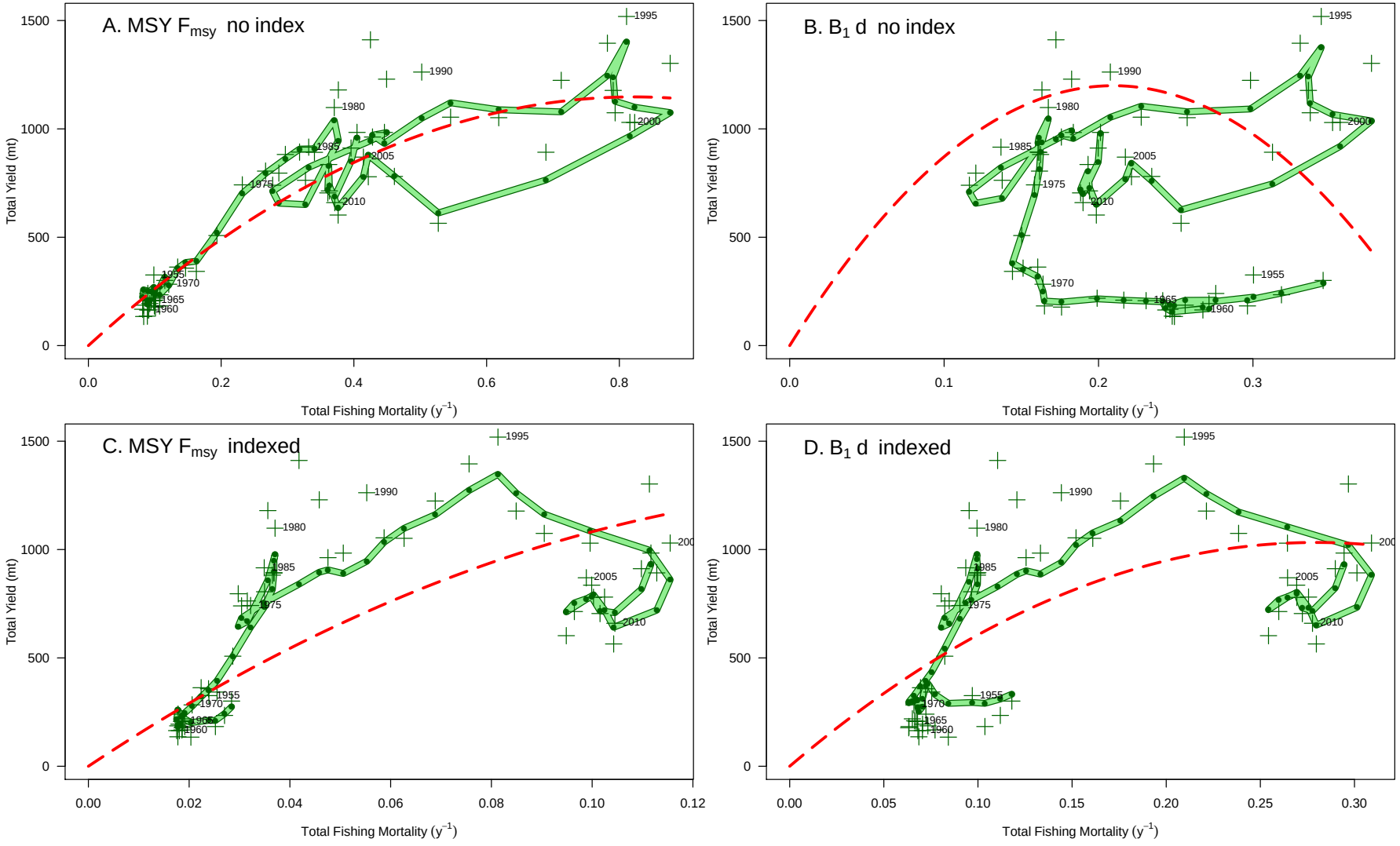
Estimabilty

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
$\lvert G\rvert_{max}$	Gradient at Minimum	0.0016409	33.1289	3.51082e-05	3.77653
n	Estimated Parameters	4	5	5	6
$-\log L$	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)
σ_P	Process Error	0.37416	0.36757	0.2743	0.2649
σ_Y	Observation Error	0.41693	0.43062	0.46924	0.47614
Q	Index Proportionality	—	—	0.04321	0.016535

Estimated Biomass Trends



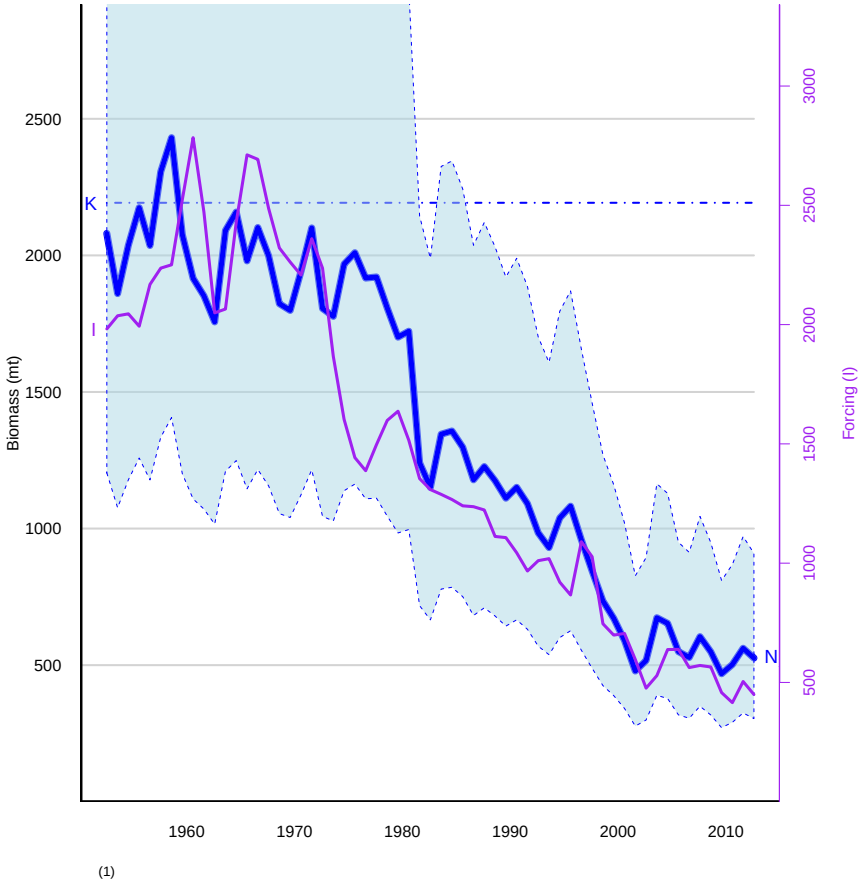
Production


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})

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
$\lvert G\rvert_{max}$	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	—
σ_P	—	0.35682	0.27044	—
σ_Y	—	0.43481	0.47162	—
Q	—	—	0.073752	—

Alternate forcing: MFCL Region 4



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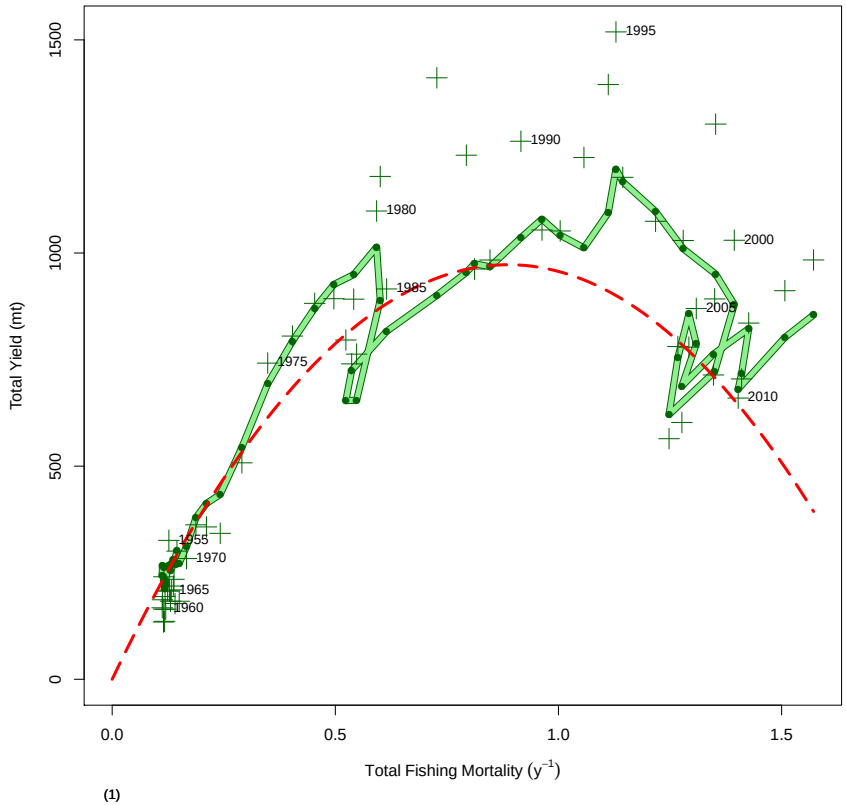

(1)

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. Technical review of model, including statistical assumptions, and computing methods.
2. Compare these results to Catch-MSY analysis.
3. Review previous uses of production models in tuna fisheries.
4. Test alternative biomass indices, including MHI-specific SEAPODYM estimates.
5. Work within WCPFC assessment process to improve applicability of WCPFC stock assessments to local requirements.