Appendix 12 : Replacement Yield Model fits to Angolan horse mackerel data.

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A replacement yield model has been fitted to the Angolan horse mackerel survey biomass data and catch data for the period 1985-2004.

Three series of data are available: *T. trecae* only, *T. capensis* only, and *T. trecae* and *T. capensis* combined.

The replacement yield model fitted to the data is simply:

$B_{t+1} = B_t + RY - C_t$ and
$S_t = qB_t e^{\varepsilon}$,
where *RY* = replacement yield, and S_t is the survey biomass estimate.

We assume $q = 1$, i.e. that the survey biomass estimates are absolute biomass estimates. The estimable parameters are thus B_{1985} (the first year biomass), and *RY*.

The data are reported in Table 1. Model results are reported in Table 2. Standard errors (Hessian-based) are reported in parenthesis. Figure 1 provides the model fits to the survey data as well as plots of biomass and catch.

[The *T. capensis* catch value for 2001 of 255000 t seems somewhat unrealistic. The *T. capensis* catch values are calculated by using the relative ratio of *trecae:capensis* in the survey biomass, and the *trecae* catch series. In 2001, it was reported from the survey that the *capensis* biomass was more than twice the size of that of *trecae*, and this results in the *capensis* catch being so large for that year.]

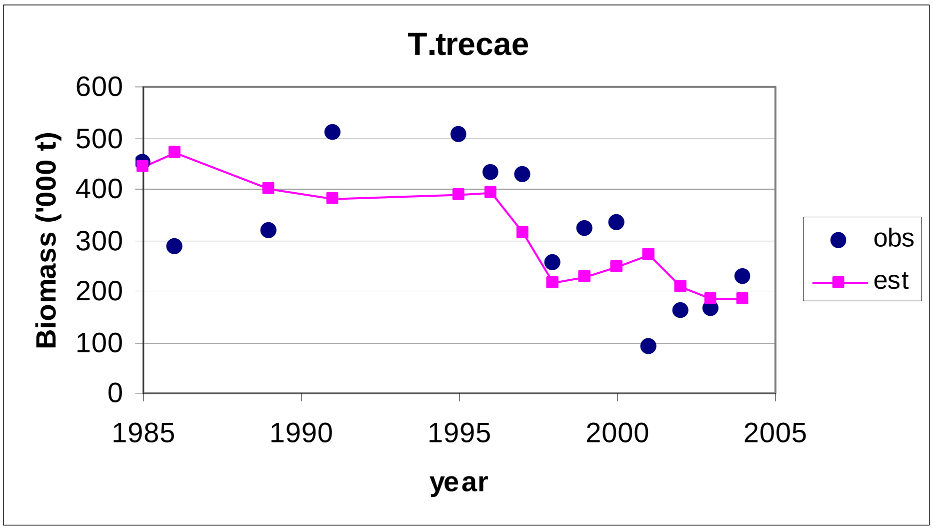
Table 1: Catch (in t) and survey biomass (in ‘000 t) for Angolan horse mackerel.

	Catch *T. trecae*	Catch *T. capensis*	Catch *T. capensis + T. trecae*	Biomass *T. trecae*	Biomass *T. capensis*	Biomass *T. capensis + T. trecae*
1985	29140	14353	43493	450	220	670
1986	92453	12607	105060	285	40	325
1987	77830	17472	95302			
1988	75848	24835	100683			
1989	84638	38026	122664	318	130	448
1990	48710	20947	74366			
1991	33598	13728	54190	510	310	820
1992	77212	25548	113547			
1993	63370	16842	85635			
1994	49944	10509	62430			
1995	52503	8547	61050	506	63	569
1996	137766	7251	145017	433	21	454
1997	154037	8107	162144	427	23	450
1998	47761	24604	72365	254	129	383
1999	38080	15554	53634	321	128	449
2000	33511	24267	57778	333	242	575
2001	120000	255000	375000	89	187	276
2002	80358	45202	125560	162	92	254
2003	60000	47143	107143	166	133	299
2004				229	39	268

Table 2: Model output statistics. [Value in parenthesis is one standard error]. Biomass units are in ‘000 t.

	Both species 1985+	***T. trecae* 1985+**	***T. capensis* 1985+**
B_{1985}	464 (80)	443 (89)	72 (48)
RY	94 (5.2)	58 (6.0)	31 (3.1)
B_{2004}	272 (40)	208 (40)	68 (29)
B_{2004}/B_{1985}	0.59 (0.13)	0.47 (0.15)	0.95 (0.57)

Figure 1a: Model fits to survey biomass (top figure) and plots of biomass and catch (bottom figure) for *T. trecae*.



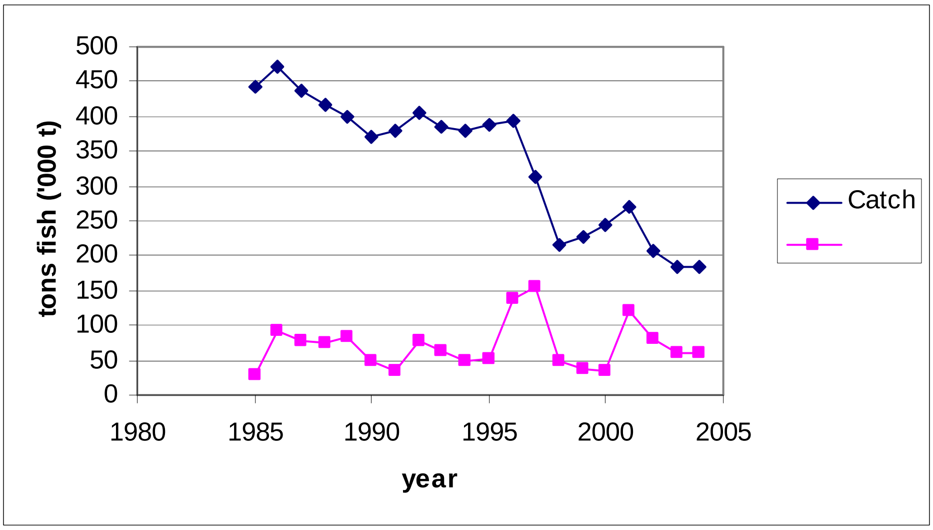
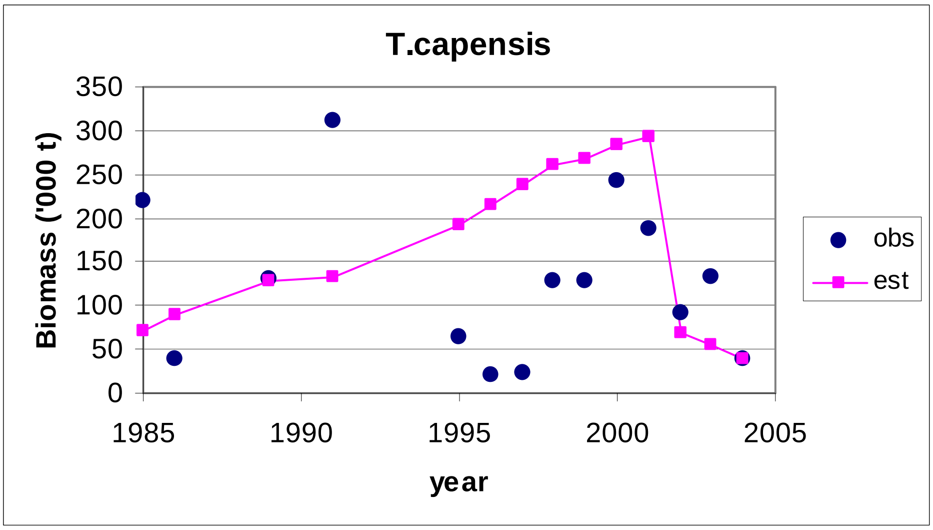


Figure 1b: Model fits to survey biomass (top figure) and plots of biomass and catch (bottom figure) for *T. capensis*.



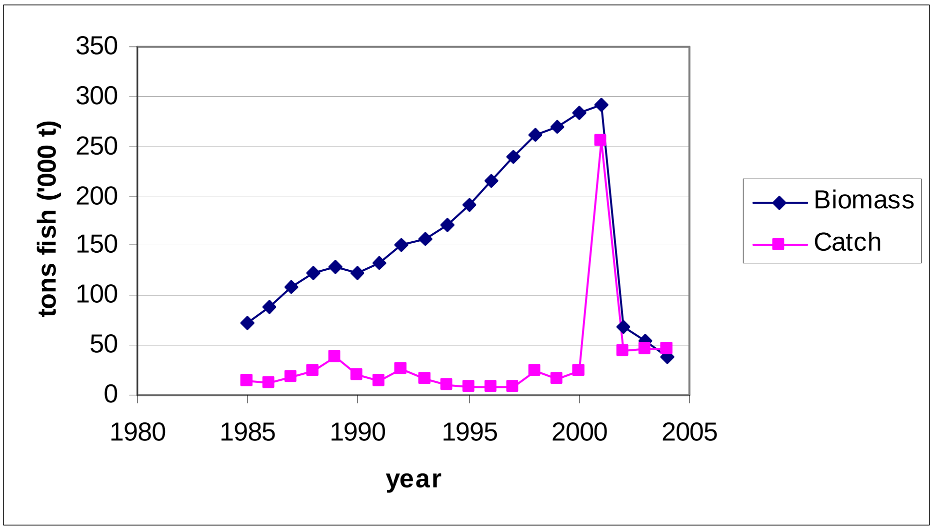


Figure 1c: Model fits to survey biomass (top figure) and plots of biomass and catch (bottom figure) for both *T. trecae*. and *T. capensis*.