Catch-based estimates of sustainable yield for cabezon (*Scorpaenichthys marmoratus*) in waters off Washington

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This report describes yield estimates for cabezon (*Scorpaenichthys marmoratus*) in waters off Washington, based on two catch-based methods: Depletion-Based Stock Reduction Analysis, or DB-SRA, and Depletion-Corrected Average Catch, or DCAC (MacCall, 2009; Dick and MacCall, 2011). Estimates of relative stock status at time *t* (B_t/B_0, or "depletion") and life history parameters are assumed equal to values reported in the most recent assessment of the cabezon substock in Oregon waters (Cope and Key, 2009).

Annual catches (in numbers) from the Washington recreational fishery (1975-86, 1990-2012) were obtained from the Washington Department of Fish and Wildlife (WDFW) and converted to catch in weight (mt) using an assumed average weight of 2.2 kg/fish (Table 1). Catches from 1987-89 were estimated using linear interpolation of values reported in 1986 and 1990. The DB-SRA model assumes a constant annual catch of 0.66 mt from 1950-1974, based on observed average catch from 1975-1979. This approximates the assumption of an equilibrium catch in the Oregon assessment. Discard mortality was assumed to be zero for cabezon due to a shallow depth distribution and lack of a swim bladder (Cope and Key, 2009).

Commercial catches in Washington have been trivial relative to recreational removals. Therefore, status assumptions taken from the Oregon assessment are based on years prior to the development of the commercial live-fish fishery in Oregon in the late 1990s. The DB-SRA model assumes that cabezon biomass off Washington in 1997 was 62% of unfished biomass on average, per the Oregon assessment (Cope and Key, 2009). The DCAC model assumes total removals between 1983 and 1997 reduced cabezon biomass by an amount equal to 23% of unfished biomass, based on the difference between 1983 and 1997 depletion estimates in the Oregon assessment. Point estimates of (female) natural mortality and age at maturity were obtained from the Oregon assessment. Parameter distributions and fixed values used in the two models are described in Table 2.

The distribution of sustainable yield produced by the DCAC model has a slightly smaller median that of the overfishing limit (OFL) distribution from the DB-SRA model (Table 3, Figure 2). The dynamic model in DB-SRA results in a much larger (and likely more realistic) estimate of uncertainty in yield. Since both models assume that stock status in Washington follows the Oregon assessment, these results do not differ greatly from a previous OFL estimate derived from adding Washington catches to the Oregon assessment model (Cope et al., 2012). Trends in cabezon biomass off WA were not available to validate the status assumptions of the catch-based methods. Reliability of yield estimates for this substock would be greatly improved by development of an informative index of relative abundance over time, or an estimate of absolute abundance.

Literature Cited

Cope, J. M. and M. Key. 2009. Status of Cabezon (*Scorpaenichthys marmoratus*) in California and Oregon Waters as Assessed in 2009. Pacific Fishery Management Council, 7700 Ambassador Place NE, Suite 200, Portland, OR 97220. 390 pp.

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TABLES AND FIGURES

Table 1. Reconstructed annual catches of cabezon in Washington. Catch in weight (mt) assumes an average weight of 2.2 kg per fish. Estimates from 1987-89 are based on linear interpolation between reported values for 1986 and 1990.

year	catch (numbers)	catch (mt)
1975	330	0.726
1976	316	0.695
1977	165	0.363
1978	449	0.988
1979	239	0.526
1980	390	0.858
1981	313	0.689
1982	473	1.041
1983	1029	2.264
1984	1248	2.746
1985	1153	2.537
1986	1673	3.681
1987		4.179
1988		4.677
1989		5.176
1990	2579	5.674
1991	2129	4.684
1992	3377	7.429
1993	2817	6.197
1994	1967	4.327
1995	2176	4.787
1996	2349	5.168
1997	2758	6.068
1998	2107	4.635
1999	1962	4.316
2000	1941	4.270
2001	2440	5.368
2002	3080	6.776
2003	3044	6.697
2004	3280	7.216
2005	3984	8.765
2006	2634	5.795
2007	2405	5.292
2008	2007	4.416
2009	3039	6.686
2010	3071	6.756
2011	3652	8.035
2012	2816	6.195

Table 2. Parameter values/distributions used in catch-based models for cabezon in Washington. Means are arithmetic means, standard deviations with an * are log-scale standard deviations. Values that are fixed (assumed known without error) are shown in parentheses.

Parameter/Qty.	Distribution	Mean (Value)	SD	Bounds
M	lognormal	0.25	0.4*	0,Inf
F_{MSY}/M	lognormal	0.8	0.1*	0,Inf
B_{MSY}/B_0	beta	0.4	0.05	0.05,0.95
Δ-DBSRA	beta	0.3814	0.1	0.01,0.99
Δ-year	n/a	(1997)	n/a	n/a
Age at maturity	n/a	(4)	n/a	n/a
Δ-DCAC	beta	0.228	0.1	0.01,0.99
DCAC catch years	n/a	(1983-1997)	n/a	n/a
sum(catch)	n/a	(69.59)	n/a	n/a

Table 3. Percentiles of DCAC and DB-SRA yield estimates for cabezon in Washington

Percentile	DCAC	DB-SRA, OFL 2015
2.5%	2.9	0.2
25%	3.6	2.1
50% (median)	**3.9**	**4.0**
75%	4.1	6.6
97.5%	4.4	13.9

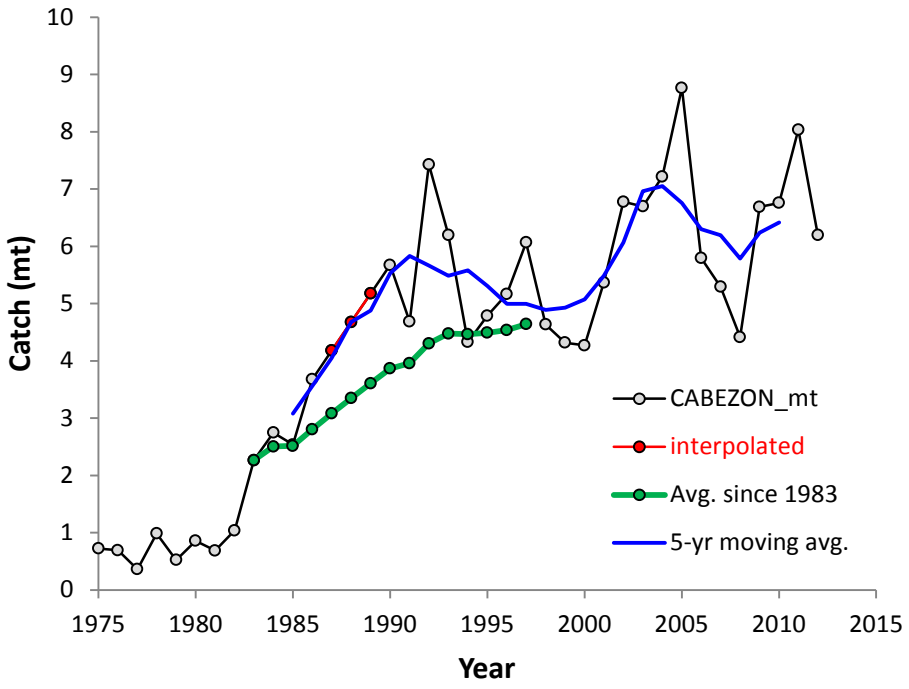

Figure 1. Recreational catch (mt) of cabezon in Washington (Source: WDFW). Numbers of fish were converted to catch in weight using an assumed average weight of 2.2 kg per fish. Estimates for 1987-1989 are based on linear interpolation between reported catch in 1986 and 1990.

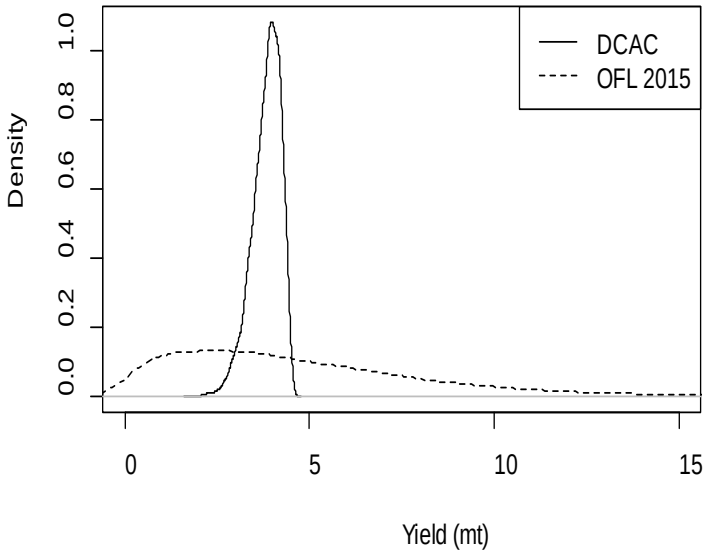

Figure 2. Estimated yield distributions (mt) for cabezon in Washington based on DCAC and DB-SRA (OFL in 2015).