Title: Discussion paper on the F_{35} approach for Aleutian Islands golden king crab reference points calculation

Motivation: The crab fisheries management plan recommends to use a default lambda value of 1 as the natural mortality multiplier unless there is sufficient justification to move away from this value for Tier 4 stocks' OFL calculations (NPFMC 2007). The recent model based overfishing level (OFL) estimates were lower than the total allowable catch prescribed for the stocks in the two management areas in the Aleutian Islands (see May and September 2014 CPT presentations). This motivated us to investigate the F_{35} approach to calculate the OFLs. The F_{35} estimates can either be used entirely under a Tier 3 set up or used to change the lambda value (lambda = F_{35}/M) and remain in the Tier 4 set up for OFL calculation.

F_{35} Approach: We used the length based model estimated parameter values for scenarios 1 (size transition matrix determined without the molt probability sub model) and 4 (size transition matrix determined with the molt probability sub model and also used the standardized fish ticket based retained CPUE for 1985/86 to 1998/99) (Siddeek et al., 2014) to calculate F_{35} reference points. The critical assumptions for reference point estimation are:

a. Natural mortality is constant (0.18) over all 14 size groups.
b. Growth transition matrix is estimated using tagging data with (scenario 1) and without (scenario 4) molt probability.
c. The catchability parameter estimate for the 2005/06-2012/13 period is used.
d. Total and retained fishery selectivities are length depended and the 2005/06-2012/13 period selectivity estimates are used. Groundfish bycatch fishery selectivity is kept constant for all length groups at 1.
e. Model estimated molt probability is not time dependent, but length dependent.
f. Model estimated recruits (in millions of crabs) are averaged for the period 1986 to 2013.
g. Model estimated groundfish bycatch mortality values are averaged for the period 2003 to 2012.

Method: We simulated the population abundance starting from the model estimated terminal year stock size by length, model estimated parameter values, a fishing mortality value (F), and adding a constant number of annual recruits. Once the stock dynamics is stabilized (we used the 99th year estimates) for an F, we calculated the MMB/R for that F. We computed the relative MMBx%/R (i.e., $\frac{? ? ? ?}{? ? ? ?}$ ó È , where

? ? ?? ? is the virgin MMB/R) for different F values. F_{35} is the F that produces the MMBx%/R percent 35. MMB_{35} (or B_{35}) is estimated as,

? ? ?? $\frac{? ? ?_{??}}{?}$ ó ? , where ? is the mean number of model estimated recruits for a selected period.

EAG:

Biomass in million pounds

Season	Tier	B_{35}	Current MMB	MMB/B_{35}	F_{OFL}	Recruitment Years to Define B_{35}	F_{35}	F_{40}	OFL	ABC (P*=0.49)
1) 2014/15	4a	14.779	15.044	1.02	0.36	1986–2013	0.36	0.28	4.270	4.248
4) 2014/15	4a	15.346	17.793	1.16	0.36	1986–2013	0.36	0.28	5.406	5.373

Biomass in 1000 t , and total OFL and ABC are in t.

Season	Tier	B_{35}	Current MMB	MMB/B_{35}	F_{OFL}	Recruitment Years to Define B_{35}	F_{35}	F_{40}	OFL	ABC (P*=0.49)
1) 2014/15	4a	6.704	6.824	1.02	0.36	1986–2013	0.36	0.28	1936.715	1926.746
4) 2014/15	4a	6.961	8.071	1.16	0.36	1986–2013	0.36	0.28	2451.921	2437.060

WAG:

Biomass in million pounds

Season	Tier	B_{35}	Current MMB	MMB/B35	F_{OFL}	Recruitment Years to Define B_{35}	F_{35}	F_{40}	OFL	ABC (P*=0.49)
1) 2014/15	4b	12.505	11.209	0.90	0.30	1986–2013	0.34	0.27	2.390	2.373
4) 2014/15	4a	12.443	12.592	1.01	0.34	1986–2013	0.34	0.27	3.303	3.285

Biomass in 1000 t, and total OFL and ABC are in t.

Season	Tier	B_{35}	Current MMB	MMB/B_{35}	F_{OFL}	Recruitment Years to Define B_{35}	F_{35}	F_{40}	OFL	ABC (P*=0.49)
1) 2014/15	4b	5.672	5.084	0.90	0.30	1986–2013	0.34	0.27	1083.936	1076.488
4) 2014/15	4a	5.644	5.712	1.01	0.34	1986–2013	0.34	0.27	1498.025	1490.263

References

NPFMC (North Pacific Fishery Management Council) 2007. Public Review Draft: Environmental Assessment for proposed Amendment 24 to the Fishery Management Plan for Bering Sea and Aleutian Islands King and Tanner Crabs to Revise Overfishing Definitions. 14 November 2007. North Pacific Fishery Management Council, Anchorage.

Siddeek, M.S.M., J. Zheng, and D. Pengilly. 2014. Aleutian Islands golden king crab (Lithodes aequispinus) model-based stock assessment. Draft report for the September 2014 (Fall) Crab Plan Team Meeting.

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