7   Norton Sound Red King Crab

Fishery information relative to OFL setting

This stock supports three main fisheries: summer commercial, winter commercial, and winter subsistence. The summer commercial fishery, which accounts for the majority of the catch, reached a peak in the late 1970s at a little over 2.9 million pounds retained catch. Retained catches since 1982 have been below 0.5 million pounds, averaging 0.3 million pounds, including several low years in the 1990s. As the crab population rebounded, retained catches have increased to around 0.4 million pounds in recent years.

Data and assessment methodology

Four types of surveys have occurred periodically during the last three decades: summer trawl, summer pot, winter pot, and preseason summer pot, but none of these surveys have been conducted every year. To improve abundance estimates, a male-only length-based model of male crab abundance was previously developed that combines multiple sources of data. A maximum likelihood approach was used to estimate abundance, recruitment, and selectivity and catchability of the commercial pot gear. The model has been updated to include the following data: 1980–2012 winter pot survey; 2013/2015 winter commercial and subsistence catches; revised commercial catch CPUE for 1977-2015; and the 1976–2015 triennial trawl survey data. The current model assumes a constant $M=0.18yr^{-1}$ for all length classes except the length classes of $> 123mmCL$, which had an estimated value of $0.641yr^{-1}$. Logistic functions are used to describe fishery and survey selectivities, except for a dome-shaped function examined for the winter pot fishery. The model timeline was also revised to have the assessment year start February 1.

The author summarized fifteen model run alternatives, in conjunction with the base model (Model 0). The author recommended, and the CPT selected, Model 5 as the recommended configuration. This model contains an estimated multiplier from the baseline natural mortality rate for the length bins of greater than 123mm CL, expanded length classes from the previous configuration of 6 length classes from 74 to >123mm CL to 8 length classes from 64 to >133mm, but the same 10 mmlength interval. Other attributes were similar to the base model from the previous assessment. Model 5 had the best retrospective pattern and the lowest Mohn's rho compared with the other configurations.

Stock biomass and recruitment trends

Mature male biomass was estimated to be at an historic low in 1982 following a crash from the peak biomass in 1977. The MMB then exhibited an increase from a recent low in 1997 to a peak in 2010, before declining in recent years. Estimated recruitment was weak during the late 1970s and high during the early 1980s, with a slight downward trend from 1983 to 1993. Estimated recruitment has generally been variable, with a slight increase in recent years.

Tier determination/Plan Team discussion and resulting OFL and ABC determination

The team recommended Tier 4, stock status a, for Norton Sound red king crab. The estimated abundance and biomass in 2016 using Model 5 are: Mature male biomass on Feb. 1: 5.87million lb (2.66 thousand t).

The $B_{MSY\ proxy}$, calculated as the average of mature male biomass on Feb. 1 during 1980-2016, was $B_{MSY\ proxy}$ = 4.53 million lb. The $F_{MSY\ proxy}$ is M =0.18 yr^{-1} and the $F_{OFL}=0.18yr^{-1}$, because the 2016 mature male biomass is larger than $B_{MSY\ proxy}$ with the CPT choosing the default of gamma =1.0.

The maximum permissible ABC would be 0.71 million lb, based on projectedretained catch on July 1. The CPT recommended an ABC less than the maximum permissible due to concerns with model

specification, lack of bycatch data as well as issues noted with the M employed for the largest length group. The CPT recommended an ABC = 80% of the OFL (20% buffer) of 0.568 million lb.

Status and catch specifications (1000t)

Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2012/13	0.80	1.93	0.21	0.21	0.21	0.24[A]	0.22
2013/14	0.93	2.27	0.23	0.16	0.16	0.26[B]	0.24
2014/15	0.96	1.68	0.17	0.18	0.18	0.21[C]	0.19
2015	1.09	2.33	0.18	0.18	0.24	0.33[D]	0.26
2016	1.03	2.66	TBD	TBD	TBD	0.32[E]	0.26

Status and catch specifications (million lb.)

Year	MSST	Biomass (MMB)	GHL	Retained Catch	Total Catch	OFL	ABC
2012/13	1.76	4.59	0.47	0.47	0.47	0.53[A]	0.48
2013/14	2.06	5.00	0.50	0.35	0.35	0.58[B]	0.52
2014/15	2.11	3.71	0.38	0.39	0.39	0.46[C]	0.42
2015	2.41	5.13	0.39	0.40	0.52	0.72[D]	0.58
2016	2.26	5.87	TBD	TBD	TBD	0.71[E]	0.57

Total catch in 2015/16 did not exceed the OFL for this stock, thus overfishing is not occurring. Stock biomass is above MSST; thus, the stock is not overfished.

Additional Plan Team recommendations

The CPT has the following recommendations for the next assessment:
- Calculate OFL by including length class wise M from Feb 1 to July 1.
- Provide OFL values calculated assuming:
  - The winter fishery will take 8% of the OFL
  - The winter fishery will take X% of the OFL, where X = the average fraction taken by the winter fishery over the last few (e.g., 5) years.
- Evaluate whether using a growth function that "slows" growth prior to the largest size bins can improve overestimation of abundance of large crab
  - Consider a piece-wise linear model (like that used for snow crab)
  - Consider treating molting probability using random walk parameters
- Evaluate applying the natural mortality multiplier 'ms' to only the largest size bin, not all bins > 123 mm.
- Evaluate estimating selectivity in the summer pot fishery in two time periods: before and after the change in buyers' preferred size (2005)
- For time series plots that include $B_{MSY\,proxy}$, do not extend the line indicating $B_{MSY\,proxy}$ beyond the temporal extent used to calculate it