Surat Thani Blue Swimming Crab

Fishery Improvement Project

Milestone 19: Report of LB-SPR analysis (Data from Year 2021 – data collection)

Background: The length-based spawning potential ratio (LB-SPR, Hordyk et al. 2016) has been conducted to assess the stock status of the blue swimming crab (BSC) in the Ban Don Bay fishing ground.

Sources of data: The BSC samples were from the landing sites around the Bandon Bay and conducted between June and December 2021. In total, 1,482 individuals were collected, in which the outer carapace width (ICW) and weight ranged 6.5 and 16.0 cm. There were 208 females, ranged between 7.5 and 15.4 cm OCW, used for estimating sized at 50% maturity.

Data analyses: Because the data was limited to 6 months and the growth curve was not well performed. The asymptotic length was estimated by $0.95(L_{max})$ and the curvature parameters was adjusted by using growth performance index (ϕ', Munro and Paly, 1983), which the value is approximately at 2.57 (Nillrat et al. 2019). The total, Z, mortality coefficient was estimated by the length converted catch curve (Pauly, 1984). Meanwhile, the natural, M, mortality coefficient was estimated by Rikhter and Efanov's Formula (Rikhter and Efanov, 1976) using size at 50% maturity as input. The fishing, F, mortality coefficient was estimated as Z-M. Size at selectivity was estimated through probability of capture curve (Pauly, 1984). The mentioned input parameters were estimated by using the FiSAT II package (FAO-ICLARM Stock Assessment Tool, Gayanilo et al., 2005). Meanwhile, the LB-SPR was estimated by using Package "LBSPR" for Program R (Hordyk, 2019).

Results: The maximum- and asymptotic- OCW were 16.0 and 15.2 cm, respectively. The curvature parameter (K) was then estimated at 1.6 year^{-1} (Fig. 1). Length at 50% maturity was estimated at 9.64 cm ICW, which took about 0.5 year to reach this size. The Z- and M-mortality coefficients were estimated at 4.38 (Fig. 2) and 2.04 year^{-1}, respectively, and then F- mortality coefficients was 2.34 year^{-1}. The probability of capture curve (Fig. 3) revealed that size at 50% and 75% selectivity were 9.8 and 10.1 cm ICW, respectively. From these obtained parameters, the estimated spawning potential ratio (SPR) of the BSC stock in Ban Don Bay was at 0.46, i.e. 46% (Fig. 4). Interestingly, the %SPR from this data set is beyond the general reference point at 40% SPR (Goodyear, 1989). However, caution should be made on the limited 6 month data.

References

Gayanilo, F.C.Jr., Sparre, P., Pauly, D. 2005. FAO-ICLARM Stock Assessment Tools II (FiSAT II). Revised version. User's guide. FAO Computerized Information Series (Fisheries). No. 8, Revised version. Rome, FAO. 168 p.

Goodyear, C.P., 1989. Spawning stock biomass per recruit: the biological basis for a fisheries management tool. ICCAT working document SCRS/89/82, 10.

Hordyk A.R. 2019. LBSPR: Length-Based Spawning Potential Ratio. R package version 0.1.4. https://CRAN.R-project.org/package=LBSPR

Hordyk A.R., Ono K., Prince J.D. and Walter C.J. 2016. A simple length-structured model based on life history ratios and incorporating size-dependent selectivity: application to spawning potential ratios for data-poor stocks. Can. J. Fish. Aquat. Sci. 73: 1787–1799 (2016) dx.doi.org/10.1139/cjfas-2015-0422

Munro, J. L. and D. Pauly. 1983. A simple method for comparing the growth of fishes and invertebrates. Fishbyte 1 (1): 5-6

Pauly, D. 1984. Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Stud.Rev. (8):325p

Rikhter, V. A., and V. N. Efanov. 1976. On one of the approaches to estimation of natural mortality of fish populations. ICNAF Res. Doc., 76/VI/8: 12 p.
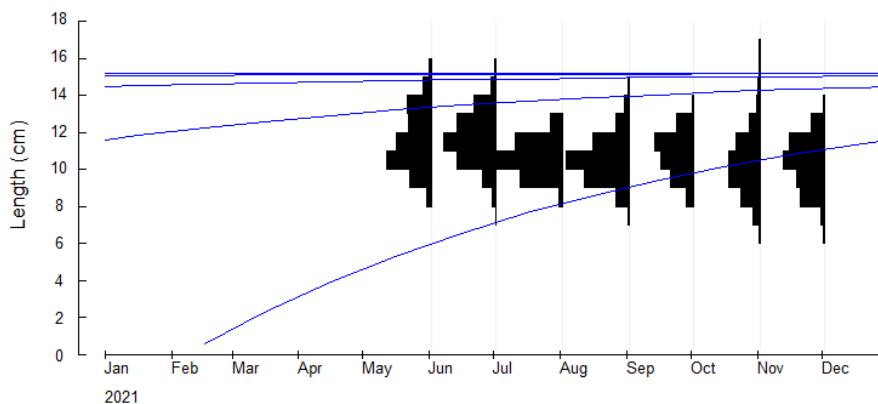
Fig. 1 Size distribution and growth curves of blue swimming crab in Ban Don Day, Surat Thani, Thailand, incorporated with the von Bertalanffy's growth curve.
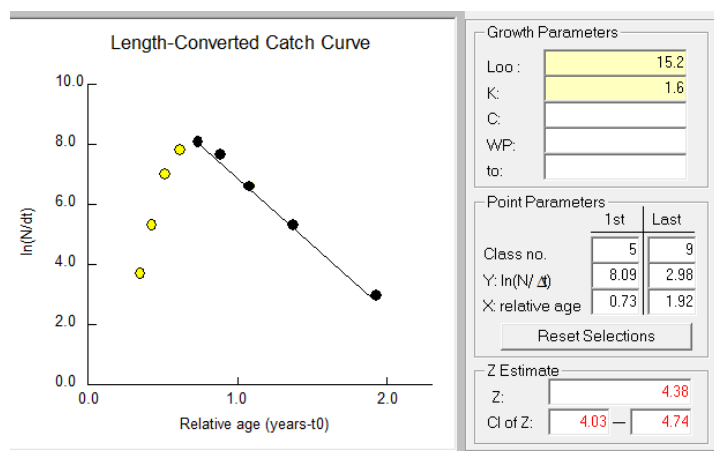
Fig. 2 Total, Z, mortality estimation from length-converted catch curve in FiSAT from length frequency data used in this study.
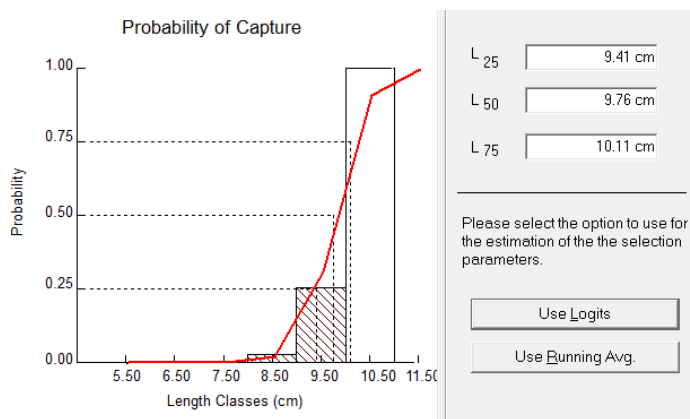
Fig. 3 Probability of capture of blue swimming crab in Ban Don Day, Surat Thani from length frequency data used in this study.
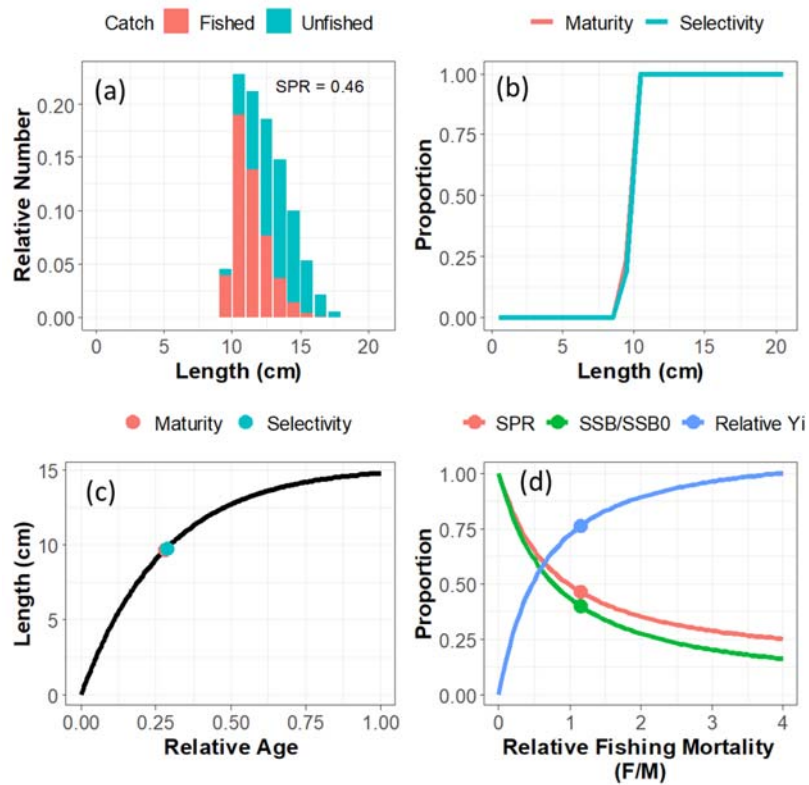
Fig. 4 Output from the LB-SPR analysis of blue swimming crab in Ban Don Day, Surat Thani.

(a) the expected (equilibrium) size structure of the catch and the expected unfished size structure of the vulnerable population, (b) the maturity and selectivity-at-length curves, (c) the growth curve with relative age, and (d) the SPR and relative yield curves as a function of relative fishing mortality.

Supplement Table 1 Data used for maturity estimation

ICW (cm) (lower limit)	Number of Samples	Number of maturities	Proportion of maturities
7	1	1	1.00*
8	17	7	0.41
9	42	20	0.48
10	65	30	0.46
11	53	32	0.60
12	14	11	0.79
13	7	5	0.71
14	8	5	0.63*
15	1	1	1.00*

Supplement Table 2 Length frequency data

ICW (cm)	June	July	August	September	October	November	December
6_7						2	1
7_8	0	1		2		9	5
8_9	7	5	5	18	9	26	33
9_10	29	19	57	61	31	42	37
10_11	60	53	98	84	44	42	56
11_12	48	70	63	49	52	32	48
12_13	31	53	17	18	23	15	18
13_14	33	30		7	1	5	2
14_15	11	7		1		3	
15_16	4	2				2	
16_17						1	

Supplement 3 Script for LBSPR analysis

```
library(LBSPR)
### Make scenrio ###
MyBSC <- new("LB_pars")
MyBSC@L_units <- "cm"
MyBSC@BinWidth <- 1
MyBSC@BinMax <- 21 #Using default of 1.3 Linf
MyBSC@BinMin <- 0
### Biology parameters
MyBSC@Linf <- 15.2
MyBSC@L50 <- 9.64 ##Length at 50% maturity
MyBSC@L95 <- 10.0 ##Length at 95% maturity
MyBSC@MK <- 1.275 ##M/K ratio M=2.04, K = 1.6
### Exploitation
MyBSC@SL50 <- 9.7 # Probability of capture
MyBSC@SL95 <- 10.1 # Probability of capture
MyBSC@FM <- 1.15
### Run the LBSPR simulation model.
BSCSim <- LBSPRsim(MyBSC)
BSCSim@FM
plotSim(BSCSim)
```