

Estimation of mortality and exploitation rate of Cobia, *Rachycentron canadum* (Linnaeus, 1766) occurring in North West coast of India

M.K. Sajeevan^{*1} & B. Madhusoodana Kurup¹

^{* 1} Kerala University of Fisheries and Ocean Studies, Panangad, Kochi- 682506, India

[E.Mail: sajeevanfsi@gmail.com]

Received 30 April 2015 ; revised 16 November 2016

Specimens collected from resource survey vessels and commercial vessels from Mumbai were utilized for the study. Growth parameters; asymptotic length (L_{∞}), growth coefficient (K) and age of fish at length zero (t_0), estimated were 194.25, 0.24 and -0.615 respectively. Natural mortality coefficient estimated following Cushing and Pauly methods were 0.354 and 0.416 respectively. Total mortality value obtained following Beverton and Holt model was 0.77 against 0.76 obtained by catch curve method. Fishing mortality (F) and exploitation ratio (E) estimated were 0.36 and 0.47.

[**Keywords:** Mortality of cobia; Stock assessment; cobia fishery; Population dynamics of cobia; Cobia fishery]

Introduction

Information on mortality rate is essential for formulation of exploitation strategy and thereby exploit and manage the fishery resources at optimal levels. Mortality estimates have been done in almost all major exploited fish stocks with a view to arrive at optimum levels of exploitation. Mortality estimates of Cobia inhabiting Chesapeake Bay¹, Gulf of Mexico² and Australia³ were carried out by Richards (1967), Williams (2001) and Fry and Griffiths (2010) which provided basic information on the dynamics of the Cobia stock. However, no information is available on mortality and exploitation of cobia occurring in Indian waters. In India, there is no target fishery for cobia, they are mostly caught as bycatch from trawlers, hook and line and gill nets⁴. Compare to other major pelagic resources, cobia landings were very less in quantity. However, fast growth rate, high demand in market and high unit prize make cobia an important resource. Hence an attempt has been made to estimate the mortality and exploitation rate of cobia occurring in North West coast of India.

Materials and Methods

Cobia specimens caught during the fishery resource survey of the vessel *MV MatsyaNireekshani* (Survey vessel belonging to the Fishery survey of India, Mumbai) for the period January 2008 to December 2009 were utilised for the study. To ensure representation from commercial fishery, specimens collected from Mumbai landing centers were also utilized for the study. A total of 1261 specimens having total length ranging from 22.6 cm to 181cm of cobia were grouped in to length classes of 10 cm interval and analysed using FAO-ICLARM Stock Assessment Tools (FISAT)⁵. Growth parameters, namely asymptotic length (L_{∞}) growth coefficient (K) and age of fish at length zero (t_0) were estimated following Ford Walford plot⁶⁻⁷ and von Bertalanffy plot⁸ were used as input parameters⁴.

The instantaneous rate of natural mortality (M) was estimated following Pauly's empirical formula⁹⁻¹⁰ and Cushing formula¹¹⁻¹². The age of longest fish, calculated following Von Bertalanffy Growth Function (VBGF) equation of the fish and Length maximum

($L_{\max}$)¹³ were utilised as input parameters for the Cushing formula¹¹⁻¹². The instantaneous rate of total mortality (Z) was estimated following the Beverton and Holt model¹⁴ and length converted catch curve method^{10, 15}. Following estimation of Z, the routine was used to estimate fishing mortality (F) following Pauly's M equation and Z following $F = Z - M$. The exploitation ratio (E) was estimated from the formula $E = F/Z$.

Results and discussion

Growth parameters, namely asymptotic length (L_{∞}), growth coefficient (K) and age of fish at length zero (t_0), estimated following Ford Walford plot and von Bertalanffy plot were 194.25, 0.24 and -0.615 respectively. The mean annual habitat temperature recorded during the study was 28°C, which was substituted in the Pauly's empirical formula. Natural mortality thus obtained as per Pauly's empirical formula was 0.416. Length maximum ($L_{\max}$) estimated was 185 cm and natural mortality coefficient thus estimated following Cushing formula was 0.354.

Values obtained estimated following Cushing¹¹⁻¹² and Pauly's empirical formula⁹ were found to be very close and were less than 0.5. However, value obtained by Pauly's empirical formula was used for further calculation, as the same is considered as more reliable and are based on interrelationship between VBGF parameters and mean habitat temperature.

All natural mortality coefficient values below 0.5 were considered as law. Hence, natural mortality of cobia estimated by the present study is an indication of low mortality rate and further indicates that more fishing effort is needed to achieve maximum sustainable yield.

Mortality rates of *Rachycentroncanadum* reported by various authors from different localities are furnished as Table 1. Natural mortality rate reported by different authors were below 0.5 which ranged from 0.2- 0.41. Mortality rate reported from Chesapeake Bay¹ and Gulf of Mexico² are comparable with the result of the present study. As showed in Table. 1, natural mortality of cobia occurring along North West coast of India was estimated by earlier study¹⁷ was 0.36. Present study estimated natural mortality at 0.41 from the same area. Differences in the mean habitat temperature (25°C by earlier study¹⁷ and 28°C by the present study) may be the reason for differences in the mortality rates estimated by both studies.

Total mortality value obtained following Beverton and Holt model was 0.77 while value computed by

catch curve method was 0.76. Total mortality value obtained following Beverton and Holt model and catch curve method were almost closer; this indicates the reliability of the estimation. However, value estimated by catch curve method was considered as the best as this method is based on more input parameters than Beverton and Holt model. Total mortality value estimated by the present study is in agreement with the results of earlier studies^{2, 18-19}.

Table 1. Mortality rates of *Rachycentron canadum* reported by various authors from different localities

Mortality			Location	Author/s
Natural (M)	Fishing (F)	Total (Z)		
0.2-0.4	-	-	Chesapeake Bay	Richards (1967)
0.24	-	-	Gulf of Aden	Edword <i>et al.</i> (1985)
-	-	0.75	Northeastern Gulf of Mexico	Franks <i>et al.</i> (1999)
0.36	-	-	North west coast of India	Somvanshi <i>et al.</i> (2000)
0.2-0.4	-	0.72	Gulf of Mexico	Williams (2001)
0.35	-	0.85	North and eastern Australia	Fry and Griffiths (2010)
0.41	0.36	0.76	North west coast of India	Present study

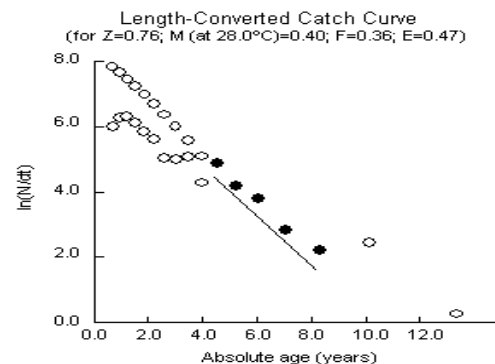


Fig.1. Length converted catch curve of *Rachycentroncanadum* inhabiting along North West coast of India

Length converted catch curve of Cobia made by plotting relative age against $\ln(N/Dt)$ is shown in Fig. 1. As showed in the Fig. 1 Fishing mortality (F) was estimated at 0.36 while exploitation ratio (E) as 0.47.

Results of Relative yield per recruit and biomass per recruit study carried out⁴ showed that the present exploitation ratio (0.47) is an indication of optimum or fully exploited state of the stock. Any further increase of fishing effort will lead to over exploitation and subsequently leads to the collapse of the fishery.

Acknowledgement

Authors are grateful to Prof. (Dr.) A. Ramachandran, Director, School of Industrial Fisheries; Dr. K. Vijayakumaran, Director General, Fishery Survey of India, Mumbai; Dr. V.S. Somvanshi, Former Director General, Fishery Survey of India, Mumbai for providing necessary facilities. Extra efforts of the officers and crew of M.V. *MatsyaNireekshani* are also acknowledged.

References

- Richards, C. E. Age, growth, and fecundity of the cobia, *Rachycentron canadum*, from Chesapeake Bay and adjacent mid-Atlantic waters. *Trans. Am. Fish. Soc.*, 96(3) (1967) 343-350.
- Williams, E. H. Assessment of cobia, *Rachycentron canadum*, in the waters of the U.S. Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFSC.469. (National Oceanic and Atmospheric Administration. National Marine Fisheries Services, Seattle, WA) 2001, pp. 61.
- Fry, G.C. and Griffiths, S.P. Population dynamics and stock status of cobia, *Rachycentron canadum* caught in Australian recreational and commercial coastal fisheries. *Fish. Manage. Ecol.*, 17(3) (2010) 231-239.
- Sajeevan, M.K. Systematics, life history traits, abundance and stock assessment of Cobia *Rachycentron canadum* (Linnaeus, 1766) occurring in Indian waters with special reference to the northwest coast of India. Ph.D. Thesis, Cochin University of Science and Technology, Kochi, India. 2011.
- Gayanilo, Jr. F.C., Sparre, P. and Pauly, D. *FiSAT II. Users manual*. (Food and Agriculture Organization. Rome) 2005, pp. 255.
- Ford, E. An account of herring investigations conducted at Plymouth during the year 1924-1933. *J. Mar. Biol. Assoc. U.K.*, 19(1933) 305-384.
- Walford, L.A. A new graphic method of describing the growth of animals. *Biol. Bull. Mar. Lab.*, 90 (1946) 141-147.
- Bertalanffy von, L. Quantitative laws in metabolism and growth. *Quart. Rev. Biol.*, 32(1957) 217-231.
- Pauly, D. On the interrelationship between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *J. Cons. CIEM.*, 39(3) (1980) 56-60.
- Pauly, D. *Fish population dynamics in tropical waters: a manual for use with programmable calculations*. ICLARM. Stud. Rev. 8. (International Center for Living Aquatic Resources Management, Manila, Philippines) 1984, pp. 325.
- Cushing, D.H. *Fishery Biology- A study in population dynamics*. (University Wisconsin Press, Madison) 1968, pp. 200.
- Cushing, D.H. The decline of herring stocks and the gadoid outburst. *J. Cons. CIEM.*, 39(1) (1980) 70-81.
- Formacion, S.P., Rongo, J.M. and Sambilay, V.C. Extreme value theory applied to the statistical distribution of the largest lengths of fish. *Asian Fish. Sci.*, 4 (1992) 123-135.
- Beverton, F. J. H. and Holt, S. J. A review of methods for estimating mortality rates in fish populations, with special reference to sources of bias in catch sampling. *Rapp. P.V. Reun. CIEM.*, 140(1956) 67-83.
- Pauly, D. Length-converted catch curves and the seasonal growth of fishes. *Fishbyte*, 8(3) (1990) 33-38.
- King, M. *Fisheries biology, assessment and management*. (Fishing news books, Oxford, England) 1995, pp. 341.
- Somvanshi, V.S., Vargese, S., Gulati, D.K., Bhargava, A.K. Some Biological aspects of kingfish *Rachycentron canadum* (Linnaeus, 1766) from the north-west Indian EEZ. *Occasional Papers Fishery Survey of India*. 10. Fishery Survey of India, Mumbai, 36 pp. Edwards, R.R.C., Bakhader, A. and Shaher, S. 1985. Growth, mortality, age composition and fishery yields of fish from the Gulf of Aden. *J. Fish Biol.*, 27(2000) 13-21.
- Franks, J. S., Warren, J. R. and Buchanan, M. V. Age and growth of cobia, *Rachycentron canadum*, from the northeastern Gulf of Mexico. *Fish. Bull.*, 97(3) (1999) 459-471.
- Fry, G.C. and Griffiths, S.P. Population dynamics and stock status of cobia, *Rachycentron canadum* caught in Australian recreational and commercial coastal fisheries. *Fish. Manage. Ecol.*, 17(3) (2010) 231-239.