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Stock Assessment of Heavybeak Parrotfish *Scarus gibbus* (Ruppell, 1829) (Family: Scaridae) off Tuticorin Coast, India (08°53.6'N, 78°16'E and 08°53.8'N, 78°32'E) – 36M

Thiruvengadam Vaitheeswaran [1], V. K. Venkataramani [2]

1 Tilapia Project-Hatchery Technical and Head Victoria Treasures Limited, Bugabo Bay Garuga on Victoria Lake, Kampala, Uganda, East Africa

2 Former Dean, Fisheries College and Research Institute, Tamil Nadu Fisheries University, Tamil Nadu, India

Corresponding author Email: frs69@rediffmail.com

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Abstract The commercial important coral reef fishes viable source, re-aggregating, have been exploited coral reef parrot fish in pears coast of Gulf of Mannar. Its beautifully colour parrot fish reported between ranges 08°53.6'N, 78°16'E and 08°53.8'N, 78°32'E at a depth of 36 m. The parrot fishing of natural mortality (M), fishing mortality (F) and total mortality (Z) was calculated at 0.47, 0.40 and 0.87, respectively. Growth equation based on modified von Bertalanffy's equation and Ford-Walford graph was arrived. The growth parameters such as L∞ = 104.50 cm and K = 0.23 was estimated combining both sexes. Length and weight frequency data obtained from the growth equation, has been dealing with *S. gibbus* attains the length of 21.96, 39.21, 51.76, 62.74, 70.58, 77.64 and 83.13 mm during first and seventh year respectively. The spawning peaks one in December and another in April could be observed. The life span of *S. gibbus* was estimated for seven years. The exploitation ratio of 0.46 indicated that the resource of *S. gibbus* is currently exploited along the Tuticorin coast. Heavy fishing pressure on the length group 6 to 81 cm revealed that *S. gibbus* in Tuticorin waters suffer due to recruitment overfishing. The present level of exploitation rate and exploitation ratio (F/Z) is estimated at 0.46 and 0.5 respectively. The average length of parrot fish, the beginning capture (Lc) was calculated as 20.0 cm. The total stock, average annual stock and maximum sustainable yield were estimated as 35.150 tonnes, 9.385 tonnes and 10.206 tonnes respectively. Virtual Population Analysis have been assessing the mortality ranges from 85 cm. The parrot fish study shows that the further stressed that strict management measures need to be undertaken to conserve this species from further to avoid exploitation and to restore the biodiversity of heavybeak parrotfish population of Gulf of Mannar in general and Tuticorin coast in particular.

Keywords *Scarus gibbus*; Population dynamics; Age and growth; Thoothukudi coast; Recruitment pattern; India

1 Background

The nest building of parrotfish is always a unique group of parrot fish (Family: Scaridae) in pearl coast of India. Parrot fish have been found in tropical, sub-tropical, Indo-Pacific, partial temperate countries and Indian Oceans, its habitat only for coral associate fishes, have been reported that the herbivorous food and feeding habit. Streelman and Alfaro (2002) have been reported that the 90 species of parrotfish in the group of (Family: Scaridae). Randall (1974) has been revealed that the parrot fish feeds on coral polyps and algae. Study revealed that the marine ornamental fish has been reported in the Gulf of Mannar, 113 species of fish from 24 families (Venkataramani et al., 2005). Tamil Nadu ranks 5th in total fish production of the country and the total fish production of the Tamil Nadu State during 2014-15 were 6.97 lakhs tonnes. The export of marine products of 93,477 MT and earned a foreign exchange of Rs. 5,308.17 crores during 2014-15 (Rupees). The fisheries sector of Tamil Nadu has contributed 0.7 percent of the total Gross State Domestic Product (GSDP) of the State (Policy note, 2015-2016). The present investigation, to estimate asymptotic length (L∞), growth coefficient (K), natural mortality (M), fishing mortality (F), total mortality (Z), exploitation ratio (E) and recruitment pattern (Lc/L∞); where Lc is length at first capture) and M/K and length-weight relationship of *S. gibbus* off Tuticorin coast of Gulf of Mannar, India.

2 Materials and Methods

The length frequency data, catch and effort data have been collected from Tuticorin coast of Gulf of Mannar from January 2004 to December 2004. *S. gibbus* the catch and effort data have been assessing for the estimation growth parameters by ELEFAN Programme (Gayanilo et.al., 1995), mortality, exploitation rates and recruitment pattern by using FiSAT programme (Gyanilo and Pauly, 1997). 'L∞' and 'K' was calculated by Ford-Walford plot (Ford, 1933; Walford, 1946) of Lt against Lt + 1 on mortality basis and 't_0' was calculated by Gulland and Holt's (1959) plot. The growth was expressed using von Bertalanffy's (1938) equation given as

$$Lt = L\infty \left(1 - e - K(t - t_0)\right)$$

Where L∞ is the asymptotic length 'K' Growth coefficient

3 Results and Discussion

Scarus gibbus, the wide range of variety of length group of fishes are characterized by proliferate of growth (depends upon tropical or temperate continent), age-at-first maturity spawning capability, in which are characteristic of r and k theory of perciform the selected species. The conservation of scarid species, off Tuticorin coast of India, is to avoid overfishing in this geographical zone.

3.1 Growth parameters

Figure 1 shows restructured length distribution for the computed growth curve. The von Bertalanffy growth equation for *S. gibbus* was estimated as L∞ = 104.50 and K = 0.23. Choat and Axe (1996) has been revealed that the bumphead parrotfish (*Bolbometopon muricatum*) to attain to the maximum reach at 1000 mm at Solomon Islands (Hamilton, 2004). *S. gibbus* is relatively moderate in growth K = 0.23. According to Sparre and Venema (1993) has suggested that the same genus group and related the species level was K and natural mortality, and it is related to same age and the length and weight of the fish. The M value was calculated 0.47 and the M/K ratio of *S. gibbus* was estimated 2.04. The M/K value is found to be in close proximity limit among the closely associated species (Beverton and Holt, 1956). The M/K ration, *S. gibbus* have been decreasing within the range of 2.0-3.0. Genus *Scaridae*, the species level was closely associated group, the result shows that the similar K and L∞ values have life-span varying by a factor of 2-4, *Chlorurus microrhinos* (K = 0.307, L∞ = 428, T_{max} = 15), *Chlorurus sordidus* (K = 1.117, L∞ = 193, T_{max} = 9), *Hipposcarus longiceps* (K = 0.282, L∞ = 350, T_{max} = 12), *Bolbometpon muricatum* (K = 0.136, L∞ = 693.81, t_0 = -0.11), *Cetoscarus bicolor* (K = 0.255, L∞ = 420.56, t_0 = -0.09), *Chlorurus microrhinos* (K = 0.301, L∞ = 429.89, t_0 = -0.08), *Scarus frenatus* (K = 0.844, L∞ = 232.36, t_0 = -0.05), *Scarus niger* (K = 0.736, L∞ = 238.01, t_0 = -0.06), *Scarus psitticus* (K = 1.190, L∞ = 172.10, t_0 = -0.05), *Scarus rivulatus* (K = 0.220, L∞ = 308.50, t_0 = -0.15), *Scarus schlegeli* (K = 0.403, L∞ = 238.81, t_0 = -0.11), *Sparisoma atomrium* (K = 1.828, L∞ = 101.08, t_0 = -0.06), *Sparisoma aurofrenatum* (K = 1.163, L∞ = 170.89, t_0 = -0.05), *Sparisoma chrysopterum* (K = 1.176, L∞ = 237.97, t_0 = -0.04), *Sparisoma rubripinne* (K = 0.811, L∞ =237.57, t_0 = -0.05) and *Sparisoma viride* (K = 0.498, L∞ = 318.96, t_0 = -0.06) (Choat and Robertson, 2002).

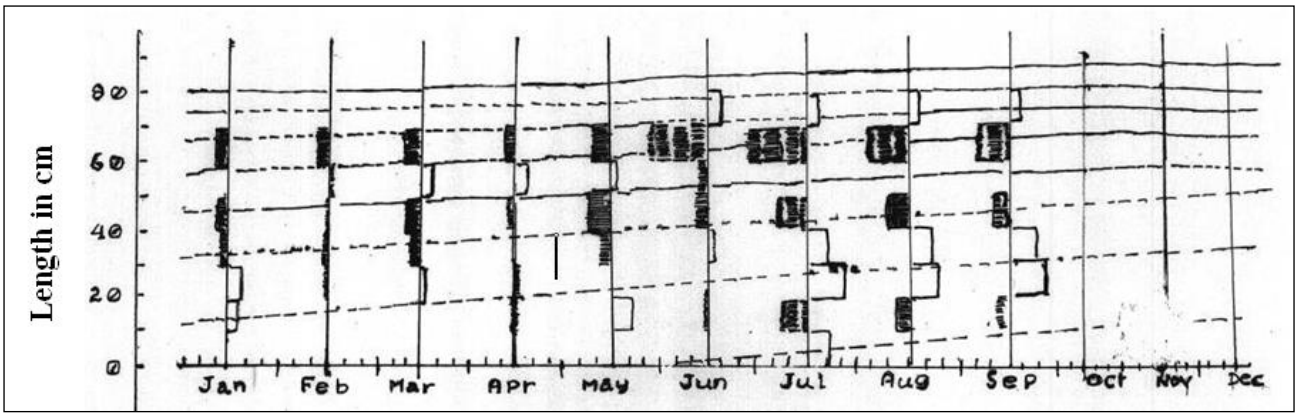

Figure 1 Estimation of growth parameter through ELEFAN I programme of *Scarus gibbus*

The total mortality (Z) and fishing mortality (F) was calculated 0.87 and 0.40, respectively. Figure 2 showing the catch curve was estimated by Z. In the present study deal with exploitation ratio (E) was estimated as 0.53. As the E is <0.5, it was estimated stock of *S. gibbus* along southeast coast is under much fishing pressure. The asymptotic length (L∞) and growth coefficient (K) have been calculated from the Ford-Walford plot was L∞ = 157.75 cm and K = 0.06. The estimated was t_0 = -0.47 year. Total mortality (Z = F + M) was calculated using the method of Beverton and Holt (1956) and natural mortality (M) using Pauly's formula (Pauly, 1978). *Bolbometopon muricatum* the estimated growth rate was (K = 0.063) and, life span of *S. gibbus* was estimated for seven years. According to Gulland (1971), if the E is >0.5 the stock may be considered as overfished. The results of Virtual Population Analysis showed the F increases to a maximum at 40 cm (Figure 3).

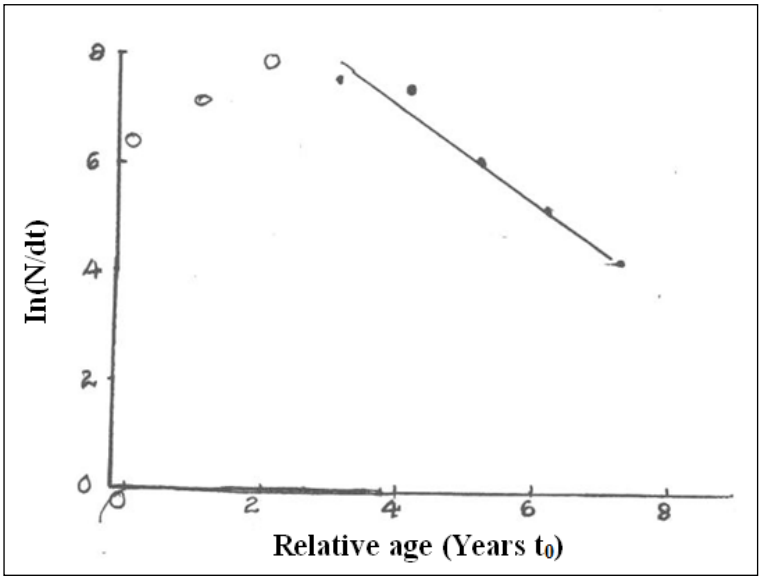

Figure 2 Total mortality estimates by-catch curve method of *Scarus gibbus*

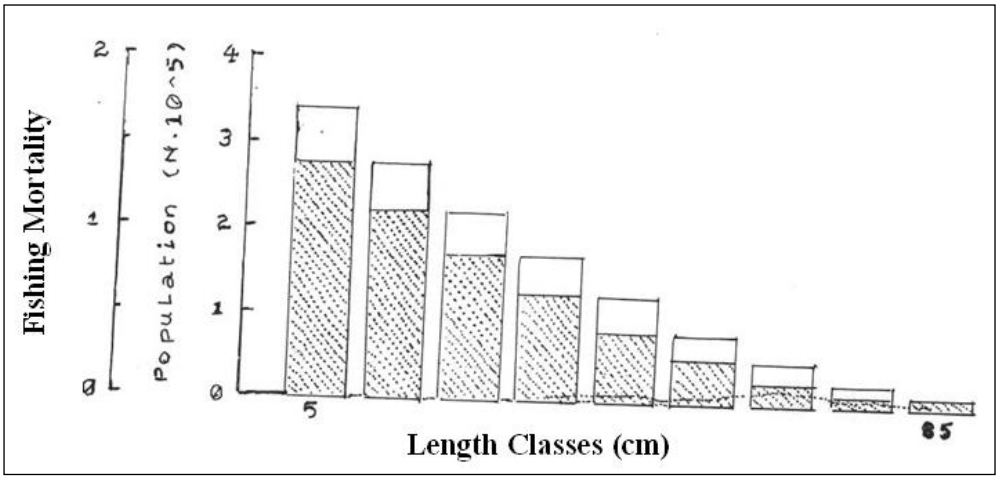

Figure 3 Virtual population analyses

3.2 Age and growth

S. gibbus, the large 264 trawlers in Tuticorin coast, the length ranges from 8.1 to 81 cm. The estimated of asymptotic length (L∞) was obtained by Powell and Wetherall (1986) was calculated L∞ = 104.50 and K = 0.23 (Figure 2). Randall and Bruce (1983) has been studied reveal that the green humphead parrotfish, *Bolbometopon muricatum*, estimated was 117 cm and weight was 46 kg. Family *Pomacentridae*, the related group of species, the length group was 60 mm and age was 16-18 years (Fowler and Doherty, 1992). The following growth parameters have been estimated by ELEFAN I method and it was L∞ = 104.50 cm and K = 0.23. *S. gibbus* the growth was calculated 21.96 and 39.21 mm, the first and second year respectively (Figure 1).

Total mortality coefficient (Z) estimated was 0.87 (Figure 2). Natural mortality was calculated 0.47 (M) and fishing mortality was 0.40. The exploitation rate (F/Z) estimated was 0.5 (Figure 4). Two peak spawning seasons was calculated during the month of December and April (Figure 5). The total potential resource is being over exploited from Tuticorin coast of Gulf of Mannar.

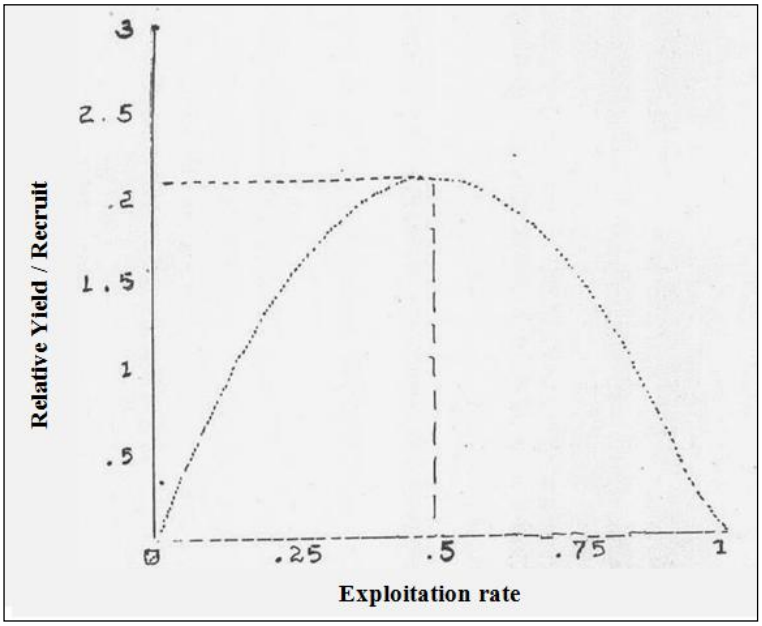

Figure 4 Relative yield-per-recruit and biomass-per-recruit *Scarus gibbus* (Lc /L∞ = 0.032. M/K = 2.04)

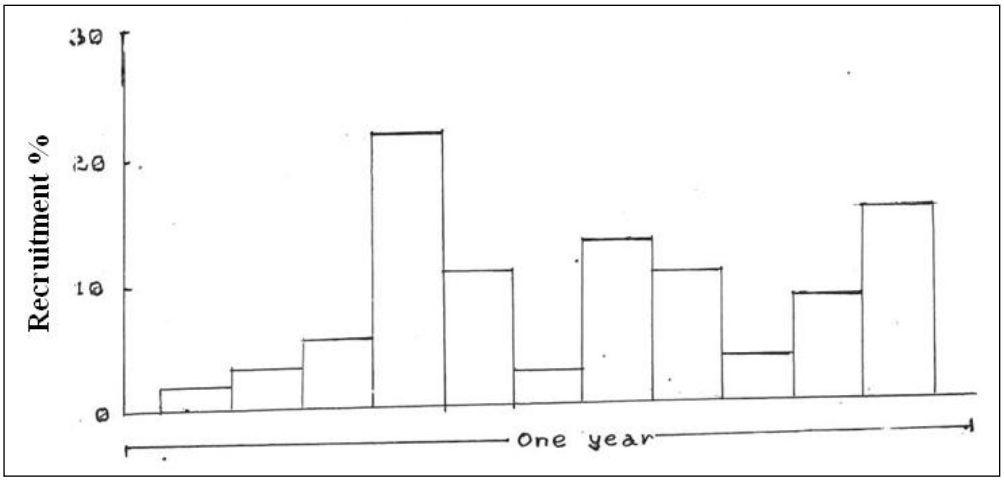

Figure 5 Recruitment pattern of *Scarus gibbus*

Length calculated for different years using von Bertalanffy's growth equation was plotted along with the observed length of the same period which showed a general agreement in the growth pattern. This also showed high degree of agreement with other methods employed. Ford-Warlford graph was constructed for *S. gibbus* by plotting Lt + 1 against Lt where Lt is the height of the animal at a particular age. Lt + 1 when intersected by a 45 °diagonal from the origin, L (length at infinity) was obtained and it was found to be 83.13 cm for this species. In the present study, age and growth were studied through different methods. However, von Bertalanffy's equation showed agreement and gave reliable results. This heavy-beak parrot fish was found to have two recruitment seasons, one major season, during December and a minor season during April (Figure 5).

3.3 Yield per recruit and biomass per recruit

S. gibbus, the length at first capture (Lc) was 21.96. The relative yield per recruit and biomass per recruit was calculated 0.03 and 2.4. The plot of yield per recruit (Y/R) against E is shown in Figure 6. The maximum Y/R was

at E = 0.014. The present E (0.53) has not exceeded the optimum exploitation rate (Emsy = which maintain the 50% of the stock biomass). The optimum yield per recruit is 0.017 g. It is suggested that for attaining the maximum yield the fishing pressure could be increased by 0.53% from the present level L50/L∞ value are given in the Figure 7. *S. gibbus*, the studies showed that the urgent need to conserve parrot fish stocks of Tuticorin coast, India. Robertson et al. (1999) study revealed that the all coral reef fishes to extended life-spans, slow growth rates (tropical/temperate region), low natural mortality rates that the indication of marine species vulnerable to extinction through man-kind activities, to alarm of overexploitation.

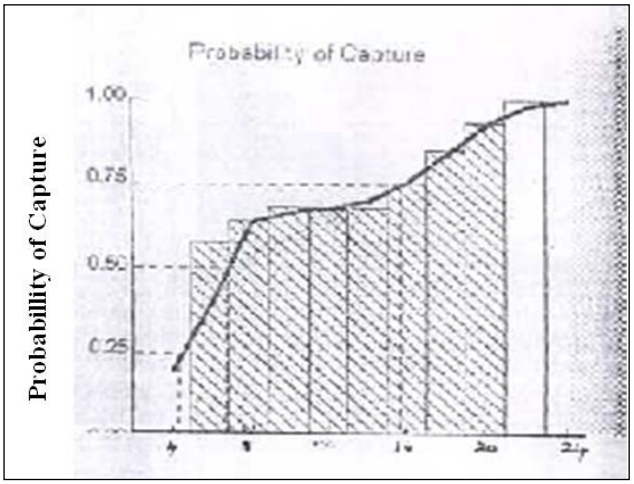

Figure 6 Yield/Recruit and Biomass/Recruit of *Scarus gibbus*

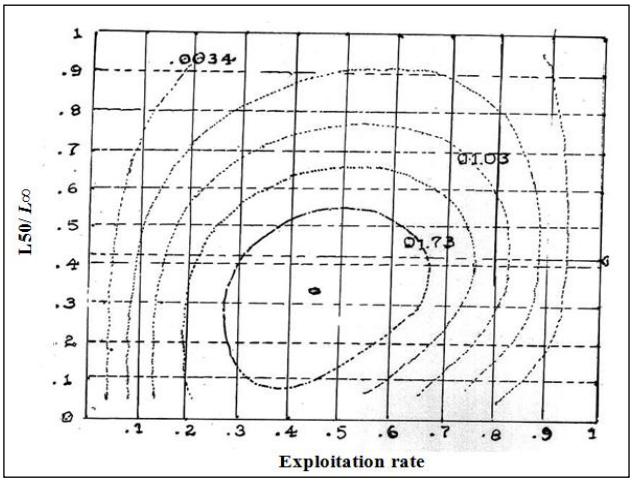

Figure 7 Yield isopleth of *Scarus gibbu*

Authors' contributions

Dr. V.K. Venkataramani, Dean and Principal Investigator, ICAR/NATP/CGP Mode project, and Dr. Vaitheeswaran Thiruvengadam, Senior Research Fellow, ICAR/NATP/CGP Mode project, he has been working as Senior Researcher of this project, he was involving and dedication of the project, sixteen species of stock assessment of marine ornamental finfishes and length frequency data collection, catch and effort data assessment, various parameters has been analysis and biodiversity assessment of marine ornamental of Gulf of Mannar, India, FiSAT package analysis in this coast.

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References

Bay L.K., and Choat J.H., 2004, High genetic diversities and complex genetic structure in an Indo-Pacific tropical reef fish (*Chlorurus sordidus*): evidence of an unstable evolutionary past, Marine Biology 144: 757-767
https://doi.org/10.1007/s00227-003-1224-3

Bellwood D.R., and Alcala A.C., 1988, The effect of a minimum length specification on visual estimates of density and biomass of coral reef fishes, Coral Reefs, 7: pp 23-27
https://doi.org/10.1007/BF00301978

Bellwood D.R., and Choat I.H., 1989, A description of the juvenile phase colour patterns of parrotfish species (family *Scaridae*) from the Great Barrier Reef, Australia. Records of the Australian Museum 41(1): 1-41
https://doi.org/10.3853/j.0067-1975.41.1989.134

Bellwood D.R., 1995a, Direct estimates of bioerosion by two parrotfish species, *Chlorurus Gibbus* and *C. sordidus*, on the Great Barrier Reef, Australian Marine Biology 121: 419-429
https://doi.org/10.1007/BF00349451

Bellwood D.R., 1995b, Carbonate transfer and intra-reef all patterns of bio-erosion and sediment release by parrotfishes (family *Scaridae*) on the Great Barrier Reef, Marine Ecology Progress Series, 117: 127-136
https://doi.org/10.3354/meps117127

Brock R.E., 1979, An experimental study on the effects of grazing by parrotfishes and the role of refuges in benthic community structure, Marine Biology, 51: 381-388
https://doi.org/10.1007/BF00389216

Beverton R.J.H., and Holt S.J., 1956, A review of methods for estimating mortality rates in exploited fish populations, with special reference to sources of bias in catch sampling. Rapp. PV. Reun, Cons. Int. Explor. Mer, 140, 67-83

Bullock L.H., Murphy M.D., Godcharles M.F., and Mitchell M.E., 1992, Age, growth and reproduction of jewfish, *Epinephelus itajara* in the eastern Gulf of Mexico, Fishery Bulletin, 90:243-249
http://www.vliz.be/imisdocs/publications/ocrd/285925.pdf

Choat J.H., and Axe L.M., 1996, Growth and longevity in fishes of the family *scaridae*, Marine Ecology Progress Series, 134: 15-26
https://doi.org/10.3354/meps134015

Choat J.H., and Robertson D.R., 2002, Age-based studies on coral reef fishes. In: Sale PF (ed) Coral reef fishes, Dynamics and diversity in a complex ecosystem, Academic Press, San Diego, CA. pp. 57-80
https://doi.org/10.1016/B978-012615185-5/50005-0

Choat J.H., Robertson D.R., Ackerman J.L., and Posada J.M., 2003, An age-based demographic analysis of the Caribbean stoplight parrotfish Sparisoma viride, MEPS, 246: 265-277
https://doi.org/10.3354/meps246265

Choat J.H., and Davies C.R., 2006, Age structure and growth in a large teleost *Cheilinus undulatus*, with a review of size distribution in labrid fishes, Marine Ecology Progress Series, 318: 237-246
https://doi.org/10.3354/meps318237

Clark J.R., Causey B., and Bohnsack J.A., 1989, Benefits from coral reef protection: Looe Key Reef, Florida. In: Magoon, OT. Converse H, Miner D, Tobin LT, Clark D) (eds), Coastal zone '89 pp. 3076-3086

Dawes J., 1999, International experience in ornamental species management. Part 2: Some resource management strategies. Ornamental Fish International Journal, 27: 10-12

Fowler A.J., and Doherty P.J., 1992, Validation of annual growth increments in the otoliths of two species of damsel fish from the southern Great Barrier Reef, Aust. J. Mar. Fre. Wat. Res., 43:1057-1068
https://doi.org/10.1071/MF9921057

Gayanilo Jr. F.C., and Pauly D., 1997, The FAO-ICLARM stock assessment tools FiSAT) reference manual, FAO computerized information series: fisheries, No.8, FAO, Rome, pp. 262

Gulland J.A., and Holt S.J., 1959, Estimation of growth parameters of data of unequal interval of time, J. Cons. Int. Explor. Mer., 25(1): 47-49
https://doi.org/10.1093/icesjms/25.1.47

Gulland J.A., 1971, The Fish Resources of Ocean, West By fleet, Survey, Fishing News (Book) Ltd. FAO, pp. 255
https://doi.org/10.1016/0044-8486(72)90050-6

Gust N., Choat J.H., and Ackerman J.L., 2002, Demographic plasticity in tropical reef fishes, Mar. Biol. 140: 1039-1051
https://doi.org/10.1007/s00227-001-0773-6

Hamilton R.J., 2004, The demographic of Bumphead Parrotfish (*Bolbometopon muricatum*) in lightly and heavily fished regions of the Western Solomon Islands, Ph.D., thesis: University of Otago: pp. 220

Jennings S., and Reynolds J.D., 1999, Predicting the Vulnerability of Tropical Reef Fisheries to Exploitation with Phylogenies and Life Histories. Conservation Biology, 13(6): 1466-1475
https://doi.org/10.1046/j.1523-1739.1999.98324.x

Lewis A.D., 1985, Fishery resource profiles: information for development planning. Suva, Fiji: Fisheries Division, Ministry of Primary Industries. pp. 91
PMid:3865617

Ministry of Environment of Forest, 2015-16, Department of Animal Husbandry, Dairying and Fisheries Department, Government of Tamil Nadu, India

Munro J.L., and Williams D.M., 1985, Assessment and management of coral reef fisheries: Biological, environmental and socioeconomic aspects, Proceedings of the International Coral Reef Symposium 5th, 4: 545-581
http://epubs.aims.gov.au/11068/3084

Mumby P.J., 2006, The impact of exploiting grazers (Scaridae) on the dynamics of Caribbean coral reefs, Ecol. App., 16 (2); 747 -769
https://doi.org/10.1890/1051-0761(2006)016[0747:TIOEGS]2.0.CO;2

Pauly D., 1978, A discussion of the potential use in population dynamics of the interrelationship between natural mortality, growth parameters, and mean environmental temperature in 122 stocks. J. Cons. Int. Explor. Mer, 1978/G-21, pp. 35

Randall J.E., 1974, The effect of fishes on corals reefs, in Proceedings of the Second International Coral Reef Symposium,Vol. 1 (eds A. Cameron, B Cambell, A. Cribb, et al.). Great Barrier Reef Committee, Brisbane, Australia, pp. 159-166

Randall J.E., and Bruce R.W., 1983, The parrotfishes of the subfamily Scaridae of the western Indian Ocean with descriptions of three new species, Ichthyological Bulletin, Rhodes University, 47: 1-39

Robertson D.R., Swearer S.E., Kaufmann K., and Brothers E.B., 1999, Settlement vs.environmental dynamics in a pelagicspawning reef fish at Caribbean Panama. Ecol Monogr, 69: 195-218
https://doi.org/10.1890/0012-9615(1999)069[0195:SVEDIA]2.0.CO;2

Sadovy Y.M., Figuerola M., and Roman A., 1992, Age and growth of the red hind Epinephelus guttatus in Puerto Rico and St Thomas, Fish. Bull, 90: 516-528
http://hdl.handle.net/10722/178537

Sadovy Y.J., and Vincent A.C.J., 2002, Ecological issues and the trades in live reef fish, In: Coral reef fish dynamics and diversity in a complex ecosystem (ed. Peter, F). pp. 391-420. San Diego: Academic Press
https://doi.org/10.1016/B978-012615185-5/50023-2

Smith M.K., 1993, An ecological perspective on inshore fisheries in the main Hawaiian Islands: (Fisheries of Hawaii and US-associated Pacific Islands). Mar. Fish. Rev. 55(2): 34-59
http://spo.nmfs.noaa.gov/mfr552/mfr5526.pdf

Sparre P., and Venema S.C., 1993, Introduction to tropical fish stock assessments Part I-Manual. F.A.O. Fish. Tech. Pap., 306: 376 pp

Spurgeon J.P.G., 1992, The economic valuation of coral reefs. Marine Pollution Bulletin, 24: 529-536
https://doi.org/10.1016/0025-326X(92)90704-A

Streelman T., and Alfaro M.E., 2002, Evolutionary History of the Parrotfishes: Biogeograph, Ecomorphology and Comparative Diversity. Evolution, 56(5): 961-971
https://doi.org/10.1111/j.0014-3820.2002.tb01408.x

van Rooij J.M., Bruggemann J.H., Videler J.J., and Breeman A.M., 1995, Plastic growth of the herbivorous reef fish Sparisoma viride: field evidence for a trade-off between growth and reproduction. MEPS, 122: 93-1059
https://doi.org/10.3354/meps122093

von Bertalanffy L., 1938, A quantitative theory of organic growth (inquiries in growth laws). In Richer, 1980. Human Biol, 10, pp. 181-213
http://www.jstor.org/stable/41447359

Venkataramani V.K., Jawahar P., Santhanam R., and Vaitheeswaran T., 2005, Marine ornamental fish of Gulf of Mannar. Indian Council for Agricultural Research, NATP and CGP, pp. 175
https://doi.org/10.6024/jmbai.2016.58.2.1922A-15

Walford L.A., 1946, A new graphic method in describing growth of animals. Biol. Bull., 90: 141-147
https://doi.org/10.2307/1538217
PMid:21023417

Wetherall J.A., 1986, A new method for estimating growth and mortality parameters from length-frequency data. ICLARAM, Fishbye., 4(1): 12-14
http://www.worldfishcenter.org/Naga/na_2924.pdf

Wood Elizabeth, 2001, Global advances in conservation and management of marine ornamental resources. Aquarium Sciences and Conservation, 3(1-3): 65-77
https://doi.org/10.1023/A:1011391700880