

**Traditional small scale fishing for yellowfin tuna *Thunnus albacares*
in Andhra Pradesh along east coast of India**

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The yellowfin tunas form one of the major components of oceanic tuna catch along the Indian coast. They are fished both along the mainland as well as the Island systems with the total annual catch from the mainland varying from 10,307 t to 19,163 t during 2010-2012. Commercial fishing is mainly by small mechanized wooden crafts and non-mechanized traditional crafts. Mechanized crafts operated pole and line, long line and gillnets and non-mechanized crafts operated hand lines and troll lines.

Highly skilled fishermen of Andhra Pradesh State situated along the east coast of India use traditional *catamarans* fitted with sails to catch yellowfin tunas from deep waters by operating either the hand lines or the troll lines. Around 1500 such units operated along the coast with an average annual landings of 4,300 t during 2010-2012. Fishing is carried out for a day as the crafts do not have any storage facility. Peak landings are during October–January followed by May-July. The annual catch per unit at Visakhapatnam was 58 kg and during the peak fishing season it increased to 71 kg per unit.

The fork length of the yellowfin ranged from 20 to 185 cm with the mean at 130 cm. Fishes above 80 cm were found to be mature and the size at first maturity was estimated to be between 85 and 90 cm. Males were dominant with a male: female ratio of 1: 0.53. The length-weight relationship is $W = 0.017077L^{2.976}$. Feeding habit of yellowfin tuna indicated the fish to be a nonselective generalist feeder, foraging on micronektonic pelagic or benthic organisms available in the epipelagic waters. Teleost fish, crabs, squids and shrimps were the major food items.

Age and growth were estimated using length based methods. The von Bertalanffy growth parameters estimated were $L_{\infty} = 197.42$ cm, annual $K = 0.30$ and $t_0 = -0.1157$. Mortality estimates were $M = 0.48$ and $Z = 0.71$ and $F = 0.23$ with the exploitation ratio $E = 0.32$. Growth was rapid during the initial years when the annual growth increments was as high as 36.6 cm during the first year then declined to as low as 3.3 cm in the tenth year. The fish attained a fork length of 56.2 cm at the end of one year. Size at maturity (87.5 cm) corresponded to an age of 1.7 years

and the oldest individual in the sample was 9+ years (186 cm). The annual mean lengths varied from 80.6 cm to 115.3 cm with an average mean length of 101.9 cm. The fishery comprised of mostly adults with 64% comprising of fishes larger than size at first maturity.

Introduction:

The Bay of Bengal has been extensively fished for its rich fishery resources, since the past several years. However, of late tuna and its fishing have emerged as an important fishery activity of the region with Visakhapatnam in Andhra Pradesh emerging as the nerve center for tuna fishing along the east coast of India. Tunas are represented by several genera and species and together they form an important pelagic finfish resource of the country. Of the several species contributing to the tuna fishery, the yellow fin tuna, *Thunnus albacares* forms the major component of the catch in this region. Highly skilled local fishermen especially at Lawsons Bay Pudimadaka and Mukam coastal villages of Andhra Pradesh travel out to the oceanic waters (>400md depth) with their small crafts and catch large sized yellowfin tunas. Though the operation looks simple and effortless, it in fact requires a lot of skill and physical endurance to catch these extremely fast moving fishes. The paper gives information on the detailed studies carried out on the fishery and biology of yellowfin tuna exploited by the traditional fisherfolk of Andhra Pradesh.

Crafts and gear used in tuna fishing

Wooden *cattamarans* consisting of logs strapped together is the most popular craft used in tuna fishing. Fibre canoes shaped like *cattamarans* have been introduced very recently in the fishery. The crafts use wind power for propulsion and the huge sails mounted on the crafts gives a speed upto 10-11 knots per hour. When wind conditions are favourable, the crafts are able to reach the fishing grounds, which are about 20-35 km away from the shore, in 2-3 hours. However, when wind conditions are unfavourable, the fishermen use oars to steer the crafts and then it takes nearly 5-6 hours to reach the fishing grounds. Now many units operating the hooks and line, especially at Pudimadaka, are fitted with outboard engines for propulsion. However, even these units have sails and use engines only if wind conditions are not favourable. Sails of varying size and shape are used by the crafts and are generally made from old plastic gunny bags. The different pieces are sewed up together with monofilament twine in the shape of the sail and fixed to the craft with the help of the bamboo mast. The sail is opened when wind conditions are favourable otherwise it is neatly rolled up and kept alongside the craft. The crew

consisting of 3 to 6 members start out for fishing early in the morning by 0300 hrs and return by 1700 hrs or they sail out late in the evening by 1700 hrs and return by early morning (0100-0400 hrs). Time of return depends purely on the prevailing wind conditions. Operation depends a lot on the prevailing weather conditions of the area. If wind conditions are not at all favourable, and if warnings of cyclone are there fishing activity is suspended.

Trolling as well as the hooks and line are the major gears operated for catching tunas along the Andhra coast. The troll lines are made of polyamide monofilament with a round bent hook (no.1,2 and 4) attached to it. The length of the line varies from 100-300 m. Each unit takes 6-10 lines on board for a day's fishing. The crew consisting of 5-6 members operates a maximum 4 lines at a time. Sardines, mackerel, flying fish and mullets are the common baits used. When these are scarce, cut pieces of tunas (*Auxis* spp. and *E.affinis*) are also used as an alternative

Fishing season and average catch per unit

Fishing for tunas is carried out throughout the year except when there is a cyclone warning and inclement weather conditions prevail. However, peak landings for yellowfin tunas are during October-January. There are around 1,500 small units operating specifically for tunas along Andhra Coast. Due to the long fishing operational hours, all units do not operate everyday. Around 600 units on an average operate daily. Each small unit operating beyond 400 m, gets 2-3 yellowfin tunas (*Thunnus albacares*). Sailfishes (*Makaira indica*), seerfish/Wahoo (*Scomberomorus commerson*, *Acanthocybium solandri*) and at times skipjack tunas (*Katsuwonus pelamis*) also landed. On a good fishing day when wind, water and weather conditions are good, 40-50 t of yellowfin tunas alone are landed at these centers. An estimated 4,300 t of yellowfin tunas are landed along Visakhapatnam coast annually by these small crafts. The catch per unit per day at Visakhapatnam was 58 kg and during the peak fishing season it increased to 71 kg per unit per day.

Post harvest and processing of catch

There is little or no post harvest treatment done on board the *cattamarans*/ fibre crafts. Once the fish is hauled on board, the hooks are carefully removed and the fish is kept as such on the deck. The crafts being small are not equipped with any chilling or ice storage facility. However the fishes are given a seawater bath periodically and brought ashore in that condition. Once the catch reaches the shore, it is disposed off to local fish merchants who in turn take

immediate action to preserve the quality of the fish and prevent further deterioration. The fish merchants supply the tunas to processors, exporters or to retailers who send it to domestic markets.

Biology

Length Frequency distribution

The fork length of *Thunnus albacares* landed during the last five years (2002-2006) ranged from 20 cm to 185 cm with mean at 135 cm. Monthwise frequency distribution showed that smaller fishes occurred in the fishery during May-July and larger fishes during November-December.

Length-weight relationship.

The length weight relationship of the yellowfin tuna landed along the Andhra coast was calculated. The length weight relationship is given by the formula $W = 0.017077L^{2.976}$

Food and feeding:

Thunnus albacares caught by the long line were found to be nonselective generalist feeders, foraging on micronektonic pelagic or benthic organisms available in the epipelagic waters. Teleost fish, crabs, squids and shrimps were the major component of food items. *Priacanthus hamrur* was the most preyed upon fish with a high IRI (40.5%) followed by the swimming crab *Charybdis smithii* (23.9%) the squid *Sthenoteuthis oualaniensis* (15.5%) and prawn *Solenocera hextii* (10.3%). In all 1656 prey items belonging to 17 families were identified. This included 11 families of fish, 5 families of crustaceans and a single family of cephalopods. Fishes were the most dominant prey item by mass (52.9%) followed by crustaceans (27.3%) and cephalopods (19.3%).

Sex ratio and maturity

Males were dominant with a male: female ratio of 1: 0.53. Fishes above 80 cm were found to be mature and the size at first maturity was estimated to be between 85 and 90 cm (87 cm).

Age and growth:

Age and growth were estimated using length based methods. The von Bertalanffy growth parameters estimated were $L_{\infty} = 197.42$ cm, annual $K = 0.30$ and $t_0 = -0.1157$. Growth was rapid during the initial years when the annual growth increments was as high as 36.6 cm during the first year then declined to as low as 3.3 cm in the tenth year. The fish attained a fork length of 56.2 cm at the end of one year. Natural mortality (M) was estimated at 0.4, total mortality (Z) at

0.71 and fishing mortality (F) at 0.23. The exploitation ratio (E) was 0.32 and exploitation rate (U) was 0.162.

Growth parameters of Yellowfin tuna estimated by different authors

Author	Region	Growth parameters			Ø
		L_{∞}	K	t_0	
Rohit <i>et al.</i> , 2012	East coast of India	197.42	0.30	-0.1157	4.00
Zhu <i>et al.</i> , 2011	Eastern & Central Pacific	175.9	0.52	0.19	4.21
Kaymaram , 2010	Oman Sea	183	0.45		
Shono <i>et al.</i> , 2007	Indian Ocean	166.07	0.38		
Hampton and Fournier, 2001	WC Pacific	184	0.395		
Lessa and Duarte-Neto , 2004	W Equatorial Atlantic	230.7	0.267	-0.081	
Somvanshi <i>et al.</i> , 2003	Indian EEZ	193.0	0.20		3.88
Sun <i>et al.</i> , 2003	Western Pacific	175.0	0.392	0.00306	4.08
Hampton , 2000	Western Pacific	166.0	0.250		3.84
Lehodey and Leroy, 1999	Western Pacific	199.6	0.390		4.19
Li <i>et al.</i> , 1995	Western Pacific	178.76	0.129		3.62
John , 1995	Andaman and Nicobar, India	171.5	0.316	-0.305	

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