

TUNA

Fishery,
Biology and
Management

N.G.K. PILLAI
P. SATHEESH KUMAR



Central Marine Fisheries Research Institute

Indian Council of Agricultural Research

P.B. No. 1603, Ernakulam North P.O., Kochi – 682 018

Kerala, India



TUNA

Fishery,
Biology and
Management

N.G.K. PILLAI
P. SATHEESH KUMAR



Central Marine Fisheries Research Institute
Indian Council of Agricultural Research
P.B. No. 1603, Ernakulam North P.O., Kochi - 682 018, Kerala, India
www.cmfri.org.in



2014

Published by :

Dr. A. Gopalakrishnan

Director

Central Marine Fisheries Research Institute

(Indian Council of Agricultural Research)

P.B. No. 1603, Ernakulam North P.O.

Kochi – 682018, Kerala, India

www.cmfri.org.in

E-mail: director@cmfri.org.in

Tel: +91 484 2394867

Fax: +91 484 2394909

Publication, Production & Co-ordination

V. Edwin Joseph

Officer in Charge

V. Mohan

Senior Technical Officer

Library and Documentation Centre

Citation: Pillai N.G.K. and Satheesh Kumar P. 2014. *Tuna: Fishery, Biology and Management*, Central Marine Fisheries Research Institute, Kochi. 222 p.

ISBN : 9789382263043

© 2014 Central Marine Fisheries Research Institute

All right reserved. Material contained in this publication may not be reproduced in any form without the permission of the publisher.

Printed at: St. Francis Press, Kochi - 682018

Contents

| | | |
|--|---|-----|
| | <i>Foreword</i> | |
| | <i>Preface</i> | |
| | <i>Acronyms</i> | |
| | Introduction | 001 |
| Taxonomy and distribution of tunas in the Indian Ocean | | 009 |
| | Fishing crafts and gears | 021 |
| | Recent trends in world tuna production | 039 |
| | Tuna fisheries in Indian Ocean | 059 |
| Tuna fisheries of the Exclusive Economic Zone of India | | 085 |
| | Climate variability and its effects on tuna production in Indian Ocean | 125 |
| Post-harvest technology of exploited tuna resources | | 147 |
| | Tuna trade | 157 |
| Tuna fisheries research and recent developments | | 165 |
| | Management of tuna fisheries | 175 |
| | Suggestions and Recommendations | 187 |
| | Bibliography | 193 |
| | Subject Index | 213 |

Director's Foreword



Dr. A. Gopalakrishnan
Director
Central Marine Fisheries
Research Institute
Kochi - 682018

Tunas are highly valued food fishes targeted by coastal fishers as well as distant water fishing nations. The oceanic waters adjoining the Asia-Pacific region contribute the bulk of the global tuna production. World tuna production touched the record high of 4.3 million tonnes in 2005. Although they constitute less than 5% of the world commercial catch by weight, they contribute much by dollar value (US\$ 5.3 billion). Tuna does the third largest product in the international seafood trade constitute over 15%. Of the global tuna production, about 21.7% (1.2 million tonnes) is contributed by Indian Ocean. The rapid development of tuna fishery in the Indian Ocean now needs constant monitoring to know the impact of exploitation on the stocks. It has been understood for many years that tuna fisheries and other fisheries for highly migratory species need international cooperation for their conservation and management. Tuna fishing and fisheries have become priority theme while addressing issues of development, utilization and management of fisheries in India in the light of EEZ regulations and other international conventions. The scenario of tuna fisheries in the Indian EEZ shows that it is still limited to the small scale fishery sector with limited inputs from the industrial sector. Tunas are expected to receive importance in the Indian fishing industry in the coming years. Research and Development efforts on tuna and tuna fisheries in the country and abroad have contributed to a rapid growth of literature.

The book titled Tuna: Fishery, biology and management is the outcome of 'Investigation on tuna and tuna fisheries in the Indian Ocean with special reference to the EEZ of India' - a project funded under ICAR Emeritus Scientist scheme. It is a compilation of available information on various aspects of tuna and tuna fisheries of the Indian Ocean with special reference to Indian EEZ. The book addresses aspects on tuna taxonomy, fishing practices, production, biology, post-harvest technologies, value addition, trade and management. The contents of the book is primarily based on information culled out from various literatures/reports on the subject, discussions with experts, stakeholders, tuna processors and exporters and field visits. An attempt has also been made by the authors to study the impact of El Nino Southern Oscillation (ENSO) phenomenon on the tuna production in Indian Ocean. The attempt on documentation and compilation of various aspects of tuna fisheries and its management is really a hard task. The MS was prepared by the authors based on the project work carried out by the senior author during his tenure as ICAR Emeritus Scientist at CMFRI. I appreciate the interest taken and efforts made by Dr. N. G. K. Pillay, ICAR Emeritus Scientist and Shri. P. Satheesh Kumar, Senior Research Fellow, Central Marine fisheries Research Institute, Kochi for this endeavour. I congratulate the authors for their untiring efforts for preparation of this updated comprehensive publication. I am sure that publication of this nature will be a very useful source of information for students, researchers, entrepreneurs, development workers and policy planners.

Dr. A. GOPALAKRISHNAN
Director

Preface



Dr. N.G.K. Pillai
ICAR Emeritus Scientist
Central Marine Fisheries
Research Institute
Kochi - 682018

Tuna, a very large and charismatic food fish with a wide distributional range, are valuable both in domestic and foreign markets and hence, play a vital role in the economies of many countries especially oceanic Islands. Tunas are highly valued food fishes targeted by coastal fishers as well as distant water fishing nations. The oceanic waters adjoining the Asia-Pacific region contribute the bulk of the global tuna production. World tuna production touched the record high of 4.3 million tonnes in 2005. Although they constitute less than 5% of the world commercial catch by weight, they contribute much by dollar value (US\$ 5.3 billion). Tuna does the third largest product in the international seafood trade constitute over 15%. Of the global tuna production, about 21.7% (1.2 million tonnes) is contributed by Indian Ocean. The rapid development of tuna fishery in the Indian Ocean now needs constant monitoring to know the impact of exploitation on the stocks. Tuna fishing and fisheries have become priority theme while addressing issues of development, utilization and management of fisheries in India in the light of EEZ regulations and other international conventions. The scenario of tuna fisheries in the Indian EEZ shows that it is still limited to the small scale fishery sector with limited inputs from the industrial sector. The exploratory surveys carried out by Govt. of India vessels, the efforts made by India in harvesting the tuna resources under various schemes such as chartering of foreign fishing vessels, joint venture, lease fishing vessels, test fishing by foreign fishing vessels and Indian owned vessels and

the Letter of Permit Scheme have indicated tuna resource availability and rich tuna fishing grounds in the Indian EEZ and contiguous high seas. Despite its potential and nature as one of the thrust areas of development of fishery in the Indian EEZ, the momentum towards it was in a slow pace, and the valuable oceanic resources of skipjack and yellowfin tuna in our waters remain to be tapped commercially. Tunas are expected to receive cardinal importance in the Indian marine fishing industry in the coming years. This necessitates synthesis of data to study the status of tuna industry in Indian EEZ and contiguous high seas and to suggest strategies and options for the development, management and conservation of tuna fishery in the EEZ of India.

The book Tuna: Fishery, Biology and Management is an effort to analyse the past data on climate variability, fishery and biology of tunas, consolidate and comprehensively present the status of the tuna fisheries under the following major chapters: i) Introduction, ii) taxonomy and distribution of tunas in the Indian Ocean, iii) fishing crafts and gears, iv) recent trends in world tuna production, v) tuna fisheries in the Indian Ocean, vi) tuna fisheries in the Indian EEZ, vii) climate variability and its effects on tuna production in Indian Ocean, viii) post-harvest technology of exploited tuna resources, ix) tuna trade, x) tuna fisheries research and recent developments, xi) management of tuna fisheries and xii) suggestions and recommendations. The references and literature cited are listed at the end. The book is primarily based on information culled out from various literatures/ reports on the subject, discussions with experts, stakeholders, tuna processors and exporters and field visits. An attempt has also been made to study the impact of El Nino Southern Oscillation (ENSO) phenomenon on the tuna production in Indian Ocean. The gathered information is presented in a systematic manner to facilitate the readers/the end users interested in tuna and tuna fisheries and its development. Further this publication would facilitate evolution of suitable and relevant tuna fisheries management plan in the Indian perspective.

Author thanks the Indian Council of Agricultural Research, New Delhi, Government of India for the award of Emeritus Scientist scheme and for the financial support to conduct this study. Authors thank Dr. C. Syda Rao, Former Director, CMFRI, Kochi for providing necessary facilities. Authors are also grateful to Dr. A. Gopalakrishnan, Director, CMFRI, Kochi for encouragement and all logistic support for publication of this book. We are grateful to Dr. P.P. Pillai, Former Principal Scientist and Head of Pelagic Fisheries Division, CMFRI, Kochi who has gone through the manuscript critically. His suggestions at various stages of the preparation of this publication were very useful.

Dr. N. G. K. Pillai
ICAR Emeritus Scientist





01

Introduction



Landings of yellowfin tuna at Neendakara (Kollam)Fishing Harbour



Fulltext not available

Skipjack tuna arranged for auction at Tharuvaikuum, Tamil Nadu



01

Introduction

The tunas, tuna like fishes and billfishes are most important among economically valuable marine fishes of the world. Tunas have been important to mankind for several thousand years. Archaeological evidence shows that early humans harvested tuna more than 6,000 years ago, and tuna products may have been among the earliest processed fisheries commodities traded among ancient civilizations. Currently, fishermen of nearly 80 coastal and island nations harvest tuna of the world's oceans. The harvest is consumed in many forms, raw, cooked, smoked, dried, and canned. They were commonly known as "Chicken of the sea" and form the third largest product in international seafood trade with about 10% of the total trade in value terms.

Tuna occurs in temperate to tropical waters and broadly classified into coastal/neritic and oceanic species. The principal market species of tuna (oceanic) were skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*), albacore (*Thunnus alalunga*), northern bluefin (*Thunnus thynnus*), and southern bluefin (*Thunnus maccoyi*). Temperature (thermocline) and food availability (areas of convergence and divergence) are reported to influence their distribution and abundance. The tunas show distinct migratory routes, spawning and feeding locations.

In the scientific and popular literature, tunas are most often described as highly migratory fishes “wanderers” of the world’s ocean. Their highly charged life styles as apex predators in the oceanic pelagic environment are facilitated by a number of anatomical, biological, and physiological specializations. Tunas have demonstrated their speed and stamina in long-distance migrations and International organizations and scientists of many nations have gathered valuable data on these migrations through tagging studies. From these studies we know that albacore tuna migrate from the coast of California to the coast of Japan, a trip of over 8,500 km moving on average of not less than 26 km per day. Northern blue fin tuna has travelled at least 7,700 km across the Atlantic Ocean in 119 days, a sustained journey of over 65 km per day. A tagged skipjack tuna released 200 km southwest of the tip of Baja California was recaptured west of Freetown in the Marshall Islands, a distance of nearly 9,500 km. Tagged yellowfin tuna have been recovered within 620 km of the site of their release.

Since the nineteenth century, and indeed since ancient times, tuna fishing has been carried out in many places in the world. These fisheries were local, and generally near the coasts. As most species of tunas are highly migratory, these fisheries caught tunas only at certain points in their life cycle, and thus had to be seasonal. They included, in the Atlantic, purse seining for bluefin off Norway, trolling for albacore in the Bay of Biscay, trap fishing in the Straits of Gibraltar and along the North African coast, Pole and line fishing for bigeye and skipjack near oceanic islands and artisanal fishing along the coasts of Africa. In the Pacific, there were various artisanal fisheries near islands in tropical waters, troll fisheries for albacore and baitboat fisheries for yellowfin and skipjack off the west coast of the United States of America, baitboat fisheries for skipjack near Japan, and many other fisheries for various tunas along the coasts of Japan. Coastal fisheries using baitboats and small seine nets existed off South America. In the Indian Ocean, fisheries for skipjack existed in Sri Lanka, India and the Maldives, and southern bluefin tuna was the target of longline fishing off Australia.

Tunas account for the largest share of the total scombroid catches from the Indian Ocean and have shown a substantial increase of 38% during the years 1989 to 2000. The fisheries comprised small scale artisanal fishery by coastal countries in this region as well as the industrial fisheries (Long line fishery) by Japan, Republic of Korea, and Taiwan. Following the establishment of the 200 nautical miles Exclusive Economic Zone (EEZ) in 1976, which have placed tremendous responsibilities on the countries bordering the Indian Ocean to see that the resources are properly surveyed, assessed and judiciously utilized and protected. In order to have access to these resources, many Industrial fishing nations entered into fisheries agreement with the coastal nations, allowing them to fish in their EEZ. This was particularly significant in the case of tuna fisheries in the Indian Ocean.

The scenario of tuna fisheries in the Indian EEZ shows that it is still limited to the small scale fishery sector with limited inputs from the industrial sector. The Indian tuna fishery comprises of two distinct segments, the coastal fishery and oceanic fishery. Tuna constitute one of the important marine fisheries resources of India having an estimated

annual catchable potential of about 2.78 lakh t in the EEZ. The current average production of tunas from the coastal waters is estimated to be 46,200 t. There are no organized tuna fisheries along the Indian coasts except in the Lakshadweep, where the small scale fishery for skipjack is established. Tunas are one of the major exploited marine fishery resources of Indian seas having good domestic demand as food fishes. All published reports and observations by various agencies indicate that a considerable magnitude of untapped tuna resource is available especially in oceanic waters of the Indian EEZ for sustainable exploitation (Sivaprakasam 1995; Mitra 1999; Pillai and Ganga 2002). They further pointed out that there is no organized tuna fishing in the high seas of Indian EEZ except in certain pockets. Many developing countries have expanded their fishing activities with an aim to intensify the exploitation of tuna resource from their EEZ as well as from the international waters (Silas 1985; James and Pillai 1991; Pillai and Jyothi 2007; Pillai 2011). Of late, attempts have been made to convert excess trawlers to longliners and diversify the fishing effort for targeted exploitation of oceanic tuna resources by OAH&F, MPEDA and the fishing industry in India (Pillai 2011; Pillai and Satheeshkumar 2013).

The rapid development of tuna fishery in the Indian Ocean now needs constant monitoring to know the impact of exploitation on the stocks. One of the prerequisites for exploiting the fishery resource is to estimate the abundance, regulate the fishing effort and catch, so that the fishery will be sustainable. Gaining knowledge of the stocks and evolving management advisories are important protocols while developing a fishery.

Despite the abundant literatures on the tuna resources in the Indian Ocean, there appears to have lack of the study on the distribution pattern of these tunas. To better conserve and maintain a sustainable yield of tuna, there is a need to understand distribution patterns of tuna stocks in space and time. The focus of the study provides an overview of the fishery resources, biology, distribution and biological reference points of various tuna species in the Indian Ocean with special reference to the Exclusive Economic Zone (EEZ) of India. It traces the history of scientific advice and management of tuna, and examines the current status of tuna stocks and new areas for tuna fisheries research and developments. In addition to contributing to the biological sustainability this will, ultimately, give a platform from which tuna fisheries can seek Marine Stewardship Council (MSC) certification and take advantage of the growing consumer awareness and demand for sustainably produced seafood.

1.1 Focus of the study

- To assess the global scenario of capture production of tunas and related species during the past decades.
- To critically evaluate the status of the tuna fishery in the Indian Ocean and the EEZ of India: trends in the exploitation of their stocks; review and documentation of the status of tuna fishery by the small scale and industrial fleets of the bordering coastal

states of the Indian Ocean and of foreign nations; likely future trends in tuna fishery under alternate scenario and documentation of projected yield.

- To collect, collate, analyse and document information on the biology and migration of tropical tuna species.
- To analyse and document the impact of climate changes such as SST, ENSO, Chlorophyll concentration and other meteorological and environmental parameters on the spatio-temporal distribution, vulnerability and capture production of tunas.
- To review the current and new information on the post-harvest technologies, and trends in domestic and export markets.
- To prepare scientific and technical documents incorporating the results of investigations under the proposed project for ready reference of the fishing industry, researches and policy planners in India for effective economic exploitation and implementation of scientific management of tuna fishery in the Indian EEZ and contiguous high seas.

1.2 Database

Research and development efforts on tuna and tuna fisheries in the country and abroad have contributed to a rapid growth of literature. Literature was gathered from the internet, national and international journals and other publications. Relevant literature on tuna and tuna fisheries documented over the years, remains scattered in various national and international journals, proceeding bulletins, Technical reports/ annual reports of Food and Agricultural Organization (FAO), scientific reports/ annual reports of the Indian Ocean Tuna commission (IOTC) and publications of CMFRI, FSI and MPEDA.

Global tuna catch data were retrieved from the website of Food and Agriculture Organization (<http://www.fao.org/fishery/statistics/tuna-catches/en>). Nominal catch data of tuna from Indian Ocean and India were collected from the Indian Ocean Tuna Commission (IOTC) (<http://www.iotc.org/English/data.php>) and tuna catch from the Indian EEZ were collected from the Central Marine Fisheries Research Institute, Kochi. Information on the historical developments and the current status of the tuna fisheries are being compiled from the literature and from interviews with the individuals from government and non-government agencies, entrepreneurs and fishers. The first author has already published a book titled Bibliography on Tunas in 2007, which is being widely referred by tuna workers. The research papers published globally on tunas since 2007 to till today have been compiled to publish a revised edition of the Bibliography on tunas.

Visits to tuna landing centers: Regular visits were conducted to Vishakhapatnam Fisheries Harbour, Chennai Fisheries Harbour, Cochin Fisheries Harbour, Neendakara (Kollam) Fisheries Harbour, Vizhinjam Fisheries Harbour and Mangalore – leading tuna landing centers along the coast of India and observed the catches and collected field measurements of dominant species.

During the study period authors have visited fishing harbours, landing centres, markets, tuna cutting and packing centers, cold storages, processing plants, R&D organizations and interacted with the concerned people/officials and collected relevant information on tuna fisheries. In this connection a questionnaire has also been prepared and mailed to owners of tuna fishing fleet and leading exporters for furnishing the information on tuna fishing and exports. The copy of the questionnaire is given below.

Visited Moon Fishery India (P) Ltd., (EU approved tuna processing plant) - the pioneer in tuna exports and exclusive tuna packers in the country located in Kochi and discussed with the Managing Director on problems and prospects of tuna fisheries. Authors also met Fisheries Development Commissioner, DAHD&F, Ministry of Agriculture, Govt. of India, Director General, Fishery Survey of India, Zonal Directors of FSI at Vishakhapatnam, Goa and Portblair, Director, Dept. of Fisheries, Lakshadweep, Scientists of CMFRI, CIFT, FSI and NIFPHATT, Dy Director (Marketing), MPEDA and discussed and gathered information on the development of tuna fishery in the country.

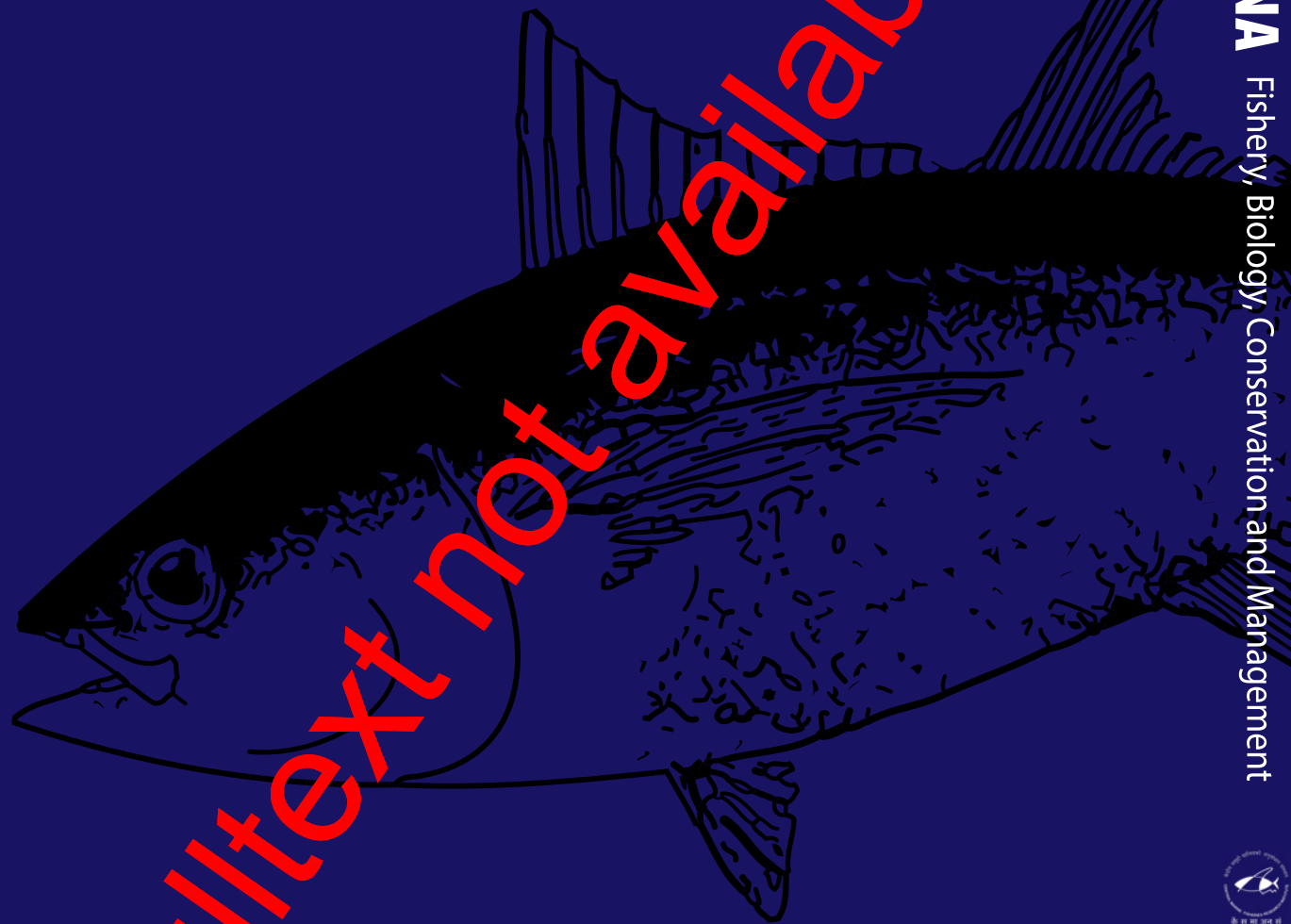

Fulltext not available



TUNA

Fishery, Biology, Conservation and Management

Fulltext not available



Central Marine Fisheries Research Institute

Indian Council of Agricultural Research

P.B. No. 1603, Ernakulam North P.O., Kochi – 682 018, Kerala, India

www.cmfri.org.in



2014