Annex 6: Biological Information of *Sardinella jusseiui*

Sardinella jusseiui was classified as a species under Lesser Sardine in version 2 assessment; therefore it was included in Fishery Action Plan. After reviewed by research agency as below, the species was excluded from re-assessment using version 3 standard and updated species composition.

Central Marine Fisheries Research Institute (CMFRI) reported that the species *Sardinella jusseiui* (Valenciennes 1847) is not being landed along the Karnataka coast. As per the literature available, Hata and Motomura (2019), the *Sardinella jusseiui* which was identified earlier is a misidentification, and the consideration of *S. jusseiui* in India, Sri Lanka, Madagascar, and Mauritius was treated as a senior synonym of *S. dayi,* and the distribution range of S limited to Madagascar and Mauritius (Sauvage 1891; Hata and Motomura 2019) Hence, providing data on *S. jusseiui* is not possible.

Another reference is Marine Fisheries Research and Management (2000) page 3

Species composition

The lesser sardine fishery along Indian coast is represented by 10 species (Bennet *et.al.*1986) viz: *Sardinella gibbosa* (Bleeker), *Sardinella albella* (Valenciennes), *Sardinella fimbriata* (Cuvier and Valenciennes), *Sardinella dayi* Regan, *Sardinella sirm* (Walbum), *Sardinella sindensis* (Day), *Sardinella clupeoides* (Bleeker), *Sardinella melanura* (Cuvier), *Sardinella leiogaster* (Valenciennes) and *Sardinella jonesi* (Lazarus). Of these, the first seven species formed the bulk of the fishery at different centres, the remaining occurring sporadically and in stray numbers at certain centres. Studies on the identification and bionomics of lesser sardines have been carried out since the early forties (Chacko, 1946 and Nair, 1953). Raja and Hiyama ('1969a) studied the systematics and biometrics of a few Indo-Pacific sardines and later Raja and Lazarus (1975) gave a detailed description of *S. dayi* of Indian seas with remarks on its close similarity with *S.madrasensis* (Lowe) and *S.jussieui* (Valenciennes). *S. melanura* and *S.sindensis* occurring along our coast was re-described by Lazarus (1977b). Lazarus (1983) based on his studies at Vizhinjam described in detail the occurrence of a new species of sardine, *S.(Amblygaster) jonesi* with a key to the species of subgenus *Amblygaster* Bleeker, 1849.

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Editors
V.N. Pillai and N.G. Menon

Central Marine Fisheries Research Institute
(Indian Council of Agricultural Research)
Tatapuram P.O., Cochin-682 014
Kerala, India

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19 Lesser sardines resources of India

Prathibha Rohit and P. Sam Bennet

ABSTRACT

The lesser sardines comprising ten species form a minor or major fishery in all the maritime states of India during one or the other part of the year. The Central Marine Fisheries Research Institute has taken up a study of the fishery and biology of the important species at some centres and has published the results periodically. The present article reviews the work carried out and highlights the important results pertaining to the fishery, biology and population characteristics along the Indian coast.

Introduction

The lesser sardines comprising several species of *Sardinella*, other than the oil sardine, has emerged as an important resource along the Indian coast. Catch data and certain important biological aspects of the dominant species have been studied at the Institute since the late fifties. The catch of lesser sardines has registered a steady increase over the past few years, both along the east and the west coasts of India. In the fifties (1950-'59) the annual average catch was around 28,862 t which increased to 70,751 t in the eighties (1980-'89) and is presently (1990-'94) around 83,749 t. Motorisation/ mechanisation of fishing, introduction of innovative fishing gear and gear materials, etc., have greatly contributed to the increase in the landings of the resource. Several species of lesser sardines form an important resource at certain centres. Biology and population characteristics of the dominant species were studied in detail as reviewed below.

Material and methods

The catch and effort data were collected from all the gears at the landing centres along both the coasts of India. Monthly estimates of catch and effort were made based on 16 – 18 day's observations of the landings each month. Data published by the Institute were also used. To study the length frequency and other biological aspects, random samples from each of the gears operating in the region were collected twice a week together with the landing data. Studies on the total length, weight, sex and maturity condition of the component species were carried out on fresh specimens. Fecundity studies were made both on the fresh and preserved samples by using standard methods. Age and growth parameters were estimated using the von Bertalanffy's growth formula; and the mortality and yield per recruit were estimated using the Beverton and Holt (1957) formula as simplified by Ricker (1975).

Species composition

The lesser sardine fishery along Indian coast is represented by 10 species (Bennet *et.al.*1986) *viz*: *Sardinella gibbosa* (Bleeker), *Sardinella albella* (Valenciennes), *Sardinella fimbriata* (Cuvier and Valenciennes), *Sardinella dayi* Regan, *Sardinella sirm* (Walbum), *Sardinella sindensis* (Day), *Sardinella clupeoides* (Bleeker), *Sardinella melanura* (Cuvier), *Sardinella leiogaster* (Valenciennes) and *Sardinella jonesi* (Lazarus). Of these, the first seven species formed the bulk of the fishery at different centres, the remaining occurring sporadically and in stray numbers at certain centres. Studies on the identification and bionomics of lesser sardines have been carried out since the early forties (Chacko, 1946 and Nair, 1953). Raja and Hiyama ('1969a) studied the systematics and biometrics of a few Indo-Pacific sardines and later Raja and Lazarus (1975) gave a detailed description of *S. dayi* of Indian seas with remarks on its close similarity with *S.madrasensis* (Lowe) and *S.jussieui* (Valenciennes). *S. melanura* and *S.sindensis* occurring along our coast was re-described by Lazarus (1977b). Lazarus (1983) based on his studies at Vizhinjam described in detail the occurrence of a new species of sardine, *S.(Amblygaster) jonesi* with a key to the species of subgenus *Amblygaster* Bleeker, 1849.

Distribution

The lesser sardines are tropical in distribution and occur along the coasts of Arabia, Red sea, east Africa, Madagascar, India, Sri Lanka, Malaysia, Singapore, Philippines, Australia and China. Along the Indian coast the resource forms a fishery in all the states, but the species exhibit discontinuous disribution with one species being dominant in one region and other species in another region.

Along the coasts of West Bengal, Orissa and Andhra Pradesh, , *S.fimbriata* and *S.gibbosa* support the fishery. Along Tamil Nadu *S.gibbosa*, *S.albella*, *S.dayi* and *S.sirm* are the dominant species. Besides these *S.clupeoides* occurs around the southern most region (Bennet, 1965). Vijayaraghavan (1953) has reported occurrence of *S.melanura* along Madras coast. All the lesser sardine species make their appearance at one time or other along the southwest coast, between Cape Comorin and Quilon; *S.gibbosa*, *S.sirm*, *S.sindensis* and *S.dayi* formed good fishery in the region. Along Karnataka –Goa coast, *S.gibbosa*, *S.fimbriata* and *S.dayi* formed the fishery whereas along Maharashtra and Gujarat, *S.fimbriata* and *S.albella* occur in the fishery. In Andaman waters, *S.albella*, *S.dayi*, *S.melanura* and *S.sirm* form the fishery. Occurrence of *S.leiogaster* also has been reported by Menon and Talwar (1975). At Lakshadweep, *S.melanura* has been reported by Jones and Kumaran (1959) and *S.clupeoides* and *S.fimbriata* by Jones (1969).

Fishery

The various species of lesser sardines together sustain a good fishery especially along Andhra-Tamil Nadu in the east coast and Kerala- Goa in the west coast. Fig. 1 gives the all India estimated annual yield of lesser sardines for the years 1950-1993. Fluctuation in the production, which is an inherent characteristic, observed in most shoaling pelagic groups is discernable in the catches of lesser sardines also. The catch fell from 53,000 t in 1950 to 16,000 t in 1954. Therafter it rose to 32, 000 t in 1959 and then fell to a mere 9,000 t in 1962. A high catch of 11,483 t was obtained in 1963. Similarly good landings were observed in the year 1975, when 1,12,117 t were landed. During the late eighties the catch has fluctuated around 75,000 t and a catch of

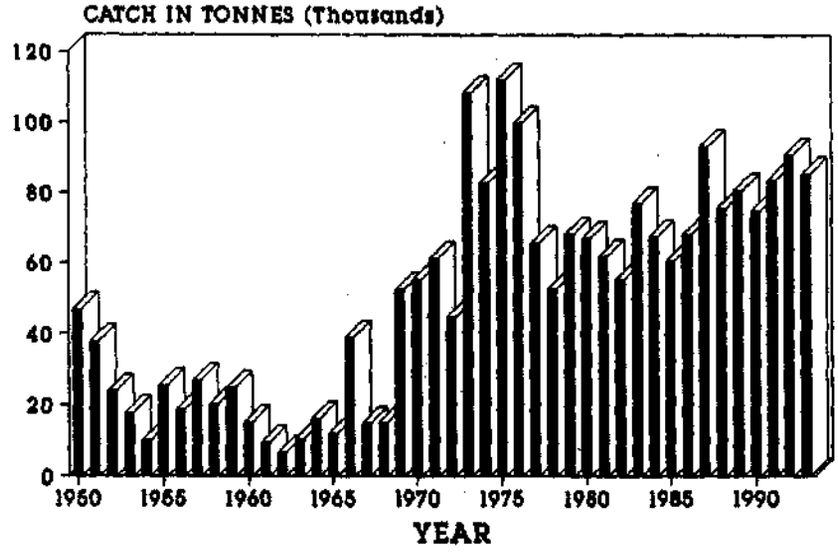

Fig.1. Estimated Annual Yield in Tonnes of Lesser Sardine during 1950-1993

85,473 t was landed during 1993.

Craft and gear

Indigenous , non-motorised, motorised and mechanised crafts are employed in the fishery. Dug-out and plank built crafts are used in the inshore waters whereas purse seiners, gill netters and trawlers are employed for exploiting the resource in the near shore areas upto a depth of 40-60 m. The *catamarans* are popular along the east coast and bring in substantial quantities of lesser sardines.

A variety of fishing tackles are employed in the capture of lesser sardines. The more widely used gears in the west coast are boat seines and purse seines. Purse seines, which replaced the *Rampani* (shore seine) in Karnataka coast, helped to enhance the lesser sardine catch in the region. Sardine gill nets are the main gear in the east and south west coasts landing lesser sardines in good numbers. Cast net and hook and line are also used to catch small quantities of lesser sardines around Vizhinjam (Lazarus,1984b). The trawlers operating in near shore regions especially below 40 m land sardines in considerable quantities along Karnataka coast.

Exploitation

An exclusive single species fishery for lesser sardines does not occur in any region. Two or more species with a dominance of one of them are landed by various gears operating along the coast and it comprises 3 to 6 % of the total fish catch of the country. Regionwise availability of the different species and catch trends for the years 1968 – '78 has been described by Bennet *et al.* (1986). Lesser sardines form an important resource along Andhra Pradesh, Tamil Nadu, Kerala, Karnataka and Goa coasts. Along West Bengal, Orissa, Maharashtra and Gujarat coasts, the resource forms a minor fishery and does not contribute greatly to the catch. The annual average statewise landings of lesser sardines along with the percentage contribution of each state to the total lesser sardine landings of the country during the nine year period of 1985 to 1993 is given in Fig.2.

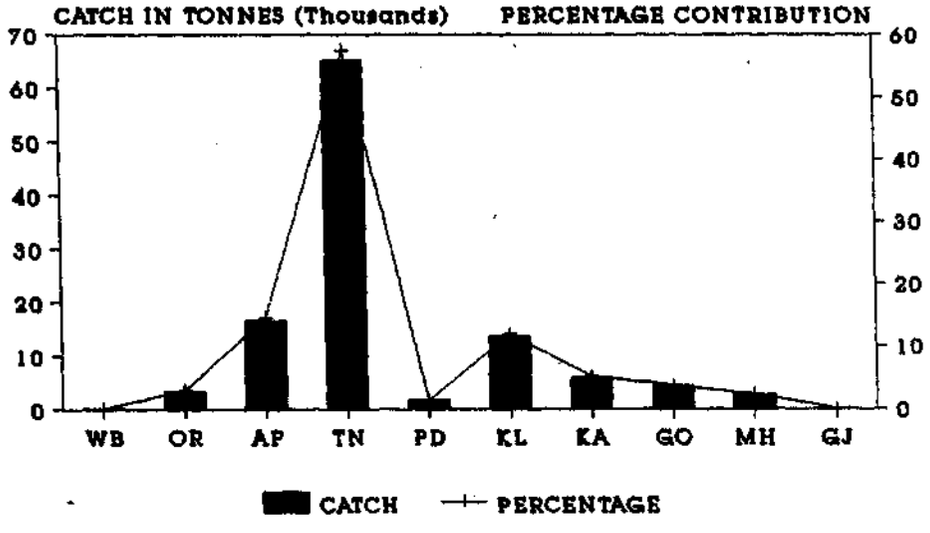

Fig.2. Average Statewise Landings of Lesser Sardines (1985-1993)

Along West Bengal coast, lesser sardines do not form an important resource and comprise only 0.19 % of the total fishery. During most of the years, the catch is meagre and the highest catch of 398 t was observed in 1991.

Lesser sardines are better represented in Orissa with the catch ranging from 959 t in 1992 to 7536 t in 1987. An average of 3478 t was landed annually during 1979-1993 and the resource contributed to 6.8 % of the total

marine fishery of the state. The peak fishing season for the resource along West Bengal -Orissa coasts is during November-April (Dharmaraja and Phillipose, 1975).

Along Andhra Pradesh coast the resource forms 12 % with an average annual (1979-'93) landings of 16,335 t. Highest catch of 28,371 t was observed during 1989 and the lowest of 6,180 t during 1979. The peak fishing season for the lesser sardines at Visakhapatnam extends from October to June with *S.fimbriata* and *S.gibbosa* forming the dominant species at the centre (Ganapathi and Rao, 1957; Rao, 1981; Rao *et al.*, 1980; Luther, 1994 and Luther *et al.*, 1994).

Along Tamil Nadu coast, the lesser sardines sustain a good fishery and forms 10% of the total marine fishery resources of the State. The average annual catch of lesser sardines is around 30,031 t. In spite of the good fishery, fluctuations in the catch associated with this group has been obvious with the catch ranging from 46,366 t in 1987 to 19,611 t in 1990. At Tuticorin the resource is available throughout the year with the peak from September to March. *S. gibbosa* forms the dominant fishery and *S.dayi*, *S.albella*, *S.sirm* and *S.clupeoides* are less dominant (Bennet and Arumugham, 1989 & 1991). At Mandapam the fishery lasts from April to October in Palk Bay with *S.albella* as the most dominant species and along the Gulf of Mannar the season extends from November to March with *S.gibbosa* as the dominant one (Bennet *et.al.*, 1986) Along Madras coast, the main fishing season is during March-April (Basheeruddin & Nayar, 1961) with *S.fimbriata* and *S.sirm* as the major species.

Pondicherry also has a good fishery for lesser sardines with the resource comprising 13.8 % of the total fish catch of the State. The average landings is around 1,762 t. The annual landings ranged from 794 t in 1990 to 3,399 t in 1983.

Along the west coast, Kerala sustains a good fishery especially south of Alleppy with annual average landings of 11,767 t. The resource comprises 8.9 % of the total marine fish catch of the State. The resource exhibited the usual periodic fluctuations with a low catch of 2,473 t in 1985 and a high catch of 22,819 t in 1993. Along Alleppy coast the fishery is good during August to December. At Vizhinjam two peak periods of fishery are observed, the first during April-July and the second during September- December with

S.gibbosa, *S.dayi* and *S.sirm* as principal species. Along Calicut coast, the peak fishing season extends from September to February with *S.gibbosa*, *S.fimbriata* and *S.dayi* as the dominant species.

Karnataka sustains a moderate fishery for lesser sardines with an annual average landing of 5,469 t comprising 3.4 % of the total. High catch of 12,894 t was observed during 1992 and a low catch of 3,151 t during 1982. The fishing season extends from September to November with *S.gibbosa*, *S.dayi* and *S.fimbriata* forming dominant species (Annigeri, 1982 & 1989).

In Goa the lesser sardines form 5.3 % of the state's total marine fish catch with an annual average landing of 3,319 t. The annual landing has been fluctuating between 658 t in 1983 and 10,761 t in 1992. The fishing season extends from September to February with peak in December. *S.gibbosa* and *S.fimbriata* are the important species.

In Maharashtra the resource forms less than 1% of the total marine fish catch. The annual average landing is about 1,846 t with the catch ranging from 254 t in 1984 to 6,935 t in 1993. The resource is caught during September- May with good catches during December to April. *S.fimbriata* and *S.gibbosa* are the chief species.

Lesser sardines do not support a fishery of importance along Gujarat coast and it comprises a mere 0.04 % of the total fish catch of the State and in some years the fishery was non-exsistant.The highest catch of 543 t was observed during 1987 and the annual average catch is estimated around 103 t.

Biological studies

The biology of the dominant species has been studied at the various Centres of the Institute and information on the size composition, maturity, fecundity, reproduction, spawning grounds, food habits, parasites infesting on them, etc., are available. The results of the studies conducted have been tabulated in Tables 1-3.

Table 1. Results of the fishery and biological studies conducted on lesser sardines at different centres.

	S.gibbosa	*S.fimbriata*	*S.albella*	*S.sirm*	*S.dayi*
FISHING	Jan-Dec (a)	Mar.-Apr (b)	Jan.-May &	Jan.-Jul.	Jul.-Dec. (b)
SEASON	Nov-Dec. (a)	Oct-Nov. &	Aug.-Dec. (a)	Sep.-Dec. (a)	

	Feb.Mar. & Jun.-Jul. (b)	May-Jun. (b)	Apr.- Jul. & Sep.- Dec. (a)	Jun.-Dec. (a) Mar.-Apr. (b)	
	Sep.-Mar.(b) Nov.-Mar. (b) Sep.-Non. (b) Dec.-Apr (b)		Sep.-Mar. (b) Apr.-Oct. (b)	Nov.-Mar. (b)	
Size range (cm) in Fishery	4-21.3 (b) 2-16.5 (b)	6-18 (b)	6-23 (b)	9-17 (b) 2-15.5 (b)	
Commercial size (cm)	5-10 (b) 12~14 (b)	10-12 (b)		14-20 (b)	12-14 (b)
Age group (yr)	0-2	0-2		0-2	0-1
Maturity Size (cm)	10.7-18.4 (a,g,h)	13.5-18.5(b), 12(g), 15(f)	14.6-15.5 (c), 10.7 (g)	20.7 (d), 19.7	14 (e)
Spawning season	Mar.-Apr. (a) Feb.-Jul. (b) Jul.-Feb. (b) Aug. – Feb (b)	Aug.- Sep. (g) Apr.-Jun. (f) Jan.-Apr. (c) Oct.-Nov. (g)	Feb.-Jul. (a) Mar.-Apr- (a) Mar.-May(g)	Feb.-Jul. (b) Oct.-Dec. & Jan.-May (e)	
Fecundity	12,786-41,326 (b)	17,974-34,545 (a) 5,500-41,700 (b)	10,000-13,500 (c)	121,500-132,900 (b)	14,000-66,280 (e)

a. Shekaran, b. Bennet *et.al.*, c. Radhakrishnan, d. Lazarus, e. Annigeri, f. Chidambaram, g. Chacko & Mathew, h. Ganapathi & Rao.

Table. 2. Important food components of lesser sardines.

S.gibbosa	***S.albella***	***S.fimbriata***	***S.dayi***	***S.sirm***	***S.clupeoides***	***S.melanura***
Zoea larvae	*Fragilaria*	Dinophysis	Calanid	Calanid	Calanid	*Pseudodiapt*
Eucalanus	*Rhyncalanus*	*Acartia*	Metanauplius	Euterpina	*Euterpina*	*omus*
Euterpina	*Labidocera*	*Temora*	*Labiducera*	nauplii	*Acertia*	*Paracalanus*
Oncaea	Eucalanus	*Pseudodoapt-*	Other	*Evadne*	*Mysis*	*Eucalanus*
Corycaceus	*Euterpina*	*omus*	crustaceans	*Acetes*	Alima	Ostracods
Acartia	*Microstella*	*Euterpina*	prawn larvae	*Mysis*	Phyllosoma	Decapod larvae

Macrostella	Other copepods	*Evadne*	*Acetes*	Prawn larvae	*Porcellosoma*	Vegetable
Pseudodiapt-	*Lucifer*	Copepod eggs	Molluscan	*Cocsinodiscus*	*Thenus*	matter
omus	*Acetes*	*Lucifer*	larvae	*Trichoceratium*	*Acetes*	*Acetes*
Prawn larvae	*Mysis*	*Mysis*	Fish tissue	*Peridinium*	Fish tissue	*Mesopodosis*
Megalopa	Megalopa	*Acetes*	*Thallassiothrix*	*Foraminifera*	*Cocsinodiscus*	
Lucifer	Bivalve larvae	Other	*Cocsinodiscus*		Bivale larvae	
Mysis	Pteropods	crustaceans	*Trichodesmium*		*Trichodesmium*	
Crustacean	Fish larvae	Prawn larvae	*Rzhizosolenia*		*Ceratium*	
remains	*Thallassiothrix*	Molluscan	*Foraminifera*			
Fish eggs	*Bacteriastrum*	larvae				
Fish larvae	*Rhizosolenia*	*Cocsinodiscus*				
Molluscan larvae	*Pleurosigma*	*Fragilaria*				
Trichodesmium	*Triceratium*	*Nitzschia*				
Cocsinodiscus	*Trichodesmium*	*Ceratium*				
Rhizosolenia	*Cocsinodiscus*	*Biddulphia*				
Bacteriastrum	*Foraminifera*	*Trichodesmium*				
Chatosigma	*Oithona*	*Navicula*				
Pleurosigma	*Corycaceus*	*Thallassiothrix*				
Thallassiothrix	*Acartia*	*Planktoniella*				
Copepods	*Sagitta*	*Pleurosigma*				
Foraminiferans	Fish eggs	*Acanthometion*				
Sagitta		Dinophysis				
Acetus		Peridium				
Alpheus						

Table 3. Parasites of lesser sardines

Name of fish	*Name of parasite*	*Mode of infection*	*Effect on host*
Sardinella gibbosa	*Aponurus spp.*	Stomach parasite	
	Heminurus spp.	Stomach parasite	
	Caligus spp.	Buccal cavity	
	Cymothoa spp.	Opercle, head	
Sardinella albella	*Peroderma*	Burried within the body of host at lateral side	Gonad retarded, never attains maturity

	Bomolocus sardinellae	Eye parasite	Gonad development
	Pumillopsis sardinellae	One parasite on each eye	retarded
Sardinella sirm	*Pumillopsis sapthepedes*	Eye parasite(on the eyeball)	Gonad retarded, never attains maturity
	Cymothod spp.	Sides of the body	
Sardinella fimbriata	*Pseudopetalus formmicoides*	Buccal cavity	
	Lernanthropus oblongus	Gill	
	Cymothoaa spp.	Sides of the body	

Population structure

Studies on the population of important/dominant lesser sardine species have been carried out at some of the centres. Estimation of the length-weight relationship, L_∞, K, to, mortality, yield, exploitation rate, etc., have been worked out for some of the species to make an assessment of the long term effect of changes in fishing on catch trends (Rao *et al*, 1980; Annigeri 1985 &1989) (Table 4). Lazarus and Thiagarajan (1994) made an assessment of the exploitation of sardine stock off Vizhinjam using Schaefer and Fox models separately on three species. The boat seine was taken as the standard effort. The results showed a need for the reduction in effort to get the MSY of individual species. However studies at Karwar indicated that there is no great pressure on the resource at present

Table 4. Important population parameters of lesser sardines

Parameter	*S.gibbosa*	*S.albella*	*S.dayi*
Length-weight	W=5.0660+3.0434	W=-6.8950+3.1757	W=-4.3525+2.3591
relationship	Log L (Female)	Log L (Female)	Log L (Female)
	W=-6.9909+3.0780	W=-5.1458+3.0518	W=-6.0753+3.4081
	log l (Male) (a)	Log L (Male) (a)	Log L (Male) (b)
Loo (mm)	96.36(a), 183 (b)	78.65 (a)	150.39 (b)
	144.26 (b)		
	0.32 (a), 1.61(b),0.75	0.3(a)	0.3(b)
	(b)		

to	-0.16(b),--0.43(b)		-0.7413 (b)
M	0.8212(b),0.8218(b)		0.7961 (b), 0.7961 9b)
F	0.09 -0.38 (b)		0.7961 (b),0.7961 9b)
Z	1.31(b)		0.54 (b)
Exploitation rate`U`	0.1224 (b)		0.54 (b)
Total annual stock Y/U	159231 (b, All India)		50514 (b, All India)
	10701 (b. Karwar)		653(b,Karwar)
Average standing stock	87399(b, All India)		21311 (b,All India)
Y/F	5873 (b,Karnataka)	1535 (b,Karnataka)	
	1435 (b,Karwar)		275 (b,Karwar)
a-sekharan	b-Bennet		

Management options

The studies show that the resource is available throughout the year at one Centre or the other. Studies on the stock assessment of some species conducted at Karwar indicated that there is no great pressure on the resource at present and there is further scope for increasing the catch along that region. However, as stock assessment estimations on all the species of lesser sardines along the entire range of distribution is lacking and as they co-exist in the same grounds, it is desirable to conduct further studies on these lines for proposing some conclusive management measures for the resource.

Economics and marketing

The lesser sardine, forming a source of cheap protein, is available almost throughout the year and fetches about Rs.3-6/- per kg at the landing centres. The fluctuations and the steep decline in the catches of oil sardine during the recent years have resulted in increased demand for lesser sardines. The fish is consumed fresh in the coastal places and is transported with ice flakes to nearby states by road and train. The resource has a great demand in the dried form also and the salt dried products are sent to interior States of India and adjacent countries. The smaller fishes, which do not fetch a good price in local markets, are dried and used as an important protein mix for the preparation of cattle/poultry/ fish feed.

Future studies

Although several species contribute to the fisheries, the biology and stock assessment studies of only a few have been carried out. Efforts have to be made to collect detailed information on all the species of commercial importance so as to forecast the fishery and give appropriate management measures for sustaining the resource. The introduction of improved and innovative gears and gradual shift in the fishing grounds has resulted in catching more of lesser sardines and also in the exploitation of certain new stocks hitherto not observed in certain regions. The catch has to be continuously monitored for racial studies on the available population in the distributional range in order to understand the existance of more than one stock in any given region.

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