shows that the yield per recruit, expressed in US dollars, will optimize at a mesh size of 125 mm or at 60% of the present effort.

The complete stock assessment has been repeated for the 1981-82-83 data. Comparison between 1980-81-82 and 1981-82-83 indicates that fishing effort appears to have increased, as well as 'overfishing'.

For the three main species, Diplodus bellottii, Pagellus bellottii and P. acarne the catch in numbers per hour decreases in time, whilst the total mortality increases.

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Note for programmers: Listings and users' instructions written by Mr. Mennes for all of the programs mentioned above can be obtained from ICLARM, by writing to the Network Secretary (address on p.1). Please use your judgement before making a request as the full set amounts to 231 pages. i.e. serious users only please!

PRELIMINARY LENGTH-BASED GROWTH PARAMETER ESTIMATES OF PERUVIAN SARDINE *(SARDINOPS SAGAX SAGAX)*

by

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Introduction

The Peruvian sardine (Sardinops sagax sagax) is one of the most important fish species caught off Peru. Its landings increased after the decline of the anchoveta (Engraulis ringens) landings (Fig. 1). With the increase of sardine landings interest about the state of the stock also increased.

Stock assessments of sardine until today have been based mainly on biomass estimations by means of acoustic surveys. Also, staff at IMARPE (Instituto del Mar del Perú) have attempted to apply Virtual Population Analysis for comparison of stock estimates with those obtained through acoustic methods and to obtain more information about the population structure of the sardine stock. Because growth is one of the most important aspects of fish biology population dynamics and because we observed differences between the estimates of growth parameters derived by several authors, we present here an attempt to obtain growth parameter estimates using the ELEFAN I program for the analysis of length frequency data.

Material and methods

The version of ELEFAN I used for the analysis of sardine length frequency data is that available from the Philippine-German Fisheries Project at the University of the Philippines (Saeger and Gayanilo 1985). The length frequency data used for the analysis were collected by IMARPE field personnel from the fishing area between 14 and 17°S along the Peruvian coast and pertain to fish caught by purse seiners (Table 1).

Results and Discussion

Table 2 shows the values of K and L_∞ obtained by several authors using different methods for sardine from the Southeastern Pacific coast.

The best fitting growth curve obtained by ELEFAN I had values of K and L_∞ similar to those obtained, also for Peruvian sardine, by Burd (1982) using length frequency data and Cardenas (in press) using otoliths.

Small differences between the K and L_∞ values estimated by Serra et al (1979) and Anon. (1983) for Chilean sardine and those estimated in this study will be noted. These differences can probably be attributed to actual differences in the growth patterns of Chilean and Peruvian sardines.

On the other hand, the low L_∞ values (and thus relatively high K-values) obtained by Samame (1974) for the Peruvian sardine and by Saldana (1983) for the sardine off Ecuador may be due to the absence of large fishes from their samples, since 39.5 cm is the maximum length reported off Peru.

We hope that future work, notably the simultaneous analysis of age and length-frequency data will validate the preliminary results presented here.

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(cont. overleaf)

MOVEMENTS

Peter Phillips has moved from Costa Rica. He is now at the Fisheries Research Laboratory, Southern Illinois University, Carbondale, Illinois, 62901, U.S.A.

Table 1. Catch-at-length data on sardine *(Sardinops sagax sagax)* from southern Peru, 1980, used in the study (in thousands).

Length (cm)	Date 1/15	2/15	3/15	4/15	5/15	6/15	7/15	8/15	9/15	10/15	11/15	12/15
6.5	2,250	828										536
7.5	8,267	5,522										4,138
8.5	13,910	31,680	261									13,509
9.5	53,957	58,699	2,766	2,491								38,135
10.5	238,672	106,849	3,328	4,462	125	73						30,124
11.5	466,988	201,865	5,113	7,819	681	0						16,998
12.5	703,283	185,000	10,933	11,459	850	316						4,459
13.5	503,436	157,506	21,531	25,494	2,150	577						220
14.5	308,559	165,434	16,158	45,240	9,323	1,464			302			63
15.5	65,317	66,087	20,217	73,883	38,687	9,716			1,270	33		0
16.5	11,018	36,228	33,578	145,336	165,359	45,296			1,286	114		0
17.5	860	9,743	77,356	234,829	241,165	84,515		22	1,372	786	3	0
18.5	112	4,916	88,375	365,066	154,201	76,042	16	22	1,053	3,644	67	0
19.5	116	868	25,786	165,949	89,774	57,682	159	98	3,126	5,017	171	0
20.5	49	0	1,795	37,452	59,675	38,390	196	478	14,795	5,334	484	76
21.5	1,362	101	422	4,055	15,450	10,676	264	1,090	21,568	13,385	588	639
22.5	1,803	73	42	1,363	1,214	1,116	214	246	16,682	23,269	756	1,484
23.5	1,177	31	146	1,457	0	434	47	2	3,643	16,878	477	3,376
24.5	146	54	105	495	1	24	5	3	466	3,195	141	3,096
25.5	386	989	307	163	95	78	37	5	4	212	46	2,119
26.5	5,303	5,252	3,432	2,610	1,739	506	212	46	45	115	23	1,350
27.5	16,404	11,935	25,031	12,229	7,247	1,443	711	366	334	1,954	215	4,558
28.5	24,401	20,194	71,149	42,206	19,377	3,592	1,476	925	775	9,111	1,263	9,326
29.5	31,992	24,426	105,325	65,147	16,210	3,897	1,695	996	825	12,875	1,897	6,591
30.5	20,255	38,209	101,627	49,377	12,347	2,844	1,393	785	649	10,424	1,361	2,172
31.5	28,818	28,969	78,914	38,903	8,636	2,159	1,037	624	576	8,169	979	1,334
32.5	26,443	23,033	40,285	22,186	2,811	1,998	889	532	637	3,938	634	935
33.5	20,475	21,128	32,126	17,263	2,123	1,445	662	453	492	4,552	638	476
34.5	10,829	13,324	18,134	5,561	1,200	370	213	158	234	2,410	283	118
35.5	2,222	2,975	7,061	1,213	182	95	25	24	73	541	50	11
36.5	13	273	873	31	32	9	1	3	27	69	3	
37.5	3	2	33			1			1			
38.5												
39.5								1	2			

Table 2. Growth parameters of *Sardinops sagax sagax* estimated from several authors using different methods.

Area	Method	K (1/year)	L_∞ (in cm)	Author
Ecuador	Back calculation of age-length	0.44	31.2	Saldaña (1983)
Peru	Back calculation of age-length	0.33	33.8	Samamé (1974)
	Back calculation of age-length	0.32	32.4	Samamé (1974)
	Length frequency	0.24	41.6	Burd (1982)
	Back calculation of age-length	0.25	38.5	Cardenas (1982)
	ELEFAN I	0.252	41.0	this study
Chile	Back calculation of age-length	0.21 0.19	38.6 41.7	Serra et al. (1979) Anon. (1983)

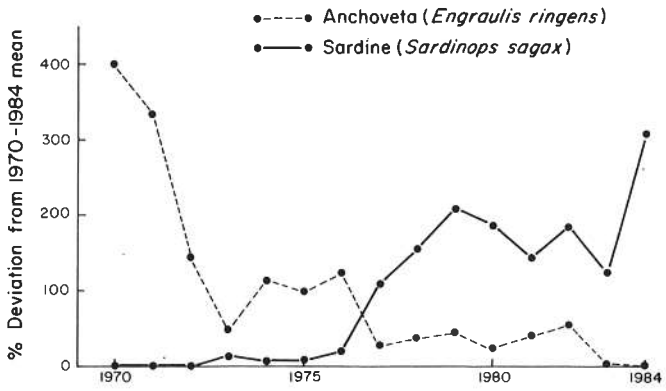

Fig. 1. Percent deviation from 1970-1984 mean catch of Peruvian anchoveta *(Engraulis ringens)* and Sardine *(Sardinops sagax)*, showing change in the relative importance of these two species (based on Peruvian catch statistics for 1970-1984).