SEASONAL FLUCTUATIONS OF SARDINE'S (Sardina pilchardus, Walb)
POPULATION ABUNDANCE ALONG THE EASTERN ADRIATIC COAST

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Introduction

Sardine (Sardina pilchardus, Walb) in yugoslav
commercial fisheries is one of the most important species, be-
cause of its quantity among the other pelagic species (anchovy,
sprat) making an average bulk of 68,0%, for the period 1967/79
year, while in the total yugoslavian yearly yield makes an
average of 53.0 percentage. On the other hand, sardine's catch
after post war period has been the main raw material for
processing industry.

With regard to its economic importance for the
yugoslavian commercial fisheries, taking into the account stati-
stical data informations: sardine's yearly and seasonal total catch
and corresponding fishing effort, for the period 1967/79 year,
studies of seasonal population a b u n d a n c e fluctuations
have been carried out along the eastern Adriatic coast for
the following purposes: to forecast possibilities for extension
of purse-seining and middle-water trawl fishing operations
throughout of the whole year, for a higher yield and to appraise
present level of sardine's exploitation concerning the sardine's
population maximum sustainable yield (MSY, C_{max}).

Material and methods

In calculation of sardine's seasonal abundance fluctuations statistical data of sardine total catch, achived only by purse-seining fishing technique, and corresponding fishing effort (total number of fishingdays-nights) of one yugoslavian cooperative fishing organization ("Jadran"-Split) and total sardine's yugoslavian catches for the period 1967-79. year have been considered.

Its worth noting that purse-seining fishing technique (encircled nets) for the sardine of the analysed fleet (in average, with engine power of 240 hp) didn't change at all during the mentioned period of the time.

For calculation of the seasonal abundance values,a method described by (G u l l a n d, 1968) has been used, i.e. relation:

$$\bar{U} = c/f \tag{1}$$

where ($\bar{U}$) is an average catch per unit effort-c p u e - (average abundance in time-season), (c) is the total sardine seasonal catch and (f) is the total fishing effort (total number of effective fishing days, i.e. nights because of night-fishing strategy). To estimate the total yugoslavian sardine's fishing effort (f_e), following relation is used:

$$f_e = C/\bar{U} \tag{2}$$

where (f_e) estimative, calculated, total fishing effort, (C) is the total yugoslavian sardine's catch and ($\bar{U}$) is the catch per unit effort of considered "statistical sample", i.e. cooperative "Jadran" - Split.

Using a global production models; linear (S c h a e f er, 1954) and exponential (F o x, 1970) it has been tryed to evalute present level of sardine's exploitation in connection to the biological potentials of the population along the eastern Adriatic coast, i.e. to the ma imum sustainable yield

(MSY, C_{max}) and optimal fishing effort (f_{opt}) for forecasting sardine's yield increment possibilities. For these purposes the following expressions have been used:

$$MSY = C_{max} = U \infty^2 / 4 b \quad \text{(after Scheafer)} \quad (3)$$

$$MSY = C_{max} = U \infty / be \quad \text{(after Fox)} \quad (4)$$

where ($U\infty$) is maximum of population abundance proportional to maximum population size, (b) and (e) are constants.

Optimal total fishing effort (f_{opt}) which correspond to the maximum sustainable yield (MSY) has been calculated from these relations:

$$f_{opt} = U \infty /2b \quad (5)$$

$$f_{opt} = 1 / b \quad (6)$$

Catchability coefficient (q) for the sardine population for the studied seasons (spring, summer, autumn) is calculated by G u l l a n d (1964) method.

Results

Obtained results are presented in tables 1, 2 and figure 2. With regards to statistical data calculations for the period 1967/79 year, it has been found out that sardine's population along the eastern Adriatic coast, inside the fishing ground, has significant seasonal a b u n d a n c e fluctuations with maximum value during the autumn (3426 kg/fishing day-night) and minimum value during the summer time (1582 kg/day-night).

On the base of available data (table 1), especially after 1975 year, for the winter season when yugoslavian purse--seining operations have been extended mostly throughout january and march months, it seems that during winter months sardine's abundance reaches its maximum, i.e. it is noted average abundance of (5290 kg/fishing day-night).

Table 1. Yugoslavian sardine's seasonal catches (C) and corresponding abundance ($\bar{U}$) values with estimated fishing effort (f_e - effective fishing days-nights) for the period 1967/79 year

Year	Winter C(tons)	%	$\bar{U}$(kg)	f_e	Spring C(tons)	%	$\bar{U}$(kg)	f_e	Summer C(tons)	%	$\bar{U}$(kg)	f_e	Autumn C(tons)	%	$\bar{U}$(kg)	f_e
1967	182	1.9	2471	74	2920	30.2	4006	729	3945	40.9	880	4483	2607	27.0	1235	2111
1968	158	1.3	927	170	4793	39.5	2197	2182	4787	39.5	1505	3181	2389	19.7	955	2501
1969	109	0.9	991	110	3535	30.5	2593	1368	3887	33.4	956	4066	4098	35.2	2063	1986
1970	73	0.7	1413	52	2377	21.7	2256	1053	3964	36.1	1155	3432	4558	41.5	1604	2842
1971	155	1.1	1185	131	3798	24.9	1486	2556	4364	29.7	983	4439	6358	43.3	3151	2018
1972	338	1.9	1246	271	3124	17.7	1799	1736	5587	31.7	1074	5202	8555	48.6	3350	2554
1973	474	2.4	1658	286	5400	27.8	3032	1781	6154	31.8	2314	2660	7403	38.1	2706	2736
1974	726	4.5	477	1521	1757	10.8	2018	871	6333	39.0	1025	6179	7409	45.7	3595	2061
1975	879	4.7	6686	132	2594	13.9	2303	1126	6566	35.3	1877	3498	8557	46.0	3122	2741
1976	1073	5.0	5815	185	6616	30.7	2670	2478	6077	28.2	2402	2530	7781	36.1	5365	1450
1977	2792	12.3	4163	670	4547	20.0	2733	1664	5429	19.9	2214	2046	10903	47.9	5105	2136
1978	700	3.1	4499	156	3698	16.6	3851	960	7008	31.5	1644	4262	9753	43.8	6229	1567
1979	748	4.0	5291	141	5685	30.7	4745	1198	7008	38.0	2537	2774	5041	27.3	6053	333
Average	647	3.3	2832	228	3911	23.8	2745	1425	5403	33.0	1582	3415	5895	40.0	3426	1721

Comparing sardine's seasonal abundance values with computed results of the global production models, linear and exponential, (table 2) especially as far as maximum sustainable sardine yield is concerned, it has been stated a possibility for sardine's yield increment throughout of the whole seasons but significantly during the spring season, and probably during the winter season which results were not considered bacause of data scarceness.

This sardine's yield increment inside of the studied fishing area has not been so great, as it generally had been thought, bacause of sardine stock size. The same findings, of sardine's biological potential yields along the eastern Adriatic coast, are stated for the sardine's management purposes.

Achieved values of the sardine population seasonal catchability coefficient (q), fig. 2, have its maximum in autumn (q = 20.3 x 10^{-5}) and spring (q = 18.7 x 10^{-5}) seasons, while at summer season coefficient is the lowest (q = 6.4 x 10^{-5}). Because of small number of data catchability coefficient for the winter season was not calculated.

C o n c l u s i o n

With regard to statistical data calculation analyses of sardine's yearly and seasonal total catch obtained only by purse-seining fishing operations, and corresponding fishing effort throughout of the period 1967/79 year along the eastern Adriatic coast (Fig. 1), folowing conclusions are derived:

- sardine's population along the eastern Adriatic coast has a significent seasonal a b u n d a n c e fluctuations, generarly with a higher abundance values during autumn-winter season of the year and might be considered as "spawning stock". Such conclusion is supported by biological data (M u ž i n i ć, 1954, 1974; G a m u l i n, 1954; K a r l o v a c, J., 1964).

Lower abundance during spring - summer season corresponds to
sardine's "feeding stock", behaviour which was treated by
V u č e t i ć (1964).

         - seasonal and yearly increment of the sardine's
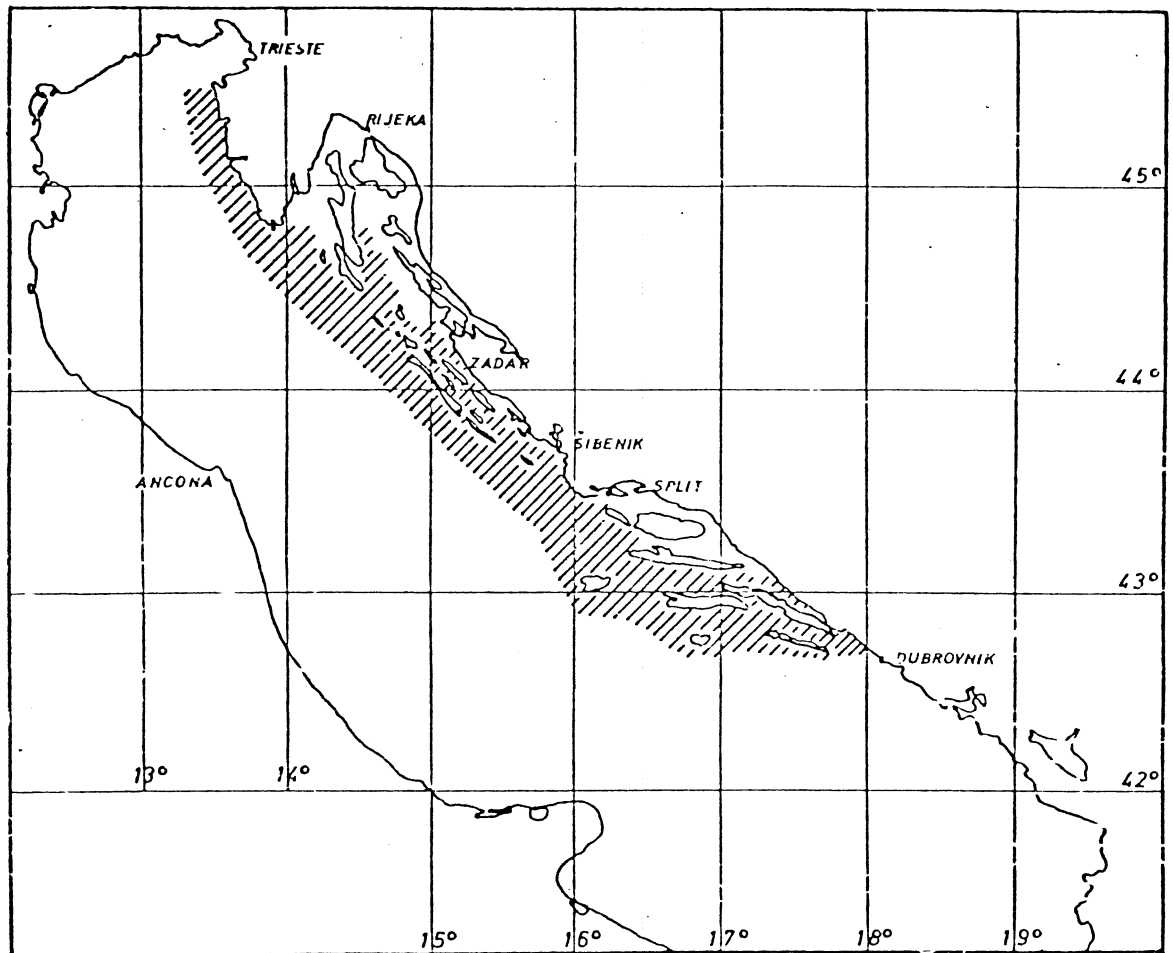yields might be achieved along the yugoslav coast, but at resonabl
level.

Figure 1 - Sardine's main fishing grounds along the eastern Adriatic
        coast where the seasonal a b u n d a n c e   fluctuations
        have been studied.

Table 2 -   Calculated seasonal values of the m a x i m u m
                 biological catch (C$_{max}$),   optimal fishing
                 e f f o r t (f$_{opt}$) for sardine population along the
                 eastern Adriatic coast by means of (S c h a e f e r,
                 1954) linear and (F o x, 1970) exponential production
                 models

Season	Method	Coefficienet correlation (r)	C$_{max}$	f$_{opt}$
Winter	-	-	-	-
Spring	Linear	- 0.470	5077	2637
	Exsponential	- 0.488	5408	3769
Summer	Linear	- 0.792	6069	3895
	Exponential	- 0.789	5520	3740
Autumn	Linear	- 0.714	7728	1897
	Exponential	- 0.601	6517	1610
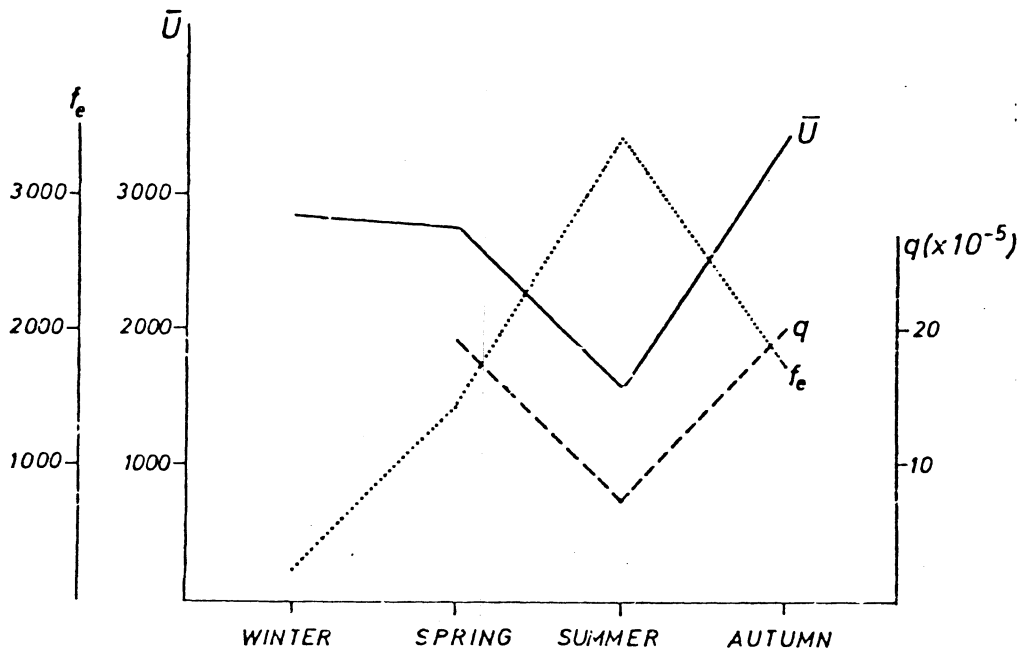
Figure 2 - Seasonal fluctations of sardine   a b u n d a n c e
           ($\bar{U}$-kg/day-nigth), fishing e f f o r t (f$_e$-fishing days)
           and c a t c h a b i l i t y coefficient (q) for the
           period 1967/79. year.

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