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FISH PRODUCTION IN EXTENSIVE POLYCULTURE IN THE ESTEROS OF CADIZ (SOUTHERN SPAIN)

by

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ABSTRACT

The annual average value of the total commercial production of marine fishes in 32 esteros is 1757.8Kg per estero, with extremes values ranging from 128 to 7952 Kg. (Table 1)

The production of all esteros combined can be split by weight as follows: mullets, 77.9%, and sea-bream, two species of sea-bass, eel and Senegalese sole, 22.1% altogether. The most important species of mullets are: Mugil auratus, M. capito and M. chelo, and from the second group, we can mention Dicentrarchus labrax and Sparus aurata. (Table 2)

Age-composition analysis shows, for all species harvested, the predominance of the 0+ and 1+ age-groups. (Table 3)

INTRODUCTION

An annual production of marine fishes of high economic value has being obtained for centuries through a rudimentary system of extensive polyculture in the esteros of Cádiz. These fishes are very appreciated both in local and national markets. Eel and sea-bream are also exported to several European countries.

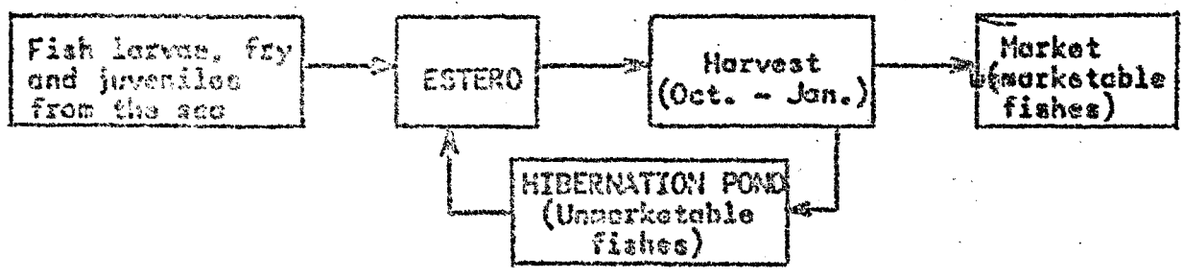
The present paper shows the actual level of fish production obtained with this kind of culture. It represents one of the preliminary steps required to determine the necessary transformations to obtain increasing yields.

CULTURE SYSTEM

The studied area comprises some 150 esteros where the fishes are reared as a joined activity to marine salt production. The esteros were used in the past as a sea-water reservoir for salt production; lately, most of them are used exclusively as a fish culture ponds.

The average depth and surface of the esteros are respectively 1 m and 20 Has. The bottom is muddy. Sea water flows through tide gates from channels connecting them with the sea.

The following diagram shows the fish production cycle of an estero:



The following species of commercial fishes are present in the esteros: Sparus aurata, Dicentrarchus punctatus, Dicentrarchus labrax, Anguilla anguilla, Solea senegalensis, Mugil cephalus, Mugil capito, Mugil auratus, Mugil saliens and Mugil chelo.

Fish larvae, fry and juveniles enter the esteros during the high tide. There is a continuous recruitment of fry and juvenile specimens of the species above mentioned in the esteros throughout the whole year, owing to their overlapping spawning periods. The volume of captures is largest from the end of the Autumn to the end of the Spring, since the spawning of most species occurs during this periods.

The tide gates are kept closed during the Spring until harvest time. Water is partially renovated only when the tide is favourable. A large conical net set across the tide gate prevents the escape of the fish collected when the sea water is flowing in; however, the net allows fry and juveniles below a certain size to enter the estero.

Fishes in the estero feed on natural preys. The high primary and secondary productivity favours the abundance and diversity of available food. This fact along with the high water temperature from May to October($> 20^{\circ}C$), allows

for a very rapid growth, greater than that observed in the open sea and other similar areas to our own (DRAKE, 1979; ARIAS, 1980).

The average values and range of variation of water temperature, salinity and disalved oxygen during the year are, respectively: 18.1ºC (8-27ºC); 41.5 o/oo (27-69 o/oo) and 5.7 mg/l (0-10 mg/l). Nitrite concentration is never superior to 0.58 µg. at. N/l; pH ranging from 7.4 to 8.4 (ARIAS and RODRIGUEZ, 1977; ARIAS and ESTABLIER, 1979).

Fish harvest takes place annually from October to January. The fishes are taken by net, once the estero has been totally emptied, by professional fishermen. All fishes are culled according to size: marketable specimens (longer than 23 cm.) are placed in boxes and sent to market; unmarketable ones (smaller than 23 cm.)are transferred to a hibernation pond. In Spring, each estero and its corresponding hibernation pond are joined by a small gate that connects each other, allowing the fishes to pass into the estero; they will form part of the following year production. Some esteros lack a hibernation pond, in wich case, all fishes, large and small, are sold in the market.

The main risk in this kind of culture is a drop in the availability of oxygen during the summer months, wich produces a high fish mortality. This risk is aggravated in some esteros by an insufficient water renovation.

MATERIAL AND METHODS

From September 1979 to January 1980 we have examined *in situ* the catches of 32 esteros. For each one the total weight of marketable fishes was taken, while the total weight of unmarketable fishes was estimated by weighting a representative sample. A sample of aproximately 10% of the total production of each estero was taken, in order to know:

a) the species composition

b) the number and the total weight of the specimens for each species

c) the lenght of the specimens of each age-group. When the number of specimens in a particular age-group was too large, a sample of 50 specimens only was measured.

RESULTS AND DISCUSSION

1. Total production

Taking all the species combined in all 32 esteros together (Table 1), is was found that average production per estero was 1757.8 Kg, ranging from 182 to 7952 Kg; 68.1% of fishes was commercialized, while 31.9% was stored in the hibernation pond for future rearing.

The different production of the esteros is due to many factors acting concurrently, such as: their size, their proximity to the sea, and even human activities. Among the latter, for instance, we can mention the foreman's efficiency and experience, that determine the amount of fry entering the estero, the maintenance of the water quality, the amount of fishes transferred to the hibernation pond, etc.

2. Species composition

Table 2 shows the minimun, maximum and mean values of weight production for each species, calculated as an average of the esteros sampled. The last two columns give the total and the percentage of total weight production.

Mullets represent 77.9% of the total catches, while all the other remaining five species make only 22.1%. These percentages vary from estero to estero, owing to the above mentioned factors.

It is worth noting the predominance of M. auratus, M. capito and M. chelo over other mullets. The difference among them could be related to their different spawning time. The spawning of the three cited species cover a period between October and April, time when the tide gates are open; hence the fry can enter freely into the esteros. The remaining mullets spawn between April and September, when tide gate net selects the entrance of fry according to size.

Among the non-mugilid species, D. labrax and S. aurata predominate.

Table 3 shows the number of specimens (as percentage) and the average length of each age-group for each species. Eel is not included because it was impossible to obtain reliable age data.

The variations in the number of individuals among the different age-g

-groups within a species are due to several factors, such as the period between the spawning season and the harvest time, growth rate, etc. (Figure 1). So that, we observe in this figure that only S. aurata achieves a marketable size within its first year of life. This does not happen for Solea senegalensis; however, its total production is sold enterely. Owing to their behaviour of burying themselves under the sand, sole individuals are sometimes overlooked during fishing operations; therefore, the 1+ age-group percentage is slightly high.

Like mullets, D. labrax and D. punctatus do not reach a marketable size until their second year of life. These two species are affected by a high mortality rate when transferred to the hibernation ponds. As a consecuence, the percentage of the second age-group is rather low.

The harvest takes place aproximately in the middle of M. cephalus and M. saliens spawning time. For this reason few fry and juveniles of these species enter the estero and the 0+ age-group percentage is accordingly low.

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Table 1.- Total weight production of marketable fish (all species combined) during 1979-1980 season, arranged by estero. * Esteros lacking hibernation ponds.

Estero Nº	Date	Unmarketable Fish (Kg.)	Marketable Fish (Kg.)	Total Production (Kg.)
1	092479	-	-	1224 *
2	100379	-	-	250 *
3	100379	-	-	220 *
4	101979	200	545	745
5	101979	200	292	492
6	102079	130	272	402
7	102079	132	1000	1132
8	102579	135	69	204
9	102679	180	910	1090
10	102679	872	1802	2674
11	102979	120	917	1037
12	102979	-	-	372 *
13	110679	1748	2963	4711
14	110879	-	-	140 *
15	110879	150	304	454
16	111279	320	300	620
17	111279	270	565	835
18	111479	860	1495	2355
19	111579	940	1752	2692
20	111679	342	935	1277
21	111979	-	-	128 *
22	112179	195	1785	1980
23	112279	2100	4326	6426
24	112879	460	311	771
25	112979	298	2190	2488
26	120379	48	397	445
27	120579	3405	4547	7952
28	121079	450	165	615
29	121179	291	1801	2092
30	121779	1183	2844	4027
31	121979	1152	2758	3910
32	010480	1040	1452	2492

Table 2.- Weight production by species obtained in 32 esteros in Cadiz during 1979-1980 season.

Species	Minimum (Kg.)	Maximum (Kg.)	Mean (Kg.)	Total (Kg.)	%
S. aurata	0	785.7	103.7	3319.3	5.89
D. labrax	2	830.4	144.3	4618.6	8.19
D. punctatus	0	184.2	35.6	1141.2	2.02
A. anguilla	1	321.0	64.5	2064.8	3.66
S. senegalensis	1	152.5	39.0	1248.8	2.21
M. cephalus	0	475.4	89.2	2856.8	5.07
M. capito	0.4	2105.7	361.7	11576.5	20.54
M. auratus	8.5	2147.1	533.2	17068.4	30.28
M. saliens	0.3	282.1	65.6	2099.0	3.72
M. chelo	0.7	2790.0	323.4	10348.6	18.36

Table 3.- Age-group frecuency and mean length per age-group and species in 32 esteros in Cadiz, during 1979-1980 season

Species	Age-group (years)	%	Mean length (cm)
S. aurata	1	93.8	28.7
	2	5.1	35.7
	3	0.8	42.0
D. labrax	0+	95.4	17.5
	1+	3.6	30.0
	2+	0.8	36.4
	3+	0.2	46.3
D. puntazzo	0+	93.8	14.1
	1+	2.1	25.2
	2+	0.4	30.5
S. senegalensis	0+	81.1	20.6
	1+	17.4	31.0
	2+	1.5	38.7
	3+	0.4	42.7
M. cephalus	0+	17.4	10.4
	1+	77.1	31.9
	2+	4.0	42.2
	3+	1.2	48.7
	4+	0.2	52.5
M. capito	1	80.6	17.2
	2	17.8	28.6
	3	1.2	32.6
	4	0.4	39.0
M. auratus	1	74.6	20.7
	2	24.2	28.1
	3	1.1	35.2
	4	0.01	39.5
M. saliens	0+	20.9	6.9
	1+	52.1	19.0
	2+	15.2	24.1
	3+	4.3	27.1
	4+	1.5	29.6
M. chelo	0+	85.5	14.5
	1+	14.4	30.1

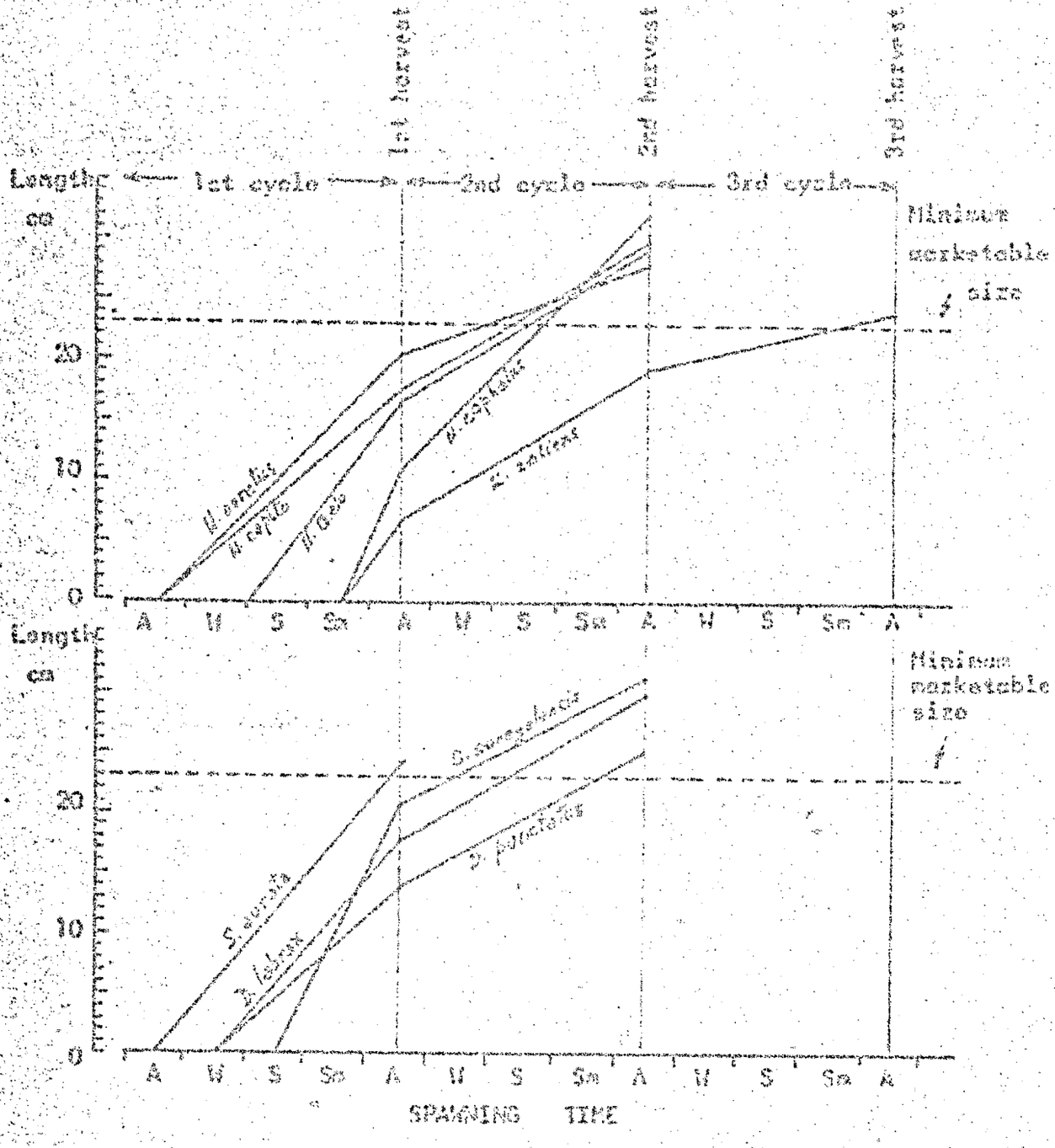

Fig 1.- Species growth per culture cycle. Graphic representation of sizes reached by the different species at the end of each rearing cycle, related to the spawning time and growth rate. The origin of the curves represents the middle point of the spawning season in each species.

A = Autumn; W = Winter; S = Spring and Sm = Summer