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BIOLOGICAL CHARACTERISTICS OF THE CATCH
FROM THE 1985-86 PACIFIC HERRING,
CLUPEA HARENGUS PALLASI, ROE FISHERY IN CALIFORNIA

by

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ABSTRACT

In Tomales Bay, 4-, 5-, and 6-yr-old herring, Clupea harengus pallasii, composed 70% by number of the 1985-86 season's catch. In San Francisco Bay, 2-, 3-, and 4-yr-old herring composed 78% by number of the roundhaul catch, and 4- and 5-yr-old herring composed 64% by number of the gill net catch.

The percent of 4-yr-old herring in both the Tomales Bay catch (25% and San Francisco Bay gill net catch (39%) is at a high level for the second year in a row.

Recruitment of 2-yr-old herring into the San Francisco Bay roundhaul fishery was about average, with 2-yr-old herring composing 33% of the catch.

The mean length of herring in the San Francisco Bay roundhaul catch increased to 178 mm BL, while the mean length of the gill net catch remained 196 mm BL. The mean length of the Tomales Bay catch decreased to 198 mm BL due to the increased number of 3- and 4-yr-old herring in the catch.

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INTRODUCTION

The Department began monitoring the age, size, and sex composition of the Pacific herring, Clupea harengus pallasii, roe fishery catch in Tomales and San Francisco Bays in 1973. Spratt (1981, 1982, 1983, 1984, and 1985) reported on data collected by sampling the herring roe fishery from 1973 until 1985. This report complements previous data to provide a continuous seasonal series from 1973 through the 1985-86 season.

METHODS

Sampling

In the Tomales Bay area, herring were collected at Marshall. In San Francisco Bay, herring were collected at Sausalito and San Francisco. Up to four samples were taken per day in each bay, when herring were available. A sample consisted of 2.3 kg (5 lb) collected after vessels unloaded.

All samples were processed in a fresh condition and laboratory procedures have remained unchanged since the fishery began in 1973 (Spratt 1981). Every fish in the sample was weighed to the nearest 0.1 g, measured in millimeters body length (mm BL), and sex and maturity were determined. Body length was used as the unit of measurement because the fleshy caudal peduncle of herring makes the hypural plate difficult to locate. Body length was measured from the tip of the snout to the end of the silvery part of the body. Otoliths were removed for age determination and stored in gelatin capsules. Ages were assigned by the author using previously determined criteria (Spratt 1981), and otoliths were read twice before final age determinations were made.

RESULTS

Tomales Bay

A total of 34 samples was collected this season and 287 individual fish were processed.

Age Composition

The Tomales Bay fishery was restricted to gill nets in 1977. From the 1977-78 through 1984-85 seasons, the catch was dominated by 5-, 6-, and 7-yr-old herring.

Normally, 5-, 6-, and 7-yr-old herring are the dominant age classes in Tomales Bay. However, in the 1985-86 season the percent of 4-yr olds in the catch increased to 25% by number, while the percent of 7-yr olds decreased to 10% by number. And for the first time, the three dominant age groups were 4-, 5-, and 6-yr olds composing 70% by number of the catch (Figure 1).

The percent of 3-yr-old herring (14%) and 4-yr-old herring (25%) in the catch is at its highest level since the fishery was restricted to gill nets in 1977.

Length Composition

The average length of herring in the Tomales Bay catch during the 1985-86 season declined to 198 mm BL (Table 1). The combined average length of 5-, 6-, and 7-yr-old herring (Table 2) did not change from the 1984-85 season (Spratt 1985). However, the record high number of 3- and 4-yr-old herring in the catch, reduced the overall mean length. The 1982 and 1983 yr classes are relatively strong in San Francisco Bay (Spratt 1985). This recruitment pattern is also becoming evident in Tomales Bay, and the overall seasonal mean length should begin to increase when these two year classes are fully recruited.

The timing of the fishery in relation to spawning was not a factor this season. Our samples were taken throughout the season and not biased toward early or late season spawning runs, which have very different age and size compositions.

Weight Composition

The mean weight at age of Tomales Bay herring declined dramatically in the 1983-84 season, when weight at age of all exploited year classes was below normal (Spratt 1984). In the 1984-85 season, the mean weight at age increased, but this season the mean weight at age decreased slightly and the average weight of the dominant year classes remains below the long-term mean (Table 3).

Sex Ratio

The female to male number and biomass (weight) ratios of the 1985-86 Tomales Bay catch were nearly equal (Table 4). The percent of females in the catch, 52% by number and 54% by weight, is less than expected. From the 1982-83 to 1984-85 season females have averaged more than 60% of the catch by number.

San Francisco Bay

A total of 56 samples was collected this season and 551 individual herring were processed. In San Francisco Bay both the roundhaul and gill net catches are sampled, but sample data is analyzed separately.

Age Composition

The percent of 2-yr-old herring in the roundhaul catch is normally a good indicator of year class strength. This season, recruitment of the 1984 yr class (2-yr olds) into the 1985-86 fishery was about average.

The 1984 yr class follows two exceptionally strong year classes and all three are affecting the relative age composition (Figure 1), which is heavily weighted toward younger age classes. The spawning season and fishery both came to an abrupt end on February 7th due to a series of winter storms that hit California. Late season spawning runs did not materialize, and it is these late runs that have the highest percentage of recruits or 2-yr olds. Therefore, the 1984 yr class may be stronger than samples indicate.

The roundhaul fishery in San Francisco Bay was again confined to the later half of the spawning season, when older herring are less available to the fishery. As a result there was only one 8-yr-old, and no 9-yr-old herring in the samples, but in 7 out of 13 seasons, 8- and 9-yr-old herring have composed 1% or less of the catch.

Prior to the 1984-85 season, the San Francisco Bay gill net fishery was dominated by 5-, 6-, and 7-yr-old herring. In San Francisco Bay, the 1984-85 season was the first full season with a minimum mesh size of 2 1/8 in. Since then, the relative number of 7-yr olds in the catch has decreased while the relative number of 4-yr olds in the catch has increased. In the 1985-86 season 4-, 5-, and 6-yr olds accounted for 77% of the catch by number and by weight (Figure 1).

Length Composition

The mean length of the San Francisco Bay roundhaul catch declined to an all-time low of 165 mm BL in the 1983-84 season (Spratt 1984). Since then, the mean length of the catch has been increasing and reached 178 mm BL (Table 1) in the 1985-86 season. Good growth characteristics are again a factor in the overall increase in mean length of the catch this season, because all age groups increased in mean length from 1 to 4 mm (Table 5) from the 1984-85 season.

The mean length of the gill net catch in San Francisco Bay is below 200 mm BL for the second time (Table 1). The average length at age (Table 6) of herring in the gill net catch increased over the 1984-85 season, but the reduced mesh size has resulted in an increase in the number of 3- and 4-yr-old herring in the catch and a decrease in the overall mean length of the catch.

Weight Composition

The overall weight composition of the San Francisco Bay roundhaul and gill net catches (Figure 1) parallels that of the age composition. The roundhaul catch was dominated by 2- and 3-yr-old herring, while the gill net catch was composed mainly of 4- and 5-yr-old herring.

Samples from the roundhaul catch in the 1985-86 season indicate that growth was above average during 1985. Weight of all age classes except 7-yr olds (Table 7) was above long-term averages.

Sex Ratio

The sex and biomass (weight) ratios of the San Francisco Bay gill net and roundhaul fisheries were similar this season. Females composed 52% of the gill net catch and 50% of the roundhaul catch (Table 4). This season the percentage of females in the roundhaul catch was normal, but the percentage of females in the gill net catch was less than expected. The trend toward smaller mesh in the gill net fishery is affecting the sex ratio of the catch, because smaller mesh nets catch a lower percentage of females than larger mesh nets (Reilly and Moore 1986).

DISCUSSION

The age composition of the Tomales Bay catch has been composed primarily of 5-, 6-, and 7-yr-old herring every season since the fishery was limited to gill nets only in 1977. These age groups comprised

between 72% and 82% of the catch until this season, when the percentage of 5-, 6-, and 7-yr-old herring dropped to 55%. This is due to initial recruitment of the strong 1982 and 1983 yr classes (3- and 4-yr olds). Those two year classes have good growth characteristics and are expected to have a positive impact as they move through the fishery.

The strength of the 1984 yr class appears to be average in San Francisco Bay, but could be weak in Tomales Bay because of low spawning escapement in 1984 (Spratt 1985b). This year class will not be fully recruited in Tomales Bay until the 1988-89 season.

The age and size composition of the San Francisco Bay roundhaul catch changed little from 1973 to 1984-85, with 2- and 3-yr-old herring dominating the catch (Spratt 1985). Recruitment of the 1984 yr class into the roundhaul fishery is about average, accounting for 33% of the catch by number. Good recruitment is one factor contributing to the modest increase in spawning biomass this season (Spratt 1986).

CONCLUSION

The biological characteristics of the Tomales Bay catch are normal, with indications that the strength of the two year classes entering the fishery may be better than average.

In San Francisco Bay, the biological characteristics of the catch indicate that relative recruitment of the 1984 yr class was about average, causing the population growth rate to slow (Spratt 1986). Recruitment of the 1985 yr class next year will be a major factor in determining population size.

Based on the biological characteristics of the catch, the condition of the herring stocks in both bays remains good, and major changes in the population's size are not expected next year. Therefore, no change is recommended for the roe fishery quotas in Tomales Bay or San Francisco Bay of 1000 tons and 7500 tons, respectively.

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TABLE 1. Mean Length of Pacific Herring from Tomales and San Francisco Bay Roe Fisheries, 1972-73 through 1985-86 Seasons.

Season	<u>Tomales Bay</u>		<u>San Francisco Bay</u>			
	Mean length mm BL	Size range	<u>Gill net</u>		<u>Roundhaul</u>	
	Mean length mm BL	Size range	Mean length mm BL	Size range	Mean length mm BL	Size range
1972-73	186	150-234	-	-	-	-
1973-74	190	146-248	-	-	177	134-222
1974-75	189	142-236	-	-	178	132-226
1975-76	184	150-230	-	-	178	128-230
1976-77	169	140-216	212	192-236	181	142-228
1977-78	217	194-248	211	178-236	178	144-232
1978-79	No Samples		203	164-234	183	146-222
1979-80	214	196-236	208	184-230	180	148-220
1980-81	208	172-234	205	170-236	178	150-226
1981-82	211	176-236	201	160-228	177	148-226
1982-83	208	184-236	203	170-230	183	152-226
1983-84	199	174-242	205	182-232	165	132-208
1984-85	202	164-232	196	158-238	176	150-206
1985-86	198	166-226	196	166-226	178	142-214

Note: Tomales Bay has been restricted to gill nets only since 1977, and minimum mesh restrictions were lowered to 2 1/8 in. from 2 1/4 in. for the San Francisco Bay gill net fishery in 1984.

TABLE 2. Length Frequency of the Tomales Bay Gill Net Catch in the 1985-86 Season.

MM BL	2	3	4	5	6	7	8	9
226						2		
224								1
222								
220					1	2	2	
218					2	1	2	
216					1	1	2	
214				1	2	2	2	
212			2	1	3	4		1
210				4	10	3	2	
208				8	2	3		
206				6	6	3	1	
204			4	5	9	5		
202			4	4	7	1		
200		2	3	12	6	1		
198		1	3	9	2			
196		2	4	6	2			
194			5	7				
192		6	13	8				
190		1	5	3				
188		2	10	4				
186		1	6					
184		3	8					
182		7	5					
180		4	1					
178		3						
176		3						
174		3						
172		2						
170								
168								
166	1	1						
N	1	41	73	78	53	28	11	2
Mean	166	184	192	200	206	211	215	218
St. dev.	-	8.3	7.2	6.6	5.7	6.8	4.5	8.5

TABLE 3. Mean Weight in Grams at Age of Herring in the Tomales Bay Gill Net Catch By Season.

Season	Age								Unwtd. mean *
	2	3	4	5	6	7	8	9	
1977-78	-	-	142	139	155	157	165	184	152
1978-79	No Samples								
1979-80	-	-	130	135	137	145	188	-	148
1980-81	-	92	113	131	141	153	161	177	140
1981-82	-	83	116	121	147	158	160	172	134
1982-83	-	-	100	120	132	150	169	172	140
1983-84	-	-	91	106	114	131	141	150	117
1984-85	76	102	109	117	135	151	161	172	135
1985-86	73	94	106	121	137	150	148	162	132
Unwtd. average	74	93	113	124	137	149	162	170	137

*Calculated from ages 4 through 8 only, because they comprise over 95% of the samples.

TABLE 4. Female to Male Sex and Biomass (Weight) Ratios of the Catch for the 1985-86 Season by Area.

Tomales Bay

Sex ratio	1:0.9
Biomass ratio	1:0.8

San Francisco Bay Gill Net

Sex ratio	1:0.9
Biomass ratio	1:0.9

San Francisco Bay Roundhaul

Sex ratio	1:1.0
Biomass ratio	1:0.9

TABLE 5. Length Frequency of the San Francisco Bay Roundhaul Catch in the 1985-86 Season.

MM BL	Age							
	2	3	4	5	6	7	8	9
214					1			
212							1	
210								
208			1			1		
206								
204			2	4		1		
202				1	1			
200				1	1			
198			2	4				
196			2	1	1			
194		1	6	5				
192		2	4	2				
190		1	5	5				
188		4	2					
186		6	7	1				
184		12	7					
182		7	4					
180	1	13	3					
178	1	20	1					
176	3	10	1					
174	3	6	1					
172	4	8						
170	9	4						
168	11	1						
166	13	1						
164	10	1						
162	9							
160	4							
158	8							
156	2							
154								
152	1							
150	1							
148	1							
146	3							
144	1							
142	1							
N	86	97	48	24	4	2	1	
Mean	164	179	188	196	203	206	212	-
St. dev.	7.6	5.7	4.3	5.3	7.7	2.8	-	-

TABLE 6. Length Frequency of the San Francisco Bay Gill Net Catch in the 1985-86 Season.

MM BL	Age							
	2	3	4	5	6	7	8	9
226							1	
224							1	
222								
220						1		
218							2	
216				1				
214						1		
212				1	2	1	2	
210				2	4	5	1	
208		1			3		1	
206			5	3	4	6		
204			1	10	4	2	1	
202			5	10	3	2		
200			7	7	4			
198		2	6	11	7	1		
196		3	14	9	5			
194		4	22	5	1			
192		3	14	7				
190		4	14	4				
188		4	9					
186		4	7	1				
184		2	4					
182		4	4					
180		2	2					
178		3						
176								
174		1						
172								
170								
168								
166	1	1						
N	1	38	114	71	37	19	9	-
Mean	166	188	193	199	202	207	215	-
St. dev.	-	7.9	5.8	5.7	5.2	4.9	7.3	-

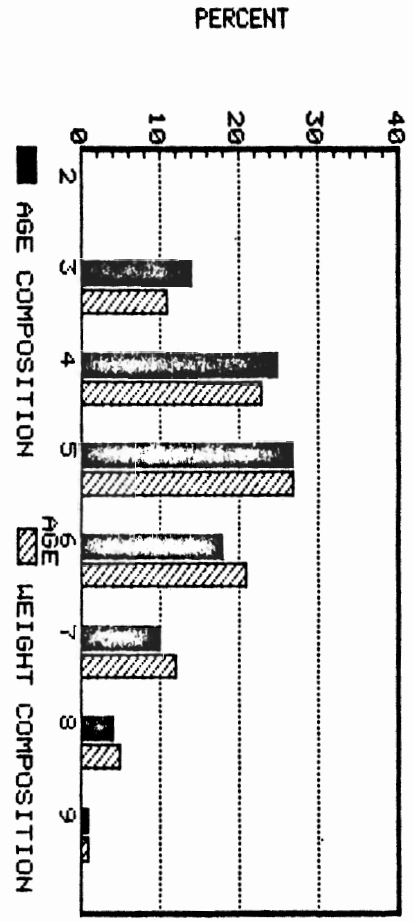
TABLE 7. Mean Weight in Grams at Age of Herring in the San Francisco Bay Roundhaul Catch.

Season	Age								Seasonal unwtd. mean *
	2	3	4	5	6	7	8	9	
1973-74	57	73	95	109	128	133	153	---	92
1974-75	55	82	89	105	124	140	149	---	91
1975-76	57	77	108	122	142	155	179	---	101
1976-77	58	80	95	116	130	153	149	160	96
1977-78	66	85	106	114	111	132	161	168	96
1978-79	70	87	103	119	128	150	---	---	101
1979-80	68	87	102	119	132	150	---	---	100
1980-81	63	83	98	124	118	137	163	---	97
1981-82	61	82	98	113	124	133	---	---	96
1982-83	62	74	93	107	120	144	147	---	91
1983-84	46	58	75	91	103	109	---	---	75
1984-85	66	84	100	115	127	129	---	---	98
1985-86	64	87	101	118	134	131	184	---	101
Unwtd average	61	80	97	113	125	138	161	164	95

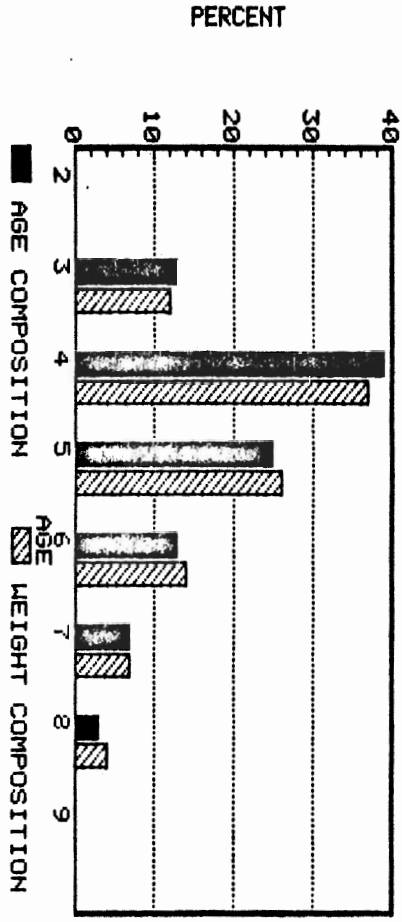
*

*Computed from age 2 through 6 only, because these age classes comprise over 90% of the catch.

TOMALES BAY



SAN FRANCISCO BAY GILL NET



SAN FRANCISCO BAY ROUNDHAUL

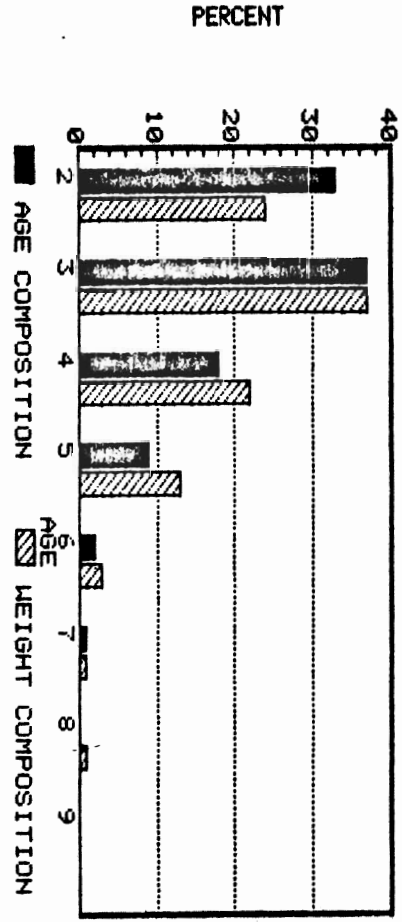


Figure 1. Age and weight composition of the 1985-86 Pacific herring roe fishery landings by area.