THE BROWN PELICAN AS A SAMPLING INSTRUMENT OF AGE GROUP STRUCTURE IN THE NORTHERN ANCHOVY POPULATION

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ABSTRACT

Marine birds are known to be sensitive indicators of a variety of factors in the marine environment including pesticide pollution, oil pollution, and abundance of prey. In the Southern California Bight the California brown pelican *(Pelecanus occidentalis californicus)* is a near obligate predator on the northern anchovy *(Engraulis mordax),* and the reproductive success of this bird is related to the availability and abundance of its prey. During investigations of this relationship, sufficient numbers of anchovies were obtained from pelican foods to permit a comparison of the age group composition of these fish with those obtained from commercial fishery samples.

During the two-year study, 244 food samples were obtained from pelicans at three breeding colony locations, and from these samples 3,889 anchovy otoliths were examined and aged. In addition length measurements were obtained from 373 fish.

Anchovies in pelican food from some locales exhibited age and length-frequency characteristics nearly identical to those reported in commercial fishery data. This technique has potential as an alternate means of sampling the northern anchovy population for age and length composition.

RESUMEN

Se conoce que las aves marinas son indicadores sensibles de una variedad de factores en el medio ambiente marino, tales como contaminación por pesticidas, contaminación por petroleo y abundancia de presas. En la Bahía del Sur de California, el pelícano *(Pelecanus occidentalis californicus)* es un depredador casi obligado de la anchoveta del norte *(Engraulis mordax),* y el éxito reproductivo de esta ave se relaciona con la disponibilidad y abundancia de sus presas. Durante la investigación de esta relación, se obtuvo una cantidad suficiente de anchovetas en los alimentos de los pelícanos como para permitir una comparación de la composición de los grupos de edad de estos peces con la que se obtuvo de las muestras de la pesquería comercial.

Durante los dos años de este estudio, se obtuvieron unas 244 muestras de los alimentos de los pelícanos en tres colonias criaderas. De estas muestras se examinaron y se determinaron las edades de 3,889 otolitos de anchoveta. Adicionalmente, se obtuvieron medidas de longitud de 373 peces.

Las anchovetas del alimento de pelícanos en algunos locales exhibieron características de frecuencia de edad y longitud casi idénticas a ésas reportadas en los datos de la pesquería comercial. Esta técnica puede ser potencialmente una manera alternativa de muestrear la población de anchoveta del norte para determinar su composición por edad y longitud.

INTRODUCTION

Seabirds are recognized as sensitive indicators of various environmental parameters in the marine environment including pesticide pollution (e.g. Anderson et al. 1975), oil pollution (e.g. Vermeer 1976), oceanographic conditions (e.g. Boersma 1978), and primary productivity (e.g. Ashmole 1971). The condition of some seabird populations is so closely associated with their food sources that Crawford and Shelton (1978) used the size of bird colonies as an index of the status of commercial fish stocks.

In the Southern California Bight (SCB), breeding California brown pelicans, *Pelecanus occidentalis californicus,* feed almost exclusively on the northern anchovy, *Engraulis mordax* (Gress et al. 1980; P.R.K., unpublished data), and pelican reproductive success is related to the availability and/or abundance of this fish (Anderson et al. 1980; Anderson et al. in preparation). In the course of studies of this predator-prey relationship, sufficient numbers of anchovies consumed by pelicans were obtained to permit a comparison with anchovies in samples taken from commercial landings. Age and length composition of anchovies from pelican food samples obtained at two breeding colonies in the SCB (Anacapa Island, 1979-1980, and Santa Barbara Island, 1980) were compared

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with samples taken from commercial landings at Port Hueneme and the Port of Los Angeles to evaluate the potential for using the pelican as a sampling instrument (Figure 1). The pelican breeding season coincides with anchovy spawning (late winter and spring) and partially overlaps the commercial anchovy fishing season. Anchovies are widely dispersed in the SCB and presumed to be in scattered schools distributed about the pelican breeding colonies during this period. This paper represents a preliminary report of our findings.

METHODS

During the 1979 and 1980 pelican breeding season (approximately January-August), 244 regurgitation samples were collected from pre-fledged young during banding operations, preserved in alcohol, and transported to the laboratory. Intact fish were removed from samples, measured to the nearest millimeter standard length (SL), and otoliths were removed. Lengths from 373 fish and 3,889 otoliths were obtained from the pelican food samples. Otoliths were stored in gelatin capsules and later examined in water under a 20-power binocular microscope to determine the number of annuli present. Criteria for determining age were based on methods described by Fitch (1951).

RESULTS

Age Composition

During the 1979 breeding season, 1,204 anchovy otoliths, of which 197 were unreadable, were obtained from the pelican regurgitations. Our inability to control the time, location, or size of the collections made on the pelican colony, because of the phenology of the pelican breeding season, resulted in only one collection useful for direct comparison with the commercial fishery. This collection was made on Anacapa Island in May of 1979 and was deemed suitable for comparison with commercial fishery samples from Port Hueneme for the same month. The pelican colony on west Anacapa Island lies about 13 miles southwest of Port Hueneme. We assumed that commercial fishing vessels originating from this port would likely catch fish also available to the Anacapa Island pelicans (based on catch location data extracted from vessel logs and on knowledge of the pelican foraging range; Gress et al. 1980). The 1978 anchovy year class comprised nearly 97% of pelican food samples in 1979. The 1977 year class, the next most numerous cohort, comprised about 2% of the pelican samples. The composition of the commercial samples yielded about 90% 1978 cohort, 8% 1977, and 2% 1976 cohort (Figure 2). The 1979 year class was too small to be recruited into the commercial fishery.

During 1980, 2,685 otoliths representing 1,342 fish from pelican food samples were aged; of these, 47 otoliths were unreadable. Regurgitations were collected from the pelican colony on Santa Barbara Island on April 23 and on Anacapa Island on June 30. The data from these samples coincided temporally with those from the commercial fishery. The Santa Barbara Island collection consisted of about 41% 1979 year class as compared to about 35% for the fishery, whereas the 1978 year class was nearly identical in both with 55% (Figure 3).

The Anacapa Island pelican data were similar to those for the commercial fishery (Figure 3). Each was composed primarily of the 1979 cohort (79% pelican, 70% commercial) and to a lesser extent the 1978 cohort (19% pelican, 26% commercial). Pelicans preyed on small quantities of newly hatched fish unavailable to the commercial fishery in both years.

Length Frequency

Measurements of anchovy lengths (SL) from pelican foods were compared with those of commercial

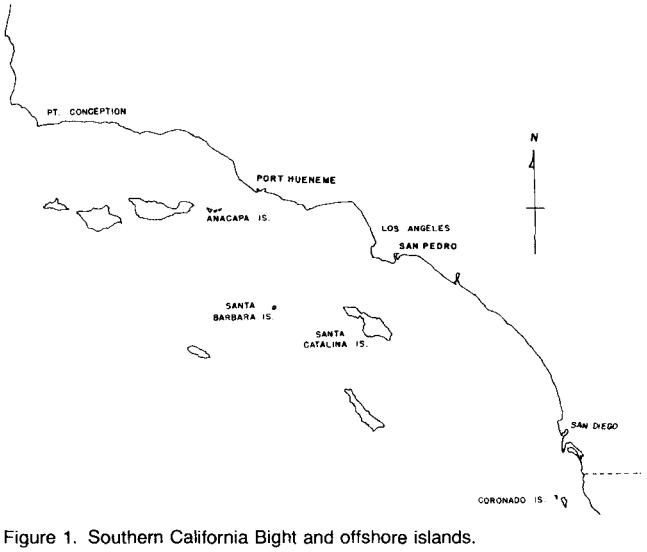

Figure 1. Southern California Bight and offshore islands.

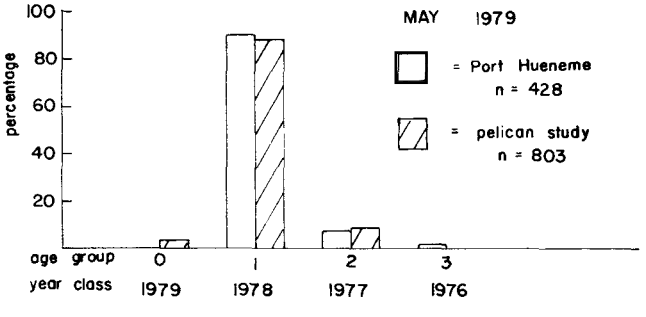

Figure 2. Age composition of northern anchovies taken from pelican food samples at Anacapa Island and from commercial fishery samples at Port Hueneme during 1979.

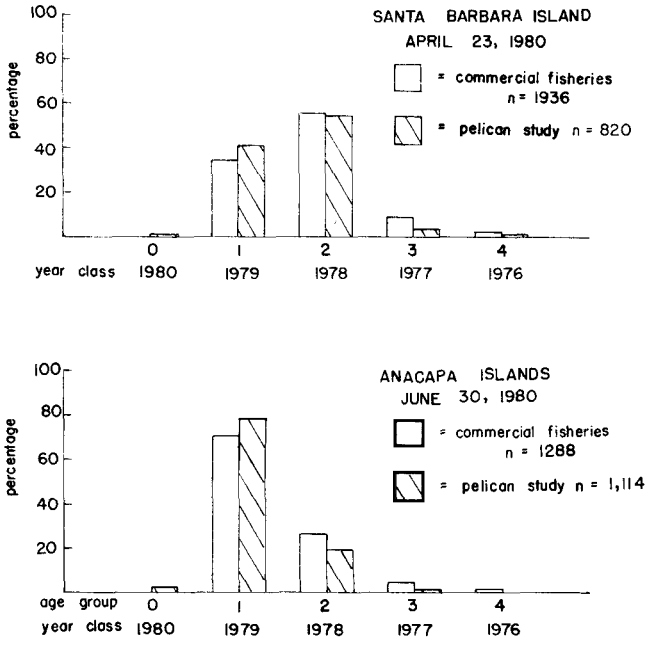

Figure 3. Age composition of northern anchovies taken from pelican food samples (Santa Barbara Island and Anacapa Island) and from commercial fishery samples (San Pedro) during 1980.

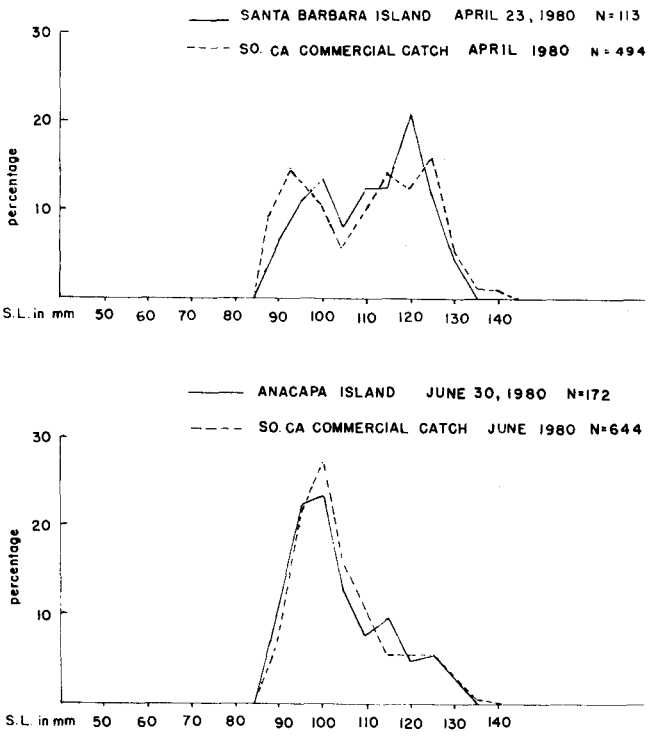

Figure 4. Length distributions of northern anchovies taken from pelican food samples (Santa Barbara Island and Anacapa Island) and from commercial fishery samples (San Pedro) during 1980.

anchovy catches. Data were available for 1980 only. Lengths from Santa Barbara Island samples (n = 113) were compared with those in the commercial catch, (n = 494). Length frequencies in samples from both sources exhibited strong similarities and displayed a bimodal distribution near 95 mm (3.7 inches) and 120 mm (4.7 inches) SL, with means of 110.5 mm (4.3 inches) for the pelican study and 113 mm (4.4 inches) for the commercial data (Figure 4). When tested by the Kolmogorov-Smirnov test for significance, the two sets of data were found to be not significant at the 1% level. The largest cumulative difference was 0.15 which did not exceed the 1% critical value of 0.17, thus concluding that the data were statistically similar. Lengths from anchovies taken from pelicans at Anacapa Island (n = 172) when compared with commercial data (n = 644) for the same month were nearly identical in length frequency distribution with a single mode at 100 mm and a mean of 103 mm (4 inches) SL (Figure 4). The Kolmogorov-Smirnov test for significance also indicated no significance between samples at the 1% level, with the largest cumulative difference of 0.06 being far below the critical value of 0.14.

DISCUSSION

Numerous variables may affect the results from each sampling method. The pelican's ability to sample anchovies is limited by its foraging range from the colony (about 30 to 50 km, CDFG unpublished data). The birds, of course, are not constrained by legal size limits, seasons, or closures. Their foraging behavior necessitates the pursuit of fish near the water surface during daylight, but the fish need not be present in commercial-size schools.

The commercial fishery, in contrast, is less limited by range but must catch legal-size fish in season outside closures. This sampling method would be affected by gear bias (e.g. mesh size). Fishing by purse seine on commercial-size schools occurs farther beneath the surface, primarily at night.

Although the differences in fishing techniques seem substantial, samples taken from both sources (for the same general area and time period) were significantly correlated by means of the Kolmogorov-Smirnov method. The potential for interaction between pelican and the anchovy fishery is supported by these findings, but this subject is discussed elsewhere (Anderson et al. 1980). A thorough examination of results and statistical analyses will be pursued when additional data are available.

CONCLUSION

This technique may provide an opportunity to examine the northern anchovy population in the event that there was no fishery or that conventional means of sampling were not available. We believe that the use

of the California brown pelican as a sampling instrument has merit and that this technique has potential as a practical alternate means of sampling the northern anchovy population for age and length composition.

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