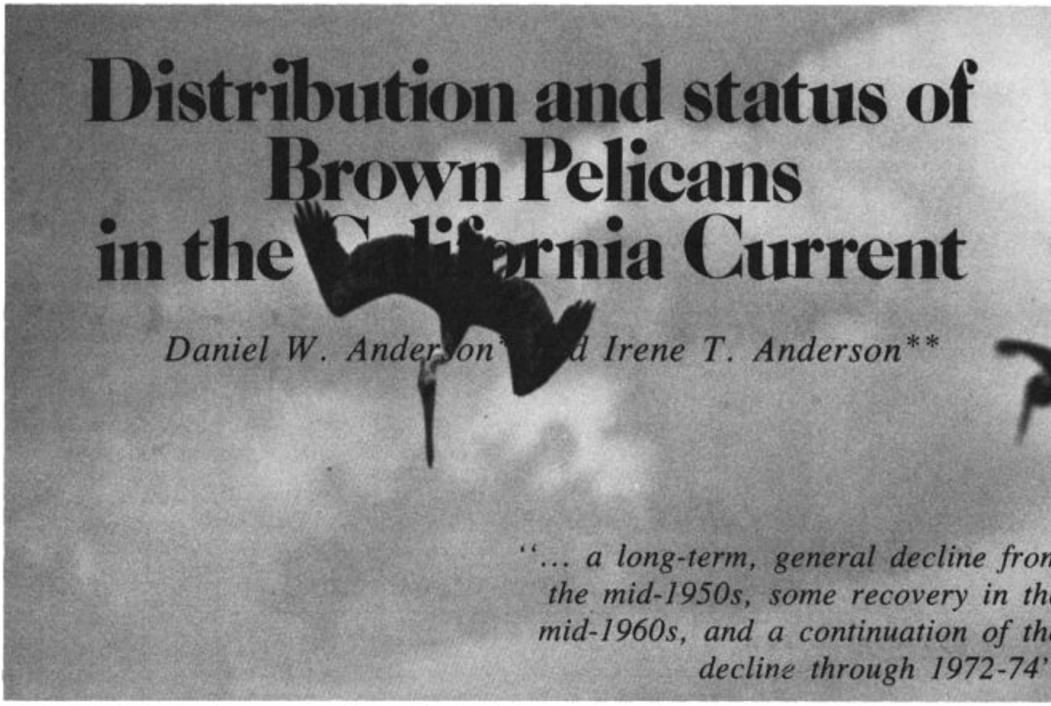

Distribution and status of Brown Pelicans in the California Current

Daniel W. Anderson and Irene T. Anderson***

"... a long-term, general decline from the mid-1950s, some recovery in the mid-1960s, and a continuation of the decline through 1972-74"

INTRODUCTION

The California Brown Pelican (*Pelecanus occidentalis californicus*) has been the subject of much recent interest. Here, we wish to quantify and determine: (1) their distributional patterns on the California Coast, and (2) their population trends over the past few decades. We will rely heavily on data sources of the National Audubon Society.

We chose to study Brown Pelicans for a number of reasons, which are mostly to our advantage, considering the use of difficult-to-interpret and potentially-biased data (see Stewart, 1954; Hickey, 1955; Kenaga, 1965; Arbib, 1967; Arbib and Heilbrun, 1973; Raynor, 1975). (1) Pelicans are largely coastal and limited to a narrow band of habitat; they are easy to count, conspicuous, easily identified, and common. (2) The California Coast is frequented by an army of highly capable and reliable Audubon census-takers. (3) Additional data are available from other sources for comparisons.

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METHODS OF STUDY

Sources of Data and Data Treatment

Christmas Bird Counts (CBCs) and Regional Reports in *Audubon Field Notes* (1950-70) and *American Birds* (1971-75) were extracted for the years 1949-74, providing 26 years of data. Regional reports were used to determine seasonal occurrence patterns of Brown Pelicans, and CBCs provided the basis of our population indices. Statistical analyses were performed on the data as mentioned in the text and as described by Steel and Torrie (1960). Figure 1 shows the Pacific coastal area and geographical points mentioned in the following discussion.

Regional Reports–Calculation of Seasonal Occurrence Patterns

In the Audubon Regional Reports, regions are designated as North-, Middle-, and South-Pacific Coast Regions (see any recent issue of *American Birds*). These three coastal regions encompass four general seasons, but the dates of occurrence are usually given for the various species of birds Such reports are expectedly spotty from year to year, but average relative occurrences over the 26-year period proved useful to us in determining the timing and intensity of coastal dispersal. Dispersion patterns were determined by averaging the monthly occurrences for each Regional Report

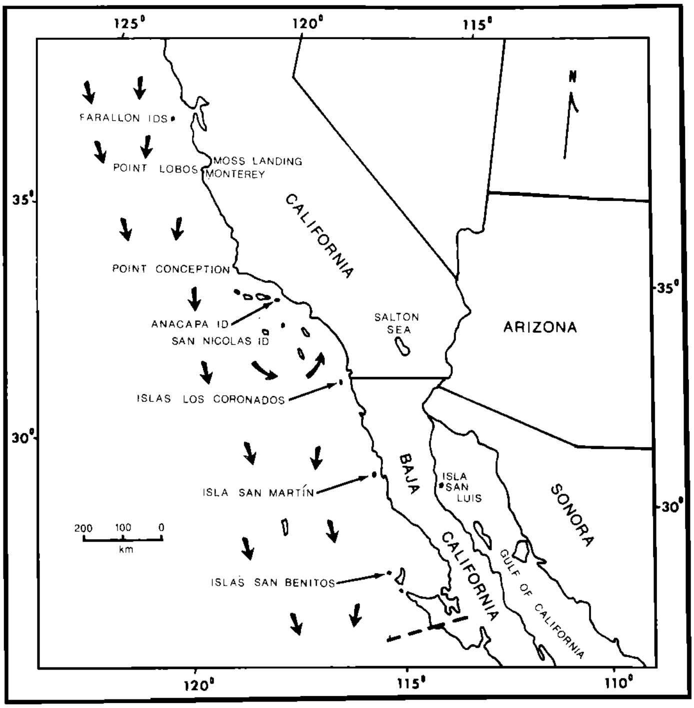

Figure 1. Region of the California and Baja California coasts where Brown Pelicans normally occur in the California Current. The thick arrows indicate the general surface flow of the California Current during the Brown Pelican breeding season. The thin arrows point to the major breeding colonies, and the dashed line delimits the southern extent of pelican populations considered as "California Current" populations.

zone and then converting them to a percentage basis.

Christmas Bird Count Data–Calculation of Population Indices

To compute valid population indices for Brown Pelicans, we considered the following information derived or estimated from the CBCs: (1) actual counts of individual birds, (2) amount of coastline covered, and (3) percentages of effort expended in suitable habitat.

Most of the CBCs contain the species count (B), approximate percentage of time spent in certain habitats (P), total party-hours of the count (H), and total miles traversed on the count (M). The percentage figure P multiplied by the total hours H equals the approximate time spent in appropriate habitats (T). The value for M on a count could include many more potential miles back and forth within the count circle as compared to the edge involved in a coastal census. To compensate for the lack of information on actual coastline covered per individual count, we substituted an approximate value for the maximum amount of coastline in each count circle (C). Miles of coastline in each count circle were different, ranging from 3 to 45 miles, and these differences needed to be accounted for. Our population indices then were calculated as follows (Index = birds per hour-mile in suitable pelican habitat): Population Index = EB/(ET) (EC). To make the index values more workable, we multiplied them by 100. *Potential Biases in the Data*

Potential Biases in the Data

Population indices were computed for the entire coast, although most of the data came from south of the San Francisco Bay area. Initially, we broke our population data into five coastal zones, but we found that year-to-year variations in pelican dispersion made the data difficult to interpret without a knowledge of the total coastal picture

Unusual weather conditions pose potential biases on individual counts (Stewart, 1954, Arbib, 1967). Poor visibility from coastal fogs, winds, and rain were major initial considerations, but we found no instances where weather was obviously influential on the counts of Brown Pelicans.

Both effort per count and the number of counts contributing to our population indices have increased over the past 26 years (Figure 2) This represents a potential bias in our population indices if the habitat has become over-saturated with effort. There was no consistent relationship, however, between effort and our Brown Pelican population indices. The same effort data applied to our reference species (Raynor, 1975), the Heermann's Gull (*Larus heermanni*), showed no significant relationship to population trend, and each species exhibited independent population trends (Figure 3). We conclude that the point of diminishing returns in effort has not been reached

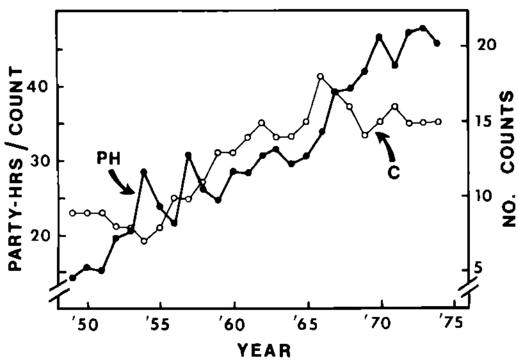

Figure 2. Census effort in Christmas Bird Counts along the California Coast from 1949 to 1974. The dashed line represents the number of counts (C) and the solid line represents party-hours in suitable habitat per count (PH)

regarding Brown Pelicans or Heermann's Gulls, and that this potential bias seems minimal.

RESULTS AND DISCUSSION

Seasonal Occurrence of Brown Pelicans on the California Coast

Late summer and fall increases in number. The Regional Report data illustrate a regular northward dispersal of Brown Pelicans along the California Coast in late summer and early fall. This is followed by a withdrawal in the late fall (Figure 4). There is close agreement between the Audubon data and those from independent sources (Figures 4A and 4B; see also Smail and Lenna, 1969; Gill, 1972; Ainley, 1972).

These buildups vary in intensity and exact timing from year to year, as discussed below, but they are alike in timing to passive dispersals of Brown Pelicans into the Southwestern Desert of Arizona, Southern California, and Sonora (McCaskie, 1970; Anderson and DeWeese, in prep) in that they closely follow the breeding season in the Gulf of California. It should also be noted (Figure 4A) that the large pelican influxes occur in Southern California normally *before* most young are fledged from the local colonies; and, the influxes in themselves usually involve high proportions of immatures. Additional, small and early increases of Brown Pelicans in the Southern Pacific Coast Region (Figure 4) may be related to increases of breeding birds near Anacapa and Los Coronados Islands (Figure 1), which are presently the only breeding colonies off or near the California Coast (Gress, 1970; Jehl, 1973) Pelican numbers peak along the north Pacific Coast in October on the average compared to August-September in the more southern regions, and these later buildups on the north coast also involve post-breeding pelicans from the Southern California breeding colonies (D. W Anderson, unpublished).

Beck (1910) and Orr (1970: 149-54) recognized this type of "migration" by Brown Pelicans and other seabirds from the south, including the Gulf of California. Chandik and Baldridge (1968) noted a gradual increase in the proportions of young birds in pelican flocks from July through August, despite the reported breeding failures of Brown Pelicans off Southern California and nothern Baja California around 1968 and later (Schreiber and DeLong, 1969; Keith *et al.*, 1971, Jehl, 1973). They correctly hypothesized that the major source of Brown Pelicans in the fall could only be from more successful colonies in Mexico

Fall increases and related environmental changes. The northward dispersals of Brown Pelicans along the California Coast are most strongly related to the seasonal changes in the California Current System (see Reid *et al.*, 1958) Late summer and fall increases occur during a regular, but variable late summer trend in water warming off California, the "Oceanic Period" (Bolin and Abbott, 1963); they then decrease in numbers during the "Davidson Current Period" (November to February). Most seabirds off the California Coast increase in number and diversity during the "Upwelling Period", reach maximum abundance during the Oceanic Period, and then decline during the Davidson Current Period (Ainley, 1975A; periods as defined by Bolin and Abbott, 1963).

Not more than ten percent of the total population of *P. o. californicus* breeds on the Pacific Coast north of Bahia de Magdalena, Baja California (D. W. Anderson, unpublished), and it seems apparent that large segments of the Gulf of California Brown Pelican population regularly moves into waters of the California Current to exploit predictably abundant food off the California and Baja California coasts after their breeding seasons. The post-breeding dispersal from the Gulf of California also involves large numbers of pelicans that move south along the Mexican West Coast, and many remain in the Gulf of California (D. W. Anderson, unpublished).

Intensity and timing of fall buildups. Major increases in the intensity of fall dispersal during some years by pelicans also concurrently involve influxes of other tropical or subtropical avifauna These unusual influxes are associated with unusual and periodic rises in water temperature, associated environmental changes, probably also major influxes of more southern food fishes, and possibly also increased availability of local fish populations.

Radovich (1961) documented the effects of a 1957-59 warming trend on sea life of the California Current. He also showed that similar phenomena have occurred historically (pre-1853 to late-1860s, Hubbs, 1948; and since 1915: 1926, 1931, and 1941). The northward dispersal of Magnificent Frigatebirds (*Fregata magnificens*) has been related to an unusually warm but regular Oceanic Period that warms the waters along the coast in September or October near Monterey Bay, California, and earlier to the south (Varoujean and Compagno, 1973). Small (1957) documented large numbers of normally more southern species of seabirds, and later associated them with exceptionally warm waters that year (Small, 1958). A trend of large numbers of southern seabirds in late summer and fall continued through 1959 (Radovich, 1961), and notably large concentrations of Brown Pelicans and Heermann's Gulls were reported along the south coast at that time (Small, 1959). In the fall of 1971, large numbers of Brown Pelicans were again reported on the Pacific Coast (Crowell and Nehls, 1972; DeSante *et al.*, 1972; McCaskie, 1972). The high numbers of fall Brown Pelicans in 1971 were due in part to exceptionally high productivity in the Gulf of California that year (D W. Anderson, unpublished), but subsequent events seem related to the most recent warmup.

The unusually early presence (June) of large numbers of Brown Pelicans at the Farallon Islands off Central California in 1958 (Bowman, 1961) can be associated with the warm water trends of 1957-59. Likewise, early arrivals in 1973 at the same location (D. G. Ainley, *pers. comm.*), at San Nicolas Island (R. E. Lust, *pers. comm.*), and near Moss Landing, California (J. M Warriner, *pers. comm.*) were associated with the most recent period of anomalous warm water (1972-73) as well as a breeding failure of Brown Pelicans in the Gulf of California in 1973 (Anderson, 1973). A breeding failure of seabirds in the Gulf of California in 1943 (Tafall, 1944) also closely coincided with an anomalous warmup in the early 1940s. (Unfortunately, no data are available from the Gulf of California during the warmup of the late-1950s.) Apparently, unusually early movements of Gulf of California seabirds to the California Coast are in many cases related to breeding failures in the Gulf. These breeding failures also seem to be consistently related to the unusually intense warmup periods along the Pacific Coast, and these warmups also seem to correspond with intense "El Niños" in the Peru Current (see Miller and Laurs, 1975).

Fall versus winter populations. In the instances where population trends of Brown Pelicans were clearly stated in the Regional Reports (R) for the fall period (as compared to the previous year), we made comparisons to the winter trends indicated by our indices from the CBCs (CH). In 26 instances where paired data, fall and winter (R *vs* CH), were available, 12 showed comparable trends (up-up or down-down) and 14 showed opposite trends. These were not significantly different from a 50:50 ratio (random) by Chi^2 ($P<0$ 5) In general, all the data available to us strongly suggested that at the time of the CBCs, winter Brown Pelican populations are independent in trend from fall populations. This suggests that the pelicans being observed and counted in winter represent a different population than those in the fall, although there are certainly present some added, unknown numbers of nonbreeders and stragglers from the Gulf of California. Band returns and color-marker sightings suggest that most Gulf-originating pelicans disappear from the California Coast by early December (D. W Anderson, unpublished).

Brown Pelican Population Trends

Our population indices suggest a recent, severe decline in the Brown Pelican population along the California Coast in winter (Figure 3B). In the last 26 years, Brown Pelicans have apparently experienced three periods of decline from population levels of the late-1940s. Our pelican population indices (obtained from potentially independent counts from year to year) are serially correlated (see Keith, 1963:21) (PI *vs*. PI + 1, r = 0 610, $P<0.01$), suggesting nonrandom population fluctuations superimposed upon the general and longterm decline.

Schreiber and DeLong (1969) reported a recent decline of the Channel Islands breeding population of Brown Pelicans, and our data are in agreement. Further comparisons of our population indices to known trends support their validity For example, Banks (1966) reported some successful nesting of Brown Pelicans, and perhaps a thousand pairs (Schreiber and Risebrough, 1972) on Anacapa Island in 1963 and 1964. These observations agree with the moderate peaking of pelican population indices from 1963 to 1966 (Figure 3). Although Anacapa's breeders have probably fluctuated in numbers considerably since historical times, our indices (assuming they are proportional to Anacapa's breeding population) project a late-1940 population at Anacapa of

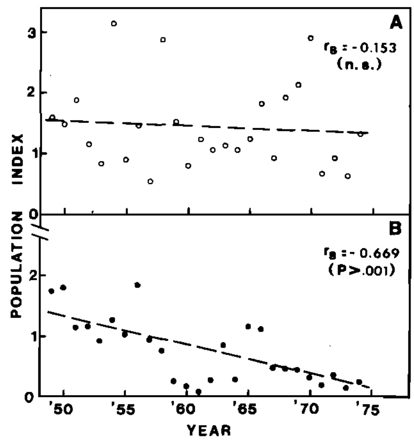

Figure 3. Population indices of Heermann's Gulls (A) and Brown Pelicans (B) over a 26-year period on the California Coast. Spearman rank correlations (r_s) are indicated for each species. Regression equations are as follows: A. gulls— Y = 1.56 — 0.009X; B. pelicans— Y = 1.42 — 0.051X.

around 2000 pairs. Historical accounts give high estimates of 1500 pairs in 1916 and 2000 pairs in 1917 (Peyton, 1917), 2000 pairs in 1936 (Anderson and Hickey, 1970), and 2000 pairs in 1939 (Bond, 1942). After the late-1940s, no estimates have been as high as 2000 pairs for Anacapa, and the maximum of 1000 pairs estimated for 1964 is still 50 per cent below historical numbers. Extreme lows in population indices in 1961 and 1973 represent less than ten per cent of historical highs In the past, even on Anacapa, there were occasional years when no breeding was reported (Gress, 1970), although it is unknown if nesting pelicans had shifted to other colony sites nearby, such as Santa Barbara Island (Hunt and Hunt, 1974) Despite wide fluctuations in pre-1940 numbers of breeding pelicans, the numbers of breeding birds seemed to increase rapidly from lows in number. The mid-1950 to 1974 pelican population indices, however, suggest a continuous, long-term decline superimposed over an oscillating population (Figure 3, Figure 5).

The mean annual rate of change of population indices for the period 1949-74 was about four per cent per year (Figure 3). For the recent period of 1969-74, however, the rate of decline increased to 11 per cent.

Recent history of breeding colonies off Southern California. Recent, continuous census data from the Anacapa Island and Islas Los Coronados areas somewhat parallel the declining trends in our recent CBC population indices, except for 1974 (Table 1). Additional data from colonies farther to the south follow this declining trend through 1973 (Jehl, 1973; J. R. Jehl, Jr., *pers comm.*). In 1974, the proportion of breeding adults in the Southern California population changed, because too few young were produced there in 1969-70 to be added to the breeding population by then (Table 1). The situation off Southern California in 1974 was a complex one, and several environmental factors may have interacted or acted alone to result in the 1974 upsurge of breeders.

First, 1974 was a year culminating in a high availability of Northern Anchovies (*Engraulis mordax*) (Mais, 1974; Anderson *et al*., 1975) Anchovies have been found to be the most important food of pelicans during the breeding season off Southern California (Anderson *et al*., 1975), at least from 1972 to 1974. An increase in food availability was also potentially related to the 1972-73 warmup off Southern California, likely resulting in a high proportion of the available breeders attempting to nest in 1974 (Anderson *et al*., 1975).

Secondly, the California breeding populations of Brown Pelicans may also have received recruitment of new breeders from the 1971 year class produced in the Gulf of California—the year 1971 was a year of exceptional productivity there, as already mentioned. Under stationary population conditions, the majority of Brown Pelicans do not breed successfully until 4-7 years of age

Table 1

Recent History of Brown Pelicans Breeding off Southern California.[1]

Year	*Estimated No. Nesting Pairs* *Anacapa[2]*	*Coronados*	*Total*	*Population Indices[3]*	*No. Young Produced* *Anacapa*	*Coronados*
1969	750	375	1125	0.43	4	0
1970	552	175	727	0.30	1	3-5
1971	540	110	650	0.19	7	30-40
1972	261	250	511	0.27	57	150
1973	247	350	597	0.13	34	50-150
1974	416	870	1286	0.22	305	880

[1]Table is adapated from Anderson *et al*. (1975).
[2]The total for Anacapa Island included some nests on nearby Santa Cruz Island in 1972 and 1974.
[3]Data are from the Christmas Bird Counts.

(D W. Anderson, unpublished; R. W. Schreiber, *pers. comm.*). However, Brown Pelicans have been reported to breed at three years in situations where adults are not present or well-established (Williams and Joanen, 1974; Blus *et al.*, 1975). Henny (1972: 44, revised by *pers. comm.*) has estimated an adult mortality rate of about 16 per cent for the closely related *P. o. carolinensis*, and on the basis of his data on the Eastern Brown Pelican, he predicted that the California Brown Pelican should be declining at a rate of 17 per cent per year, assuming no immigration. The differences between 16-17 per cent and the average rate of decline of the population indices (four per cent) may indicate that significant immigration into wintering populations (and also possibly breeding populations) is taking place off Southern California. The possibility also exists that Henny (1972) has overestimated adult mortality for Brown Pelicans, but until better data are available, his estimates are the best available for comparative purposes. It is also possible that adult mortality has been compensatory to the very poor productivity off Southern California until 1974, and that the age-structure of breeding adult Brown Pelicans has changed.

To further examine the possibility of outside recruitment, early banding reports (Bond, 1942, 1948) suggest possible exchange of pelicans hatched on one colony to another colony as breeders. It is too early to determine from recent banding studies if young pelicans produced in the Gulf of California take up residence as adults in the California Current colonies, but we believe they do. To lend support to this hypothesis, one four-year Brown Pelican, a female in breeding condition, was illegally shot near Carlsbad, California on June 3, 1975. This bird had been banded by D.W.A. on Isla San Luis in the Gulf (Figure 1) on May 15, 1971, and in all likelihood was a local breeder when it died.

Theoretically a third source of 1974 breeders on Anacapa and Coronados Islands could have been adult pelicans disturbed off Isla San Martin (Figure 1; Jehl, 1973) by tourism (J. R. Jehl, Jr , *pers. comm.*).

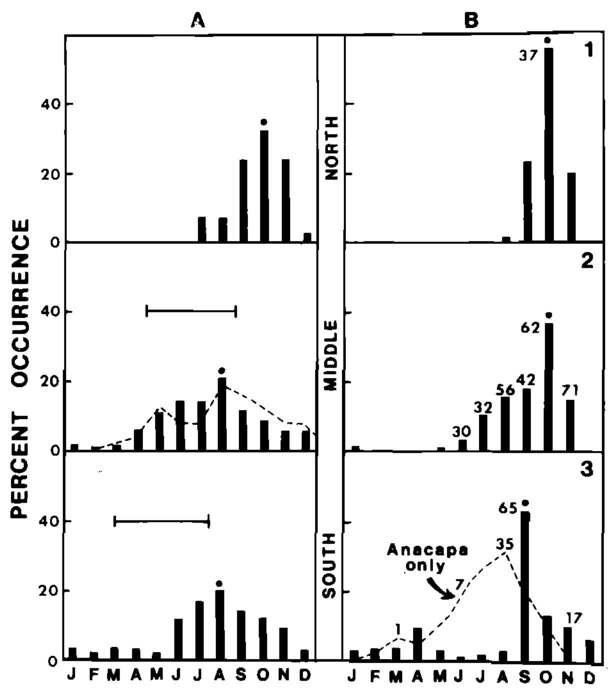

Figure 4. Dispersion patterns of Brown Pelicans along the California Coast. The closed circles represent months of maximum abundance. A. Data from Audubon Regional Reports broken down by region. The dashed line for the "Middle" Region represents a correction to eliminate reports definitely associated with breeding in that area The horizontal bars in the "Middle" and "South" Regions represent the normal breeding seasons of pelicans in those areas. B. Recent representative counts along the California Coast for comparisons: 1 = data from R. M Jurek, *pers. comm.*, 1970, (n = 179 observations); 2 = data from J. S. Warriner, *pers. comm.*, 1971, (n = 4240 observations); 3 = coastal area from R. M. Jurek again (n = 288 observations) and Anacapa data from Gress (1970) and D.W.A. (field notes) (n = 4433 observations). Numbers above bar graphs in B. are percentages of immatures observed.

A review of factors possibly involved in Brown Pelican population changes. It is widely known that oceanic pollution has been the predominant cause of at least the recent Brown Pelican declines reported for the California and Baja California West Coast (Keith *et al.*, 1971; Risebrough, 1972; Jehl, 1973; Anderson *et al.*, 1975), although populations in the Gulf of California are largely stationary (D. W. Anderson, unpublished). The most characteristic feature of the Pacific Coast pelican declines has been a failure to produce adequate numbers of young (Risebrough *et al.*, 1971; Anderson *et al.*, 1975). It is most logical to assume that the stress of environmental pollution was superimposed upon additional environmental stresses, especially in the fluctuating environment of the tropical and warm-temperate waters off Southern California and Baja California (see Briggs, 1974 for a delineation of these waters).

Ainley and Lewis (1974) discuss failures of some populations of large-sized avian and mammalian predators to recover off mid-California after man-related decimations from 1910 to 1930. These authors believe that decimations of the Pacific Sardine (*Sardinops sagax*) in the mid-1940s was the major factor in this failure on the Farallon Islands—smaller predatory seabirds breeding there have shown steady increases. According to our population indices, however, Brown Pelican populations remained steady at least through the mid-1950s, ten years or more after large stocks of sardines had disappeared (Figure 5).

In the Gulf of California, Brown Pelicans feed on a large variety variety of fish, although predominantly on the Clupeidae (including Pacific Sardines), Engraulididae (including several species of anchovies), and Scombridae (D. W. Anderson, unpublished). Since two important species of fish, the Pacific Sardine and the Pacific Mackerel (*Scomber japonicus*), are now essentially gone from California waters (Mais, 1974), one might expect that the food supply of Brown Pelicans has been reduced there in recent years. Northern Anchovies, however, generally replaced Pacific Sardines (Murphy, 1966), but only importantly south of Point Conception, California (Ainley and Lewis, 1974), where pelicans persist as breeders. And in contrast, farther north, there are still more potential food fishes available such as additional Clupeids, Osmerids, and other surface fish (see Miller and Lea, 1972).

Variations in biomass or indices of abundance of potentially important pelican food fishes off Southern California (based on current food-habits in the Gulf of California) seem somewhat related to the normal oscillations in Brown Pelican population indices (Figure 5), although the data do not suggest that the long-term population decline (Figure 3B) was related to changes in food supply. Northern Anchovies are recently and by far the predominant commercial midwater fish off Southern California, and they increased in the surface area of schools from 1971 to 1973 (Mais, 1974). Understanding changes in their abundance may aid in understanding Brown Pelican population oscillations. However, fisheries data are difficult to relate to pelicans because the abundance (biomass) of the fisheries resource in relation to the abundance (availability) of the food source relative to pelicans may not always be comparable. Here (Figure 5), we have attempted to present a picture we believe places the two aspects into their proper perspective. The variation in the number of schools of anchovies is not necessarily related to changes in the actual biomass (Mais, 1974), but fortunately here, it is probably more closely related to changes in food availability relative to the pelicans.

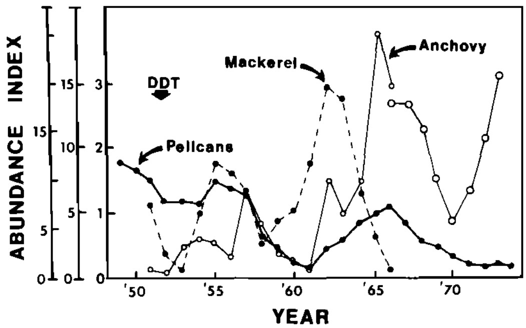

Figure 5. Qualitative comparisons between population indices of California Brown Pelicans and various indices to the availability of two of its three major food sources. The third major food item, Pacific Sardines, had essentially disappeared as a viable food source by the early 1950s (Talbot, 1973). The arrow designated by "DDT" represents the period when that or related pollutants became prevalent in the Southern California Bight (Hom *et al.*, 1974). After 1966, Northern Anchovy abundance was measured by a new technique (Mais, 1974), making the fisheries data more meaningfully comparable to the pelican data. These data were scaled to the earlier anchovy data, but they may not be strictly comparable. Sources of data and units of expression are as follows: pelicans—CBC population indices, three-year moving averages; Pacific Mackerel—Kramer and Smith (1970) and Blunt and Parrish (1969), spawning biomass (kk lb); pre-1966 anchovy—Ahlstrom (1966) and Kramer and Ahlstrom (1968), inshore larvae X 10^{15}; post-1966 anchovy—January to July means, as data were available, of anchovy schools per mi^2 (Mais, 1974).

At Pt. Lobos, California (Figure 1), Baldridge (1974) provided further indication that the major decline of Brown Pelicans off California was owing to an environmental factor newly operating on these birds, such as oceanic pollution. Pt. Lobos was the northernmost nesting colony of *P. o californicus* and probably illustrated most vividly the natural environmental factors limiting range expansion. Baldridge suggested that breeding there may have occurred primarily under oceanic warmup conditions. In the late-1950s, substantial nesting attempts were observed for Pt. Lobos, but these attempts resulted in only two young produced out of 52 nests in 1958, and seven young in 27 nests in 1959 (Baldridge, 1974). During 1960-66, no young were produced there, and from 1967 to the present, no adults have attempted to nest. Accounts by Baldridge from 1933 to 1937 suggest normal historical reproduction by Brown Pelicans at Pt. Lobos.

GENERAL DISCUSSION

The 1974 resurgences of numbers of breeding adult pelicans on Anacapa and the Coronados (Table 1) followed the 1972-73 increase in ocean surface temperatures. We do not know if the increases in population indices during the 1960s (Figure 5) represent prior improvements in breeding associated with the 1957-58 warmup, but the relationship is tempting to cite. At least one is left with the impression that Brown Pelicans are most typically seabirds of warmer waters. The Brown Pelican seems to be a species that does its best in the California Current System under conditions of surface-water warmup (both periodic and seasonal). The increases in surface sport fisheries during the same warmups (California Dept. of Fish and Game, 1975) seem to be more than coincidental.

According to Ainley (1975B), who studied feeding strategies in seabirds, "plungers" (see Ashmole, 1971) such as Brown Pelicans are indeed characteristic of tropical and warm-temperate (subtropical) waters. Such waters are generally not turbid. Although California Brown Pelicans are not deep plungers, being less dependent on nonturbid waters, their peak numbers off California during the Oceanic Period characterize their major influx and largest numbers. Perhaps the Brown Pelican is also somewhat of a "generalist" in feeding compared to other, more specialized seabirds (see Ainley, 1975B), and this has allowed it to reproduce in northern subtropical and southern temperature waters. Past reports of sporadic and widespread nesting by pelicans on several other California Channel Islands (Grinnell and Miller, 1944: 51), suggest that nesting substrate has not been limiting for populations in the California Current System. Instead, possible overlap between large numbers of "nonresident" and locally breeding pelicans during the later stages of the Upwelling Period and through most of the Oceanic Period, owing to possible competition, may have partially limited further increases of breeding pelicans into the northern California Current in the past, as suggested by Ainley (1975A) for some other resident seabirds Even more likely, the small population of Brown Pelicans off California in December may also be limited by severe wintering conditions and by a shorter average period of abundant food than populations to the south. The most intriguing aspect of this entire situation is the possibility that Brown Pelicans breeding in the California Current System comprise a distinct ecotypic or behavioral unit

Our population data are limited, but they suggest that Brown Pelican populations off Southern California have historically oscillated in relation to environmental changes. The pelican's oceanic environment in this area is in a constant state of flux. However, the overall trend of population decline since the mid-1950s, with an oscillating pattern still superimposed, has almost certainly been due to environmental pollution

Through no effort of man, the rate of this man-induced decline was somewhat dampened perhaps by periodic warmups, the high productivity elsewhere that likely preceded these periods (as in 1971), the resultant strong year-classes of pelicans, and the ultimate dispersals of some of these birds into the California Current to take up breeding. An improvement in pelican productivity off Southern California in 1974, with improving eggshell condition and declining residues of DDT-compounds (Anderson *et al.*, 1975), may finally represent more positive results by man toward pelicans.

SUMMARY

Dispersion patterns and population trends of California Brown Pelicans (*Pelecanus occidentalis californicus*) were studied through the use of National Audubon Society Regional Reports and Christmas Bird Counts from 1949 through 1974 Data were then compared to our own and other sources of information.

Brown Pelicans regularly disperse north in large numbers from Mexican waters in late summer and fall, inflating California coastal counts from late July through early November each year These post breeding influxes are associated with oceanographic conditions that probably provide abundant food for a large number of seabirds off the coast at that time; and, dispersing pelicans

reach the California Coast during the same general period in which local breeders are still feeding young on nests. Dispersing pelicans are generally gone again by early December. In December, Christmas Bird Counts represent local (mid-California Current) breeding populations.

Christmas Bird Count population indices for Brown Pelicans off California suggest historical fluctuations in relation to fluctuations of major food fish, but also a long-term, general decline from the mid-1950s, some recovery in the mid-1960s, and a continuation of the decline through 1972-74.

ACKNOWLEDGMENTS AND COMMENT

The many persons who counted pelicans and compiled data over the years deserve much credit. Despite potential, but surmountable biases, we are confident that the data we used were adequate in satisfying our objectives. We hope that future researchers will further refine our methods and continue to use and evaluate Audubon data on other seabirds. We recommend that CBC census takers also begin to record age-ratios of Brown Pelicans.

Citations given as "D. W. Anderson, unpublished" represent some of the senior author's observations from studies conducted for the U. S. Fish and Wildlife Service, and that agency supported much of the present work. H. R. Leach, California Dept. of Fish and Game, encouraged us originally to begin this study, and the following persons provided valuable advice and comment D. G. Ainley, A. Baldridge, L. R. DeWeese, J. E. Fitch, H. W. Frey, C. J. Henry, J. J Hickey, J. R. Jehl, Jr., J. O. Keith, and R. W. Schreiber.

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