Olivaceous Cormorant. Photo by Allan D. Cruickshank from the Audubon Collection/PR.

Population trends and status of the Olivaceous Cormorant

"Christmas Bird Count data can be extremely useful in identifying population trends in wintering cormorant populations"

by Michael L. Morrison and R. Douglas Slack

Introduction

The Olivaceous Cormorant is a wide ranging neotropical species which reaches its highest North American concentrations along the Texas coast. Concern has been raised over the apparent crash and subsequently sustained low numbers of this cormorant in Texas during the 1960s. However, no detailed study of any aspect of the bird's life history has been conducted (Palmer 1962, Hildebrand and Blacklock 1969, Oberholser 1974). Through analysis of 26 years of Audubon Christmas Bird Count (CBC) data and other supportive evidence, this paper attempts to determine population trends and status of the Olivaceous Cormorant (*Phalacrocorax olivaceus*) in North America.

The use of Texas as a major wintering ground by the Double-crested Cormorant (*P. auritus*) suggests possible competition between it and the Olivaceous Cormorant. Consequently, our analysis included determination of Double-crested Cormorant population trends and the possible effects of this species on the Olivaceous Cormorant. The interactions of daily and seasonal environmental variables, measures of observer effort, and count normalization procedures on CBC data were also analyzed for both cormorants.

The use of CBC data to plot population trends has been a center of controversy for several decades (Stewart 1954, Hickey 1955, Arbib 1967). Recently, the application of proper statistical analysis, when combined with a general knowledge of a species' dispersal patterns, has overcome many problems associated with CBC interpretation (excellent reviews of CBC literature are supplied by Bock and Smith 1971, De Haven 1973, and Raynor 1975).

The National Audubon Society, Welder Wildlife Foundation, and Texas Parks and Wildlife Department have conducted extensive aerial and ground surveys of fish-eating bird colonies in Texas each breeding season since 1964. The Texas Cooperative Fish-eating Bird Survey (TBS) thus allows a unique opportunity to draw comparisons between trends shown by it and the CBC. The use of breeding surveys enhances trend interpretation in species which exhibit varying winter dispersal patterns (Brown 1971), such as cormorants and hawks.

After historic population trends and present status of a species have been determined, the study and subsequent understanding of other aspects of its life history (e.g., clutch size, sex ratios, mortality rates) take on added meaning. The analysis of CBC data was initiated in order to establish a foundation upon which various parts of an ongoing life history study of the Olivaceous Cormorant could be built.

Methods

Of 21 CBC areas reporting Olivaceous Cormorants since 1949, nine (n = 128 counts) were consistent enough to allow trend analysis. Except for the Sabine National Wildlife Refuge (southwestern Louisiana), all counts were from coastal Texas. Data transcribed from each count were: cloud cover; low temperature; wind speed; number of observers; number of parties; total party-hours; total party-miles; number of Olivaceous Cormorants; and number of Double-crested Cormorants. Six normalization factors were calculated for both cormorants: number of birds/observer; number of birds/party; number of birds/party-hour and 10 party-hours; and number of birds/party-mile and 100 party-miles. Mean low temperature and total precipitation for December were transcribed from Texas National Oceanic and Atmospheric Administration (NOAA) Climatic Data (U.S. Dept. of Commerce, Wash., D.C.) for each count area/year (or nearest reporting station). Data were then punched onto computer cards.

Simple (r) and multiple (R) correlation coefficients were computed using MINITAB, a statistical computing system run at the Texas A&M University Data Processing Center, to determine what variable (r) or group of variables (R) accounted for number of birds observed on counts. Further analysis involved use of the Cox and Stuart (1955) test for trend, a distribution-free (non-parametric) statistical test which can be used to analyze trends in ordinal data. The results of this test are qualitative in nature and reflect if numbers are increasing, decreasing, or stable in a count area Breeding surveys of the Texas Cooperative Fish-eating Bird Survey (TBS) since 1964 were summarized for location and size of cormorant colonies

Results and Discussion

As a prerequisite to analysis of population trends from CBC data, the effect of varying degrees of observer effort on number of birds counted over time must be assessed. The use of various measures of effort as normalizing factors for count data was recently studied (Raynor 1975), with the conclusion that for most species it makes little difference which measure of effort is used (for normalization) due to the interrelated nature of the measures.

However, because of species dispersal patterns (e.g., flocking vs solitary species), certain normalizing factors tend to be better suited for use in subsequent analytical methods, or are sometimes not even necessary. This applies especially to flocking species which congregate in small areas of their available habitat (Stewart 1954).

Olivaceous Cormorants are usually found in shallow water habitats which contain large numbers of suitable perching sites (e.g., posts, pilings). Cormorants, in general, spend the entire winter day in large flocks adjacent to or on feeding grounds which reduces energy expenditures associated with flight. Therefore, little count effort need be expended to account for the majority of cormorants in an area. Consequently, if a cormorant population remained constant over time, normalization of their numbers as count effort increased would show a false population trend (declining)

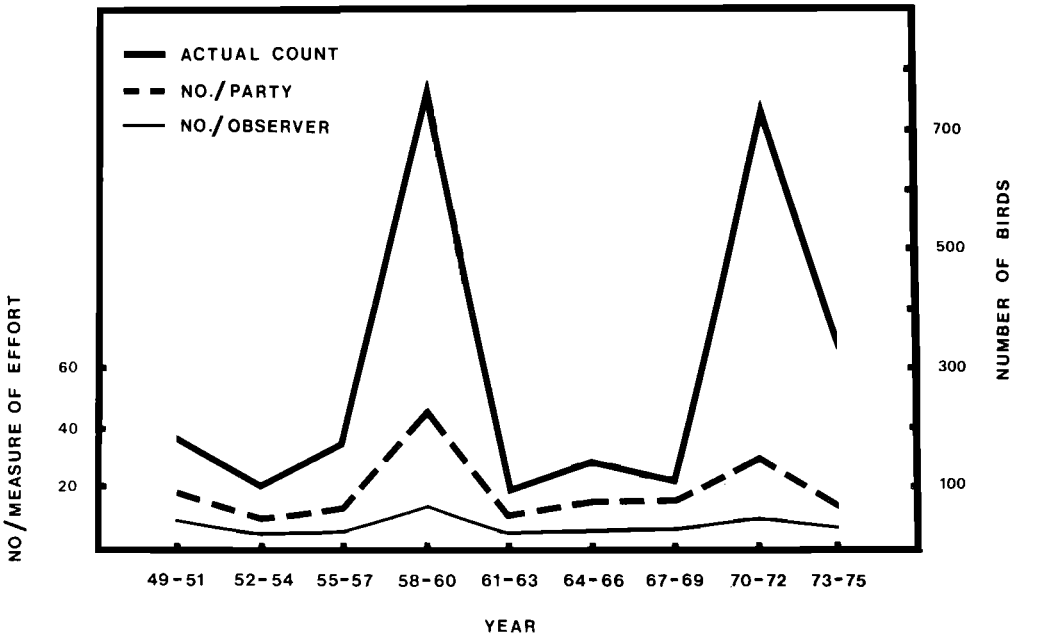

Fig. 1. Comparison of actual number of Olivaceous Cormorants counted and two normalization factors from Christmas Bird Count data.

Six normalization factors were used to test this hypothesis. Even though count effort has varied widely in Texas, the population trend for both Olivaceous and Double-crested Cormorants remained the same regardless of the normalization used, and varied only in magnitude (and not date) of fluctuation. All normalization factors reduced the magnitude ("peak") of fluctuation, which was due to count effort increasing more rapidly than actual birds counted. For example, as number of observers has increased more rapidly than number of parties, the trend shown by the former is a flatter graphed line than that for the latter (Fig. 1). All normalization of data dampened the fluctuations associated with both Olivaceous and Double-crested Cormorant population trends. These results are supported by lack of correlation (r and R) between birds counted and any measure of effort (non-normalized data). Therefore, actual number of birds counted was used in all trend analysis, which had been suggested but not thoroughly tested by previous authors for flocking species (Stewart 1954, Raynor 1975).

The Texas population of Olivaceous Cormorants is characterized by low, fluctuating numbers (Fig 2b) A nine-year (1961–1969) period of reduced population levels was evident from CBC data and corresponds to trends in nesting birds (TBS data) during the same period. Oberholser (1974) stated that Olivaceous Cormorants underwent a population crash in the 1960s only slightly less drastic than that of Brown Pelicans (*Pelicanus occidentalis*). He felt that numbers of both breeding and wintering Olivaceous Cormorants are now returning to pre-1940 levels when thousands were reported from coastal Texas. Breeding Olivaceous Cormorants are also reported to be increasing in southwestern Louisiana (Portnoy, Louisiana State University, Baton Rouge, pers comm., 1976). Population trends shown from CBC data are thus supported by three other sources.

Double-crested Cormorants showed a similar trend although their numbers have been rising rapidly since the mid-1960s (Fig. 2a). Although used primarily as a wintering ground by birds from presumably northern locations, Texas also supports scattered breeding colonies. The increase in wintering Double-crested Cormorants may indicate an improvement of this species' midwestern populations (see Arbib 1975) The similarity in trends of Olivaceous and

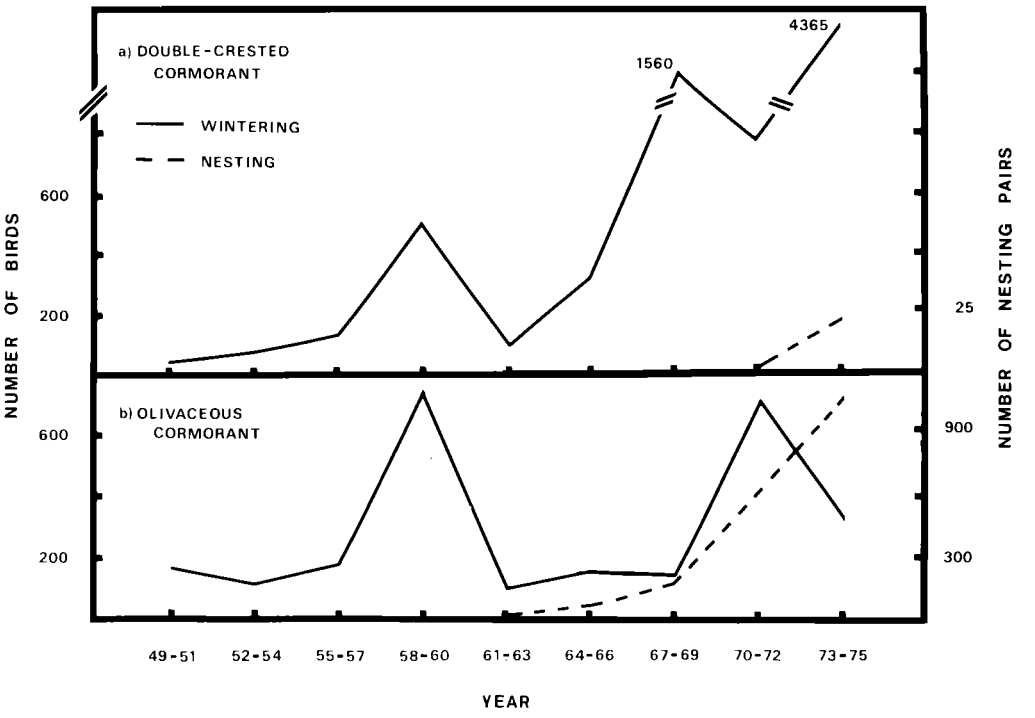

Fig. 2. Population trends of Olivaceous and Double-crested Cormorants wintering (CBC data, left axis) and breeding (TBS data, right axis) in Texas.

Double-crested Cormorants indicates that several variables might be affecting both species in much the same way.

No statistically significant correlation was found between number of Olivaceous Cormorants and number of Double-crested Cormorants on a count. The possible exclusion of one species through competitive interaction as numbers increase and/or food and space resources decrease has been raised for other cormorant species (Lack 1945). The population trends for Olivaceous and Double-crested Cormorants on areas of sympatry revealed many locations of possible competition (Table 1).

Environmental factors are variables which may affect the number present and/or counted in a CBC area. Extreme weather conditions

Table 1. Population trends of Olivaceous and Double-crested Cormorants using Cox and Stuart (1955) test of trend on Christmas Bird Count data.

	Trend	
Location	*Olivaceous*	*Double-crested*
Anzalduas-Bentsen, Texas	Increasing	Sporadic[1]
Bolivar Peninsula	Increasing	Sporadic[1]
Corpus Christi	Sporadic[1]	Strongly increasing
Corpus Christi (Flour Bluff)	Sporadic[1]	Strongly increasing
Laguna Atascosa N.W.R.	Strongly declining	Strongly increasing
La Sal Vieja	Stable	Strongly increasing
Santa Ana N.W.R.	Sporadic[1]	Sporadic[1]
Welder Wildlife Refuge	Sporadic[1]	Strongly increasing
Sabine N.W.R., Louisiana	Strongly increasing	Stable
Overall Trend	Slightly increasing	Strongly increasing

[1] Numbers too variable for analysis by this test

during the count may hamper the ability of observers to locate birds, while monthly or seasonal conditions may do more to influence the actual number of birds present. It is necessary, therefore, to account for those environmental factors which determine number of birds counted as opposed to number actually present (Bock and Lepthien 1974, Raynor 1975).

No significant correlations were found between number of birds counted (for both Olivaceous and Double-crested Cormorants) and any environmental factor when all counts were analyzed collectively. However, analysis of each individual count area revealed a positive correlation for the Sabine National Wildlife Refuge between number of Olivaceous Cormorants and both cloud cover ($r = 4733$, $.025 < p < .05$) and wind speed ($r = 4690$, $.025 < p < .05$); multiple correlation increased the contribution of these two variables to 61% ($R = .6116$, $.01 < p < .025$). On windy and cloudy (rainy) days cormorants further reduce their already restricted movements, thus increasing the count of birds actually present. Unlike most bird species, cormorants do not normally retreat into dense thickets to escape inclement weather. Double-crested Cormorants, however, did not show such correlations at Sabine.

Numbers of Olivaceous and Double-crested Cormorants counted and the December weather conditions failed to show significant correlations. The variations in winter weather conditions along coastal Texas are relatively minor and probably account for the lack of significance. The large number of wintering Double-crested Cormorants in Texas is also likely explained by these mild weather patterns. Further, a review of general weather patterns by year (NOAA data) did not reveal any obvious factors which might explain the population trends of either cormorant.

The magnification of environmental contaminants (pesticides and PCBs, for example) through the various trophic levels of a food web are well known. Many species of breeding fish-eating birds in Texas were found to have high levels of such contaminants in 1970, including the Olivaceous Cormorant (King *et al.*, in prep.). King and his coworkers felt that analysis of egg and tissue samples prior to 1970 would probably have revealed higher residues. Subsequent (1976) analysis has shown these residues to be declining in Olivaceous Cormorants (Morrison, unpubl.).

Lowered reproductive success and death of individuals during stressful periods due to high residue levels has been found in several bird species (Velzen *et al.* 1972, Scott *et al* 1975), and may at least partially account for low Olivaceous Cormorant numbers in Texas during the 1960s. Similar factors might have affected Double-crested Cormorants on their more northern breeding grounds (lowered reproductive success), with individuals succumbing during stressful migration periods. An improvement of general environmental quality would thus enhance breeding success and population levels of both cormorants, as shown through recent CBC and TBS surveys.

Many historic breeding and feeding sites of the Olivaceous and Double-crested Cormorant have been destroyed throughout their ranges since 1940 (Oberholser 1974, Mitchell 1975). The increasing number of breeding Olivaceous Cormorants in Texas since 1967 is due partially to their sustained use of two National Audubon Society sanctuaries (Table 2). The establishment of only a few protected areas may help account for the recent upturn in Texas Olivaceous Cormorant numbers. Analysis of CBC data and breeding surveys outside of Texas would help clarify

Table 2. Utilization (number and percent of state total) of Audubon sanctuaries by nesting Olivaceous Cormorants from Texas Cooperative Fish-eating Bird Survey data.

	Vingt'une Island		*Sidney Island*	
Year	*Number pairs*	*% Total*	*Number pairs*	*% Total*
1967	14	100	—[1]	—[1]
1968	100	100	—	—
1969	150	82	—	—
1970	175	72	—	—
1971	0	0	60	64
1972	300	31	300	31
1973	300	34	220	25
1974	250	25	200	20
1975	100	33	200	66
1976	200	15	200	15

[1] Colony not established on Sidney Island until 1971

the population trends of Double-crested Cormorants on a broader scale.

The northeastern United States population of Great Cormorants (*P. carbo*) has increased during the 1970s, and continued its southward range expansion in 1976 (De Sante 1976). Brandt's (*P. pencillatus*) and Pelagic (*P. pelagicus*) Cormorants wintering on the northern California coast have also increased in the last several CBCs (Stallcup and Winter 1976). Many of the same factors may thus be working on cormorant populations in general, accounting for the upturning trends across most of the country.

Few biological phenomena are the result of a single factor. The effect of habitat destruction, when combined with possible lowered reproductive success and increased mortality due to environmental contaminants, appears to be the best available explanation for lowered population levels of Olivaceous Cormorants in the 1960s. However, a multitude of unseen factors may be acting directly or indirectly to further complicate trend interpretation. Competition with fish-eating birds other than cormorants, disease, parasites, and/or an alteration in food supply, could contribute to the population trends shown. The establishment of protected areas (Audubon sanctuaries, National Wildlife Refuges), as well as continued reduction of environmental contaminants, may allow the Olivaceous Cormorant to sustain or increase its present populations.

Regardless of the causative factors, the collaboration of various surveys and literature sources has shown analysis of Audubon Christmas Bird Count data to be extremely useful in identifying population trends in wintering cormorant populations. Future counts will be monitored (and are encouraged for other cormorant species) to determine if the apparent increases are a continuing trend.

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