

# ARRIVAL AND DEPARTURE FREQUENCIES OF GREAT BLUE HERONS AT TWO OREGON ESTUARINE COLONIES

RANGE D. BAYER

423 SW 9th, Newport, Oregon 97365 USA

**ABSTRACT.**—Great Blue Heron (*Ardea herodias*) departure synchrony was greatest within 2 h of low tide, and the largest average colony synchrony was then 23% of the breeding herons/h. The average time between arrivals per heron at a 36–39-nest and an 8-nest colony was 6.7 h, which indicates that herons infrequently returned to a colony. Most herons (64% at the larger colony, 95% at the smaller colony) departed the colony alone. The clumping of the remaining departures probably resulted, at least in part, from coincidence. Arrivals and departures were more clumped at the larger colony. Received 20 October 1980, accepted 20 February 1981.

KREBS (1974) indicated that Great Blue Heron (*Ardea herodias*) departures from a colony were clumped and herons departed the colony in flocks. Therefore, Krebs concluded that a Great Blue Heron colony may serve as an "Information Center," where unsuccessfully foraging herons learn the location of good foraging areas by following successful herons from the colony (see Ward and Zahavi 1973). In contrast, Pratt (1980) found little evidence that such following occurred.

Here I examine the rates of Great Blue Heron colony arrivals and departures to determine the degree of arrival and departure synchrony, the sociality of heron departures, and the average frequency of colony arrivals and departures. I also discuss these data in relation to the Information Center hypothesis.

## STUDY AREA AND METHODS

All observations were made at Great Blue Heron colonies near the Yaquina (44°38'N, 124°03'W) and the Coos estuaries (43°22'N, 124°15'W), both located on the central Oregon coast. Yaquina-S was a 39- and 36-nest colony in 1974 and 1975, respectively, and Coos-E was an 8-nest colony in 1975 (Bayer and McMahon in press). Great Blue Herons (henceforth termed herons) were the only ardeids that nested in either colony.

I recorded all heron colony arrivals and departures at Yaquina-S from a hill 300 m away from the colony during 66 h between 0430 and 1930 (Pacific Standard Time) on 8 days in June and early July 1974 and 1975. At an observation post 200 m from Coos-E, I recorded all heron arrivals and departures during 16.5 h between 0400 and 1930 (PST) on 15, 16, and 17 June 1975. During these observations, most of the Yaquina-S heron chicks would have been about 30–60 days old, and Coos-E chicks would have been 30–45 days old (calculated from Bayer and McMahon in press). I recorded only diurnal arrivals and departures, but herons also arrived and departed from the colonies at night (unpubl. data). Individual herons were not distinguished.

Most Yaquina-S and Coos-E herons foraged in intertidal areas in the 3 h before and after low tides. Tides at these estuaries are semidiurnal mixed, with the lowest low tides and the greatest tidal ranges occurring fortnightly. High and low tide cycles alternate, with approximately 6 h between cycles. The difference between Mean Higher High Water and Mean Lower Low Water (MLLW, 0.0 m) is 2.56 m (Oregon State Land Board 1973).

## RESULTS

*Colony synchrony.*—At Yaquina-S, arrivals and departures were significantly correlated to the time of low tide (except for arrivals during flood tide) (Fig. 1) and with tide height (Fig. 2). Most arrivals and departures occurred within 2 h of low tide (Fig. 1) and when tide elevations were less than 0.0 m (Fig. 2). At Coos-E, there

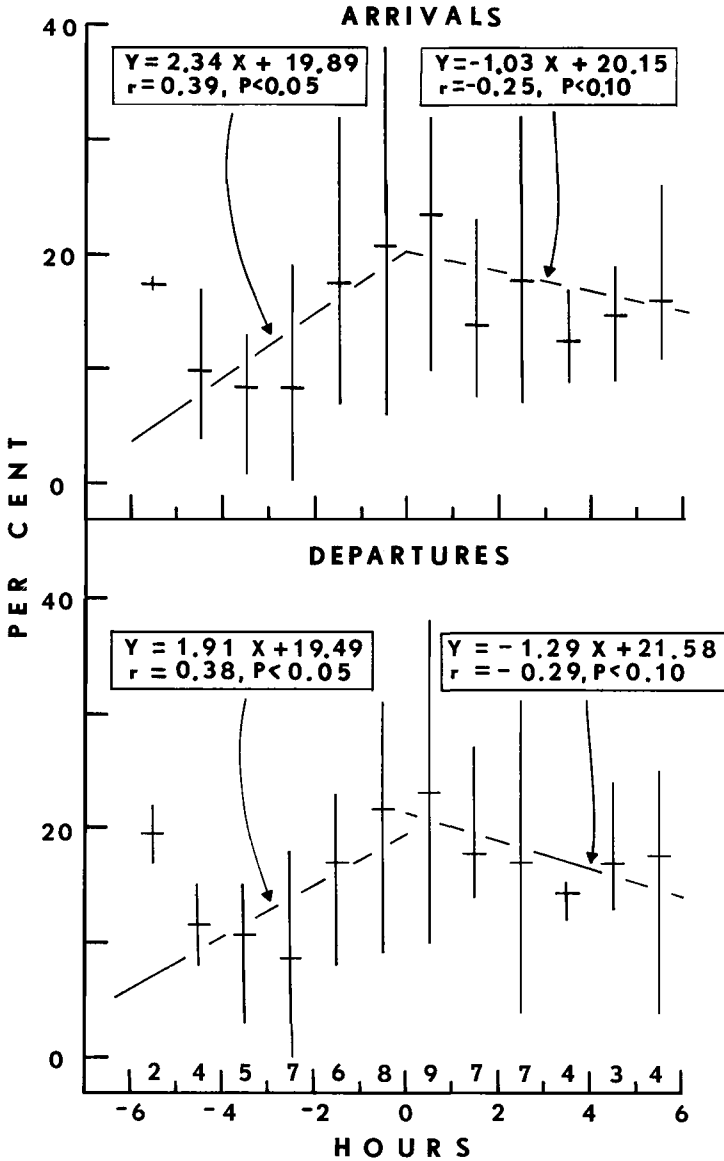


Fig. 1. Linear regressions (slanted discontinuous lines), means (horizontal lines), and ranges (vertical lines) of percentage of Yaquina-S breeding herons arriving or departing during 1-h observation periods before and after low tide (expressed as Time 0). The time relative to low tide for each observation was the time relative to low tide at mid-observation. Hours observed per low tide period for both arrivals and departures are listed along baseline of departures.

were insufficient data to determine the relationship between arrivals or departures and tidal condition.

At Yaquina-S, the maximum arrival rate was 27 herons/h, with an arrival rate of 20 or greater in only 7 of 64 h of observations. At Coos-E, the maximum rate was 5 herons/h. The maximum departure rate at Yaquina-S was also 27 herons/h,

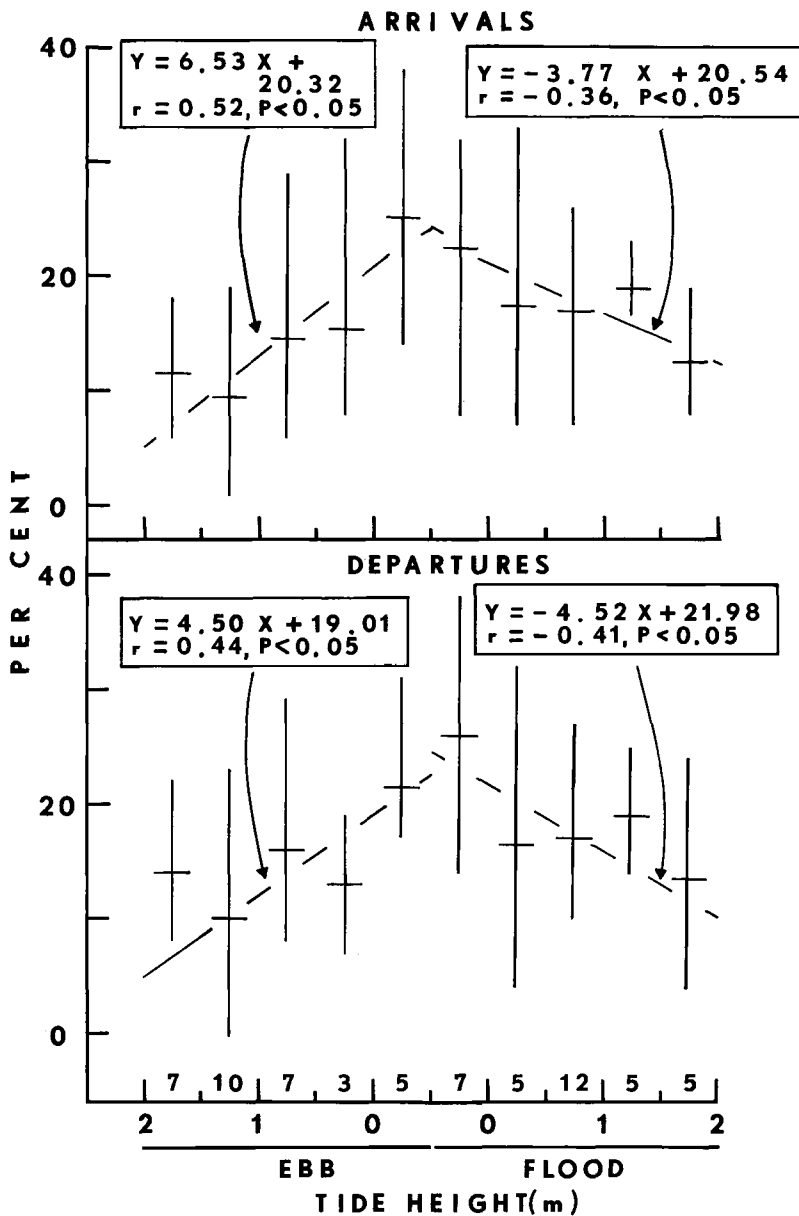


Fig. 2. Linear regressions, means, and ranges of percentage of Yaquina-S breeding herons arriving or departing during 1-h observations for ebb and flood at 0.5-m tide height intervals. The height for each period was the height at mid-observation. Symbols as in Fig. 1.

with a rate 20 or greater during 8 h, and at Coos-E the maximum rate was 6 herons/h.

Colony synchrony can be measured only by dividing the arrival or departure frequencies by the total number of breeding herons. The greatest average arrival synchrony at Yaquina-S with time of tide was 23% (Fig. 1) and with tide height

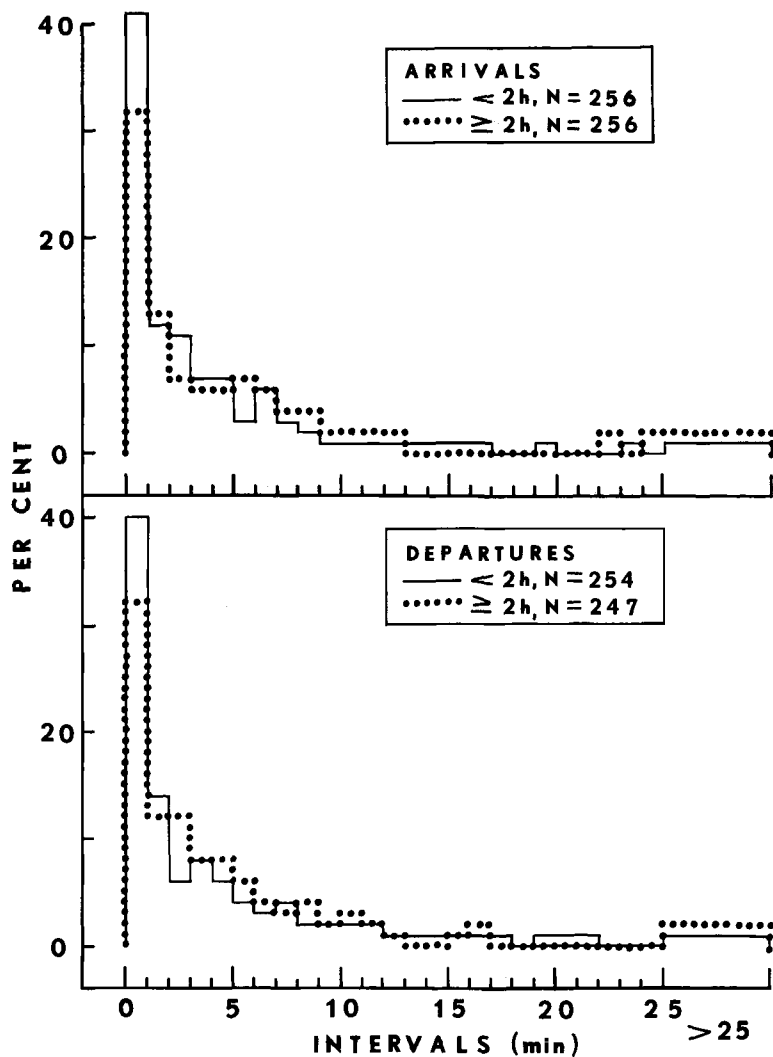


Fig. 3. Percentage of distribution of all 1978 Yaquina-S heron intervals between arrivals or departures either within 2 h or 2 h or more from low tide.

was 25% (Fig. 2) of the breeding herons/h. The greatest average departure synchrony with time of tide was 23% (Fig. 1) and with tide height was 26% (Fig. 2). At Coos-E, there were insufficient data to determine an average peak synchrony, but the maximum Coos-E arrival (31%) and departure (35%) synchronies were within the synchrony range of Yaquina-S (Figs. 1 and 2).

Low colony synchrony is also indicated by the small proportion of the colony departing in 5-min observations from Yaquina-S. During the period of peak departures (i.e. within 2 h of low tide), an average of only 1.8% (SD = 1.9,  $n = 242$  observations) of Yaquina-S herons departed per 5-min observation.

The low degree of colony synchrony also indicates a long time between arrivals or departures for the average heron. The mean of the average hourly arrival and

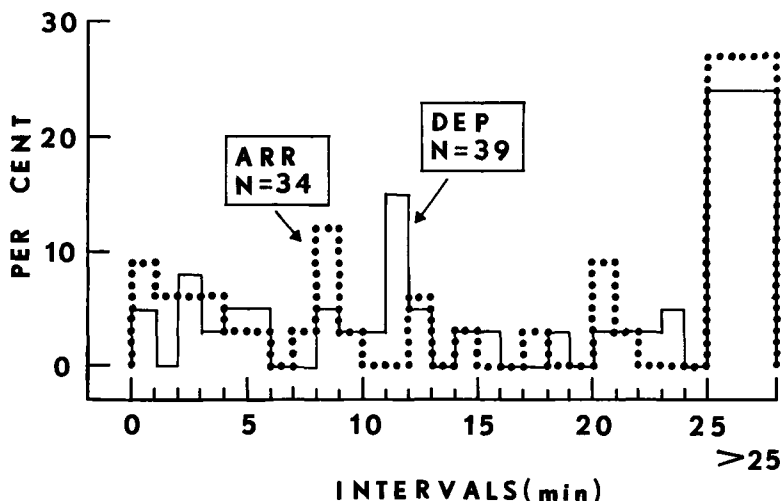


Fig. 4. Percentage distribution of all Coos-E heron intervals between arrivals or departures.

departure rates throughout all hours of observation was only 0.15 arrivals or departures  $\cdot$ heron $^{-1} \cdot$ h $^{-1}$  at Yaquina-S and 0.15 arrivals and 0.16 departures  $\cdot$ heron $^{-1} \cdot$ h $^{-1}$  at Coos-E. The inverse, the average time between an individual's arrival or departure, was thus 6.7 h at Yaquina-S and 6.7 and 6.3 h at Coos-E, respectively. The time between arrivals or departures at maximum average synchrony at Yaquina-S was 4.3 h.

*Arrival and departure clumping.*—Assuming an average flight speed of 38.7 km/h (range 30.6–46.8 km/h, Palmer 1962), I calculated that herons flying 1 min apart are 0.6 km apart. I found that most (59–95%) colony arrivals and departures were greater than 1 min apart (Figs. 3 and 4), so most herons were not arriving or departing the colony in tight flocks.

At Yaquina-S, the intervals between colony arrivals or departures were less within 2 h of low tide than for 2 h or greater (Fig. 3). To test the statistical significance of this trend, I used the two-sample rank test (Goldstein 1964: 115) on the data shown in Fig. 3 for 1-min categories up to 9 min apart and for two additional categories (intervals 10–14 and  $\geq$ 15 min apart). I found that the trend of greater clumping within 2 h of low tide was not significant (arrivals,  $x^* = 0.25$ ,  $P > 0.10$ ; departures,  $x^* = 0.22$ ,  $P > 0.10$ ). At Coos-E there were insufficient data to test for a difference with stage of tide.

The degree of arrival clumping was similar to the degree of departure clumping for a colony (Figs. 3 and 4). For Yaquina-S, I used the above categories to determine that the intervals between arrivals or departures did not differ significantly from each other ( $< 2$  h from low tide,  $x^* = 0.83$ ,  $P > 0.10$ ;  $\geq 2$  h,  $x^* = 0.31$ ,  $P > 0.10$ ). At Coos-E there were sufficient data for only three categories (intervals  $\leq 9$ , 10–14, and  $\geq 15$  min apart). Using the same test, I again found no significant difference between intervals for arrivals and departures ( $x^* = 0.54$ ,  $P > 0.10$ ).

Intervals between Coos-E arrivals or departures were much less clumped than those of Yaquina-S (Figs. 3 and 4). Using the two-sample rank test for three categories (intervals  $\leq 9$ , 10–14, and  $\geq 15$  min apart), I found that these intervals were

significantly different between the two colonies (arrivals,  $x^* = 4.22$ ,  $P < 0.01$ ; departures,  $x^* = 5.97$ ,  $P < 0.01$ ).

The clumping of departures was correlated with the clumping of arrivals at both Yaquina-S and Coos-E. I found that the number of departures was significantly correlated (Yaquina-S,  $r = +0.59$ ,  $t = 8.99$ ,  $P < 0.01$ ; Coos-E,  $r = +0.42$ ,  $t = 3.41$ ,  $P < 0.01$ ) with the number of arrivals per 15-min observation period (Yaquina-S,  $n = 154$ ; Coos-E,  $n = 55$ ). Further, the difference between the number of arrivals and departures per 15-min observation was not significant (Yaquina-S, paired- $t = 0.51$ ,  $P > 0.10$ ; Coos-E, paired- $t = 0.41$ ,  $P > 0.10$ ).

#### DISCUSSION

*Arrival clumping.*—Arrival clumping may result from synchrony with extrinsic factors such as tides (Paine 1972, this paper) and/or socially induced flights. Socially induced flights may occur at the foraging grounds when the flight of one heron toward the colony may induce others to do likewise (also see Davis 1975). This may be particularly important for herons that started foraging about the same time because of tidal height constraints. The generally longer intervals between arrivals at Coos-E may have resulted from the fact that there were fewer herons leaving the foraging areas to return to Coos-E that could have induced the return flights of other herons.

*Flock departures.*—Krebs (1974) defined a flock to exist when heron departures were 5 min or less apart. By his definition of a flock, Krebs found that most herons (I estimate about 65% from his Fig. 5) departed the colony in flocks at peak colony synchrony. Five min is too long between departures, however, to consider herons as part of the same flock, because herons flying 5 min apart would be 3.2 km apart at the average heron flying speed of 38.7 km/h (Palmer 1962). A more realistic interval between departures is 1 min, and with a 1-min interval I found that a total of 34% of Yaquina-S and only 5% of Coos-E breeding herons could be considered as departing the colony together. Similarly, Pratt (1980) found that only 24% of the herons at a California coastal colony departed within 4 min of each other. Thus, Great Blue Herons most frequently depart the colony alone.

“Flock” departures could result from coincidence resulting from several nonexclusive causes other than birds using the colony as an Information Center. First, such flocks may be artifacts of environmental conditions. For example, ardeid departure frequencies are influenced by tides (Paine 1972, Krebs 1974, Brandman 1976, Erwin and Ogden 1979, this paper) or times of day (Brandman 1976, Erwin and Ogden 1979, Warren 1979). Second, flocks may simply result from birds arriving in flocks, spending about the same amount of time at the colony, and then departing, probably still as synchronized as when they arrived. If herons arrived randomly at the colony and departures were clumped, then departure clumping might indicate departure of social flocks. But this is not the case, for arrivals were asynchronous at Coos-E, and departures were also asynchronous (Fig. 4). Third, flocks may result partly from the flight of one heron inducing the flight of other herons that can leave the colony (also see Davis 1975), especially of herons that arrived at about the same time. Fourth, flock departures may be an artifact of colony size (i.e. the probability of independently behaving birds departing coincidentally increases with colony size). Thus, the higher proportion of flocks at Yaquina-S than at the smaller Coos-E may represent the higher probability of birds departing “together” when there are more birds departing.

*Individual colony return frequency.*—Herons returned to the colony infrequently. Theoretically, a heron could make several trips from the foraging grounds to the colony in an hour, for the distance between Yaquina-S and most Yaquina foraging grounds ( $\leq 5$  km, pers. obs.) could be flown, at average speed, one-way in 7.8 min. I found, however, that the average arrival time for a Yaquina-S heron was 6.7 h.

The low return rate to the colony is to be expected. As suggested by Pratt (1980), during the time spent at the colony, truly ephemeral foraging areas could have moved or disappeared (also see Bayer in prep.). Further, a heron would expend time and energy in flying to the colony, waiting, and somehow identifying a successfully foraging nonterritorial heron. If a heron mistakenly followed a territorially foraging heron, which could be very "purposeful" and have territories up to 34 km from a colony (Peifer 1979), the follower would expend energy without any compensation, because the follower would be subsequently chased from the foraging site. A heron would better spend its time at the foraging ground foraging solitarily or following flocks as they formed. Evidence of Great Blue Herons or other ardeids cueing to flocks at foraging areas was found by Krebs (1974) and Kushlan (1977).

#### ACKNOWLEDGMENTS

I am grateful to many people from the Oregon State University Marine Science Center and Ore-Aqua Foods, Inc., who made completion of this work possible. I am thankful to J. A. Wiens, D. Mock, T. Custer, and H. M. Pratt for providing constructive comments on earlier drafts of this manuscript. The field research was completed while I was a graduate student at Oregon State University.

#### LITERATURE CITED

- BAYER, R. D., & E. McMAHON. In press. Colony sizes and hatching synchrony of Great Blue Herons in coastal Oregon. Murrelet.
- BRANDMAN, M. 1976. A quantitative analysis of the annual cycle of behavior in the Great Blue Heron (*Ardea herodias*). Unpublished Ph.D. dissertation, Los Angeles, Univ. California.
- DAVIS, J. M. 1975. Socially induced flight reactions in pigeons. *Anim. Behav.* 23: 597-601.
- ERWIN, R. M., & J. C. OGDEN. 1979. Multiple-factor influences upon feeding flight rates in wading bird colonies. *Proc. Colonial Waterbird Group* 3: 225-234.
- GOLDSTEIN, A. 1964. Biostatistics: an introductory text. New York, MacMillan Co.
- KREBS, J. R. 1974. Colonial nesting and social feeding as strategies for exploiting food resources in the Great Blue Heron (*Ardea herodias*). *Behaviour* 51: 99-134.
- KUSHLAN, J. A. 1977. The significance of plumage colour in the formation of feeding aggregations of Ciconiiforms. *Ibis* 119: 361-364.
- OREGON STATE LAND BOARD. 1973. Oregon estuaries. State of Oregon Land Board, Div. State Lands.
- PAINE, J. M. 1972. A study of colonial nesting in the Great Blue Heron (*Ardea herodias*). Unpublished B.S. thesis, Vancouver, Univ. British Columbia.
- PALMER, R. S. (Ed.). 1962. Handbook of North American birds, vol. I. New Haven, Connecticut, Yale Univ. Press.
- PEIFER, R. W. 1979. Great Blue Herons foraging for small mammals. *Wilson Bull.* 91: 630-631.
- PRATT, H. M. 1980. Directions and timing of Great Blue Heron foraging flights from a California colony: implications for social facilitation of food finding. *Wilson Bull.* 92: 489-496.
- WARD, P., & A. ZAHAVI. 1973. The importance of certain assemblages of birds as "information centres" for food finding. *Ibis* 115: 517-534.
- WARREN, N. M. 1979. Ecology of Great Blue Herons on Silver Creek, Idaho. Unpublished M.S. thesis, Moscow, Idaho, Univ. Idaho.