River) on drier and less vegetated substrate. We saw no Black Terns (*Chlidonias niger*) near the Forster's Tern sites in contrast to Bergman et al. (Wilson Bull. 82:435–444, 1970). Only two Forster's Tern nests were placed on muskrat houses, although muskrats and their houses were common. This infrequent use of muskrat houses contrasts with 53–98% of the nests on muskrat houses in Iowa (Bergman et al. 1970; Weller and Spatcher, Spec. Rept. 43, Iowa St. Univ., Ames, Iowa, 1965). From the third week of May to the first week of June 1982, 67% of nests at which clutch-size was recorded, had three eggs. In 1980, sites checked in the first 2 weeks of June had nests under construction and incomplete clutches which suggests a prolonged nesting cycle or renesting. These observations of nesting chronology are consistent with the Iowa data of Bergman et al. (1970).

Discussion.—Based on published information, Forster's Terns, during most of this century, were uncommon and scattered nesters in southern Lake Huron and Lake St. Clair, and the lower Great Lakes. This is no longer true. This species must be considered common in our survey area. The increase we describe represents a substantial shift from the discontinuous breeding range usually described for this species, and shows a concentration of breeding colonies from southeastern Michigan through southwestern Ontario. Perhaps the recent increase represents a return to former numbers and distribution. Or, the rapid increase may be a response to greater food and nesting site availability coupled with the loss of competition from a closely related species, the Common Tern. The latter species has recently lost habitat (Shugart and Scharf 1983) due to high water levels. Forster's Terns, in this study area, are less vulnerable to flooding with their floating nests, and seem to have a longer period of nest initiation than Common Terns.

We assume that such a large increase in such a short time of 1976–77 to 1982 signals an ecological change of unknown magnitude. At this time we have no basis for further speculation.

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Post-fledging departure from colonies by juvenile Least Terns in Texas: implications for estimating production.—Least Terns (*Sterna antillarum*) have been classified as endangered in California since 1973 (Bureau of Sport Fisheries and Wildlife, Resour. Publ. No. 114, 1973), and decline in numbers has been suggested for much of its range in North America and for the similar Little Tern (*Sterna albifrons*) in Europe (Nisbet, Bird-Banding 44:27–55, 1973; Fisk, Am. Birds 29:15–16, 1975; Lloyd et al., Br. Birds 68:221–237, 1975; Arbib, Am. Birds 33:830–835, 1979; Tate and Tate, Am. Birds 36:126–135, 1982). Despite a generally accepted decline, quantitative evaluations of reproductive parameters are few, aside from estimates of fledging success or fledgling : adult ratios presented by Massey (Proc. Linnaean Soc. N. Y. No. 72:1–24, 1974), Blus and Prouty (Wilson Bull. 91:62–71, 1979), and Massey and Atwood (Auk 98:596–605, 1981).

Earlier reports on Least Tern breeding biology often referred to counts of juveniles at colonies as a direct measure of annual productivity, and these counts were acknowledged as the usual method to estimate survival to fledging (Massey 1974). Massey and Atwood

(1981) recently suggested that more intensive work at colonies provides better estimates. The general body of Least Tern literature, however, still implies that counts of fledglings can provide a direct estimate of annual production. In this paper, we examine colony tenure by recently fledged Least Terns with regard to potential bias in the assessment of production based on juvenile counts at colonies. Further, we discuss how such counts might be improved if used in lieu of more intensive studies.

Methods.—Data were collected during the 1979 and 1980 breeding seasons at four colonies in Aransas and San Patricio counties on the central Texas coast: (1) Aransas Pass is a mainland site on a dredged material disposal area created early in 1979; (2) Copano Shell Island is a 0.05-ha natural shell island about 40 m from the mainland in a secondary bay system; (3) Portland (Sunset Lake) is a 2.3-ha sand and shell area between a tidally influenced lagoon and a heavily traveled highway; and (4) Rockport (Little Bay) colony is at a public beach and park and has existed for at least 25 years despite routine human disturbance. The flora at all sites is characteristic of species found on natural and disturbed saline substrates as described by Jones (Flora of the Texas Coastal Bend, Mission Press, Corpus Christi, Texas, 1977:xix) and Lonard and Judd (Southwest. Nat. 25:313–322, 1980).

Juvenile terns 12 days of age or older were captured by hand at colonies from late May to late July during each year. Individually identifiable Herculite® or Saflag® tags were attached to each wing with a stainless steel clip that pierced the patagium. Tags and clips approximated 2.5% of fledging weight. Fledging dates for each juvenile were estimated based on developmental stages described by Jackson (Miss. Kite 6:25–35, 1976) and judged to be accurate within 2 days based on known-age chicks. Fledging was considered to be the age at first flight as discussed by Burger (pp. 367–447 *in* Behavior of Marine Animals, Vol. 4, J. Burger, B. Olla, and H. E. Winn, eds., Plenum Press, New York, New York, 1980).

Colonies were visited approximately weekly to locate marked juveniles from first fledging during the last week of May through August each year. During each visit, the colony proper and loafing areas were examined one to five times with 7× binoculars and 20× spotting scope. Thorough visual examination of use-areas for marked terns was conducted at distances of 20–100 m, depending on tern tolerance, prior to causing any upflight. Duration of our presence near colonies was 20–500 min depending on the colony nesting population and other work in progress. The average visit was 138.5 ($N = 23$) and 146.1 ($N = 28$) min in 1979 and 1980, respectively, during which terns were disturbed only periodically. Visits were made during all daylight hours from 06:00–23:00 CDT; 20% of visits included periods between 18:00 and darkness.

A probability value was assigned to the detection of marked juveniles using a colony site during any visit. In estimating this probability, each juvenile was assumed to be using a colony from the fledging date until the last visit observed. The number of visits seen divided by the potential visits present was used as a measure of detection for each individual. The average of all observations represented the generalized detection probability.

Results and discussion.—Tags were applied to 93 juvenile terns, of which a minimum of 59 (63.4%) were known to have fledged eventually. Only 20 tagged young were known or suspected to have died prior to fledging. Thus, as many as 73 (78.5%) may have survived to fledging, a rate that is comparable to the 76.8 ± 2.0% (2 SE) fledging rate estimated independently for banded young (unpubl.).

Observations during at least four weekly visits post-fledging yielded estimates of duration of presence at colonies for 58 tagged juveniles. Twenty-six of these juveniles (44.9%) were not seen at colonies more than 2 weeks post-fledging and 86.3% were not seen after 3 weeks (Table 1). There was no significant trend in departure times between the first one-half of juveniles that were marked each year and those that were marked and fledged later in the fledging period (Cox-Stuart test, $P > 0.25$, Daniel [Applied Nonparametric Statistics, Hough-

TABLE 1

DURATION OF COLONY TENURE BY MARKED LEAST TERN JUVENILES ON THE TEXAS GULF COAST, 1979–1980

Days after fledging	Terns departing in time interval					
	1979[a]		1980[a]		Combined	
	N	%	N	%	N	%
0–7	5	16.7	2	7.1	7	12.1
8–14	7	23.3	12	42.9	19	32.8
15–21	13	43.3	11	39.3	24	41.4
22–28	2	6.7	3	10.7	5	8.6
>28	3	10.0	0	0	3	5.1
Total	30		28		58	

[a] Departure interval frequencies did not differ between years ($\chi^2 = 5.91$, df = 4, $P > 0.20$).

ton-Mifflin Co., Boston, Massachusetts, 1978:58]). Further, there was no monotonic relationship between fledging date and departure interval for all tagged young (Spearman $r = -0.082$, df = 57, $P > 0.10$). Therefore, the tabulated departure schedule was consistent from early June through mid-August. It is possible that extremely late-fledged young (>15 August) could exhibit shorter departure intervals as colonies become deserted toward the end of the breeding season, but that time period was not represented in this data set and generally would comprise a minor component of total young fledged. None of the three juveniles shown as departing at >4 weeks was seen anytime prior to their last known presence at colonies; they likely left colonies very early and then revisited much later. Detection probability was similar both years, averaging 0.67 ± 0.02 (SE) overall.

Several potential explanations exist for the distribution of departure intervals. First, excessive mortality among marked chicks during the first 3 weeks post-fledging would yield similar data. However, 12 of the 58 juveniles (20.7%) included in this analysis were subsequently seen away from their natal colony from 10–44 days post-fledging. Thus, the 86% disappearance rate by week 3 (Table 1) exceeded the maximum possible mortality rate. Two juveniles tagged at other less intensively studied colonies were seen more than 6 weeks post-fledging at 90–200 km away from original colonies.

Second, older marked juveniles may have been using colonies but were not seen or were away at the time of visits. These explanations are possible, but the detection probability approached 70% and marked individuals known to be present generally were seen regardless of time of visit. Our observations did not discount juveniles using colonies only as nighttime roosts, but visits near dusk did not indicate that previously unseen juveniles were present then. Nighttime roosting areas used by recent fledglings may be far removed from the colony of origin (Massey and Atwood 1981).

The final possibility is that juveniles departed the colonies soon after fledging. This explanation seems most acceptable considering: (1) the probability of detecting fledglings using a colony; (2) the consistent observations within and among years of the study; and (3) the resightings of marked juveniles away from colonies. This conclusion is further substantiated by similar departure times in other areas. Juvenile Least Terns in California were seen away from natal colonies from 16–28 days post-fledging (Massey 1974, Massey and Atwood 1981). Band recovery data through August 1980 contain records of eight juveniles from the eastern

TABLE 2

COMPARISONS AMONG ESTIMATES OF FLEDGLING PRODUCTION AT THREE TEXAS COASTAL LEAST TERN COLONIES, 1979–1980

					Sum of fledgling counts relative to breeding chronology[b]		
Colony	Year	Est. breeding pairs	Est. total fledged[a]	Single highest fledgling count	Within colony chronology	Inter-colony chronology	Est. total fledglings corrected for early departure[c]
Rockport	1979	112	90–100	45	98	83	104
Rockport	1980	140	110–120	47	94	63	100
Aransas Pass	1980	88	35–40	15	17	20	24
Copano Shell Is.	1980	26	15–18	7	7	4	8

[a] Estimates based on reproduction studies conducted concurrently.

[b] Estimates = sum of counts made at peak fledging, 4 weeks, and 8 weeks after peak fledging.

[c] Estimate = [$\text{Count}_{(1)}$ made during second week of fledging coastwide] plus [$\text{Count}_{(2)} - 0.55(\text{Count}_{(1)})$] plus $\sum_{i=3}^{n}$ [$\text{Count}_{(i)} - 0.05(\text{Count}_{(i-2)}) - 0.55(\text{Count}_{(i-1)})$]. Where i = the numerical sequence value of counts at 2-week intervals and n = the total number of counts.

U.S. that were found outside the 10-min block where banded from 3–22 days after banding and thus <3 weeks post-fledging. While this evidence of rapid departure has been available for some time, implications toward estimation of annual production apparently was not previously recognized, at least not in published form.

The fledging chronology observed in the Texas colonies involved in this study spanned 12 weeks, with 8 weeks required for completion of 90% of the fledging during both years. Contrasting these time periods with the brief colony tenure of marked juveniles reveals a potential bias in the relationship between juvenile counts and cumulative survival to fledging. Counts of fledglings at colonies likely represent only the young fledged during the previous 2–3 weeks. Such counts would substantially underestimate total success and would be difficult to interpret unless conducted at similar breeding stages in each colony and often enough to include most young prior to their departure.

Limited data collected at three colonies during 1979–1980 verified that single counts of juveniles substantially underestimated total production (Table 2). In contrast, multiple counts timed with the breeding chronology (especially those corrected for fledgling departure) provided more realistic estimates of survival to fledging. With adequate information concerning regional breeding chronology, the potential exists for using multiple counts of juveniles to assess annual production of Least Terns throughout their range. A suitable correction was obtained for the Texas colonies studied by using five–six counts starting 2 weeks into fledging and continuing at 2-week intervals until fledging was complete. The formula for this departure correction is footnoted in Table 2. The multipliers in this formula (0.55 and 0.05) represent the proportion of previously counted fledged juveniles expected to be present during repeated visits to colonies based on data in Table 1. Observer familiarity with temporal and spatial aspects of each colony should dictate proper timing of counts and area examined.

The data presented here apply to Texas and are necessarily preliminary; empirical verification in other areas is warranted. These procedures provide a means of estimating production when only brief visits to colonies at lengthy intervals are possible and the intent is to obtain gross estimates over large areas. Consideration should be given to evaluating applicability to other precocial colonial ground-nesting species whose fledgling survival may be inaccurately estimated by "traditional" counts. Procedures may be especially applicable during future fieldwork designed to compile geographic summaries of waterbird nesting status like those of Erwin (Coastal Waterbird Colonies: Cape Elizabeth, Maine to Virginia, U.S. Fish and Wildl. Serv., FWS/OBS-79/10, 1979) and Sowls et al. (Catalog of California Seabird Colonies, U.S. Fish and Wildl. Serv., FWS/OBS-80/37, 1980). These procedures are not suggested for colonies where ongoing studies can provide more detailed data for production estimates and associated confidence limits.

In summary, the majority of juvenile Least Terns appear to depart colonies within 3 weeks after fledging. Single counts of fledged juveniles substantially underestimate cumulative production. Awareness of these phenomena will permit more accurate assessment of fledging rate for Least Terns. At a minimum, multiple counts should be made on a schedule timed with the breeding chronology in the survey area and should be corrected for juvenile departure. Observer familiarity with colonies is requisite to the appropriate timing of counts and examination of use areas. Counts using such procedures are not suggested as substitutes for estimates derived from more intensive studies of survival.

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Expanded use of the variable circular-plot census method.—Since its introduction by Reynolds et al. (Condor 82:309-313, 1980), the variable circular-plot method (VCPM) has become a popular means of censusing birds (Ralph and Scott, eds., Stud. Avian Biol. 6, 1981). Designed for use in rough terrain, the method has now been applied in a variety of vegetation types (e.g., DeSante, Stud. Avian Biol. 6:177-185, 1981; Morrison et al., Stud. Avian Biol. 6:405-408, 1981; Scott et al., Wildl. Soc. Bull. 9:190-200, 1981a). The method allows density estimates based on species-specific detection distances obtained by observers at fixed locations. The method assumes, however, that individual birds are located anywhere within the species-specific radius around the fixed point; that is, locations of individuals are not mapped as with the classic spot-map method (SMM; Williams, Ecol. Monogr. 6:317-408, 1936; Kendeigh, Ecol. Monogr. 14:67-106, 1944; see also Ralph and Scott 1981). The SMM provides an estimate of territorial bird density and is often used for assessing the accuracy of other methods (Franzreb, Stud. Avian Biol. 6:164-169, 1981; Szaro and Jakle, Wilson Bull. 94:546-550, 1982). The SMM, however, is usually applicable only to small areas of moderate terrain during the breeding season (Emlen, Auk 94:455-468, 1977). This paper describes a simple way to use the VCPM as a means of: (1) locating areas of highest use by birds, (2) rudimentarily delineating territories, and (3) assessing the problems of double-counting individuals.

The method.—The only information required in addition to that recorded for standard VCPM counts (Reynolds et al. 1980) is the direction of the bird from the census station. A compass can be hand-held or attached to a clipboard and the direction (azimuth) of each individual bird seen or heard can be recorded along with distance and other information of