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**STATUS, DISTRIBUTION, AND
PRODUCTION OF THE INTERIOR LEAST
TERN AND PIPING PLOVER
ALONG THE MAINSTEM MISSOURI RIVER
IN SOUTH DAKOTA, 1986**

**REPORT TO THE U.S. ARMY CORPS OF ENGINEERS
Missouri River Division, Omaha, Nebraska**

By

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PREFACE

This project was initiated in May of 1986 and continued through the end of the nesting season in late August of 1986.

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ABSTRACT

Surveys of interior least tern (Sterna antillarum athalassos) and piping plover (Charadrius melodus) populations were conducted in South Dakota in 1986. Least terns are listed as endangered and piping plovers as threatened by both South Dakota and federal law. Objectives were to determine population status, nesting habitat characteristics, and factors limiting productivity. Overall, 372 adult least terns and 226 adult piping plovers were censused. Forty-one nesting areas were located, all of which were sparsely vegetated sandbars, beaches, or parkinglots. Due to record high water levels on the mainstem Missouri River throughout the May to August nesting period, production was very low for both species. A nesting population of least terns along a natural portion of the Cheyenne River did however show dramatically higher production. Specific recommendations for species protection and continued study are provided, but in general a "natural river" scenario would be most beneficial during the May-July nesting period. Management suggestions for terns and plovers appear to be complementary with fisheries resource goals especially below Gavins Point Dam where 69% of the tern and 89% of the plover nesting populations were observed.

INTRODUCTION

In 1985 the U.S. Fish and Wildlife Service (USFWS) listed the interior least tern (Sterna antillarum athalassos) as endangered and the piping plover (Charadrius melodus) as endangered or threatened over all of its breeding range, under the Endangered Species Act of 1973, as amended (USFWS 1985a, 1985b). The Endangered Species Act requires Federal agencies to ensure that their actions do not jeopardize the continued existence of any Federally listed endangered or threatened species or result in the destruction or adverse modification of their habitat. Pursuant to this, the U.S. Army Corps of Engineers (COE), Missouri River Division, has entered into formal Section 7 consultation on these two species with USFWS in North Dakota (ND), South Dakota (SD), and Nebraska (NE) (Col. Tucker, COE Missouri River Division, Omaha, NE, pers. comm.).

This paper is a completion report for the COE, and presents results from interior least tern and piping plover surveys on the SD portion of the mainstem Missouri River in 1986. Although COE had considered the river reach from Gavins Point Dam to Ponca State Park, NE, a segment of the Nebraska portion of the Missouri for this study, information on that reach is included in this report.

Due to habitat declines, the South Dakota population of interior least tern has been listed as state endangered and the piping plover as state threatened. Historical information on the abundance of these two species for SD is lacking. Few nongame inventories were conducted on the Missouri prior to completion of the Pick Sloan Plan by the COE in the 1960's. Of the remaining one-fourth SD Missouri River available for terns and plovers, all is subject to water releases which may be negatively impacting these two species. Normal flows of spring flooding, sandbar scouring and midsummer sandbar exposure have been replaced by more stabilized flows resulting in vegetative encroachment of sandbars with remaining sandbars subject to inundation during the critical nesting season (Dinsmore 1981, Ducey 1981).

This study was a joint project between biologists of the Cooperative Fish and Wildlife Research Unit of South Dakota State University, and the Wildlife Division of the South Dakota Game, Fish and Parks Department (GFP). The objectives were to (1) survey the breeding populations and distribution of least terns and piping plovers in SD, (2) determine nesting habitat characteristics, (3) document production and (4) identify factors affecting productivity. All objectives were completed during the 1986 May-August breeding season. This report summarizes information gained from field surveys, discusses habitat management implications, and provides recommendations for protection priorities, management guidelines, and further study.

STUDY AREA AND METHODS

The study area included the Missouri River from the ND state line to Ponca State Park, NE. Three primary areas for ground surveys were identified during aerial surveys, and include (1) the Missouri River reach from Gavins Point Dam to Ponca State Park, NE, (2) the Missouri River reach from Fort Randall Dam to Springfield, SD, and (3) Oahe Reservoir in the vicinity of the Cheyenne River mouth, Little Bend Recreation Area, and Bush's Landing. In addition, portions of the Cheyenne River were surveyed in conjunction with a South Dakota State University Masters Degree study.

Aerial surveys of likely nesting habitat were conducted on 27-28 May and 2 July. Areas flown were habitats where nesting had been documented or where adult birds had been observed during previous May to August breeding seasons. Potential habitats were flown at a lower altitude to flush interior least terns. Concentrations of interior least terns found by aerial surveys were mapped on state highway, county, or Missouri River recreational maps, providing locational information for later boat surveys. A 2 July survey was conducted over Oahe Reservoir near the Little Bend area (RM 1072 to RM 1235) after interior least terns were found nesting on what was previously not considered potential habitat.

Total population censuses of the entire study area were conducted from early June to early July. All suitable habitats near areas mapped during aerial surveys were searched for least terns and piping plovers. Least terns actively defend nesting areas, aiding in location of colony sites (John Dinan, NE Game and Parks Commission, Lincoln, NE, pers. comm.). Searches of appropriate habitat for piping plover nest sites and potential nesting habitat for both species were made during this period with the use of a boat. Biological information collected at each site included number of adults, number of pairs, number of flightless young and juveniles, number of nests (active and inactive) and number of eggs per nest. The floatation method of determining embryo developmental stage in tern eggs was used to estimate incubation stage for each nest (Hays and LeCroy 1971). All active nesting areas were revisited a minimum of two times, at approximately 21 day intervals from the first visit, in order to estimate production.

Concurrent with population censuses, measurements of habitat characteristics were conducted at each nesting site. General measurements included sandbar (or beach) size, colony size, percent vegetative cover, vegetation species composition, and average height of vegetation. Nest measurements included elevation above water, distance to water's edge, distance to nearest non-vegetative object, height and type of nearest object, distance to nearest plant, height and species of nearest plant, percent cover within 1m² of nest, and soil substrate type. Additionally, habitat characteristics were

measured at twenty sites where no terns or plovers were nesting. These "potential" sites were divided into two groups: (1) 10 sites which appeared by cursory examination to exhibit similar characteristics as currently active nesting sites, and (2) 10 sites which appeared to exhibit the same characteristics as nesting sites except for greater percent cover, height, and higher species diversity.

Habitat characteristic measurements were normally conducted during the first visit to a site. To avoid excessive exposure of nests and chicks during inclement or hot weather, measurements were usually made early or late in the day or in as brief a time as possible. In the latter case, a visit was divided into two shorter visits whereby: terns and plovers were censused, nests were located, and chicks banded during the first period. We would then leave the area for several hours or overnight and return to conduct habitat measurements during the second period. Due to heavy rains during the 5-6 June survey below Gavins Point Dam, measurements were not conducted at all sites on this reach of the river.

For the purposes of this report, only three of the habitat characteristics will be discussed: nesting area size, nest height above water level, and distance of nest from water's edge. Analysis and discussion of the remaining habitat characteristics will be the topic of a thesis report, not presently completed.

Elevation above water and distance from water's edge for each nest were measured to the nearest one-tenth foot and foot, respectively, using a surveyor's level and rod. Pool elevations and discharge data from each of the four mainstem dams in SD were obtained from the COE. This data set was used to assess the relationship of nest height above water for each site.

Evidence of human disturbance, flooding, predation, or other factors potentially limiting productivity were documented when evident.

All interior least tern and piping plover chicks captured were banded with USFWS aluminum leg bands.

RESULTS

Distribution and Habitat Characteristics

Forty-one nesting areas were found in SD and were distributed as follows: 24 between Gavins Point Dam and Ponca State Park, three between Fort Randall Dam and Springfield, eight on Oahe Reservoir between the face of the dam north to approximately Whitlocks Crossing, and six on the Cheyenne River. No terns or plovers were found between

Oahe Dam and Fort Randall Dam, despite documented nesting records from previous years. Reference to all sites in this paper includes nesting area identification number and river mile designation.

Terns and plovers utilized three habitat types as nesting areas: sandbar, beach, and parkinglot. With the exception of one pair of plovers on a parkinglot at Gavins Point Dam, all nesting areas between Fort Randall and Ponca State Park were bare to sparsely vegetated sandbars. Three pairs of piping plovers nested on parkinglots along Oahe Reservoir. One parkinglot plover nest was successful, but only due to intensive site protection. The remaining five nesting areas on Oahe and all areas on the Cheyenne River were bare to sparsely vegetated beaches.

The size of nesting areas ranged from 0.05 to 11.24 hectares (0.405 hectare = 1 acre). Oahe Reservoir beaches were the smallest areas, and ranged from 0.05 to 0.18 hectares. The average beach size was 2.08 hectares (SD = 2.61, Var = 6.83). Average sandbar size was 3.15 hectares (SD = 3.51, Var = 12.35). Tern and plover nesting area sizes are summarized in Table 1.

Measurements of nest to water distances and nest heights above water were conducted at all sites where possible. These are summarized in Tables 2 and 3 (0.305 meter = 1 foot). Since nest height and distance to water are subject to temporal variation, date of site measurements is referenced in Tables 2 and 3. Values presented represent means of all nests present at a site; no separation is made between tern and plover nests.

Comparisons of nest to water distances between sites would present misleading results due to temporal and spatial variations in water levels among sampling dates. However, a few general deductions can be made. On Oahe Reservoir beaches, where nesting areas are small, nest to water distances are short. Nest to water distances at the sites below Fort Randall are short relative to those below Gavins Point Dam. While nesting areas below Fort Randall and Gavins Point may have experienced fluctuating water levels, those on Oahe and the Cheyenne River generally experienced decreasing water levels as the season progressed. By the 17 August visit to colony #16007 on Oahe Reservoir (RM 1108.5) decreases in water flows exposed an expansive stretch of shoreline and nest height above water and distance to water's edge increased.

Mean nest elevation measurements above water level for nesting areas below Fort Randall and Gavins Point were converted to a discharge values in order to plot the relationship of mean nest elevation to discharge at those sites. These values were determined by adding 1000 cfs for every 0.2 feet of nest elevation above water to the discharge measurement from the nearest upstream station on the date of site measurement. Graphs for sites between Gavins Point Dam and the James

TABLE 1

SUMMARY OF TERN AND PLOVER NESTING AREA SIZE, 1986

Site ID RM Date Area in Hectares

Cheyenne River

35001	43.5	7 Jun	3.340
35002	59.5	25 Jun	3.082
35003	51.8	26 Jun	3.982
35004	47.0	26 Jun	2.960
35005	57.5	17 Jul	0.540
35006	53.6	18 Jul	8.376

Oahe Reservoir

16001	1155.0	12 Jun	0.171
16002	1155.0	12 Jun	0.430
16003	1105.7	19 Jun	0.141
16004	1104.2	19 Jun	0.176
16005	1072.8	30 Jun	0.406
16006	1108.0	8 Jul	0.133
16007	1108.5	8 Jul	0.051
16009	1127.0	9 Jul	0.082

Below Ft. Randall

12001	839.0	14 Jun	1.437
12003	873.0	15 Jun	10.566
12008	832.8	12 Jul	1.178

Below Gavins Point

11001	804.0	13 Jul	3.887
11002	803.2	14 Jul	0.989
11003	801.6	15 Jul	1.382
11004	801.0	15 Jul	1.329
11005	800.9	15 Jul	1.559
11006	798.0	15 Jul	2.240
11007	755.3	24 Jul	11.236
11008	766.0	25 Jul	6.711
11009	770.0	25 Jul	1.505
11010	782.6	22 Jul	0.251
11011	781.3	22 Jul	0.693
11012	778.5	22 Jul	2.257

TABLE 2

SUMMARY OF NEST TO WATER DISTANCE, 1986

Site ID	RMI	Date	Number of nests	Mean distance (feet)	Standard deviation	Variance
<u>Cheyenne</u>						
35001	43.5	7 Jun	2	46.935	34.486	1189.257
35002	59.5	25 Jun	3	59.944	6.345	40.258
35003	51.8	26 Jun	3	51.816	9.270	85.935
35004	47.0	26 Jun	1	25.91	0	0
35005	57.5	17 Jul	1	29.96	0	0
35006	53.6	18 Jul	2	na*	na	na
<u>Oahe Reservoir</u>						
16001	1155.0	12 Jun	1	32.600	0	0
16002	1155.0	12 Jun	1	38.780	0	0
16003	1105.7	19 Jun	1	2.990	0	0
16004	1104.2	19 Jun	1	1.830	0	0
16005	1072.8	30 Jun	1	32.770	0	0
16006	1108.0	8 Jul	2	3.170	0.948	0.898
16007	1108.5	8 Jul	3	6.841	2.112	4.462
16007**	1108.5	30 Jul	9	4.877	2.794	7.804
16009	1127.0	9 Jul	1	4.360	0	0
<u>Ft. Randall</u>						
12001	839.0	14 Jun	16	6.039	3.586	12.861
12003	873.0	15 Jun	5	6.614	1.222	1.493
12008	832.8	12 Jul	7	6.706	2.593	6.728
<u>Gavins Point</u>						
11001	804.0	13 Jul	10	23.470	12.499	156.247
11002	803.2	14 Jul	3	12.192	4.311	18.581
11003	801.6	15 Jul	4	14.288	10.979	120.532
11004	801.0	15 Jul	3	7.920	3.170	10.047
11005	800.9	15 Jul	1	13.700	0	0
11006	798.0	15 Jul	1	15.200	0	0
11007	755.3	24 Jul	3	36.070	11.023	121.545
11008	766.0	25 Jul	7	25.929	18.123	328.434
11009	770.0	25 Jul	4	24.765	6.540	42.773
11010	782.6	22 Jul	11	23.424	18.737	351.091
11011	781.3	22 Jul	8	12.859	5.680	32.263
11012	778.5	22 Jul	4	15.583	10.176	103.546

* not available, measurements not conducted at site.

** colony site measurements conducted twice.

TABLE 3

SUMMARY OF NEST ELEVATION ABOVE WATER, 1986

Site ID	RMI	Date	Number of nests	Mean elevation (feet)	Standard deviation	Variance
<u>Cheyenne River</u>						
35001	43.5	7 Jun	2	6.275	2.256	5.088
35002	59.5	25 Jun	3	5.124	0.499	0.249
35003	51.8	26 Jun	3	6.260	0.114	0.013
35004	47.0	26 Jun	1	3.875	0	0
35005	57.5	17 Jul	1	na*	na	na
35006	53.6	18 Jul	2	1.417	0	0
<u>Oahe Reservoir</u>						
16001	1155.0	12 Jun	1	11.950	0	0
16002	1155.0	12 Jun	1	19.250	0	0
16003	1105.7	19 Jun	1	0.890	0	0
16004	1104.2	19 Jun	1	2.200	0	0
16005	1072.8	30 Jun	1	12.100	0	0
16006	1108.0	8 Jul	2	1.610	0.099	0.010
16007	1108.5	8 Jul	3	1.292	0.387	0.150
16007**	1108.5	30 Jul	9	2.496	0.506	0.256
16009	1127.0	9 Jul	1	0.750	0	0
<u>Below Ft. Randall</u>						
12001	839.0	14 Jun	16	0.614	0.068	0.005
12003	873.0	15 Jun	5	1.796	0.591	0.349
12008	832.8	12 Jul	7	0.659	0.085	0.007
<u>Below Gavins Point</u>						
11001	804.0	13 Jul	10	0.582	0.147	0.022
11002	803.2	14 Jul	3	0.575	0.026	0.001
11003	801.6	15 Jul	4	0.352	0.183	0.034
11004	801.0	15 Jul	3	0.825	0.114	0.013
11005	800.9	15 Jul	1	0.660	0	0
11006	798.0	15 Jul	1	0.560	0	0
11007	755.3	24 Jul	3	0.521	0.100	0.010
11008	766.0	25 Jul	7	0.731	0.071	0.005
11009	770.0	25 Jul	4	0.673	0.207	0.043
11010	782.6	22 Jul	11	0.430	0.159	0.025
11011	781.3	22 Jul	8	0.569	0.251	0.063
11012	778.5	22 Jul	4	0.608	0.099	0.010

* not available, measurements not taken at site.

** colony site measurements conducted twice.

River are based on discharge from Gavins Point only; graphs for sites between the James River and Vermillion River are based on discharge from Gavins Point plus the James River; and graphs for sites below the Vermillion River are based on discharge from Gavins Point plus the James and Vermillion Rivers. All graphs for sites on the Fort Randall river reach are based on discharge from Fort Randall Dam only. Mean nest elevation measurements for nesting areas on Oahe Reservoir were converted to mean sea level (msl) based on water elevation at sites on the dates of site measurements in order to plot the relationship of mean nest elevation to pool elevation at those sites. Graphs of mean nest elevation in relation to discharge and mean nest elevation in relation to water elevation are presented in Appendix Figures 1-23.

Status and Production

A total of 372 interior least terns were censused in SD, with 257 (69%) below Gavins Point Dam, 36 (10%) below Fort Randall, 27 (7%) on Oahe Reservoir, and 52 (14%) on the Cheyenne River. Two hundred and twenty-six piping plovers were censused, with 201 (89%) below Gavins Point, 17 (7%) below Fort Randall, and 8 (4%) on Oahe Reservoir. Of the 41 nesting areas, five were occupied by piping plovers only, 10 by terns only, and 26 were sympatric colonies comprised of both terns and plovers.

Nesting activity by least terns and piping plovers in SD began in late May and continued into late August. Clutch size for least terns ranged from 1-3 eggs and averaged 2.1 eggs per active nest ($N = 225$, $SD = 0.78$, $Var = 0.64$). Clutch size for piping plovers ranged from 1-4 eggs and averaged 2.5 eggs per active nest ($N = 98$, $SD = 1.20$, $Var = 1.45$). Although a large number of nests were produced, fledging success was very low. Only 44 least terns and eight piping plovers were estimated to fledge along the Missouri River and its tributaries in SD in 1986.

Of the 44 least terns fledged, production was highest on the Cheyenne River with 18 birds (41%), 14 (32%) from below Gavins Point Dam, six (14%) from below Fort Randall Dam and six (14%) from Oahe Reservoir. Of the eight piping plovers, four (50%) fledged from below Gavins Point, three (37.5%) from Oahe Reservoir, and one plover (12.5%) from below Fort Randall Dam. Twenty three least tern and five piping plover chicks were banded with USFWS leg bands.

Chick and fledgling success for adult pairs of terns and plovers is summarized in Table 4. Assuming that a 50% success rate is needed from the average clutch size to produce a self-sustaining population, production rates would be 1.05 least terns fledged per adult tern pair and 1.25 piping plovers fledged per adult plover pair. These values are considerably higher than mean fledging success for terns and plovers in SD in 1986. The fledging success ratio for least terns was 0.37 fledged terns per adult pair, and that for plovers was 0.31 fledged plovers per adult pair.

TABLE 4

1986 Least Tern and Piping Plover Chick and Fledging Success

<u>Location</u>	<u>Chicks/Adult Pair</u>	<u>Fledged/Adult Pair</u>
Least Terns:		
Gavins Point	0.34	0.10
Fort Randall	0.50	0.27
Oahe Reservoir	0.53	0.40
Cheyenne River	<u>0.88</u>	<u>0.72</u>
MEANS	0.56	0.37
Piping Plovers:		
Gavins Point	0.19	0.04
Fort Randall	0.75	0.13
Oahe Reservoir	<u>0.75</u>	<u>0.75</u>
MEANS	0.56	0.31

Summaries of tern and plover production for Gavins Point, Fort Randall, Oahe Reservoir, and the Cheyenne are shown in Appendix Figures 24-27. Production data, including numbers of adults, pairs, active nests, inactive nests, chicks and fledged birds, for all nesting areas is presented in Tables 5-8.

Limiting Factors on Productivity

All sandbar nesting areas were affected to some degree by water levels, the Cheyenne River system by natural flooding conditions, and the remainder of the Missouri by COE water release policies. Although beach nesting areas are least affected by higher water levels, wave action poses a serious threat to productivity. Evidence of wave action or flooding was documented at 24 sites (59%) with 53 tern nests (25% of all tern nests) and 32 plover nests (27% of all plover nests) destroyed or abandoned due to 'washing', which may be a result of rain action, wave action, flooding or a combination of these. All sites below Fort Randall and Gavins Point had signs of water disturbance at some time during the summer. In addition, nest scrape dampness was evident at most sites and may have added to the low production.

Sites # 16001, 16002, and 16005 (Appendix Figs. 15, 16, 19) were parkinglots and were not influenced by high water levels during the 1986 nesting season. Nests at sites #16003 and 16004 (Appendix Figs. 17-18) were destroyed due to wave action on Oahe Reservoir in mid to late June. No birds remained at those sites by the second visit; washing and strata movement was evident at both. Site #12003 (Appendix Figure 14) was inundated and abandoned due to water releases below Fort Randall Dam during the week of 15 June.

Human use observed at tern and plover nesting areas consisted of hiking, picnicking, camping, and fishing. Spent fireworks, empty beer bottles, campfire pits, or other evidence of human use was found on 12 sites, particularly those below Fort Randall and Gavins Point Dam. No direct evidence of nest failure resulting from these activities was recorded, but one abandoned nest was found with spent firecrackers in it at site #11003 (RM 801.6) on 15 July. One additional human related cause of nest loss, disturbance due to domestic dogs and cats, was not documented but likely to occur.

Possible egg loss due to predation was noted at 5 sites. We are not certain whether eggs were predated before or after nest abandonment. However, several potential predators of tern and plover eggs and chicks were seen on or near nesting areas. These included: coyote (Canis latrans), raccoon (Procyon lotor), opossum (Didelphis marsupialis), Prairie rattlesnake (Crotalus viridis), northern harrier (Circus cyaneus), red-tailed hawk (Buteo jamaicensis), and great blue heron (Ardea herodias).

TABLE 5

Least Tern and Piping Plover Production 1986 - GAVINS POINT

Site ID	RM	Adults	Pairs	Active Nests	Inactive Nests	Eggs	Chicks	Fledged
Least Terns:								
11001	804.0	11	5	13	3	31	3	2
11002	803.2	8	4	5	3	24	0	0
11003	801.6	11	5	9	2	25	0	0
11004	801.0	7	4	1	0	3	2	2
11013	801.0	7	3	0	1	4	1	1
11005	800.9	18	9	5	2	13	2	2
11006	798.0	2	1	0	0	0	0	0
	796.4	11	5	0	0	0	0	0
	789.5	3	1	1	0	1	0	0
	783.4	12	6	6	0	8	0	0
11010	782.6	10	5	11	5	30	2	0
11011	781.3	13	11	16	5	36	2	2
11012	778.5	11	8	21	7	50	19	3
	776.8	6	3	0	0	0	0	0
11014	773.8	0	0	0	0	0	1	0
	770.5	20	10	11	0	23	0	0
11009	770.0	22	11	26	1	60	4	1
11008	766.0	22	11	14	7	32	8	1
	764.8	10	5	5	0	9	0	0
	762.5	18	9	9	0	16	0	0
	758.5	10	5	6	0	14	0	0
	757.0	5	6	6	0	9	0	0
11007	755.3	20	10	8	3	26	2	0
Totals:		257	137	173	39	414	47	14

TABLE 5 (continued)

Least Tern and Piping Plover Production 1986 - GAVINS POINT

Site ID	RM	Adults	Pairs	Active Nests	Inactive Nests	Eggs	Chicks	Fledged
Piping Plovers:								
11001	804.0	9	7	17	12	69	6	0
11002	803.2	4	2	2	0	13	0	0
11003	801.6	14	7	2	2	7	0	0
11004	801.0	5	2	2	2	11	2	1
11013	801.0	4	2	1	0	4	0	0
11005	800.9	13	6	3	0	8	4	2
11006	798.0	3	1	1	1	3	0	0
	796.4	13	6	3	0	6	0	0
	789.5	5	2	1	0	1	0	0
	783.4	8	4	3	0	5	0	0
11010	782.6	10	5	7	3	27	0	0
11011	781.3	8	4	5	4	24	3	0
11012	778.5	14	7	11	1	32	0	0
	776.8	8	4	1	0	3	0	0
11014	773.8	0	0	0	0	0	0	0
	770.5	10	5	5	0	13	0	0
11009	770.0	12	7	7	1	29	3	1
	767.0	2	1	1	0	4	0	0
11008	766.0	14	7	7	1	26	0	0
	764.8	3	2	2	0	5	0	0
	762.5	2	0	0	1	2	0	0
	758.5	6	3	1	0	1	0	0
	757.0	4	2	2	0	4	0	0
11007	755.3	30	15	4	1	13	1	0
Totals:		201	101	88	29	310	19	4

TABLE 6

Least Tern and Piping Plover Production 1986 - FORT RANDALL

Site				Active	Inactive			
ID	RM	Adults	Pairs	Nests	Nests	Eggs	Chicks	Fledged
Least Terns:								
12001	839.0	14	10	12	13	45	6	6
12003	873.0	11	5	4	1	8	0	0
12008	832.8	11	7	7	0	15	5	0
Totals:		36	22	23	14	68	11	6
Piping Plovers:								
12001	839.0	14	7	4	5	12	6	1
12003	873.0	3	1	1	1	4	0	0
12008	832.8	0	0	0	0	0	0	0
Totals:		17	8	5	6	16	6	1

TABLE 7

Least Tern and Piping Plover Production 1986 - OAHE RESERVOIR

Site				Active	Inactive			
ID	RM	Adults	Pairs	Nests	Nests	Eggs	Chicks	Fledged

Least Terns:

16003	1105.7	2	1	1	0	1	0	0
16004	1104.2	2	1	1	0	1	0	0
16006	1108.0	6	3	1	2	3	2	0
16007	1108.5	15	9	11	1	19	6	6
16009	1127.0	2	1	1	0	3	0	0

Totals:		27	15	15	3	26	8	6
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Piping Plovers:

16001	1155.0	2	1	1	0	3	0	0
16002	1155.0	2	1	1	0	2	0	0
16005	1072.8	2	1	1	0	3	3	3
16007	1108.5	2	1	2	0	4	0	0

Totals:		8	4	5	0	12	3	3
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TABLE 8

Least Tern and Piping Plover Production 1986 - CHEYENNE RIVER

Site				Active	Inactive			
ID	RM	Adults	Pairs	Nests	Nests	Eggs	Chicks	Fledged
Least Terns:								
16003	1105.7	2	1	1	0	1	0	0
35001	43.5	4	1	1	0	4	4	4
35002	59.5	7	3	3	0	8	4	2
35003	51.8	7	3	6	0	15	3	2
35004	47.0	4	2	1	0	1	1	0
35005	57.5	8	4	1	0	3	3	3
35006	53.6	10	5	2	0	4	2	1
other*		11	6	-	-	-	6**	6
Totals:		51	25	14	0	34	22	18

Piping Plovers:

Totals:	0	0	0	0	0	0	0	0
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* birds located at sites other than colony sites.

** the number of chicks assumed to have produced 6 fledglings.

Young birds can be very sensitive to environmental conditions. Excessive heat, cold, or rain may cause weakening and death of tern and plover chicks. One dead piping plover (approximately 7 days old) was found at site #11001 (RM 804.0) on 13 July. A dead least tern chick (approximately 18 days old) was found in a nest at site #11010 (RM 782.6) on 22 July. One chick which was banded at approximately 2 days of age was recaptured ten days later. The chick was only slightly larger than when first captured, it was somewhat sluggish in movement, and it appeared to have bruises or healed lacerations on its head. The causes of death or injury were not determined.

Site #35003 on the Cheyenne River (RM 58.1) was the only one with evidence of livestock disturbance. Cattle tracks and droppings were present over the entire area upon our second site visit. All three pairs of terns were in the process of renesting. Two terns eventually fledged from this site.

DISCUSSION

Distribution and Productivity

The distribution and productivity of interior least terns and piping plovers on the mainstem Missouri River in SD is largely determined by the relation of habitats to water levels. Fluctuations in water levels, which reflective of mainstem dam discharges, inflow, hydropower, and downstream water needs, affect the amount of beach and sandbar habitat available for nesting (Dryer and Dryer 1985). Untimely discharge of water from Fort Randall and Gavins Point Dams may cause inundation of colony sites. Vegetative encroachment of sandbars caused by reduced sandbar scouring due to long-term alterations of instream flows (U.S. Geological Survey 1983) further limits habitat availability. Although human disturbance of nesting areas is undoubtedly a factor affecting tern and plover distribution and productivity it does not rival the impact of water level fluctuations in SD. Predation is also a limiting factor but the degree of affect remains uncertain.

Near record level inflows to the Missouri River through most of the 1986 production season resulted in limited availability of suitable habitat for nesting. In normal or low flow years more sandbar and beach habitat would be exposed on Oahe Reservoir, below Fort Randall, and below Gavins Point than in 1986. Reports of nesting terns and plovers indicate that suitable nesting habitat is available between Oahe Dam and Fort Randall Dam in normal or low flow years. Although least terns and piping plovers may return to particular colony sites for several consecutive years (Carreker 1985, Dinsmore 1981), normal and low flow years would allow broader dispersal potential for expanding populations of terns and plovers in the state.

On the SD mainstem Missouri River, water management regimes are critical to tern and plover nesting success. The period from nest initiation to fledging of tern chicks is approximately 45 days, while the period for plovers is approximately 65 days (Ducey 1981, Dinsmore 1981, Nebraska Game and Parks Commission 1985). Ideally, with nest initiation for terns and plovers in SD commencing in late May to early June, most hatching would occur in mid to late June and the nesting cycle would be complete for both species by the end of July. By late July in 1986, however, most sites still had active nests (e.g. nests being incubated) and few chicks were present at the sites.

If suitable habitat is not available because of high water levels during the nest initiation period, least terns and piping plovers are likely to select marginal nesting habitat (Massey and Atwood 1978, J. Dinan, pers. comm.). The high number of abandoned nests, numerous renesting attempts, and low fledging success in 1986 is reflective of high water affects on nesting area suitability and, hence, low productivity. Many sandbars below Fort Randall and Gavins Point suitable for tern and plover nesting were low profile (less than 18 inches above surface water) and, therefore, subject to wind action or small water level changes. Nesting area size on Oahe Reservoir beaches were small and subject to high wave action. Large, high, exposed sandbars used in previous years for nesting are now vegetated. The natural process with which to replace these bars no longer exists.

Fledging success for terns ($N = 44$) and plovers ($N = 8$) in SD in 1986 was very low. Assuming that a 50% survival rate of each clutch would produce enough young for a self-sustaining population, data for SD tern and plover fledging success in 1986 (Table 4) indicates that these populations are experiencing a radical decline. The Cheyenne River had the highest tern fledging success with a ratio of 0.72 fledged per adult pair. Oahe Reservoir had the highest plover fledging success with a ratio of 0.75 fledged per adult pair. Fledging success below Fort Randall and Gavins Point Dams was considerably lower.

On the Cheyenne River, a free-flowing tributary to the Missouri, nesting area size, nest to water distance, and nest height above water generally increase with decreasing water levels over time. The detriments of small nesting area size and low site profile diminishes through the nesting period. Increased nesting area size reduces the potential for predation, and increased nest height above water elevation reduces the potential for nest disturbance by wave action or high water. Of all least terns fledged in SD in 1986, 18 (41%) were from Cheyenne River habitats.

Recreational use of the Missouri River is high during May through August. This overlaps the usual tern and plover breeding season. Many of the sandbars and beaches suitable for plover and tern nesting are also the most desirable for boaters, picnickers, and other

recreational activities, most of which conflict in time, space, or both. This problem is particularly severe below Fort Randall and Gavins Point, where there are too few sandbars suitable for birds and people (recreationists). Recreational use of the Cheyenne River is low and human disturbance at colonies there is minimal, although there was evidence of disturbance by livestock.

Least terns feed opportunistically on forage fish. The distance they must fly from nesting sites to foraging areas may be an important component of habitat suitability (Carreker 1985), and a limiting factor in tern distribution on tributaries of the Missouri River. Food availability may also limit plover distribution, restricting their breeding range in SD to areas along the Missouri River. Present fisheries management goals also include provisions for forage fish production (A. Talsma, GFP, Pierre, pers. comm.) and should complement least tern management. Piping plovers feed mostly on insects (Whyte 1985).

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

The following recommendations for protection, management, and continued study of interior least terns and piping plovers in SD are based on the 1986 tern and plover survey, previous surveys, published and unpublished literature, and professional judgement. The authors must caution however that our study results are specific for 1986, a high water year.

The key to protecting least terns and piping plovers is to determine the location of nesting areas and to protect this existing habitat accordingly. Since water level variations affect habitat availability, habitat quality and species distribution, annual surveys are necessary to identify new nesting areas, confirm use of old nesting areas, monitor productivity and protect nesting sites. Until the population of terns and plovers recovers to the extent suggesting delisting, habitat and nesting areas will need monitoring and protection efforts.

Plans for enhancement of tern and plover habitat should be made. During normal and low flow years maximization of nesting area size, nest to water distances, and nest elevations above water levels may be relatively easy to manage using well planned water releases. Enhanced areas will then serve as "bonus" areas to help build population levels. In high water years, enhanced areas will serve as nesting refuges allowing at least enough production to insure species perpetuation. Previously utilized but presently vegetated areas could be reestablished as suitable habitat and maintained to provide nesting habitat available in all years regardless of system water conditions.

Water discharge plans at all SD mainstem dams should include provisions for tern and plover production. Discharges must be lowered and remain constant during the late May to late July nesting season. Daily and weekly fluctuations during the critical nesting period should be avoided. The release schedule recommended by the Nebraska Game and Parks Commission (1985) should be recognized as the COE goal for Gavins Point and Fort Randall dams. Similar release schedules need to be recommended for Big Bend and Oahe dams based on additional studies performed during normal or low water years. Once nesting colonies are discovered and studied, results can be used for such recommendations.

Preliminary investigations into fisheries management guidelines for Lake Oahe suggest complimentary goals. Nesting habitat for terns and plovers would be established by periodically inundating then exposing reservoir shoreline and islands. Nesting sites along Lake Oahe discovered during 1986 could be enhanced to provide nesting refuges during high water periods. By utilizing fisheries management guidelines, abundant nesting habitat will likely be available during normal and low water years.

A system of active nest site protection should be developed and implemented. Signs describing each species, the reason for protection, and individual personal responsibilities should be printed and posted at each boat ramp located within 5 miles of a nesting colony. Additional warning signs should be placed at each colony known or suspected of human disturbance. Patrols by enforcement authorized personnel should be performed periodically at each known colony. Additional enforcement attention may also be required during holidays and weekends at sites known to attract recreationists. In addition, an information and education program should be developed to include pamphlets, news releases and presentations geared toward greater public awareness of tern and plover protection efforts.

We cannot overemphasize the need for continued interior least tern and piping plover surveys in order to better determine management suggestions for normal or low water years. Additional studies should be designed to gain a better understanding of tern and plover populations and to facilitate refinement of management plans for protection of these endangered and threatened species in SD. Further studies may include but not be restricted to:

- 1) identification of ideal habitat in normal flow years
- 2) assessment of habitat availability as a limiting factor in distribution and production
- 3) assessment of habitat suitability as a limiting factor in production
- 4) determine the change over time in the quality and quantity of sand bar habitat

- 5) determination of benefits of manipulated alternative nesting areas to species abundance
- 6) assessment of food availability as a limiting factor in distribution and production
- 7) determination of impacts of human use on productivity
- 8) determine the long term effects of Missouri River aggradation and degradation on tern and plover nesting habitat, and
- 9) design a model for determining accurate water elevations at a given point on the river given a specific discharge.

In summary, both terns and plovers have adapted to the Missouri's system of spring flooding, sandbar scouring, and exposure of sandbars during summer low water. Any management of the mainstem system which emphasizes the "natural river" scenario will most certainly benefit both endangered species and other natural resources. A COE water release schedule beneficial to tern and plover productivity and compatible with other resource needs must be established and implemented.

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APPENDIX

Figure 1. Mean nest elevation relative to discharge at Gavins Point Colony #11001, RM 804.0; Tern and Plover - Sandbar site

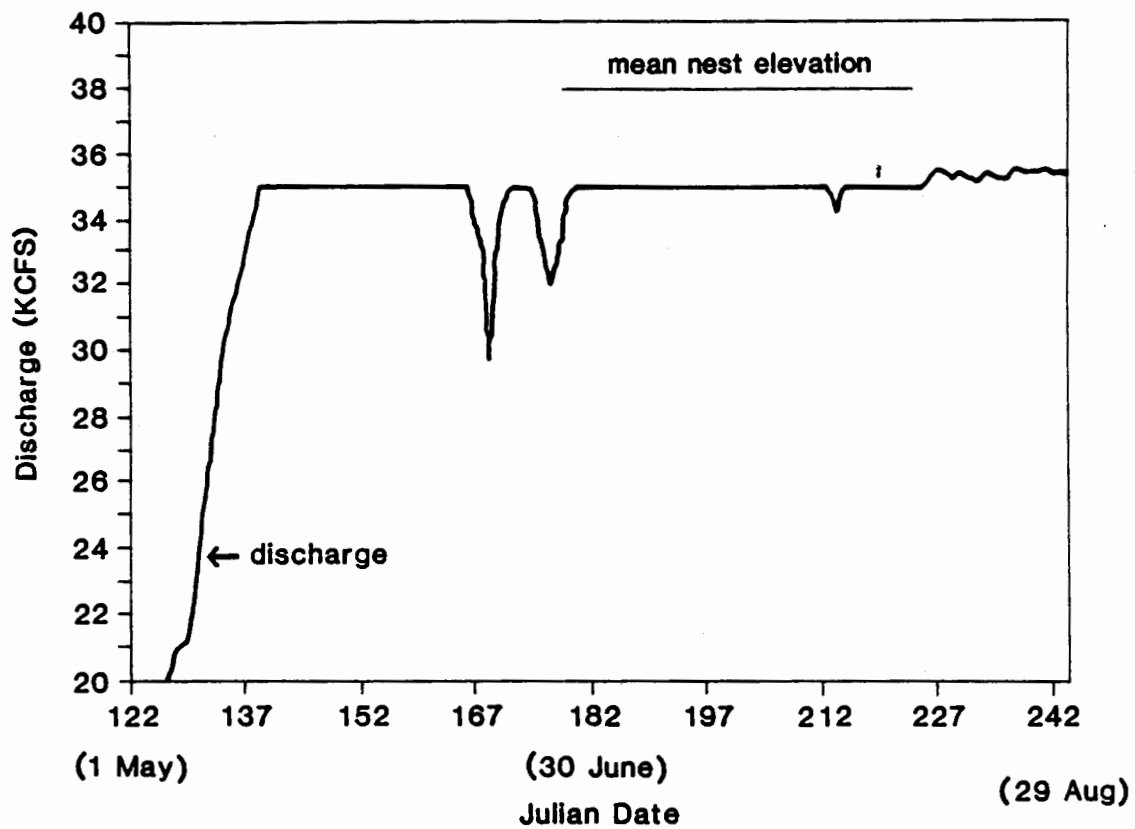


Figure 2. Mean nest elevation relative to discharge at Gavins Point Colony #11002, RM 803.2; Tern and Plover - Sandbar Site

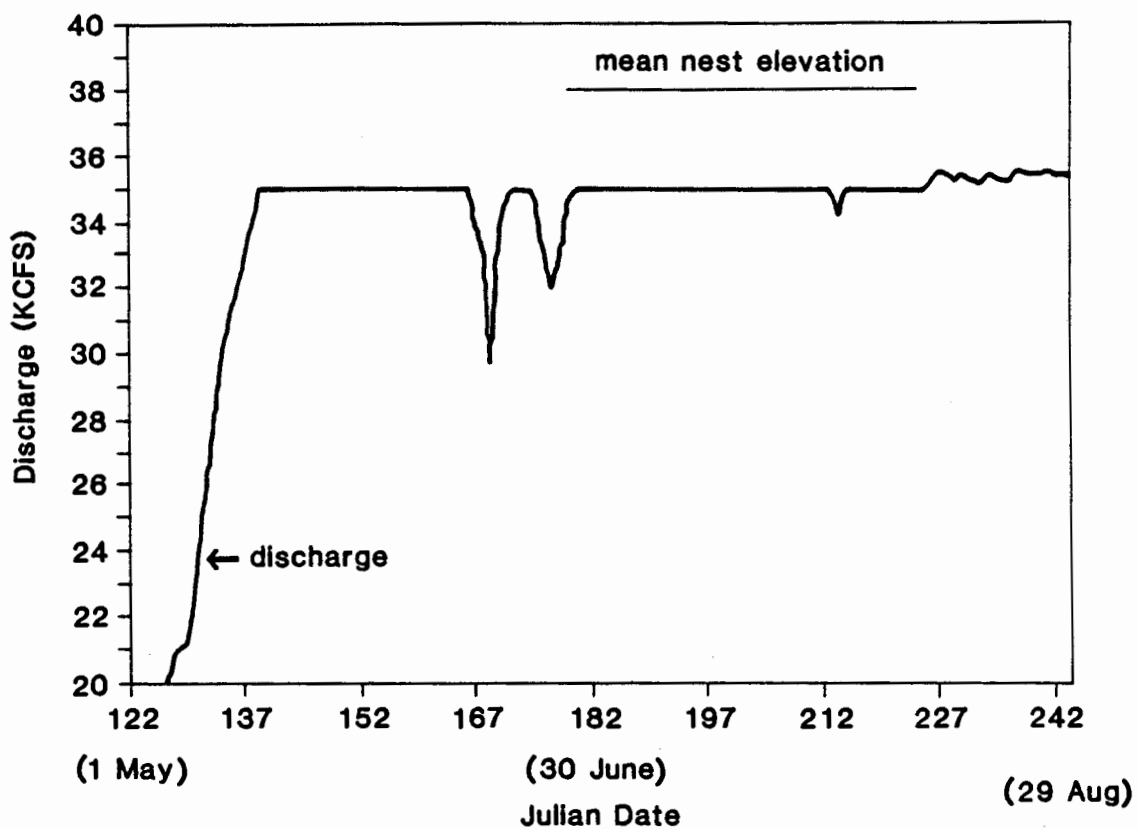


Figure 3. Mean nest elevation relative to discharge at Gavins Point Colony #11003, RM 801.6; Tern and Plover - Sandbar Site

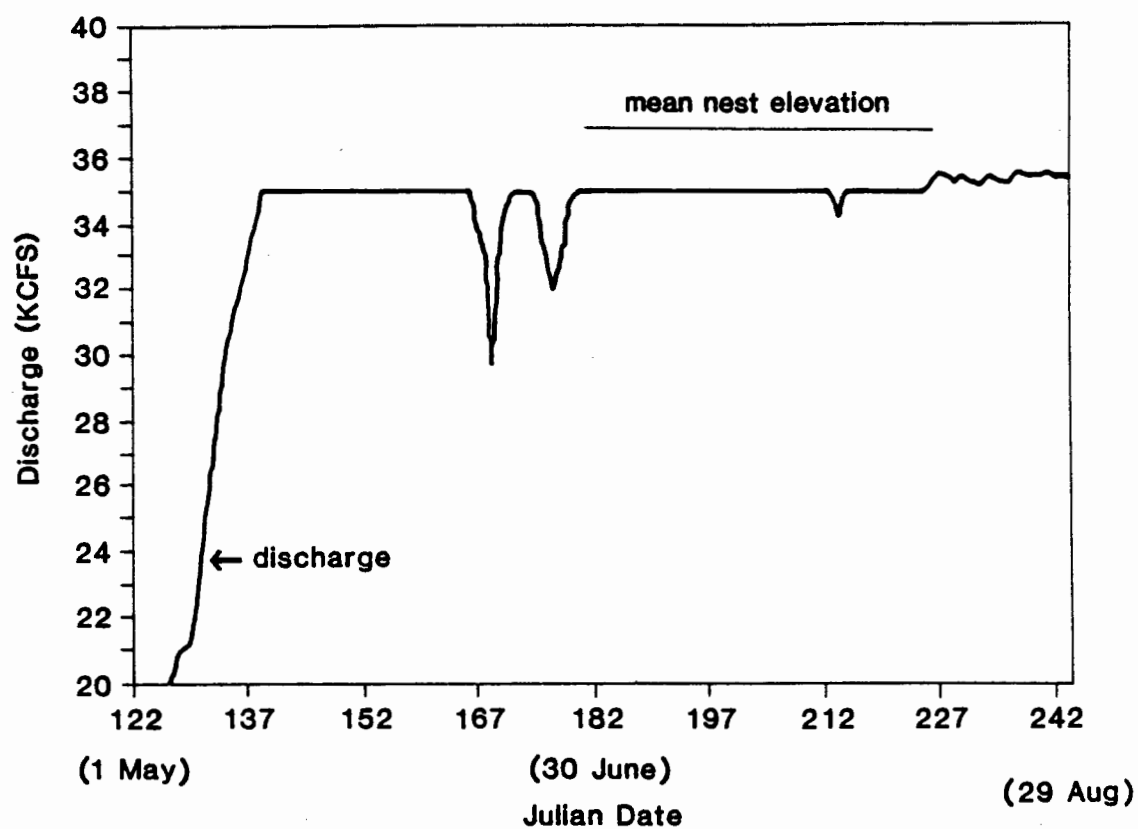


Figure 4. Mean nest elevation relative to discharge at Gavins Point Colony #11004, RM 801.0; Tern and Plover - Sandbar Site

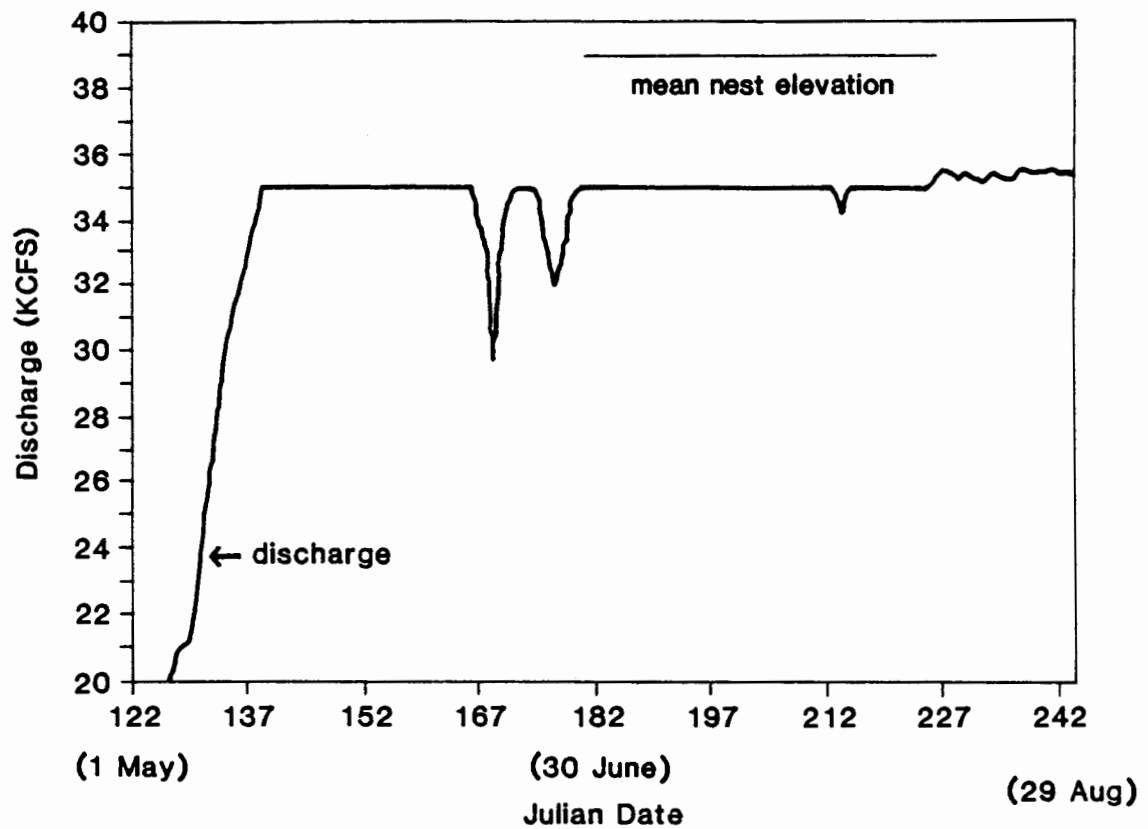


Figure 5. Mean nest elevation relative to discharge at Gavins Point Colony #11005, RM 800.9; Tern and Plover - Sandbar Site

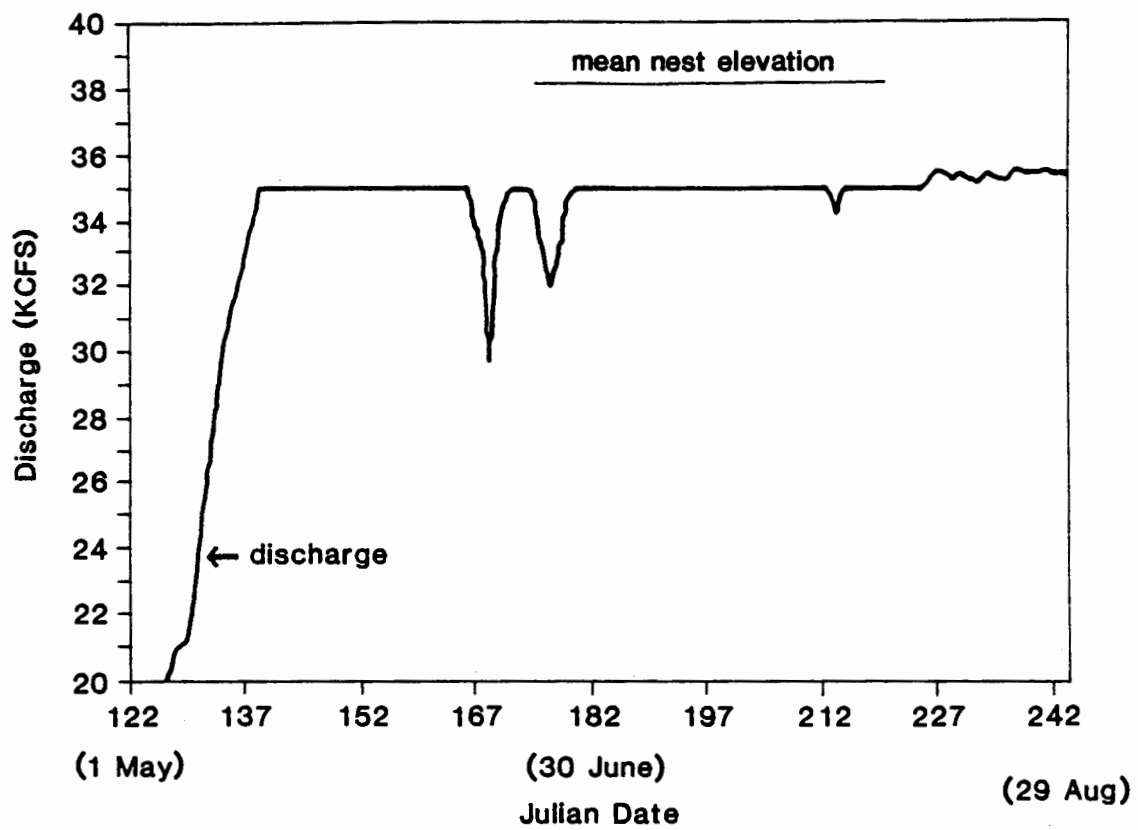


Figure 6. Mean nest elevation relative to discharge at Gavins Point Colony #11006, RM 798.0; Piping Plover - Sandbar Site

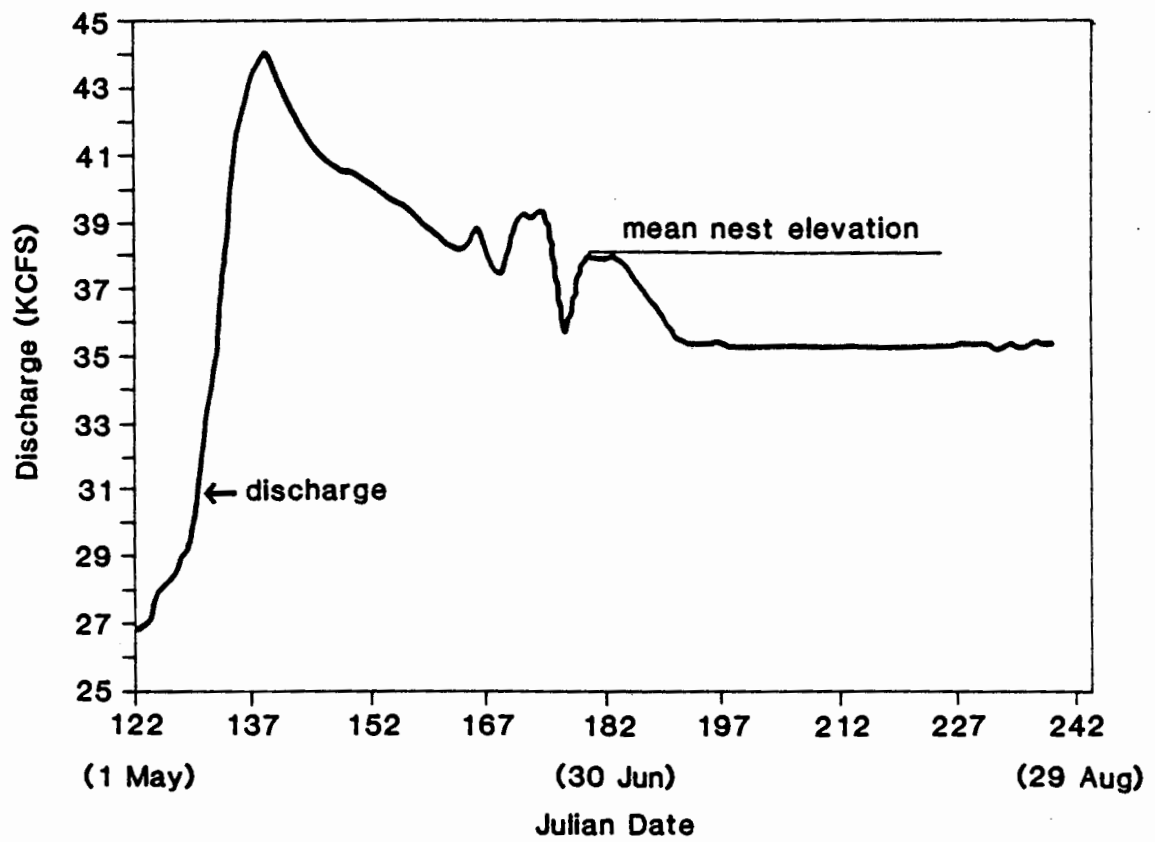


Figure 7. Mean nest elevation relative to discharge at Gavins Point Colony #11007, RM 755.3; Tern and Plover – Sandbar Site

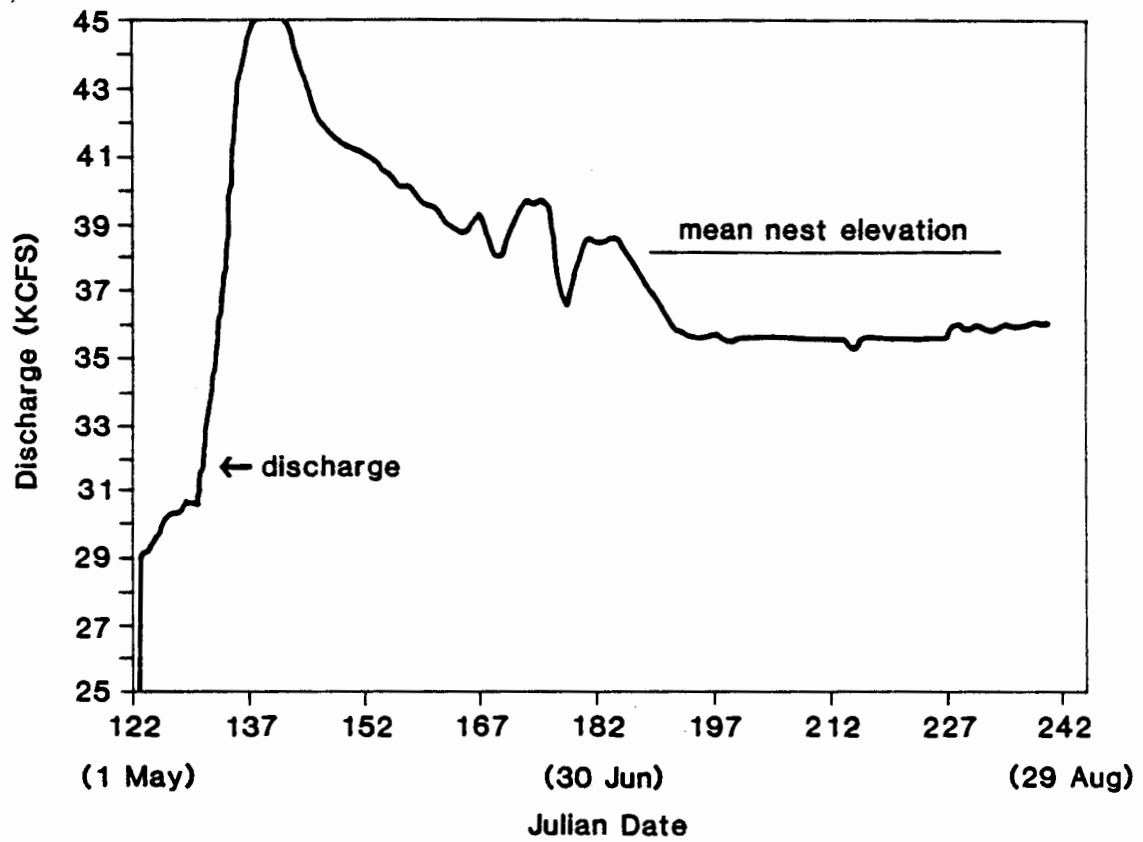


Figure 8. Mean nest elevation relative to discharge at Gavins Point Colony #11008, RM 766.0; Tern and Plover – Sandbar Site

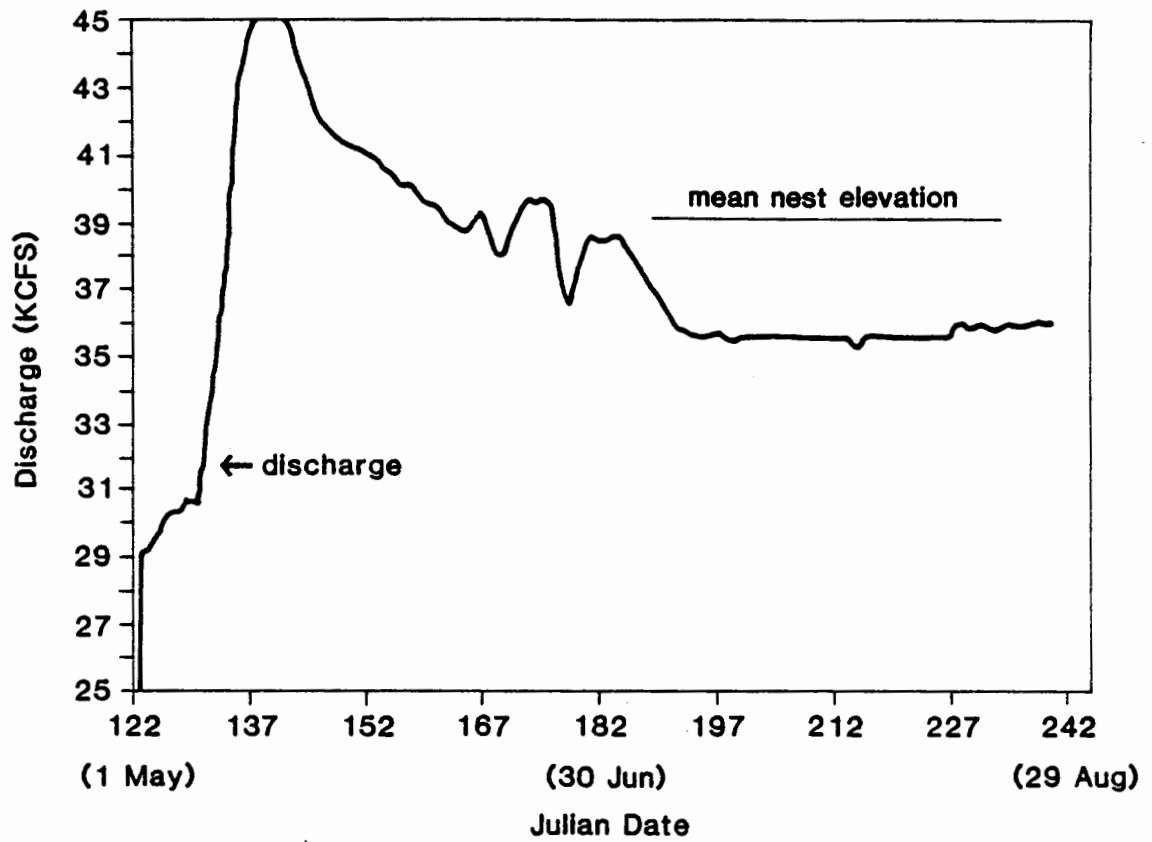


Figure 9. Mean nest elevation relative to discharge at Gavins Point Colony #11009, RM 770.0; Tern and Plover - Sandbar Site

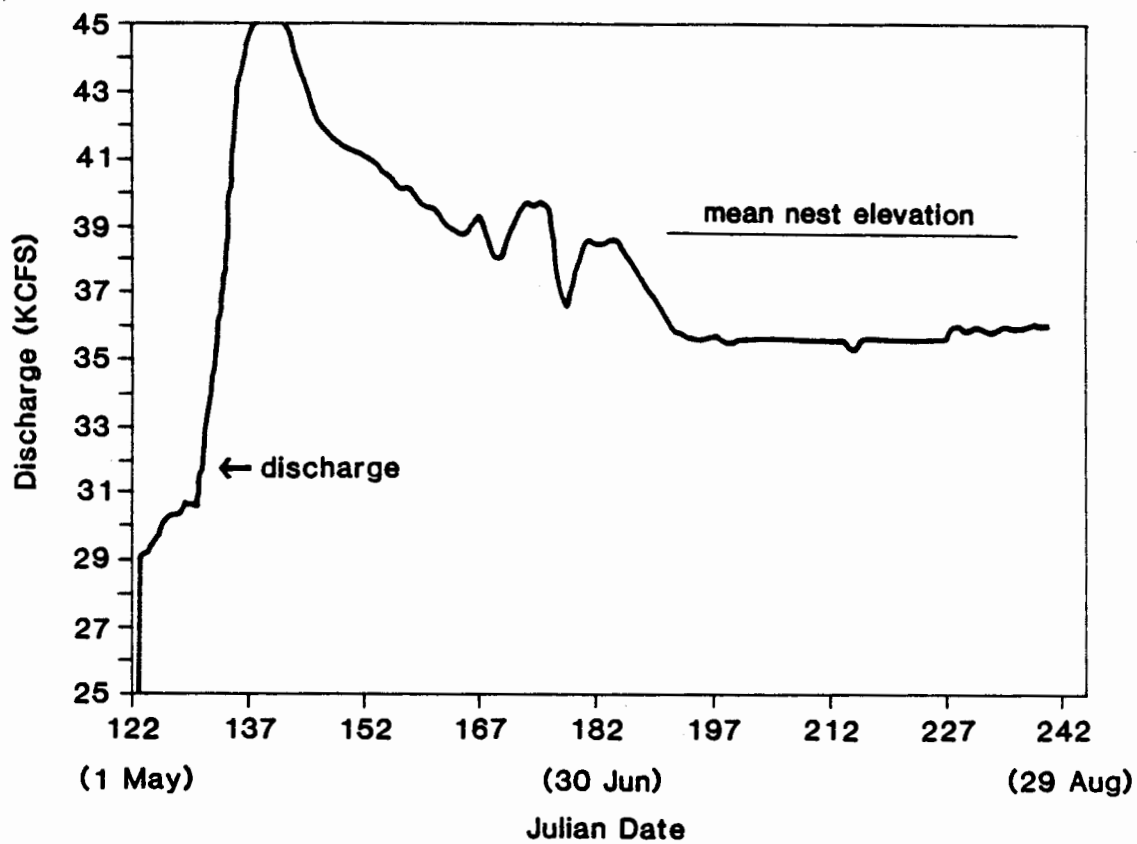


Figure 10. Mean nest elevation relative to discharge at Gavins Point Colony #11010, RM 782.6; Tern and Plover - Sandbar Site

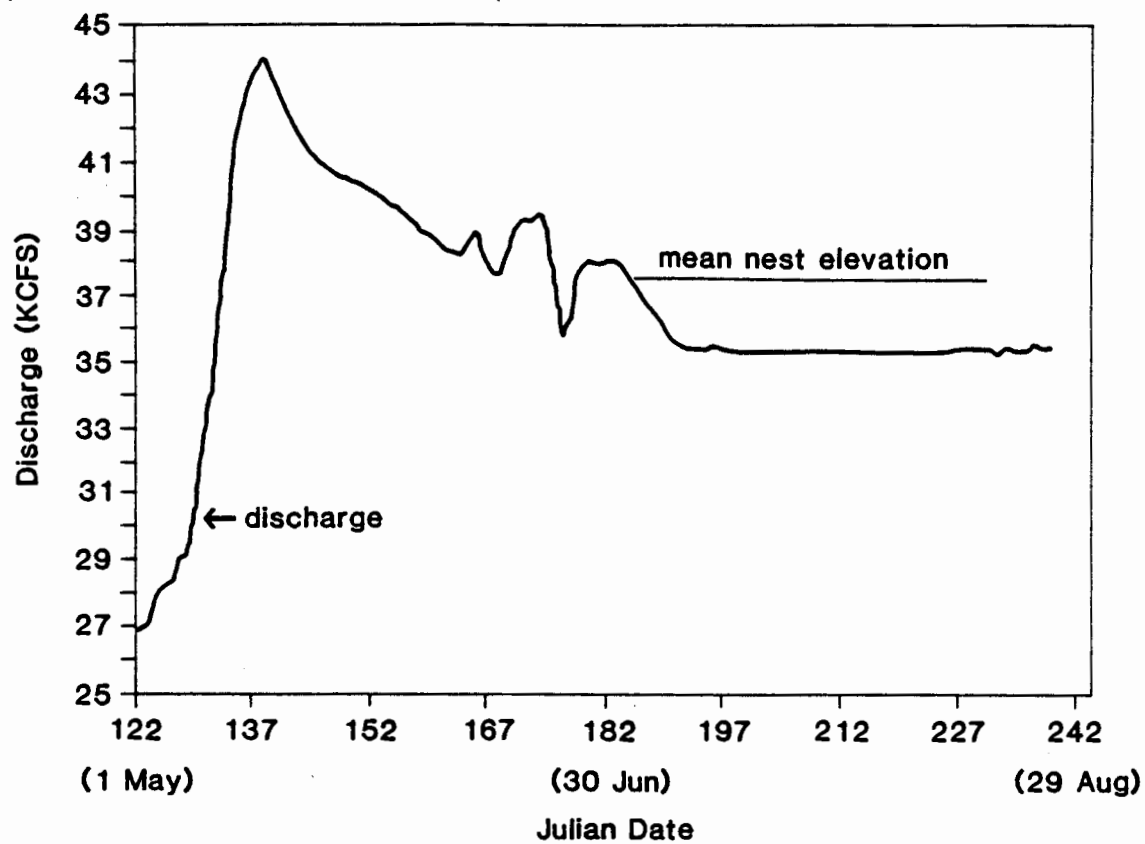


Figure 11. Mean nest elevation relative to discharge at Gavins Point Colony #11011, RM 781.3; Tern and Plover – Sandbar Site

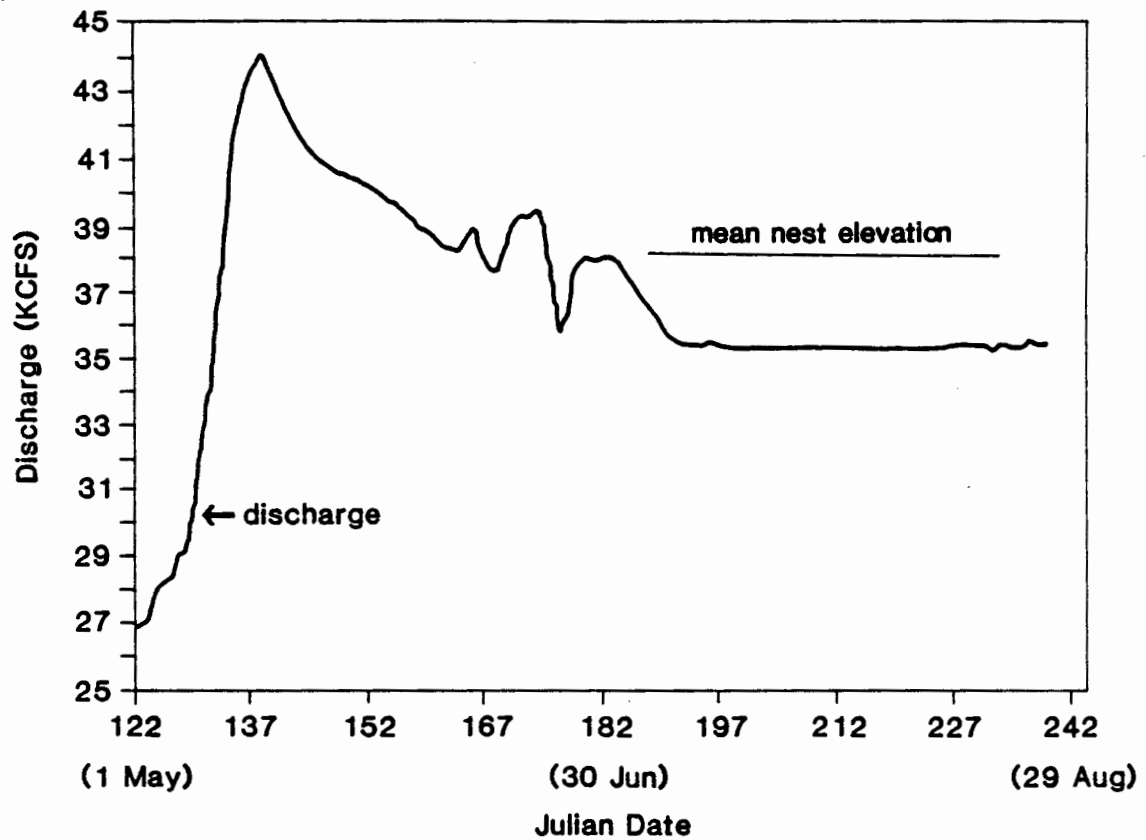


Figure 12. Mean nest elevation relative to discharge at Gavins Point Colony #11012, RM 778.5; Tern and Plover - Sandbar Site

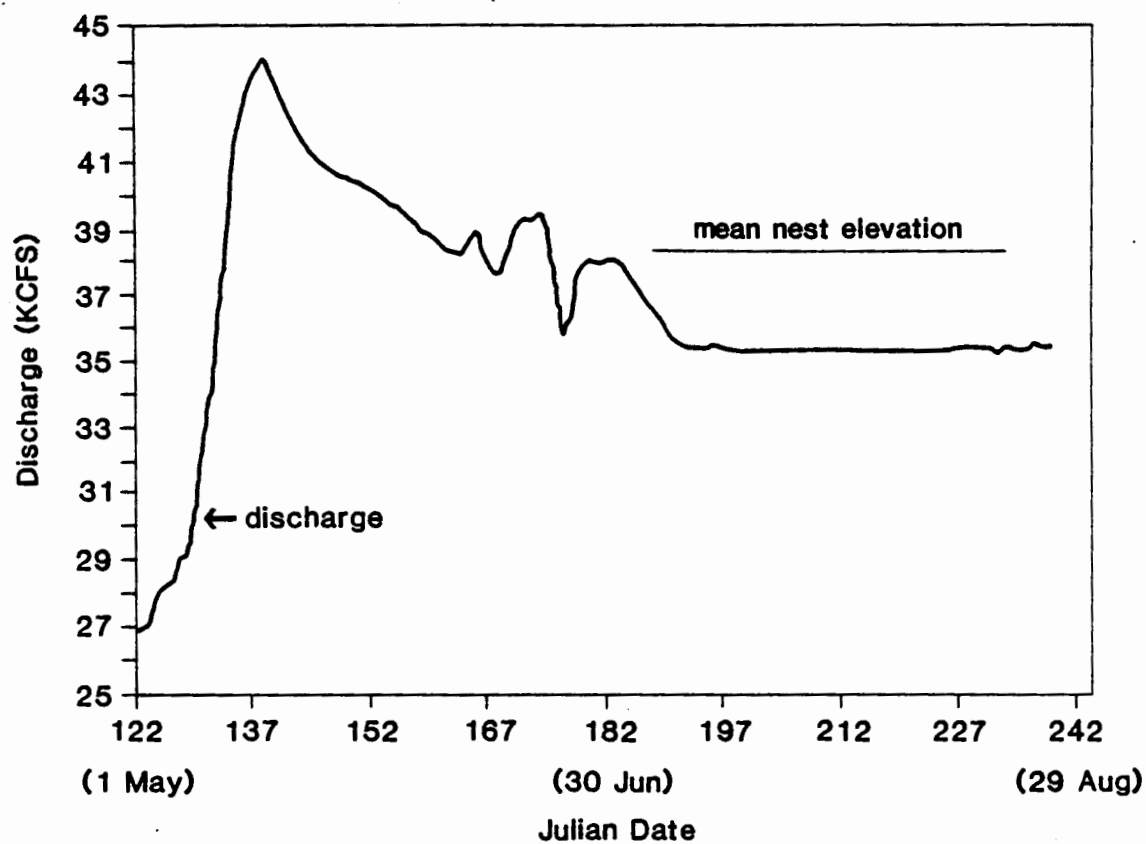


Figure 13. Mean nest elevation relative to discharge at Ft. Randall Colony #12001, RM 839.0; Tern and Plover – Sandbar Site

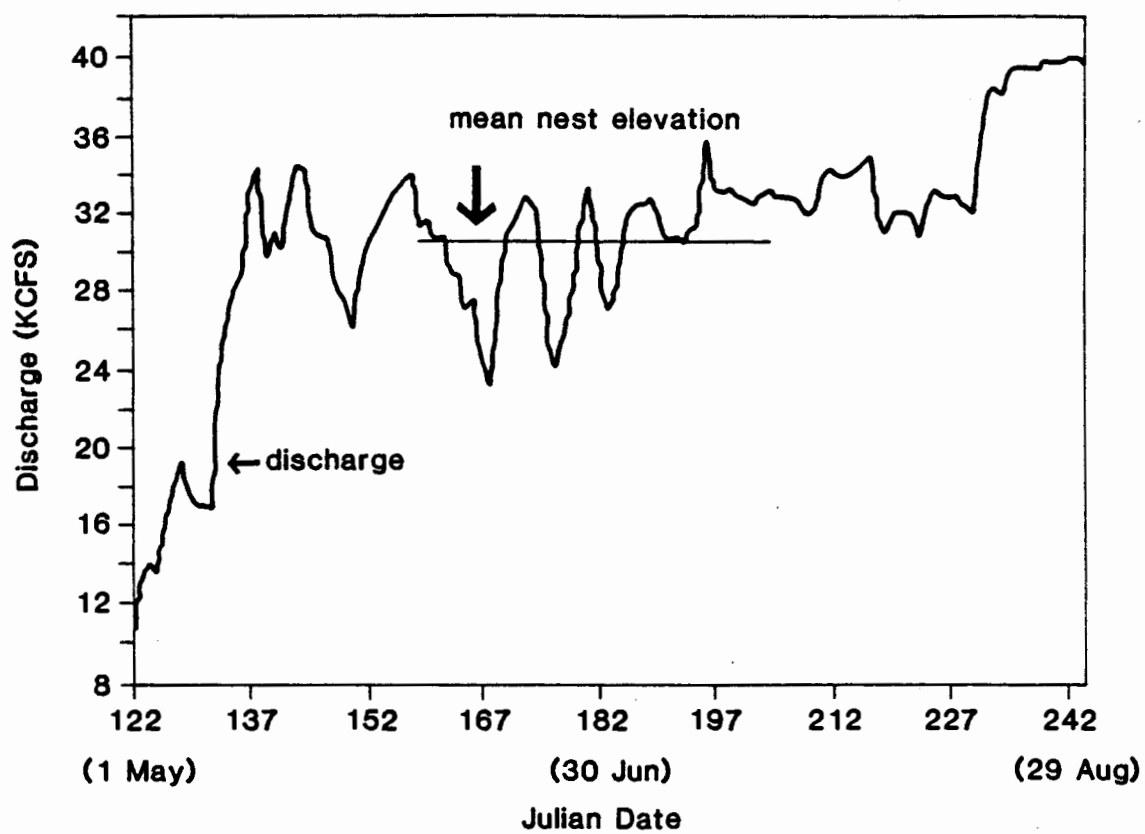


Figure 14. Mean nest elevation relative to discharge at Ft. Randall Colony #12003, RM 873.0; Tern and Plover – Sandbar Site

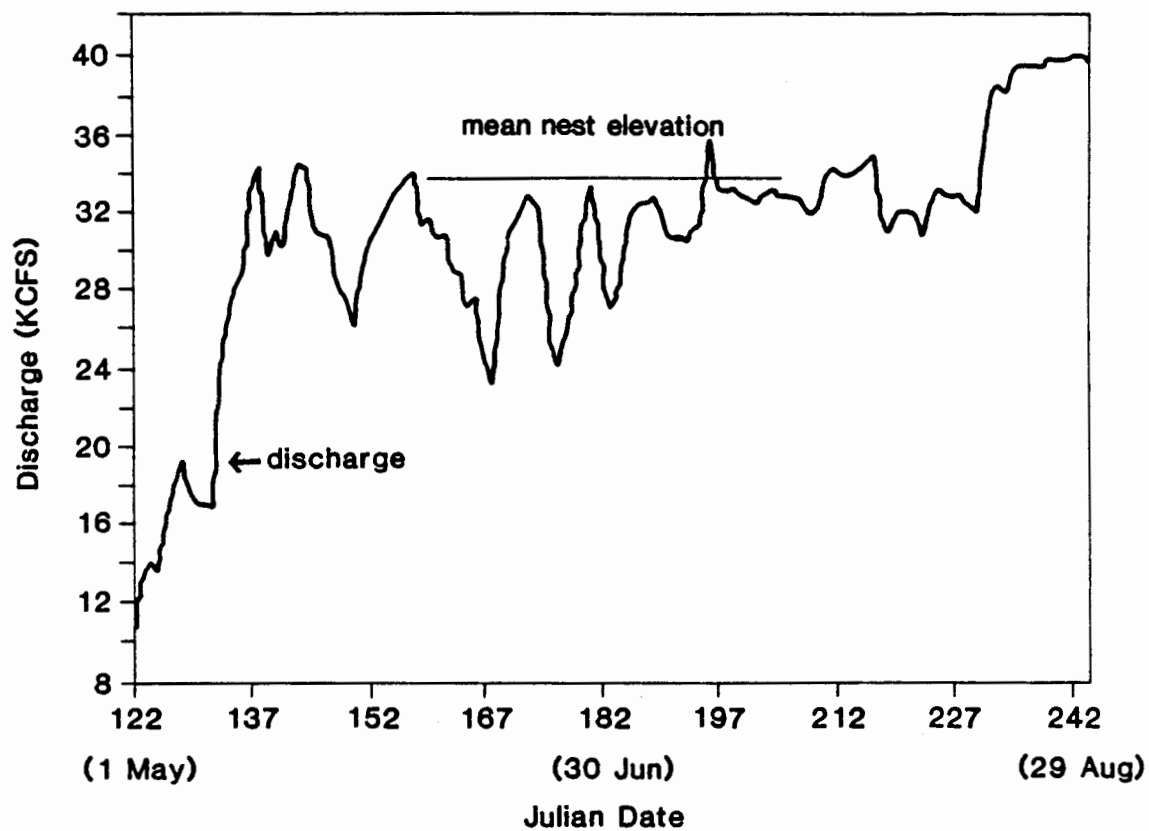


Figure 15. Mean nest elevation relative to discharge at Ft. Randall Colony #12008, RM 832.8; Least Tern - Sandbar Site

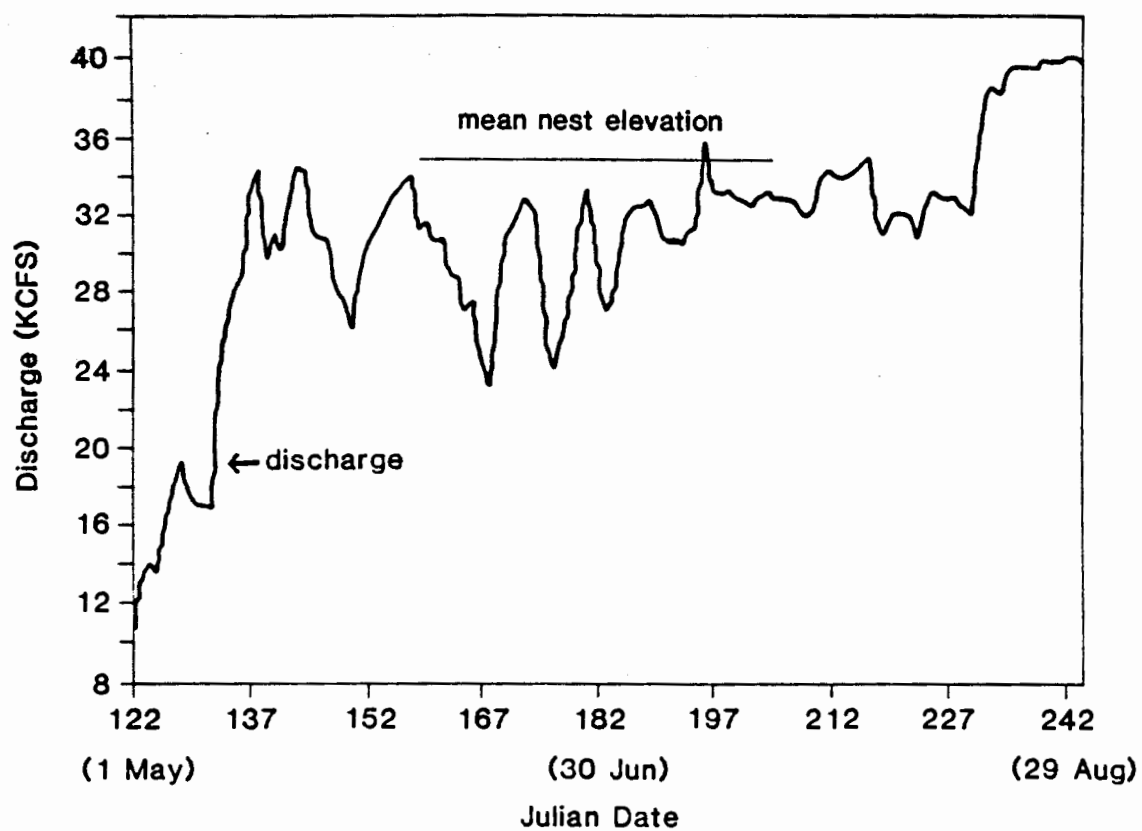


Figure 16. Mean nest elevation relative to water elevation at Oahe Reservoir
Colony #16001, RM 1155.0; Piping Plover – Parkinglot Site

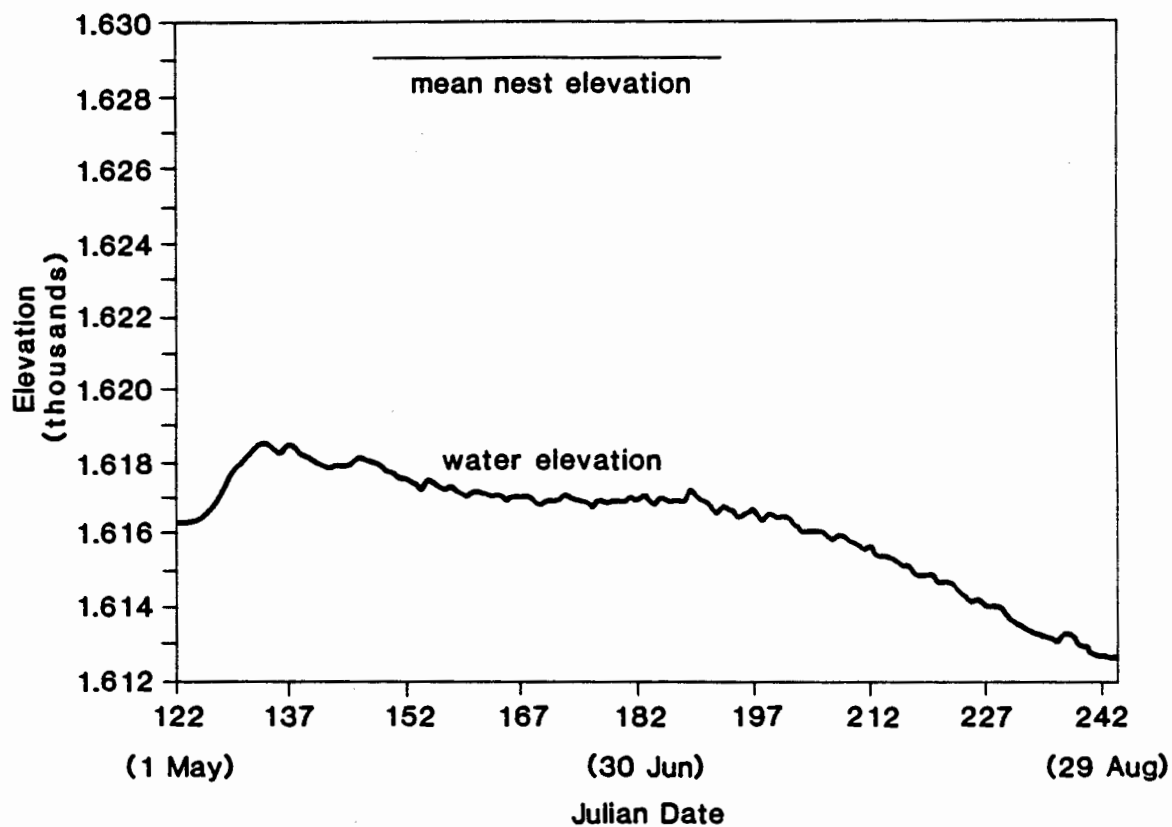


Figure 17. Mean nest elevation relative to water elevation at Oahe Reservoir
Colony #16002, RM 1155.0; Piping Plover - Parkinglot Site

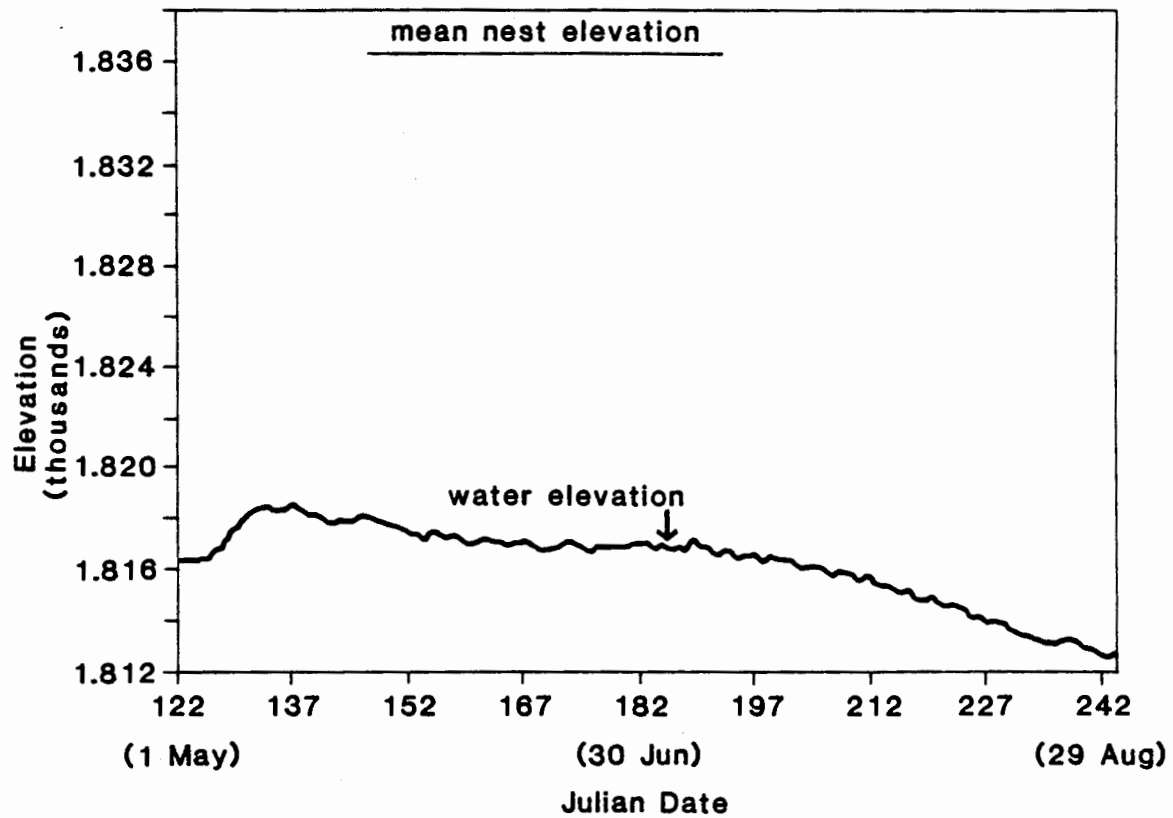


Figure 18. Mean nest elevation relative to water elevation at Oahe Reservoir Colony #16003, RM 1105.7; Least Tern - Beach Site

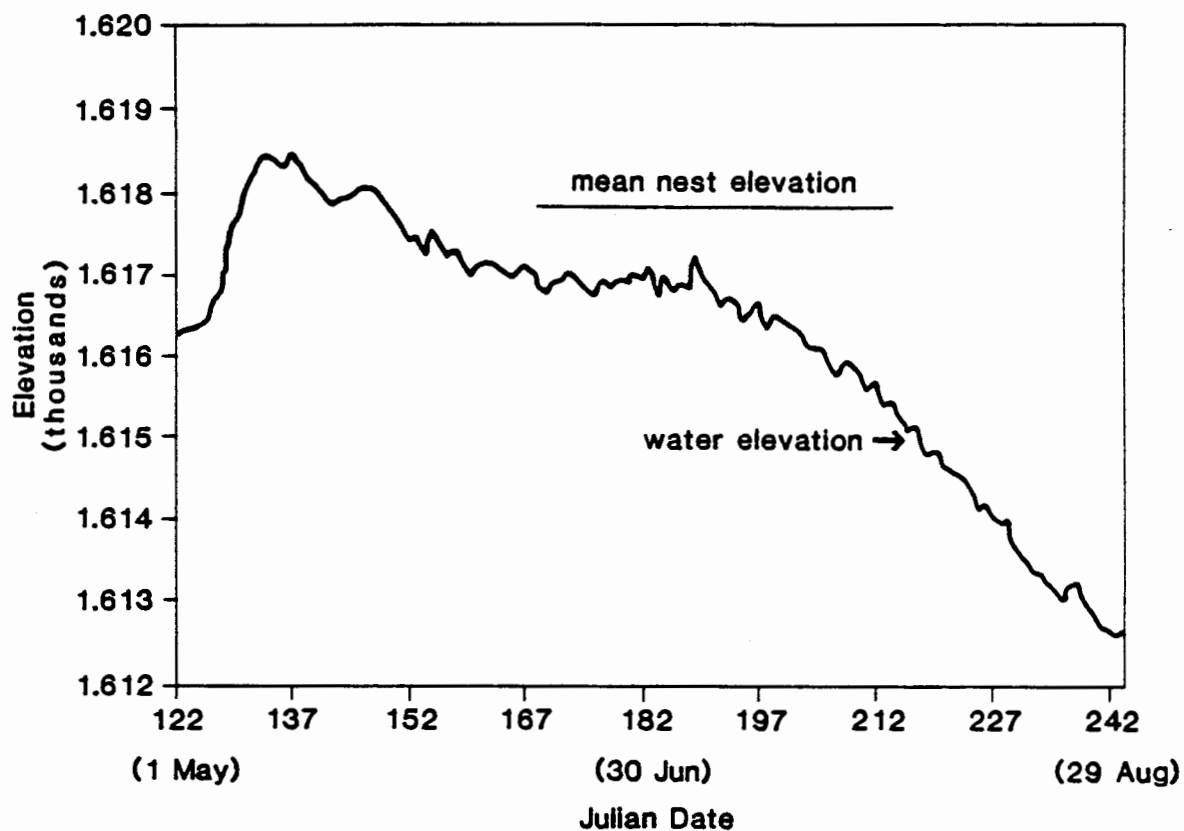


Figure 19. Mean nest elevation relative to water elevation at Oahe Reservoir Colony #16004, RM 1104.2; Least Tern - Beach Site

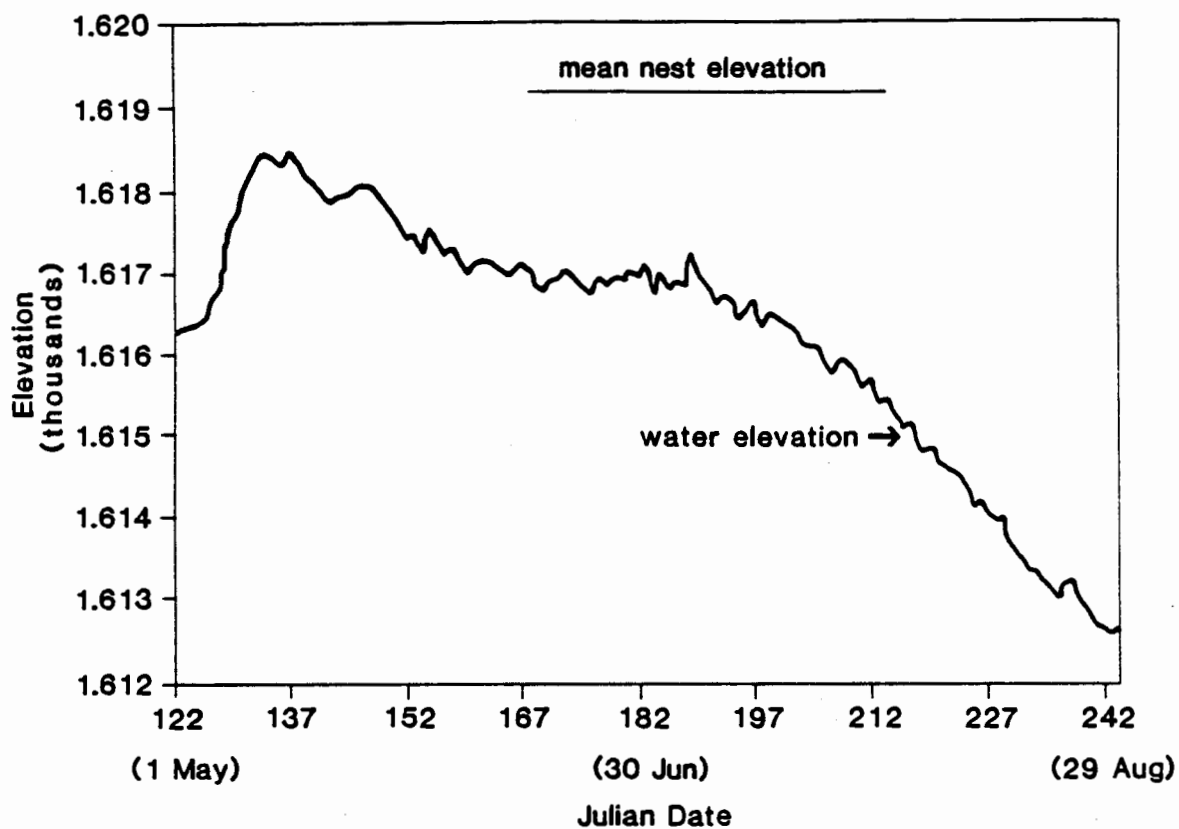


Figure 20. Mean nest elevation relative to water elevation at Oahe Reservoir
Colony #16005, RM 1072.8; Piping Plover – Parkinglot Site

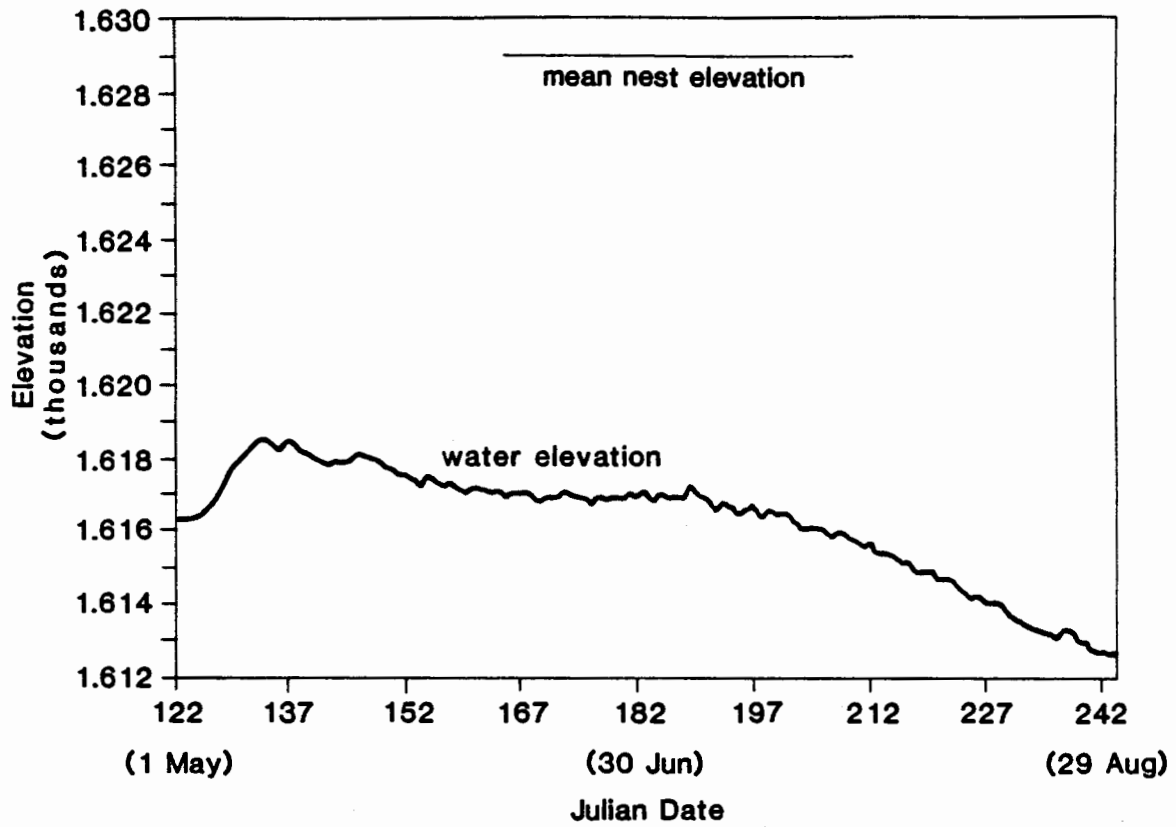


Figure 21. Mean nest elevation relative to water elevation at Oahe Reservoir
Colony #16006, RM 1108.0; Least Tern - Beach Site

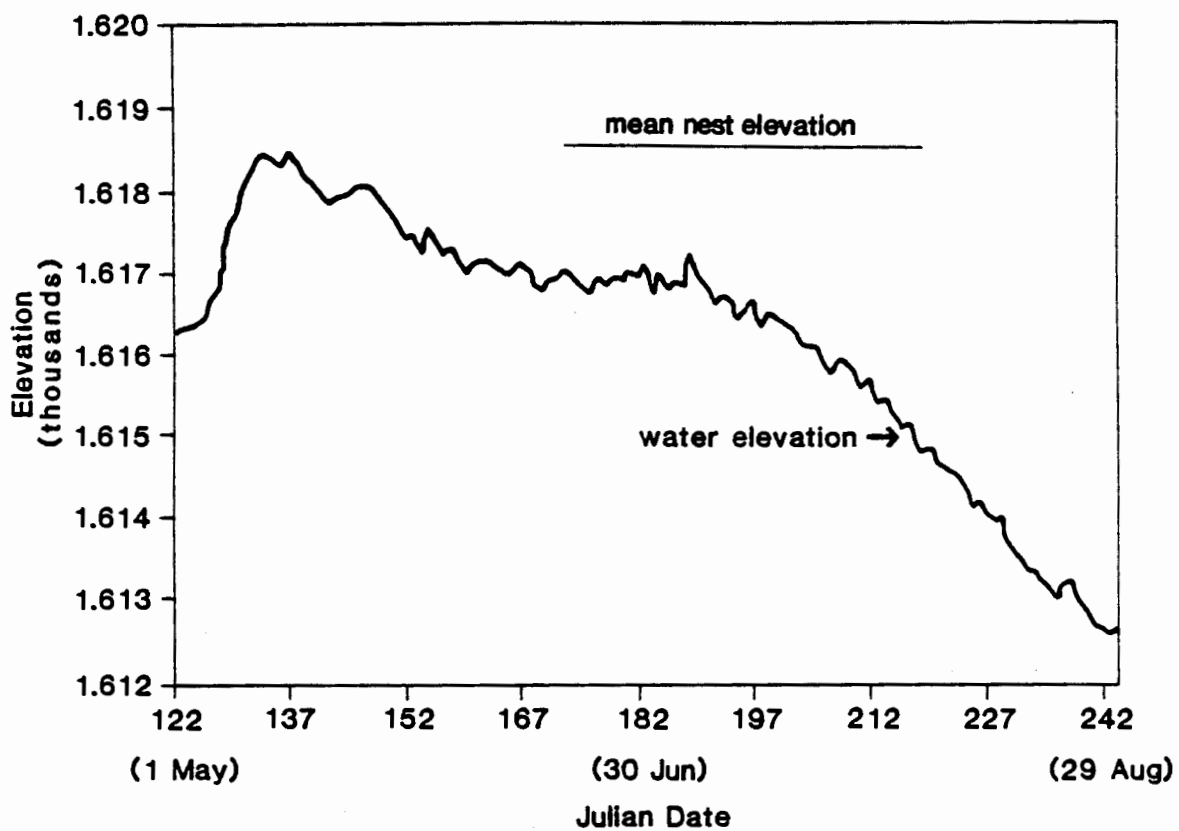


Figure 22. Mean nest elevation relative to water elevation at Oahe Reservoir
Colony #16007, RM 1108.5; Tern and Plover - Beach Site

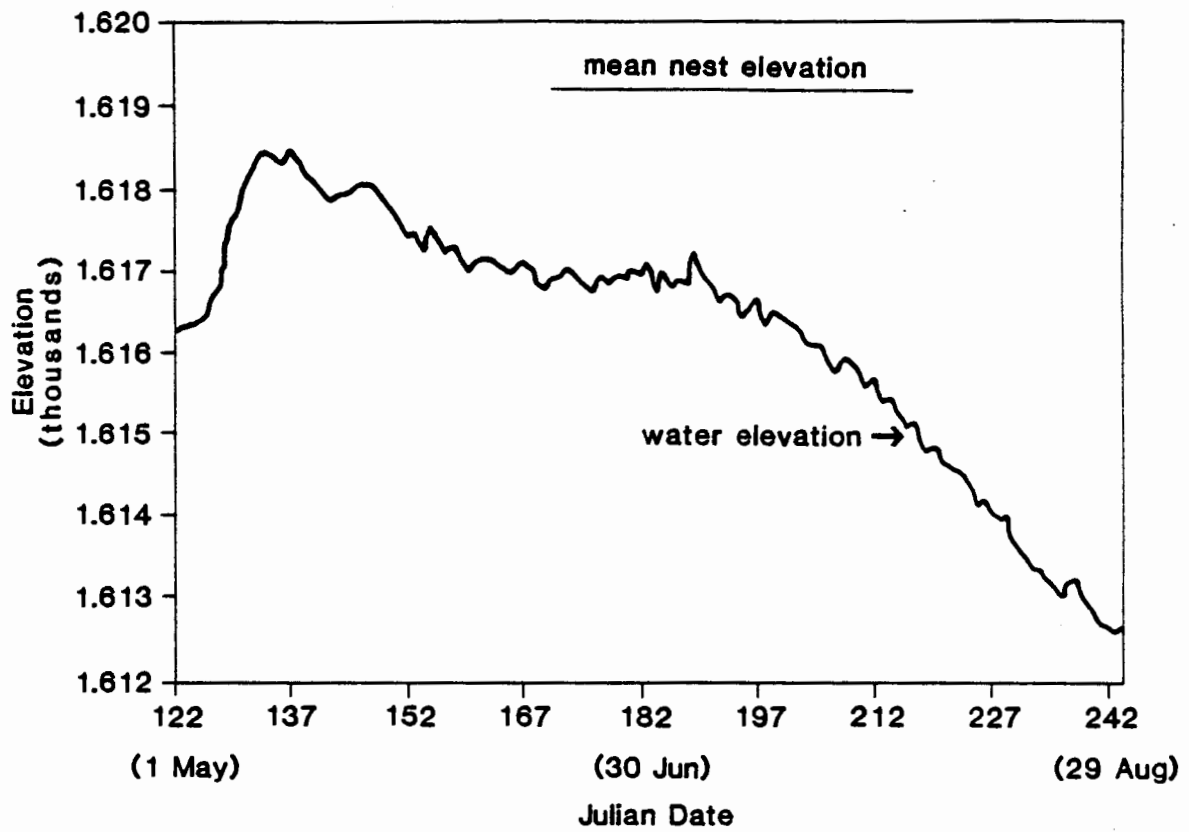


Figure 22a. Mean nest elevation relative to water elevation at Oahe Reservoir
Colony #16007a, RM 1108.5; Tern and Plover - Beach Site

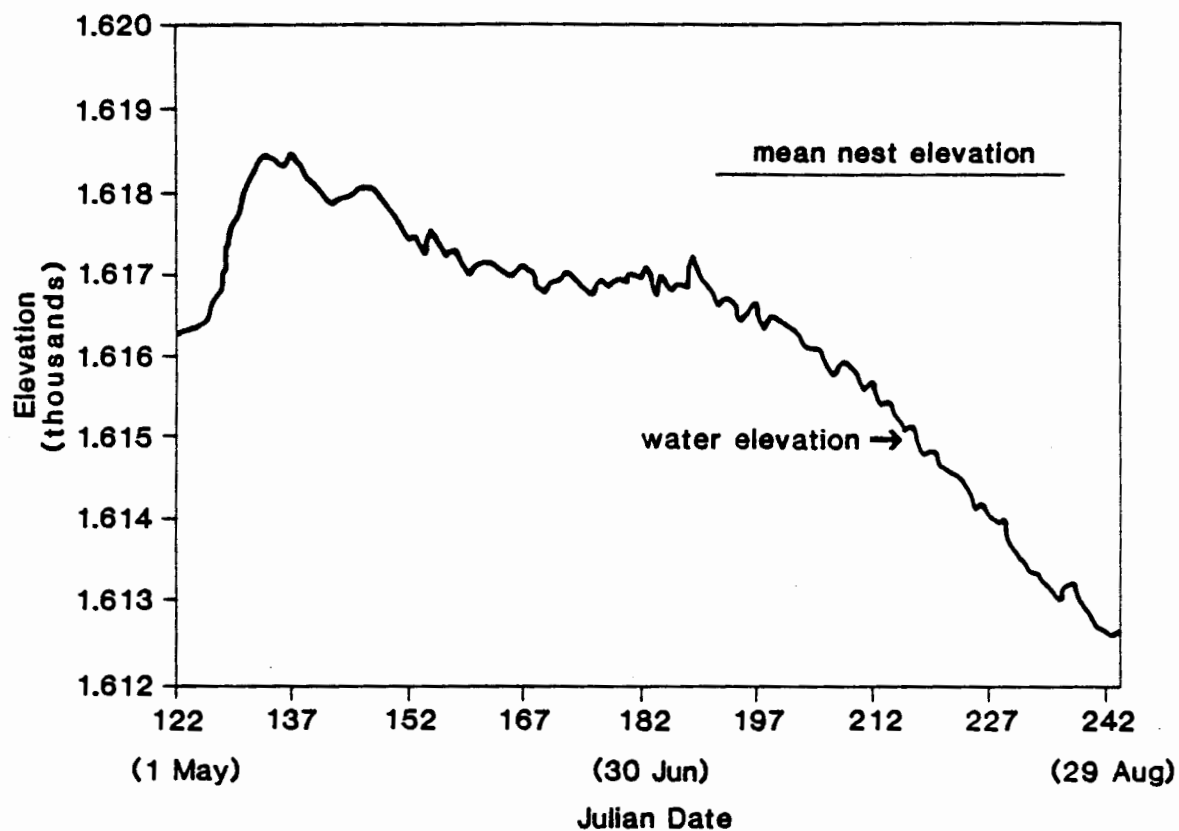


Figure 23. Mean nest elevation relative to water elevation at Oahe Reservoir
Colony #16009, RM 1127.0; Least Tern - Beach Site

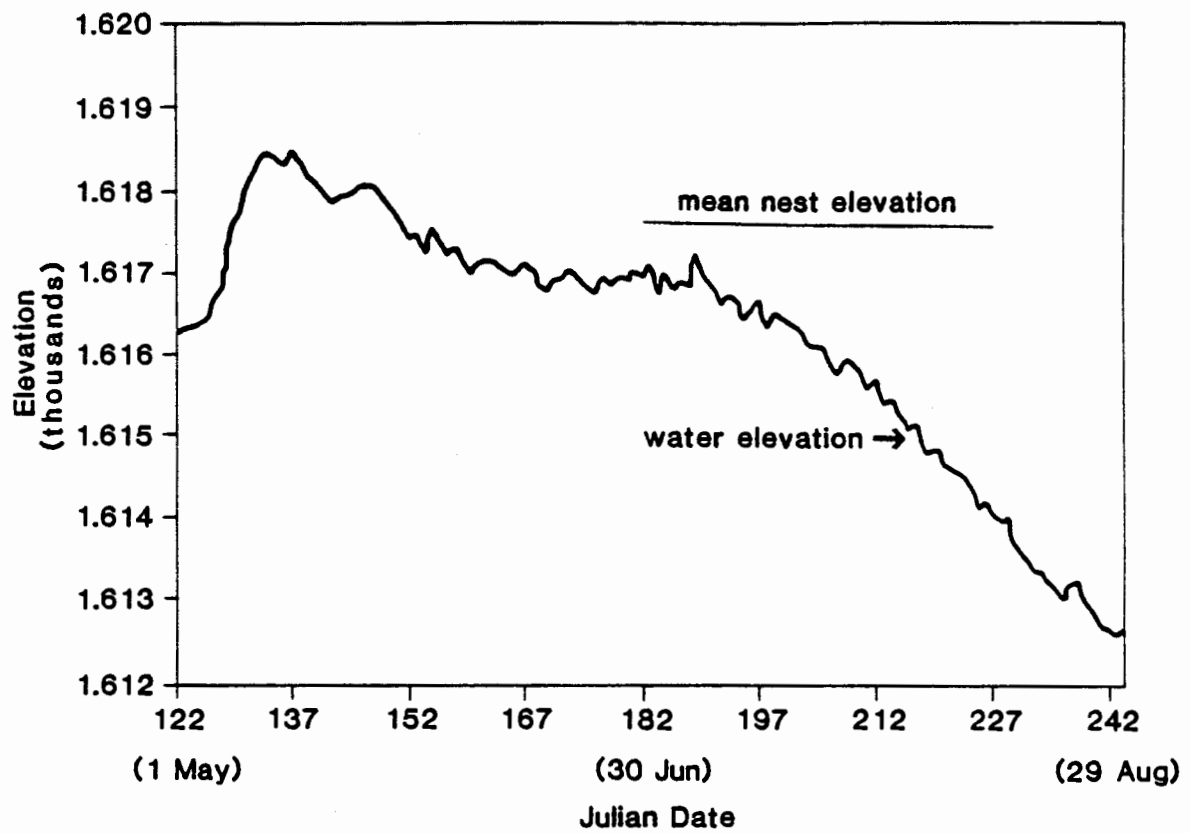


FIGURE 24.

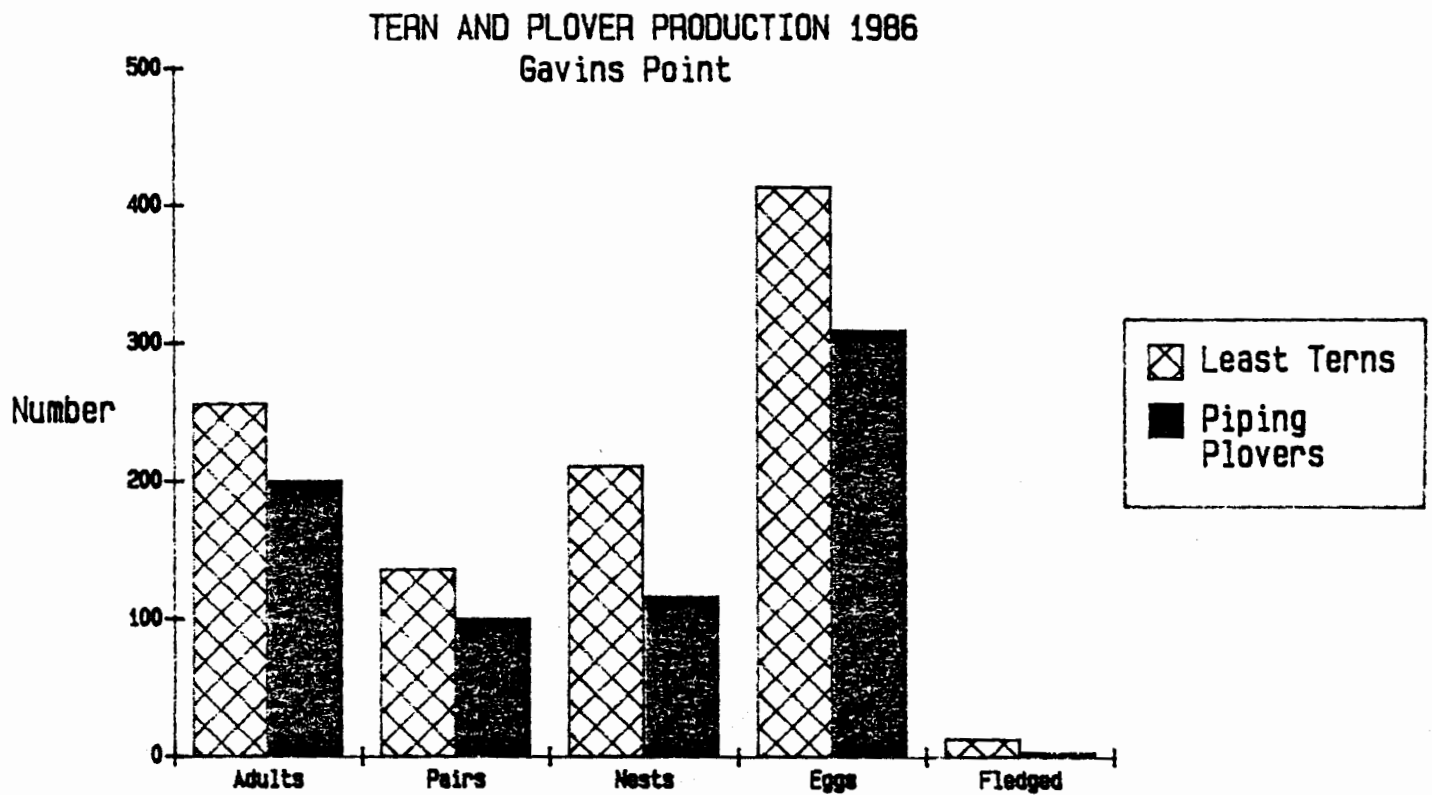


FIGURE 25.

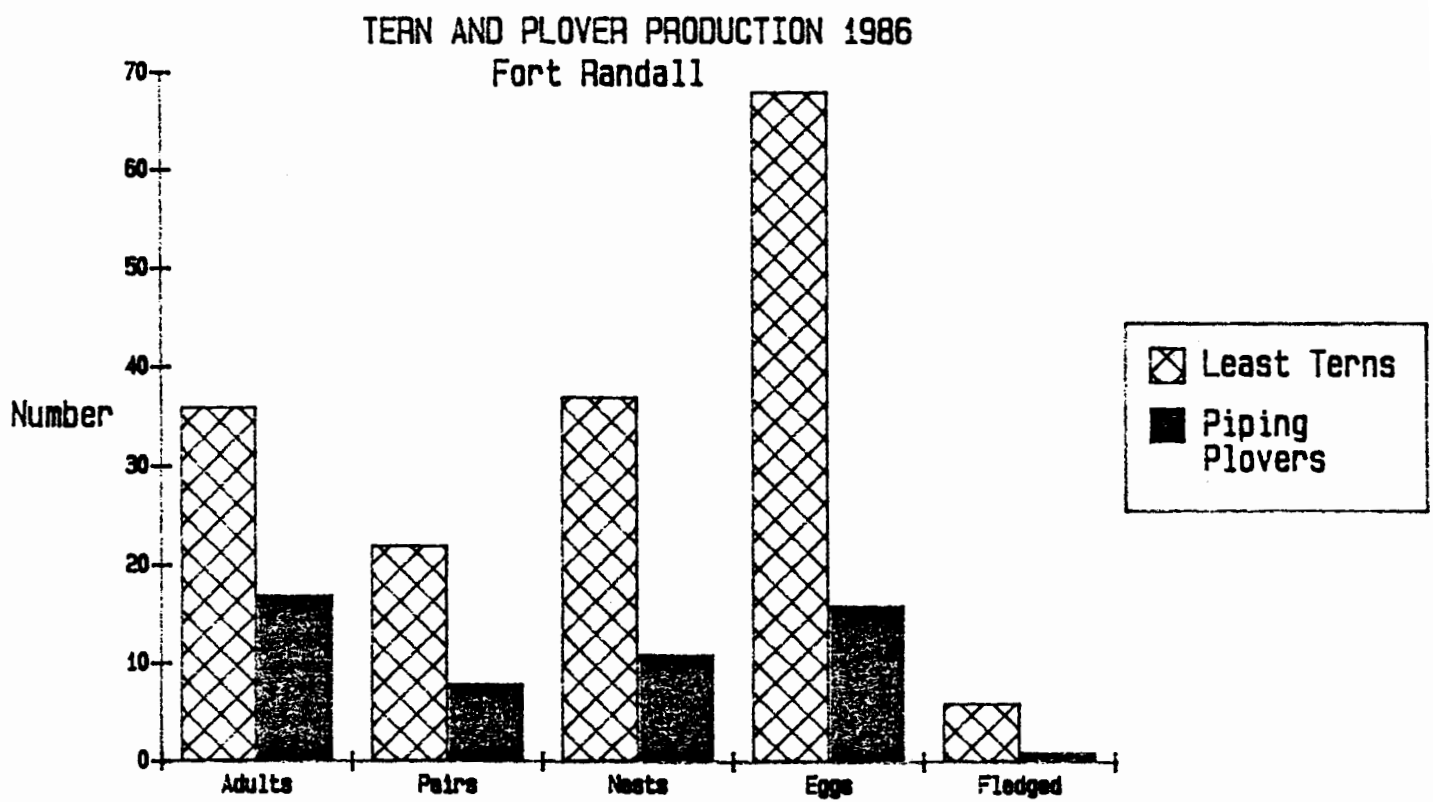


FIGURE 26.

