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STELLER SEA LION RESEARCH AT ANO NUEVO ISLAND, CALIFORNIA, DURING THE 1992 BREEDING SEASON.

By

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ABSTRACT

The purpose of this study was to determine the current status, feeding habits and genetic relationships of the population of Steller sea lions breeding on Año Nuevo Island, California. The numbers of adult females, adult and subadult males continued to decline from 1990 counts, possibly due to the El Niño that occurred during the 1992 breeding season. The number of pups counted from the ground remained approximately the same as in 1990. Scats from Steller sea lions and California sea lions were collected to test for possible competition for prey during the breeding season. Genetic analysis of the central California population showed a marked similarity with haplotypes found in Southeast Alaska and Oregon, and general dissimilarity with types found in Russia, the Eastern Aleutians, Western and Central Gulf of Alaska.

INTRODUCTION

The Steller sea lion (*Eumetopias jubatus*) is currently listed as threatened under the U.S. Endangered Species Act due to a dramatic range-wide decline over the last 30 years (Loughlin et al 1992). The decline has not been uniform, however, with some populations completely disappearing and others increasing in numbers (Loughlin et al 1992).

In the northern portion of the specie's range, declines have occurred at breeding sites off Russia, in the Bering Sea, Aleutian Islands and Gulf of Alaska, while increases have occurred in Southeastern Alaska. Breeding numbers in British Columbia, Oregon and northern California appear to be largely stable (the BC population has been stable since an approximately 50% decline due to harvesting 1913-1968, Loughlin et al 1992, NMFS Steller Sea Lion Recovery Plan 1992).

In southern California, breeding and hauling sites on the California Channel Islands were totally abandoned in the 1970's (Bonnell et al. 1978, Antonelis and Fiscus 1980). Off central California, the population on Año Nuevo Island (ANI) has undergone an 80% decline over the last 30 years, with a possible stabilization in numbers in the last 10 years (LeBoeuf et al 1991), and there has been a 90% decline of Steller sea lions breeding on the Farallon Islands (NMFS Steller Sea Lion Recovery Plan 1992).

Año Nuevo Island is presently the southernmost breeding site for this species. Although this population has suffered a similar decline to that in the northwestern part of the range, due to the distance between these areas, and the fact that the apparently healthy southeastern Alaska, British Columbia and Oregon populations fall between them, it is unlikely that the northwestern Pacific and southern/central California declines are due to the same causes. The northern decline is thought to be the result of an increased fishery for pollock (*Theragra chalcogramma*) in that area, a major prey item for Steller sea lions (Loughlin and Merrick 1988, Pitcher 1981, NMFS Steller Sea Lion Recovery plan 1992).

This study had three major goals: (1) To conduct ground censuses coinciding with aerial surveys by NMFS. Ground and aerial counts will determine if the population has stabilized, or is continuing to decline. (2) To collect scat samples of both California and Steller sea lions. Most California sea lions (*Zalophus californianus*) which haul out on ANI during the breeding season are juvenile and subadult males. Given that the subadult male *Zalophus* are about the same size as adult female *Eumetopias*, there is an excellent possibility that they utilize the same prey base (diving ability and prey size in pinnipeds is partly dependent upon body size). In addition, there is very little information on the species and sizes of prey utilized by lactating females on ANI. (3) The collection and genetic analysis of tissue samples from dead Steller sea lions of any age/sex class, or live pups to determine the relationship of the ANI population to northern populations. If the ANI population is made up largely of immigrants from the northwest part of the range, then the decline there and in central California may be part of the same phenomenon. If the ANI population is more closely related to the southeastern Alaska/BC/Oregon populations, then the ANI decline is more likely due to other factors. Alternately, the ANI population may be a remnant of a more southerly genetic pool and therefore, totally distinct from either northwestern or southeastern Alaska populations.

METHODS

Ground censuses

Counts of all Steller sea lions on breeding areas were conducted on 7 and 8 July 1992. A census of all the pinnipeds on ANI was conducted on 9 July 1992. The counts on 7-8 July were taken from a blind located above Area 9 (see map, Figure 1), utilizing binoculars (8x40) and a Bausch and Lomb Discoverer telescope (15-60x zoom). Sea lions were divided into the categories: males (presumed territorial), adult females, pups, juveniles (juvs, includes yearlings and 2-3 year olds) and subadult males (SAMS).

On 9 July, a whole island census of all pinniped species was conducted as follows:

1. The census commenced at 1030 hours. Weather conditions included hazy overcast sky, wind 2-5 mph, air temperature 68^{o}F.
2. Steller sea lions were categorized as above for Steller sea lion only censuses. *Zalophus californianus*, *Phoca vitulina* and *Mirounga angustirostris* were not broken into any age/sex categories.
3. The census was started at area 10E, and proceeded in a clockwise direction around the island (Figure 1). A manual tallying device was used on areas with large numbers of animals. Areas 10E and 8 were counted from the Foghorn house using a Celestron C90 telescope. Areas 8A, 8B, 9B and 20 were counted along the cliff above them using binoculars (7x50). Areas 9, 9A, 10W, 10E (front ridge), 11 and 12

were censused from the Area 9 blind. A Bausch and Lomb Discoverer telescope was used to count Areas 11 and 12, otherwise counts were done with binoculars. All remaining areas were counted using binoculars only. Areas 13, 14, 15, and 16 were censused from the Area 16 blind. Weaner beach (NW end of area 17) was counted by sneaking up and leaning over the cliff above it. Area 17 (main beach) was censused from the Area 17 blind. Area 19 was counted from the base of the fallen light tower. Areas 2, 3E, 3W, 4, 5, and 6 were censused from the Area 3 blind. Area 3A was counted from the SE side of the Foghorn house. Areas 6A, 7, and 18 were censused from the Area 7 blind at the back of the Foghorn house. Areas 1 and the SE portion of Area 2 could not be counted due to Cormorants breeding around the "old house".

Targets were set out to aid in distance measurements on the aerial photographs. Three targets (1 ft square with green and black checkerboard) were placed on Area 7 at distances of 30 and 50 feet, with one target acting as the center of a 45° angle. A Brunton field transit was used to determine the angle. Two points, one with the same altitude as target 1, and the other with the same altitude as target 2 were located on the breeding area (10E, see map, Figure 2) also using the field transit.

Scat samples

Eumetopias jubatus

Scat samples from Steller sea lions were difficult to obtain, primarily for two reasons: (1) The animals presently breed only on offshore rocks that are not easy to access. Due to the tentative nature of the ANI population, we do not spook animals in order to obtain scat samples. In addition, females tend to defecate over the edges of the rock into the water. (2) Later in the season, when Steller sea lions move to other more accessible parts of the island, they are mixed in with large numbers of *Zalophus*, which makes it difficult to be certain a given scat is from a *Eumetopias*. Despite these constraints, 7 scats were obtained, 6 from females and 1 from a male.

Zalophus californianus

During the June and July collections, scats were primarily obtained from beach 17 during disturbances caused by the arrival of the boat bringing researchers to and from the island. At these times, large numbers of *Zalophus* entered the water making access to the beach possible. Scats were collected with metal shovels and each scat was placed in a separate "whirl-pak" plastic bag. The date, location, species and approximate age/sex class of sea lion were also noted on the bag. Only obviously fresh (wet) scats were collected. The 30 July, 8 September, and 26 October samples were obtained on area 19 each in a single day, after the animals had moved from this area to beaches. All scats were stored in a freezer at the Long Marine Laboratory within a day of collection.

Tissue sample collection and analysis

Thirteen samples were used for this analysis. Most samples (n=7) were collected from pups that had died on ANI during the 1992 breeding season. Two samples were collected from live-caught pups. Additional material came from: 1 pup that died on ANI during the 1990 breeding season, 2 adult females, 1 sub adult male (Table 3). Skin punches from tagging, biopsy or clipping were used for the analysis. Samples were frozen immediately after collection.

DNA was extracted from the samples using established protocols (Thomas et al 1990). A segment of mitochondrial DNA control region was amplified using the polymerase chain reaction (PCR), and utilizing primers developed in an earlier study (Bickham et al in press). Amplified products were used as templates for sequencing using the dideoxynucleotide chain termination method and Sequenase enzyme (United States Biochemical). The products of the sequencing reactions were resolved in a polyacrylamide gel and autoradiographed. Sequences were compared with those from samples collected in Russia, Alaska and Oregon, using the haplotypes defined in Bickham et al (in press). Haplotypes were identified by differences in nucleotide sequences occurring on 20 variable sites within the 236 nucleotides read. A total of 22 different haplotypes were identified by Bickham et al (in press).

RESULTS

Ground censuses

Replicate censuses conducted at Steller sea lion breeding areas on 7 and 8 July revealed similar counts for most age/sex classes (Table 1). Sixteen more pups were counted (primarily on area 12) on 8 July, while 4 SAMs were present on 7 July and none on 8 July. Although the numbers of adult females and males remained about the same during the whole island census on 9 July, the number of pups again increased by 18 (Table 2). Due to their small size, pups are often obscured by adults as well as by small rock formations. Higher pup counts are usually obtained later in the season as females begin to take longer trips at sea and pups become more mobile. The highest pup count (136) was obtained on 5 August.

Scat samples

California sea lion scats were collected in June, July, September and October 1992 (Table 3). Scats were collected opportunistically, when the animals had vacated an area due to natural movements or an unavoidable disturbance. Only fresh scats were collected, and an effort was made to collect "solid" scats although the majority of scats produced were extremely diarrhetic.

Eumetopias scats were collected whenever an animal was observed defecating in an accessible area. Extreme care was taken in identifying scats from *Eumetopias* versus *Zalophus*. An examination of the breeding areas (10E, 10W) after the *Eumetopias* had abandoned it yielded no scats (brown pelicans (*Pelecanus occidentalis*) had invaded the area as the sea lions left, trampled any sea lion scats and defecated on top of them). Results of scat analysis have not yet been completed by Mark Lowry, SWFSC.

Tissue samples

Comparison of haplotypes identified by Bickham et al (in press) from the northern populations to those found on Año Nuevo Island showed general concurrence with types found in southeast Alaska and Oregon (Table 4). The eleven animals from ANI yielded 7 different haplotypes. Six of these haplotypes were identical to those identified by Bickham et al, while one type (GG) was unique to ANI. Type GG was most closely aligned to type H, differing by 2 nucleotide substitutions.

Animal EJ92AUG09 was the only previously identified type (A) not found in either Southeast Alaska or Oregon. Type A was found by Bickham et al (in press) primarily in Russia, with a lower frequency of occurrence moving east and south.

DISCUSSION

Ground censuses

Although the number of pups counted on the ground in 1992 was approximately the same as that in 1990 (111 counted on 11 July, 135 counted on 1 August), the numbers of females, sub adult, and adult males had declined by approximately 50% in the two year interim (see LeBoeuf and Morris 1990). The 1992 El Niño may be responsible for the low numbers of adults. One of the major differences in numbers of adult males between 1990 (11 July) and 1992 (9 July) is the existence of a large number (33) of apparently non-reproductive males on Area 2 in 1990 (there were no females on this area). There was also a larger number of adult females on the breeding areas (particularly areas 10E, 10W) in 1990 (199 in 1990 vs. 80 in 1992). Since the number of pups in ground counts was essentially the same between years (111 in 1990 vs. 127 in 1992), the extra females were probably nonreproductive that year. It seems, then, that during 1992 either due to the El Niño, or other factors contributing to the decline, non-reproductive animals did not haul out on ANI to the same extent as in 1990. There were also fewer sub adult male Steller sea lions in 1992, however, categorization of adult and sub adult males varies somewhat between observers; LeBoeuf and Morris (1990) may have categorized some sub adults on Area 2 as adult males. Theoretically, more juveniles should have been present during the El Niño year (1992) to continue to nurse. As expected, a few more juveniles were counted in 1992, but again, this may be a categorization problem in that some juveniles may have been classified as adult females in 1990.

Genetic analysis

Bickham et al (in press, Table 3) found that there were significant differences between mtDNA haplotype frequencies found in various regions. The Southeast Alaska and Oregon populations, although not distinct from each other, were different from all other populations at the $p \leq 0.10$ level (ony 2 comparisons exceeded the $p<0.05$ level). Except for type A, the central California haplotypes are most similar to those found in Southeast Alaska and Oregon. This makes sense from a geographic standpoint, but does not make sense in relation to the decline, since both the Oregon and SE Alaska populations appear to be stable or increasing over the last 30 years (NMFS Steller Sea Lion Recovery Plan 1992). If the same factors were responsible for the northwestern and southern range declines of this species, we would expect these populations to show more genetic similarity. For instance, if a reduction in walleye pollock (especially certain size classes) is responsible for the northwestern decline of this species, as hypothesized (Loughlin and Merrick 1988), it is difficult to imagine a scenario whereby individuals from the Central California population utilize the same fishing grounds as the Russian, Eastern Alaska, Western and Central Gulf of Alaska populations, but the Southeast Alaska and Oregon populations do not. The declines occurring in various parts of the range are probably due to different factors.

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Table 1. Censuses taken at Año Nuevo Island of Steller sea lion breeding areas on 7 (1a) and 8 (1b) July 1992. Abbreviations: "juvs" = yearlings and juveniles up to approximately 3 years, "SAMs" = Subadult males.

a. 7 July 1992

area	males	females	pups	juvs	SAMs	
9	2	1	1	0	0	
9A	1	0	0	0	0	
10E	15	29	35	2	0	
10W	8	23	22	3	3	
11	2	0	0	0	1	
12	11	28	35	6	0	
Total	**39**	**81**	**93**	**11**	**4**	228

b. 8 July 1992

area	males	females	pups	juvs	SAMs	
8	1	0	0	0	0	
9	2	1	1	0	0	
9A	1	0	0	0	0	
10E	13	27	33	2	0	
10W	10	15	29	1	0	
11	2	0	0	0	0	
12	13	36	46	9	0	
Total	**42**	**79**	**109**	**12**	**0**	242

Table 2. Census of all pinnipeds on Año Nuevo Island taken on 9 July 1992. Only areas that had animals present are listed although all areas were checked. The first five categories are for Steller sea lions (abbreviations as in Table 1). Counts for all age/sex classes of *Zalophus californianus, Phoca vitulina,* and *Mirounga angustrirostris* were combined.

	Eumetopias jubatus							
area	males	females	pups	juvs	SAMs	*Zalophus*	*Phoca*	*Mirounga*
2	1	0	0	0	1	76	0	0
3E	0	0	0	0	0	151	0	0
3W	0	0	0	0	0	283	0	0
3A	0	0	0	0	0	32	33	0
6A	0	0	0	0	0	2	6	0
7	2	0	0	0	0	5	0	0
8	1	0	0	0	1	0	0	0
9	2	1	1	0	0	0	1	0
9A	1	0	0	0	0	0	0	0
10E	12	27	55	1	0	0	0	0
10W	9	19	18	4	0	0	0	0
11	2	1	1	0	2	5	2	0
12	10	32	52	4	1	0	0	0
13	0	0	0	0	0	1	13	1
14	1	0	0	0	4	197	20	11
15	0	0	0	0	0	17	51	0
16	0	0	0	0	0	168	17	0
17	0	0	0	0	0	1837	22	334
19	0	0	0	0	0	31	0	0
20	0	0	0	0	0	0	5	0
Totals	**40**	**80**	**127**	**9**	**8**	**2805**	**170**	**346**

Total Steller sea lions: 264

Table 3. Scat samples collected on Año Nuevo Island June-October 1992.

Date	Location	Age/Sex Class	# Samples	Container
Zalophus californianus:				
12 June 92	area 17 ANI	mostly SAM, juv males	3 bags	small bucket #1
18 June 92	area 7	" "	1	
24 June 92	area 19	" "	2	
6 July 92	area 17	" "	5	
10 July 92	area 19	" "	3	
13 July 92	area 17	" "	5	
17 July 92	area 17	" "	2	
27 July 92	area 17	" "	7	
30 July 92	area 19	all males >4 years old	39 bags	large bucket #2
8 Sept 92	area 19	mostly SAM, juv male, but some females	52 bags	large bucket #3
26 Oct 92	area 19	mostly males	16 bags	small bucket #4
Eumetopias jubatus:				
various dates, areas		6 females, 1 male	7 bags	small bucket #4

Table 4. Tissue samples used for genetic analysis of *Eumetopias jubatus* from central California, including Año Nuevo Island (ANI). All samples were clips from fore- or hindflippers except for SSL10 (piece of skin), SSL11 (skin biopsy), and EJ92SEP17LP (tagging plug). The adult female EJ92JAN26 was stranded on Greyhound Rock Beach (GRB), located 7 km south of ANI. Animal SSL10 was stranded in Marin County, CA. Region denotes areas where these haplotypes were found by Bickham et al (in press), number of animals with this haplotype found in each area given in parentheses.

Date	Location	ID number	Age/sex	Haplotype[1]	Other Regions with Same Haplotype[3]
7/90	ANI	EJ90JUL	dead female pup	L	SE AK(1)
1/26/92	GRB	EJ92JAN26	dead adult female	BB	RUS(5) E ALE(3) CG AK(3) SE AK(1) OR(3)
6/02/92	ANI	EJ92JUN02	dead female pup	GG[2]	
6/30/92	ANI	EJ92JUN30A	dead adult female	H	SE AK(2) OR(2)
6/30/92	ANI	EJ92JUN30B	dead female pup	N	OR(3)
7/16/92	MMC	SSL10	subadult male	K	SE AK(1)
8/6/92	ANI	EJ92AUG06	dead female pup	L	
8/9/92	ANI	EJ92AUG09	dead female pup	A	RUS(6) WG AK(2) CG AK(1)
9/17/92	ANI	EJ92SEP17A	dead male pup	L	
9/17/92	ANI	EJ92SEP17C	dead male pup	Q	OR(1)
9/17/92	ANI	EJ92SEP17LP	live male pup	N	
10/2/92	ANI	EJ92OCT02	dead female pup	BB	
10/13/92	ANI	SSL11 (Stella)	live female pup	H	

[1]Haplotypes given are from Binkham et al (in press)

[2]GG is a previously unreported haplotype

[3]Abbreviations: RUS = Russia, E ALE = Eastern Aleutians, WG AK = Western Gulf of Alaska, CG AK = Central Gulf of Alaska, SE AK = Southeastern Alaska, OR = Oregon

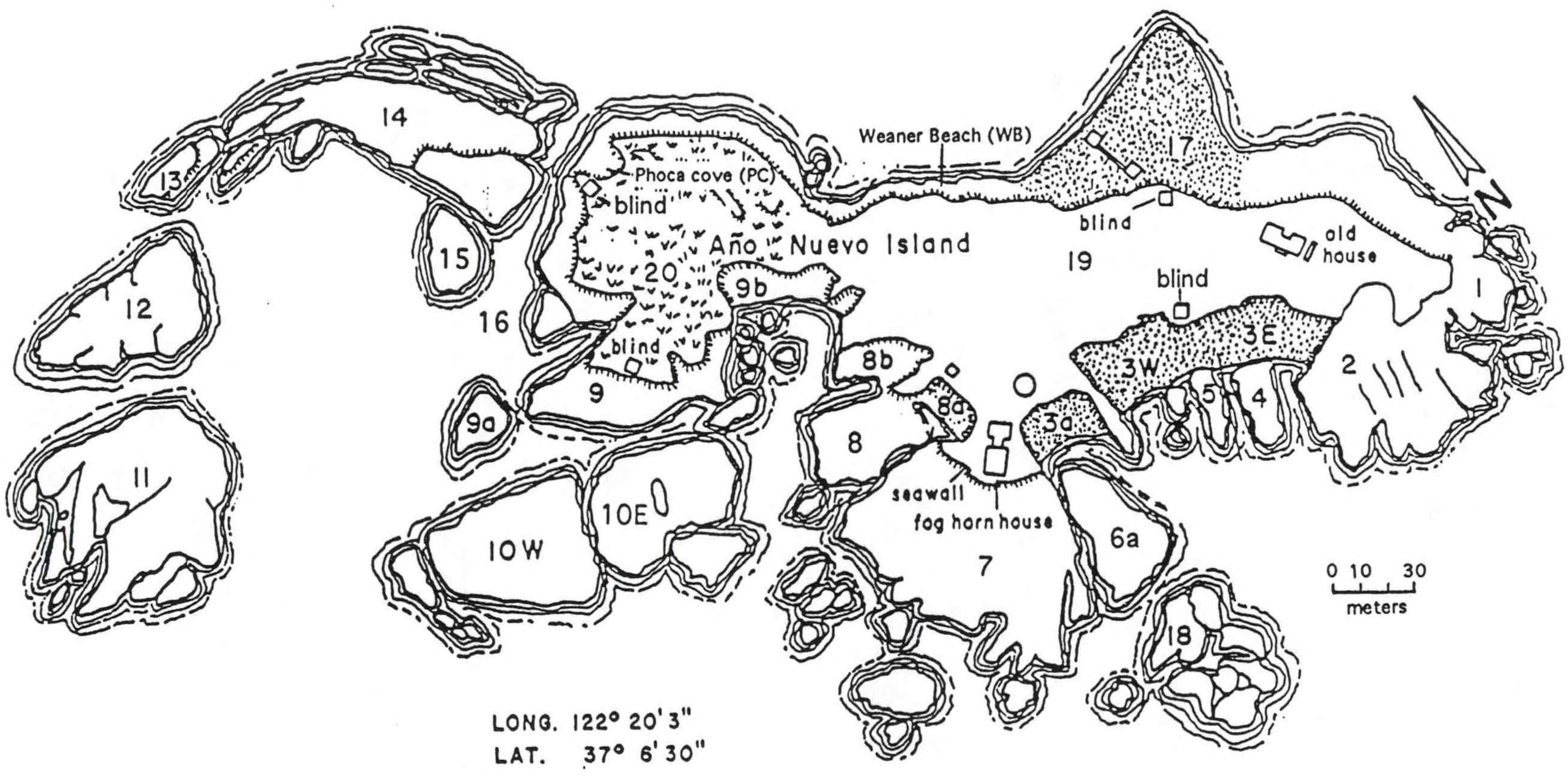

Figure 1. Map of Año Nuevo Island indicating area numbers, and observation blinds mentioned in this report.

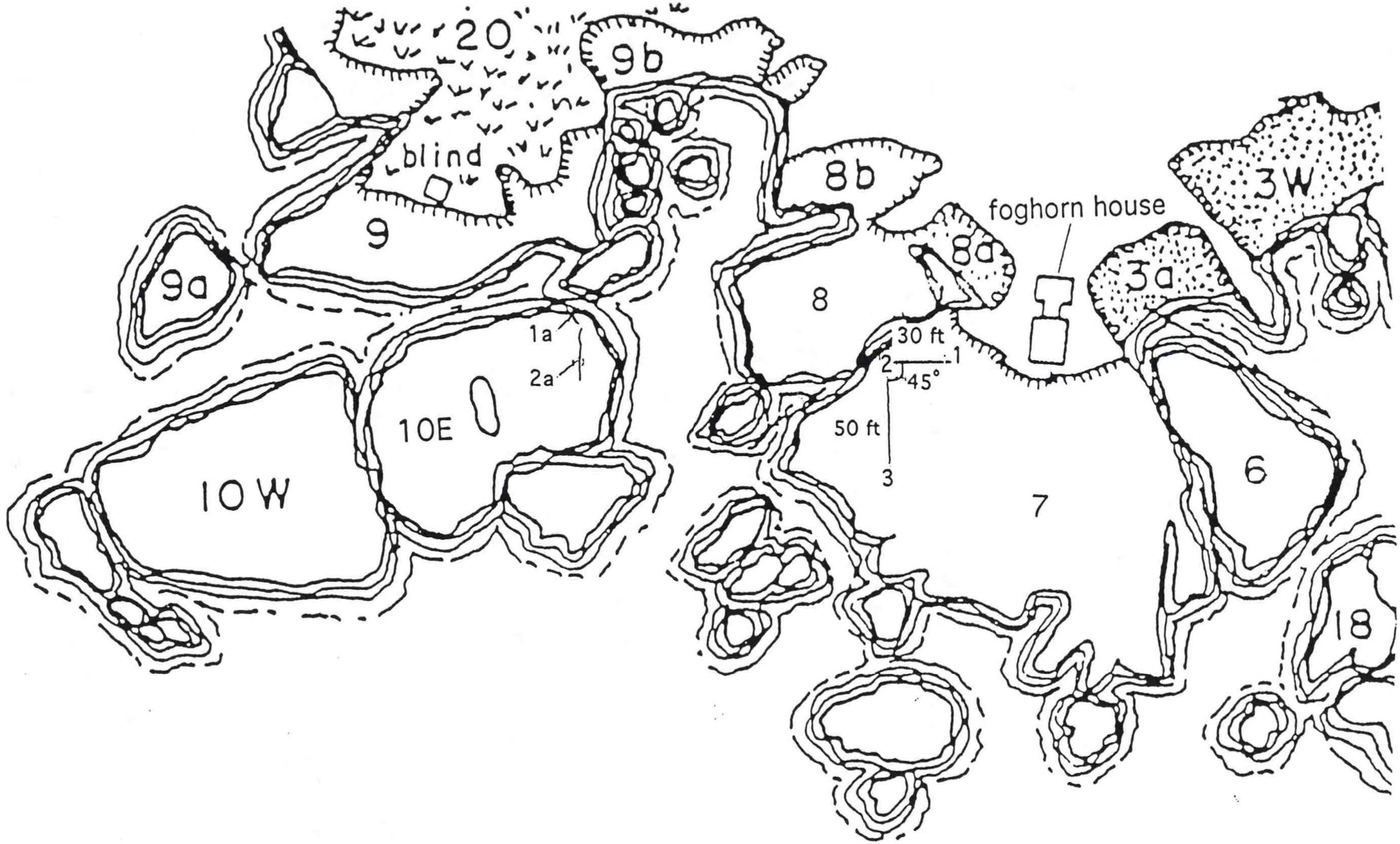

Figure 2. Map of areas 7, 10E and 10W showing location of targets placed for aerial photographs. Numbers 1, 2 and 3 correspond to the targets. 1a is the point on breeding area 10E approximately the same altitude as target 1, and 2a is a cliff on 10E approximately the same altitude as target 2.