

X13
28835
V. 93
#1

ISSN 0038-3872

SOUTHERN CALIFORNIA ACADEMY OF SCIENCES

BULLETIN

Volume 93

Number 1



BCAS-A93(1) 1-44 (1994)

APRIL 1994

Southern California Academy of Sciences

Founded 6 November 1891, incorporated 17 May 1907

© Southern California Academy of Sciences, 1994

OFFICERS

Hans M. Bozler, *President*
David L. Soltz, *Vice-President*
Kristine B. Hartney, *Secretary*
Margaret A. Neighbors, *Treasurer*
Daniel A. Guthrie, *Editor*

BOARD OF DIRECTORS

1992-1994	1993-1995	1994-1996
Kristine B. Hartney	Jack W. Anderson	Donald G. Buth
Lillian Y. Kawasaki	Hans M. Bozler	Martin F. Golden
Edward J. Kormondy	Margaret A. Neighbors	Daniel A. Guthrie
David L. Soltz	Jane R. Peterson	R. Nichols Hazelwood
Susan E. Yoder	Maria E. Zavala	Gloria J. Takahashi

Membership is open to scholars in the fields of natural and social sciences, and to any person interested in the advancement of science. Dues for membership, changes of address, and requests for missing numbers lost in shipment should be addressed to: Southern California Academy of Sciences, the Natural History Museum of Los Angeles County, Exposition Park, Los Angeles, California 90007-4000.

Professional Members.	\$ 30.00
Student Members	20.00

Memberships in other categories are available on request.

Fellows: Elected by the Board of Directors for meritorious services.

The Bulletin is published three times each year by the Academy. Manuscripts for publication should be sent to the appropriate editor as explained in "Instructions for Authors" on the inside back cover of each number. All other communications should be addressed to the Southern California Academy of Sciences in care of the Natural History Museum of Los Angeles County, Exposition Park, Los Angeles, California 90007-4000.

Date of this issue 4 May 1994

SOUTHERN CALIFORNIA ACADEMY OF SCIENCES



1994 Annual Meeting May 6-7 University of California, Irvine

Symposia being planned include: The Impact of Changes in Federal Science Policy on Southern California; Restoration of Wildlands After Fires; Wetlands Restoration; Earthquakes in Southern California; The Effects of Science Policy on Women.

Southern California Academy of Sciences
900 Exposition Boulevard
Los, Andeles, California 90007
Telephone: 213/744-3384

Abstract Instructions

Abstracts will appear exactly as submitted. Consequently, they must be cleanly typed and correct in format. Abstracts which fail to conform to the guidelines or are mailed after the deadline will not appear in the symposium program.

Abstracts must be typed and submitted on an 8½" × 11" sheet. It will be reproduced at 100% of original size, therefore use type that is no smaller than 10 point/12 pitch. If using a word processor, a laser printed copy is preferred. If using a typewriter, type must be clean, so use an electric typewriter with clean keys and a relatively new black or carbon ribbon. Do **not** erase.

Arrange abstract as follows in a space 6" wide × 4" high (see example below). Do not show the enclosing box.

1. TITLE must be all capital letters. Do **not** italicize, except species names.
2. Underline author(s) name(s), listing the presenter first.
3. List the institution and department for each author.
4. On the next line, begin text with 5 space paragraph indentation. Single space text.
5. List acknowledgments within parentheses following text.

With your abstract submit on a 3" × 5" index card the following:

1. Full name of presenter, affiliation, mailing address and telephone number (with area code).
2. Indicate student or professional.
3. Title of your paper.
4. The subject field in which you wish to present.

Abstract and card are due **MARCH 1, 1994** to Program Chair
Southern California Academy of Sciences
900 Exposition Boulevard
Los Angeles, CA 90007

Sample Abstract

6"

MICROBIAL ACTIVITY IN THE DIGESTIVE TRACT OF THE HALFMOON, *Medialuna californiensis*. J. S. Kandel¹, J. R. Paterek² and M. H. Horn¹. ¹California State Univ. Fullerton, CA 92634 and ²Agouron Institute, La Jolla, CA 92037.

We report the presence of a diverse microbial flora and of microbial fermentation products in the hindgut region of the halfmoon, *Medialuna californiensis*, a seaweed-eating fish from southern California coastal waters. Viable aerobic and anaerobic bacteria were found in all sections of the gut, but were of highest concentration (10^5 – 10^8 /ml) in the hindgut. Microscopy revealed vibrios, spirilla, rod-shaped bacteria and flagellated protozoa in the midgut and hindgut, but primarily vibrios and rods in the stomach and foregut. Acetic, isobutyric and butyric acids, the volatile products of microbial breakdown of carbohydrates, were found only in the hindgut, as was ethanol, a nonvolatile product. These results provide the first evidence for microbial fermentation and its possible contribution to the energy supply in a north-temperate herbivorous fish.

The Biology and Current Status of the Long-eared Owl in Coastal Southern California

Peter H. Bloom

*Western Foundation of Vertebrate Zoology, Calle San Pablo,
Camarillo, California 93010*

Abstract. — The Long-eared Owl (*Asio otus*) is poorly known in southern California. This paper reviews its historic nesting distribution in Orange and western San Diego counties as determined from 79 egg set records from 5 museum collections, and contrasts this with the distribution of 50 nesting attempts as recorded in Orange and northern San Diego counties between 1968–1992. Comparisons reveal a substantial area of extirpation in the coastal region with a small, remnant population in interior areas. The number of historic breeding territories has decreased by at least 55%. Reproduction appears good with 85% of 40 nests fledging young. Diet was typical of other regions with small rodents (*Microtus californicus*, *Reithrodontomys megalotis*, and *Thomomys bottae*) comprising 90% of the prey by number.

Except for anecdotal accounts from early in this century, little is known about the biology of the Long-eared Owl (*Asio otus*) in coastal southern California (Dawson 1923; Willett 1933; Bent 1938). In this paper I present information obtained over a 24-year period (1968–1992) on nesting Long-eared Owls in coastal Orange and San Diego counties, California (Fig. 1) and contrast this with the historic (1889–1961) nesting distribution (Table 1). Also included are data on the breeding biology, nesting habitat, predators, diet, and the results of 1991 and 1992 surveys of historic and recent nest territories. These data were collected largely on an opportunistic basis while monitoring the breeding biology of the more common raptor species.

The impetus for this paper stems in part from reports of declines of Long-eared Owls in Pennsylvania, New Jersey, and California (Clark and Klem 1986; Bosakowski et al. 1989; Marti and Marks 1989), and recent distribution maps (Burton 1984; Johnsgard 1988; Marti and Marks 1989) which incorrectly indicate that the species does not breed in southwestern California. It also updates previous Long-eared Owl status reports provided in Garrett and Dunn (1981) and Unitt (1984).

Study Area

The historic breeding distribution of the Long-eared Owl included all of southern California (Grinnell and Miller 1944) with the likely exception of some interior eastern desert areas. For the purposes of this paper the historic study area included all of Orange County, the coastal slope of San Diego County west of Mount Palomar, and the Cuyamaca and Laguna mountains (Fig. 1). My study area included southern and western Orange County, and northern San Diego County,

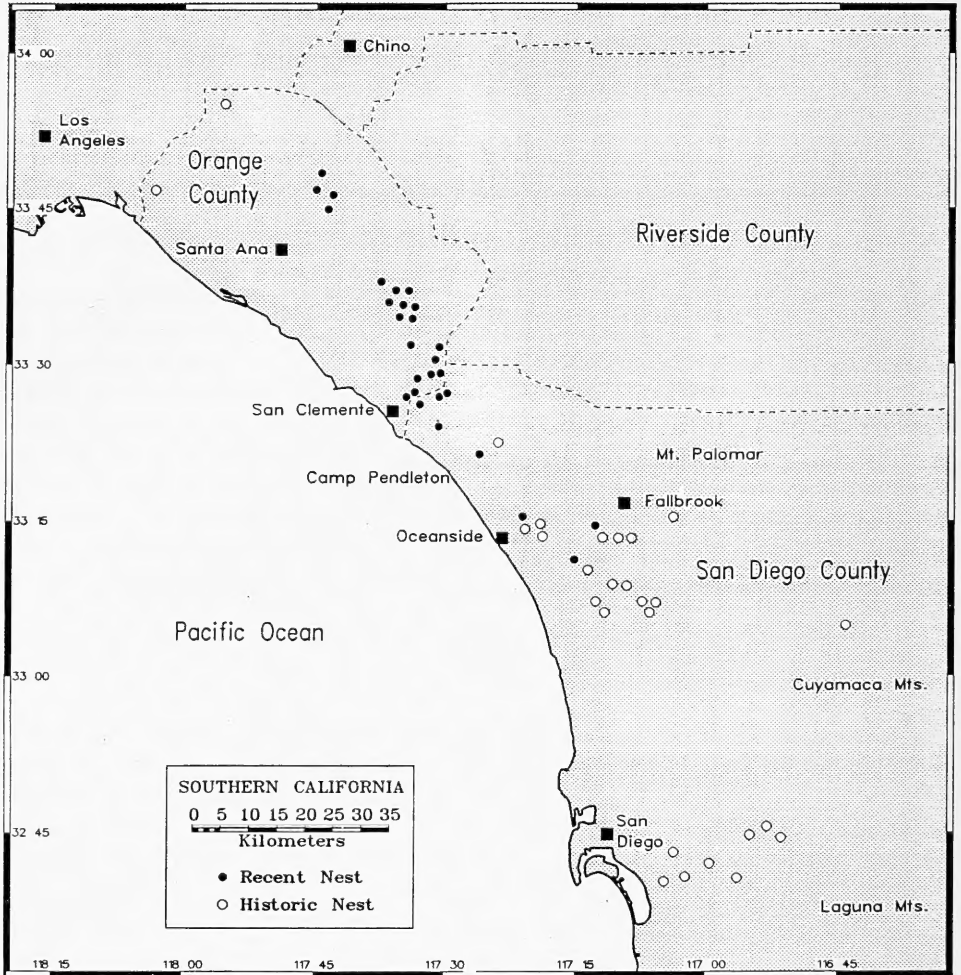


Fig. 1. Historic (1889–1961) and recent (1967–1992) locations of nesting Long-eared Owls in Orange and western San Diego counties.

California. Within Orange County, specific study sites included Rancho Mission Viejo, Irvine Ranch, Starr Ranch Audubon Sanctuary, Casper's Wilderness Park, Irvine Park, Wagon Wheel Park, Whiting Ranch Park, and Aliso-Wood Canyon Park. Within San Diego County, specific study sites were restricted to Camp Pendleton Marine Corps Base.

Oak woodland, riparian woodland, coastal sage scrub, native grassland, and non-native grassland are the predominant habitats in this region and elevation varies from sea level to 460 m. Precipitation averages 36 cm/yr and is seasonal, peaking in February (Bloom 1989).

Methods

All Orange and San Diego county egg set records were examined at the Western Foundation of Vertebrate Zoology (WFVZ), Museum of Vertebrate Zoology (MVZ),

San Bernardino County Museum (SBCM), and the Santa Barbara Museum of Natural History (SBMNH) (Table 1). These collections contained the majority of Orange and San Diego county sets (L. Kiff pers. comm.). Owing to the vagueness of locality data on nesting records, no attempt was made to recheck exact nest locations. However, I examined street maps and conducted 15 aerial surveys, 1–2 hr in duration, to determine the extent of urbanization and the likelihood of a former territory being occupied. I have never found an active Long-eared Owl nest within 1 km of a residential area in California. Therefore, if a residential street now exists within 1 km of a historic Long-eared Owl nest site I considered it abandoned.

Many Long-eared Owl nesting territories were encountered while searching for nests of other raptorial species. Specific surveys for nesting Long-eared Owls in 1991 and 1992 lasting 0.5–4 hr in duration, were conducted between 15 January and 1 June each year, and consisted of examining known and potential nest groves and listening for calling adults or begging young. Bal-chatri traps and mist nets were also used to ascertain the presence or absence of Long-eared Owls (Smith et al. 1983; Bloom 1987). Additional recent nest records were provided by other observers (Table 2).

Calculations of habitat loss figures in Orange County between 1972 and 1990 were derived from reports detailing land use changes (County of Orange 1972, 1993). For the purposes of this paper I used only land-use classifications that might support breeding Long-eared Owls. These included only the designations “open space” and “vacant,” which (in the 1974 edition) were defined as parks, cemeteries, beaches, and unused urban land. Unused urban land contained large ranches and the Trabuco District of the Cleveland National Forest. From the 1993 edition I used the designations that most closely approximated the 1974 edition, including “open space/recreation,” “vacant <31% slope,” and “vacant >30% slope.” These include beaches, local and regional parks, national forests, golf courses, cemeteries, wildlife preserves, recreational marinas, and public and private campgrounds (County of Orange 1993). The latter 2 categories contain mostly ranchlands. While habitats such as cemeteries, beaches, golf courses, and marinas are not typically Long-eared Owl breeding habitat, excluding their acreages would make this part of my methodology difficult to repeat; therefore, my breeding habitat acreage estimates as they relate to changes between 1972–1990 for Orange County are undoubtedly inflated and the actual acreage of suitable owl habitat is substantially less.

Foods habits were ascertained from pellets found in and directly below all active nests. Skulls and mandibles were used in the identification of rodents. A nest was considered successful if it fledged at least one young.

Results

Historic record.—Seventy-nine egg sets collected between March 1889 and March 1961 from Orange (2) and coastal San Diego counties (77), respectively, were found in museum collections. Mean clutch size for these sets was 5.1 (S.D. = 1.0; range 2–7). Nests were located throughout the coastal region in 10 species of trees and shrubs. Of 69 nest substrates recorded, 21 were oak (*Quercus* sp.), 18 each in willow (*Salix* sp.) and cottonwood (*Populus fremonti*), 4 in *Eucalyptus* sp., 3 in sycamore (*Platanus racemosa*), and 1 each in orange, alder (*Alnus rhombifolia*),

Table 1. Historic nesting records of Long-eared Owls in Orange and San Diego counties from collections at the WFVZ, MVZ, SBCMNH, and SBMNH.

Museum no.	Date	Locality	No. eggs	Collector
San Diego County				
WFVZ 4,463	7 Feb. 1931	9 mi. W of Pala	2	Harrison
WFVZ 48,109	25 Feb. 1926	McCoy Grove	4	Gallup
WFVZ 73,766	17 Mar. 1898	Lakeside	4	Ingersoll
WFVZ 52,699	14 Mar. 1920	San Diego River	4	Ingersoll
WFVZ 73,763	19 Mar. 1893	Lakeside	6	Ingersoll
WFVZ 46,973	11 Mar. 1923	Near San Marcos	5	Gallup
WFVZ 48,256	11 Mar. 1923	Near San Marcos	5	Gallup
WFVZ 73,759	14 Mar. 1925	Lakeside	5	Burnham
WFVZ 4,466	9 Mar. 1933	5 mi. E of Escondido	7	Roberts
WFVZ 96,063	10 Mar. 1901	Grijito	4	Dixon
WFVZ 73,784	10 Mar. 1907	Crescent Valley	6	Sharp
WFVZ 72,133	13 Mar. 1936	Sweetwater Lake	5	Harvey
WFVZ 4,468	14 Mar. 1936	Santa Margarita Ranch	6	Harrison
WFVZ 52,701	14 Mar. 1923	Lakeside	5	Burnham
WFVZ 73,782	11 Mar. 1923	San Marcos	5	Sharp
WFVZ 52,702	13 Mar. 1921	Sweetwater River	5	Burnham
WFVZ 73,772	10 Mar. 1921	Near Lakeside	5	Ingersoll
WFVZ 52,698	14 Mar. 1920	San Diego River	3	Ingersoll
WFVZ 9,986	15 Mar. 1916	Jamacha	5	Ingersoll
WFVZ 72,021	15 Mar. 1916	Near Lakeside	4	Huey
WFVZ 9,886	15 Mar. 1913	Near Lakeside	5	Huey
WFVZ 73,768	22 Mar. 1897	Near Lakeside	5	Ingersoll
WFVZ 73,769	22 Mar. 1897	Lakeside	7	Ingersoll
WFVZ 73,764	18 Mar. 1894	Lakeside	6	Ingersoll
WFVZ 4,467	20 Mar. 1934	¼ mi. N of Bonsall	5	Harrison
WFVZ 73,792	16 Mar. 1933	Flinn Springs	7	Potter
WFVZ 73,774	16 Mar. 1933	Dihissa	5	Ingersoll
WFVZ 4,470	26 Mar. 1940	10 mi. E of Encinitas	5	Harrison
WFVZ 4,469	26 Mar. 1940	10 mi. E of Encinitas	5	Harrison
WFVZ 32,412	28 Mar. 1949	Bonsall	5	Dixon
WFVZ 52,099	27 Mar. 1919	San Diego	7	Piltfield
WFVZ 73,785	30 Mar. 1919	Escondido	6	Sharp
WFVZ 73,700	27 Mar. 1920	Lakeside	5	Ingersoll
WFVZ 71,995	27 Mar. 1927	Dihissa	5	Huey
WFVZ 73,783	30 Mar. 1913	Crescent Valley	5	Sharp
WFVZ 89,900	25 Mar. 1895	Lakeside	3	Ingersoll
WFVZ 73,765	25 Mar. 1895	San Diego River	4	Ingersoll
WFVZ 73,761	30 Mar. 1889	Lakeside	6	Ingersoll
WFVZ 83,462	18 Mar. 1961	San Luis Rey Mission	4	Quigley
WFVZ 4,471	22 Mar. 1942	Rancho Santa Fe	7	Harrison
WFVZ 75,642	20 Mar. 1949	San Luis Rey River	5	Hall
WFVZ 73,762	21 Mar. 1892	Lakeside	5	Ingersoll
WFVZ139,573	17 Mar. 1923	Old Maids Canyon	6	Heaton
WFVZ 4,464	26 Feb. 1933	2 mi. E of Bonsall	6	Harrison
WFVZ 4,465	27 Feb. 1933	½ mi. E of Bonsall	6	Harrison
WFVZ147,086	12 Mar. 1949	San Luis Rey River	6	Hall
WFVZ161,078	5 Mar. 1919	Bandy Can., San Pasqual	6	Carpenter
WFVZ 48,108	21 Feb. 1926	Bandy Canyon	5	Gallup
WFVZ127,962	6 Apr. 1917	Bonsall	5	Carpenter
WFVZ 73,786	4 May 1919	Marikle Canyon	4	Sharp

Table 1. Continued.

Museum no.	Date	Locality	No. eggs	Collector
WFVZ124,571	5 May 1903	San Pasqual	4	Wood
WFVZ 89,899	28 Mar. 1917	San Diego County	5	Potter
WFVZ 72,134	6 Apr. 1934	Sweetwater Lake	5	Harvey
WFVZ 73,781	13 Apr. 1902	San Pasqual	4	Sharp
WFVZ126,245	13 Apr. 1902	San Pasqual	7	Carpenter
WFVZ 55,120	7 Apr. 1901	San Pasqual	6	Carpenter
WFVZ 89,898	30 Apr. 1917	Lakeside	3	DeGroot
WFVZ 48,009	19 Apr. 1908	San Pasqual	5	Carpenter
WFVZ 73,760	8 Apr. 1923	Santa Isabel	5	Burnham
WFVZ 48,107	8 Apr. 1923	San Pasqual Valley	5	Gallup
WFVZ 4,476	3 Mar. 1920	Near Lakeview	7	Ingersoll
WFVZ 73,767	1 Mar. 1897	Lakeside	5	Ingersoll
WFVZ 52,700	6 Mar. 1920	San Diego River	4	Burnham
WFVZ 4,477	4 Mar. 1921	Fanita Ranch, Santee	5	Meanley
WFVZ107,394	15 Mar. 1903	San Pasqual	7	Dixon
WFVZ 52,703	6 Mar. 1921	Mission Valley	6	Burnham
WFVZ128,897	16 Mar. 1904	San Pasqual	5	Sharp
WFVZ 73,790	2 Mar. 1923	Fanita Ranch, Santee	5	Bancroft
WFVZ 73,771	10 Mar. 1901	Lakeside	7	Ingersoll
WFVZ 73,773	12 Mar. 1893	Escondido	3	Ingersoll
MVZ 13,305	29 Mar. 1925	Bonsall	3	Dixon
MVZ 5,973	17 Mar. 1896	Lakeside	5	Ingersoll
MVZ 5,974	25 Mar. 1900	Lakeside	5	Ingersoll
MVZ 5,972	27 Mar. 1920	Lakeside	5	Brown
SBCM 8,788	12 Mar. 1932	Bonsall	5	Hanna
SBCM 19,303	18 Feb. 1928	Lakeview	7	Sechrist
SBMNH 368-3*	20 Mar. 1897	Lakeside	6	Arnold
		Orange County		
WFVZ115,182	12 Apr. 1891	Alamitos	6	Shields
WFVZ147,087	12 Mar. 1939	Near La Habra	4	Hall

* County location not given on original data slip; I presumed it was San Diego County.

sumac (*Rhus* sp.), walnut (*Juglans regia*), and grape (*Vitis girdiana*). Of 47 nests for which the original nest builder was noted, 38.3% were American Crows (*Corvus brachyrhynchos*), 25.5% "rat" (*Neotoma* sp.), 12.8% Cooper's Hawks (*Accipiter cooperii*), 12.8% Red-shouldered Hawks (*Buteo lineatus*), 6.4% Swainson's Hawks (*B. swainsoni*), and 4.3% Red-tailed Hawks (*B. jamaicensis*).

Since egg collectors frequently returned to nesting territories each year, I determined that the minimum number of localities included in the 79 historic nest records represented at least 33 different localities. Eighteen (54.5%) of these 33 localities are now densely settled urban areas, or agricultural areas, and are no longer capable of supporting nesting Long-eared Owls. Nine localities given on data slips were too general to evaluate their current potential for nesting by Long-eared Owls or could not be found on maps. Only 6 (18%) (Jamacha, Sweetwater Lake, Bandy Canyon, San Pasqual Valley, Santa Ysabel, Santa Margarita Ranch) still showed any potential (> 1 km from residential area) of being used by Long-eared Owls for nesting.

Recent studies.—Fifty observations of Long-eared Owl nesting attempts were

Table 2. Recent Long-eared Owl nest records in Orange and San Diego counties.

Date	Location/observation
Orange County	
April 1968	Weir Can., 3 km N of confluence with Santiago Can., Orange Co., CA. Five young, 2 fledged.
April 1973	Arroyo Trabuco, 0.5 km S of O'Neill Park, Orange Co., CA. Active nest (E. Lindquist pers. comm.).
1 April 1971	Weir Can., 4 km N of confluence with Santiago Can., Orange Co., CA. Five small young. 18 April 1971, 3 young.
April 1973	Fox Can., 0.5 km E of confluence with Bell Can., Starr Ranch Audubon Sanctuary, Orange Co., CA. Fledged young present.
8 April 1974	Weir Can., 4 km N of confluence with Santiago Can., Orange Co., CA. Five eggs. 10 May 1974, failed.
May 1982	0.5 km N of Blind Can., Orange Co., CA. One recently predated fledged young (J. Bryan pers. comm.).
22 May 1977	Bell Can., 0.75 km N of confluence with Crow Can., Starr Ranch Audubon Sanctuary, Orange Co., CA. Fledged young present (D. Bontrager pers. comm.).
28 April 1984	Bell Can., 0.75 km N of confluence with Crow Can., Starr Ranch Audubon Sanctuary, Orange Co., CA. Six eggs, 2 young, 4 weeks old.
24 April 1984	Canada Gobernadora, Wagon Wheel Park, Orange Co., CA. One young (G. Chester pers. comm.).
11 May 1986	Gabino Can., 2.6 km N of confluence with La Paz Can., Orange Co., CA. Five young. 27 May 1986, 1 young predated.
22 May 1988	La Paz Can., 0.5 km N of confluence with Gabino Can., Orange Co., CA. Fledged young, 2 predated by Cooper's Hawk.
April 1988	Bell Can., 1 km S of Starr Ranch Audubon Sanctuary, Casper's Wilderness Park, Orange Co., CA. Fledged young present.
11 May 1988	Canada Gobernadora, Wagon Wheel Park, Orange Co., CA. Fledged young, 1 predated by Cooper's Hawk.
18 May 1989	La Paz Can., 0.5 km N of confluence with Gabino Can., Orange Co., CA. Three fledged young, 1 predated by Cooper's Hawk.
19 April 1991	Canada Gobernadora, Wagon Wheel Park, Orange Co., CA. Three young.
18 April 1991	Cristianitos Can., 0.1 km N of confluence with Talega Can., Orange Co., CA. Four young, one of which was predated by a Red-shouldered Hawk.
29 March 1992	Cristianitos Can., 0.1 km N of confluence with Talega Can., Orange Co., CA. Two young.
29 March 1992	Cristianitos Can., 0.1 km N of confluence with Talega Can., Orange Co., CA. Three young, one of which was predated by a Red-shouldered Hawk.
12 April 1992	Gabino Can., 2.3 km N of confluence with La Paz Can., Orange Co., CA. Five young.
13 April 1992	Canada Gobernadora, Wagon Wheel Park, Orange Co., CA. Four young.
15 April 1992	Cristianitos Can., Talega Reserve, Orange Co., CA. Fledged young.
15 May 1992	Gabino Can., 2.6 km N of confluence of La Paz Can., Orange Co., CA. Three fledged young.
19 May 1992	Santiago Can., 0.25 km S of Irvine Lake, Orange Co., CA. Fledged young present.
22 May 1992	Canada Gobernadora, 0.25 km S Wagon Wheel Park, Orange Co., CA. Fledged young present.
25 May 1992	Bell Can., 0.1 km N of Fox Can., Starr Ranch Audubon Sanctuary, Orange Co., CA. Two fledged young.

Table 2. Continued.

Date	Location/observation
8 April 1992	La Paz Can., 0.5 km N of confluence with Gabino Can., Orange Co., CA. Two young.
15 April 1992	La Paz Can., 0.6 km N of confluence with Gabino Can., Orange Co., CA. Three fledged young.
1 May 1992	La Paz Can., 1.2 km N of confluence with Gabino Can., Orange Co., CA. Fledged young.
San Diego County	
21 April 1974	Horno Can., Camp Pendleton, San Diego Co., CA. Three fledged young.
10 April 1983	Lower San Onofre Can., Camp Pendleton, San Diego Co., CA. Five young. 16 April, failed due to mammal predation.
6 May 1983	Santa Margarita River, 8 km upstream from ocean, Camp Pendleton, San Diego Co., CA. Fledged 1 young.
1 April 1983	Talega Can., at confluence with Cristianitos Can., Camp Pendleton, San Diego Co., CA. One addled egg, failed.
Spring, 1988, 1989, 1990	South of Fallbrook, Hwy 76 and Gird St., San Diego Co., CA. Active nest (J. Oakley pers. comm.).
Spring 1973, 1974, 1975, 1983, 1988	Near Vista at Calveva Lake. San Diego Co., CA. Active nest (J. Oakley pers. comm.).
22 April 1983	Talega Can., 4.5 km N of confluence with Cristianitos Can., Camp Pendleton, San Diego Co., CA. Three fledged young.
4 March 1984	Talega Can., 4.5 km N of confluence with Cristianitos Can., Camp Pendleton, San Diego Co., CA. One addled egg, 4 young.
20 April 1984	Talega Can., 4.6 km N of confluence with Cristianitos Can., Camp Pendleton, San Diego Co., CA. Fledged young present.
18 May 1985	Talega Can., 4.5 km N of confluence with Cristianitos Can., Camp Pendleton, San Diego Co., CA. Failed with small young and eggs.
May 1989	Talega Can., Camp Pendleton, San Diego Co., CA. Failed with 3 small young (J. R. Bryan pers. comm.)
May 1989	Three km NE of Poway, San Diego Co., CA. Two fledged young (J. R. Bryan pers. comm.).
27 April 1991	Talega Can., 4.5 km N of confluence with Cristianitos Can., Camp Pendleton, San Diego Co., CA. Fledged young present.
16 May 1991	Talega Can., 2.6 km N of confluence with Cristianitos Can., Camp Pendleton, San Diego Co., CA. Three fledged young.
29 March 1992	Talega Can., 4.5 km N of confluence with Cristianitos Can., Camp Pendleton, San Diego Co., CA. Two Long-eared Owl eggs and 3 Cooper's Hawk eggs in the same nest being incubated by a Cooper's Hawk. Long-eared owl nesting attempt failed.
29 March 1992	Talega Can., 4.6 km N of confluence with Cristianitos Can., Camp Pendleton, San Diego Co., CA. Five young.

made in 30 different nesting territories in Orange and San Diego counties between 1968 and 1992 (Table 2). Specific surveys of known Long-eared Owl nest territories were conducted in 1991–1992. Of 20 nest territories surveyed in 1991, 6 were active and 4 of these produced young. Fourteen territories were inactive. Of 18 nest territories surveyed in 1992, 12 were active and 11 produced young. Six territories were inactive.

Of 29 nests where the identity of the original nest builders was known, 68.9, 17.2, and 13.7 percent, respectively, were in abandoned nests of Cooper's Hawks, American Crows, and Common Ravens (*Corvus corax*). Thirty nest trees were coast live oaks (*Q. agrifolia*), and 1 was a willow. The most frequently used nesting habitat was closed canopy, young, coast live oak woodland where Cooper's Hawks and American Crows nested simultaneously, or, in alternating years, with the owls. In 4 instances in 1992, 2 pairs of Long-eared Owls nested within 25–100 m of each other.

Clutch sizes ranged from 2–8 eggs; mean clutch size was not determined. Thirty-four (85%) of 40 nests were successful. Nest failures from predation of individual Long-eared Owl chicks by Cooper's Hawks and Red-shouldered Hawks was frequent, especially if they nested in the same grove (Table 2). Competition for nests was occasionally intense. On 29 March 1992, I observed an old Cooper's Hawk nest with an adult Cooper's Hawk incubating 2 Long-eared Owl eggs and 3 of its own. The presence of an agitated adult Long-eared Owl in adjacent trees suggested that the Cooper's Hawk had recently usurped the Long-eared Owl nest and eggs. The nest fledged only Cooper's Hawks. Predation by Cooper's Hawks on Long-eared Owl chicks occurred during 3 nesting attempts at 2 territories, and in at least one instance all young were taken. D. R. Bontrager (pers. comm.) also observed an instance of attempted predation by an adult Red-shouldered Hawk on a Long-eared Owl fledgling in Orange County (Table 2). Red-shouldered Hawks preyed on at least 1 young from each of four nesting attempts and on one adult. One dead young Long-eared Owl was also found in the nest of a Red-tailed Hawk (*B. jamaicensis*). Elsewhere the Red-tailed Hawk has been recorded as a predator of adult Long-eared Owls (Collins 1960).

One hundred thirty-four pellets collected from 11 Long-eared Owl territories between 1985–1992 contained 102 vertebrates including California vole (*Microtus californicus*) (39), western harvest mouse (*Reithrodontomys megalotis*) (30), Botta pocket gopher (*Thomomys bottae*) (23), white-footed mouse (*Peromyscus*) sp. (4), pocket mouse (*Perognathus*) sp. (3), ornate shrew (*Sorex ornatus*) (1), and 2 unknown passerines.

Discussion

Long-eared Owls were formerly common in San Diego and Orange counties but are now becoming increasingly rare in southern California. New and early investigators (Cooper 1870; Sharp 1907; Dawson 1923; Willett 1933) all reported the species as common in oak woodland and willow thicket habitats of southwestern California. Sharp (1907) regarded it as a "common resident" and further stated that "Up to a few years ago almost every crow's, hawk's, or rat's nest along the river in San Pasqual had its pair of owls." Grinnell and Miller (1944) described the status of Long-eared Owls in California as "numbers are so large as to warrant term "common," even "abundant" locally. Reduction of late years

is apparent, in the main probably mainly as result of clearing bottomlands for farming." Marti and Marks (1989) noted that the species is declining in California, and Garrett and Dunn (1981) stated that the Long-eared Owl has "virtually been eliminated there [in southern California] as a breeder." Unitt (1984) provided further documentation of the scarcity of recent San Diego County breeding records for this species and its substantial decline, stating that the species now nests only in the Anza Borrego Desert. He placed the last known coastal San Diego County breeding record at that time (1984) as 13 May 1973 near Oceanside.

The known present breeding population and historic distribution as determined from recent surveys and egg collections from two southern California counties suggest the Long-eared Owl has declined by at least 55% and possibly as much as 82%. Based upon recent habitat use trends in Orange County, the species will probably continue to decline. Of 112,195 ha (277,234 ac) of potential Long-eared Owl breeding habitat available under the categories of "open space" and "vacant" (County of Orange 1974) in 1972, only 94,982 ha (234,701 ac), representing a 15.3% decline, were still available in 1990 (County of Orange 1993). The reduction of active nesting territories is directly attributable to habitat change; however, a limited quantity of unsurveyed potential nesting habitat exists within the Cleveland National Forest which, when coupled with county, state park, National Audubon Society, and private conservancy acreages, may afford some continuing protection for owls within Orange and San Diego Counties. Presently, no Long-eared Owl breeding activity is known in any Orange County ranch or parklands west of the I-5 freeway. However, potential habitat remains there, and much of it may be designated as wilderness park additions. If so, these areas may yet be able to support a few breeding pairs of Long-eared Owls. The species was extirpated in most of western San Diego County west of I-15 with the exception of Camp Pendleton, and possibly portions of the San Luis Rey River, Santa Margarita River, and Fallbrook vicinity (Fig. 1). Most notable is the lack of any recent nesting records from the San Diego vicinity that was referred to by Grinnell and Miller (1944) as one of three "centers of abundance" in California and an area from which a minimum of 36 historic nesting records are known within 25 km of San Diego (Table 1, Fig. 1). The only hints of continued nesting activity in this area is from Cedar Canyon, east of San Diego, where a recently killed Long-eared Owl was found in summer, and 4 roosting owls were found in winter in the Proctor Valley, Otay Ranch area (Preston et al. 1992). Unitt (1984) also referred to records of roosting Long-eared Owls on the coastal slope with a maximum of 12 at Rancho Otay in 1979.

Based upon observations of 7 adults at different spring locations (1972–1992), I suspect that Camp Pendleton may still support several breeding pairs of Long-eared Owls along the Santa Margarita River between the coastal estuary and the confluence of De Luz Creek, and in the Santa Margarita Mountains near Case Springs. However, after 20 years of nesting raptor surveys which resulted in only 7 confirmed Long-eared Owl breeding territories I suspect the population is small (Table 2). One of the above territories has been inactive since 1974, and 2 have been inactive since 1983.

Long-eared Owls use a variety of vacant raptor and corvid nests and do not build their own. Hence, as numbers of other raptors decline so do opportunities for surplus nest structures that the owls depend upon. For example, 3 historic

nest sites in San Diego County were built by Swainson's Hawks, a species Sharp (1902) called formerly "abundant" near Escondido. Swainson's Hawks are now completely extirpated from coastal southern California (Bloom 1980; Risebrough et al. 1990). As competition between raptors for increasingly smaller areas of nesting habitat and nest sites grows, so will the potential for predation on Long-eared Owls, as exemplified by the observed interactions with adjacent nesting Cooper's Hawks and Red-shouldered Hawks.

Crow and raven breeding populations are large and probably increasing on the study area (pers. observ.). Although nest site availability may be proportionately greater now than historically due to increased numbers of nesting ravens, the degree of predation exerted by ravens on breeding Long-eared Owls may be an additional important factor in the decline of the owl. It is interesting that none of 69 historic Long-eared Owl nests were built by ravens, yet 13.7% of 29 recent nests were built by this species.

Compared with nest success studies in Idaho (34–51%) (Marks 1986) and Oregon (70%) (Bull et al. 1989) the 85% nest success reported in this study is high and may in part be attributable to the inclusion of nests discovered late in the season which could have inflated nesting success. It may also be due to nesting habitat quality. As suggested by Bull et al. (1989) on their coniferous Oregon study area, dense canopy cover probably reduces predation. The majority of territories in my study were composed of dense, closed canopy oak woodland which probably afforded greater protection from predation than shrubsteppe habitats in Idaho (Marks 1986). Higher quality foraging habitat would also be expected to increase nesting success.

The high proportion of small rodents found in Long-eared Owl diets in this study was similar to that found elsewhere in the United States, with voles and gophers predominating (Marti 1976; Craig and Trost 1979; Marks and Yensen 1980; Bull et al. 1989). However, as would be expected due to different habitats, they were distinct from Long-eared Owl diets in the Colorado Desert of California where pocket mice and kangaroo rats (*Dipodomys* sp.) were dominant (Barrows 1989).

Although I did not perform a rigorous analysis of Long-eared Owl nesting and foraging habitat, all territories contained substantial quantities of grasslands within 1 km of oak woodland and riparian nesting habitat where voles and gophers could be caught, suggesting that adjacent grasslands were important in the selection by Long-eared Owls of nest sites.

The destruction of grassland foraging habitat in spite of the preservation of small riparian and oak woodland nesting habitats has probably contributed to the Long-eared Owl's decline in southern California. Preservation of substantial open space reserves that contain both nest groves and adequate foraging habitats may yet prevent the local extirpation of this wide ranging owl species.

Acknowledgments

Rancho Mission Viejo, Western Foundation of Vertebrate Zoology, and the National Audubon Society provided funding for this study and are gratefully acknowledged. D. L. O'Neill and R. J. O'Neill are thanked for the numerous ways they supported the research. The field assistance of R. Jackson, E. H. Henckel, J. L. Henckel, R. J. Morales, and D. L. O'Neill was very helpful. Special thanks go

to D. R. Bontrager, G. Chester, J. R. Bryan, J. A. Chubb, E. Lindquist, and J. Oakley for the use of unpublished observations. The assistance of L. Smith with records from Orange County is appreciated. Constructive comments were provided by C. T. Collins, J. S. Marks, C. D. Marti, M. L. Morrison, and L. F. Kiff. T. Danufsky (SBMNH), L. F. Kiff (WFVZ), G. Cardiff (SBCM), and N. K. Johnson (MVZ) are thanked for making museum records available.

Literature Cited

- Barrows, C. W. 1989. Diets of five species of desert owls. *Western Birds*, 20:1-10.
- Bent, A. C. 1938. Life histories of North American birds of prey. *U.S. Nat. Mus. Bull.*, 170:1-482.
- Bloom, P. H. 1980. The status of Swainson's Hawk in California, 1979. Final report II-8.0, Bureau of Land Management and Federal Aid in Wildlife Restoration, Project W-54-R-12, California Department of Fish and Game. The Resources Agency, California Department of Fish and Game, and Bureau of Land Management, Sacramento, California, 42 pp.
- . 1987. Capturing and handling raptors. National Wildlife Federation. *Raptor Management Techniques Manual*. Pp. 99-123.
- . 1989. Red-shouldered Hawk home range and habitat use in southern California. M.Sc. thesis. California State Univ., Long Beach.
- Bosakowski, T., R. Kane, and D. G. Smith. 1989. Decline of the Long-eared Owl in New Jersey. *Wilson Bull.*, 101:481-485.
- Bull, E. L., M. G. Henjum, and A. L. Wright. 1989. Nesting and diet of Long-eared Owls in conifer forests, Oregon. *Condor*, 91:908-912.
- Burton, J. A., ed. 1984. *Owls of the world*. Tanager Books, Dover, New Hampshire. 208 pp.
- Clark, R. J., and D. Klem, Jr. 1986. An overview of endangered declining birds of Pennsylvania and adjacent states. Pp. 211-233 in *Endangered and threatened species programs in Pennsylvania and other states: causes issues, and management*. (S. K. Majumdar, F. J. Brenner, and A. F. Rhoades, eds.), Pa. Acad. Sci., Philadelphia.
- Collins, C. T. 1962. Red-tailed Hawk attacks Long-eared Owl. *The Wilson Bull.*, 74:89.
- Cooper, J. G. 1870. Ornithology, vol. 1, Land birds. Pp. 426-427 in *Geological survey of California*. (S. F. Baird, ed.), Univ. Press, Cambridge, Massachusetts.
- County of Orange. 1974. Orange County progress report, October 1974. Vol. 11.
- . 1993. Orange County progress report, January 1993. Vol. 27.
- Craig, T. H., and C. H. Trost. 1979. The biology and nesting density of breeding American Kestrels and Long-eared Owls on the Big Lost River, southeastern Idaho. *Wilson Bull.*, 91:50-61.
- Dawson, W. L. 1923. The birds of California. 3:1080-1087. South Moulton Company, San Diego, California.
- Garrett, K., and J. Dunn. 1981. *Birds of southern California: status and distribution*. The Artisan Press, Los Angeles, California. 408 pp.
- Grinnell, J., and A. H. Miller. 1944. The distribution of the birds of California. *Pacific Coast Avifauna* No. 27.
- Johnsgard, P. A. 1988. *North American Owls Biology and Natural History*. Smithsonian Institution Press. Washington D.C., 295 pp.
- Marks, J. S., and E. Yensen. 1980. Nesting sites and food habits of Long-eared Owls in southwestern Idaho. *Murrelet*, 61:86-91.
- . 1986. Nest-site characteristics and reproductive success of Long-eared Owls in southwestern Idaho. *Wilson Bull.*, 98:547-560.
- Marti, C. D. 1976. A review of prey selection by the Long-eared Owl. *Condor*, 78:331-336.
- , and J. S. Marks. 1989. Raptor status reports: medium-sized owls. Pp. 123-134 in *Proc. western raptor management symposium and workshop*. (B. G. Pendleton, ed.), Natl. Wildl. Fed., Washington, D.C.
- Preston, K. L., J. C. Lovio, and P. J. Mock. 1992. Otay Ranch Management Study. Ogden Environmental and Energy Services Co., 37 pp.
- Risebrough, R. W., R. Schlorff, P. H. Bloom, and E. Litrell. 1990. Investigations of the decline of Swainson's Hawk populations in California. *J. of Raptor Res.*, 23:63-71.
- Sharp, C. S. 1902. Nesting of Swainson's Hawk. *The Condor*, 4:116-118.

- . 1907. The breeding birds of Escondido. *The Condor*, 9:84–88.
- Smith, J. C., M. J. Smith, B. L. Hilliard, and L. R. Powers. 1983. Trapping techniques, handling methods, and equipment use in biotelemetry study of Long-eared Owls. *N. Amer. Bird Band.*, 8:46–47.
- Unitt, P. 1984. The birds of San Diego County. *Memoir 13. San Diego Society of Natural History*, 276 pp.
- Willett, G. 1933. A revised list of the birds of southern California. *Pacific Coast Avifauna Number 21*, 204 pp.

Accepted for publication 23 April 1993.

Occurrence and Habitat Use of Marine Mammals at Santa Catalina Island, California from 1983-91

Susan H. Shane

West Coast Whale Research Foundation, 250 Cottini Way,
Santa Cruz, California 95060

Abstract.—A nine-winter-long study (1983-91) of marine mammals at Santa Catalina Island, California provided data on the ecological relationships among three pinniped and nine cetacean species observed there. A dramatic reduction in the number of California sea lions occurred during and following the winter with the most severe effects from the 1983 El Niño. The most striking change in cetacean occurrence was a precipitous decline in pilot whale numbers followed by an increase in abundance of Risso's dolphins. The six most often-sighted cetaceans appeared to partition the habitat according to water depth and distance from shore.

Long-term data on the occurrence and habitat use of several marine mammal species at one geographical location are relatively rare. Such data were accumulated on nine species of cetaceans and three species of pinnipeds at Santa Catalina Island, California during nine consecutive winters (1983-91). While this study originally focused on short-finned pilot whale (*Globicephala macrorhynchus*) social organization, its other objectives were: 1) to record which species were present at the island during each winter and 2) to identify habitat use patterns for each species (Shane 1984). The severe El Niño (EN) event of 1983, one of the strongest in over four centuries (Quinn et al. 1987), had its greatest impact on the study area during the second year of the project, 1983-4 (McGowan 1985). Thus, EN served as a natural experiment with the potential for exerting a profound influence on marine mammals at Santa Catalina.

The length of this study and the consistency of techniques and primary observer make the data collected particularly useful for understanding aspects of the ecological relationships among the species observed, as well as showing changes in their occurrence over time. The only other comprehensive data on marine mammals in the southern California Bight were collected opportunistically by Norris and Prescott (1961) and systematically during Outer Continental Shelf surveys in the mid-1970's by Dohl et al. (1981) and Bonnell et al. (1981).

Methods

Santa Catalina Island (118°30'W, 33°26'N), henceforth called Catalina Island, is located approximately 40 km offshore of the Los Angeles area in the southern California Bight (SCB) (Fig. 1). This 33 km-long island lies in a northwest-southeast orientation and has 86 km of shoreline. The waters surrounding the island are almost continually enriched by the Southern California Eddy (Owen 1980). Catalina is located in a boundary area south of which coastal upwelling occurs

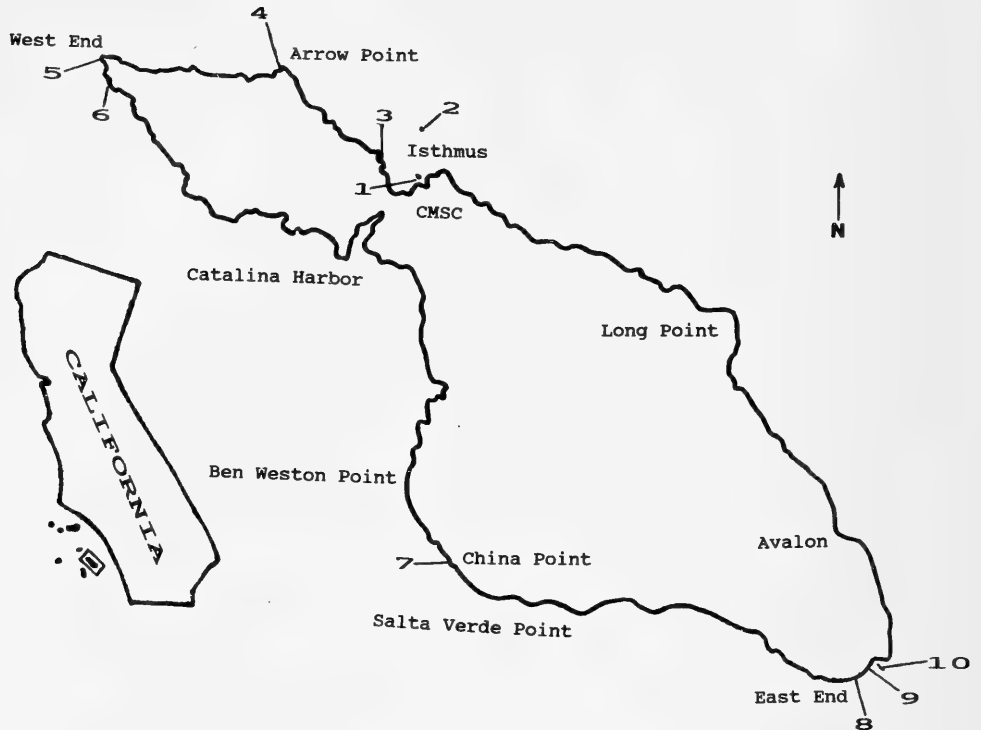


Fig. 1. Santa Catalina Island, California, located 42 km south of Los Angeles. Sites #1-10 are haul-out areas used by California sea lions in 1983-91. CMSC = Catalina Marine Science Center (base port for this study).

nearly year-round and north of which winds produce onshore transport and downwelling (Norton et al. 1985). The water depth at a distance of 1 km offshore varies between 55 and 183 m. Long-term (1942-81) average sea surface temperatures (SST) around Catalina range from a February low of 13.5°C to an August high of 19.4°C (NOAA 1982).

All marine mammals sighted were recorded. Marine mammals were observed primarily from a 5.1 m Boston Whaler with an 85 hp or 70 hp outboard engine. Boat searches involved traveling at approximately 15-25 km/h between 0.4 and 1.6 km offshore with one observer scanning the inshore 180 degrees and a second observer scanning the offshore 180 degrees. A few sightings were made from land at the Catalina Marine Science Center (CMSC) (Fig. 1), from a single-engine, high-wing aircraft (altitude = 213-240 m, speed = 90 nm/h, 2-4 km offshore, N = 6 flights), and from a boat crossing the San Pedro Channel between the mainland and the island.

The amount of time spent at Catalina each winter varied from as long as four months to as short as three days. A relative measure of search effort is indicated by the number of days and hours spent searching for marine mammals and the number of times the island was circumnavigated in the boat each year (Table 1).

The abundance and location of all pinnipeds sighted were recorded. California sea lions (*Zalophus californianus*) were counted both in the water and on land at

Table 1. Marine mammal search effort at Santa Catalina Island, CA. (circum. = circumnavigations.)

Dates in field	Time spent searching		No. of circum. in boat
	Days	Hours	
10 Jan.–21 Mar. 1983	50	145	1
5 Dec. 1983–26 Mar. 1984	92	180	12
15–19 Nov. and 30 Nov. 1984–11 Mar. 1985	97	353	28
6–12 Feb. 1986	7	37	4
20–27 Jan. 1987	8	40	5
1–8 Feb. 1988	7	42	5
27 Jan.–3 Feb. 1989	8	46	4
15–18 Feb. 1990	3	17	3
28 Jan.–3 Feb. 1991	8	45	3

several regular haul-out sites around the island (Fig. 1). All harbor seals (*Phoca vitulina*) observed incidentally in the water and hauled out were counted. Additionally, harbor seals were sought out and counted at all haul-out sites around the island one time in each of six years. An incomplete survey was conducted in a seventh year.

Dead marine mammals were always recorded. In 1983 an unusually large number of dead sea lions (51) was recorded and necropsies performed on 24 of them.

Cetacean records included the date, time, location, species, total number of individuals, number of calves, water depth, distance offshore, direction of travel, and activity. To determine in an unbiased manner whether the short field seasons from 1986 onward were sufficient for sighting most cetacean species present in a given year, a random numbers table was used to randomly select days in the field each year. The number of new species seen on each day was recorded. During each of the years with short field seasons (1986–91), one hundred percent of the cetaceans were sighted within two to seven field days (mean = 4.2 days; S.D. = 1.72 days). During the two typical years with long field seasons (1983–4 and 1984–5), 83% and 71%, respectively, of the species were seen within two to seven field days. The species missed by the random sampling procedure in these two years were rare (seen once or, in one case, seven times) during that year. Data from the long 1983 field season are not equivalent to those in other years, since most of the field time was spent at the Isthmus and the island was circumnavigated only once, possibly reducing the chances of seeing many different species. Thus, it was concluded that one week of field time was sufficient for deciding whether pilot whales, as well as the other most frequently-seen species (Risso's dolphins, *Grampus griseus*, gray whales, *Eschrichtius robustus*, bottlenose dolphins, *Tursiops truncatus*, and Pacific white-sided dolphins, *Lagenorhynchus obliquidens*) occurred in a given year. Except for 1990, no field season was shorter than seven days (Table 1).

Methods of measuring water depth varied from year to year. In 1984–5 and 1988–91 water depth was recorded using a fathometer (either a Si-Tex Honda HE-300 with a maximum depth of 480 ft. [146 m] or a Humminbird LCR400 with a maximum depth of 600 ft. [183 m]). Depth values are missing from sightings made from land, air, and from occasional sightings made from the boat. In 1983–

4 depth was taken from a nautical chart based upon triangulation from the sighting location. No depth data were collected in 1986 or 1987.

Distance from shore was estimated according to the following seven categories: less than 0.1 km, 0.1–0.4 km, 0.4–0.8 km, 0.8–1.6 km, 1.6–2.4 km, 2.4–3.2 km, and over 3.2 km. Distance estimates were calibrated using known distances between landmarks.

Cetacean activity was recorded upon first encountering a group. Activities included traveling, feeding, resting, socializing, social traveling, and bowriding. Traveling involved forward progress in one direction. Feeding was recorded when animals dove repeatedly in one area, facing in varying directions when surfacing. Resting animals either floated at the surface or swam very slowly in one direction. Socializing involved frequent body contact between animals and, often, surface behavior such as leaping and slapping.

Photographs were taken of pilot whales, bottlenose dolphins, and Risso's dolphins for individual identification. This paper includes only the results of the bottlenose dolphin photo-identification effort. Kodachrome 64, Kodachrome 200 color transparency and Tri-X black and white films were used in a Canon AE-1 camera equipped with a 70–210 mm, 80–300 mm or 70–200 mm lens.

Results

The results of this study need to be viewed with reference to the 1983 EN event which exerted a strong influence on oceanographic conditions and marine fauna off southern California. Satellite-derived sea surface temperatures (SST) at Catalina Island during this study are plotted with reference to normal SST recorded by NOAA (1982) in Fig. 2. The SST during the period of this study were generally warmer than normal, as was found by Strong (1989). However, this apparent warming trend is attributed to biases in satellite data by Reynolds et al. (1989). The 1983 EN clearly had the strongest effect on SST at Catalina in 1983–4, and the marine mammal occurrence data reflect that. A second, moderate EN occurred in 1987 (Quinn et al. 1987).

Pinnipeds

The abundance of California sea lions at Catalina changed during the study period (Table 2). Counts of over 800 sea lions in 1983 dropped to about 200 or less in ensuing years, starting in 1983–4 when EN's impact in the area was greatest.

Sea lion distribution varied somewhat over the years of this study (Table 2). While sea lions in varying numbers always hauled out at Catalina's East End, additional large numbers hauled out at several other sites which usually, though not always, coincided with the area where commercial squid boats were fishing (Fig. 1). Sea lion haul-outs typically were small rocky islands, large boulders or rocky outcrops along shore. The sole exception was a sandy beach at the East End used only in 1983, 1983–4, and 1991.

While sea lion age class and gender were not consistently recorded, subadult males, yearlings, juveniles and adult females all occurred at Catalina throughout the study period. California sea lions do not produce pups on Catalina.

In January–March 1983 squid fisherman were observed shooting at California sea lions, because they considered the animals a threat to their livelihoods. Necropsies were performed on 24 of 51 dead sea lions observed. Sixty-three percent

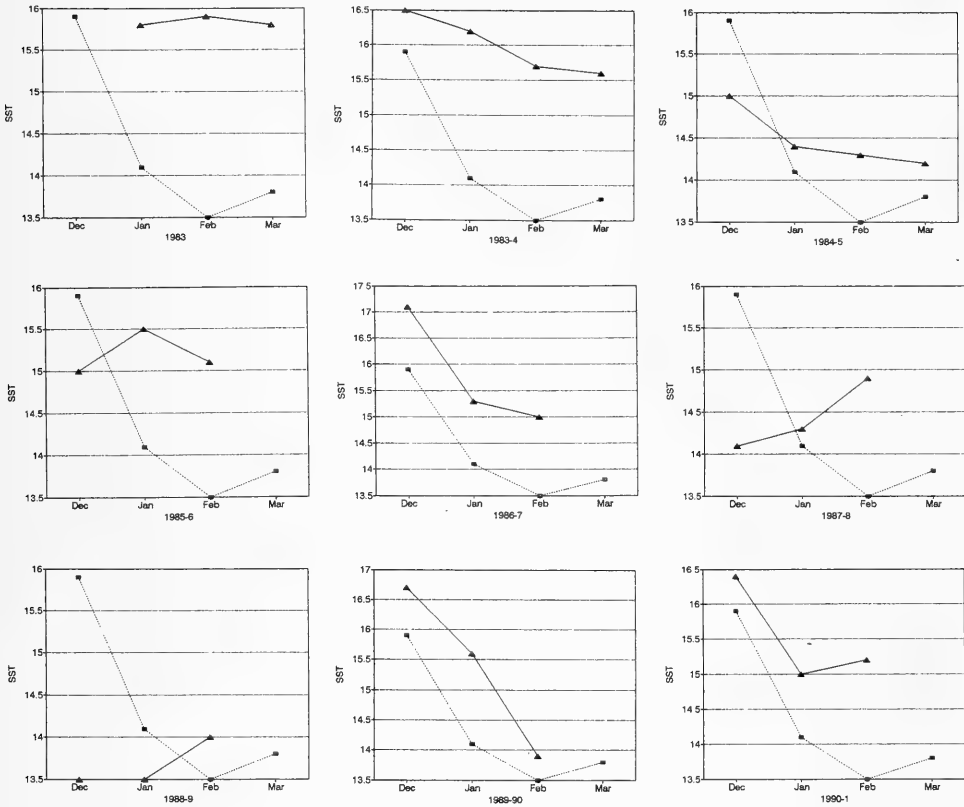


Fig. 2. Sea surface temperatures (SST) (solid line with filled triangles) in °C at Catalina Island, California, in nine winters from 1983 to 1991 (NOAA 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991). For comparison, each graph shows the normal monthly SST (dashed line with filled squares) which is an average of data from 1942–81 (NOAA 1982).

(15/24) of these showed positive or probable evidence of gunshot wounds: shattered bones or skulls, shredded internal organs, and bullet holes. Sightings of dead sea lions were rare in the ensuing eight winters, probably because there were fewer sea lions at the island to conflict with squid fishing and because squid fishing was never again concentrated near the base port (where dead sea lions were readily found) as it was in 1983.

California sea lions were observed swimming with cetaceans, most commonly bottlenose dolphins, pilot whales, and Risso’s dolphins. While these associations sometimes occurred in the prime squid fishing area for a given year, such associations, especially with bottlenose dolphins, also occurred in areas apart from the squid fishing fleet.

Harbor seals hauled out in small groups (< 10) at several sites around Catalina and also were seen in the water. The most consistently-used haul-out area was the East End where boulders along the shore were used. Adult females hauled out on Catalina’s southwestern beaches to bear pups beginning in February each year. Most of these beaches are small, sandy, secluded, surrounded by high cliffs, and located between Ben Weston Point and Salta Verde Point (Fig. 1). The results of

Table 2. Maximum counts of California sea lions during the winters of 1983–91. The primary haul-out areas for each year refer to sites labeled with numbers on Fig. 1. (* = in water near commercial squid boats.)

Year	Max. count	Date of count	Primary haulouts
1983	898	14 Feb.	1, 8, 9, 10
1983–84	240	24 Jan.	9
1984–85	108	7 Feb.	*
1986	113	11 Feb.	7
1987	135	26 Jan.	6
1988	250	4 Feb.	6, 10, *
1989	249	3 Feb.	7
1990	204	15 Feb.	6, 7, 10
1991	220	31 Jan.	6, 7, 9, 10

the annual harbor seal counts varied depending upon the timing of pup production for that year and the timing of the count (Table 3).

Although northern elephant seals (*Mirounga angustirostris*) were not found regularly at Catalina, a total of five elephant seals were observed there during the study. Weanling-sized pups were seen in 1983, 1983–4, and 1985. One hauled out just north of Ben Weston Point for one month. Another weanling hauled out with a 23 cm-diameter fresh shark bite on its body. Yearling-sized seals were seen twice in December, 1984.

Cetaceans

Nine species of cetaceans were sighted around Catalina during 1983–91 (Tables 4–5). Gray whales and bottlenose dolphins were observed every year, and Risso's dolphins, Pacific white-sided dolphins and common dolphins (*Delphinus delphis*) were sighted in most years. Pilot whale sightings became rarer as the study progressed (Table 5). Sperm whales (*Physeter catodon*) and northern right whale dolphins (*Lissodelphis borealis*) were seen once each, and Dall's porpoises (*Phocoenoides dalli*) were seen three times. Changes in occurrence and relative abundance of the five most frequently-sighted species (excluding pilot whales) can be seen by looking at the number of sightings per hour for each species in each year (Fig. 3).

Group size.—The average group size varied considerably among species with

Table 3. Total counts of harbor seals in the water and hauled out around Catalina Island, CA, during winter in 1984–91. No counts were made in 1983 or 1987. Tidal state during the count is described with the relative tidal height given in parentheses. (int. = intermediate; * = incomplete count.)

	3/4/84	3/9/85	2/11/86	2/2/88	2/1/89	2/15/90	1/30/91
# Adults	91	144	37	109	—	211	52
# Pups	57	64	7	12	—	56	1
Total #	148	208	44*	121	79	267	53
Tide	falling (high)	high	rising (high)	falling (low)	falling (low)	falling (int.)	falling (int.)

Table 4. Total number of sightings of cetaceans (except pilot whales) at Catalina Island, CA, in 1983–91.

Species	Year								
	83	83–84	84–85	86	87	88	89	90	91
Gray whale	17	44	88	14	14	1	8	2	7
Bottlenose dolphin	22	10	74	6	6	5	15	1	10
Risso's dolphin	0	3	2	3	30	7	18	1	8
Pacific white-sided dolphin	2	13	24	3	0	1	0	0	0
Common dolphin	2	8	7	1	2	3	1	0	0
Dall's porpoise	0	0	1	0	0	1	0	0	1
Northern right whale dolphin	0	0	0	0	0	1	0	0	0
Sperm whale	1	0	0	0	0	0	0	0	0

common dolphins having the largest groups ($\bar{x} = 67.1$) and gray whales having the smallest groups ($\bar{x} = 1.8$) of those cetaceans seen regularly (Table 6).

Water depth.—While there was considerable overlap in the depths occupied by different species, certain patterns were apparent. Common dolphins were seen consistently in the deepest water, while pilot whales were found in the shallowest water (Table 7). Bottlenose dolphins frequented the greatest range of depths. Because the fathometers used had limits of 146 m and 183 m in range, occasions on which cetaceans were in deeper waters are excluded from this analysis, except in 1983–4 when depth was calculated using a nautical chart and triangulation. Thus, although there is a bias toward shallower water in the mean values presented in Table 7, it is a bias which applies to all species, so the depths are an accurate representation of relative cetacean distribution by depth.

Distance offshore.—As Fig. 4 shows, the distribution of the six most frequently-seen species with respect to distance offshore closely followed the pattern established with relation to water depth. Common dolphins were sighted farthest offshore, while pilot whales were restricted to less than 1.6 km from shore. Both Pacific white-sided dolphins and Risso's dolphins were more frequently seen less than 1.6 km out, while bottlenose dolphins and gray whales were observed over the entire range of distances surveyed.

Activity.—Traveling was the most frequently-recorded activity for each of the five most often-sighted species (excluding pilot whales whose behavior was analyzed separately), accounting for 68–93% of all activities recorded. Bottlenose dolphins and Risso's dolphins exhibited the widest range of activities, each performing each recorded activity at least once. Generally, there were too few records of each activity to adequately describe the behavior of the five species considered.

Table 5. Highest daily counts of short-finned pilot whales sighted at Catalina Island, CA, and the number of days on which pilot whales were seen in 1983–91.

	Year								
	83	83–84	84–85	86	87	88	89	90	91
# Whales	100	17	20	33	0	0	16	0	0
# Days	27	1	30	2	0	0	1	0	0

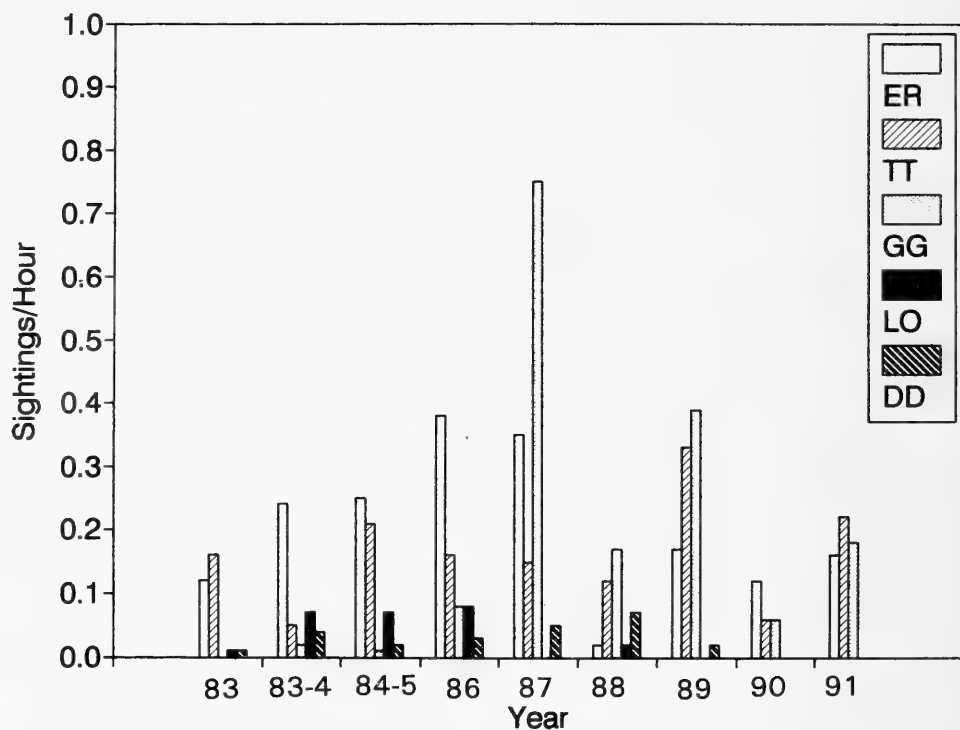


Fig. 3. Number of sightings per hour of field time for frequently-sighted species of cetaceans at Catalina Island, CA, in 1983-91. Species abbreviations: ER = gray whale; TT = bottlenose dolphin; GG = Risso's dolphin; LO = Pacific white-sided dolphin; DD = common dolphin.

The only other cetacean activity of note occurred when gray whales were socializing and exhibiting surface behavior. On seven of the nine such occasions other species, including bottlenose dolphins ($N = 7$), pilot whales ($N = 1$), Risso's dolphins ($N = 1$), and California sea lions ($N = 2$), joined the socializing gray whales, often abandoning their previous behavior to do so. These attendant species usually exhibited a high level of arousal (leaping, rapid swimming) that corresponded to the activity of the large whales.

Table 6. Group size for nine species of cetaceans seen at Catalina Island, CA, in 1983-91. (N = number of groups sighted.)

Species	Mean	Std	Median	Min	Max	N
Common dolphin	67.1	91.37	30	2	300	24
Pilot whale	14.0	6.20	15	2	33	62
Risso's dolphin	13.1	13.60	10	1	100	72
Pacific white-sided dolphin	10.3	7.64	8	1	30	43
Bottlenose dolphin	8.3	6.85	6	1	30	149
Dall's porpoise	4.7	1.15	4	4	6	3
Northern right whale dolphin	2	—	—	—	—	1
Gray whale	1.8	1.05	1	1	7	195
Sperm whale	1	—	—	—	—	1

Table 7. Mean water depth (in meters) in which six species of cetaceans were seen at Catalina Island, CA, in 1983–91. No water depth data are available for the other cetaceans sighted. (N = number of sightings with depth recorded.)

Species	Mean	Std	N
Common dolphin	176.0	107.05	10
Pacific white-sided dolphin	98.3	57.75	25
Bottlenose dolphin	92.8	125.31	86
Gray whale	83.5	65.15	82
Risso's dolphin	69.6	23.38	22
Pilot whale	39.6	19.47	27

Direction of travel: gray whales.—Gray whales were observed en route to and from Mexican waters during their annual migration. Generally, whales moved southward before 15 February and northward after that. For instance, during the three long seasons, 100% (1983), 91% (1983–4) and 97% (1984–5) of the gray

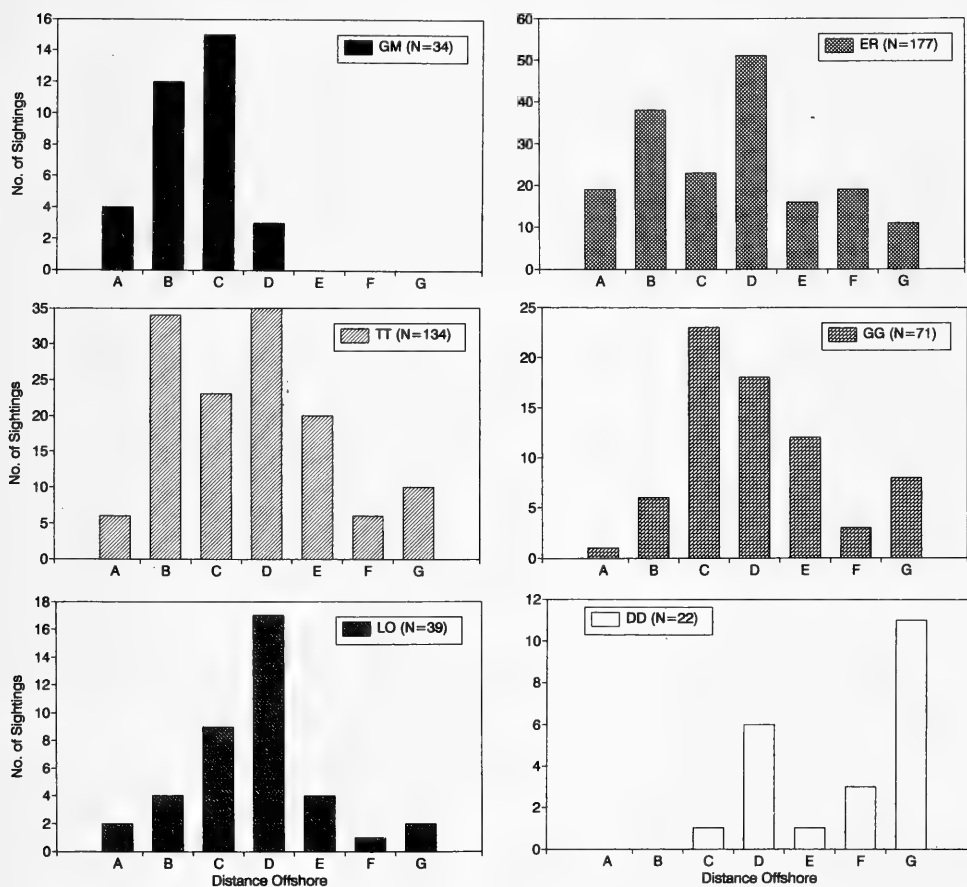


Fig. 4. Frequency of sightings of six cetaceans at varying distances from shore around Catalina Island, CA, in 1983–91. Species abbreviations are as in Fig. 3 (also GM = pilot whale). Distance offshore: A = 0–0.1 km; B = 0.1–0.4 km; C = 0.4–0.8 km; D = 0.8–1.6 km; E = 1.6–2.4 km; F = 2.4–3.2 km; G = over 3.2 km.

whales sighted traveling southward were seen before 15 February, and 100% (1983), 100% (1983–4) and 76% (1984–5) of the northward traveling whales were seen after that date. Of the 170 records for which direction of travel was recorded, the earliest record of southward movement was 31 December (1984) and the latest record of southward travel was 4 March (1984). The earliest northward traveling gray whale was seen on 31 December (1984), while the latest northward migrator was observed on 20 March (1984) (note that the field seasons always ended by 26 March).

Bottlenose dolphin association with other species.—Bottlenose dolphins were associated with other cetaceans on 81 of 149 sightings (54%). These associations involved pilot whales (N = 57), Risso's dolphins (N = 14), gray whales (N = 8), pilot whales and gray whales together (N = 1), and the lone sperm whale (N = 1).

In winter 1984–5 the association between bottlenose dolphins and a single pod of 20 pilot whales monitored for 30 days was observed closely. Dolphins accompanied the whales on 24 of those 30 days. Most often, the dolphins intermingled with the pilot whales when the latter were feeding. Frequently, dolphins appeared suddenly when the whales began to feed.

Whenever the two species initially were observed separately and later seen joining together, it was clearly the dolphins which joined the pilot whales and not vice versa. On six occasions (five days), the pilot whales formed a tight group, moved closer to shore than previously (ending up 50–200 m offshore five times), and occasionally changed direction, when bottlenose dolphins appeared in the vicinity. The whales' behavior was interpreted to represent an attempt to avoid discovery by the dolphins. The dolphins never joined the whales on three of these occasions. They did join together twice, and one occasion was inconclusive. The dolphins usually left the pilot whales when the latter stopped feeding.

Bottlenose dolphin photo-identification project.—Bottlenose dolphins are far more difficult to photograph at Catalina than in Texas or Florida where other studies were conducted (Shane 1980, 1987, 1990a). This difficulty arises from the fact that the dolphins at Catalina move faster, form less cohesive groups, and change direction more often and more erratically than the dolphins studied in the Gulf of Mexico. These characteristics, plus the fact that bottlenose dolphins were not the focal study species at Catalina, account for the relatively small number of photo-identified dolphins (Table 8). Of the 50 recognizable individuals, 36 were seen only once. Seven individuals were identified in two winters and one in three winters. Six dolphins were seen two to three times during a single year.

Discussion

Pinnipeds

The annual study period coincided with different periods in the reproductive cycles of the three pinniped species encountered. It was the non-breeding period for California sea lions, whereas it was the breeding time for harbor seals and northern elephant seals (Bartholomew and Boolootian 1960; Odell 1971).

While most adult and subadult male California sea lions typically move northward from the California Channel Islands in the non-breeding season (Bartholomew and Boolootian 1960; Orr and Poulter 1965), the sightings at Catalina show that some may stay in the relative vicinity of the breeding areas. Catalina is only

Table 8. Sightings of 14 photo-identified bottlenose dolphins seen on more than one day at Catalina Island, CA, in 1983–91. The numbers under each year indicate the number of days that individual was seen that year. The other 36 photo-identified dolphins were each seen once.

ID #	83	83–84	84–85	86	87	88	89	90	91
1		2	5	1					
2		1	2						
3	1	1							
4	1		1						
6		1	1						
7			2						
8			3						
9			2						
10						1	1		
11									3
14	1		1						
17		1	1						
18			2						
23			2						

35–40 km from two breeding islands, San Clemente and Santa Barbara. Conceivably, some males also may move to Catalina from Mexico during the winter (Bartholomew and Boolootian 1960). The presence of adult female and young *Zalophus* at Catalina in winter corresponds with the hypothesis that these animals either remain at the breeding sites or move southward in fall through spring (Bartholomew and Boolootian 1960; Orr and Poulter 1965).

The largest change in counts of California sea lions occurred after the first year of the study. In seven of the nine years many sea lions aggregated where commercial squid fishermen were catching squid, suggesting that market squid (*Loligo opalescens*) is an important prey item at Catalina. Market squid was the sixth most abundant prey item in terms of percent occurrence for California sea lions at San Clemente Island in 1981–6 (Lowry et al. 1990), and it was the fifth most abundant prey for sea lions at San Nicolas Island in 1981–6 (Lowry et al. 1991). Antonelis et al. (1984) also identified market squid as one of the four most important prey items for sea lions at San Miguel Island. EN had its most severe effect on market squid catches around Catalina in 1984 (Table 9). The lowest sea lion counts at Catalina were just above 100 in 1984–5, 1986, and 1987. Residual EN effects also were found by DeLong et al. (1991) who reported that pup numbers in the Channel Islands were still below 1982 levels in 1986. While Francis and Heath (1991) noted no significant change in numbers of adult and subadult males at San Nicolas Island from 1981 through 1984, the number of adult females there did decline during that period. DeLong et al. (1991), noting this decrease in female abundance, could not determine whether females died or moved to other sites in the SCB or in Mexico. Thus, the smaller number of sea lions at Catalina may have been a reflection of the large-scale population effects of the 1983 EN event. A longer study by Lowry et al. (1992) recorded a steady increase in California sea lion pup numbers during censuses at several Channel Islands from 1984–92. The fact that sea lion counts at Catalina in 1991 were still at one-quarter of their 1983 levels suggests that either there was an unusual influx of sea lions to Catalina in 1983 or that EN caused a long-term shift in winter distribution away from Cat-

Table 9. Landings of market squid (*Loligo opalescens*) in the Los Angeles area, much of which is caught around Catalina Island, CA (California Dept. of Fish and Game, Statistics, Long Beach, CA 90802, pers. comm.).

Year	Total in tons
1977-1981 (avg.)	8235
1982	4729
1983	941
1984	73
1985	3414
1986	8956
1987	5976
1988	16,634
1989	18,027
1990	10,797
1991	13,566

alina. The latter hypothesis seems more likely in light of the fact that, according to McGowan (1985), "the biological response [to EN in the SCB as of March 1983] was quite modest" despite increased SST, a depressed thermocline and decreased salinity.

Whole-island harbor seal counts varied from 53 (1991) to 267 (1990). The counts were made prior to peak pupping in 1988, 1989, and 1991, possibly accounting for lower counts in those years. Pupping apparently occurred quite early in 1990, and the 1984 and 1985 counts, both made in March, may have been lower than the 1990 total as a consequence of EN. However, variation in haul-out patterns according to time of day and other factors may make interannual comparisons invalid (LeBoeuf and Bonnell 1980). Tidal state did not correlate with year-to-year fluctuations in seal numbers at Catalina (Table 3), but the small number of seal counts and lack of actual tidal heights at the seal haul-outs prohibit any definitive conclusion about tidal effects. The location of harbor seal breeding sites was the same in this study as those reported by Bonnell et al. (1981). During that study the highest count was of 183 harbor seals in April 1977.

Cetaceans

The data collected on the most frequently-seen species of cetaceans are generally indicative of some degree of habitat partitioning. Habitat partitioning is largely a reflection of diet differences between the species. Group sizes are determined, at least partially, by prey type and method of feeding. Common dolphins were found in large groups farthest offshore in deep water; they feed primarily on anchovies and squids during winter off southern California (Leatherwood and Reeves 1983). Pilot whales and Risso's dolphins, both primarily squid eaters (Leatherwood and Reeves 1983), formed groups of approximately 15, and both were found in the shallowest waters on average. Pacific white-sided dolphins formed smaller groups in water of intermediate depth; they consume both epipelagic and mesopelagic schooling fishes and squids (Kajimura and Loughlin 1988). Bottlenose dolphins, renowned for their catholic diet (Leatherwood 1975), formed relatively small groups and were found in the widest range of depths compared with the other species observed. In the Gulf of California, Silber (1990)

postulated some degree of habitat partitioning between bottlenose dolphins, common dolphins, and the vaquita (*Phocoena sinus*) based on diet, water depth, and distance from shore. The vaquita was intermediate between the other two species.

The number of sightings of each species per hour of field time (Fig. 3) is the best indication of trends in the occurrence and relative abundance of the most often-sighted cetaceans. The most noteworthy changes in sighting frequency occurred for gray whales, Risso's dolphins, and pilot whales (Table 5). From 1983–4 through 1987 gray whales were seen quite frequently, and then from 1988 through 1991 the sighting rate dropped by 50%. Schulberg et al. (1991) and Sumich and Show (1991) reported that during this same period most gray whales used corridors offshore of Catalina Island and San Clemente Island during migration. Schulberg et al. (1991) specifically noted that use of the inshore corridor decreased between 1987 and 1990. Data from the Catalina study suggest a shift farther offshore than Catalina during this time period.

Risso's dolphins were seen rarely prior to 1987. In that year approximately 100 Risso's dolphins remained in nearshore Catalina waters throughout the field season, thus accounting for the extraordinarily high sighting rate of 0.75/hr. Risso's dolphins were seen regularly at Catalina during 1988–91, and the sighting rate averaged six times higher than during 1983–6. A dramatic increase in shoreline observations of live Risso's dolphins was reported throughout the southern California Bight during the late 1980's (A. Schulman, American Cetacean Society, San Pedro, California 90731, pers. comm.; D. Beeninga and G. Hoffman, Newport Beach, California 92661, pers. comm.) and strandings increased, as well (J. Heyning, Los Angeles County Museum, Los Angeles, California 90007, pers. comm.). In their summary of Risso's dolphin sightings in the eastern North Pacific, Leatherwood et al. (1980) reported a large proportion of sightings in the area offshore of southern California, with movements onto the continental shelf occurring in 1974–5 when SST were high due to an EN. Despite this increase in sightings, Dohl et al. (1981) found that Risso's dolphins represented less than 3% of all cetaceans seen in the SCB from 1975–8. Norris and Prescott (1961) recorded no sightings of Risso's dolphins during five years of cetacean observations in southern California. Kruse (1989) summarized historic fluctuations in Risso's dolphin abundance in Monterey Bay, California. She concluded that Risso's dolphins may have become more common in Monterey Bay "over the last few decades" and that the 1983 EN may have caused this species to shift northward. The increase in Risso's dolphin sightings at Catalina followed this same EN and may have been associated with the corresponding increase in SST. In general, winter SST around Catalina Island have remained at least slightly above normal in every year except 1988–9 since the 1983 EN (NOAA 1983–1991). More importantly, the explosion in numbers of Risso's dolphins corresponded with a striking decline in abundance of pilot whales at Catalina (Table 5). Risso's dolphins may have filled the medium-sized, squid-eating cetacean niche that was vacated by pilot whales when market squid vanished temporarily in 1983–4 just after EN.

The association between bottlenose dolphins and other species of cetaceans is striking. Norris and Prescott (1961) also noted the strong affiliation between bottlenose dolphins and pilot whales. In 50% of the bottlenose dolphin sightings recorded by Dohl et al. (1981), this species was associated with other cetaceans. In most cases (72%) the associated cetaceans were pilot whales. More recently,

Scott and Chivers (1990) reported frequent associations between bottlenose dolphins in the eastern tropical Pacific and other cetaceans, especially pilot whales. The associations between bottlenose dolphins and other species observed in this study seemed to be based on shared prey items (as with pilot whales and Risso's dolphins) and on curiosity (as with socializing gray whales and the sperm whale). Bottlenose dolphins are opportunistic feeders which frequently take advantage of human fisheries to improve their access to food (Busnel 1973; Leatherwood 1975; Shane 1990b; Corkeron et al. 1990; Pryor et al. 1990). Because the dolphins appeared to initiate contact with other species, especially feeding pilot whales, such associations may improve the dolphins' chances of acquiring prey. The curiosity-driven associations reflect the dolphins' sociability and interest in unusual phenomena. When attracted to socializing gray whales, the dolphins' activity level increased (i.e., more leaping and rapid swimming), and socializing between dolphins appeared to increase as well. Such a reaction fits Wilson's (1975:51) definition of the "audience effect," one form of social facilitation.

The fact that 36 of the 50 photo-identified bottlenose dolphins were sighted only once indicates that many animals may be transients rather than residents of Catalina. However, some dolphins return to or remain at Catalina in different years, and some dolphins are seen repeatedly during a single winter. The preponderance of resightings of identifiable dolphins in 1984-5 (Table 8) is a reflection of the fact that most of the time that year was spent with a single pod of pilot whales, and the bottlenose dolphins were associated with those whales. Therefore, given a sufficient attraction (e.g., abundant squid and another cetacean adept at finding that prey), bottlenose dolphins do appear to remain in one area for an extended period of time. The major unanswered questions are: 1) Are any bottlenose dolphins year-round residents at Catalina? 2) When dolphins leave Catalina, where do they go? Analysis by Shultz et al. (1988) found no matches between 41 dolphins with distinctive markings at Catalina and 421 dolphins photo-identified along the southern California coast as of 1988. Thus, photographic data support Walker's (1981) conclusion, based upon parasite loads and cranial measurements, that the coastal and island populations of bottlenose dolphins are separate.

Acknowledgments

Chip Deutsch and Jim Estes provided helpful comments on an earlier draft of this paper. Craig Strang, Sallie Beavers, Michael Poole, Jan Östman, Becky Rumsey, Sara Heimlich-Boran, and other short-term field assistants, too numerous to name, helped with the field work. Partial funding for this study was received from the National Marine Fisheries Service (Southwest Fisheries Center), the U.S. Marine Mammal Commission, the Theodore Roosevelt Memorial Fund of the American Museum of Natural History, the Monterey Bay Chapter of the American Cetacean Society, and the Biology Board of the University of California at Santa Cruz. This work was conducted under Marine Mammal Protection Act permit #624.

Literature Cited

- Antonelis, G. A., C. H. Fiscus, and R. L. DeLong. 1984. Spring and summer prey of California sea lions, *Zalophus californianus*, at San Miguel Island, California 1978-1979. *Fish. Bull., U.S.*, 82:67-76.

- Bartholomew, G. A., and R. A. Boolootian. 1960. Numbers and population structure of the pinnipeds on the California Channel Islands. *J. Mamm.*, 41:366-375.
- Bonnell, M. L., B. J. LeBoeuf, M. O. Pierson, D. H. Dettman, G. D. Farrens, and C. B. Heath. 1981. Pinnipeds of the Southern California Bight. Part 1—Vol. III (Principal Investigator's Reports). Summary of marine mammal and seabird surveys of the Southern California Bight Area (1975-1978). Final Report to the Bureau of Land Management. National Technical Information Service PB-81-248-171. Springfield, VA, 535 pp.
- Busnel, R. G. 1973. Symbiotic relationship between man and dolphins. *Trans. N.Y. Acad. of Sci.*, 35:112-131.
- Corkeron, P. J., M. M. Bryden, and K. E. Hedstrom. 1990. Feeding by bottlenose dolphins in association with trawling operations in Moreton Bay, Australia. Pp. 329-336 in *The bottlenose dolphin*. (S. Leatherwood and R. R. Reeves, eds.), Academic Press, San Diego.
- DeLong, R. L., G. A. Antonelis, C. W. Oliver, B. S. Stewart, M. C. Lowry, and P. K. Yochem. 1991. Effects of the 1982-1983 El Niño on several population parameters and diet of California sea lions on the California Channel Islands. Pp. 166-217 in *Pinnipeds and El Niño: responses to environmental stress*. (F. Trillmich and K. A. Ono, eds.), Springer-Verlag, Berlin.
- Dohl, T. P., K. S. Norris, R. C. Guess, J. D. Bryant, and M. W. Honig. 1981. Cetacea of the Southern California Bight. Part 2—Vol. III (Principal Investigator's Reports). Summary of marine mammal and seabird surveys of the Southern California Bight Area (1975-1978). Final Report to the Bureau of Land Management. National Technical Information Service PB-81-248-189. Springfield, VA, 414 pp.
- Francis, J. M., and C. B. Heath. 1991. Population abundance, pup mortality, and copulation frequency in the California sea lion in relation to the 1983 El Niño on San Nicolas Island. Pp. 119-128 in *Pinnipeds and El Niño: responses to environmental stress*. (F. Trillmich and K. A. Ono, eds.), Springer-Verlag, Berlin.
- Kajimura, H., and T. R. Loughlin. 1988. Marine mammals in the oceanic food web of the eastern subarctic Pacific. *Bull. of the Ocean Res. Inst., Univ. of Tokyo*, 26(II):187-223.
- Kruse, S. L. 1989. Aspects of the biology, ecology, and behavior of Risso's dolphins (*Grampus griseus*) off the California coast. M.S. Thesis, University of California, Santa Cruz.
- Leatherwood, S. 1975. Some observations of feeding behavior of bottle-nosed dolphins (*Tursiops truncatus*) in the northern Gulf of Mexico and (*Tursiops* cf. *T. gilli*) off southern California, Baja California and Nayarit, Mexico. *Mar. Fish. Rev.*, 37:10-16.
- , W. F. Perrin, V. L. Kirby, C. L. Hubbs, and M. Dahlheim. 1980. Distribution and movements of Risso's dolphin, *Grampus griseus*, in the eastern North Pacific. *Fish. Bull., U.S.*, 77:951-963.
- , and R. R. Reeves. 1983. *The Sierra Club handbook of whales and dolphins*. Sierra Club Books, San Francisco.
- LeBoeuf, B. J., and M. L. Bonnell. 1980. Pinnipeds of the California Islands: abundance and distribution. Pp. 475-493 in *The California Islands*. (D. M. Power, ed.), Santa Barbara Museum of Natural History, Santa Barbara.
- Lowry, M. S., C. W. Oliver, C. Macky, and J. B. Wexler. 1990. Food habits of California sea lions *Zalophus californianus* at San Clemente Island, California, 1981-86. *Fish. Bull., U.S.*, 88:509-521.
- , B. S. Stewart, C. B. Heath, P. K. Yochem, and J. M. Francis. 1991. Seasonal and annual variability in the diet of California sea lions *Zalophus californianus* at San Nicolas Island, California, 1981-86. *Fish. Bull., U.S.*, 89:331-336.
- , P. Boveng, R. J. DeLong, C. W. Oliver, B. S. Stewart, H. Deanda, and J. Barlow. 1992. Status of the California sea lion (*Zalophus californianus californianus*) population in 1992. National Marine Fisheries Service—Southwest Fisheries Center Administrative Report LJ-92-32. SWFC, P.O. Box 271, La Jolla, CA 92038.
- McGowan, J. A. 1985. El Niño in 1983 in the Southern California Bight. Pp. 166-184 in *El Niño north: Niño effects in the eastern subarctic Pacific Ocean*. (W. S. Wooster and D. L. Fluharty, eds.), Washington Sea Grant Program, Univ. Washington.
- NOAA. 1982. Oceanographic monthly summary 2(4). National Weather Service, National Environmental, Satellite, Data and Information Service.
- . 1983. Oceanographic monthly summary 3. National Weather Service, National Environmental, Satellite, Data and Information Service.

- . 1984. Oceanographic monthly summary 4. National Weather Service, National Environmental, Satellite, Data and Information Service.
- . 1985. Oceanographic monthly summary 5. National Weather Service, National Environmental, Satellite, Data and Information Service.
- . 1986. Oceanographic monthly summary 6. National Weather Service, National Environmental, Satellite, Data and Information Service.
- . 1987. Oceanographic monthly summary 7. National Weather Service, National Environmental, Satellite, Data and Information Service.
- . 1988. Oceanographic monthly summary 8. National Weather Service, National Environmental, Satellite, Data and Information Service.
- . 1989. Oceanographic monthly summary 9. National Weather Service, National Environmental, Satellite, Data and Information Service.
- . 1990. Oceanographic monthly summary 10. National Weather Service, National Environmental, Satellite, Data and Information Service.
- . 1991. Oceanographic monthly summary 11. National Weather Service, National Environmental, Satellite, Data and Information Service.
- Norris, K. S., and J. H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. *Univ. California Publ. in Zool.*, 63:291–402.
- Norton, J., D. McLain, R. Brainard, and D. Husby. 1985. The 1982–83 El Niño event off Baja and Alta California and its ocean climate context. Pp. 44–72 in *El Niño north: Niño effects in the eastern subarctic Pacific Ocean*. (W. S. Wooster and D. L. Fluharty, eds.), Washington Sea Grant Program, Univ. Washington.
- Odell, D. K. 1971. Censuses of pinnipeds breeding on the California Channel Islands. *J. Mamm.*, 52:187–190.
- Orr, R. T., and T. C. Poulter. 1965. The pinniped population of Ano Nuevo Island, California. *Proc. California Acad. Sci.* 4th series 32:377–404.
- Owen, R. W. 1980. Eddies of the California Current System: physical and ecological characteristics. Pp. 237–263 in *The California Islands*. (D. M. Power, ed.), Santa Barbara Museum of Natural History, Santa Barbara.
- Pryor, K., J. Lindbergh, S. Lindbergh, and R. Milano. 1990. A dolphin-human fishing cooperative in Brazil. *Mar. Mamm. Sci.*, 6:77–82.
- Quinn, W. H., V. T. Neal, and S. E. Antunez de Mayolo. 1987. El Niño occurrences over the past four and a half centuries. *J. of Geophys. Res.*, 92:14,449–14,461.
- Reynolds, R. W., C. K. Folland, and D. E. Parker. 1989. Biases in satellite-derived sea-surface-temperature data. *Nature*, 341:728–731.
- Schulberg, S., I. Show, and R. Van Schoik. 1991. Results of a four year study to characterize the spatial and temporal aspects of the gray whale migration through the Southern California Bight. Abstract. S. California Acad. Sci. Annual Meeting, 10–11 May 1991, Los Angeles, CA.
- Scott, M. D., and S. J. Chivers. 1990. Distribution and herd structure of bottlenose dolphins in the eastern tropical Pacific Ocean. Pp. 387–402 in *The bottlenose dolphin*. (S. Leatherwood and R. R. Reeves, eds.), Academic Press, San Diego.
- Shane, S. H. 1980. Occurrence, movements and distribution of bottlenose dolphin, *Tursiops truncatus*, in southern Texas. *Fish. Bull., U.S.*, 78:593–601.
- . 1984. Pilot whales and other marine mammals at Santa Catalina Island, California in 1983–84. National Marine Fisheries Service—Southwest Fisheries Center Administrative Report LJ-84-28C. SWFC, P.O. Box 271, La Jolla, CA 92038.
- . 1987. The behavioral ecology of the bottlenose dolphin. Ph.D. Dissertation, University of California, Santa Cruz.
- . 1990a. Behavior and ecology of the bottlenose dolphin at Sanibel Island, Florida. Pp. 245–265 in *The bottlenose dolphin*. (S. Leatherwood and R. R. Reeves, eds.), Academic Press, San Diego.
- . 1990b. Comparison of bottlenose dolphin behavior in Texas and Florida, with a critique of methods for studying dolphin behavior. Pp. 541–558 in *The bottlenose dolphin*. (S. Leatherwood and R. R. Reeves, eds.), Academic Press, San Diego.
- Shultz, G. M., S. H. Shane, and R. H. Defran. 1988. Photo-identification comparisons between coastal and offshore island Pacific bottlenose dolphins. Abstract. Third Biennial Conference and Symposium: The World's Whales, A Closer Look. American Cetacean Society, San Pedro, CA 90731.

- Silber, G. K. 1990. Distributional relations of cetaceans in the northern Gulf of California, with special reference to the vaquita, *Phocoena sinus*. Ph.D. Dissertation, Univ. of California, Santa Cruz.
- Strong, A. E. 1989. Greater global warming revealed by satellite-derived sea-surface-temperature trends. *Nature*, 338:642-645.
- Sumich, J. L., and I. T. Show. 1991. Offshore migrations of southbound gray whales in the California Bight, 1988-1990. Abstract. Southern California Academy of Sciences Annual Meeting, 10-11 May 1991, Los Angeles, CA.
- Walker, W. A. 1981. Geographical variation in morphology and biology of bottlenose dolphins (*Tursiops*) in the eastern North Pacific. National Marine Fisheries Service—Southwest Fisheries Center Administrative Report No. LJ-81-03C. 52 pp.
- Wilson, E. O. 1975. *Sociobiology: the new synthesis*. Belknap Press of Harvard University Press, Cambridge, MA.

Accepted for publication 14 January 1993.

Denning Characteristics of Black Bears in the San Gabriel Mountains of Southern California

Cynthia H. Stubblefield and Gerald T. Braden

California State Polytechnic University Pomona, Department of Biology,
3801 W. Temple Avenue, Pomona, California 91768

Abstract.—Denning habits of San Gabriel Mountain black bears were studied during the winters of 1987 through 1990. Mean denning period of five male bears was mid-November to mid-March. Denning periods for all bears ranged from late October to late March. Bears entered dens significantly later in 1988 than in 1987, 1989, and 1990 ($P < .05$). We speculate that fluctuations in food item availability might have affected the onset of denning. Exit dates ($\chi^2 = 1.2$, $P = 0.758$) and denning duration ($\chi^2 = 4.79$, $P = 0.187$) were not significantly different between years. Dens were located primarily in tree cavities (*Pseudotsuga macrocarpa* and *Quercus chrysolepis*) or under large boulders. All bears with more than one known den site reused a previous den. No incidents of winter activity were observed.

The San Gabriel and San Bernardino Mountains are home to the southernmost populations of black bear (*Ursus americanus*) in California. Black bears were introduced into both ranges in 1933 after the extirpation of *Ursus arctos*, formerly the only ursid inhabitant (Burghduff 1935; Grinnel et al. 1937). San Bernardino black bears have been extensively studied (Boyer 1976; Siperek 1979; Novick 1981; Hogan 1984); with the exception of a reconnaissance study by Moss (1972) which did not include information on denning, the San Gabriel Mountain population was not described prior to 1991 (Braden 1991).

Objectives of this four year black bear study (1987 through 1990) were to determine mean annual home range, habitat use, food preferences, and denning habits. Presented here are the results of our study on denning habits. Specifically, we sought to determine a mean denning period for San Gabriel Mountain black bears and a general description of their den sites.

We expected similarities in denning habits between this population and those of black bears throughout the southwest. However, due to incidents of winter-active male bears in central and southern California (Sequoia National Park [Graber 1991], San Bernardino Mountains [Novick 1981]) we speculated that some bears in this population might also be winter active.

Methods

Study area.—The study area was a 200 km² section of the San Gabriel Mountains (34°15'N, 117°45'W) approximately 32 km from downtown Los Angeles. Elevations ranged from 450 m to 1890 m and average annual temperature was 13.1°C. Average annual precipitation was 858 mm (January–December), of which more than 70% fell mainly as rain between January and May. Precipitation during

the study years was approximately half the annual average (United States Department of Commerce, Climatological Data California 1987–1990). The cool (average minimum February temperature = 0.84°C), moist winters, and hot (average maximum July temperature = 28.6°C), dry summers, and abruptly varying topography strongly influenced the distribution of vegetation, resulting in a mosaic of habitat types. Chaparral consisting of *Adenostoma fasciculatum*, *Arctostaphylos* sp., *Ceanothus* sp., *Cercocarpus* sp., and *Quercus dumosa* was the most extensive vegetation type. Other vegetation types included oak woodland (pure stands of *Q. chrysolepis* or mixed with *Q. wislizenii*), oak in association with conifer (primarily *Pseudotsuga macrocarpa* and *Pinus coulteri*), and pure stands of conifer (*Pinus ponderosa*, *P. jeffreyi*, and *P. lambertiana*). Riparian consisting of *Alnus rhombifolia*, *Acer macrophyllum*, and *Salix* sp. comprised less than 5% of the study area (Weislander 1934).

Winter weather conditions were relatively mild during the study. However, a series of snow storms during December of 1988 and March of 1991 resulted in several road closures within the study area.

The area is heavily used for recreation, including hunting. Bear season usually runs from mid-October through the end of December. The ten year average for Los Angeles County is three bears per year (Department of Fish and Game 1990 Bear Take Report). In 1987, one collared bear (15M) was legally killed.

Bears have unrestricted access to the dumpster contents of several camps and residences within the area.

Trapping and tracking.—Between July 1986 and August 1990 eight bears (one adult female, one juvenile female, and six adult males) were captured using culvert traps or Aldrich foot snares. Bears were immobilized with a 2:1 mixture of ketamine hydrochloride and zylazine hydrochloride and fitted with radiotransmitter collars (Telonics; Mesa, Arizona). Age, weight, dimensions, and general condition were also noted. Collars were motion-sensing and broadcasted at either of two pulse rates depending on the activity of the bear. Bears were located from the ground by triangulation using a Yagi three-element antenna. Each triangulation consisted of at least three compass bearings. The maximum angle between any two of the three bearings was as close to 90° as was physically possible given the terrain. Most ground locations were obtained 0.5 km to 1.0 km from the bear. When bears were widely dispersed or ground location attempts failed, a fixed wing aircraft was used to obtain location.

Den entry dates were defined as the midpoint between the last recorded movement and the first of a series of stationary signals. Den emergence dates were defined as a midpoint between the last denning location and the first location away from the den (O'Pezio et al. 1983). Length of hibernation was defined as the interval between the entrance and exit dates. Dens were located approximately one month after bear entry and revisited later for characterization.

Den entrance, exit, and duration were compared across all four years with the SAS Kruskal-Wallis NPAR1WAY procedure (SAS 1985). Post hoc comparisons were made using Tukey's LSD test for nonparametric data (Conover 1980).

Steep terrain prevented the location of every den. Bears whose dens were found and characterized included: 15F (N = 3), 34M (N = 3), 55F (N = 1), and 00M (N = 2). At least one year's worth of entrance and exit dates were available for most other bears (14M, 80M, 15M).

Table 1. Summary of den site characteristics.

Bear	Year ¹	Slope (%)	Habitat type	Cover (%)	Elevation (m)	Den aspect	Entrance aspect	Site
34M	87	46	Oak	90	1384	ENE	NE	Boulder
34M	89	53	Oak	90	989	ENE	NE	Boulder
34M	90*	46	Oak	90	1384	ENE	NE	Boulder
00M	87	80	Conifer	85	927	NNW	SE	<i>P. macrocarpa</i>
00M	88**	80	Conifer	85	927	NNW	SE	<i>P. macrocarpa</i>
15F	88	34	Oak	40	1274	NNE	up	<i>O. chrysolepis</i>
15F	89	75	Oak/ Conifer	65	1500	WNW	E	<i>P. macrocarpa</i>
15F	90**	75	Conifer	65	1500	WNW	E	<i>P. macrocarpa</i>
55F	87	67	Conifer	70	1317	ESE	up	<i>O. chrysolepis</i>

¹ Year of entrance.

* Same den site as 1987, no data on 1988 den.

** Same den site as previous year.

Results

Den characteristics.—All bears with at least two known den sites reused a previous den (34M, 1987 and 1990; 15F, 1989 and 1990).

All dens were found in tree cavities (base, limb, or mid trunk of *Quercus chrysolepis* or *Pseudotsuga macrocarpa*) or under boulders and all dens were located among stands of oak or conifer (Table 1).

Two of the eight dens we located contained bedding (34M's 1989 den, unidentified leaves and small branches; 15F's 1988 den, *Yucca whipplei* leaves). Excavated dens were not observed during this study.

Dens of San Gabriel Mountain black bears were generally located on north facing slopes.

Entrance and duration.—Male bears entered their dens significantly later in 1988 than all other years ($\chi^2 = 8.33$, $P = .04$ for Kruskal Wallis and $P < .05$ for each pairwise comparison).

Length of denning ranged from early September to late March (Table 2) and was not significantly different between years ($\chi^2 = 4.8$, $P = .19$; based on Kruskal Wallis tests).

During 1988, 1989, and 1990 bear 80M disappeared without trace of radio signal from ground or air (each spring he reappeared). Period of disappearance, which ranged from early September to late December, was treated as a denning period.

All bears remained at their den sites even on warm winter days.

Exit.—Bears consistently ($\chi^2 = 1.18$, $P = .76$) emerged from their dens in March despite variations in den entrance dates (between years and between bears). Spring-like weather conditions usually prevailed during this time however, bears emerged from their (1990) dens in March of 1991 during a rare storm with heavy rains and snow.

Discussion

Den entrance, exit, and duration.—Denning behavior has been associated with several variables. In general, these include food availability (Rogers 1987; O'Pezio

Table 2. Denning dates¹ of black bears in the San Gabriel Mountains during 1987 through 1990.

Bear	Age ²	Entrance dates				Exit dates				Duration			
		87	88	89	90	88	89	90	91	87/88	88/89	89/90	90/91
15M	5	10/22	—	—	—	3/9	—	—	—	139	—	—	—
34M	6	10/22	—	12/8	12/10	2/28	—	3/1	3/10	129	—	83	89
00M	11	10/25	12/26	—	—	2/3	3/4	—	—	101	68	—	—
80M	6	10/8	12/15	9/29	10/31	3/27	3/19	3/29	3/10	171	94	208	130
14M	6	—	12/14	12/12	10/31	—	2/28	3/4	—	—	76	79	—
Male mean		10/20	12/17	11/8	11/21	3/30	3/9	3/12	3/10	135	79	123	110
15F	1.5	—	12/27	12/27	12/13	—	3/8	3/1	3/10	—	71	64	87
55F	5	11/26	12/26	—	—	2/26	—	—	—	82	—	—	—

¹ All dates are approximate and varied ± 1-7 days.

² Age (years) as of 1988.

Table 3. Comparison of approximate denning dates for black bears across North America.

Location	Begin	End	Duration	Reference
East-central Alberta	early Oct.–early Nov.	early April	171	Tietje and Ruff (1980)
Southwest Washington	late Oct.–late Nov.	late March	125	Lindzey and Meslow (1976)
West-central Idaho	mid Oct.–late Nov.	mid April	171	Amstrup and Beecham (1976)
Montana	late Oct.	mid April–mid May	192	Jonkel and Cowan (1971)
Coastal North Carolina	mid Dec.	late April	125	Hamilton and Mar- chinton (1980)
Central Arizona	early Nov.	mid March–mid April	141	LeCount (1983)
Central California	mid Dec.	late March	104	Graber (1990)
Southern Califor- nia	mid–late Dec.	early March–late April	100	Novick et al. (1981)
Southern Califor- nia	mid Oct.–mid Dec.	early March	112	This study

et al. 1983) weather (Jonkel and Cowan 1971), circannual rhythm (Johnson and Pelton 1980), bear condition (Lindzey and Meslow 1976), photoperiod (LeCount 1983), or combinations of the above (Schwartz et al. 1987). The importance of these individual factors and how they influence denning behavior may vary from year to year and between bears within a region (O'Pezio et al. 1983).

Bears in this study denned for about the same length of time as bears in the San Bernardino Mountains (Novick et al. 1981), and similarly mild climates (Lindzey and Meslow 1976; Hamilton and Marchinton 1980; Graber 1991), and for a shorter period of time than bears in colder climates (Amstrup and Beecham 1976; Tietje and Ruff 1980; Jonkel and Cowan 1971).

Den emergence dates were similar to those found in the San Bernardino Mountains (Novick et al. 1981) and Sierra Nevada range (Graber 1991) of California (Table 3).

A small sample size precludes an effective evaluation of the influence of age and sex on denning behavior of San Gabriel Mountain black bears. Two females (55F and 15F, both with no sign of pregnancy or cubs) observed during this study entered their dens later than male bears (approximately one month later than male bear mean) but emerged around the same time. These observations are consistent with those of Beecham et al. (1983) who found adult males den significantly earlier than non-pregnant females. Novick et al. (1981) and Schwartz et al. (1987) have reported that pregnant females den earlier and longer than males and non-pregnant females.

It has been suggested that food availability and the acquisition of body fat may be the initial elements triggering den entrance (Rogers 1987). When body fat is low and food is available, bears have postponed denning by feeding later in the year until food resources were unavailable (Jonkel and Cowan 1971; Herrero 1978; Johnson and Pelton 1980; Tietje and Ruff 1980). Conversely, bears have denned early after reaching optimum fat levels when food resources were abundant as well as when nutritious foods were in short supply (Rogers 1987).

We suggest fluctuations in food item availability may play a large role in the onset of denning in San Gabriel Mountain black bears. In 1986, the acorn crop was prolific and acorns were available throughout the spring, summer, and early fall of 1987. Entrance dates (late October of 1987), which coincided with the disappearance of acorns, may have been the result of bears having reached optimum hibernation weight after feeding heavily on such a high calorie item for most of the year. The following fall acorns were absent but holly-leaf cherries (*Prunus ilicifolia*) were abundant and persisted well into January of 1989 (bears denned in late December of 1988). Scat contents from 1988 indicated bears were foraging late in the year on this readily available but possibly less preferred item.

Our observations from 1989 and 1990, when bears entered dens at approximately the same time (mid November), indicated that several natural foods were available to bears. There were no obvious fluctuations in food item availability; bears were eating the same items in similar proportions during both years. Acorns and coffeeberries (*Rhamnus ilicifolia*) dominated fall scats, and although the holly-leaf cherry crop was plentiful in the field, they were found in less than 2% of the scats (Stubblefield 1993).

Several researchers have reported winter-active male bears which did not den at all (Hamilton and Marchinton 1980, Novick 1981, Graber 1991). Graber (1991) suggested, after observations of winter-active male bears in Sequoia National Park, foraging especially at aggregate clumps (natural or anthropogenic), may be more energy efficient than hibernating.

Despite availability of natural foods and access to anthropogenic foods, all bears observed during this study denned.

We observed that bears cease their camp visits in late September and October. Abandonment of camps appeared to coincide with the initiation of deer season in late September followed by bear season in late October. Hunting may curtail the quantity of time spent foraging on anthropogenic foods thus increasing the importance of natural foods during this time of the year. Although availability or nutritive contribution of food resources (natural or anthropogenic) were not measured directly during our study, our observations tend to support the hypothesis that food availability may influence the onset of denning especially during extreme years.

Weather may not be the most important factor triggering the onset or duration of denning in San Gabriel Mountain black bears. Other researchers suggest the relationship between temperature or weather and den entrance (Novick et al. 1981) and den emergence are weak (O'Pezio 1983). Novick et al. (1981) felt that in regions with mild climates the severity of the winter influences the time of emergence and the duration, but not the onset, of denning. Although an increase in temperature is reported to influence den emergence and duration (Novick et al. 1981), bears in the San Gabriel Mountains consistently exit their dens at approximately the same time each year despite variations in weather (heavy rain and snow during 1991 emergence) or their individual den entrance dates.

Den characteristics and reuse.—Den location, presence or absence of bedding, and excavation vary between regions. The use of rocks (LeCount 1983; Novick 1981; Beecham et al. 1983) and trees, cavity or base, (Jonkel and Cowan 1971; Hamilton and Marchinton 1980; Johnson and Pelton 1981) as dens is well documented, but the presence of nesting materials varies considerably and appears

independent of winter weather conditions. In southern California, use of bedding materials appears limited. Novick et al. (1981) reports a small amount of bedding material was found in San Bernardino Mountain dens (no mention of the actual number of dens containing bedding) while within the San Gabriel Mountains, only two of the nine dens we found (55F, 1987; 34M 1989) contained nesting material.

Den excavation by black bears has been observed in most regions (Johnson and Pelton 1981, Tennessee; LeCount 1983, Arizona; Beecham et al. 1983, Idaho) including the San Bernardino Mountains (Novick et al. 1981). San Bernardino Mountain black bears (Novick et al. 1981) "construct" their dens by excavating under standing trees or large boulders whereas San Gabriel Mountain black bears appear to be making use of natural cavities in trees or openings between boulders. However, the cavity under one boulder den (34M, 1989) might have been the result of a previous (bear or year) excavation.

Most black bear studies, even in the nearby San Bernardino Mountains (Novick et al. 1981), indicate that bears seldom reuse dens. LeCount (1983) suggested reuse may indicate a shortage of quality dens. Since logging pressure is minimal and estimated bear density moderate to low, this explanation does not seem likely for the San Gabriel Mountain population. Perhaps bears associate a previous den site with safety and available foods upon emergence.

Due to the small sample size of individuals observed, generalized statements concerning denning habits of San Gabriel Mountain black bears are limited. Additional research is needed before the factors affecting the timing of denning as well as the characteristics of den sites can be accurately assessed within this population.

Acknowledgments

We would like to thank Curtis Clark, David Moriarty, and Glenn Stewart for their guidance. Permission to trap and collar bears was granted by the California Department of Fish and Game. Financial support was provided by Alan Neal and the Los Angeles County Fish and Game Commission. A special thanks to Rob Martens and Ken Watanabe for their assistance in locating dens.

Literature Cited

- Amstrup, S. C., and J. J. Beecham. 1976. Activity patterns of radio-collared black bears in Idaho. *J. Wildl. Mgmt.*, 40:340-348.
- Beecham, J. J., D. G. Reynolds, and M. G. Hornocker. 1983. Black bear denning activities and den characteristics in west-central Idaho. 5th Internat. Conf. Bear Res. and Mgmt., 5:79-86.
- Boyer, K. B. 1976. Food habits of black bears (*Ursus americanus*) in the Banning Canyon area of San Bernardino National Forest. Unpubl. Master's Thesis. California State Polytechnic University, Pomona, California, 63 pp.
- Braden, G. T. 1991. Home ranges, habitat use, and denning characteristics of black bears (*Ursus americanus*) in the San Gabriel Mountains of southern California. Unpubl. Masters Thesis. California State Polytechnic University, Pomona, California, 80 pp.
- Burgdoff, A. E. 1935. Black bears released in southern California. *California Fish and Game*, 21: 83-84.
- Conover, W. J. 1980. Practical nonparametric statistics. Second edition. John Wiley and Sons, New York, New York, 493 pp.
- Department of Fish and Game. 1990. California Bear Take Report.

- Graber, D. M. 1991. Winter behavior of black bears in the Sierra Nevada, California. 8th Internat. Conf. Bear Res. and Mgmt., 8:269-272.
- Grinnel, J., J. S. Dixon, and J. M. Linsdale. 1937. Furbearing mammals of California. Vol. 1. University of California Press, Berkeley, California, 375 pp.
- Hamilton, R. J., and R. L. Marchinton. 1980. Denning and related activities of black bears in the coastal plain of North Carolina. 4th Internat. Conf. Bear Res. and Mgmt., 4:121-126.
- Herrero, S. 1978. A comparison of some features of the evolution, ecology, and behavior of black and brown/grizzly bears. *Carnivore*, 1:7-17.
- Hogan, N. F. 1984. Home range and habitat preferences of female black bears (*Ursus americanus*) in the San Bernardino Mountains of southern California. Unpubl. Masters Thesis. California State Polytechnic University, Pomona, California, 48 pp.
- Johnson, K. G., and M. R. Pelton. 1980. Environmental relationships and the denning period of black bears in Tennessee. *J. Mamm.*, 61:653-660.
- Jonkel, C. J., and McT. Cowan. 1971. The black bear in the spruce-fir forest. *Wildlife Monographs*, 27:1-57.
- LeCount, A. L. 1983. Denning ecology of black bears in Central Arizona. 5th Internat. Conf. Bear Res. and Mgmt., 5:71-78.
- Lindzey, F. G., and E. C. Meslow. 1976. Winter dormancy in black bears in southwestern Washington. *J. Wildl. Mgmt.*, 40:408-425.
- Moss, H. H. 1972. A study of the black bear in the San Gabriel Mountains. Unpubl. Masters Thesis. California State Polytechnic University, Pomona, California, 63 pp.
- Novick, H. J., J. M. Siperek, and G. R. Stewart. 1981. Denning characteristics of black bears (*Ursus americanus*) in the San Bernardino Mountains of southern California. *California Fish and Game*, 67:52-61.
- O'Pezio, J., S. H. Clarke, and C. Hackford. 1983. Chronology of black bear denning in the Catskill region of New York. 5th Internat. Conf. Bear Res. and Mgmt., 5:87-93.
- Rogers, L. L. 1987. Effects of food supply and kinship on social behavior, movements, and population growth of black bears in northeastern Minnesota. *Wildlife Monographs*, 97:1-72.
- SAS Institute. 1985. SAS user's guide: basics, version 5.
- Schwartz, C. C., S. D. Miller, and A. W. Franzmann. 1987. Denning ecology of three black bear populations in Alaska. 7th Internat. Conf. Bear Res. and Mgmt., 7:281-292.
- Siperek, J. M. 1979. Physical characteristics and blood analysis of black bears (*Ursus americanus*) in the San Bernardino Mountains of southern California. Unpubl. Masters Thesis. California State of Polytechnic University, Pomona, California, 63 pp.
- Stubblefield, C. H. 1993. Food habits of black bears in the San Gabriel Mountains of southern California. *Southwestern Nat.* *In press.*
- Tietje, W. D. and R. L. Ruff. 1980. Denning behavior of black bears in the boreal forest of Alberta. *J. Wildl. Mgmt.*, 44:858-870.
- United States Department of Commerce. 1987-1990. Record of river and climatological observations. Mount Wilson Station. Asheville, North Carolina.
- Wieslander, A. E. 1934. Vegetation types of California. Pasadena, Pomona, and Tujunga Quadrangles. United States Forest Service, Arcadia, California.

Accepted for publication 25 June 1993.

RESEARCH NOTES

Additional Archaeological Evidence for Colorado River Fishes in the Salton Basin of Southern California

Kenneth W. Gobalet

*Department of Biology, California State University,
Bakersfield, California 93311*

Fish remains recovered from archaeological sites in the Salton Basin of southeastern California have attracted considerable attention, in part, because most fishes represented are endangered and are normally associated with the lower Colorado River or the Sea of Cortez. They also capture the imagination because their habitat was the huge prehistoric Lake Cahuilla fed by the Colorado River where now only stark desert vegetation or the saline Salton Sea exist. In a previous survey of the fishes represented by remains recovered from archaeological sites of the Salton Basin, Gobalet (1992) reported the remains of razorback sucker, *Xyrauchen texanus*, Colorado squawfish, *Ptychocheilus lucius*, bonytail, *Gila elegans*, striped mullet, *Mugil cephalus*, and machete, *Elops affinis*. He also suggested that more species might have been present in Lake Cahuilla than have been previously reported or that hybrids may have been present. That summary omitted numerous unpublished archaeological site reports that quantified the recovered fish remains.

The fish remains recovered from archaeological sites CA-IMP-6427 (Elmore site), CA-RIV-1331, CA-RIV-1349, and CA-RIV-4128 have recently been studied. Results of those projects, along with findings of other researchers overlooked in the prior study, are reported here. Site CA-IMP-6427 is located adjacent to State Route 86, 2 miles east of Kane Spring in western Imperial County, California. It was occupied around A.D. 1663 (Don Laylander, pers. comm., January 1993). Sites CA-RIV-1331 and CA-RIV-1349 are located at the mouth of Toro Canyon, south of Indian Wells in Riverside County, California. Radiocarbon dates for these two sites are 320 ± 90 y.b.p. for CA-RIV-1331 and 110 ± 88 y.b.p. for CA-RIV-1349 (Jerry Schaefer, personal communication, April 1993). CA-RIV-4128 is located north of Coachella on the Cabazon Indian Reservation.

Specific objectives of this study have been to comprehensively evaluate the new material to determine whether or not humpback chub (*Gila cypha*), roundtail chub (*G. robusta*) or flannelmouth sucker (*Catostomus latipinnis*) were present as suggested previously by Gobalet (1992) and to determine whether or not evidence for hybridization could be found. These findings and the data missed by Gobalet (1992) give a more complete and accurate picture of the fishes that occupied Lake Cahuilla.

The fish identifications were determined by comparison with the skeletons at California State University, Bakersfield, supplemented with the comparative materials indicated in the materials examined section. The precaudal vertebrae of minnows (Cyprinidae) can be distinguished from those of suckers (Catostomidae) by the presence of a narrow strut interconnecting the socket of the parapophysis

Table 1. Summary of fish remains recovered from archaeological sites in the Salton Basin of Southern California. Indicated below are the number of elements identified.

	<i>Gila elegans</i> , bonytail	<i>Xyrauchen texanus</i> , razorback sucker	<i>Ptychocheilus lucius</i> , Colo- rado squaw- fish	<i>Mugil cephalus</i> , striped mullet	<i>Elops affinis</i> , machete	Reference
RIV-1331	16	8	1	—	1	This report
RIV-1349	337	33	1	—	—	This report
RIV-2937	5	30	1	—	—	Salls 1985
RIV-2997	83	10	1	2	—	Salls 1985
RIV-2998	46	—	—	—	—	Salls 1985
RIV-2999	54	2	—	1	—	Salls 1985
RIV-3000	33	1	1	1	—	Salls 1985
RIV-4128	20	310	—	—	—	This report
IMP 4434	45 gm	310 gm	—	6 gm	—	Follett 1985a
IMP 5204	3420	194	2	43	5	Roeder & Salls 1986
IMP 1141	8	14	—	—	—	Salls & Roeder 1987
IMP 5428	8	5	—	—	—	Salls & Roeder 1987
4-IMP-1049	3	—	—	—	—	Salls & Roeder 1988
4-IMP-5270	—	16	—	—	—	Salls & Roeder 1988
IMP-3688	35	31	—	1	—	Follett 1985b
IMP-4926	—	53	—	—	—	Roeder 1982
IMP-6427	3	35	—	—	1	This report
SDI-4443	65	12	—	1	1	Findley 1977
14 sites	2666	1582	110	62	2	Gobalet 1992
Total	6802	2335	117	111	10	

with the neural spine. The caudal vertebrae of minnows have a ventrally projecting spine on the posteroventral portion of the centrum that is lacking in suckers. All catostomid elements are probably razorback sucker. The remains identified as bonytail might possibly be another member of the genus *Gila*, but this seems increasingly unlikely.

The tally of fish remains recovered from archaeological sites CA-IMP-6427, CA-RIV-1331, CA-RIV-1349, and CA-RIV-4128 are found in Table 1 along with the findings of fish remains from 28 other widely separated sites within the Salton Basin. Bonytail and razor back sucker were clearly the dominant large species captured by the Cahuilla Native Americans and were probably the dominant species in the lake with the piscivorous squawfish and machete, and bottom feeding mullet, minor in importance. The biology of these fishes and the methods of aboriginal capture have been reviewed extensively by Gobalet (1992).

No remains of the flannelmouth sucker, roundtail or humpback chubs have been found. It appears that the only member of the *Gila robusta* complex present in Lake Cahuilla or its Salton Basin tributaries was the bonytail and the only sucker, the razorback sucker. Without the presence of additional chubs or suckers, hybridization would not have occurred. Sampling techniques that do not lead to the microscopic evaluation of midden material still leave doubt as to whether the small desert pupfish (*Cyprinodon macularius*), *Gila* topminnow (*Poeciliopsis occidentalis*), or woundfish (*Plagopterus argentissimus*), were present as Gobalet

(1992) suggested. No such sampling was undertaken in these projects. These studies collectively suggest that bonytail and razorback suckers were the dominant large species in Lake Cahuilla and that the predatory Colorado squawfish, diadromous striped mullet, and machete, were rare.

Acknowledgments

The following individuals have my thanks for contributing to this study: David Catania, Michael E. Douglas, Lloyd T. Findley, Paul Langenwaller, W. L. Minckley, Douglas W. Nelson, Mark A. Roeder, Jerry Schaefer, Don Laylander, Julie Gunn, Aggie Arvizu, and Traci Alexander.

Materials Examined

Institutional abbreviations are as listed by Leviton et al. (1985) except those designated KWG are in the collection at California State University, Bakersfield.

Catostomus latipinnis: ASU 13844, UMMZ 179561; *C. macrocheilus*: KWG 353; *C. occidentalis*: KWG 240; *C. tahoensis*: KWG 545; *C. fumeiventris*: KWG 536; *Chasmistes cujus*: KWG 488; *Xyrauchen texanus*: ASU 14882; *Gila bicolor*: KWG 358, KWG 377, KWG 357; *G. cypha*: UMMZ 178667-S, 179577-S, ASU 14156; *G. elegans*: CAS 25865, CAS 66037, CAS 66038; UMMZ 179581, UMMZ 176972-S, UMMZ 179580-S, ASU (uncataloged, 360 mm S.L.); *G. robusta*: ASU 10509, CAS 25850, UMMZ 182502-S; *Ptychocheilus grandis*: KWG 539, KWG 540, KWG 548; *P. lucius*: ASU 13866, CAS 26210; *P. oregonensis*: KWG 347, KWG 404, KWG 454.

Literature Cited

- Findley, L. T. 1977. Archeoichthyology of the Barrel Springs site (CA-SDI-4443) with notes on adjacent areas of the Colorado Desert, California. Unpublished manuscript.
- Follett, W. I. 1985a. Fishbone analysis. Pp. C-1 to C-8 in Lake Cahuilla prehistoric occupation at IMP-4434 and IMP-5167 Imperial Valley, California. (D. Gallegos, ed.), Manuscript on file, WESTEC Services, Inc., 5510 Morehouse Drive, San Diego, CA 92121-1709.
- . 1985b. Analysis of fish remains from six localities adjacent to State Route 86, Imperial County, California. Pp. 175-182 in Report of archaeological test excavations at five sites located along Highway 86 in Imperial County, California: CA-IMP-3675, CA-IMP-3676, CA-IMP-3678, CA-IMP-5099 and CA-IMP-5101, 11-IMP-86, 60.9, 67.8, 11208-182641. (M. D. Rosen, ed.), Manuscripts on file, Environmental Planning Branch Caltrans District 11, P.O. Box 85406, San Diego, CA 92138-5406.
- Gobalet, K. W. 1992. Colorado River fishes of Lake Cahuilla, Salton Basin, southern California: a cautionary tale for zooarchaeologists. Bull. Southern California Acad. of Sci., 91(2):70-83.
- Leviton, A. E., R. H. Gibbs Jr., E. Heal, and C. E. Dawson. 1985. Standards in herpetology and ichthyology: part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. Copeia, 1985(3):802-832.
- Roeder, M. A. 1982. An analysis of column samples from archaeological sites (IMP-4926), western Imperial County, California. Pp. D-1 to D-4 in Archaeological data recovery program: northern portion of IT Corporation Imperial Valley site. (R. Philips, ed.), Manuscript on file, WESTEC Services Inc., 5510 Morehouse Drive, San Diego, CA 92103.
- , and R. A. Salls. 1986. Fish remains from the late prehistoric Dunaway Road site, Imperial County, California. Pp. 105-118 in Late prehistoric adaptations during the final recessions of Lake Cahuilla: fish camps and quarries on West Mesa, Imperial County, California. (J. Schaefer, ed.), Manuscript on file, USDI, Bureau of Land Management, 333 South Waterman Avenue, El Centro, CA 92243.
- Salls, R. A. 1985. Fish remains from the Oak Tree West sites (CA-RIV-2937-3000), Coachella Valley Riverside County, California. Unpublished manuscript.

- , and M. A. Roeder. 1987. Fish remains. Pp. 145–149 *in* Settlement and subsistence at San Sebastian: a desert oasis on San Felipe Creek, Imperial County, California. (J. Schaefer, L. J. Bean, and C. M. Elling, eds.), Manuscript on file, USDI, Bureau of Reclamation, 400 Railroad Avenue, P.O. Box 427, Boulder City, NV 89005.
- , and ———. 1988. Fish remains. Pp. 160–163 *in* Lowland Patayan adaptations to ephemeral alkali pans at Superstition Mountain, West Mesa, Imperial County, California. (J. Schaefer, ed.), Manuscript on file, USDI, Bureau of Land Management, El Centro Resource Area Office, 333 S. Waterman Avenue, El Centro, CA 92243.

Accepted for publication 5 August 1993.

Occurrence of the Swallow Damsel­fish, *Azurina hirundo*, from Islands off Southern California

Robert N. Lea¹ and Florence McAlary²

¹California Department of Fish and Game, Marine Resources Division,
20 Lower Ragsdale Drive, Monterey, California 93940

²University of Southern California, Wrigley Marine Science Center,
P.O. Box 398, Avalon, California 90704

The damselfish genus *Azurina* is comprised of two species restricted to the eastern Pacific Ocean (Allen 1991). *Azurina hirundo* Jordan and McGregor [*in* Jordan and Evermann 1898], the swallow damselfish, is known from several island groups off the coast of Mexico: Isla Guadalupe (type locality), Islas San Benito (RNL, pers. observation), Rocas Alijos, and Islas Revillagigedo. Gotshall (1989) speculated that it "may occur as far north as the Coronado Islands, Baja California and San Clemente Island, California." Its occurrence at Clipperton, Las Tres Marias, and the islands within the Sea of Cortez is unknown. *Azurina eupalama* Heller and Snodgrass 1903, the Galapagos damselfish, is considered a Galapagos Archipelago endemic; the type locality is Hood Island (also known as Española). It has not been collected or observed at either Cocos Island (R. J. Lavenberg, Natural History Museum of Los Angeles County and W. A. Bussing, University of Costa Rica; pers. comm.) or at Malpelo Island (McCosker and Rosenblatt 1975).

The most notable character in distinguishing these two taxa is color: *A. hirundo* is metallic blue to black while *A. eupalama* is olive and gray. Allen (1991) gives meristic characters (pectoral rays and gill rakers on lower limb) which are non-overlapping and which also serve to differentiate these species. Heller and Snodgrass (1903) mention morphometric differences between *hirundo* and *eupalama*; however, after examining specimens of both forms at the Marine Vertebrates Collection, Scripps Institution of Oceanography, it appears that morphometry is not dependable for separating these species.

On 4 March 1991, while diving at Big Fisherman Cove, Santa Catalina Island (lat 33°26.8'N, long 118°29.0'W), the junior author (FM) observed two unusual damselfish which were schooling with the locally common damselfish, the blacksmith, *Chromis punctipinnis*. The two fish were estimated at 5 to 6 inches in length and were at a depth of ca. 8 m; water temperature at 10 m was 14.9°C. These damselfish were recognized as *Azurina*, having been seen by FM at Isla Guadalupe, Mexico in 1983. *Azurina hirundo* is generally similar in color to *Chromis punctipinnis* but is much more elongate and possesses a strongly forked caudal fin; *A. eupalama* is olive and gray in color. Unfortunately, these fish were not photographed or collected, hence this record must remain anecdotal. Five months later, on 1 August 1991, near Pyramid Cove, San Clemente Island (ca. lat 32°50'N, long 118°22'W), Larry Naylor, an underwater photographer, observed and photographed three individuals at two locations at this island (Fig. 1). The length of these damselfish was estimated as between 5 and 6 inches. Two of these fish were at ca. 8 m and the third at 16 m, all in close association with the bottom.



Fig. 1. Swallow damselfish, *Azurina hirundo*, at Pyramid Cove, San Clemente Island, 1 August 1991. Photo by Larry Naylor.

On 23 July 1992, a single *Azurina* was observed at Big Fisherman Cove (by FM), essentially the same location as the 1991 observation.

These three observations, one corroborated by underwater photography, represent the first documented occurrences of the swallow damselfish from Californian waters. The addition of *Azurina hirundo* to the California ichthyofauna is yet another example of a tropical organism occurring in the warm-temperate marine environment off southern California (Radovich 1961; Hobson 1969; Swift 1986; Brooks 1987; Lea et al. 1989; etc.). New records of tropical species from California can be expected in the future, especially during and immediately following periods of oceanic warming such as the El Niño events of 1957–59, 1982–84, and 1992–93. The majority of these occurrences constitute expatriated individuals or minor populational movements and under most circumstances represent dead-end or waif populations in terms of their reproductive potential.

Literature Cited

- Allen, G. R. 1991. Damsel-fishes of the world. Mergus Publ., Melle, Germany. 271 pp.
- Brooks, A. J. 1987. Two species of Kyphosidae seen in King Harbor, Redondo Beach, California. *Calif. Fish and Game*, 73(1):49–50.
- Gotshall, D. W. 1989. Pacific Coast inshore fishes. Third Ed. Sea Challengers, Monterey, Calif. 96 pp.
- Heller, E., and R. E. Snodgrass. 1903. Papers from the Hopkins Stanford Galapagos Expedition, 1898–1899. XV. New fishes. *Proc. Washington Acad. Sci.*, 5:189–229, plates ii–xx.
- Hobson, E. S. 1969. First California record of the Guadalupe cardinalfish, *Apogon guadalupensis* (Osburn and Nichols). *Calif. Fish and Game*, 55(2):149–151.

- Jordan, D. S., and B. W. Evermann. 1898. The fishes of North and Middle America. Bull. U.S. Nat. Mus., No. 47 (pt. 2):1241-2183.
- Lea, R. N., J. M. Duffy, and K. C. Wilson. 1989. The Cortez angelfish, *Pomacanthus zonipectus*, recorded from southern California. Calif. Fish and Game, 75(1):45-47.
- McCosker, J. E., and R. H. Rosenblatt. 1975. Fishes collected at Malpelo Island. Pp. 91-93 in The biological investigation of Malpelo Island. (J. B. Graham, ed.), Smithsonian Contr. Zoology 176.
- Radovich, J. 1961. Relationships of some marine organisms of the northeast Pacific to water temperatures, particularly during 1957 through 1959. Calif. Dept. of Fish and Game, Fish Bull. 112:62 p.
- Swift, C. C. 1986. First record of the spotted scorpionfish, *Scorpaena plumieri* from California: The curtain falls on "A comedy of errors." Calif. Fish and Game, 72(3):176-178.

Accepted for publication 12 December 1992.

Contribution no. 165 of Wrigley Marine Science Center.

Proceedings of the Symposium

***Interface Between Ecology and Land Development
in California***

Edited by Jon E. Keeley

An outstanding compilation of timely papers by researchers, conservationists, consultants, and policymakers, including:

- | | |
|-------------------------------|--|
| Peter H. Raven | <i>Ecology and Species Extinction</i> |
| Jonathan L. Atwood | <i>California Gnatcatcher and Coastal Sage Scrub</i> |
| Martin L. Cody | <i>Theoretical and Empirical Aspects of Habitat Fragmentation</i> |
| Jim A. Bartel | <i>Endangered Species Act: Land Development, Politics, and Reauthorization</i> |
| Cheryl Swift et al. | <i>Habitat Linkages in an Urban Mountain Chain</i> |
| Wayne R. Ferren et al. | <i>Rare and Threatened Wetlands of California</i> |
| G. Ledyard Stebbins | <i>Conservation of California's Rare Habitats</i> |
| Todd Keeler-Wolf | <i>Rare Community Conservation in California</i> |
| Joy B. Zedler | <i>Restoring Biodiversity to Coastal Marshes</i> |
| Ted V. St. John et al. | <i>Use of Mycorrhizal Plants in Revegetation and Restoration</i> |
| Marylee Guinon | <i>Habitat Valuation and Restoration Costing</i> |
| Jim Jokerst | <i>An Alternative Approach to Vernal Pool Mitigation Planning</i> |

and **twenty-nine** other papers dealing with land management, biodiversity, habitat corridors, buffer zones, rare species, and community restoration.

Price, \$26.00 (soft cover, includes tax and shipping)

Available from:

*Southern California Academy of Sciences
900 Exposition Blvd. Los Angeles, CA 90007*

With this issue, the BULLETIN bids farewell to its two long-time editors: Technical Editor, Jon Kelley, and Managing Editor, Gretchen Sibley. For Jon it has been 10 years; for Gretchen 14; and both have decided it is time to retire. Jon, in addition to a heavy teaching schedule, will be pursuing his own publishing ventures. Gretchen will be working on other projects. Their influence will long be felt, since much of the material on hand for future issues of the BULLETIN will reflect their talent and judgment. The Academy is deeply grateful for their years of editorial service to this journal.

We also are fortunate in their successor. With the next issue, Daniel A. Guthrie becomes Editor of the BULLETIN. Long a member of the Academy, he currently serves on the Board of Directors and we welcome his willingness to accept the challenge.

INSTRUCTIONS FOR AUTHORS

The BULLETIN is published three times each year (April, August, and December) and includes articles in English in any field of science with an emphasis on the southern California area. Manuscripts submitted for publication should contain results of original research, embrace sound principles of scientific investigation, and present data in a clear and concise manner. The current AIBS *Style Manual for Biological Journals* is recommended as a guide for contributors. Consult also recent issues of the BULLETIN.

MANUSCRIPT PREPARATION

The author should submit *at least two additional copies with the original*, on 8½ × 11 opaque, nonerasable paper, double spacing the entire manuscript. **Do not break words at right-hand margin anywhere in the manuscript.** Footnotes should be avoided. **Manuscripts which do not conform to the style of the BULLETIN will be returned to the author.**

An abstract summarizing in concise terms the methods, findings, and implications discussed in the paper *must* accompany a feature article. *Abstract should not exceed 100 words.*

A feature article comprises approximately five to thirty typewritten pages. Papers should usually be divided into the following sections: abstract, introduction, methods, results, discussion and conclusions, acknowledgments, literature cited, tables, figure legend page, and figures. Avoid using more than two levels of subheadings.

A research note is usually one to six typewritten pages and rarely utilizes subheadings. Consult a recent issue of the BULLETIN for the format of notes. Abstracts are not used for notes.

Abbreviations: Use of abbreviations and symbols can be determined by inspection of a recent issue of the BULLETIN. **Omit periods after standard abbreviations:** 1.2 mm, 2 km, 30 cm, but Figs. 1–2. Use numerals *before* units of measurements: 5 ml, but nine spines (10 or numbers above, such as 13 spines). The metric system of weights and measurements should be used wherever possible.

Taxonomic procedures: Authors are advised to adhere to the taxonomic procedures as outlined in the International Code of Botanical Nomenclature (Lawjouw et al. 1956), the International Code of Nomenclature of Bacteria and Viruses (Buchanan et al. 1958), and the International Code of Zoological Nomenclature (Stoll et al. 1961). Special attention should be given to the description of new taxa, designation of holotype, etc. Reference to new taxa in titles and abstracts should be avoided.

The literature cited: Entries for books and articles should take these forms.

McWilliams, K. L. 1970. Insect mimicry. Academic Press, vii + 326 pp.

Holmes, T. Jr., and S. Speak. 1971. Reproductive biology of *Myotis lucifugus*. J. Mamm., 54:452–458.

Bratstrom, B. H. 1969. The Condor in California. Pp. 369–382 in *Vertebrates of California*. (S. E. Payne, ed.), Univ. California Press, xii + 635 pp.

Tables should not repeat data in figures (line drawings, graphs, or black and white photographs) or contained in the text. The author must provide numbers and short legends for tables and figures and place reference to each of them in the text. Each table with legend must be on a separate sheet of paper. All figure legends should be placed together on a separate sheet. **Illustrations and lettering thereon should be of sufficient size and clarity to permit reduction to standard page size;** ordinarily they should not exceed 8½ by 11 inches in size and after final reduction lettering must equal or exceed the size of the typeset. All half-tone illustrations will have light screen (grey) backgrounds. Special handling such as dropout half-tones, special screens, etc., must be requested by and will be charged to authors. **As changes may be required after review, the authors should retain the original figures in their files until acceptance of the manuscript for publication.**

Assemble the manuscript as follows: cover page (with title, authors' names and addresses), abstract, introduction, methods, results, discussion, acknowledgements, literature cited, appendices, tables, figure legends, and figures.

A cover illustration pertaining to an article in the issue or one of general scientific interest will be printed on the cover of each issue. Such illustrations along with a brief caption should be sent to the Editor for review.

PROCEDURE

All manuscripts should be submitted to the Editor, Daniel A. Guthrie, W. M. Keck Science Center, 925 North Mills Avenue, Claremont, CA 91711. **Authors are requested to submit the names, addresses and specialties of three persons who are capable of reviewing the manuscript.** Evaluation of a paper submitted to the BULLETIN begins with a critical reading by the Editor; several referees also check the paper for scientific content, originality, and clarity of presentation. Judgments as to the acceptability of the paper and suggestions for enhancing it are sent to the author at which time he or she may be requested to rework portions of the paper considering these recommendations. The paper then is resubmitted and may be re-evaluated before final acceptance.

Proof: The galley proof and manuscript, as well as reprint order blanks, will be sent to the author. He or she should **promptly and carefully read** the proof sheets for errors and omissions in text, tables, illustrations, legends, and bibliographical references. He or she marks corrections on the galley (copy editing and proof procedures in *Style Manual*) and **promptly returns both galley and manuscript** to the Editor. Manuscripts and original illustrations will not be returned unless requested at this time. **All changes in galley proof attributable to the author (misspellings, inconsistent abbreviations, deviations from style, etc.) will be charged to the author.** Reprint orders are placed with the printer, not the Editor.

CONTENTS

- The Biology and Current Status of the Long-eared Owl in Coastal Southern California. By Peter H. Bloom 1
- Occurrence and Habitat Use of Marine Mammals at Santa Catalina Island, California from 1983-91. By Susan H. Shane 13
- Denning Characteristics of Black Bears in the San Gabriel Mountains of Southern California. By Cynthia H. Stubblefield and Gerald T. Braden 30
- Research Notes**
- Additional Archaeological Evidence for Colorado River Fishes in the Salton Basin of Southern California. By Kenneth W. Gobalet 38
- Occurrence of the Swallow Damsel fish, *Azurina hirundo*, from Islands off Southern California. By Robert N. Lea and Florence McAlary 42

LIBRARY
APR 2 1996
NEW YORK
BOTANICAL GARDENS

COVER: Swallow damselfish *Azurina hirundo* at Pyramid Cove, San Clemente Island, 1 August 1991.
Photo by Larry Naylor.