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Four Seasons Abundance Changes of *Zalophus californianus californianus* (Lesson 1828), Allen, 1880, in the Gulf of California, Mexico

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ABSTRACT

This paper describes for the first time the relative abundance, population structure and numeric variation of California sea lions in the Gulf of California, Mexico, during four different seasons. The relative abundance estimates varied from the highest 17,162 sea lions in July of 1990 (summer) to a minimum 7,470 in February of 1992 (winter), representing a reduction of 10,000 sea lions. Hypotheses about the migration of part of the population to the Pacific Ocean were compared and discussed against their residency inside the Gulf, and seasonal dispersion of individuals along this inner sea.

Key words: *Zalophus californianus californianus*, Seasonal variations, relative abundance, migration, Gulf of California, Mexico

INTRODUCTION

California sea lions, *Zalophus californianus californianus*, is one of the four species of Pinnipeds in Mexican waters. It is the most abundant and broadly distributed. Their geographical distribution goes from the border with the United States of America, to the coasts of Nayarit, Mexico, including the Gulf of California (Daugherty, 1965, Zavala-Gonzalez, 1990). Gallo and Ortega (1986) reported two sightings of solitary sea lions south in Acapulco, State of Guerrero, Mexico, while Gallo and Solórzano (1991) extended the area of these sightings near the border of Mexico-Guatemala. Sea lions inhabit mainly beaches, rocks, islets and islands. These groupings are known as “loberas” (rookeries) and can be classified as: breeding (BR), non-breeding (N-BR) and temporary (T). In the BR and N-BR, there are animals all the year round, but only in the BR, there are newborns. The T are for temporary occupation of sea lions, which are generally small rocks without protection against winds and surf. There are 40 recognized rookeries in the Gulf of California, 13 of which are BR, 18 N-BR and at least 9 T (Zavala-Gonzalez, 1990). The last population estimation of the Mexican portion was carried out by Le Boeuf et al., (1983) between 1979 and 1981. They estimated a total of 83,000 animals, of which, 63,000 on the Mexican Pacific

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Islands and 20,000 in the Gulf of California, with annual productions of 7,000 pups inside the Gulf, and 29,000 on the Mexican Pacific islands. Ten years later, Zavala-Gonzalez (1990) estimated 30,000 California sea lions inside the Gulf of California. One relevant aspect on the behavior of this species is their migratory cycle, described as variations in seasonal numbers of animals (increases-decreases). Description of massive movements of mature males from the coasts of the southern California bight area, U.S.A. towards the north (States of Washington, U.S.A. and British Columbia, Canada) were described by Bartholomew and Boolootian (1960), Hancock (1970), Bigg (1973) and Bonnell et al., (1978). In Mexico, these fluctuations have been reported after the breeding period only for subadult males (Aurioles, 1982, Aurioles et al., 1983; Maravilla, 1986). The aim of this study was to analyze the complete scheme of seasonal fluctuations inside the Gulf, reinforced with recent genetic studies that showed the isolation of sea lions populations from the Gulf regarding those out in the Pacific Ocean (Schramm 2002).

Table 1 - Name, category and periods of study for each locality.

	Name	Key	Autumn	Sum	Spr	Wint
1	Islotes	Br	89,90,91		91	92
2	San Pedro Nolasco	Br	90,91	90	91	92
3	San Pedro Martir	Br	89,90,91	90	91	92
4	San Esteban	Br	89,90,91	90	91	92
5	Rasito	Br	89,90,91	90	91	92
6	Cantiles	Br	89,90,91	90	91	92
7	Los Machos	Br	89,90,91	90	91	92
8	Granito	Br	89,90,91	90	91	92
9	Roca vela	T	89,90,91	90	91	92
10	San Jorge	Br	89	90	91	92

Colonies distribution is shown in Fig. 1.

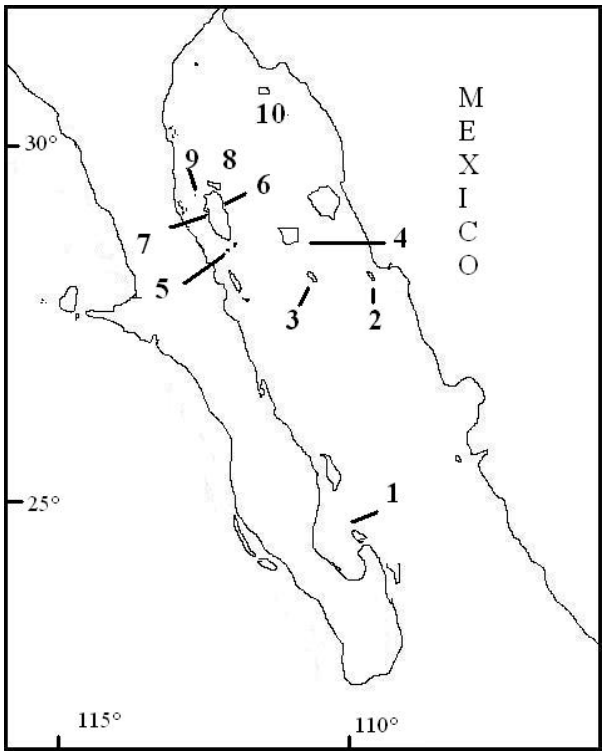

Figure 1 - Area of study

MATERIALS AND METHODS

Abundance and Distribution. To determine the seasonal distribution of this population, the study area was chosen all along the Gulf of California including 10 different colonies including 9 of the 13 breeding rookeries and one temporary (Table 1). The study period was divided as: spring = March 21 - June 21; summer = June 22 - Sept 20; autumn = Sept. 21 - Dec. 20 and winter = Dec 21 - March 20.

For the determination of relative abundance, each locality from land and/or by sea, was censused counting every animal on the beaches, rocks or entire islands, separating and classifying them into five different sex/age groups recognized for this species on the field (Le Boeuf, et al., 1983, Aurioles, 1982; Aurioles, et al., 1983; Maravilla, 1986, and Zavala-Gonzalez 1990). (Table 2). These were Mature Males (M), Mature Females (F), Subadult Males (SM), Juveniles (J), Pups (P) and Miscellaneous (m) which included those not positively identified or in the water during the censuses.

For island estimations, raw data from census without any correction factor were used.

Table 2 - Categories by age/sex to census California sea lions.

Class	Size	Color	Estimated age
M	Up to 2.5 m	Usually black	9-12 yrs old
F	1.5 to 2 m	Brown - cream	4-18 yrs old
SM	1.8 to 2 m	Dark brown	4-9 yrs old
J	1 to 1.8 m	Cream brownish	1-4 yrs old
P	0.4 - 1 m	Dark	0-1 yrs old
M	All those animals not clearly identified		

RESULTS AND DISCUSSION

Population censuses

Tables 3 (a and b) show the numbers for population estimations obtained at each rookery by direct counts for the six field trips.

Every rookery was visited during each field trip. During the first trip (autumn of 1989) a total of 11,562 individuals were counted. For the autumn of 1990, 11,585 animals, and for third autumn census at the end of this season (November 1991), census produced an estimation of 10,867 sea lions.

Table 3a - Censuses for three autumn periods in the Gulf of California, Mexico.

Rookery	Aut. 89	Aut. 90	Aut. 91
San Jorge	3,528	3,800	3,200
San Esteban	2,651	3,145	2,870
S.P. Martir	1,630	1,423	1,493
Granito	920	709	473
S.P. Nolasco	900	783	1,018
Cantiles	721	940	725
Los machos	614	284	625
Rasito	253	279	258
Islotes	241	150	155
Roca vela	104	72	50
Totals	11,562	11,585	10,867

Table 3b - Censuses for summer, spring and winter in the Gulf of California, Mexico.

Rookery	Sum 90	Spring 91	Win 92
San Jorge	6,159	4,719	2,171
San Esteban	4,234	3,961	2,010
S.P. Martir	1,450	1,526	757
Granito	1,387	930	676
S.P. Nolasco	1,039	784	655
Cantiles	1,239	1,096	567
Los machos	1,072	1,511	279
Rasito	355	290	149
Islotes	153	176	206
Roca vela	74	50	0
Totals	17,162	15,043	7,470

Table 3b showed that numbers during spring and summer corresponded to the breeding and post breeding periods, when the population numbers reached the highest values for this region.

The summer census (July 1990) correspond to the end of the breeding season with 17,162 sea lions being highest recorded number. By the end of spring 1991, 15,043 individuals were counted. Finally, winter estimation in February 1992 produced a total of 7,470 individuals in these 10 islands. Looking at data for the autumn periods, relatively most important rookeries in numbers of

individuals were San Jorge, San Esteban and San Pedro Martir, which accounted between the 67 to 72 % of the total. Autumn of 1991 was considered more representative instead of the mean of three periods considering the continuity with previous period (Spring 91) (Table 4).

Table 4 - Totals of age/class categories per season

SEASON	M	F	SM	J	P	m	TOTAL
Spring	824	8,035	1,241	1,824	3,077	42	15,043
Summer	736	7,578	806	2,494	5,499	49	17,162
Autumn	297	5,203	1,176	2,264	1,686	241	10,867
Winter	348	3,113	855	1,707	952	495	7,470

Table 5 - Percentages for each season age/class

Season	M	F	SM	J	P	m	Total
Spring	5.48	53.41	8.25	12.13	20.45	0.28	15,043
Summer	4.29	44.16	4.70	14.53	32.04	0.29	17,162
Autumn	2.73	47.88	10.82	20.83	15.51	2.22	10,867
Winter	4.66	41.67	11.45	22.85	12.74	6.63	7,470
	4.29	46.78	8.80	17.59	20.19	2.35	

Adult Females were the most abundant group regardless of the season. They accounted from 41 to 53% of population (Table 5). According to the season, Pups represented 2nd or 3rd place. In summer, they contributed with 32%. These results agreed with those obtained by Aurioles (1982), Le Boeuf et al., (1983), and Zavala-Gonzalez (1990) with the maximum abundance and pup production during summer (breeding season). During the autumn, after the breeding season, juveniles surpassed the number of pups. Also some females and males moved out of the breeding rookeries in search for food. More than 50% of females are absent during the winter (Table 5). Also, the total number of sea lions registered a reduction of more than 50% from summer to winter. Zavala-Gonzalez (1990) proposed two peaks of abundance: during late spring and late summer. The first, produced by breeding adults (males and females) arriving to the breeding colonies and the annual production of pups, and second produced by arrival of SM and J. Similar results were obtained in this work for spring census corresponding to the middle of the breeding period (May to June - July). For summer census, also there were coincidences with Zavala's proposal. Aurioles et al., (1983), and Maravilla (1986) proposed a migration pattern for subadult males, going out of the Gulf of California. Zavala-Gonzalez (1990) observed same behavior adding the impact of juveniles. Present result showed the low impact produced by subadult males over the total population numbers. In some rookeries (e.g. Islotes), they impacted because of the small population number on the island (In the autumn 1989 there were 81 SM, almost 50 more than mean = 30). Other categories varied, for pups, which saw reduction at the end of the first year of life about 50% is due to mortality (Aurioles and Sinsel, 1988). Juveniles, non-lactating females and males tended to disperse (Zavala-Gonzalez, 1990).

Le Boeuf et al., (1983) observed some sea lions at sea, few of them close to the islands. During our navigation along the Gulf with sunlight, we registered important numbers of sea lions at sea. Qualitatively, we encountered more sea lions at sea during our winter cruises. The occurrence of enough food resources in the middle-northern Gulf, where about 81% of the sea lions population was concentrated (Aurioles and Zavala, 1994), along with recent genetic findings supported our proposal of the residence of the "population" of the Gulf of California. Schramm (2002) found genetic isolation between the sea lions from the Pacific Ocean, and those living inside the Gulf of California. These two populations seemed to be in progressive isolation. All this supported our proposal for a new explanation of seasonal changes in numbers among the different rookeries being the dispersal of animals along the entire

Gulf looking for food resources, more than migration and exchanges with sea lions from outside the Gulf.

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RESUMO

O leão marinho da Califórnia (*Zalophus californianus californianus*) é a única espécie de Otariidae (PINNIPEDIA) que vive em permanência no Golfo da Califórnia, México. Vive em grupos, principalmente em rochas, ilhas ou porções de praias de algumas ilhas. Este artigo descreve pela primeira vez as variações da abundância e estrutura populacional dos leões marinhos desta região, nas quatro estações do ano. Realizamos seis censos, entre Outubro de 1989 e Janeiro de 1992 (3 censos correspondendo ao outono e um a cada uma das outras estações. Os censos foram feitos de barco, em terra ou combinados, com contagem direta e separando os indivíduos em 5 classes de idade e sexo. As estimativas de abundância variaram de 17,162 indivíduos, em Julho de 1990 (na Primavera), ao mínimo de 7,470, no Inverno de 1992, o que representa uma redução de 10,000 leões marinhos. A hipótese da migração de parte da população para o Oceano Pacífico é discutida e comparada com a de residência da população, bem como a nossa proposta de uma dispersão dos indivíduos pelo Golfo do Califórnia.

REFERENCES

Aurioles, G. D. (1982), Contribución al conocimiento del lobo marino de California *Zalophus californianus*. Tesis de Licenciatura. Universidad Autónoma de Baja California Sur, La Paz, B.C.S. 74 pp.

Aurioles, D.; Sinsel, F.; Fox, C.; Alvarado, E. and Maravilla, O. (1983), Winter migration of subadult male California sea lions (*Zalophus californianus*) in the southern part of Baja California. *Journal of Mammalogy*, **64** : (3), 513-518.

Aurioles, G. D. and Sinsel, F. (1988), Mortality of california sea lion pups at Los Islotes, Baja California Sur, México. *J. Mammalogy*, **69**, 180-193.

Aurioles, G. D. and Zavala-Gonzalez, A. (1994), Algunos factores ecológicos que determinan la distribución y abundancia del lobo marino *Zalophus californianus*, en el Golfo de California. *Ciencias Marinas*, **20** : (4), 535-553.

Bartholomew, G. A. and Boolootian, R. A. (1960), Numbers and population structure of the pinnipeds on the California Channel islands. *Journal of Mammalogy*, 41 : (3), 366-375.

Bigg, M. A. (1973), Census Of California sea lions on southern Vancouver island British Columbia. *Journal of Mammalogy*, **54** : (2), 285-287.

Bonnell, M. L.; LeBoeuf, B. J.; Pierson, M. O.; Dettman, D. H. and Farrens, G. D. (1978), Summary of marine mammal and seabird surveys of the southern California bight area 1975-1978. v. 3- Investigator's reports, Part 1 - Pinnipeds of the southern California bight, 535 p. Univ. Calif. Sta. Cruz, Calif., Final report to the Bureau of Land Management, under contract AA550-CT7-367.

Daugherty, A. E. (1965), Marine Mammals of California. The ressources Agency. Departmen of Fish and Game. Sacramento, CA. 86 pp.

Gallo, R. J. P. and Ortega, A. (1986), The first report of *Zalophus californianus* in Acapulco, Mexico. *Marine Mammal Science*, **2**, 158.

Gallo, R. J. P. and Solórzano, J. L. V. (1991), Two new sightings of California sea lions on the southern coast of Mexico. *Marine Mammal Science*, **7** : (1), 96.

Hancock, D. (1970), California sea lions as regular visitants of the British Columbia coast. *Journal of Mammalogy*, **51** : (3), 614.

Le Boeuf, B.; Aurioles Gamboa, J. D.; Condit, R.; Fox, G.; Gisiner, R.; Romero; R. and Sinsel, F. (1983), Size and distribution of the California sea lion population in México. *Proceedings of the California Academy of Science*, **43**, 77-85.

Maravilla C. M. O. (1986), Fluctuaciones estacionales del lobo marino de California *Zalophus californianus* (Lesson 1828), Allen, 1880, en 5 colonias reproductoras de México. Tesis Profesional. Universidad Autónoma de Baja California sur. 65 pp.

Schramm, U. Y. (2002), Estructura Genética y filogeografia del lobo marino de California (*Zalophus californianus californianus*) en aguas adyacentes a la península de Baja California, México. Tesis de Doctorado. Universidad Autónoma de Baja California. Fac. de Ciencias Marinas. Ensenada B.C. México. 146 pp.

Zavala-González, A. (1990), La Población del Lobo Marino Común *Zalophus californianus* (Lesson 1828) en las Islas del Golfo de California, México. Tesis de Licenciatura. Facultad de Ciencias. UNAM. México, D.F. 235 pp.

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