Cal/Ecotox
Exposure Factors for California Sea Lion (Zalophus californianus)*

Endpoint Type	Endpoint Value	Error	Range	Units	Sex	Life Stage	Location	Note	Reference
Body Fat (total or %)	19.3			%	F	Pup	CA	a	1
Body Fat (total or %)	18.7			%	M	Pup	CA	b	1
Body Weight - Mean	100			kg	F	Adult	CA	c	2
Body Weight - Mean	380			kg	M	Adult	CA	d	2
Body Weight - Mean	32.2	1.6 SE	25.7-38.1	kg	B	Juvenile	Lab	e	3
Body Weight - Mean			32.6 - 37.0	kg	F	Juvenile	Lab	f	4
Body Weight - Mean	9			kg	NR	Neonate	CA	g	2
Body Weight - Mean			14-17	lbs	NR	Neonate		h	5
Body Weight - Mean	8.1	0.163 SE		kg	NR	Neonate	CA	i	6
Body Weight - Mean	8.4	0.146 SE		kg	NR	Neonate	CA	j	6
Body Weight - Mean	8.2	0.229 SE		kg	NR	Neonate	CA	k	6
Body Weight - Mean	8.6	0.227 SE		kg	NR	Neonate	CA	l	6
Body Weight - Mean	12,000	231 SE	8,333 - 14, 512	g	B	Pup	Lab	m	7
Body Weight - Mean	9.12	0.128 SE		kg	F	Pup	CA	n	8
Body Weight - Mean	7.59	0.289 SE		kg	F	Pup	CA	o	8
Body Weight - Mean			13.1 - 19.6	kg	F	Pup	CA	p	9
Body Weight - Mean	9.09	0.112 SE		kg	M	Pup	CA	q	8
Body Weight - Mean	10.32	0.715 SE		kg	M	Pup	CA	r	8
Body Weight - Mean			14.6 - 23.2	kg	M	Pup	CA	s	9
Clutch or Litter Size	1			pup/litter	F	Adult	CA	t	10
Clutches or Litters per year			0.23-0.30	pups/female/yr	F	Adult	CA	u	11
Dietary Composition	northern anchovy (65%); Pacific Whiting (52%); market squid (13%)			%	F	Adult	CA	v	12
Dietary Composition	see citation			%	F	Adult	CA	w	9
Dietary Composition	Pacific whiting (48.7%); market squid (46.7%); juvenile rockfish (35.9%); northern anchovy (20.0%); red octopus (9.7%); jack mackerel (4.6%); nail squid (4.6%); squid (4.1%);chub mackerel (3.6%); Pacific pompano (2.5%); California lantern fish (2.5%)			%	B	Both Adult and Juv.	CA	x	13
Dietary Composition	northern anchovy (50.6%); Pacific whiting (29.3%); jack mackerel (27.9%); rockfish (25.9%); Pacific mackerel (11.3%); unid. fishes (6.6%); market squid (21.9%); octopus (6.4%); squid, Onychoteuthis (4.7%); squid, Abraliopsis (2.2%); pelagic red crab (10.8%)			%	NR	NR	CA	y	14
Dietary Composition	northern anchovy (51.3%); jack mackerel (24.6%); pelagic crab (21.2%); Pacific whiting (19.6%); rockfish (19.0%); market squid (16.3%); blacksmith (10.7%); Pacific mackerel (9.5%); octopus (5.1%); squid (2.2%); senorita (1.1%); lanternfish (1.3%)			%	NR	NR	CA	z	15

Exposure Factors for California Sea Lion (Zalophus californianus)

Endpoint Type	Endpoint Value	Error	Range	Units	Sex	Life Stage	Location	Note	Reference
Dietary Composition	northern anchovy (24.7%); jack mackerel (11.8%); pelagic red crab (10.2%); Pacific whiting (9.4%); rockfish (9.2%); market squid (7.9%); blacksmith (5.1%); Pacific mackerel (4.6%); octopus (2.5%); squid (1.1%)			%	NR	NR	CA	aa	15
Food Ingestion Rate			2032 - 2152	kcal/d	F	Pup	CA	ab	1
Food Ingestion Rate	609	24.0 SE		g/d	F	Pup	CA	ac	1
Food Ingestion Rate	5.93	0.467 SE		%/d	F	Pup	CA	ad	8
Food Ingestion Rate	7.37	0.242 SE		%/d	F	Pup	CA	ae	8
Food Ingestion Rate			2144 - 2636	kcal/d	M	Pup	CA	af	1
Food Ingestion Rate	723	31.0 SE		g/d	M	Pup	CA	ag	1
Food Ingestion Rate	5.96	0.405 SE		%/d	M	Pup	CA	ah	8
Food Ingestion Rate	8.00	0.260 SE		%/d	M	Pup	CA	ai	8
Foraging Distance	54.2	32.4 SD		km	F	Adult	CA	aj	12
Growth Rate			95.0 - 109.1	g/d	F	Pup	CA	ak	1
Growth Rate	95.0	11.75 SE		g/d	F	Pup	CA	al	8
Growth Rate	75.8	62.56 SE		g/d	F	Pup	CA	am	8
Growth Rate	120.0	8.16 SE		g/d	F	Pup	CA	an	8
Growth Rate			92.4 - 120.6	g/d	M	Pup	CA	ao	1
Growth Rate	107.5	5.74 SE		g/d	M	Pup	CA	ap	8
Growth Rate	109.2	41.62 SE		g/d	M	Pup	CA	aq	8
Growth Rate	144.1	16.13 SE		g/d	M	Pup	CA	ar	8
Growth Rate	0.130	0.006 SE		kg/d	NR	Pup	CA	as	6
Growth Rate	0.101	0.007 SE		kg/d	NR	Pup	CA	at	6
Growth Rate	0.132	0.007 SE		kg/d	NR	Pup	CA	au	6
Growth Rate	0.125	0.007SE		kg/d	NR	Pup	CA	av	6
Longevity	28			yrs	NR	Adult	Lab	aw	16
Metabolic Rate	321.4	23.7 SE		ml O2/min	B	Adult	Lab	ax	17
Metabolic Rate	403.7	36.0 SE		ml O2/min	B	Adult	Lab	ay	17
Metabolic Rate	see citation			L O2/min	M	Adult	Lab	az	18
Metabolic Rate	5.1	0.4 SE		ml O2/min/kg	B	Juvenile	Lab	ba	3
Metabolic Rate	26.9	1.9 SE		ml O2/min/kg	B	Juvenile	Lab	bb	3
Metabolic Rate			11.8-15.01	ml O2/min/kg	B	Juvenile	Lab	bc	19
Metabolic Rate	2.1			kcal/kg/hr	F	Juvenile	Lab	bd	4
Metabolic Rate	0.78	0.10		ml O2/g/hr	B	Pup	Lab	be	7
Population Density	see citation			#/km2	B	Both Adult and Juv.	CA	bf	20
Survival/ Mortality	66		14-100	%	NR	Juvenile	Lab	bg	21
Survival/ Mortality	10-18			%	F	Pup	CA	bh	11
Survival/ Mortality	51.6	7.7 SD	44.0 - 59.4	%	NR	Pup	MEXICO	bi	22
Territory Size	130		15 - 291	m2	M	Adult	CA	bj	23
Territory Size	130		15-291	m2	M	Adult	CA	bk	24
Time of Hatching or Parturition	May-late June				F	Adult	CA	bl	10

Endpoint Type	Endpoint Value	Error	Range	Units	Sex	Life Stage	Location	Note	Reference
Time of Hatching or Parturition	May/June				NR	Pup	CA	bm	24
Time of Mating/ Laying	May - June				B	Adult	CA	bn	2
Time of Mating/ Laying	May - Aug.				B	Adult	CA	bo	11
Time of Mating/ Laying	June/July				B	Adult	CA	bp	24
Time of Mating/ Laying	May - Aug.				F	Adult	CA	bq	23
Water Ingestion Rate	549	21.6 SE		g/d	F	Pup	CA	br	1
Water Ingestion Rate	651	27.9 SE		g/d	M	Pup	CA	bs	1

Notes

a	N=1; Age=3 mo; San Nicolas Island [lat., 33^oW; long., 119^oW]; body weight = 15.0 kg
b	N=1; Age=3 mo; San Nicolas Island [lat., 33^oW; long., 119^oW]; body weight = 22.7 kg
c	N=NR
d	N=NR
e	N=6
f	N=2
g	N=NR
h	neonate weight; N=16
i	mean weight; El Nino 1983; N=31 neonates; Age=3 days or less; San Nicolas Island
j	mean size neonate ; pre El Nino 1982; N=39 neonates; Age=3 days or less; San Nicolas Island
k	mean weight, post el Nino 1984; N=16 neonates; Age=3 days or less; San Nicolas Island
l	mean weight; 2 years post el Nino (1985); N=16 neonates; Age=3 days or less; San Nicolas Island
m	N=39; Age=3-5 wks; captured at San Nicolas Island, CA
n	N=4; Age=30 d; July; San Nicolas Island; El Nino yr; not significantly different from post-El Nino yr
o	N=7; Age=5 d; June; San Nicolas Island; pre-El Nino yr; not significantly different from post-El Nino yr
p	range of mean weights taken over 5 yrs at 2 sites; N=41 - 151/yr; Age=4 mo; San Miguel and San Clemente Islands
q	N=7; Age=5 d; June; San Nicolas Island; pre-El Nino yr; not significantly different from post-El Nino yr
r	N=7; Age=30 d; July; San Nicolas Island; El Nino yr; not significantly different from post-El Nino yr
s	range of mean weights taken over 5 yrs at 2 sites; N=51 - 136/yr; Age=4 mo; San Miguel and San Clemente Islands
t	N=NR; San Miguel Island
u	range of fecundity over 4 yrs; peak pup/peak female counts; N=4360-6952 pups; San Nicolas Island
v	% occurrence of most frequent prey in scats; N=23 animals; Condition=post-partum; June - July; Adams Cove, San Miguel Island [lat., 34^o01'55"N; long., 120^o26'25" W]; see citiation for figure of diet composition
w	figure of % occurrence of prey items in scats; N=73 - 283; summer; San Miguel and San Clemente Islands
x	% occurrence of major prey (>1%) in scats; N=224 scats; spring and summer; San Miguel Island; see citation for detailed list of prey species and figure of estimated prey weights
y	% frequency of occurrence of major (>2%) prey in scats; N=1232 scats; yr-round; San Nicholas Island; see citation for extensive list of prey items
z	% of scats in which major (>1%) prey occurred; N=1309 scats; San Clemente Island; see citation for detailed list of prey
aa	% occurrence of major (>1%) prey taxon from a tally of occurrences of all prey taxa in scats; N=1309 scats; San Clemente Island; see citation for detailed list of prey
ab	daily energy intake estimated from milk intake; range of means for 2 yrs; N=1-8/yr; Age=1 mo; San Nicolas Island [lat., 33^oW; long., 119^oW]
ac	daily milk intake; N=19; Age=1-2 mo; June - July; San Nicolas Island [lat., 33^oW; long., 119^oW]; mean body weight range = 7.76 - 9.26 kg
ad	daily milk intake as % of pup body weight; N=4; Age=1-2 mo; July; San Nicolas Island; El Nino yr; not significantly different from post-El Nino yr; also expressed as 2046 +/- 230.6 kcal/d
ae	daily milk intake as % of pup body weight; N=7; Age=5-30 d; June; San Nicolas Island; pre-El Nino yr; also expressed as 2187 +/- 130.6 kcal/d
af	daily energy intake estimated from milk intake; range of means for 2 yrs; N=5-9/yr; Age=1 mo; San Nicolas Island [lat., 33^oW; long., 119^oW]
ag	daily milk intake; N=24; Age=1-2 mo; June - July; San Nicolas Island [lat., 33^oW; long., 119^oW]; mean body weight range = 8.53 - 11.52 g
ah	daily milk intake as % of pup body weight; N=5; Age=1-2 mo; July; San Nicolas Island; El Nino yr; not significantly different from post-El Nino yr; also expressed as 2323 +/- 299.8 kcal/d
ai	daily milk intake as % of pup body weight; N=7; Age=5-30 d; June; San Nicolas Island; pre-El Nino yr; also expressed as 2834 +/- 83.9 kcal/d
aj	N=9; Condition=post-partum; June - July; Adams Cove, San Miguel Island [lat., 34^o01'55"N; long., 120^o26'25" W]
ak	daily weight gain; range of means for 2 yrs; N=4-8/yr; Age=1 mo; San Nicolas Island [lat., 33^oW; long., 119^oW]
al	daily weight gain during 1st mo of life; N=4; Age=5-30 d; June-July; San Nicolas Island; post-El Nino yr
am	daily weight gain during the 2nd mo of life; N=4; Age=1-2 mo; July; San Nicolas Island; El Nino yr; not significantly different from post-El Nino yr

an	daily weight gain during 1st mo of life; N=7; Age=5-30 d; June-July; San Nicolas Island; pre-El Nino yr
ao	daily weight gain; range of means for 2 yrs; N=5-9/yr; Age=1 mo; San Nicolas Island [lat., 33^oW; long., 119^oW]
ap	daily weight gain during 1st mo of life; N=4; Age=5-30 d; June-July; San Nicolas Island; post-El Nino yr
aq	daily weight gain during the 2nd mo of life; N=5; Age=1-2 mo; San Nicolas Island; El Nino yr; not significantly different from post-El Nino yr
ar	daily weight gain during 1st mo of life; N=7; Age=5-30 d; June-July; San Nicolas Island; pre-El Nino yr
as	2 years post el nino (1985); 0-2 months; N=38; Age=0-2 months; San Nicolas Island
at	pups 0-2 months old; El Nino 1983;; N=30; Age=0-2 months; San Nicolas Island; difference to pre-and post El Nino stat. significant
au	pre-el Nino; 0-2 months; N=32; Age=0-2 months; San Nicolas Island
av	post el Nino 1984; N=32; Age=0-2 months; San Nicolas Island
aw	captive longevity record; N=NR
ax	oxygen uptake at rectal temperature of 16.4C.; N=3; Age=3-4 yrs; body weight range = 59 - 64 kg
ay	oxygen uptake at rectal temperature of 30.9C.; N=3; Age=3-4 yrs; body weight range = 59-64 kg
az	figure of oxygen consumption during swimming; N=1; Age=6 yr
ba	resting metabolic rate; N=6
bb	metabolic rate during excercise; N=6
bc	range of mean field metabolic rates estimated by oxygen consumption using direct respirometry and doubly labelled water methods; exercise regime used to simulate swimming; N=6; Age=1 yr
bd	resting metabolism; N=2
be	resting metabolic rate measured over a range of ambient temperatures (16-25C); N=39; Age=3-5 wks; captured at San Nicolas Island, CA; see citation for figure of relationship between body mass, ambient temperature and oxygen consumption
bf	maps of sea lion densities; N=NR; Yr-round; southern California Bight
bg	mean annual survivorship for animals >30 d; N=38 births/10 yr; captive in British facilities
bh	range of % mortality during the first 2 mo of life; estimated over 3 yrs; N=2679 pups; Age=0-2 mo; San Nicolas Island
bi	mean annual minimum survival rate; data collection started 5-6 weeks after beginning of pupping season; N=3 yrs; Los Islotes, Baja California Sur
bj	territory size during breeding; N=20 territories; July; San Nicolas Island
bk	N=24-25 males; Condition=breeding; June/July; San Nicolas Island, CA
bl	pupping season; N=NR; San Miguel Island
bm	N=127 pups; San Nicolas Island
bn	breeding; N=NR
bo	time of breeding; N=NR; San Nicolas Island
bp	N=not reported; Condition=breeding; June/July; San Nicolas Island, CA
bq	breeding season; pupping and mating; N=NR; San Nicolas Island; article has various other data associated with breeding biology
br	total daily water intake derived from sum of milk water intake and metabolic water production; N=19; Age=2 mo; San Nicolas Island [lat., 33^oW; long., 119^oW]
bs	total daily water intake derived from sum of milk water intake and metabolic water production; N=24; Age=2 mo; San Nicolas Island [lat., 33^oW; long., 119^oW]

References

1 Oftedal, Olav T., Sara J. Iverson and Daryl J. Boness. 1987. Milk and energy intakes of suckling California Sea Lions (Z. californicus) pups in relation to sex, growth and predicted maintenance requirements. Physiol. Zool. 60(5):560-575.

2 Antonelis, George A. and Clifford H. Fiscus. 1980. The pinnipeds of the California current. Calif. Coop. Ocean. Fish. Investig. Rep. 21:68-78.

3 Butler, P. J., A. J. Woakes, I.L. Boyd and S. Kanatous. 1992. Relationship between heart rate and oxygen consumption during steady-state swimming in California sea lions. J. Exp. Biol. 170:35-42.

4 South, F.E., R. H. Luecke, M. L. Zatzman and M. D. Shanklin. 1976. Air temperature and direct partitional calorimetry of the California sea lion (Zalophus californianus). Comp. Biochem. Physiol., A , Comp. Physiol. 54(1):27-30.

5 Scheffer, V. B. 1981. Newborn size in marine mammals. Pac. Discovery. 34(3):19-26.

6 Boness, D. J., O. T. Oftedal,and K. A. Ono. 1991. The effect of El Nino on pup development in the California sea lion (Zalophus californianus); I. Early postnatal growth, In: Trillmich, Fritz and Kathryn A. Ono,, eds. Pinnipeds and El Nino: Responses to Environmental Stress. New York, N.Y.: Springer Verlag. p 173-179.

7 Thompson, Steven, D., Kathryn A. Ono, Olav T. Oftedal and Daryl J. Boness. 1987. Thermoregulation and resting metabolic rate of California sea lion (Zalophus californianus) pups. Physiol. Zool. 60(6):730-736.

8 Iverson, S. J., O.T. Oftedal and D.J. Boness. 1991. The effect of El Nino on pup development in the California sea lion (Zalophus californianus) II: Milk intake, Ch. 19. In: Trillmich, Fritz and Kathryn A. Ono, eds. Pinnipeds and El Nino: Responses to Environmental Stress. New York, NY: Springer Verlag. p 180-184.

9 DeLong, R. L., G.A. Antonelis, C.W. Oliver, B.S. Stewart, M.S. Lowry and P.K. Yochem. 1991. Effects of the 1982-1983 El Nino on several population parameters and diet of California sea lions on the Califonia channel islands, Ch. 17. In: Trillmich, Fritz and Kathryn A. Ono, eds. Pinnipeds and El Nino: Responses to environmental stress. New York, NY: Springer Verlag. p 166-172.

10 Brownell, R. L. and B.J. LeBoeuf. 1971. California sea lion mortality: Natural or artifact, Ch. 14. In: Straughan, Dale, eds. Biological and Oceanographical Survey of the Santa Barbara Channel Oil spill 1969-1970, Volume I. Los Angeles, CA: Allan Hancock Foundation, University of Southern California. p 287-305.

11 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 Nino on San Nicolas Island, Ch. 12. In: Trillmich, Fritz and Kathryn A. Ono, eds. Pinnipeds and El Nino: Responses to Environmental Stress. New York, NY: Springer Verlag. p 271-288.

12 Antonelis, George A., Brent S. Stewart and Wayne F. Perryman. 1990. Foraging chracteristics of female northern fur seals (Callorhinus ursius) and California sea lions (Zalophus californianus). Can. J. Zool. 68:150-158.

13 Antonelis, George A., Clifford H. Fiscus and Robert L. DeLong. 1984. Spring and summer prey of California sea lions, Zalophus californianus, at San Miguel Island, California 1978-79. Fish. Bull. 82(1):67-76.

14 Lowry, Mark S., Brent S. Stewart, Carolyn B. Heath, Pamela K. Yochem and John M. Francis. 1991. Seasonal and annual variability in the diet of California Sea Lions Zalophus californianus at San Nicholas Island, California, 1981-86. Fish. Bull. 89(2):331-336.

15 Lowry, Mark S., Charles W. Oliver, Carolyn Macky and Jeannie B. Wexler. 1990. Food habits of the California sea lion, Zalophus californianus, at San Clemente Island, California, 1981-86. Fish. Bull. 88:509-521.

16 Jones, Marvin L. 1982. Longevity of captive mammals. Zool. Gart. 52(2):113-128.

17 Matsuura, D. T. and G. C. Whittow. 1973. Oxygen uptake of the California sea lion and harbour seal during exposure to heat. Am. J. Physiol. 225(3):711-715.

18 Costello, R.R. and G.C. Whittow. 1975. Oxygen cost of swimming in a trained California sea lion. Comp. Biochem. Physiol., A , Comp. Physiol. 50:645-647.

19 Boyd, I. L., A. J. Woakes, P.J. Butler, R.W. Davis and T.M. Williams. 1995. Validation of heart rate and doubly labelled water as measures of metabolic rate during swimming in California sea lions. Funct. Ecol. 9(2):151-160.

20 Bonnell, Michael L. and R. Glenn Ford. 1987. California sea lion distribution: A statistical analysis of aerial transect data. J. Wildl. Manage. 51:13-20.

21 Gates, Luke, Suzanne Tatersall and David Nicholson. 1995. An overview of captive births and survivorship of California sea lions 1985-1995. Ratel. 22(1):5-9.

22 Aurioles, David and Francisco Sinsel. 1988. Mortality of California sea lion pups at Los Islotes, Baja California, Mexico. J. Mammal. 69(1):180-183.

23 Odell, D. K. 1975. Breeding biology of the California Sea lion, Zalophus californianus. Rapp. P.-v, Reun. Cons. Int. Explor. Mer. 169:374-378.

24 Odell, Daniel Keith. 1972. Studies on the biology of the California sea lion and the northern elephant seal on San Nicolas Island, California. Ph.D. dissertation. University of California, Los Angeles. p.147 p.

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