

Northern Elephant Seal Survival

This report is based on the paper “Lifetime survival rates and senescence in northern elephant seals” by Richard Condit, Joanne Reiter, Patricia Morris, Ryan Berger, Sarah Allen and Burney Le Boeuf. The paper can be found [HERE](#).

Before we go to charts and calculations, some results to consider:

- It is important to recognize that the data and the results of this study are about weaned pups born at Año Nuevo. Some of the seals in the study, while born at Año Nuevo, spent some of their lives at other rookeries. The data for Piedras Blancas and other rookeries would very likely be different
- Since movement of seals between rookeries is significant, inferences about the Año Nuevo population distribution by age or gender cannot be made from the survival data.
- The study finds that for the years from age 4 to age 18 the females have a roughly constant annual survival rate of about 85%. Throughout their life, the annual survival rate for males is about 68% or 2/3.
- The statement “Only one in six make it to age 4.” is not supported by this data. Rather, approximately, one in four females (25.2%) and one in five males (20.1%) make it to age 4. Perhaps a better approximation for communicating mortality is “Only 30% make it to age 3.”

Between 1985 and 1987 372 weaned pups were branded (just like in cowboy movies) and their reappearance at Año Nuevo *or at other rookeries* was monitored. The paper and its appendices describe the rather complex analysis of the data. The results are shown in **Table 1** below, based on Table 3 of the Condit paper. Reference will be made to the various columns of the table in **bold** type.

The **Annual Survival** data indicate for each successfully weaned pup, female or male, the probability that it survived from the previous year to the year indicated. That is, 57.3 % (the orange box) of females survived from weaning to year 1, of those 69.3% survived to year 2, etc. This data comes directly from Table 3 of the paper. If the colony is to be stable, the 1000 weaned female pups must, over their lifetime, wean 1000 female pups

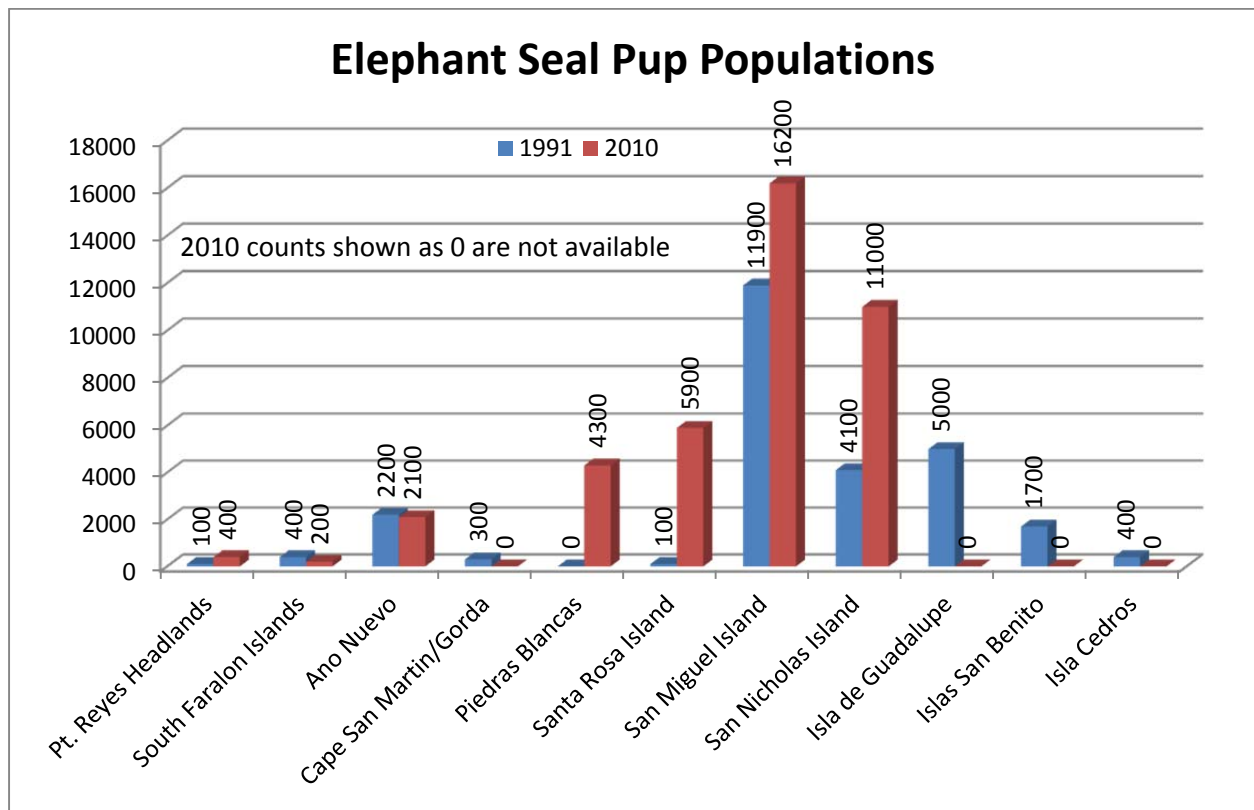
The **Survivorship** column shows the same data expressed as the number of seals that survived from weaning to the indicated year. So, for 1000 weaned female pups, the number that survived to age 3 is just 1000 times the probability it survived from weaning to age 1 (57.3%) times the probability it survived from age 1 to age 2 (69.3%) times the probability it survived from age 2 to age 3 (77.7%). You can check on your calculator that $1000 \times 0.573 \times 0.693 \times 0.777 = 309$. So if 1000 female pups are born in year 0, 309 will survive to year 3. The same process works for male pups. The Survivorship numbers shown are just 1000 times those shown in Table 3.

The stable population test noted above is demonstrated in the column labeled **Replacement**. If each year 1000 female pups are born then the adult females from those pups, ages 3 to 21, must wean at least 1000 pups. If the number they wean is more than that then the colony will grow; if less than that the colony will shrink. An estimate of **fecundity** is made for these females. It represents the probability that they will give birth to female pups (50%) and successfully wean them (90%). There is data from Año Nuevo that support both numbers for birthing as a whole – but no separate data on age dependence. (We do know that experienced females and

females with their first pregnancy later than four years are more successful than first timers and the youngest mothers.)

Looking at the green boxes, the 210 females of age 5 will produce 94 weaned female pups if the fecundity is 45%. For the **Annual Survival** values found and an estimate of 45% for females 4 and older and 25% for 3 year old females, the number of pups born is the sum of the # female pups or 789, less than the 1000 required for a stable colony. Based upon the survival data and reasonable estimates of fecundity, the Año Nuevo colony will shrink without compensating immigration. Richard Condit points out that the early survival numbers for the females are very powerful influences in that replacement value. Setting Annual Survival for females to age 1 and from age 1 to age 2 to the average annual survival from age 3 on, 82%, would raise the replacement number from 789 to 1336, well over the sustaining level.

In considering this survival data, it is important to recognize that if they applied to all rookeries, that is to the species itself, the number of northern elephant seals would be shrinking at about 2.5%/year. That is clearly not the case as can be seen from the figure below. Looking at the California rookeries, the number of pups increased from 19,100 to 40,100, an average annual rate of increase of over 3.5%. Thus barring major shifts between Mexican and Californian seals, the annual survival data from Año Nuevo clearly do not characterize the species.



1991 data from Stewart, B.S., Yochem, P.K., Huber, H.R., De Long, R.L., Jameson, R.J., Sydeman, W.J., Allen, S.G. & Le Boeuf, B.J. 1994. History and present status of the northern elephant seal. In: Elephant Seals: Population Ecology, Behavior and Physiology (B. J. Le Boeuf & R. M. Laws, eds), pp. 29–48. University of CA Press, Berkeley.

2010 data by private communication from Michael Lowry. Not for publication beyond the FES docent community.

If you have Excel on your computer you can download the Excel file [HERE](#) and play with the numbers. All of the yellow highlighted numbers can be changed and the impact on the number of female replacements, 789 with the current numbers, can be observed. For convenience the fecundity of females age 4 and greater is set by a value at the top of the column but individual values by age can also be set.

References:

Condit, R., Reiter, J., Morris, P. A., Berger, R., Allen, S. G. and Le Boeuf, B. J. 2013. Lifetime survival rates and senescence in northern elephant seals. *Marine Mammal Science*.

Le Boeuf, B. J., Condit, R., Morris, P. A. and Reiter, J. 2011. The northern elephant seal (*Mirounga angustirostris*) rookery at Año Nuevo: a case study in colonization. *Aquatic Mammals* 2011, 37(4), 486-501.

Table 1

Age	Annual Survival		Survivorship		45.0%	789
	F	M	F	M	Fecundity	# female pups
0	100.0%	100.0%	1000	1000		
1	57.3%	66.1%	573	661		
2	69.3%	67.6%	397	447		
3	77.7%	68.3%	309	305	25.0%	77
4	81.6%	68.3%	252	208	45.0%	113
5	83.3%	68.2%	210	142	45.0%	94
6	84.0%	78.1%	176	111	45.0%	79
7	84.6%	68.0%	149	75	45.0%	67
8	85.1%	67.9%	127	51	45.0%	57
9	85.5%	68.1%	108	35	45.0%	49
10	86.0%	68.5%	93	24	45.0%	42
11	86.4%	69.8%	81	17	45.0%	36
12	86.9%	71.1%	70	12	45.0%	32
13	87.3%	71.7%	61	9	45.0%	28
14	87.7%	69.8%	54	6	45.0%	24
15	88.0%	63.3%	47	4	45.0%	21
16	88.0%		42		45.0%	19
17	87.0%		36		45.0%	16
18	83.9%		30		45.0%	14
19	77.4%		23		45.0%	11
20	65.9%		15		45.0%	7
21	50.7%		8		45.0%	4