

(*Eumetopias jubatus*). *Aquatic Mamm.* **15**: 137-144.  
 KOOYMAN, G. L. & GENTRY, R. L. (1986): Diving behavior of South African fur seals. In *Fur seals: maternal strategies on land and at sea*: 142-152. Gentry, R. L. & Kooyman, G. L. (Eds). Princeton: Princeton University Press.  
 RAND, R. W. (1959): The cape fur seal (*Arctocephalus pusillus*). Distribution, abundance and feeding habits off the southwestern coast of the Cape Province, Union of South Africa. *Invest. Rep. Div. Fish., Dept. Comm. & Ind.* No. 34: 1-65. Pretoria: The Government Printer.  
 SCHUSTERMAN, R. J. & GENTRY, R. L. (1971): Development of a fattened male phenomenon in

California sea lions. *Developmental Psychobiology* **4**: 333-338.

SPOTTE, S. & ADAMS, G. (1979): Note on the food intake of captive adult male northern fur seals (*Callorhinus ursinus*). *Aquatic Mamm.* **7**: 65-67.

WARNEKE, R. M. & SHAUGHNESSY, P. D. (1985): *Arctocephalus pusillus*, the South African fur seal: taxonomy, evolution, biogeography and life history. In *Studies of sea mammals in south latitudes*: 53-78. Ling, J. K. & Bryden, M. M. (Eds). South Australian Museum.

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## Marine mammals in zoos, aquaria and marine zoological parks in North America: 1990 census report

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The first census of marine mammals on display in North America taken in 1976 (Cornell & Asper, 1978) was updated in 1979 (Cornell *et al.*, 1982), in 1983 (Asper *et al.*, 1988) and most recently in 1990. All zoos, aquaria and marine zoological parks in the United States and Canada holding marine mammals have participated. Each institution was contacted by letter and telephone and all supplied data on (1) the histories of the animals currently on display, (2) acquisitions, (3) breeding programmes and births and (4) mortalities (Asper *et al.*, 1988).

At the end of the 1990 census period, there were 102 zoological institutions maintaining marine mammals in North America, 87 in the United States and 15 in Canada. Sixty-nine of these were classified as zoos and 33 as marine zoological parks

or aquaria whose principal purpose is to display marine mammals. An additional 18 private and research collections open to the public were also included. In the past seven years (census period 1983-1990), three zoological institutions have stopped holding marine mammals and 11 have added marine mammals to their inventories. Six private collections were established during this time.

### NUMBERS AND SPECIES DISTRIBUTION

As of 31 March 1990 there were 1550 marine mammals on display, 431 cetaceans representing ten species, 1049 pinnipeds representing 14 species, 33 manatees and 37 sea otters (Table 1). The increase in total number from 1343 in the 1983 census, was largely due to an

SPECIES	TOTAL NO. ON EXHIBIT				CARRY-OVER 1983-1990 (%)	YEARS IN AQUARIA (RANGE)
	1976	1979	1983	1990		
CETACEA						
Boutu or Amazon dolphin						
<i>Inia geoffrensis</i>	3	3	2	1	50	20
Rough-toothed dolphin						
<i>Steno bredanensis</i>	2	2	1 <sup>1</sup>			
Spotted or Spinner dolphin						
<i>Stenella</i> spp	12	5		1 <sup>1</sup>		3
Common dolphin						
<i>Delphinus delphis</i>	4	7		1 <sup>1</sup>		4
Bottle-nosed dolphin						
<i>Tursiops truncatus</i>	286	297	304	328	68	0-30
(incl. Atlantic and Pacific)						
Pacific white-sided dolphin						
<i>Lagenorhynchus obliquidens</i>	14	10	23	18	56	1-21
Melon-headed whale						
<i>Peponocephala electra</i>		2				
Commerson's dolphin						
<i>Cephalorhynchus commersoni</i>		1 <sup>1</sup>		10		1-7
False killer whale						
<i>Pseudorca crassidens</i>	2	2	6	10	50	1-23
Killer whale						
<i>Orcinus orca</i>	17	24	23	28	91	1-22
Pilot whale						
<i>Globicephala</i> spp	7	7	3	4	100	1-28
Harbour porpoise						
<i>Phocoena phocoena</i>			1 <sup>1</sup>			
White whale						
<i>Delphinapterus leucas</i>	10	19	13	30	54	0-17
TOTAL CETACEA	357	379	376	431		
CARNIVORA						
Sea otter						
<i>Enhydra lutris</i>	9	17	23	37	54	1-14
PINNIPEDIA						
Steller's sealion						
<i>Eumetopias jubata</i>	12	12	9	8	62	2-22
Californian sealion						
<i>Zalophus californianus</i>	423	626	571	665	71	0-27
Southern sealion						
<i>Otaria byronia</i> (= <i>flavescens</i> )	10	8	6	6	100	8-20
South American fur seal						
<i>Arctocephalus australis</i>		2	2	2	100	15
South African fur seal						
<i>Arctocephalus pusillus</i>	12	11	11	8	60	1-16
Northern fur seal						
<i>Callorhinus ursinus</i>	8	24	19	28	61	1-14
Walrus						
<i>Odobenus rosmarus</i>	10	19	24	22	77	1-23
Grey seal						
<i>Halichoerus grypus</i>	30	37	36	44	86	1-36
Harbour seal						
<i>Phoca vitulina</i>	217	248	238	254	66	0-37

SPECIES	TOTAL NO. ON EXHIBIT				CARRY-OVER 1983-1990 (%)	YEARS IN AQUARIA (RANGE)
	1976	1979	1983	1990		
Baikal seal <i>Phoca sibirica</i>		4				
Ringed seal <i>Phoca hispida</i>				1		6
Harp seal <i>Phoca groenlandica</i>	2	4	5	3	40	4-10
Hooded seal <i>Cystophora cristata</i>	1	4	1	4	100	2-7
Monk seal <i>Monachus schauinslandi</i>			1	3	100	4-6
Leopard seal <i>Hydrurga leptonyx</i>		1				
Northern elephant seal <i>Mirounga angustirostris</i>	32	19	1 <sup>1</sup>	1 <sup>1</sup>		5
TOTAL PINNIPEDIA	757	1019	924	1049		
SIRENIA						
Amazonian manatee <i>Trichechus inunguis</i>	2	2	1			
West Indian manatee <i>Trichechus manatus</i>	10	11	19	33	75	2-42
TOTAL SIRENIA	12	13	20	33		
TOTAL MARINE MAMMALS	1135	1428	1343	1550		

<sup>1</sup>Originally a stranded animal.

**Table 1.** A summary of marine mammals on display in North America as of March 1990 compared with numbers from the 1979 and 1983 censuses. Per cent carry-over of animals present in 1983 to 1990 and the range of years over which individuals of the 1990 census have been maintained are also given.

increased number of offspring. The relative proportions of the species on display have remained essentially the same as in previous census periods (see Asper *et al.*, 1988).

As in the 1983 census, *c.* 70% of the individual animals were carried over from the previous census date to the current census date (31 August 1983-31 March 1990). Of the animals which entered the marine mammal collection from 1983-1990, a total of 67% came from captive breeding programmes representing a 15% increase from the 52% in 1983. The percentage of acquisitions coming from wild populations remained the same for the two census periods (22%) and the percentage of stranded/rehabilitated acquisitions declined from 26% to 11%.

The trend towards captive births becoming an increasing source of acquisition has been seen in both pinniped and cetacean species over the 14 years of the marine mammal censuses. For example, the percentage of captive-bred pinniped acquisitions for the 1983-1990 census period was 84%, a dramatic increase from the previous census periods (Fig. 1). For three of the pinniped species, Grey seals *Halichoerus grypus*, South African fur seals *Arctocephalus pusillus* and Steller's sealions *Eumetopias jubata*, all additions to the collection from 1983-1990 were captive-born. For California sealions *Zalophus californianus*, 93% of the additions were captive-born. Increases in the percentage of captive-bred acquisitions have been seen for cetaceans as well (Fig. 1).

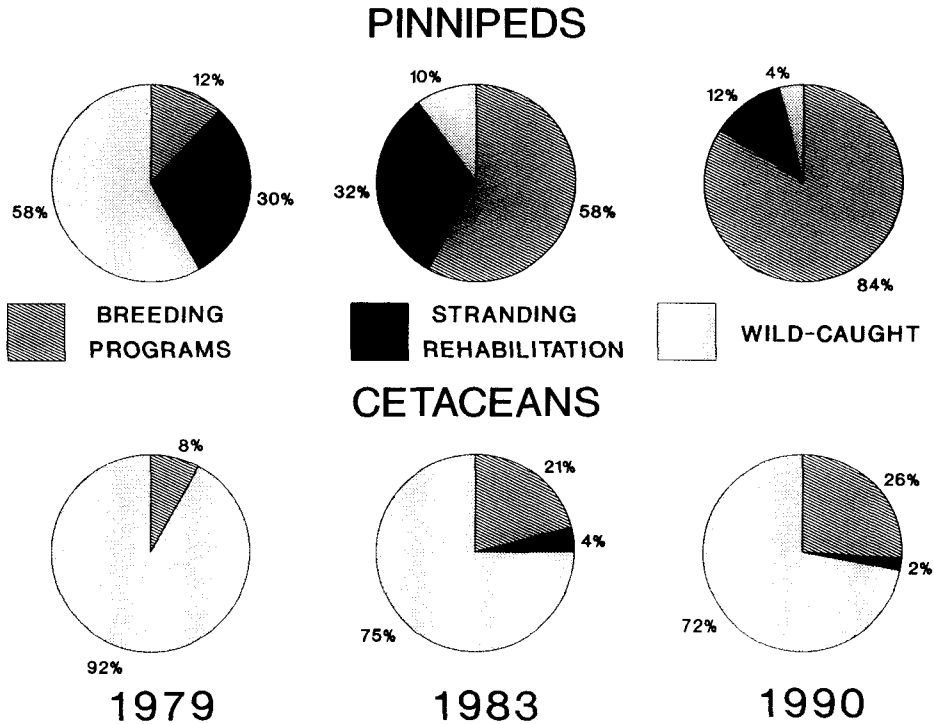


Fig. 1. Comparison of origins of acquisitions for pinnipeds and cetaceans for each of the census periods 1976–1979 (1979), 1979–1983 (1983) and 1983–1990 (1990).

As in previous censuses three species, *Z. californianus*, Harbour seals *Phoca vitulina* and Bottle-nosed dolphins *Tursiops truncatus*, constitute 80% of all marine mammals on display in 1990. All other species were represented by 44 or less individuals; eight species were only represented by one to three individuals and three of these latter species were represented only by stranded animals. The 26 species on display represent only 22% of the 117 marine mammal species currently recognized by the Marine Mammal Commission and the low numbers of most of these 26 species reflect minimal representation of marine mammals in zoological institutions.

#### LENGTH OF TIME IN AQUARIA

The number of years which animals in the 1990 census have been in the collection ranged from new acquisitions (largely

young of that year) to 42 years for the West Indian manatee *Trichechus manatus* (Table 1).

#### REPRODUCTION

As in previous census periods, the number of marine mammal births continued to increase (Table 2). Births were recorded in 17 species. This included all the cetacean species for which more than one animal was present in captivity, all the pinniped species with more than five animals present, sea otters and manatees. Births in three species, Commerson's dolphin *Cephalorhynchus commersoni*, Pacific white-sided dolphin *Lagenorhynchus obliquidens* and False killer whale *Pseudorca crassidens*, were new to this census period. Of all the facilities maintaining marine mammals 56% reported births in this census period, an increase of approximately 6% from 1983.

SPECIES	1976-1979 NO. (no./year)	1979-1983 NO. (no./year)	1983-1990 NO. (no./year)	TOTAL 1976-1990
CETACEA				
Bottle-nosed dolphin <i>Tursiops truncatus</i>	25(8)	57(14)	122(19) <sup>1</sup>	204
Pacific white-sided dolphin <i>Lagenorhynchus obliquidens</i>			4(<1)	4
Commerson's dolphin <i>Cephalorhynchus commersoni</i>			7(1)	7
False killer whale <i>Pseudorca crassidens</i>			1(<1)	1
Killer whale <i>Orcinus orca</i>	2(<1)	2(<1)	12(2)	16
Pilot whale <i>Globicephala</i> spp		1(<1)	1(<1) <sup>2</sup>	2
White whale <i>Delphinapterus leucas</i>	1(<1)	1(<1)	2(<1)	4
CARNIVORA				
Sea otter <i>Enhydra lutris</i>	3(1)	22(6)	12(2)	37
PINNIPEDIA				
Steller's sealion <i>Eumetopias jubata</i>	5(2)	5(1)	4(<1)	14
Californian sealion <i>Zalophus californianus</i>	124(41)	270(68)	490(75)	884
Southern sealion <i>Otaria byronia</i> (= <i>flavescens</i> )	7(2)	1(<1)	4(<1)	12
Fur seals				
<i>Arctocephalus</i> spp	4(1)	8(2)	8(2)	20
Northern fur seal <i>Callorhinus ursinus</i>	1(<1)	2(<1)	22(4)	25
Walrus <i>Odobenus rosmarus</i>	3(1)	2(<1)	4(1)	9
Grey seal <i>Halichoerus grypus</i>	18(6)	19(5)	43(7)	80
Common harbour seal <i>Phoca vitulina</i>	38(13)	73(18)	156(24)	267
SIRENIA				
West Indian manatee <i>Trichechus manatus</i>		6(1)	7(1)	13
TOTAL BIRTHS	234(78) <sup>3</sup>	470(118) <sup>4</sup>	899(138)	1599 <sup>3</sup>

<sup>1</sup>Two of the *Tursiops* calves were sired by a *Pseudorca crassidens* (the same sire in both cases). One of these was stillborn, the other was alive at the end of the 1990 census period.

<sup>2</sup>A stillborn *Globicephala* calf was sired by a *Tursiops truncatus*. There were no other hybrids in the 1983-1990 census period.

<sup>3</sup>1979 TOTAL BIRTHS includes three *Stenella* spp births not listed in the table because this species is no longer being maintained in breeding collections.

<sup>4</sup>1983 TOTAL BIRTHS includes one *Mirounga angustirostris* birth not listed in the table because this species is no longer being maintained in breeding collections.

**Table 2.** A summary of captive marine mammal reproduction for census periods 1976-1979, 1979-1983, 1983-1990 and total number of births for 1976-1990. Total number is given for each period and average number per year is in parenthesis. The number of births for previous census periods have been updated in this census as more data became available.

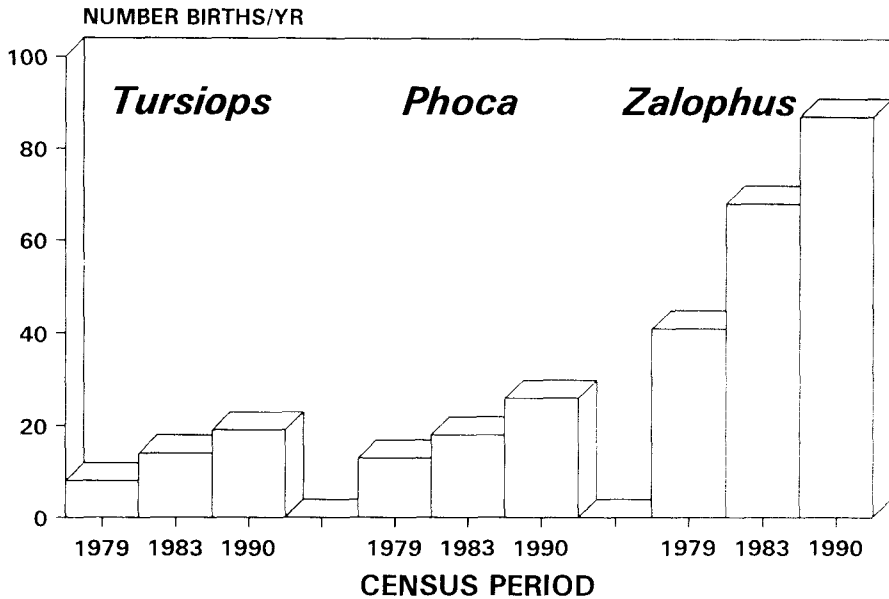


Fig. 2. A comparison of annual birth rates in captivity for *Tursiops*, *Phoca* and *Zalophus* for the 1979, 1983 and 1990 census periods.

The incidence of second-generation offspring, to either ♂♂ or ♀♀ which were themselves born in captivity, increased markedly in the last census period: c. 54% of the births reported for *H. grypus* were second generation; c. 28% of the births for *P. vitulina*; c. 13% for *Z. californianus*; c. 14% for *T. manatus*; c. 8% for *T. truncatus*; and c. 8% for Sea otters *Enhydra lutris*.

In the 14 years covered by all three census periods (1976–1990), a total of 1599 births has been recorded for marine mammal species in zoological institutions in the USA and Canada (Table 2). These births include 204 *T. truncatus*, 267 *P. vitulina* and 884 *Z. californianus*, plus births in an additional 16 species.

For pinnipeds, the success of breeding programmes is demonstrated by the fact that acquisitions for many species during the last census period came predominantly or entirely from captive births. *Zalophus californianus* and *P. vitulina* have shown an increase in annual birth rate in all three census periods (Fig. 2). This is

typical of many of the less well-represented species as well. As of 1990, 47% of the facilities maintaining *Z. californianus* and 32% of those maintaining *P. vitulina* have recorded births compared with 27% and 24% respectively in 1979. The most common pattern seen was facilities with young animals in 1979 began to show births in the 1983 continuing through the 1990 census periods. Indeed, one of the principal problems identified by zoos and aquaria in this last census period was that now too many *Z. californianus* were being born in their facilities and birth control measures were having to be investigated.

Despite the very positive trends in pinniped breeding, the 1990 census showed that more institutions were maintaining a single animal or individuals of one sex; for example, for *Z. californianus* this went from 25% of the institutions in 1983 to 43% in 1990 and for *P. vitulina* from 25% to 30%. In some instances this was due to the loss of older animals, in others to the apparent choice to maintain single-sex exhibits. If the latter trend

continues it could be expected to have a negative effect on future acquisitions of these species from captive births.

For cetaceans, breeding potential has been well established for *T. truncatus* with increases in the numbers of births seen in all census periods (Fig. 2). However, while there was an increase in the percentage of facilities holding *T. truncatus* which recorded births from 1979 to 1983 (21–38%), there was no further increase in numbers of facilities recording births from 1983 to 1990. Furthermore, the percentage of facilities with one animal or single-sex holdings went from 14% in 1979 and 16% in 1983 to 34% in 1990. Although a number of new colonies with breeding potential were established in the 1990 census period, these predominantly contain young animals. Therefore, it will probably be some time before these new colonies will be productive breeding groups.

Births in six other cetacean species, including three new species, were seen in the 1990 census period (Table 2). Notably, there was successful introduction and breeding of *C. commersoni* in the 1990 census period (Joseph *et al.*, 1987; Cornell *et al.*, 1988). This suggests that it is possible to constitute breeding colonies of cetaceans which can become reproductively active in a short time period. The immediate success of this breeding colony is thought to be due to the fact that a number of animals of varying ages were simultaneously introduced to captivity and remained together in an undisturbed social group.

Births were recorded for manatees and Sea otters in the 1990 census period (Table 2). Of the four facilities maintaining manatees, three had births. The annual birth rate was similar to that seen in the 1983 census. Births per year in Sea otters, however, were one-third of their 1983 number. Only six institutions were exhibiting Sea otters: three of these had only one animal, one sex or a neutered ♂; one had a young ♂ and ♀; one had a breeding ♂ and an old ♀; and one institu-

tion alone had an active breeding colony. Several Alaskan Sea otters were added to collections following the oil spill at Valdez, Alaska, in May 1989 and with the increased breeding potential, the numbers of births in these colonies could be expected to rise again in the future.

#### AGE STRUCTURE

The age group distribution for individuals in the collection as of each census date was compared for *Zalophus*, *Phoca* and *Tursiops* for the 1979, 1983 and 1990 censuses (Fig. 3). For the two pinniped species there has been a gradual shift from high numbers of young animals and low numbers of older animals to a more gradual age distribution with higher numbers of older animals. For *Tursiops* there has been a shift from the largest proportion of animals being in the five to nine and ten to 14 year age groups, to a relatively equal distribution through most age groups. In 1990 a lower proportion of *Tursiops* in the 15–19 year age group, a prime reproductive age group for ♀ *Tursiops*, signals a potential decline in birth rate as this population continues to age.

Age group distributions for the other pinniped and cetacean species were also compared for 1979, 1983 and 1990. For the Northern fur seal *Callorhinus ursinus*, *E. jubata*, the White whale *Delphinapterus leucas* and *P. crassidens* the 1990 age distribution is younger than it has been in previous years and it may be some years before sexual maturity is reached by some of these species in zoological institutions. For *H. grypus*, Walrus *Odobenus rosmarus*, *O. orca*, *T. manatus* and *E. lutris*, animals are distributed across all age groups with more individuals in older age categories. The remaining species are characterized by varying degrees of ageing animals with little or no replacement in the younger age categories. This latter group includes, *Arctocephalus* spp, the Southern sealion *Otaria byronia*, *L. obliquidens*, *Globicephala* spp and the Boutou or Amazon dolphin *Inia geoffrensis*. If breeding programmes for these

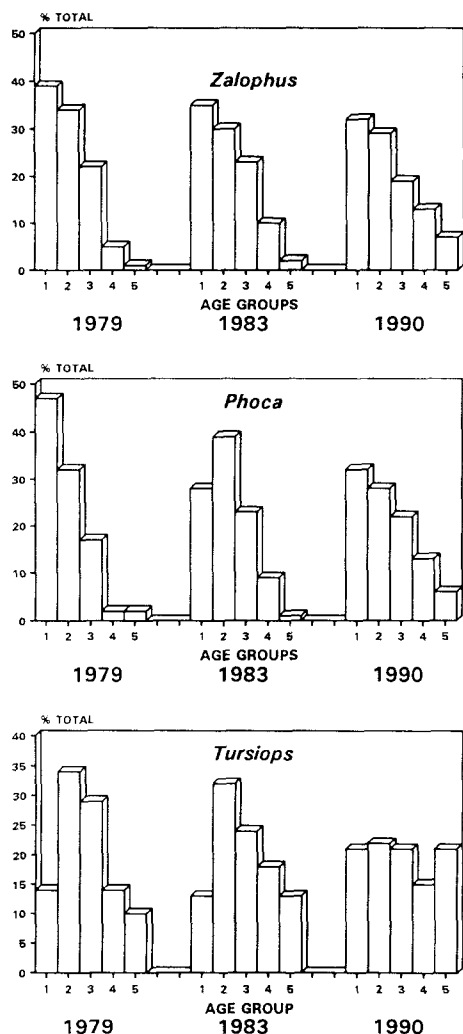


Fig. 3. Comparison of the age group distributions of *Zalophus*, *Phoca* and *Tursiops* for 1979, 1983 and 1990. Numbers in each age group are based on percentages of the total number of that species present as at 31 August. Age group 1 = 0-4 years of age; group 2 = 5-9 years of age; group 3 = 10-14 years of age; group 4 = 15-19 years of age; group 5 = 20+ years of age.

species are to continue, the addition of younger animals is necessary.

#### LONGEVITY & MORTALITY

Cumulative survival indices were determined for each species by life table/age cohort analysis (Cutler & Ederer, 1958)

using data from all census periods. Median time of survival (based on age) and the range of ages seen in captivity for each species as of 1990 are given in Table 3. Ages of all animals in the census were known either from date of birth or by their having entered the collections as pups and yearlings or, in the case of cetaceans, estimated by each facility based on length at capture. The median times of survival for *Z. californianus*, *P. vitulina* and *T. truncatus* were similar to those seen at the end of the 1983 data (Asper *et al.*, 1988). Data for the other species were not previously available. In species such as *O. orca* and *O. rosmarus*, a large proportion of the collection are older animals which have been in captivity since the establishment of the collection, therefore, estimates of median survival time do not reflect maximum survivorship of these species in captivity.

Crude annual mortality rates for *Z. californianus*, *P. vitulina* and *T. truncatus* were the same as for the 1983 census (6%, 5% and 7% respectively). Mortality rates were not determined for the other species because of low numbers.

#### SUMMARY

As of the 1990 census, zoos, aquaria and marine zoological parks were displaying 26 species of marine mammals. Births were recorded for 17 of these species and there was a continued increase in breeding programmes and births throughout the census periods. For pinniped species, acquisitions in the last census period came predominantly from captive births. An increased proportion of acquisitions from captive births was also seen for cetacean species. One species, *C. commersoni*, was brought into the captive population and had seven births within the last census period.

Breeding success has been achieved for the majority of the marine mammal species being maintained in captivity. However, we call attention to the low numbers of animals in several of the less well-represented species, as well as noting



SPECIES	<i>n</i>	MEDIAN SURVIVAL AGE (years)	TOTAL RANGE OF AGES (years)
CETACEA			
Bottle-nosed dolphin <i>Tursiops truncatus</i>	634	17	0-42
Pacific white-sided dolphin <i>Lagenorhynchus obliquidens</i>	36	13	0-25
Killer whale <i>Orcinus orca</i>	39	21	0-28
White whale <i>Delphinapterus leucas</i>	45	15	0-25
CARNIVORA			
Sea otter <i>Enhydra lutris</i>	37	14	0-21
PINNIPEDIA			
Californian sealion <i>Zalophus californianus</i>	1091	14	0-39
Northern fur seal <i>Callorhinus ursinus</i>	56	13	0-20
Walrus <i>Odobenus rosmarus</i>	32	26	0-27
Grey seal <i>Halichoerus grypus</i>	69	17	0-36
Common harbour seal <i>Phoca vitulina</i>	413	16	0-42

Table 3. Median survival time by age, 1990.

a number of ageing collections and an increase in the number of single animal or single-sex exhibits in the better represented species such as *Z. californianus*, *P. vitulina* and *T. truncatus*. We propose that the zoological community look into expanding and reconstituting these collections. Given the environmental concern over accelerating global ecosystem degradation, it would also seem appropriate to consider diversification of the current marine mammal collection. With the techniques currently available for caring for and breeding marine mammal species, it should be possible to establish successful breeding programmes for additional species in a short period of time. We propose that this be considered a priority for future efforts on the part of the zoos and aquaria.

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## REFERENCES

- ASPER, E. D., CORNELL, L. H., DUFFIELD, D. A. & DIMEO-EDIGER, N. (1988): Marine mammals in zoos, aquaria and marine zoological parks in North America: 1983 census report. *Int. Zoo Yb.* **27**: 287-294.
- CORNELL, L. H. & ASPER, E. D. (1978): A census of captive marine mammals in North America. *Int. Zoo Yb.* **18**: 220-224.
- CORNELL, L. H., ASPER, E. D. & DUFFIELD, D. A. (1982): Census up-date: captive marine mammals in North America. *Int. Zoo Yb.* **22**: 227-232.
- CORNELL, L. H., ANTRIM, J. E., ASPER, E. D. & PINCHEIRA, B. J. (1988): Commerson's dolphins (*Cephalorhynchus commersonii*) live-captured from the Strait of Magellan, Chile. *Rep. int. Whal. Comm. Special Issue No. 9*: 183-194.
- CUTLER, S. J. & EDERER, F. (1958): Maximizing utilization of the life table method in analysing survival. *J. Chronic Dis.* **8**: 699-711.
- JOSEPH, B. E., ANTRIM, J. E. & CORNELL, L. H. (1987): Commerson's dolphin (*Cephalorhynchus commersonii*): a discussion of the first live birth within a marine zoological park. *Zoo Biol.* **6**: 69-77.

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