

Estimated and predicted changes in the cat population of Australian households from 1979 to 2005

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Objective To estimate and predict changes in the cat population of Australian households from 1979 to 2005.

Method Telephone surveys were used to estimate Australia's total household cat population for each year from 1979 to 1999. A simple mathematical model based on population characteristics in 1995 was used to predict future population changes to 2005. Estimates and predictions for 1996 to 1999 were compared to validate the model.

Results Australia's household cat population increased steadily from 2.23 million in 1979 to peak at 3.24 million in 1988. Since then it has steadily declined to 2.60 million in 1999. The population size predicted from the mathematical model was similar to that from surveys for the years 1996 to 1999. It is predicted that the population will continue to decline to approximately 2.19 million in 2005. The proportion of Australian households owning cats fell from 31.1% in 1994 to 25.8% in 1999, while the average number of cats per cat-owning household remained relatively constant at 1.47.

Conclusions Australia's household cat population is decreasing, falling by 19% between 1988, when it reached its peak, and 1999. This contrasts with the US where the population increased by 13.9% over the same period. The decline in Australia appears to be due to a decrease in the total number of cat-owning households rather than the number of cats per cat-owning household. It is likely that this trend will continue unless there is a change in household pet ownership preferences in the meantime.

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Knowledge of the size and trends of domestic pet populations plays an important role in planning and decision-making for government and industry.¹ This information has been used to assist in pet population regulation and control,²⁻⁴ to address pet-associated concerns, to establish referent pet populations for current and future epidemiological studies,⁵ and to provide marketing information for veterinarians and others involved in veterinary practice and pet-related industries.^{6, 7}

To this time, and in contrast to the situation in some countries, there is no readily-accessible information about domestic cat populations in Australia. In this study, we report on telephone surveys used to estimate Australia's cat population since 1979 and a simple mathematical model used to predict the future trend in population numbers. By combining a modelling approach with information obtained in surveys, an attempt was made to identify the major factors affecting population changes.

Materials and methods

Estimates of the population of domestic cats owned by Australian households were made by two methods. From 1979 to 1999 annual estimates of the cat population were obtained

by telephone surveys, and a simple mathematical model was used to predict the population from 1996 to 2005. A comparison of population estimates using both methods during 1996 to 1999 was used to validate the model.

Telephone surveys

Surveys were undertaken from 1979 to 1999 as part of a wider project to monitor trends in a range of aspects of pet ownership in Australia. Different research companies undertook the surveys in different years using a similar design, with the most recent surveys (1994-1999) undertaken by ACNielsen Research Pty Ltd.^{8,9} The domestic cat population in Australian households was estimated on a yearly basis throughout this period, and forms the basis of the work reported here. Although re-calculation of these population estimates from the telephone surveys was undertaken by ACNielsen Research Pty Ltd in 2000, the survey and model estimates have not been altered in the present study.

The sample size and selection methods were designed to provide reliable estimates for national, state and regional populations of household pet-owning characteristics.

From 1979 to 1997, 12,000 interviews were undertaken each year. In 1998, the number of interviews was reduced to 6000 and in 1999, the number was 9000.

All households with a telephone listing in Australia's 'White Pages' directory, comprising about 90% of all households, were used as the sample frame in this work. Households for interview were selected from the sample frame by geographical stratification according to the Australian Bureau of Statistics statistical regions, comprising the metropolitan, major urban areas, major provincial cities, minor provincial cities and remaining rural areas of each State/Territory. The intensity of sampling in each region was proportional to the percentage of the Australian population in that region apart from some over-sampling in non-urban areas, where population sizes are smaller, to achieve more precise estimates of cat numbers in these areas. This over-sampling was subsequently weighted back to original proportions at the analysis stage. Within each defined region, a sample of households was chosen by systematic random sampling from the alphabetic listing of households with telephone numbers in the 'White Pages' such that all households within a region had an equal chance of selection. Interviews were undertaken throughout each year over a mid-month period from Saturday to the following Wednesday, thereby providing 12 independent samples throughout each year for each region.

Contact procedures were designed to ensure that each selected household was given a similar opportunity to respond. This involved a standard schedule of follow-up calls when initial calls were unsuccessful. Interviews were conducted using a computerised interviewing system which incorporated on-line question sequencing and editing to ensure correct entry of survey responses.

For the present study, monthly interview data were aggregated to provide annual estimates for characteristics of

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Australia's domestic cat population. Other data were also collected in the interviews but are not reported here.

Mathematical model

The age structure and basic dynamics of the Australian household cat population which guided model development are represented in Figure 1. A simple mathematical model using a life table method¹⁰ was developed in late 1995 based on findings from the 1994 and 1995 surveys. Using this model, the annual household cat population was then predicted for the years 1996 to 2005.

The annual uptake rate of kittens into households was assumed to be constant from year to year. In this model, this rate was calculated as the number of cats less than one year of age in 1995 divided by the total population of cats in 1994. The number of cats less than one year old taken up by households in each subsequent year was then calculated by multiplying the constant annual uptake rate by the total number of cats in the population in the preceding year. The probability of cats surviving from one year to the next (the annual survival probabilities) was estimated for each age group such that the result fitted the known population age structure that was measured in the 1995 survey. For simplicity in the model, it was assumed that the uptake into households of cats one year or older and the number of cats surviving more than 20 years were negligible.

Calculations were made in a Microsoft Excel (Microsoft, Redmont, WA) spreadsheet. In addition, simulations within the spreadsheet were performed using @Risk (Palisade, Newfield, NY) to generate a band of uncertainty in the predictions of future populations. A betaPERT probability distribution¹¹ was used to model the survival probability of each age-class, with the estimate from the survey data being used as the most likely value, and maximum and minimum values for the distribution being the most likely value plus and minus 5%, respectively. The betaPERT distribution is a smoothed triangular distribution, and is defined using estimates of the minimum, most likely and maximum values of the variable.¹¹ The simulation was run for 1000 iterations, with a random value being drawn from each age-class distribution for each iteration. For each year the model output provides a mean, maximum and minimum estimate of the predicted annual population.

Results

The estimates for the total Australian household cat population for each year from 1979 to 2005 using the two methods are shown in Table 1 and Figure 2. In the model, an uptake rate of 0.105 was used, which equals 312,000 (the number of cats less than one year of age in 1995) divided by 2.968 million (the total population of cats in 1994). The estimated age pyramid of Australia's domestic cat population in 1995 is presented in Figure 3, and the annual survival probabilities are shown in Table 2.

Annual populations predicted by the model are slightly different from the subsequent survey estimates for the four years for which estimates were obtained using both methods (0.1% lower in 1996, 1.1% lower in 1997, 1.5% higher in 1998 and 1.3% lower in 1999). However, in each of the four years, the predicted value is well within the sampling error of the surveys. This suggests that the approach used in the model has captured the major determinants of the household cat population.

The Australian household cat population climbed steadily from 2.23 million in 1979 to reach a peak of 3.24 million in 1988. Since that time, the population has decreased steadily to

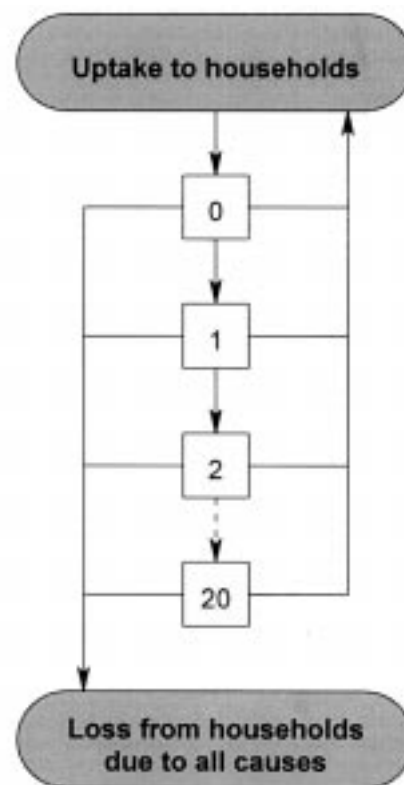


Figure 1. Flow diagram representing the age structure and basic dynamics of the Australian household cat population used to develop the mathematical model. The numbers in the small boxes represent progressing age in years. The arrows represent flows of animals. The arrows joining the square boxes represent the flow of cats from one age class to the next each year. The downwards arrow on the left represents the loss of cats from each age class each year. The upwards arrow on the right represents the uptake to households each year of kittens bred from all age classes.

2.81 million in 1995 and 2.60 million in 1999. The mathematical model predicts that, if the present uptake rate of cats into households and loss rates remain relatively constant, the total household cat population will decline to 2.51 million by the year 2000 and to 2.19 million by 2005.

Discussion

The telephone surveys described here are the first published account of changes over time in Australia's household cat population. The surveys provide strong evidence that the population is declining. This finding is supported by the mathematical modelling which attempts to explain changes in the population in terms of maintenance of the age structure of the cat population and uptake rate of kittens by households.

In 2000, the survey estimates of the Australian domestic cat population since 1979 were changed by ACNeilsen Research Pty Ltd, following changes to the methods used by this organisation to estimate population characteristics from geographically-stratified data. Following this re-calculation, there has been a reduction in estimates each year from 1979 to 1999, by a factor of 2.0 to 8.9%. We have elected to present results based on the original data in this paper, but also provide the adjusted

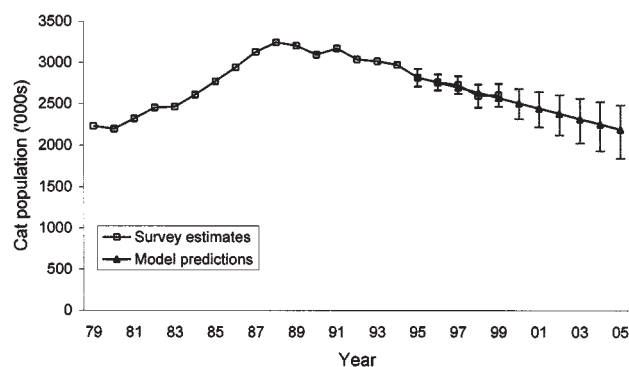


Figure 2. Estimates of Australia's domestic cat population from 1979 to 2005. Values for 1979 to 1999 are based on telephone surveys with 95% confidence limits shown for 1995 to 1999. Values for 1996 to 2005 are predictions from a mathematical model with average, minimum and maximum values obtained from a betaPERT distribution for 2000 to 2005.

survey figures in Table 1. The adjustment has not altered the observed trend in the household cat population, nor the factors that contribute to the declining domestic cat population in Australian households.

Since 1988, the ongoing decline in the overall population of household cats represents a compounding annual decrease of more than 1.9%. In 1999, the domestic cat population was 19.7% less than the population in 1988. If this trend continues as currently predicted, the Australian population in 2005 will have declined by more than 32% from its peak. These findings are supported by the estimated age pyramid of Australia's cat population in 1995,³ which suggests a population in decline. The younger age cohorts are not as large as would be expected if survival of age cohorts was relatively constant, and indicates a reduction in the net replacement rate into the population relative to the net rate of loss due to all causes.¹² This decline is in contrast to the situation in the USA and UK, where cat populations are increasing. In the USA, the compounding annual increase has been variously estimated at 1.2%,¹³ 1.6%,¹⁴ and 1.9%.⁶ Based on a 1.9% compounding annual increase, the US household cat population would have increased by 18.8% between 1988 and 1999 but other research suggests a more modest increase of 3.7% between 1991 and 1996.¹⁵ A similar annual compounding increase of 1.9% has been reported for the UK.⁶

Although the average number of cats per cat-owning household in Australia has remained relatively static at approximately 1.47,⁹ the percentage of households owning a cat appears to be declining. In 1994, 31.1% of Australian households owned a cat, whereas in 1999 it was 25.8%.⁹ By way of contrast, in the USA there has been an increase in the number of cats per cat owning household^{6,15} (from approximately 1.96 in 1986 to 2.1 in 1996)⁶, whereas the estimated proportion of households owning cats has variously been reported as increasing (31.8% in 1991 and 33.4% in 1997)⁶ and decreasing (30.9% in 1991 and 27.3% in 1996).¹⁵ It is interesting to note that while the human population of the US is 14.5 times the Australian population, the household cat population in the US is 24 times that in Australia. It would therefore appear that a contributing factor to the decline in Australia is that fewer households are taking up cat ownership.

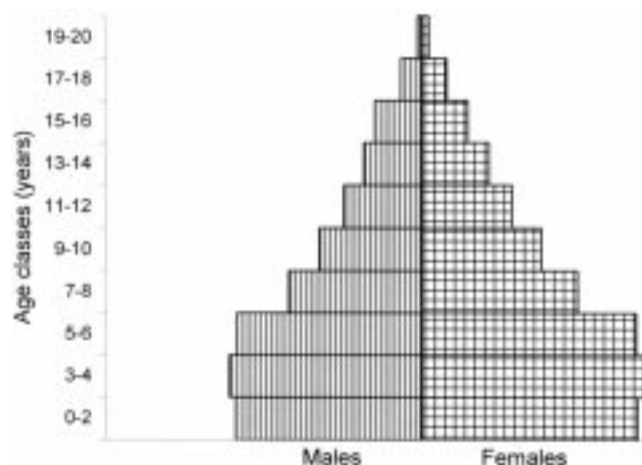


Figure 3. Age pyramid of the cat population in Australian households, based on telephone survey results from 1995.

Table 1. Estimates of Australia's total household cat population from surveys and mathematical modelling.

Year	Survey estimates ('000s)		
	Based on original calculations	Following adjustment in 2000	Model prediction ^a ('000s)
1979	2232	2092	-
1980	2197	2066	-
1981	2321	2121	-
1982	2451	2231	-
1983	2463	2372	-
1984	2608	2524	-
1985	2770	2673	-
1986	2941	2805	-
1987	3125	2912	-
1988	3241	2986	-
1989	3201	3026	-
1990	3092	3030	-
1991	3170	3001	-
1992	3033	2943	-
1993	3013	2864	-
1994	2968	2771	-
1995	2813 ^b	2676	2813 ^b
1996	2757	2591	2754
1997	2725	2530	2694
1998	2593	2510	2632
1999	2603	2545	2569
2000	-	-	2505
2001	-	-	2441
2002	-	-	2377
2003	-	-	2314
2004	-	-	2252
2005	-	-	2190

^aBased on population structure derived from original survey calculations

^bThe survey estimate and model prediction for 1995 are necessarily the same because the model was constructed using annual survival probabilities determined from the 1995 survey.

Table 2. Probability of survival of cats from year-to-year estimated from the 1995 survey.

Age (years)	Probability of survival to next year
0	0.80
1	0.94
2	0.94
3	0.93
4	0.93
5	0.90
6	0.87
7	0.87
8	0.87
9	0.87
10	0.87
11	0.86
12	0.85
13	0.83
14	0.80
15	0.75
16	0.60
17	0.50
18	0.30
19	0.10
20	0

Cat ownership in a society results from a complex interplay of many socio-economic factors. The reasons for the ongoing decline in Australia's household cat population are thus likely to be varied and complex. However, some points emerge from studies undertaken both in Australia and overseas.

First, the high desexing rates of cats in Australia may have resulted in an insufficient number of kittens available for uptake into households. In Australia, approximately 91% of breeding age females are desexed.⁹ Based on a study of pet cats in a Kansas community, Nassar and Mosier¹⁶ estimated that desexing 76-88% of females would result in zero population growth, depending on the percentage of the remaining intact animals that reproduced. If birth and uptake rates decline simultaneously, it is possible to have an overall declining population with little apparent change in the number of kittens presented to shelters for which a home is not found. Second, the perception that household cats are a threat to wildlife has led to a number of actions, including regulatory restrictions on cat ownership by local authorities in some areas. In telephone surveys between 1994 and 1999, concerns about the wildlife threat posed by cats has been consistently identified, after a 'dislike of cats', as the most important reason for not owning a cat.⁹ This may partly explain the declining number of cat-owning households in Australia. There has also been some suggestion that part of the decline can be attributed to fundamental shifts in the dynamics of Australia's human population. It is speculated, for example, that 'baby boomers', as their chil-

dren mature, may be less inclined to replace pets that were acquired when children were young.⁶ To date, however, there has been little evidence for this, with surveys showing that the reduction in cat ownership is occurring in households of all types.⁹

As suggested by McGreevy et al,¹⁷ there are likely to be a range of socio-economic impacts on the broader Australian community as a result of the declining domestic cat population. With fewer domestic cats, the community will have less opportunity to derive benefit from the advantages associated with pet ownership, including known health benefits and likely health cost savings.^{18,19} In addition, cats form a significant part of the revenue stream for the pet care industry, including veterinary practices. Approximately 70% of the annual turnover of veterinary practices is derived from the care of dogs and cats, and in 1998, the estimated expenditure for the care of cats was \$365 million, including \$150 million on veterinary charges.⁶ Reflecting the potential impact of this population decline on veterinary practices in Australia, McGreevy et al¹⁷ reported a reduction or no measurable change in feline clinical work in a significant number of veterinary practices in the Sydney metropolitan area for the period 1996 to 2000.

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