With the cats away the mice may play

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It took scientists nineteen years to eliminate feral house cats from the sub-Antarctic Marion Island. Why was it necessary to remove them? Research had shown that the cats were responsible for the devastation of the seabird community using the island as a breeding ground.[1,2] Considering the influence of the birds on mineral and energy cycling on the island,[3] their reduction in numbers by cat predation would have had far-reaching consequences for the ecology of the island. Furthermore, with some 450 000 birds being killed in 1975 alone, and with this figure then increasing annually by an estimated 23%, this invasive and exotic predator was clearly jeopardizing the future of several defenceless seabird species.[4] The eradication of the cats thus made conservation sense. However, since then house mice, another species introduced by man, have become a menace with serious consequences for their invertebrate prey. Does this mean that they now also have to be removed from Marion Island, especially since the Prince Edward Islands have been declared a special nature reserve in terms of the 1989 Environmental Conservation Act?

The presence of mice (*Mus musculus senso lato*) on Marion Island was used as a reason to introduce cats soon after the annexation of the island group by South Africa in 1948.[5] To the best of our knowledge, mice have been present on the island at least since 1818 and have some affinity with Scandinavian populations.[6] A study on them during 1979-80 concluded that they were in dynamic equilibrium with their prey, which mostly comprised a variety of invertebrate species.[7,8] On the other hand, a study on the cats at about the same time showed that they preyed mainly on burrowing petrels (seabirds of the families Procellariidae and Pelecanoididae), with mice contributing only some 16% to the diet.[1] The successful introduction of the highly specific disease, feline panleucopaenia, into the cat population in 1977 was soon followed by a dramatic decline in cat numbers,[9] and by 1982 only an estimated 615 cats remained on the island.[2] Even though almost 50% of their diet by then consisted of mice,[10] the decrease in cat numbers since 1977, according to our calculations, meant that there was little change in the absolute number of mice taken by cats (Table 1).

However, another factor then entered the equation. Valdon Smith[11,12] and co-workers from the University of the Orange Free State showed, from their analyses of temperature and rainfall recorded since 1949, that Marion, like the sub-Antarctic region in general, was subject to a change in climate. Smith speculated that this would have resulted in an increase in mouse numbers, which, through the enhanced predation of invertebrate detritivores, would have had far-reaching consequences for decomposition and mineral cycling on the island. At that time, however, no information was available on trends in the numbers of mice and their invertebrate prey.

Table 1. Numbers and densities of feral cats,[2,21] occurrence of mice in their diet[1,10] and predation pressure expressed as the number of cats per km² feeding on mice.

Year Zone*	Cat numbers	Cat densities (km^{-2})	% Stomachs containing mice	Predation pressure
1975				
Coastal	1786±276	18.01	16	2.88
Interior	354±88	2.61		0.42
1982				
Coastal	444±92	4.48	44	1.97
Interior	172±54	1.27		0.56
1992	0	0	0	0

*Scientists working on cats distinguished between the coastal (<100 m a.s.l.) and interior (100–450m a.s.l.) zones of the island.

The numerous efforts[13–15] to estimate the influence of mice on the island, including Smith's speculations, were based on either educated number crunching or a feeling that things were changing on the island. Apparent year-to-year changes in mouse abundance and the patchy nature of the distribution of their invertebrate prey added considerably to the difficulty of getting to grips with the real influence of mice on the functioning of this system. In spite of these problems, Steven Chown (University of Pretoria) and Smith, by comparing variables of invertebrates living on Marion Island with those from the nearby mouse-free Prince Edward Island, concluded that mice were indeed having a deleterious effect on invertebrates.[16] This influence manifested itself in a change in the size of prey, an alteration in the composition of the invertebrate community, and potential changes in mating strategies of weevils. Chown and Smith[16] also showed that mouse predation on plants may have consequences for the island's vegetation. They based all their arguments on the premise that mouse densities would have increased as a result of climatic conditions becoming more favourable for the rodents over the past 15 years. These suggestions prompted further research on the mice. Matthewson, van Aarde and Skinner[17] concluded, after a spell of field work during 1991-92, that mouse densities then were higher indeed than in 1979-80, but only at the end of summer. Field work continued during 1993-94 and our recent analyses[18] of all relevant data showed that densities in summer during the 1990s were indeed higher than those recorded during the summer of 1979-80. The higher densities were associated with increased incidences of pregnancy and higher fecundity rates during 1991-92 (see Table 2). Winter densities during the 1990s, on the other hand, continued to be similar to those recorded in 1979-80.

Our recent analyses suggest that low

Table 2. Population densities (individuals per ha) at the end of summer and winter during 1979-80, 1991-92 and 1993-94. The incidence of pregnancy, percentage females pregnant and fecundity during these years are also presented. Modified from van Aarde *et al.* [18]

Variables	1979-80	1991-92	1993-94
Density at end of summer			
Biotically influenced areas	127.5	248.8	178.5
Vegetated black lava	62.5	85.4	107.6
Swampy grassland	65.6	50.7	115.1
Density at end of winter			
Biotically influenced areas	70.6	41.6	62.5
Vegetated black lava	19.6	7.0	19.2
Swampy grassland	27.8	31.8	16.8
Incidence of pregnancy	2.1	5.9	1.6
Percentage females pregnant*	32.4	71.4	18.6
Fecundity	2.4	14.8	1.1

*Females >2 months of age

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densities at the end of winter are followed by high population growth rates during summer, while high densities at the end of winter are followed by low population growth rates in summer. More interesting is that although the minimum temperatures recorded during the three coldest months of 1979-80 (0.9 ± 0.4°C) were considerably lower than those observed during the 1990s (2.0 ± 0.6°C), the mortality among mice during winter was not at all related to minimum winter temperatures. Instead, mortality rates were directly related to density and the winter decline may be ascribed to density-dependent factors, probably refuge and/or food availability.

Based on the above and following the indications from published work that these mice were having a negative effect on the island, we considered it important to re-address the apparent impact of mice and how this may have changed over the last 15 years. Previous workers[14,15] estimated that mice take 0.7–1% of the daily standing crop of macro-invertebrates — this estimate was based on the density estimates and dietary composition recorded by Gleeson[7] and invertebrate biomass estimated during 1976-77.[19]

Considering that mouse densities changed over the last 15 years, it is likely that invertebrate densities or biomass also changed, presumably as a result of altered depredation rates. If invertebrate biomass changed owing to increased predation by mice, then the abundance of invertebrates should have been lower during the nineties than the seventies. However, invertebrate biomass apparently did not follow a declining trend over the last 15 years, but was marked by year to year differences (Table 3). This obviously resulted in fluctuations in food availability for the mice; our recent estimates of their impact on invertebrates range between 0.99% and 2.85% of the standing crop taken. The important point to note here is that data currently available suggests that fluctuations in invertebrate biomass were independent of mouse predation.

Following Marion Island's recent conservation status, as well as the acceptance of the commitments outlined in the Management Plan for the Prince Edward Islands, it now is of importance to understand the role that mice have in this ecosystem, especially with reference to their effect on their invertebrate prey. We therefore recently launched a project which, as part of the research programme supported logistically and financially by the Department of Environmental Affairs and Tourism, will centre on the influence of mice on their invertebrate prey and on an assessment of mea-sures that might be taken to control mice. Based on the results to be obtained from exclusion plots we hope to establish whether the mice do have an effect on the invertebrate communities of the island. We also hope to illustrate the potential value of removing mice from the system, thereby improving the base for future decisions on whether or not to control or eradicate this alien species. Such management actions may have important consequences for this ecosystem, which is apparently still recovering from the disturbance evoked by the presence of feral cats, not to mention those consequent upon their eradication. The apparent density-dependent control of mice prompts one to ask: Do we want to reduce mice numbers or even eradicate them from Marion Island? We clearly do need more information. During a workshop held at the University of Pretoria[20] and attended by most of those who have been involved in research on these mice, it was concluded that: 'Eradication of mice at Marion Island is feasible. However, considerable management research on secondary poisoning, ... and the minimization of its effect on non-target species is required.'... 'Eradication is desirable. However, local ecological research is required and management research concerning possible options for control and the effects of eradication must be undertaken.'

Table 3. Invertebrate biomass (g m^{-2}) and impact of mouse predation (% taken of daily standing crop) on invertebrates during 1976-77,[19] 1979-80,[8] 1992-93,[16] 1993-94. Only the four major prey types are presented. From van Aarde *et al.* [18]

	Food item	1976-77	1979-80	1992-93	1993-94
Biomass	*Pringleophaga marioni* larvae	0.62	0.19	0.79	0.32
	Weevil larvae	0.42	0.16	0.46	0.12
	Weevil adults	0.12	0.06	0.14	0.08
	Spiders	0.14	0.07	0.29	0.17
Impact	*Pringleophaga marioni* larvae	1.47	4.82	0.82	3.16
	Weevil larvae	1.11	0.32	0.50	3.00
	Weevil adults	1.49	2.98	2.48	6.83
	Spiders	0.83	1.66	0.23	0.61
Total impact		0.99	2.70	0.75	2.85

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