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Age Structure and Sex Ratio in a Population of Harvested Feral Pigs in New Zealand

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Data on age structures and sex ratios were collected from feral pig, *Sus scrofa* Linnaeus, 1758, populations in the northern part of the South Island, New Zealand. The age of 1966 pigs was assessed from (a) tooth replacement and wear (b) cementum layering in molars. The age structure of the feral pig population studied is typical of heavily utilized populations. There was severe hunting mortality in the youngest age groups, with almost 70% of the harvested population consisting of animals less than 1 year old. Another 13% of the bag constituted animals from 1—2 years of age. Animals older than 2 years comprised less than 18%. The overall mean age was 10.99 months, while the median value was 3.18. The oldest pig was a female aged 168 months, the oldest male was 120 months. The sex ratio (1:0.72) showed a preponderance of males in a sample of 2,389 pigs sexed. The sex ratio of foetuses was not significantly different from unity ($p>0.05$).

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1. INTRODUCTION

Pigs were introduced and released in New Zealand in the mid 18th century. They rapidly expanded their range and at present occupy most parts of both main islands. Feral pig populations mainly comprise recent domestic breeds, though these are intermixed locally with breeds derived from the Pacific Islands. Pigs are favoured by hunters and, apart from their recreational value, provide pork for home consumption and for export. Studies reported here were aimed at the acquisition of data fundamental to the rational management of this resource.

2. RESEARCH PROCEDURE AND DATA

Data on age structure and sex ratios were collected while studying the status of feral pig (*Sus scorfa* L.) populations in the northern part of the South Island, New Zealand. Individual hunters, hunter clubs, game dealers, NZ Forest Service, and Department of Conservation personnel were requested to provide details on each pig killed or purchased. The information included the sex of the pig and a request for the extraction and tagging of its lower jaw. Pigs were mainly hunted with dogs although occasional hunters hunted alone and shot pigs they encountered. About 500 pig hunters throughout the study area participated in the project.

The age of pigs was assessed from (a) tooth replacement and wear and (b) cementum layering in molars (Hayashi *et al.* 1977). Altogether 2,386 autopsy records of feral pigs were returned by hunters during the period July 1986 to December 1987. The temporal distribution of kills is given in Fig. 1. The sample available for age analyses (n=1966) was smaller than shown in Fig. 1 because some jaws were lost or not supplied. Exploratory data analysis (EDA) showed that the two different hunting methods (dogging and shooting) produced significantly different age structures, with shooting favouring juveniles. Accordingly, all shot samples were deleted and analyses confined to the dogged sample.

For each sow examined the number and sex of foetuses or the number of teats extended was determined.

The area sampled was divided into 15 regions (Fig. 2). The percent frequency of all pigs in 6-month age classes was produced for each region. We used percent frequency rather than actual frequency to overcome unequal sample size and make the plotted data directly comparable.

From initial analyses, we concluded that the overall age data were skewed to the right, were moderately kurtosed, and significantly deviated from normal distribution. LOG transformations were applied to normalise data. For comparison of mean values of age among regions and between sexes two-factor ANOVA was applied on transformed data. Mean age values in the various regions were compared using the Least Significant Difference (LSD) test at a probability of 0.05 (Andrews *et al.* 1980).

Regression analysis was performed to determine what kind of relationship existed between age and frequency. Age and age class data were used and curves for both frequency and % frequency were fitted. The curves that best fitted the sample data were nega-

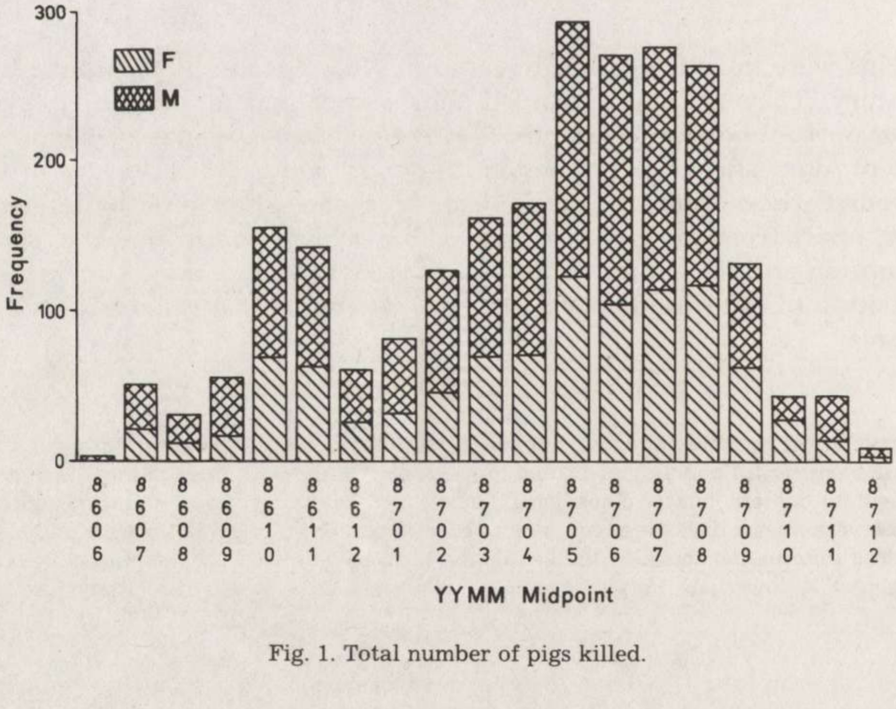

Fig. 1. Total number of pigs killed.

tive exponential or negative power curve in nature and in both cases this involved applying a natural LOG transformation to one or both the scales before doing the linear regression analysis. Sex ratio data were analysed non-parametrically using the Chi-square test.

3. RESULTS

3.1. Seasonal Distribution of the Pigs

Pig kills varied seasonally (Table 1). Pigs are hunted throughout the year, but peak numbers are harvested in May — August (late autumn and winter) and least in December — January (early midsummer).

3.2. Age Structure

The age structure of the harvested population is presented in Fig. 3. After the inclusion of frequencies of foetuses (O age) and sucklings (3 months), the age structure acquired the form presented in Fig. 4. These O and 3-month age classes were generated by computer from the original data and are only approximations.

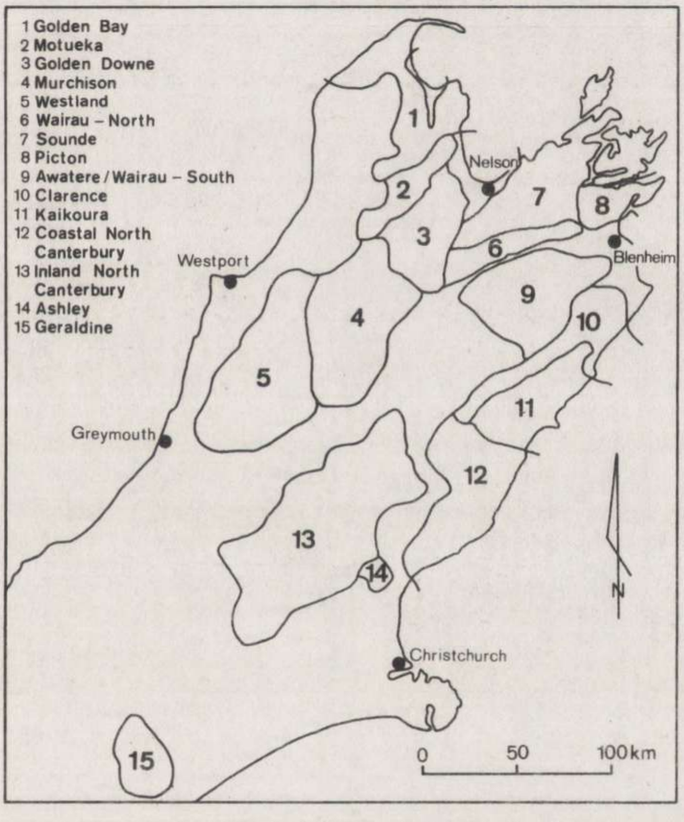

Fig. 2. Study area in the northern part of the South Island showing pig range within the 15 regional subpopulation areas.

The following curve was best fitted to our data:

$$\% \text{ f}=65.3x(1+\text{age group})^{-0.85}-1 \qquad \text{Correlation } R=0.9679.$$

There is severe mortality in the youngest age groups, with almost 70% of the harvested population consisting of animals less than 1 year old. Another 13% of the bag constitute animals from 1-2 years of age. Animals older than 2 years comprise less than 18%. The overall mean age was 10.99 months, while the median value was 3.18. The oldest pig, a female, was aged 168 months, the oldest male was 120 months. When converted into year long classes, this population has the picture presented in Table 2.

Age structure diagrams were produced for each of the 15 regions (Fig. 2). Sample sizes ranged from 55 to 375 and averaged 131. The summary of statistical analyses for age structures of regional subpopulations is given in Table 3, and indicates that the 15 regions had significantly different mean ages ($F_{14,1955}=7.09$, $p<0.001$).

From the regional populations studied, four subpopulations, namely Inland North Canterbury, Golden Bay, Sounds, and Geraldine were selected to portray statistical differences, or differences in hunting practices, establishment histories, and pig density.

Table 1
Seasonal distribution of pigs killed (1986 and 1987 combined).

Season	Males	Females	Total
Spring (Sept.—Nov.)	322	254	576
Summer (Dec.—Feb.)	172	107	279
Autumn (March—May)	366	265	631
Winter (June—Aug.)	528	371	899
Total	1388	997	2385

Table 2
Distribution of age groups of feral pig population.

Age in years	Frequency	Percent	Cumulative frequency	Cumulative percent
1	3,174	69.2	3,174	69.2
2	600	13.1	3,774	82.3
3	413	9.0	4,187	91.3
4	198	4.4	4,385	95.6
5	96	2.1	4,481	97.7
6	61	1.3	4,542	99.1
7	21	0.4	4,563	99.5
8	6	0.1	4,569	99.7
9	10	0.2	4,579	99.9
10	4	0.1	4,583	100.0
11	2	0.1	4,585	100.0
Total	4,585	100.0	—	—

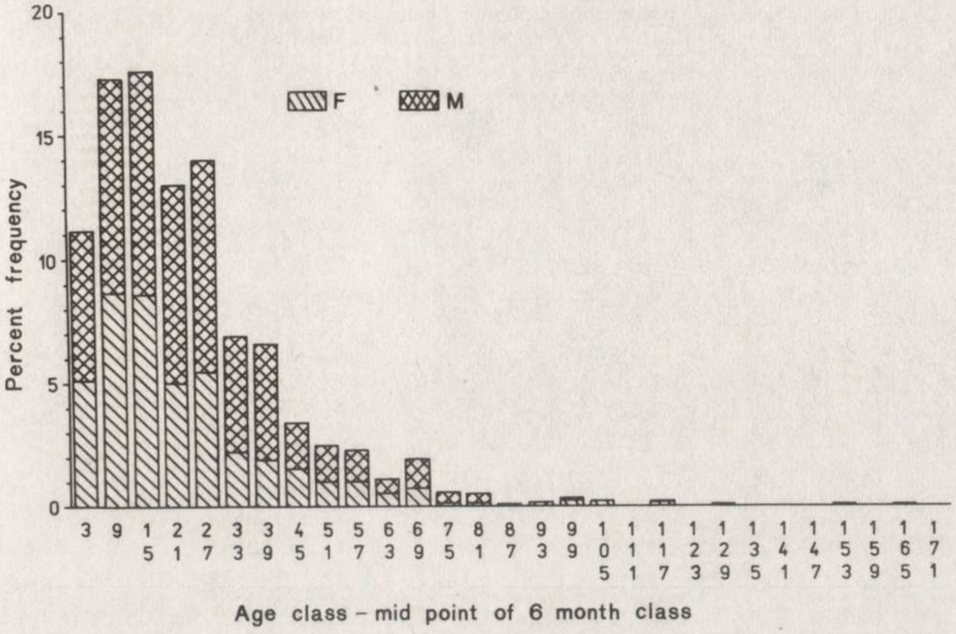

Fig. 3. Pig age distribution.

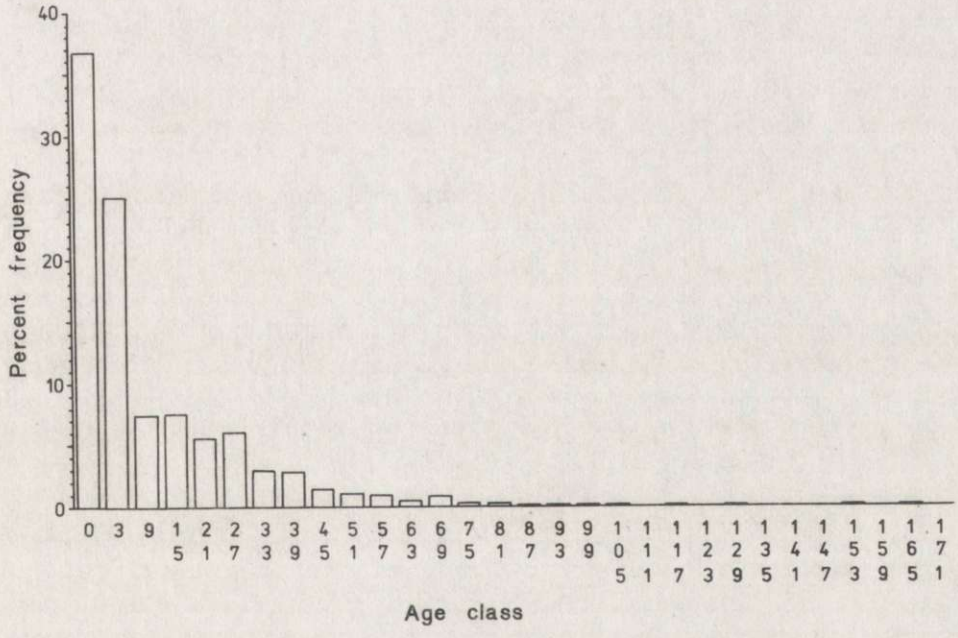

Fig. 4. Pig age distribution after the inclusion of foetuses and sucklings.

Table 3
Summary of statistical analyses for age structures of regional pig subpopulations.

Region	df	χ^2	p
1	10	10.944	$p>0.05$
2	7	17.862	$p<0.05$
3	16	20.743	$p>0.05$
4	11	9.998	$p>0.05$
5	15	21.651	$p>0.05$
6	17	16.083	$p>0.05$
7	12	15.611	$p>0.05$
8	12	18.155	$p>0.05$
9	12	13.099	$p>0.05$
10	13	20.427	$p>0.05$
11	15	20.109	$p>0.05$
12	8	17.560	$p>0.05$
13	11	14.246	$p>0.05$
14	11	7.829	$p>0.05$
15	14	13.976	$p>0.05$

3.3. Regional Subpopulations

Region 1: Golden Bay (Fig. 5).

Pigs have been present here from before 1900. Further releases since 1900 have expanded their range. It is an example of a long established population with low density. The population is heavily hunted and hunters report a decline in pig numbers. Some hunters release sows caught by dogs because of their concern over populaton decline. Pockets of high density remain mainly due to hunter access problems. The sample of 101 animals was supplied by numerous hunters, and possessed a mean age of 29.2 months, 27.4 months for females, and 30.1 months for males. There were no pigs reported older than 75 months.

Region 7: Marlborough Sounds (Fig. 6).

The Marlborough Sounds were colonised by pigs released by Captain Cook in 1773, and is an example of a heavily hunted population which shows no indication of decline. This region has the highest density of pigs on the study area. Hunter access is easy by land and water. However, pigs mainly inhabit thick forest and scrub cover and often outrun the dogs. The robust sample of 375 was supplied by many hunters and three game buyers. It had a mean age of 26.3 months (females 25.6, males 26.8 months) with many old pigs present (the oldest 153 months). The sample was statistically similar to Golden Bay and Inland North Canterbury.

Region 13: Inland North Canterbury (Fig. 7).

Pigs have been present from before 1900, though their distribution has since decreased as a result of land clearance for farming. The sample of 95 animals was affected by hunting practices. Because of past declines in numbers, many hunters release dogged sows, hence there appears an uneven sex ratio. The sample was supplied by many hunters and one game buyer. The subpopulation is of low density but contained some old animals. Accessible areas are heavily hunted, but remoteness and restricted hunter access are important considerations.

The mean age of the sample was 31.2 months, with 32.1 months for males and 29.1 for females. This was the highest mean age among regional subpopulations, and resulted from the large number of adult males taken.

Region 15: Geraldine (Fig. 8).

This subpopulation was established about 1980, and is an example of an irruptive population that has increased rapidly in number and range and is still increasing. Little hunting occurred during establishment and although hunting has recently increased, it is still light by comparison with other regions. The sample of 98 pigs was mainly supplied by two hunters and differed significantly from all others.

The mean age in the Geraldine sample was 11.6 months, 8.1 for males and 13.9 for females, and was less than half that of most other subpopulations. No pigs were older than 45 months, and hunters considered that few older pigs existed.

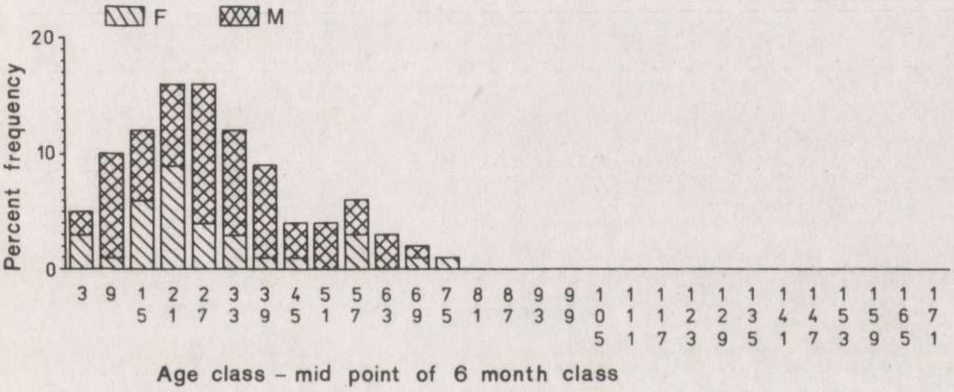

Fig. 5. Pig age distribution — Golden Bay subpopulation.

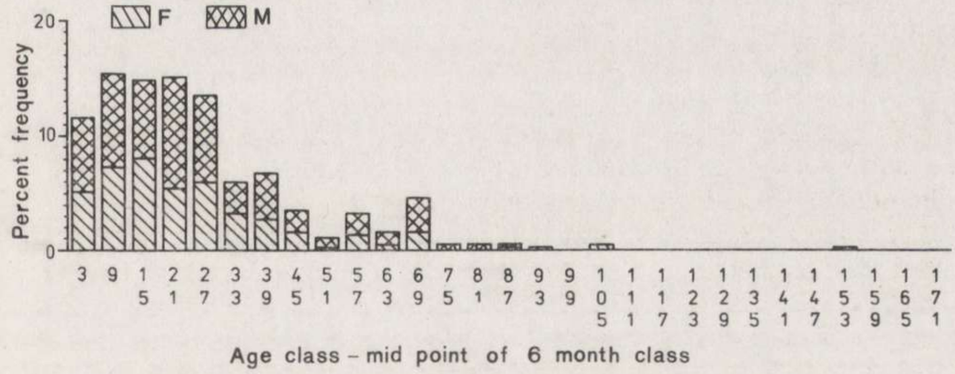

Fig. 6. Pig age distribution — Sounds subpopulation.

3.4. Sex Ratio

There were significant differences in the age class distribution of males and females ($\chi^2_{14}=49{,}929$, $p<0.001$), and the sex ratio within the prescribed age classes differs significantly also. Overall, there were

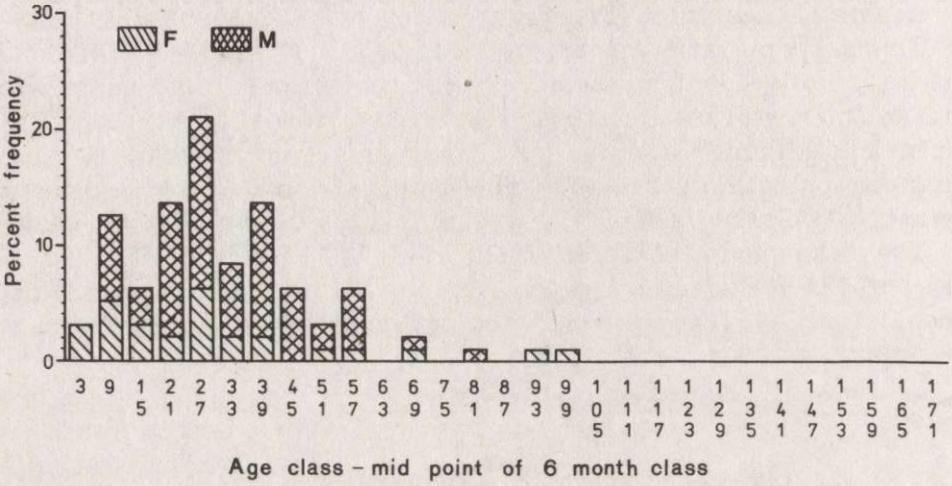

Fig. 7. Pig age distribution — Inland North Canterbury subpopulation.

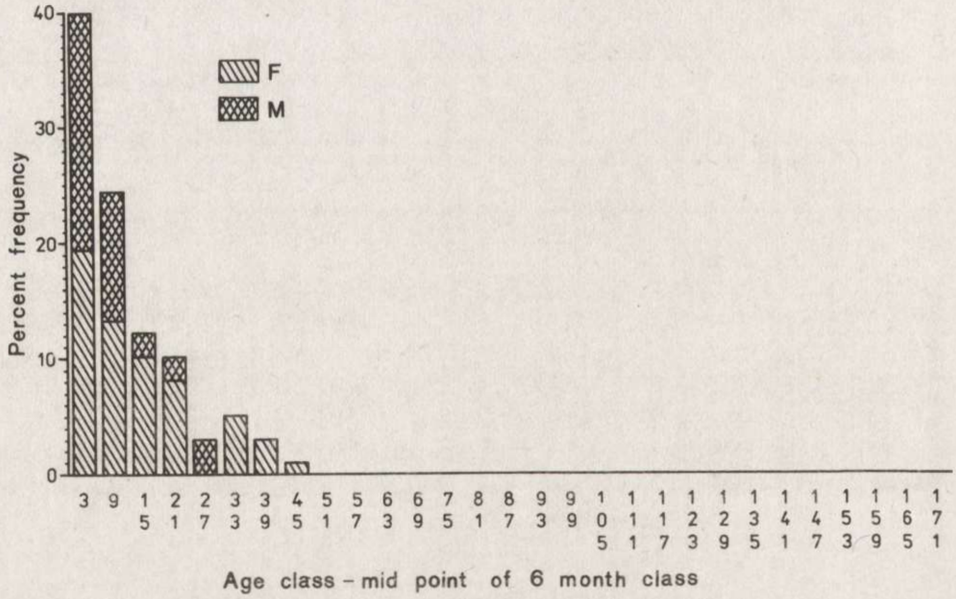

Fig. 8. Pig age distribution — Geraldine subpopulation.

1392 males and 997 females in the sample of 2389 pigs killed in the project, a ratio of 1:0.72. The sex ratio of foetuses examined was 1:0.95 (212 males and 201 females) and was not significantly different from unity ($p>0.05$).

Despite the imbalance in the overall sex ratio, regional sex ratios were generally nonsignificant, with real differences occurring only between the sexes in the Kaikoura ($\chi^2_{20}=117.672$, $p<0.001$), and Geraldine ($\chi^2_{18}=20.628$, $p<0.01$) samples.

4. DISCUSSION

The seasonal variation of pig kills (Table 1) was found earlier by Dzięciołowski (1987) for the feral pig population in Golden Downs, South Island, New Zealand.

The harvest obtained by hunters was substantial and reflected both the widespread distribution of pigs and the local popularity of pig hunting with dogs. Clarke (1989), in a study of pig hunter harvesting patterns, identified 1120 hunters in the study area. Average regional harvests among a surveyed sample of 141 hunters ranged from 23-87 pigs/year, though these harvest rates may not be representative of all hunters. During the present study most hunters supplied only a small proportion of the pigs they killed; in particular they supplied fewer pigs in the 3-month-old age class (Fig. 3) than were expected from the foetal and suckling data (Fig. 4). As a result, and as earlier indicated by EDA, the age structures of harvested pigs are undoubtedly biased towards older animals. Reasons for this relate mainly to the failure of hunters to recover small piglets killed by dogs (on account of their size), and secondly, to the instinctive behaviour of many dogs who seek to catch the larger pigs in a group. Thus, although recorded age structures are biased, the harvesting method results in considerable mortality in all age classes.

Ueckermann (1972) found in a confined population of wild boars that even when animals under 1 year constituted 72-74% of the annual harvest, population increase could not be prevented. So, even the removal by hunting of almost 70% of New Zealand feral pig populations possibly may not arrest population growth.

The age distribution of the study population indicates a heavy hunting impact. The main effect of hunting is a higher population turn-over. In an intensively hunted environment, turnover may result in 50—75% of individuals being replaced every year (Gaillard *et al.* 1987).

Henry and Conley (1978) in their studies on survival and mortality

Table 4
Sex ratios in three pig (*Sus scrofa*) populations.

Animal	Sex ratio M	Sex ratio F	N	Source
Wild boar (Poland)	1.0	0.7	3160	Miłkowski & Wójcik (1984)
Wild boar (Spain)	0.8	1.0	106	Garzon-Heydt (1987)
Feral pig (New Zealand)	1.0	0.7	2389	This paper

in European wild boars, found that average mortality was 51% for the total population, 53% for males and 50% for females. The turnover period (time required for a cohort of 1000 to be reduced to 5 or less) was 5.8 years with over 1 year difference in the turnover period for males (4.8), compared to females (5.9). Mean life expectancy was 1.46 years and was slightly less for males (1.38) than for females (1.52).

Garzon-Heydt (1987), in his analysis of wild boar harvest in Spain, found an overall average age of 22.8 months (n=167) with 21.9 for males (n=53) and 24.9 for females (n=103). Similar results were reported by Jezierski (1977) for wild boar in Poland, namely an overall mean age of 23 months, with mean age of males 21 months and that of females 24 months. Average age of our sample (n=1966) is 50% less (10.99 months for males and 11.56 months for females).

Sex ratios in three geographically distant populations of *Sus scrofa* are compared in Table 4. All three examples document harvested portions of populations. It is noteworthy that the two biggest samples (Miłkowski & Wójcik, 1984, and this study) yielded exactly the same result. On the other hand, Andrzejewski and Jezierski (1978) found the number of females in their live-trapped population of wild boars exceeded the number of males, particularly so in older age classes.

Despite the practice of releasing pregnant or lactating sows in the study area sex ratios were not unduly influenced; instead other factors may explain the differences. For example, differences in sex ratio in Geraldine occurred because of an atypical pattern of pig occupation in this predominantly exotic (*Pinus radiata, Pseudotsuga menziesii)* forest area. Pigs in Geraldine occur in mobs in a pattern characteristic of early spread, and mainly favour the young *Pseudotsuga menziesii* stands. Females comprise the bulk of these mobs and were easier targets for dogs than were adult males that lived on the periphery of the herd. Uneven hunting pressure and selection by dogs probably also explain the sex ratio differences in Kaikoura.

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STRUKTURA WIEKOWA I PŁCIOWA POPULACJI ZDZICZAŁYCH ŚWIŃ

Streszczenie

Badania objęły populację zdziczałych świń (*Sus scrofa* Linnaeus, 1758) zasiedlającą północną część Południowej Wyspy Nowej Zelandii (Ryc. 2). W okresie 18 miesięcy (lipiec 1986 — grudzień 1987 r.) pozyskano materiał z 2386 zwierząt (Ryc. 1). Materiał stanowiła ankieta z wiadomościami o dacie i miejscu pozyskania, płci, ubarwieniu, masie i długości ciała, kondycji fizycznej, występowaniu pasożytów zewnętrznych jak wszy i kleszcze, nienormalonściach w rozwoju, ciąży, liczbie płodów i liczbie wyciągniętych sutków u samic. W niniejszej pracy wykorzystano jedynie dane dotyczące wieku i płci. Do ankiety dołączono dolną szczękę zwierzęcia. Na jej podstawie wiek zwierzęcia był określany niezależnie dwoma metodami, mianowicie (1) wymiany i starcia zębów oraz (2) warstw cementu w korzeniach zębów trzonowych. Wyodrębniono 15 regionów dla któ-

rych dokonano charakterystyki struktury wiekowej w 6-miesięcznych klasach wieku. Praca zawiera przykłady czterech takich subpopulacji regionalnych.

Rozkład grup wiekowych wykazuje przesunięcie na prawo, umiarkowaną skośność oraz odchylenie od rozkładu normalnego. Dane o liczbie płodów wykazały rozkład normalny i zostały włączone do analizy krzywych wieku. Zależność pomiędzy wiekiem a frekwencją określono przy pomocy analizy regresji. Krzywe najlepiej dopasowane do danych empirycznych to krzywa wykładnicza i potęgowa z wykładnikiem ujemnym. Otrzymano następujące równanie krzywej:

$$\% \ f = 65.3x(1+\text{grupa wieku})^{-0,85} - 1$$

przy współczynniku korelacji R=0,9679.

Tabela 1 ukazuje sezonowy rozkład pozyskania świń. Przy całorocznym polowaniu najwięcej pozyskuje się późną jesienią i zimą, najmniej latem.

Ryc. 3 przedstawia rozkład wieku pozyskanych zwierząt. Po włączeniu danych o liczebności płodów i wyciągniętych sutków (świadczących o liczbie młodych) otrzymano rozkład przedstawiony na Ryc. 4.

Struktura wieku analizowanej populacji jest typowa dla populacji intensywnie użytkowanych. Występuje duża śmiertelność w najmłodszych grupach wieku. Ponad 70% usuniętych z populacji stanowiły zwierzęta w wieku do 1 roku. Średni wiek wynosił 10.99 miesięcy a mediana 3,18. Najstarsze zwierzęta liczyły 11 lat. (Tabela 2).

Analiza wariancji dowiodła, że 15 wyodrębnionych regionów charakteryzowało się subpopulacjami o różnym przeciętnym wieku. Test χ^2 wykazał istotne różnice w rozkładzie klas wieku samic i samców. Ogólny liczbowy stosunek płci charakteryzował się przewagą samców 1:0,7.