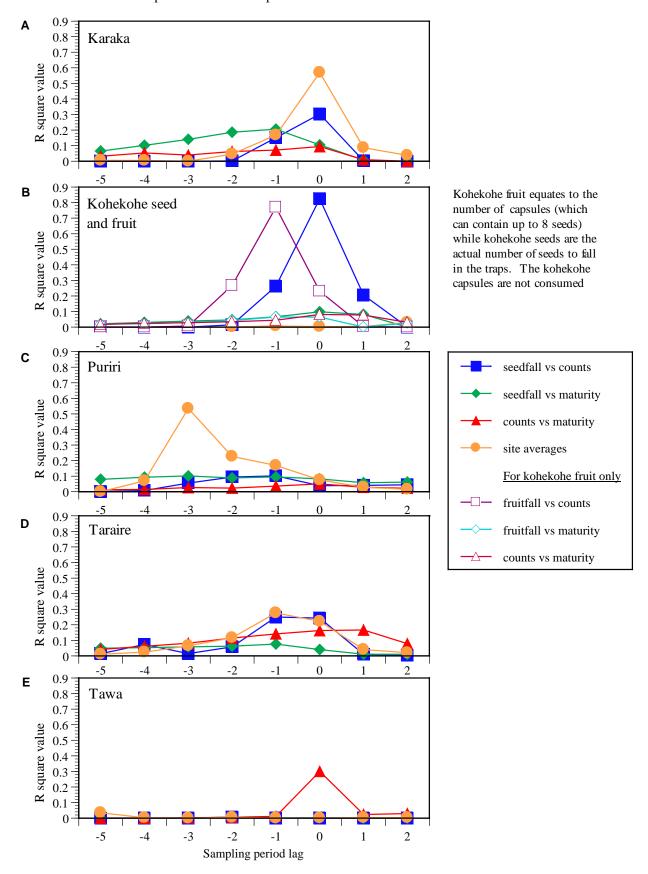
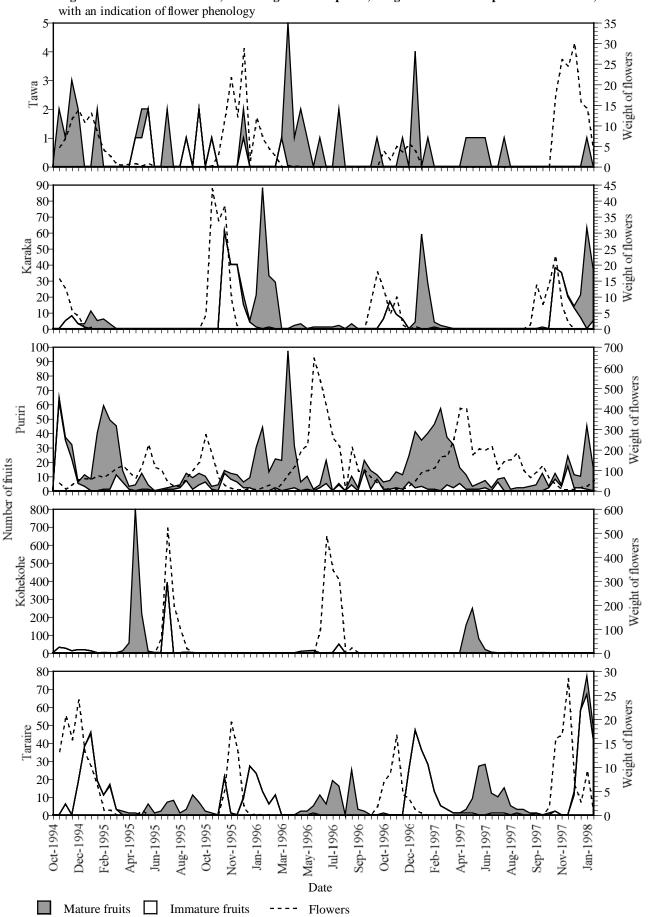
Figure 4.1: R-square values from linear correlations between various phenology methods to determine the degree of lag between methods. Comparisons were between individual trees and their target traps, except for the site averages, which compare number of fruits per cubic metre for all 10 phenology trees for each species with the average number of fruits for each species over all 30 traps.





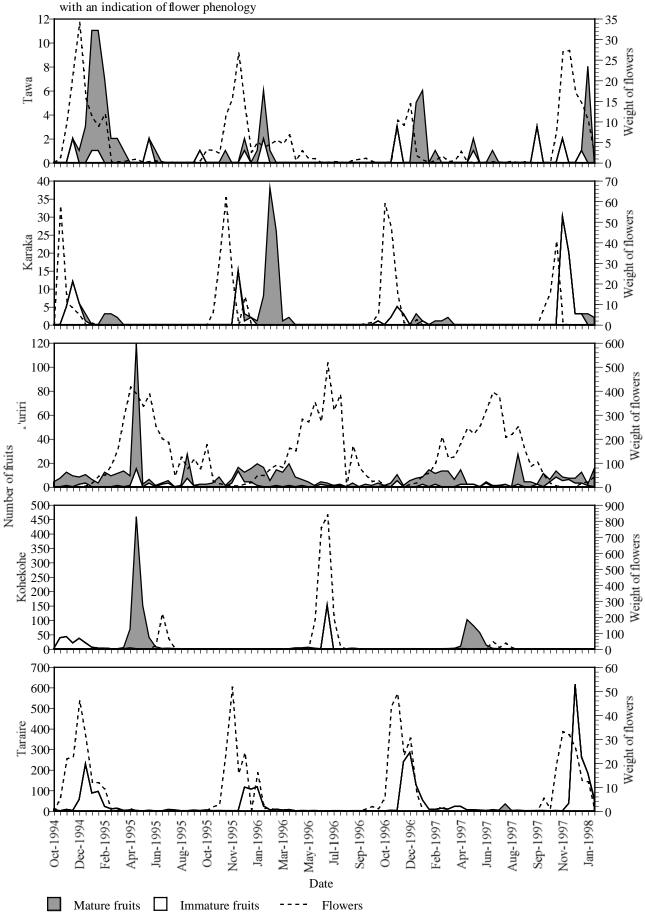


Figure 5.2: Number of fruits, from large-fruited species, caught in seedfall traps at Whitford, with an indication of flower phenology

Figure 5.3: Fruitfall timing for individual trees during three consequetive years at Wenderholm (25th to 75th percentiles) and average fruit-fall over three years (Grand average). Error bars top graph = average absolute differences from mean for 25th (left most) and 75th (right most) percentiles respectively. Thin lines on lower graphs indicate that less than 5 fruits fell into the trap that year.

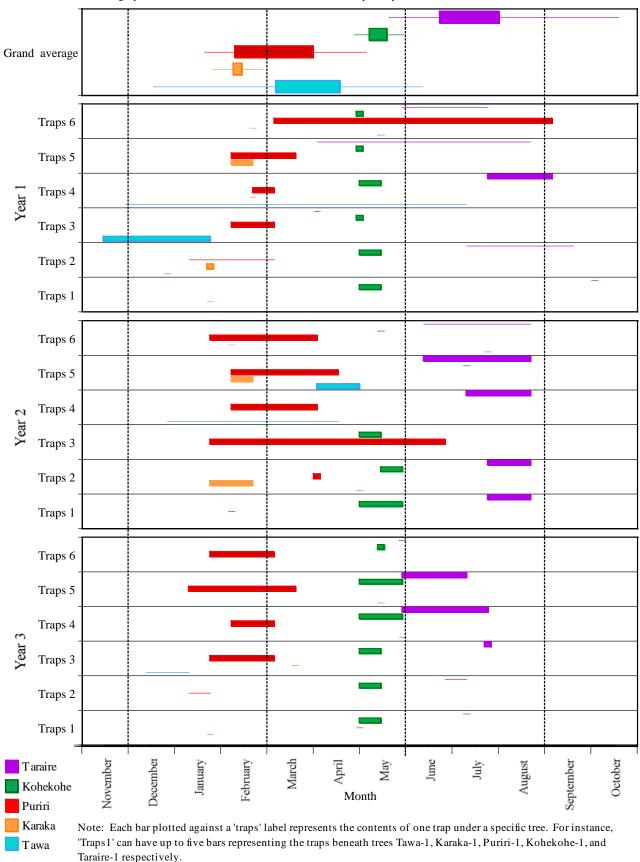
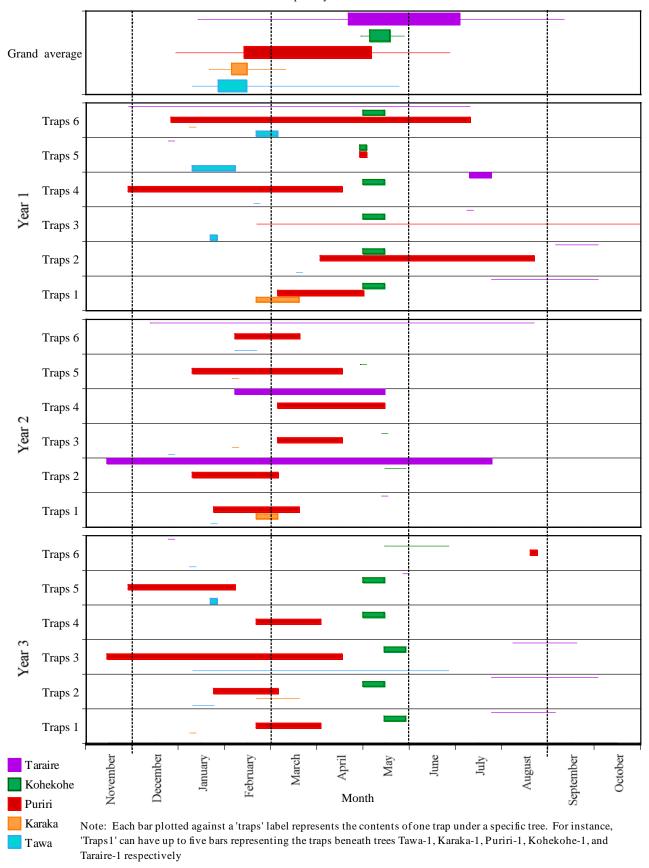


Figure 5.4: Fruitfall timing for individual trees during three consequetive years at Whitford (25th to 75th percentiles) and average fruit-fall over three years (Grand average). Error bars top graph = average absolute differences from mean for 25th (left most) and 75th (right most) percentiles respectively. Thin lines on lower graphs indicate that less than 5 fruits fell into the trap that year.



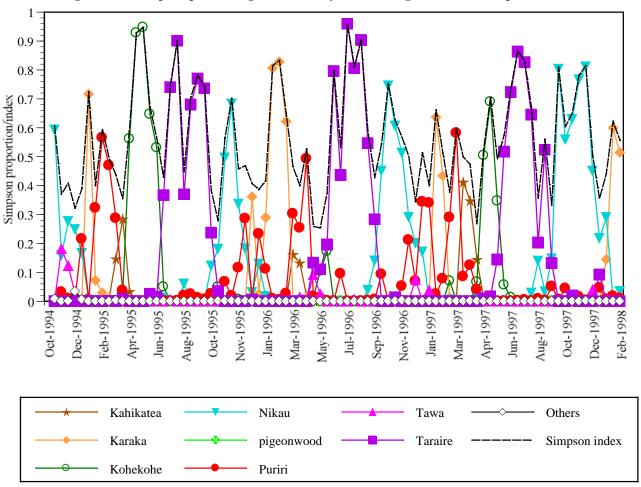
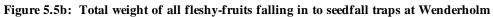
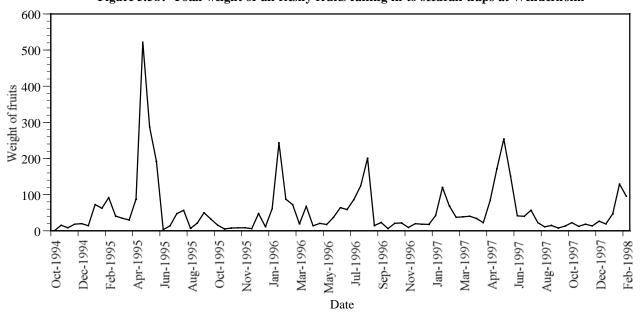


Figure 5.5a: Simpson plot of weight of all fleshy-fruits falling in to seedfall traps at Wenderholm





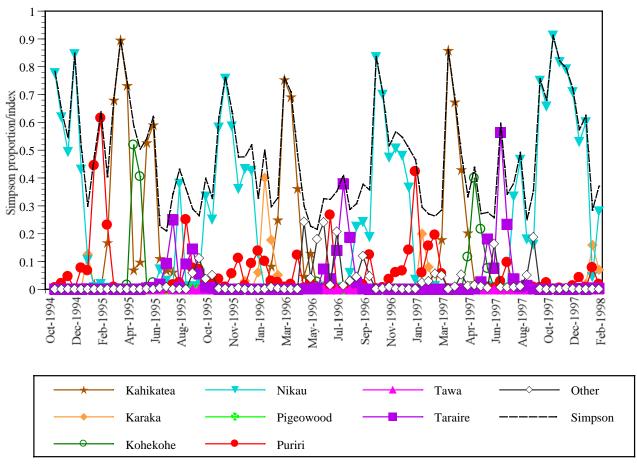
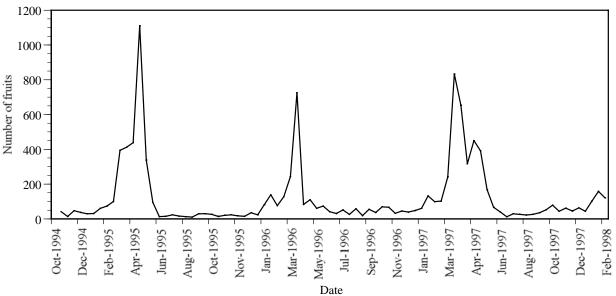


Figure 5.6a: Simpson plot of number of all fleshy-fruits falling in to seedfall traps at Wenderholm





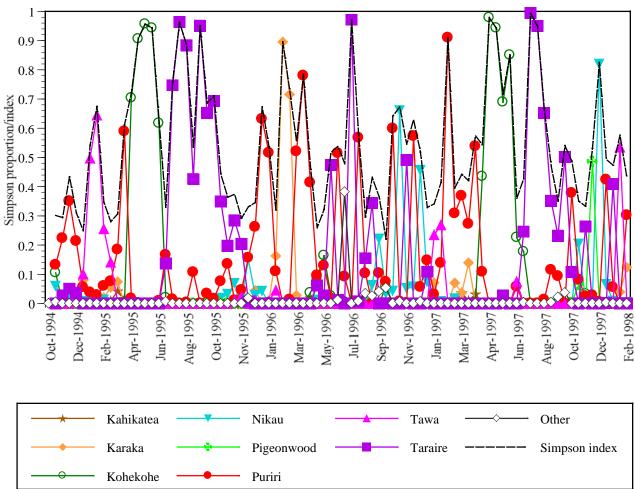
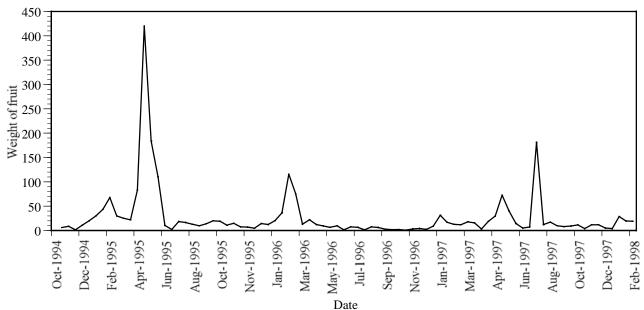


Figure 5.7a: Simpson plot of weight of all fleshy-fruits falling in to seedfall traps at Whitford





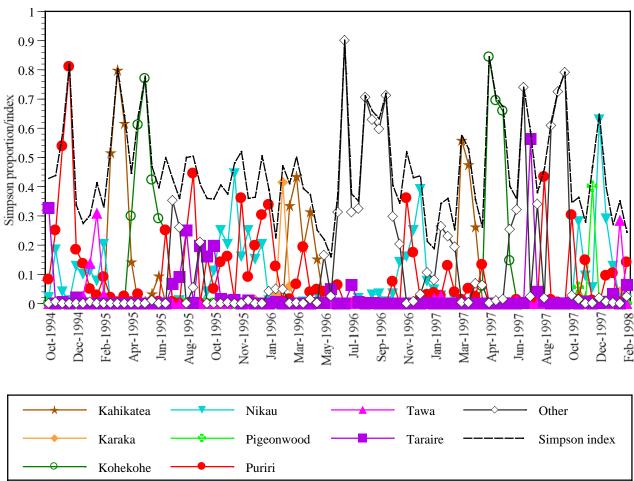
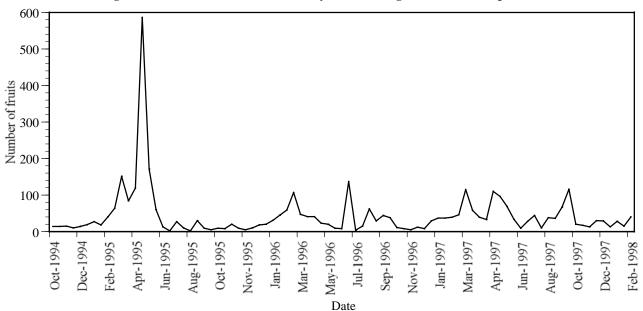


Figure 5.8a: Simpson plot of number of all fleshy-fruits falling in to seedfall traps at Whitford





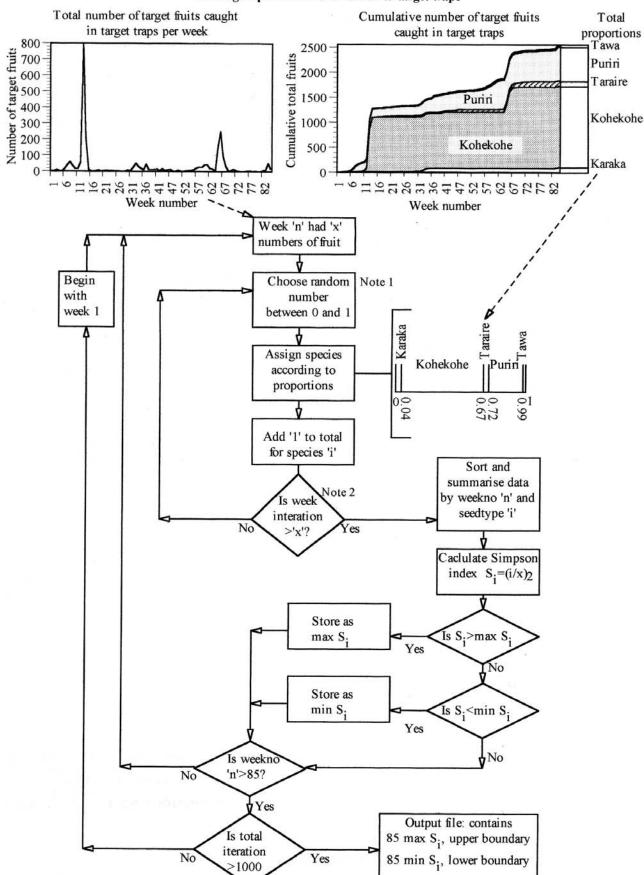


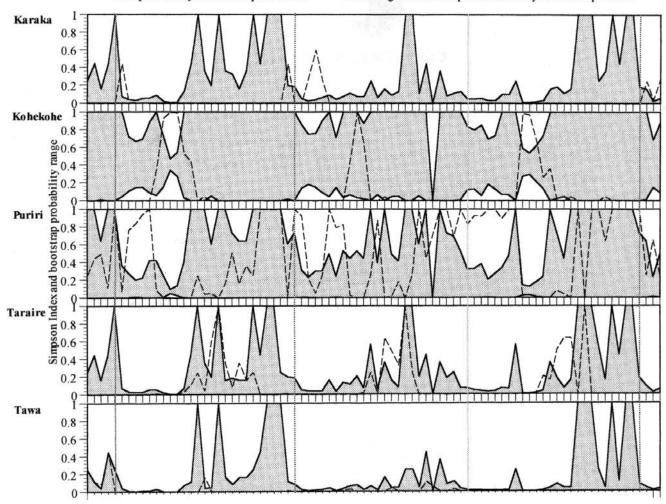
Figure 5.9: Flow diagram of Monte Carlo procedure for estimating parameters for target species fruits to fall in to target traps

Note 1: Akin to choosing a random fruit, e.g. if the number falls between 0.67 and 0.72 then the fruit is assigned as taraire. Note 2: 'x' is the number of fruit to fall into seedfall traps during that sampling period.

Figure 5.10: Simpson analysis for number of target fruits to fall in target traps at Wenderholm Regional Park

The probability limits, generated by resampling the original data 1000 times are shown.

The probability of the Simpson index --- exceeding the bootstrap boundaries by chance is p<0.001



Number of fruits produced by target species at Wenderholm

shown in two graphs; for those species that produced low numbers of fruits, and those species that numerically dominated the total fruit production amongst the target species.

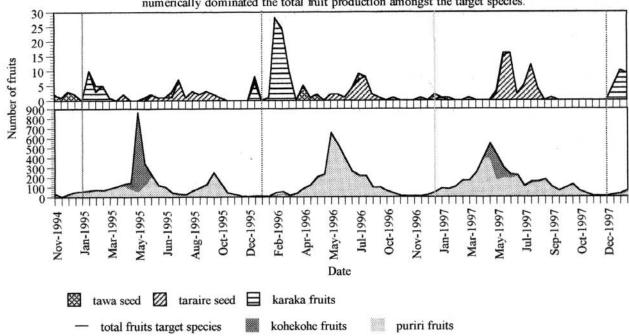
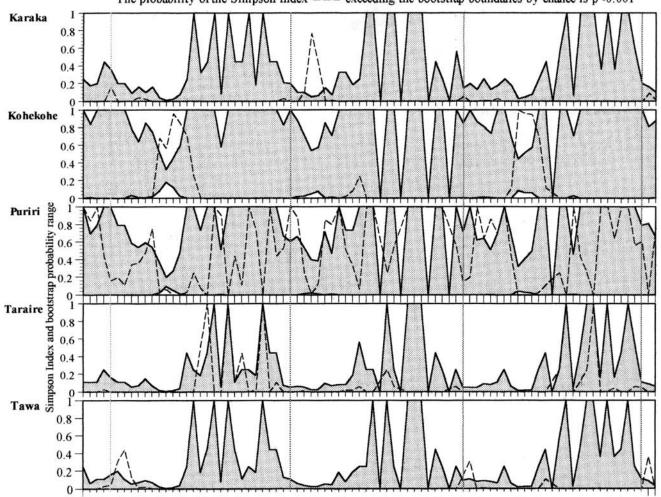


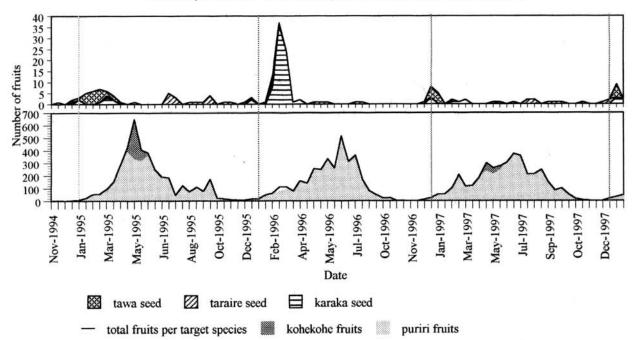
Figure 5.11: Simpson analysis for number of target fruits to fall in target traps at Whitford Bush
The probability limits, generated by resampling the original data 1000 times are shown.

The probability of the Simpson index --- exceeding the bootstrap boundaries by chance is p<0.001



Number of fruits produced by target species at Whitford,

shown in two graphs; for those species that produced low numbers of fruits, and those species that numerically dominated the total fruit production amongst the target species.



Karaka tree number Kohekohe tree number 0 10 9 8 7 6 5 4 3 2 Puriri tree number <u>1</u>0 10 9 8 7 6 5 4 3 2 1 0 10 9 8 7 6 5 4 3 2 1 Taraire tree number Tawa tree number Tawapou tree number Aug-1995 Sep-1996 Mar-1995 Jun-1995 Oct-1995 Dec-1995 Apr-1996 Nov-1996 Mar-1997 Apr-1997 Jun-1997 Jan-1995 Feb-1996 May-1996 Jul-1996 Jan-1997 Oct-1997 Dec-1997 Feb-1998 May-1995 Aug-1997 Date

Figure 5.16: Occasions that phenology trees at Wenderholm had one or more ripe fruits

Karaka tree number 10 9 8 7 6 5 4 3 2-1-0-Puriri tree number Kohekohe tree number Tawa tree number Taraire tree number Mar-1995 Oct-1996 Jan-1995 = Aug-1995 Dec-1995 = Feb-1996 Apr-1996 Jun-1995 Oct-1995 Nov-1996 Dec-1997 Oct-1997 May-1995 May-1996 Jul-1997 Jul-1996 Jan-1997 Mar-1997 May-1997 Sep-1997

Date

Figure 5.17: Occasions that phenology trees at Whitford had one or more ripe fruits

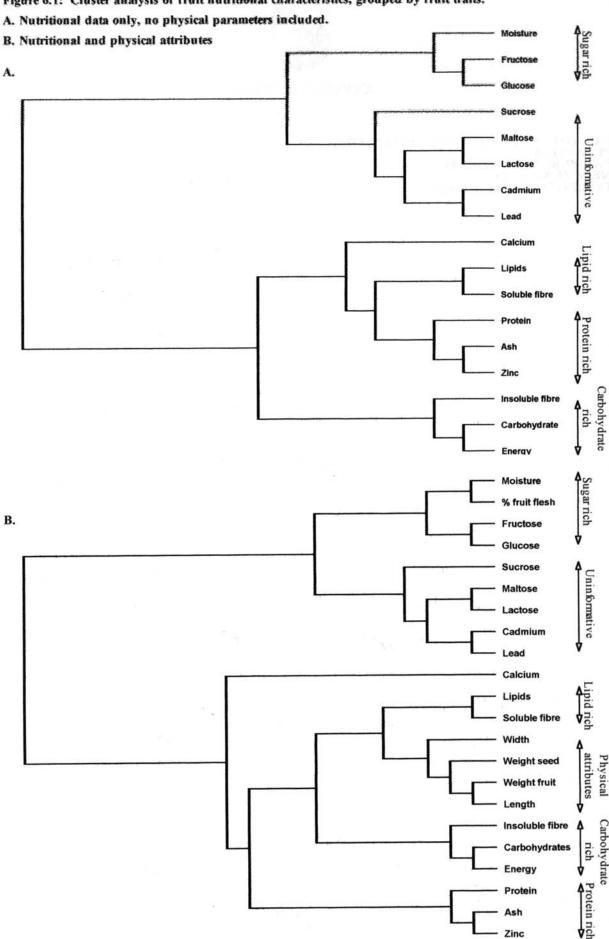


Figure 6.1: Cluster analysis of fruit nutritional characteristics, grouped by fruit traits.

Figure 6.2: Cluster analysis of fruit species, grouped by nutritional characteristics. A. Nutritional data only, no physical parameters included. B. Nutritional and physical attributes 'Type' VI A. Miro 'Type' V Tawapou Kohekohe 'Type' IV Nikau Taraire Type' II Supplejack Type' III Titoki Kahikatea 5 Kahikatea 1 Kahikatea 2 Kahikatea 3 Kahikatea 4 Hinau 'Type' VI B. 'Type' V Tawapou **Taraire** 'Type' IV Nikau Kohekohe Tawa Puriri Karaka Supplejack Pigeonwood Titoki Kahikatea 5 Kahikatea 1 Kahikatea 2 Kahikatea 3

Kahikatea 4

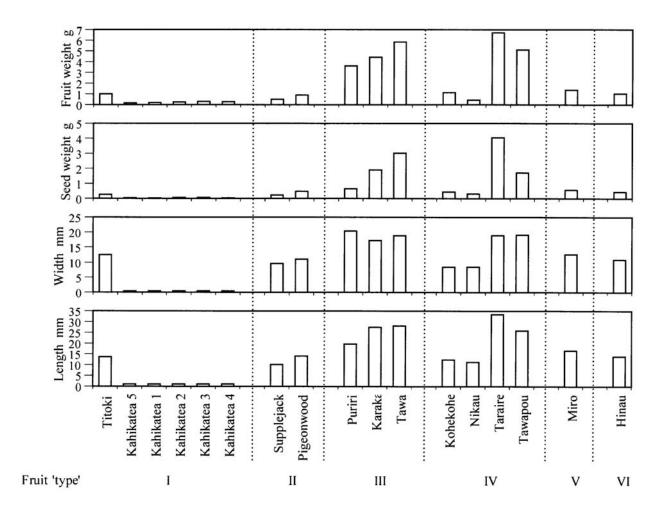
100 Moisture % 80 60 40 20 0 4 Fructose % 2 5 % 4 3 2 1 3 2 1 100 Fruit flesh % 80 60 40 20 % 0.8 -% 0.6 -0.4 -0.2 -0.5 % 0.4 % 0.3 0.2 0.1 Cadminm mg/kg 60.0 60.0 60.0 60.0 70.0 90.0 0 1.4 – 1.2 – 1.2 – 1.0 – % 0.8 90.6 0.4 0.2 Karaka Tawa Nikau Taraire Miro Hinau Kahikatea 5 Puriri Kohekohe Kahikatea 1 Kahikatea 2 Kahikatea 3 Kahikatea 4 Supplejack Tawapou Pigeonwood Π Fruit 'type' I ${\rm III}$ IV V VI

Figure 6.3: Nutritional characteristics of fruits, grouped by cluster results.

Calcium mg/kg 1000 500 0 5 % pidi7 1 0 Soluble fibre % 3 Protein % 2 3 % qsy 1 0 Zinc mg/kg 8 6 6 4 2 2 Euergy kJ/100g 600 400 200 0 Karaka Taraire Tawa Nikau Kahikatea 5 Kohekohe Miro Puriri Hinau Kahikatea 1 Kahikatea 2 Kahikatea 3 Kahikatea 4 Supplejack Pigeonwood Tawapou I Π IV VI Fruit 'type' Ш V

Figure 6.3 cont.: Nutritional characteristics of fruits, grouped by cluster results (p.2).

Figure 6.3 cont.: Physical characteristics of fruits, grouped by cluster results (p.3).



5 90 80 70 60 50 40 30 20 10 % moisture or fruit flesh 4 sangar % 0 Fruit flesh Fructose Glucose Moisture 0.9 1.4 0.8 1.2 0.7 mg/kg metal 0.6 0.6 0.5 0.4 0.3 0.8 0.6 0.4 0.2 0.2 0.1 0 Cadmium Lead Sucrose Maltose Lactose % lipid or soluable fibre 1200 1000 mg/kg calcium 800 600 400 200 Lipids Soluble fibre Calcium 3 12 10 % protein or ash 8 mg/kg zinc 6 4 2 0 Protein Ash Zinc 800 45 20 ocarbo or insol. fibre sol. 20 15 10 5 5 700 5 0 100 Insoluble fibre Carbohydrates Energy 30 6 25 5 20 (IIII) 15 9ZIS 10 :SZIS Weight (g) 2 5 1 0 Fruit weight Seed weight Width Length Fruit 'types' III II IV V VI

Figure 6.4: Mean fruit characteristics for fruit 'types' presented as averages for cluster 'categories'.

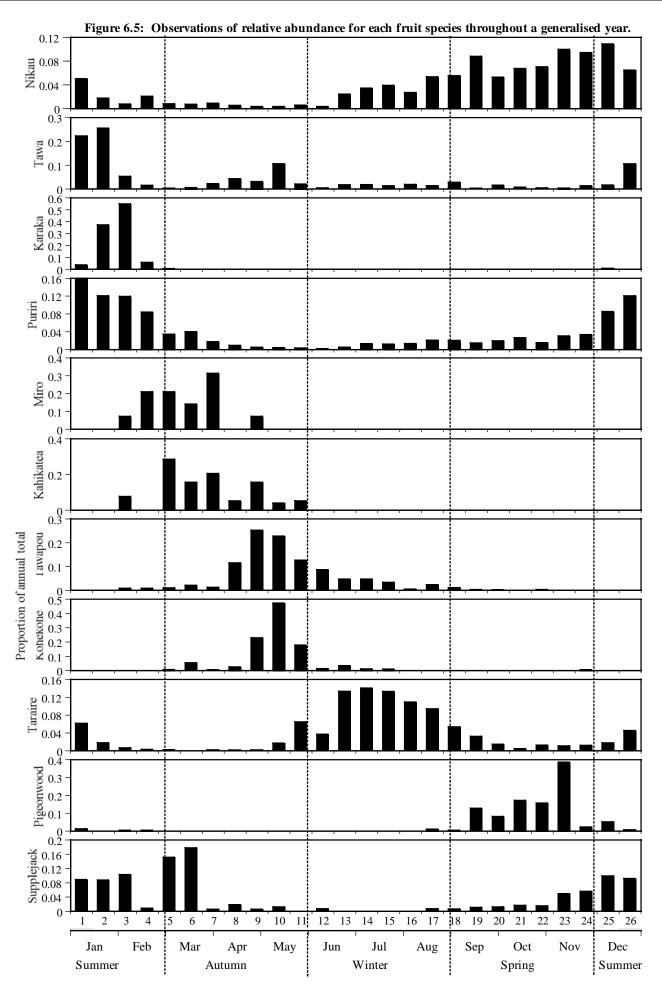
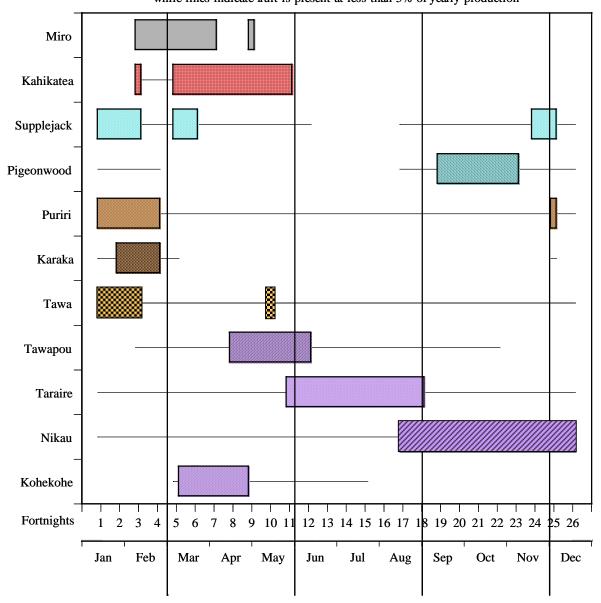


Figure 6.6: Observed availability of fruits in Auckland throughout a generalised year by nutritional fruit 'types'.

Boxes indicate more than 5% of the yearly production of a species,
while lines indicate fruit is present at less than 5% of yearly production



Key to fruit 'types'. These colour and pattern combinations are used throughout this Chapter.

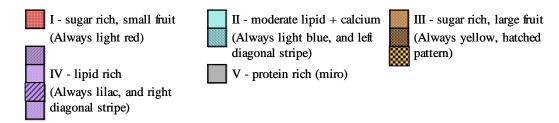


Figure 6.7: Observed availability and nutritional fruit 'type' throughout the year compared with kereru behaviour and seed deposition over all sites during this study.

The data for observed kereru feeding behaviour and deposition of consumed fruits in seedfall traps have been compiled from all six sites. **Graph a**: Availability of fruit 'types' throughout the year;. **Graph b**: Feeding observations; **Graph c**: Total fruit deposition; **Graph d**: Fruit deposition when kahikatea fruits are excluded.

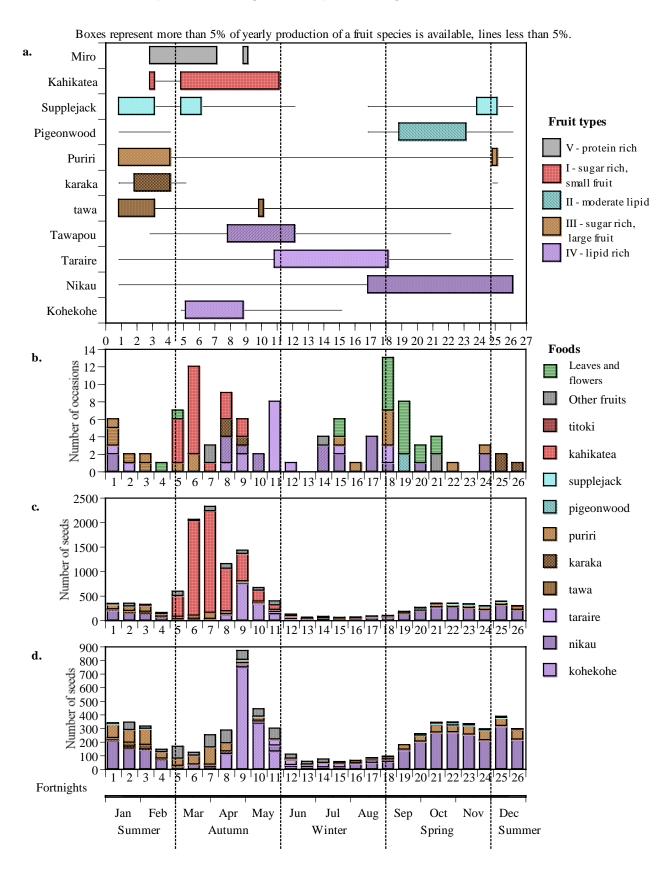


Figure 6.8: Availability and nutritional value of fruits throughout the year compared with observed kereru feeding and nesting.

Graph a: Availability and nutritional value of fruits (data this study).

Graph b: Observed kereru feeding data from September 1988 to September 1989 at Wenderholm (unpublished data M. Clout). These data are direct feeding observations of birds per fortnightly period.

Graph c: Number of new nests found per month at Wenderholm; data from Clout et al. (1995b).

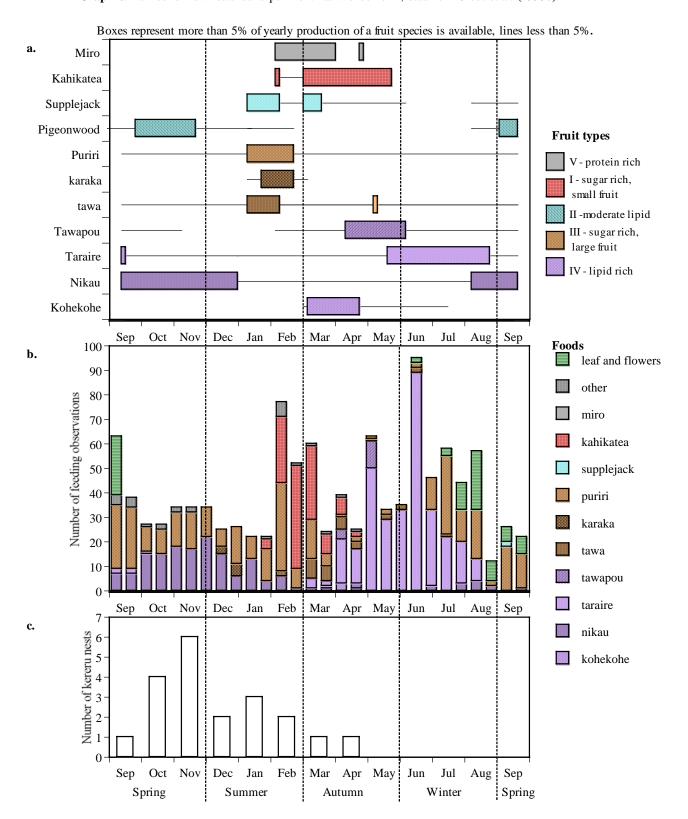
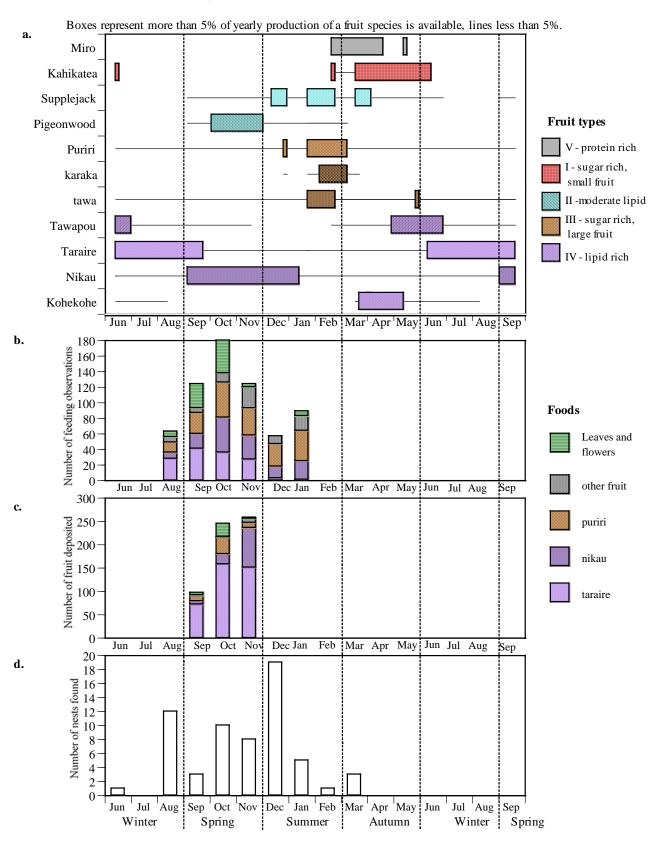


Figure 6.9: Availability and nutritional value of fruits throughout the year compared with observed kereru feeding and nesting in 1993/94.

Observed kereru behaviour during breeding periods at Wenderholm (data from James, 1995); **Graph a**: Availability of fruit 'types'; **Graph b**: Kereru feeding observations; **Graph c**: Fruit deposition below kereru nest; **Graph d**: Detection of new kereru nests



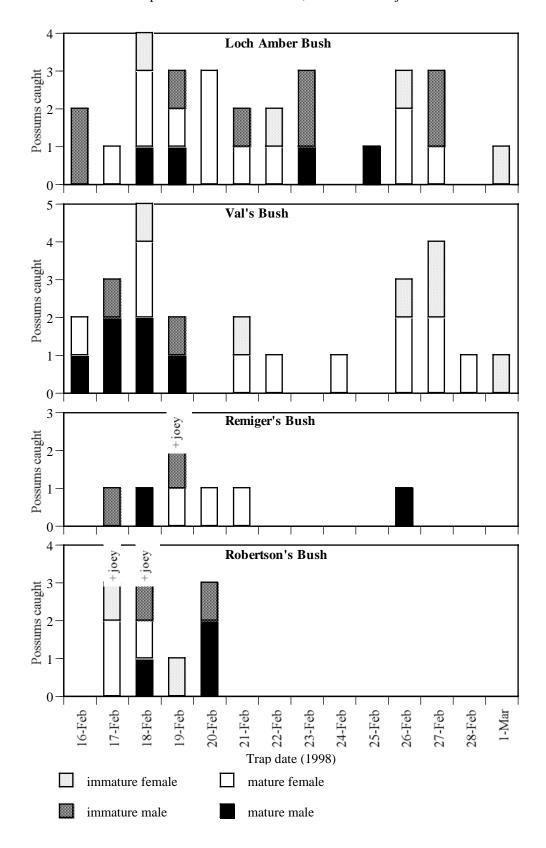
450 400 350 300 250 200 150 100 35 30 25 25 15 10 350-350-300-250-150-100-50 600 500 400 300 200 200 100 2500 2000 Kahikatea 1500 1000 500 0 1600 1400 1200 1000 800 600 400 200 Number of fruits Taraire Supplejack poonuo 15 10 10 5 5 0 17 18 19 20 21 5 7 8 9 10 11 12 13 14 15 16 22 3 4 Not eaten Consumed Sampling fortnight

Figure 6.10: Number of consumed and uneaten fruits to fall into seedfall traps, summed over all sites by sampling fortnight

0.1 0.3 80.08 80.06 80.04 0.2 0.02 0.3^{0} 8.4 0.3 -0.3 -0.2 -0.1 -0.1 0.1 0.1 0.5 - 0.0 Karaka - 0.0 - 0.2^{0} 8.4 0.15 0.3 Proportion of total annual feeding observations by kerereu 0.1 0.2 0.05 0.4 Proportion of total annual fruit production per species 0.8 0.3 Kereru 0.2 0.6 0.4 0.1 0.2 0.7 8.5 Xahikatea (Nahikatea (0.4 -0.4 -0.3 -0.2 -0.1 0.1 0.3 Day 0.2 0.1 8.0 0.7 0.6 0.5 0.4 0.3 0.2 0.1 e 0.5 0.4 0.4 0.2 0.2 0.1 -0.6 -0.5 -0.4 -0.3 -0.2 × 0.2° 0.15 0.1 0.05 0.05 -0.10.4 Dog 0.3 0.2 0.1 0.8 -0.6 -0.4 -0.4 -0.4 0.2 P 0.2° Supplejack 0.15 0.05 0.8 0.6 0.4 0.2 8 9 10 11 16 17 19 20 21 14 18 Feb Mar May Sep Oct Aug Consumed fruits in seedfall traps 1988/89 kereru feeding observations Ripe fruit available in trees 1994/98 kereru feeding observations

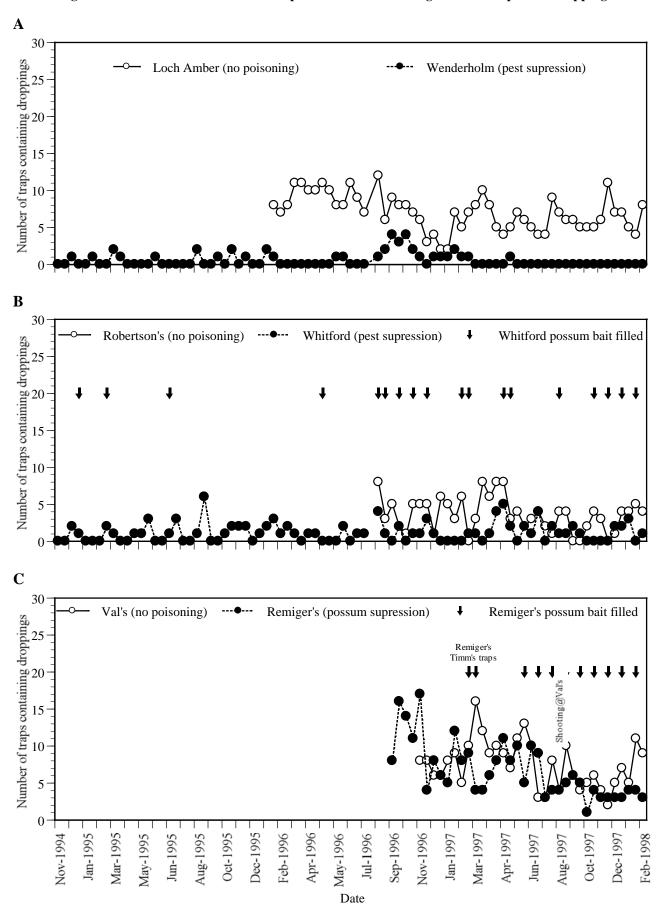
Figure 7.7: Number of possums trapped per site.

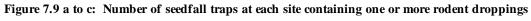
The data are separated into male and female, and mature and juvenile animals

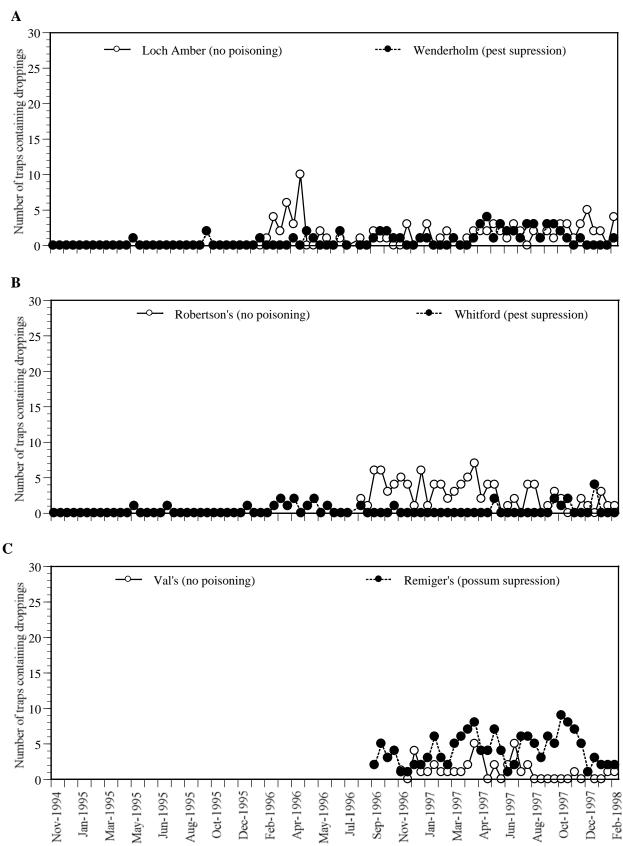


p.175

Figure 7.8 a to c: Number of seedfall traps at each site containing one or more possum droppings



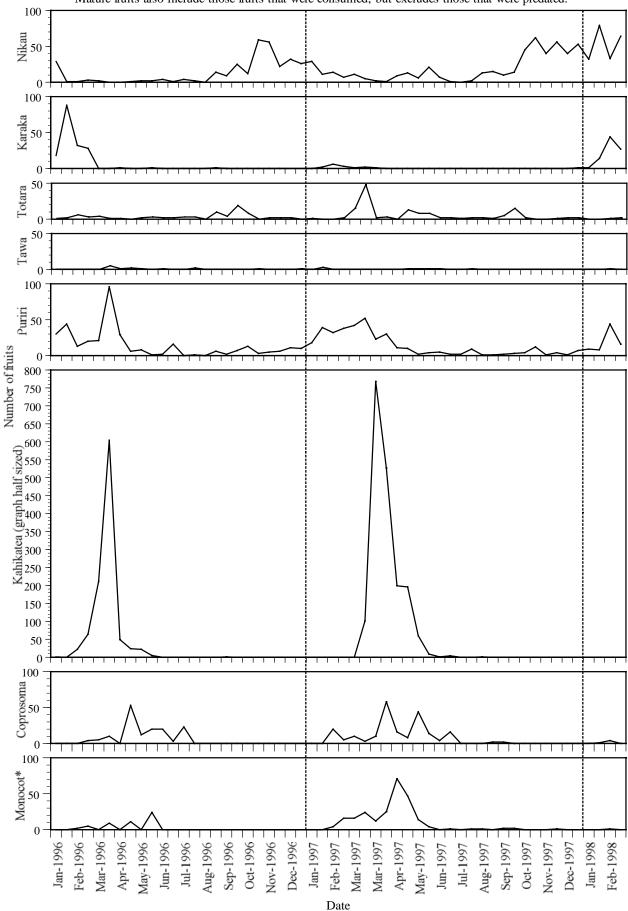




Date

Figure 7.11: Number of mature, undamaged fruits found in seedfall traps at Wenderholm Regional Park, page 1

Mature fruits also include those fruits that were consumed, but excludes those that were predated.



^{*}Monocot = small spiral black seeds, most likely cabbage tree (Cordyline) or Astelia

Figure 7.11: Number of mature, undamaged fruits found in seedfall traps at Wenderholm Regional Park, page 2 Mature fruits also include those fruits that were consumed, but excludes those that were predated.

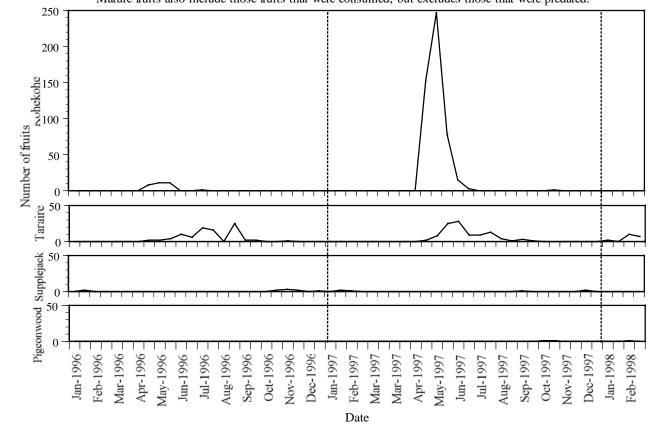
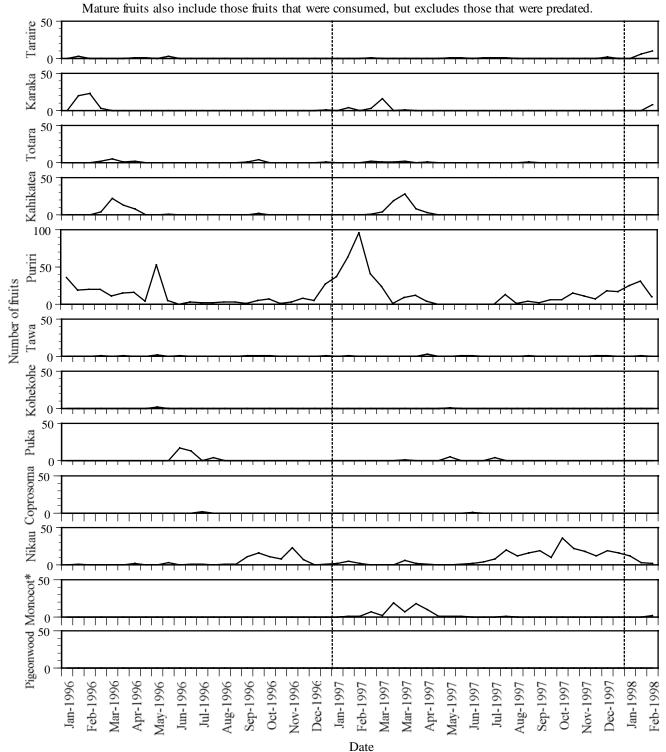
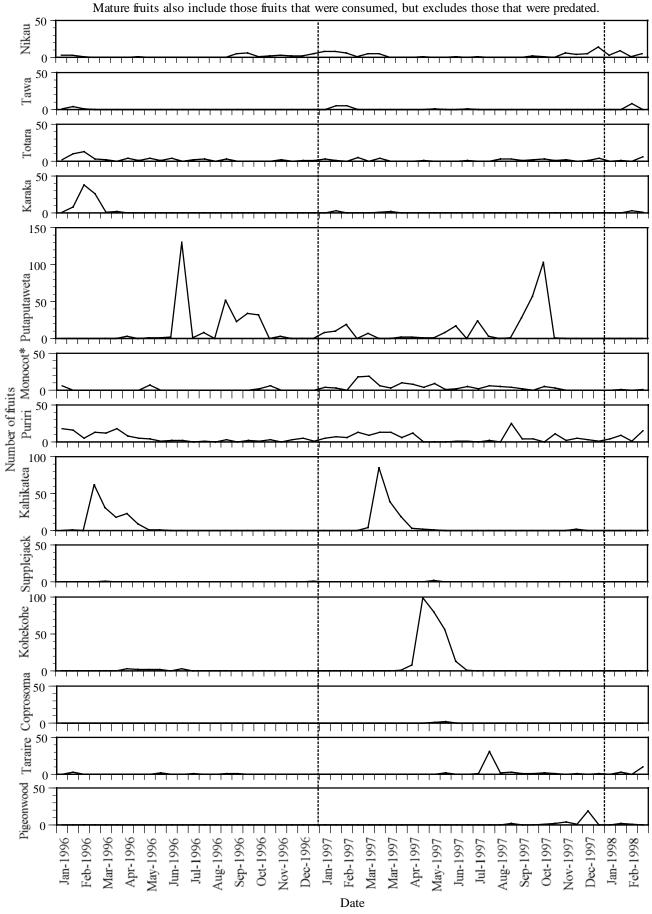


Figure 7.12: Number of mature, undamaged fruits found in seedfall traps at Loch Amber Bush.



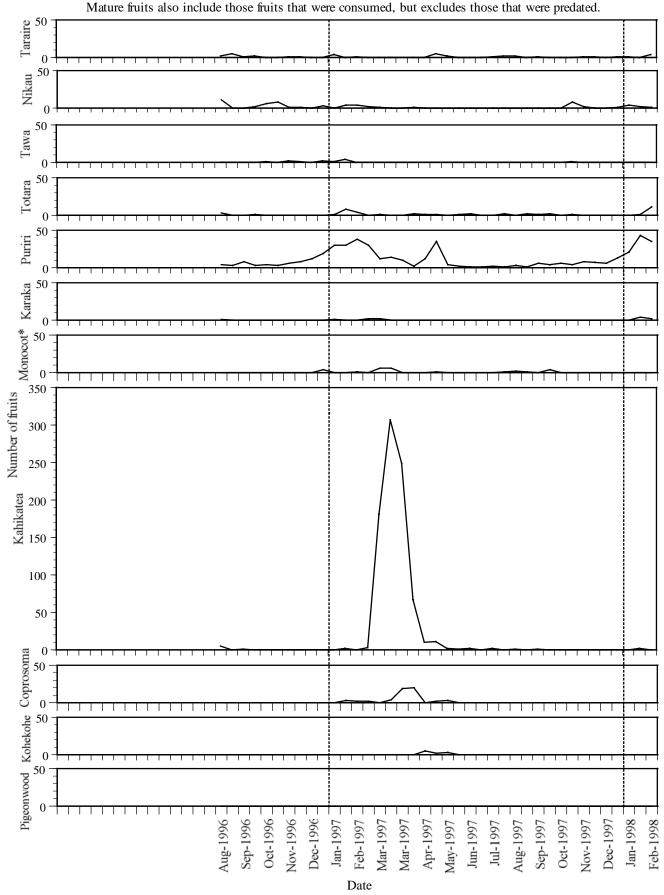
^{*}Monocot = small spiral black seeds, most likely cabbage tree (Cordyline) or Astelia

Figure~7.13:~Number~of~mature,~undamaged~fruits~found~in~seed fall~traps~at~Whitford~Bush.



^{*}Monocot = small spiral black seeds, most likely cabbage tree (Cordyline) or Astelia

Figure~7.14:~Number~of~mature,~undamaged~fruits~found~in~seed fall~traps~at~Robertson's~Bush.



^{*}Monocot = small spiral black seeds, most likely cabbage tree (Cordyline) or Astelia

Figure 7.15: Number of mature, undamaged fruits found in seedfall traps at Remiger's Bush, page 1. Mature fruits also include those fruits that were consumed, but excludes those that were predated. 150 100 Nikan 05 Taraire Coprosoma Supplejack 50 Number of fruits Karaka 0 100 Puriti 20 200 150 100 Totara 50 Monocot* Oct-1996 Apr-1997 Jan-1998 Nov-1997 Dec-1996 Jul-1997 Aug-1997 Sep-1997 Dec-1997 Sep-1996 Nov-1996 May-1997 Oct-1997 Feb-1998 Mar-1997 Mar-1997 Jun-1997 Jan-1997 Feb-1997

Date

*Monocot = small spiral black seeds, most likely cabbage tree (Cordyline) or Astelia

Figure 7.15: Number of mature, undamaged fruits found in seedfall traps at Remiger's Bush, page 2.

Mature fruits also include those fruits that were consumed, but excludes those that were predated.

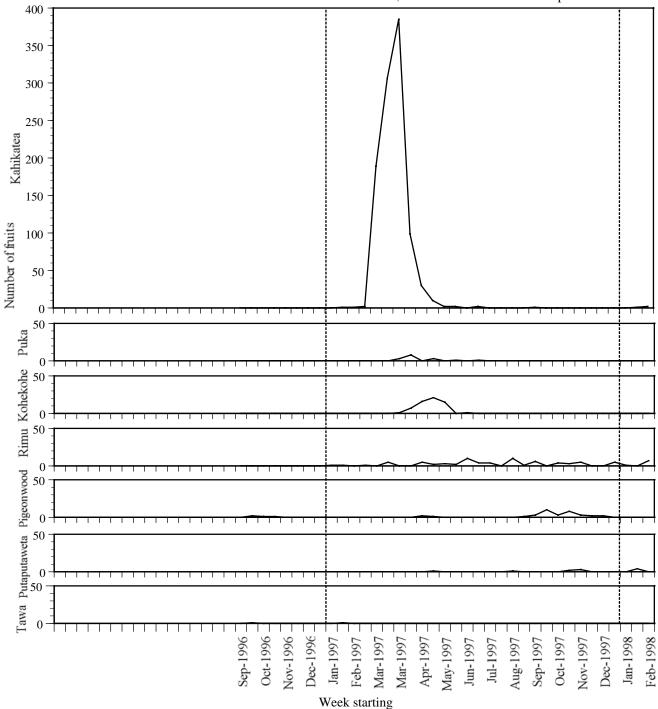
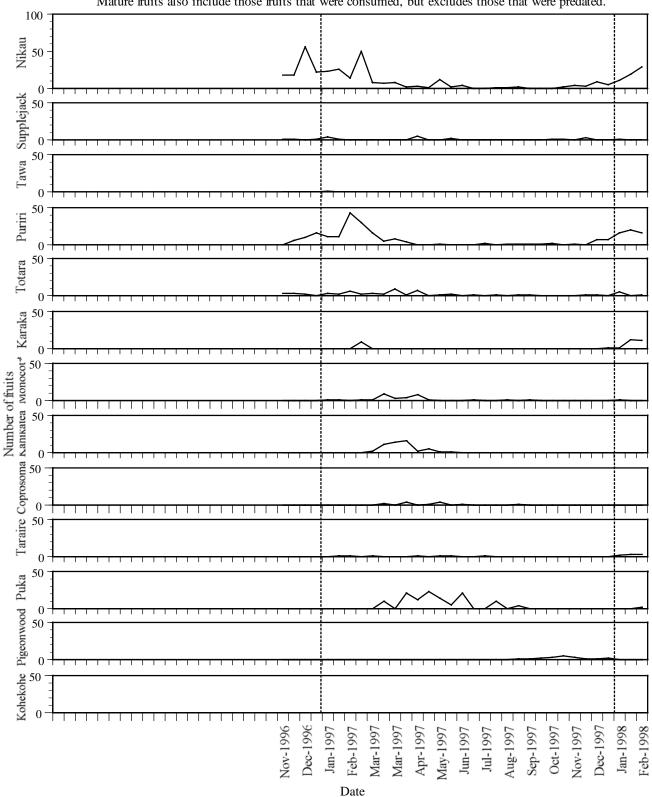
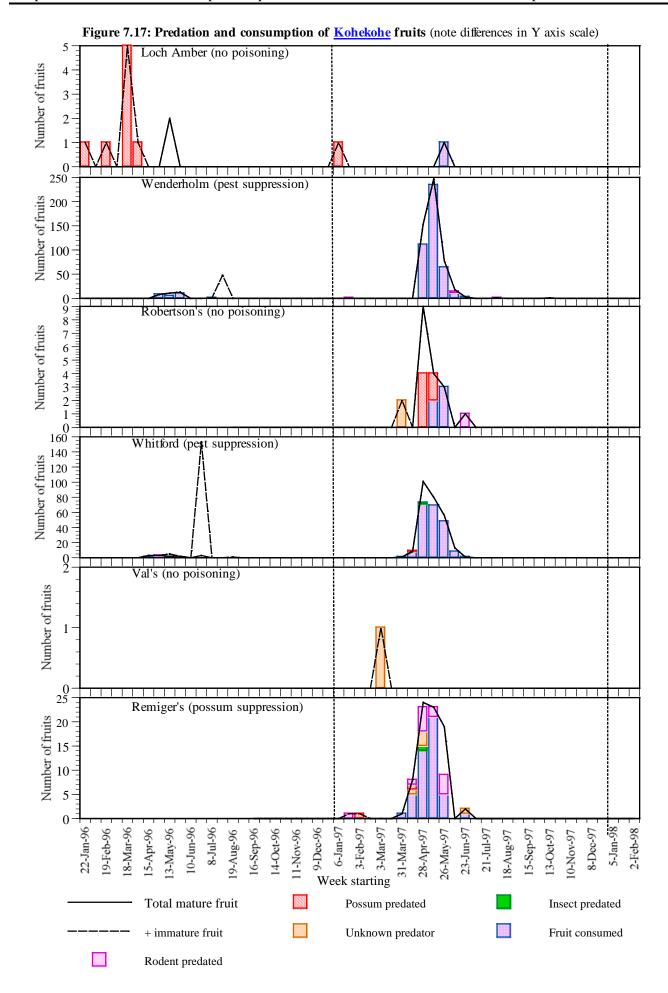
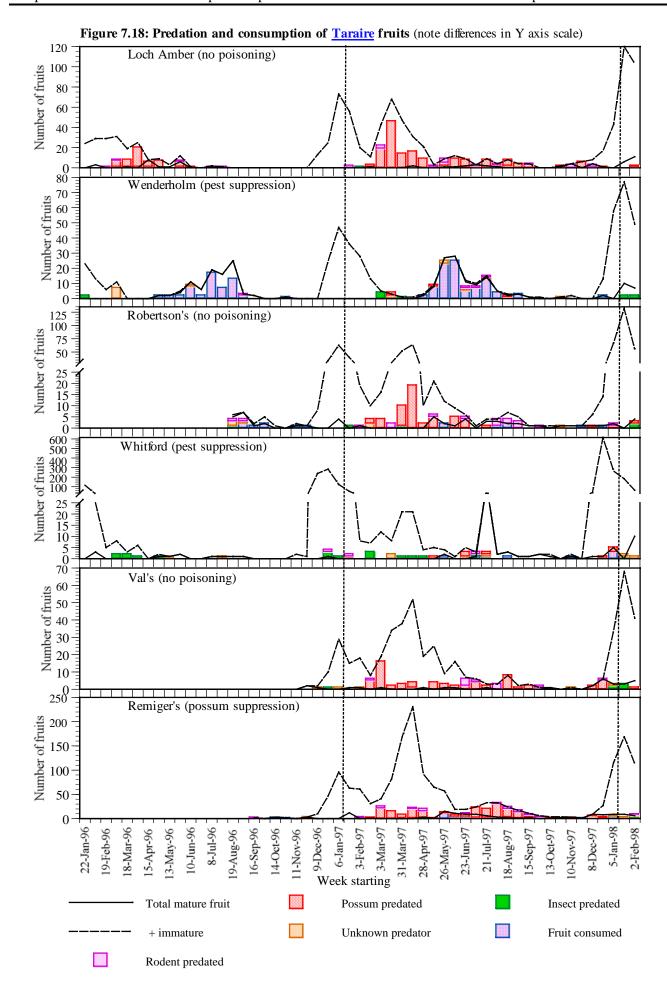


Figure 7.16: Number of mature, undamaged fruits found in seedfall traps at Val's Bush. Mature fruits also include those fruits that were consumed, but excludes those that were predated.



^{*}Monocot = small spiral black seeds, most likely cabbage tree (Cordyline) or Astelia





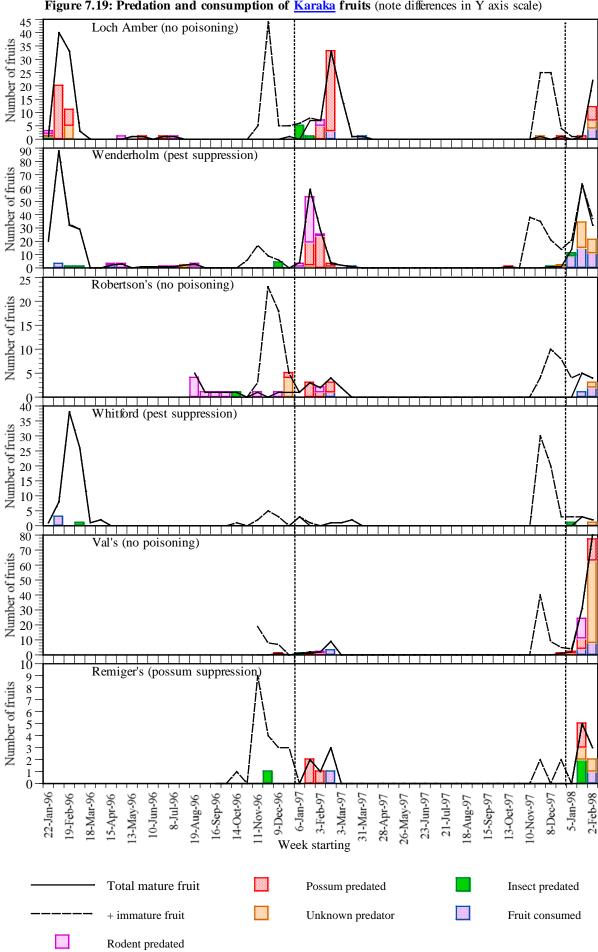
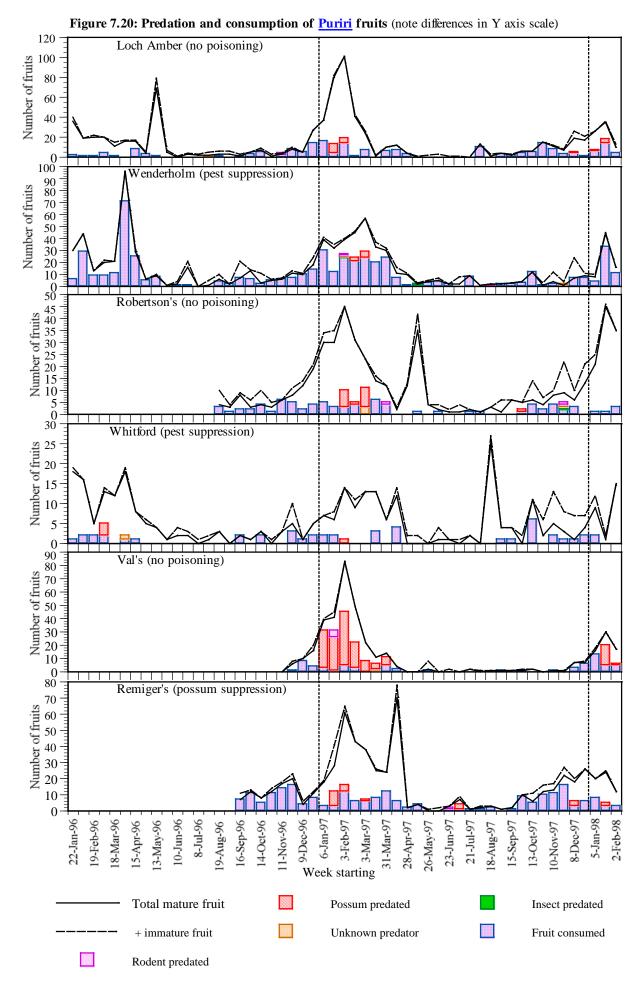
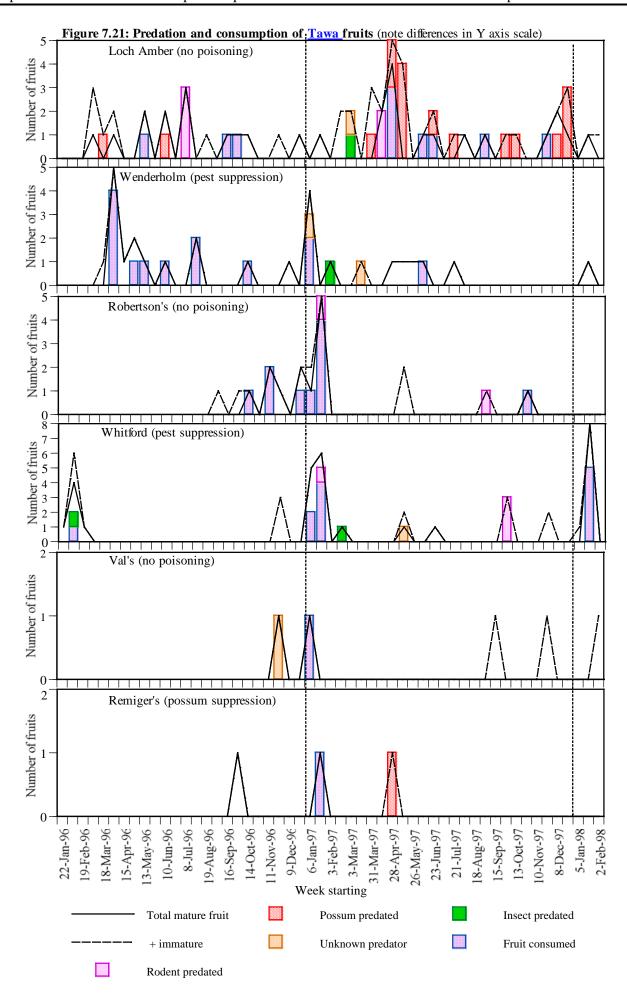
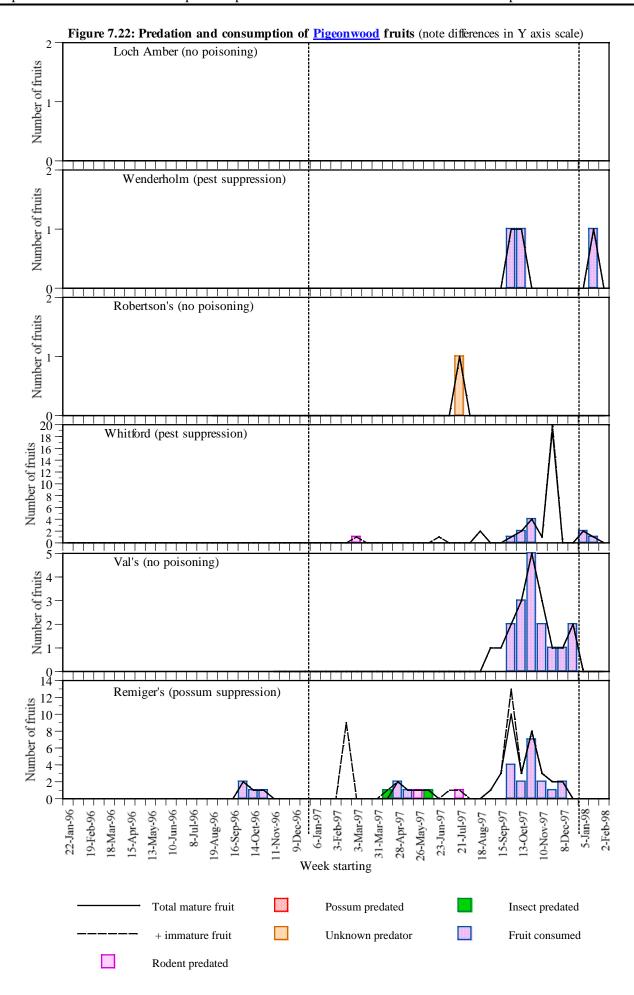
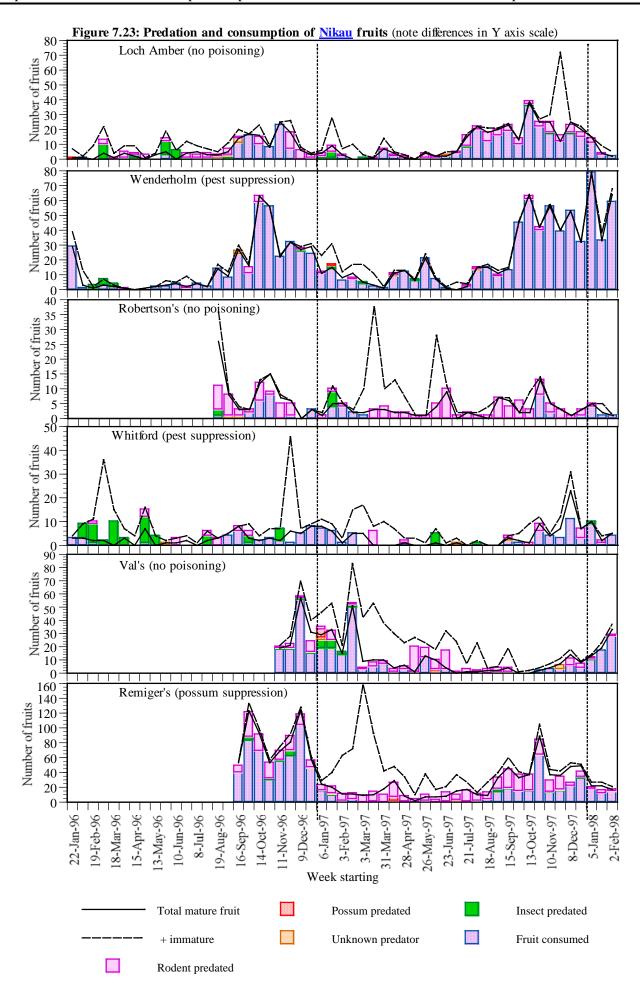


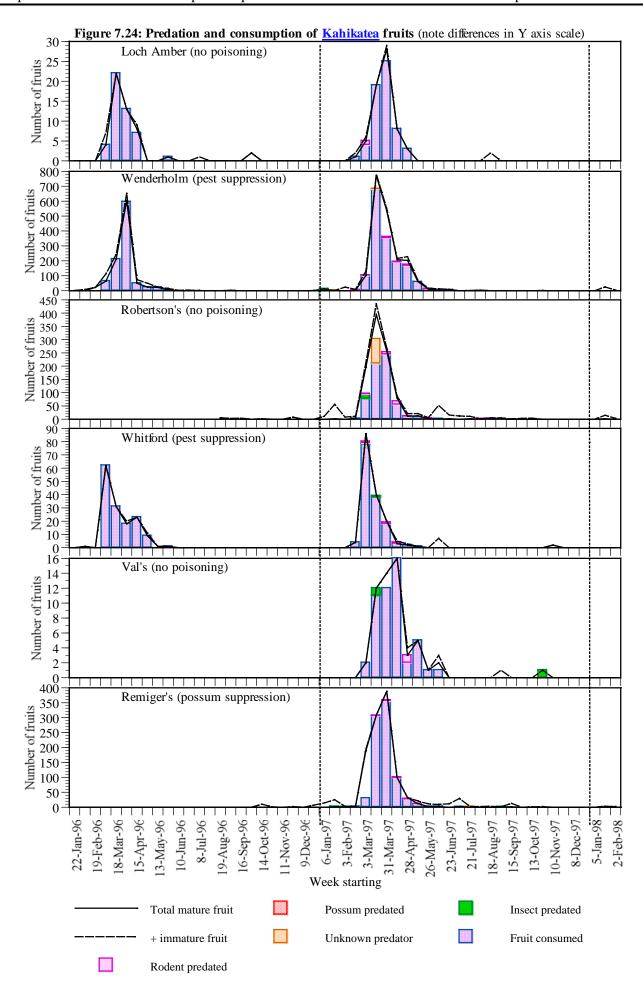
Figure 7.19: Predation and consumption of Karaka fruits (note differences in Y axis scale)











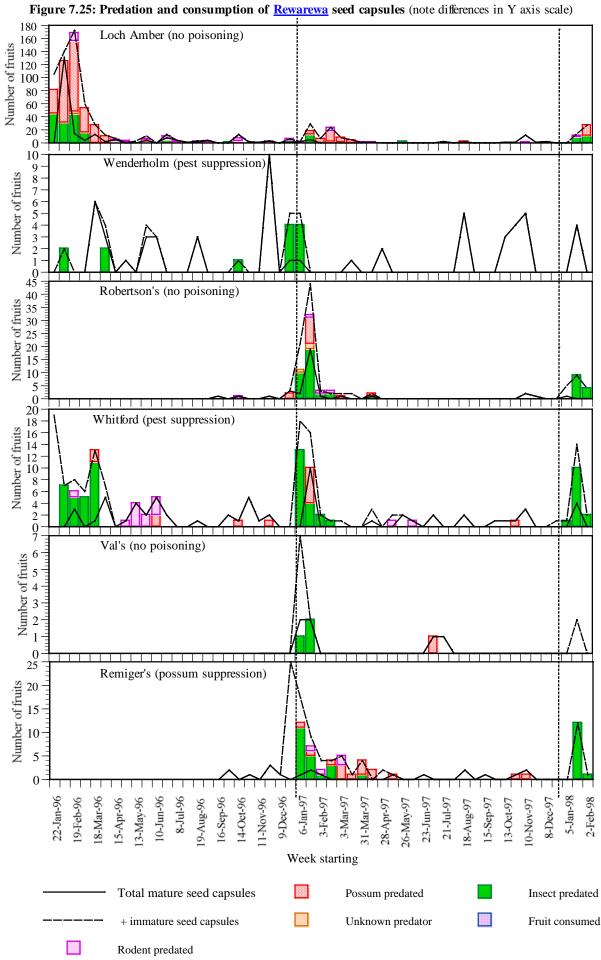
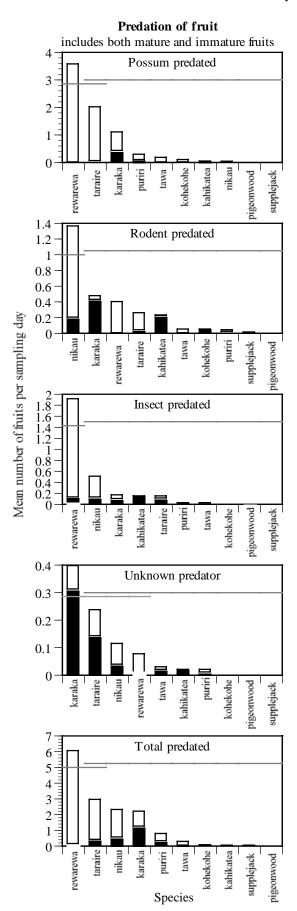
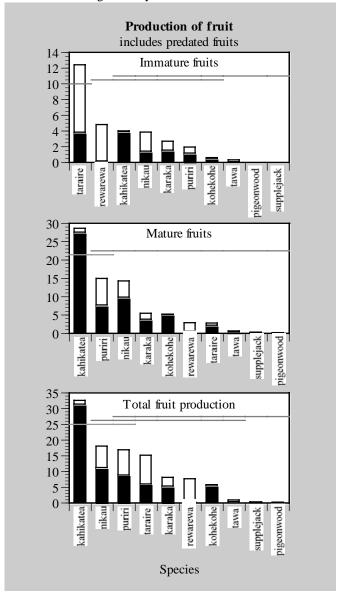
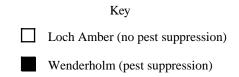


Figure 7.26: Comparison between levels of predation, bird consumption and fruit production for Wenderholm and Loch Amber.

Columns connected by horizontal lines are not significantly different







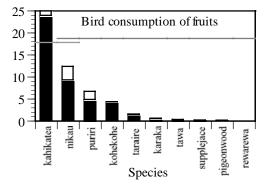
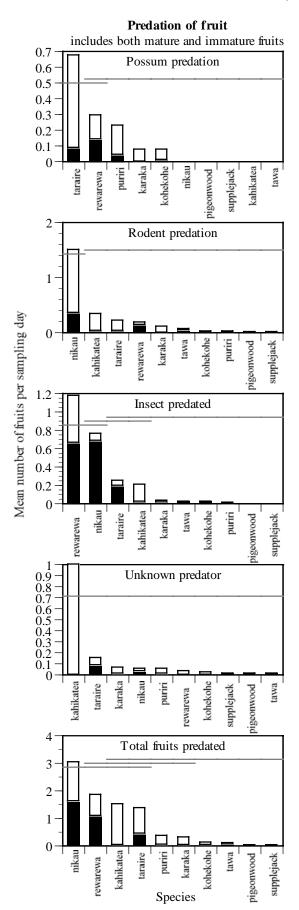
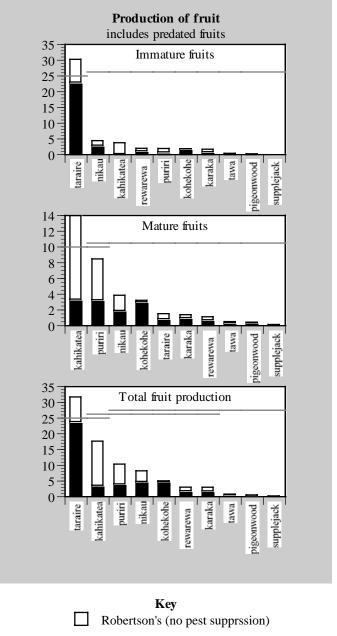
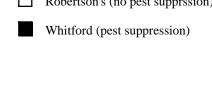


Figure 7.27: Comparison between levels of predation, bird consumption and fruit production for Whitford and Robertson's.

Columns connected by horizontal lines are not significantly different







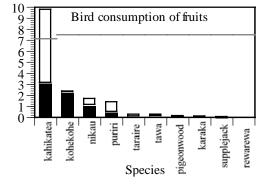
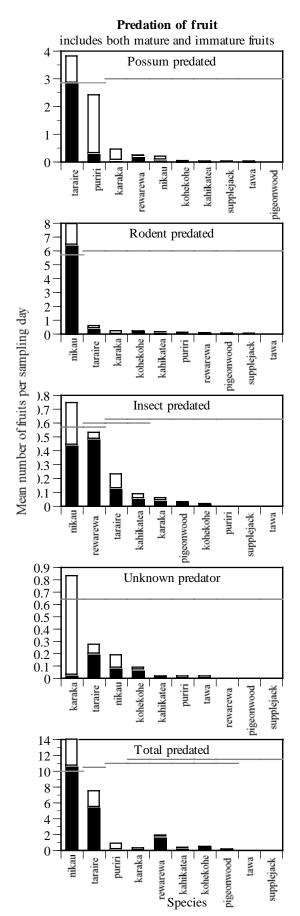
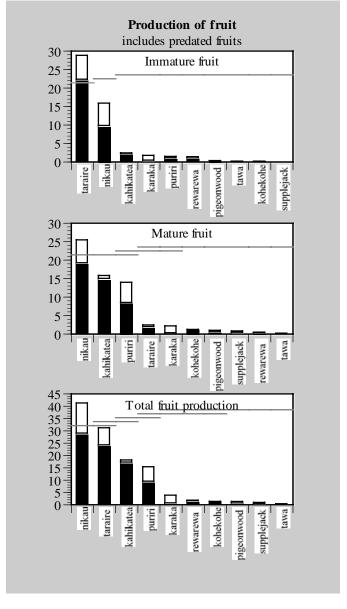


Figure 7.28: Comparison between levels of predation, bird consumption and fruit production for Remiger's and Val's.

Columns connected by horizontal lines are not significantly different





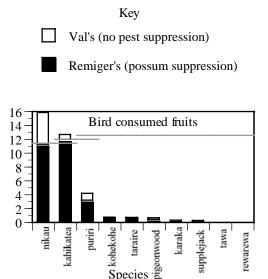


Figure 7.29 a to c: Number of seedfall traps at each site containing one or more insect dropping

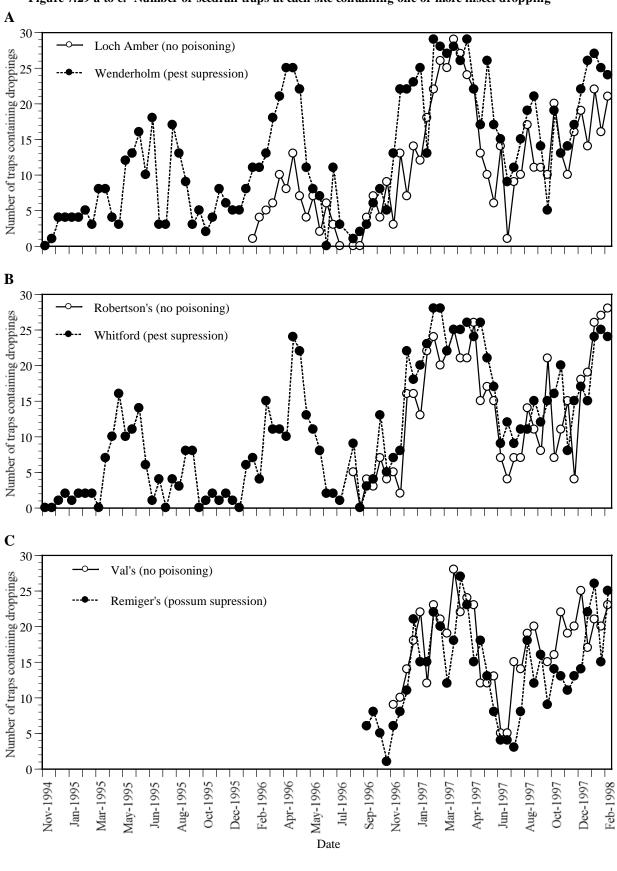


Figure 7.30 a to c: Number of seedfall traps at each site containing one or more weta dropping

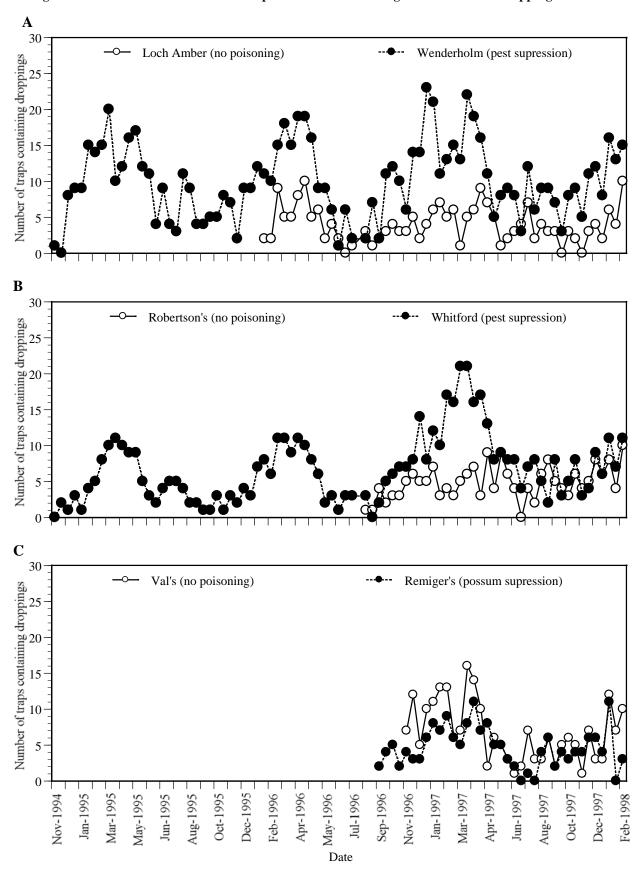


Figure 7.31 a to c: Number of sedfall traps at each site containing one or more pigeon dropping

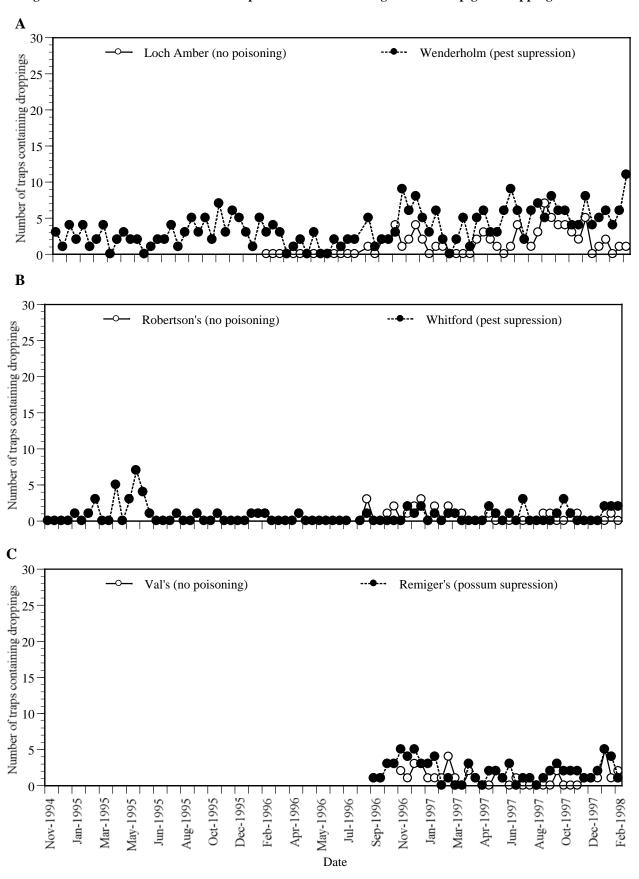
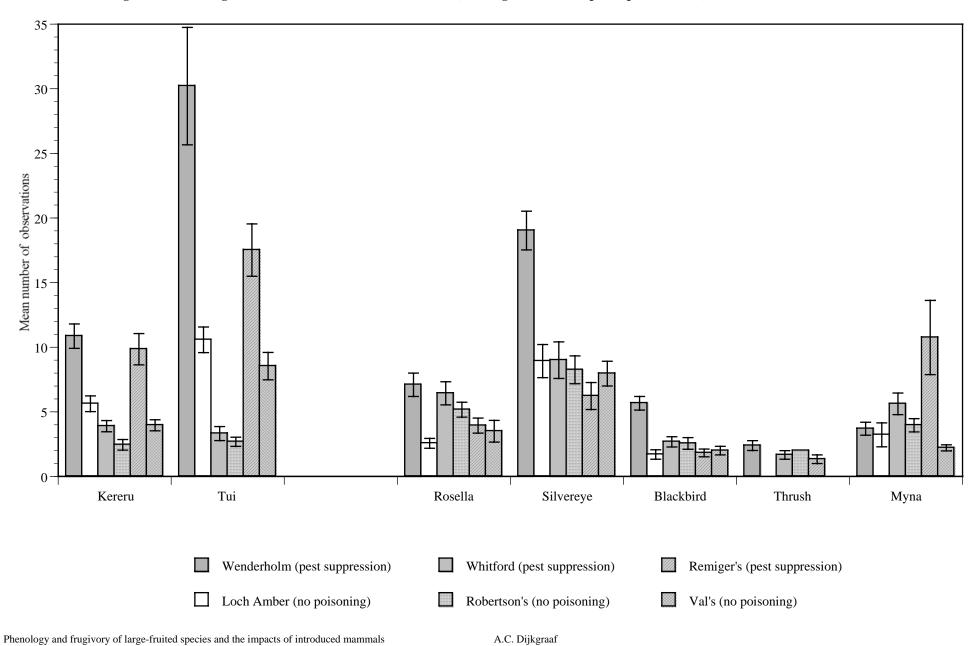


Figure 7.33: Average number of observations (seen or heard) of frugivorous bird species per site visit (error bars are 95% standard error)



16

14

12

Mean number of observations 9 8 01

4

Harrier

Figure 7.34: Average number of observations (seen or heard) of non-frugivorous bird species per site visit (error bars are 95% standard error)

Pukeko

Kingfisher

Wenderholm (pest suppression)

Loch Amber (no poisoning)

Fantail

Warbler

Whitford (pest suppression)

Robertson's (no poisoning)

Pheasant

Magpie

Finches

Remiger's (pest suppression)

Val's (no poisoning)

Swallow

Skylark

Figure 7.35: Number of frugivorous birds at Wenderholm and Loch Amber, grouped by flock size

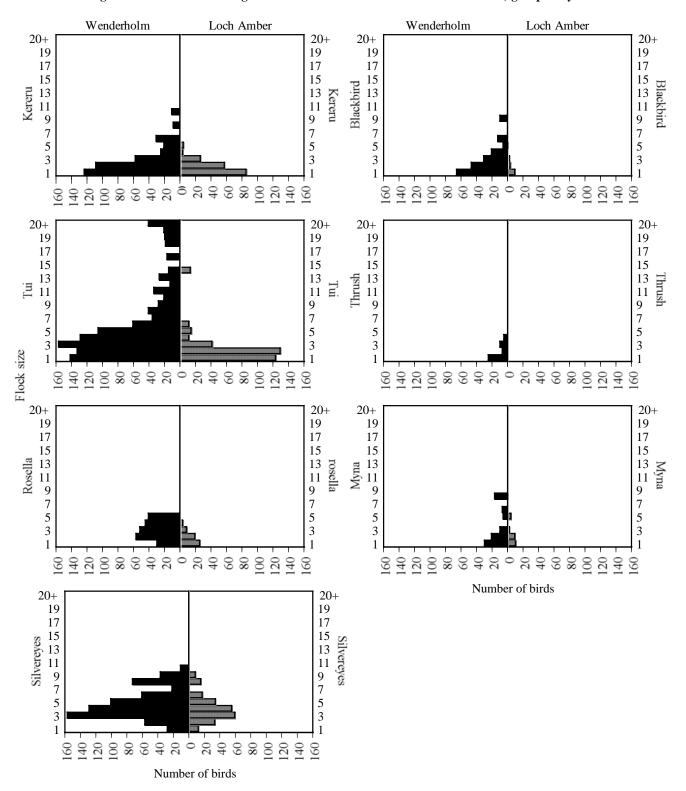


Figure 7.36: Number of frugivorous birds at Whitford and Robertson's, grouped by flock size

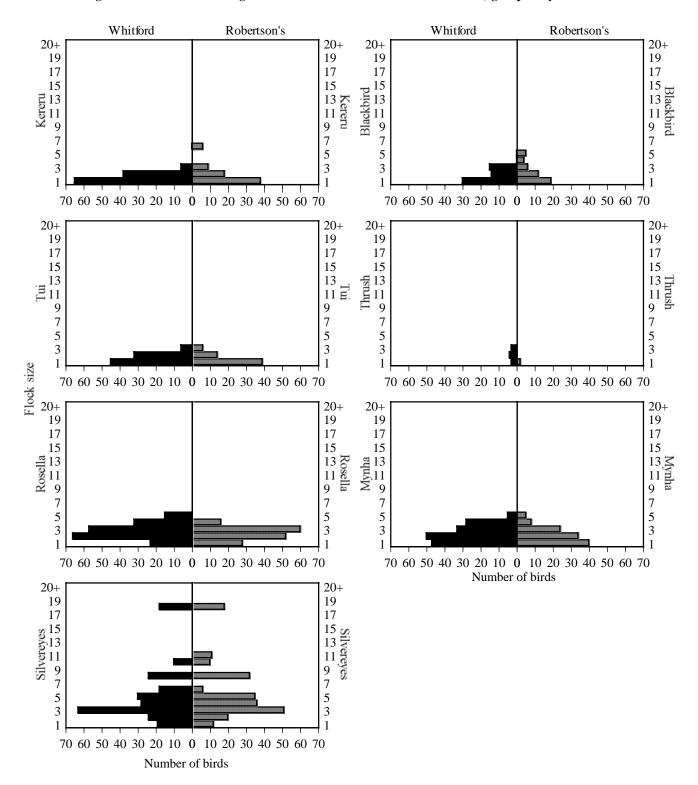


Figure 7.37: Number of frugivorous birds at Remiger's and Val's, grouped by flock size

