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Rapid assessment of pollination & dispersal service in *Fuchsia*

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Acknowledgements

- Thanks to Brian Karl, Merilyn Merrett, Paul Peterson for help with field work
- The 2007 participants in the pollination survey
- FRST/PGSF for funding under SARB OBI

Useful Ecological Indicators

1. must produce results that are clearly **understood** and accepted by scientists, policy makers, and the public
2. any **statistical limitations** of the indicator's performance should be **documented**
3. A range of values should be established that **defines ecological condition** as acceptable, marginal, and unacceptable
4. should be **relevant** for specific management decisions and public acceptability

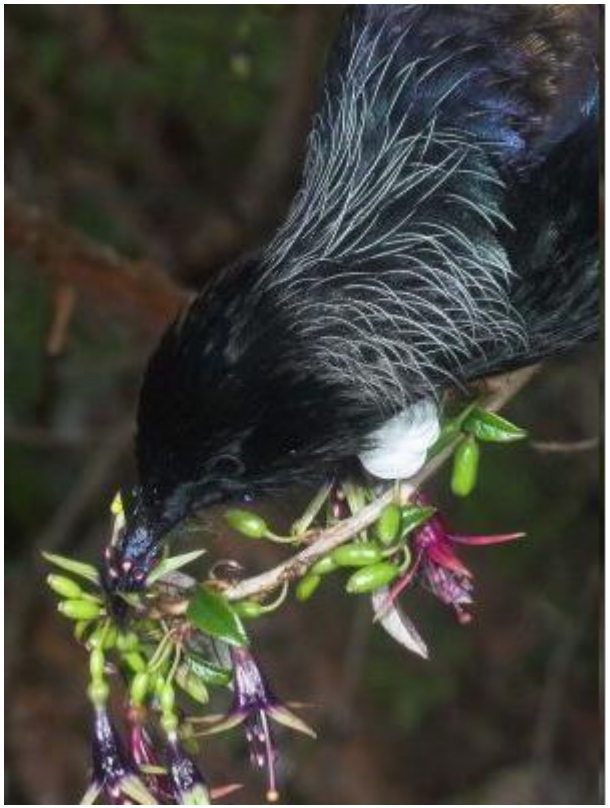
Jackson, L.F., Kurtz, J.C., & Fisher, W.S. (2000). Evaluation guidelines for ecological indicators, Rep. No. EPA/620/R-99/005. U.S. Environmental Protection Agency, Triangle Park, NC. http://www.epa.gov/emap/html/pubs/docs/resdocs/ecol_ind.pdf

Feasible and Practical

- Needs to be quick and easy
- Repeatable and easily taught
- Note prone to significant sampling error
- Examples Used in NZ
  - Foliage Browse Index (FBI) or Foliage Canopy Index (FCI)
  - Macroinvertebrate Index (MCI)
  - Trap Catch Index (TCI)
- We propose two new Indices – the FPI & FDI – pollen on the stigma, ripe to unripe fruit ratios


Fuchsia excorticata
Pollination Service by Native Birds - FPI
Fruit Dispersal - FDI

Pollination



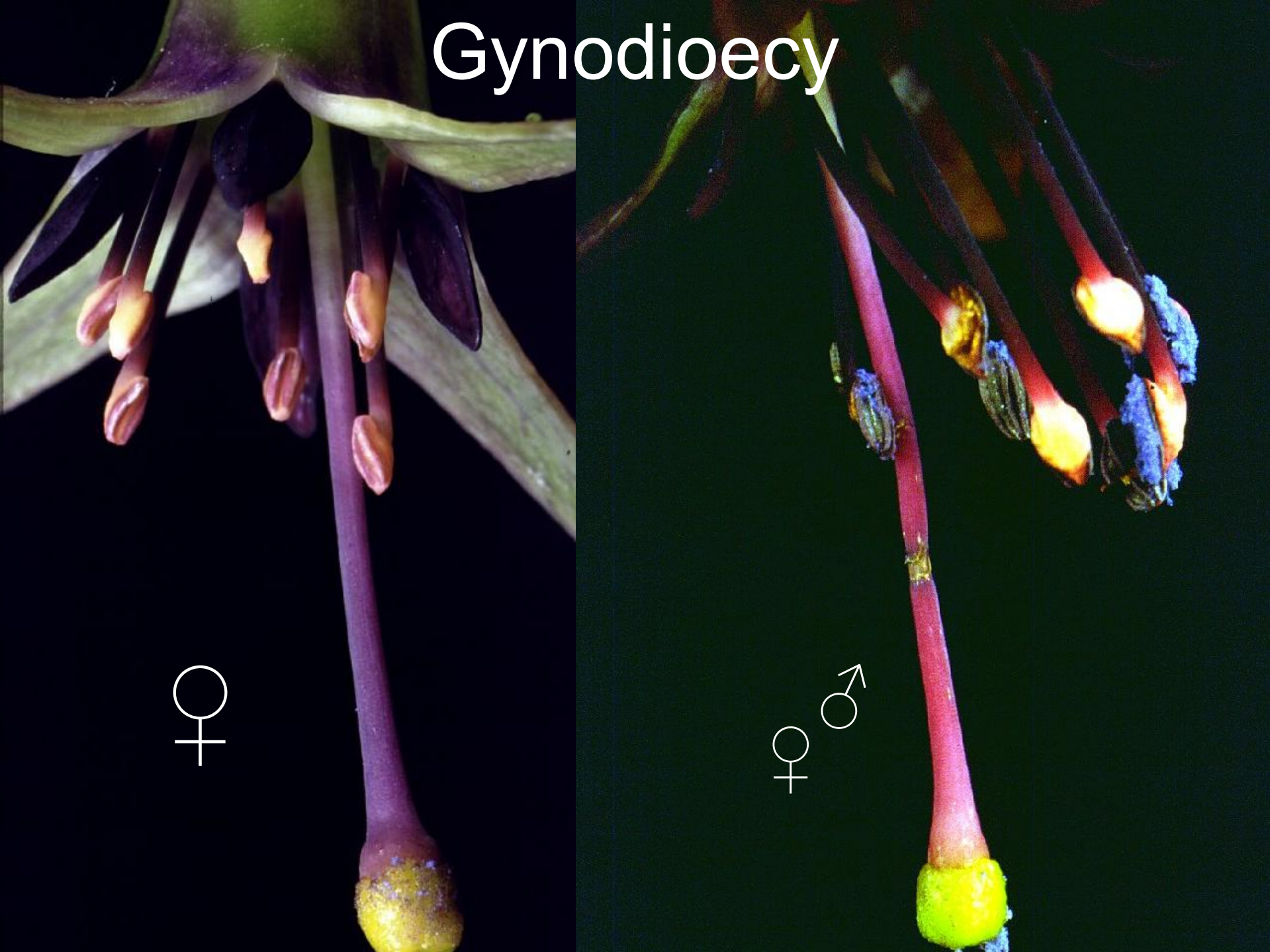
http://www.ngamanuimages.org.nz

Fuchsia Pollination

- Gynodioecious (females and hermaphrodite plants)
- Herkogamy varies in hermaphrodite plants (separation of anthers and stigma)
- Self compatible
- Pollinated by bellbirds and tui; often robbed by silvereyes
- Blue pollen visible on yellow stigma

Robertson, A.W., Ladley, J.J., Kelly, D., McNutt, K.L., Peterson, P.G., Merrett, M.F., & Karl, B.J. (2008) Assessing pollination and dispersal in *Fuchsia excorticata* (Onagraceae). *New Zealand Journal of Botany* **46**, 299-314.

Gynodioecy



Smaller flowers
No pollen – must outcross
Offspring 50:50 F:H

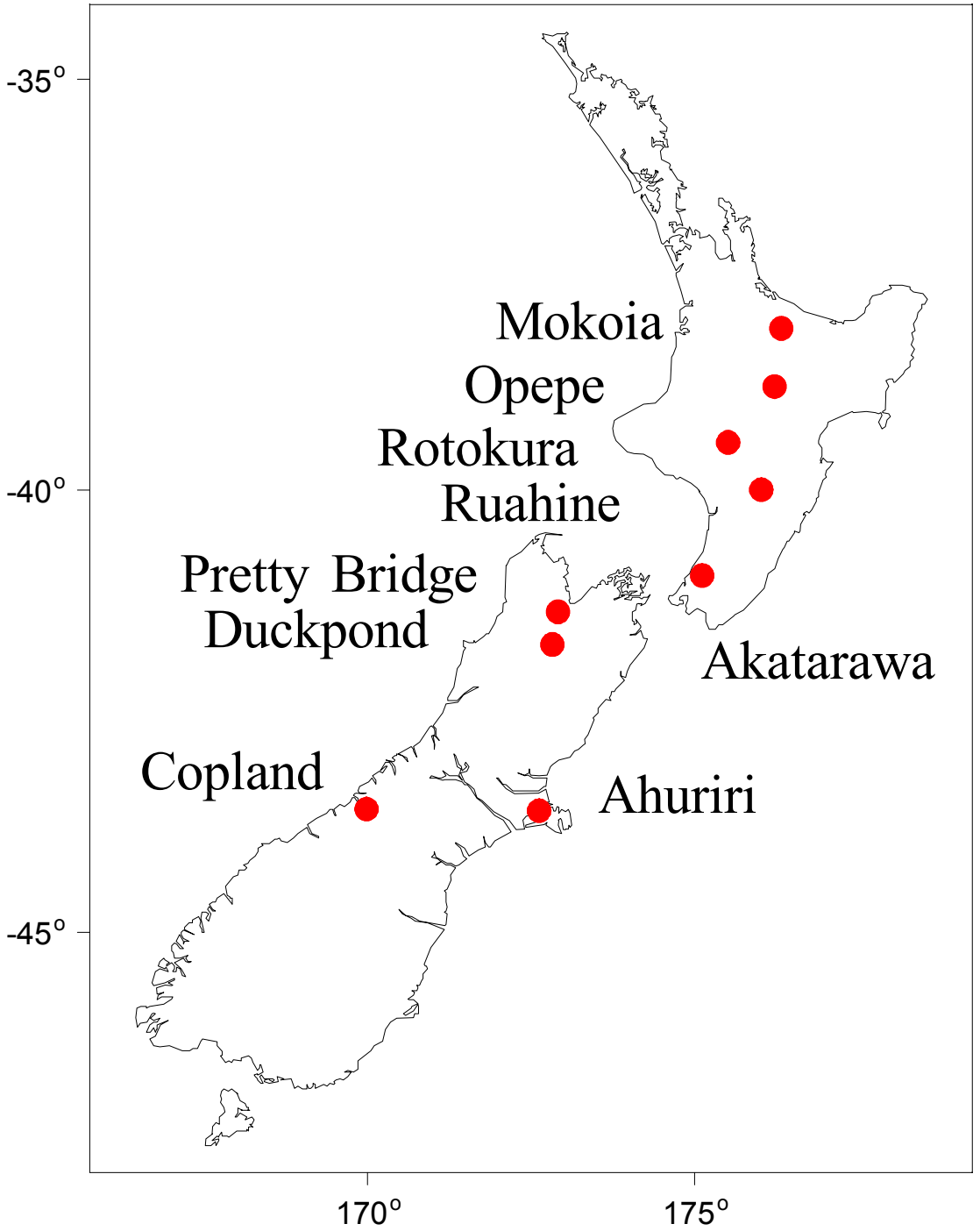
Larger flowers
Make pollen – can self
Offspring all hermaphrodites

So sex ratio in theory should range from 0 to 50% female, in the field 14 to 42% (average 29.5%)

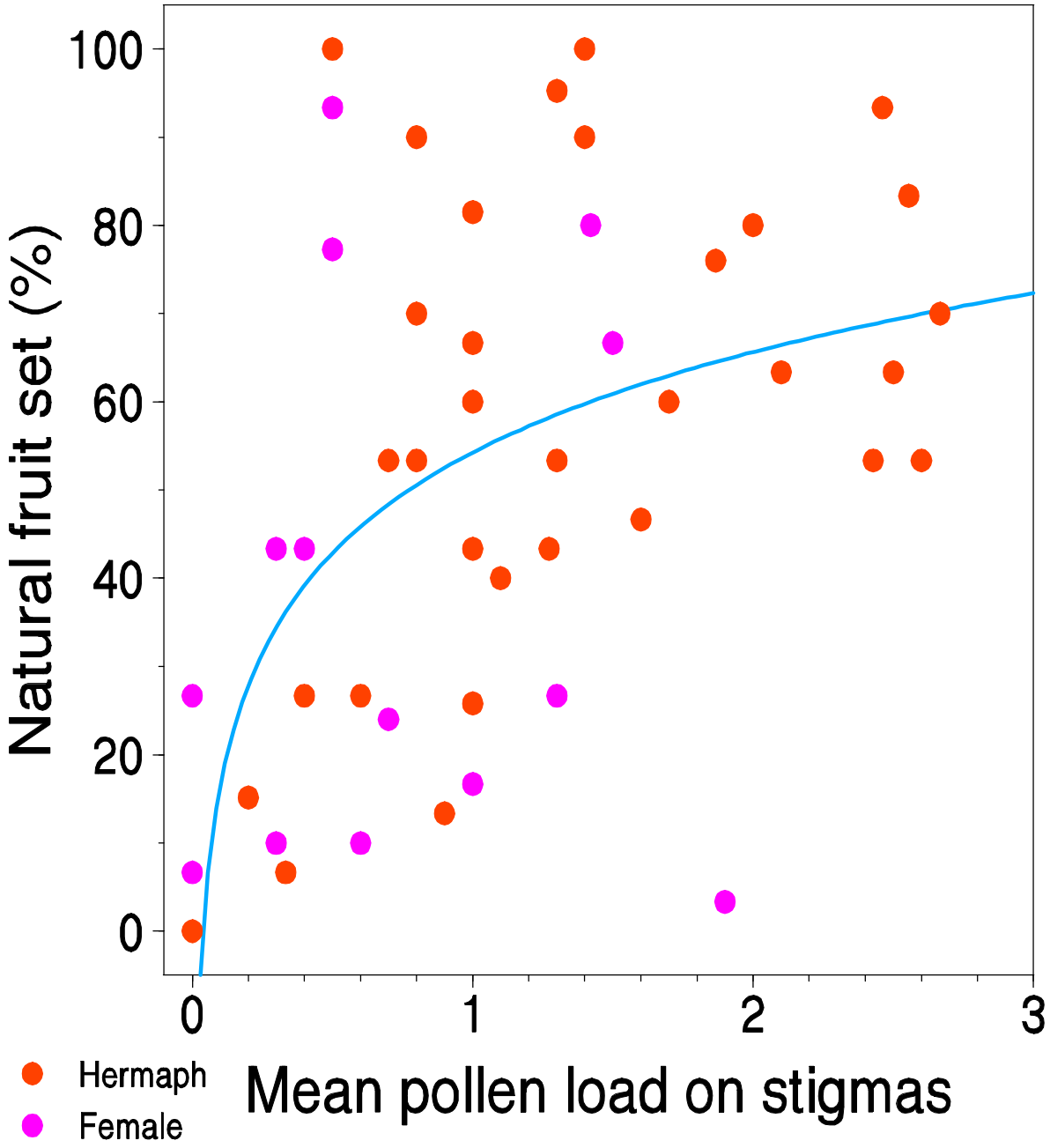
Herkogamy affects selfing

- Hermaphrodite flowers vary in the gap between anthers and stigma
- Flowers with larger gap are less likely to self in absence of pollinators

- Sites through North and South Islands

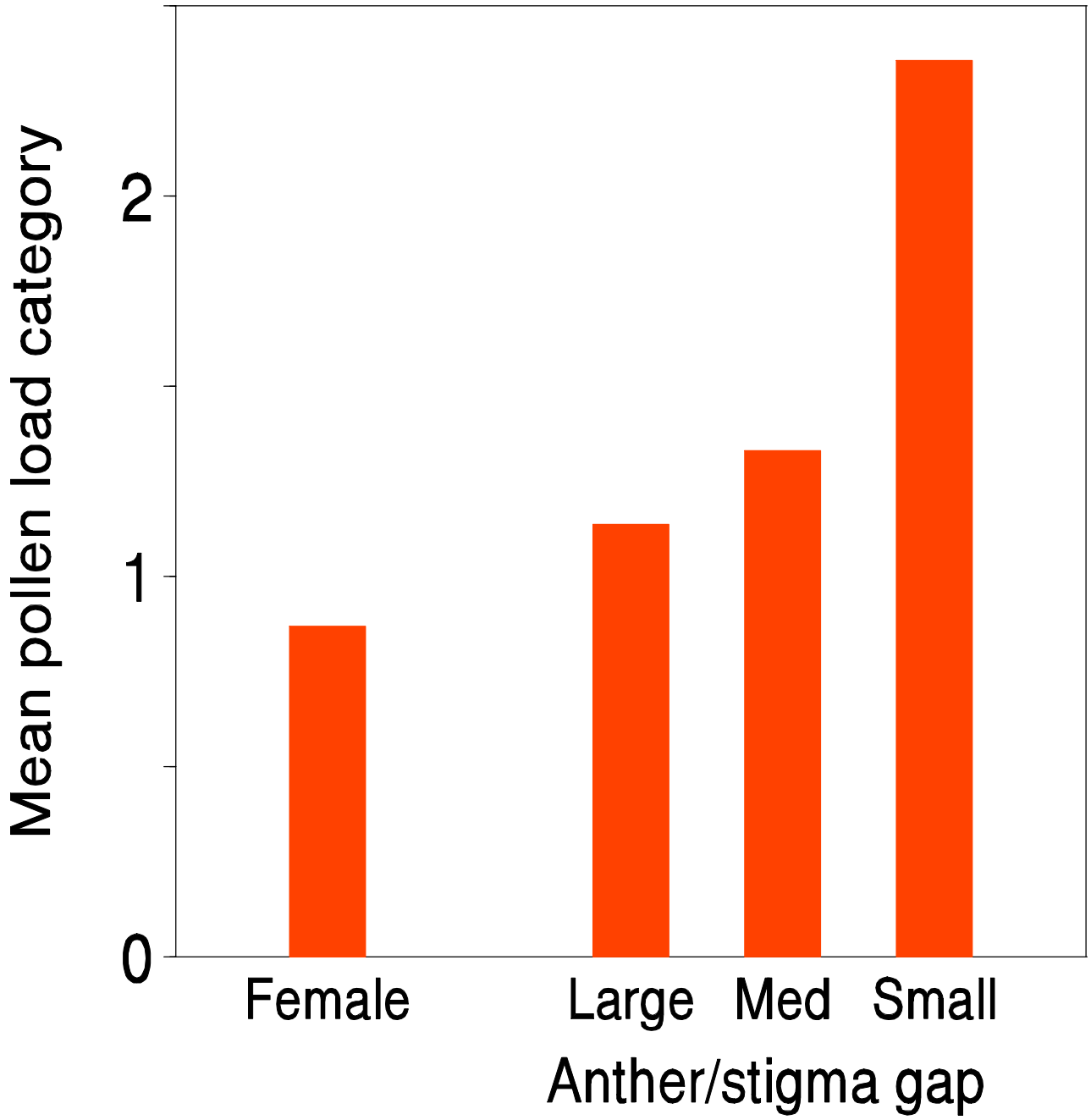


Mean pollen load is related to natural fruit set per plant (p=0.0097)



Pollen load is higher when anthers are closer to stigma

F = 15.6
p < 0.001

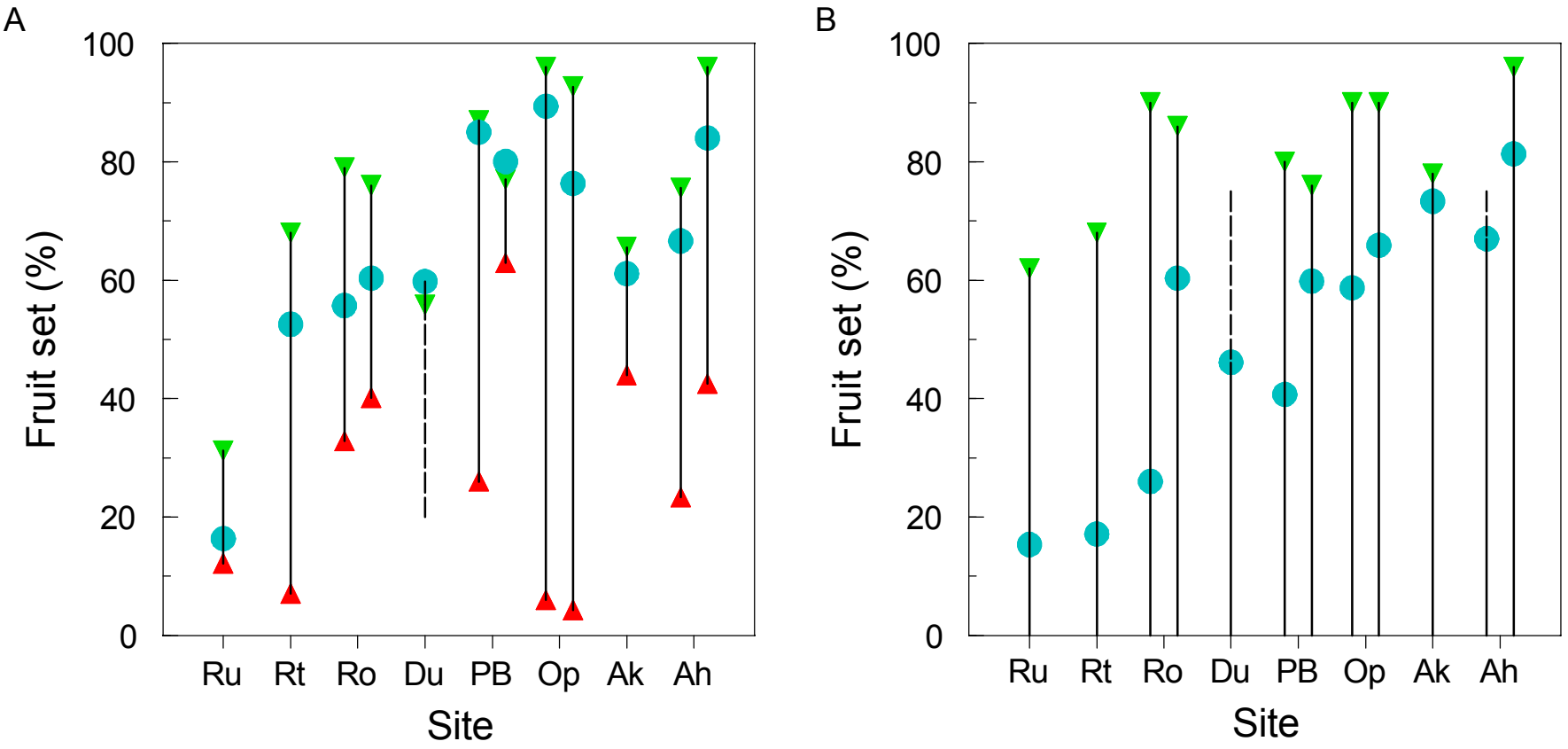


Measuring pollen limitation (seed quantity) in *Fuchsia*

- On plants (both sexes) measure fruit set on hand, natural and bagged flowers
- Calculate PLI
- Done at 8 mainland sites over several seasons

Hermaphrodites

Females



- Pollen limitation varied between sites, and was stronger in females
- Mean Pollen Limitation Index (PLI) was 0.17 for hermaphrodites, 0.40 for females

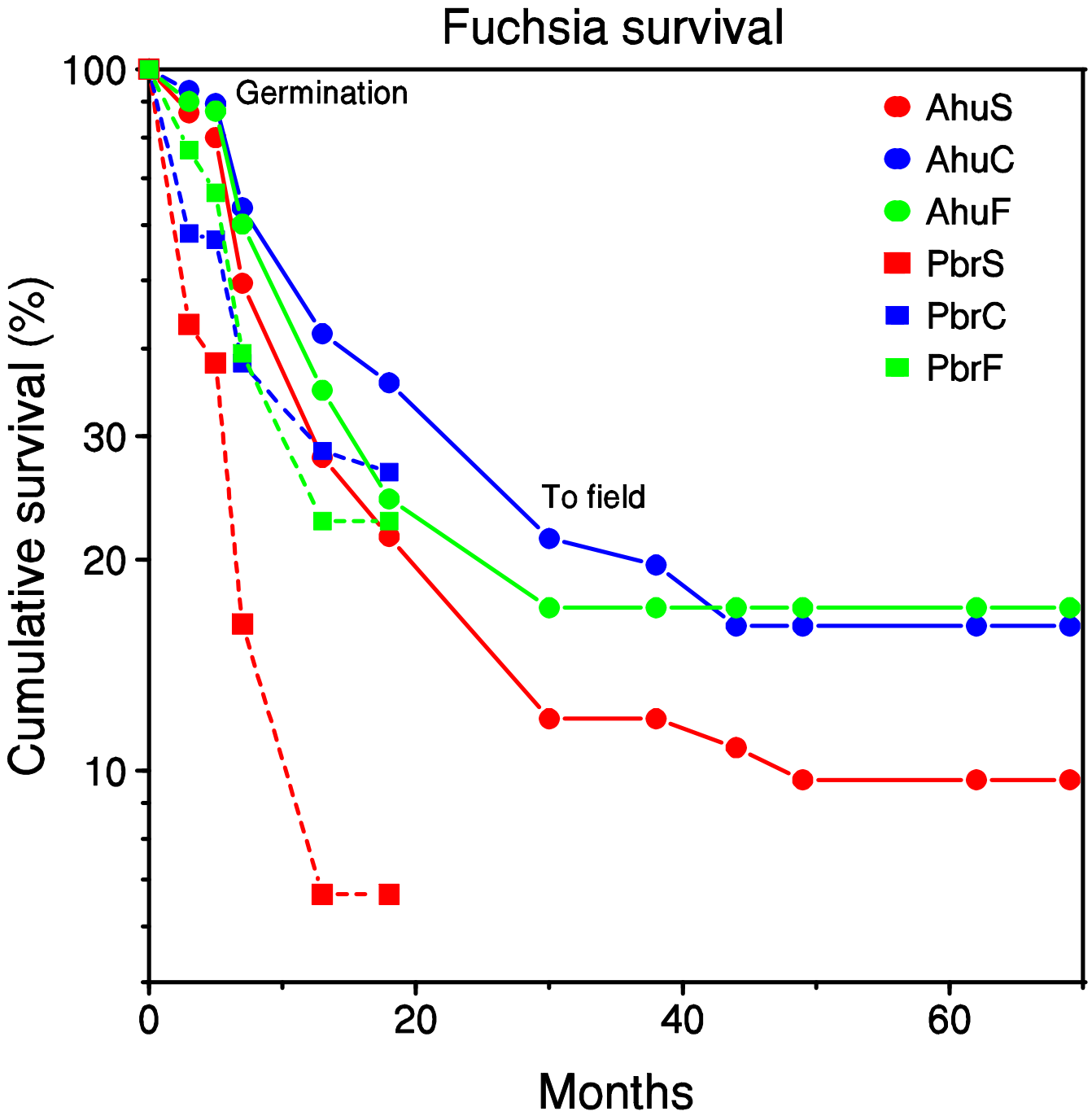
Summary: Fuchsia pollination

- At some mainland sites fruit set is pollen limited, especially on females
- While hermaphrodites suffer less reduction in seed quantity, they are likely to experience an increase in selfing if pollinator density is low
- Hence, important to know if selfed seeds are lower quality

Measuring inbreeding depression (seed quality)

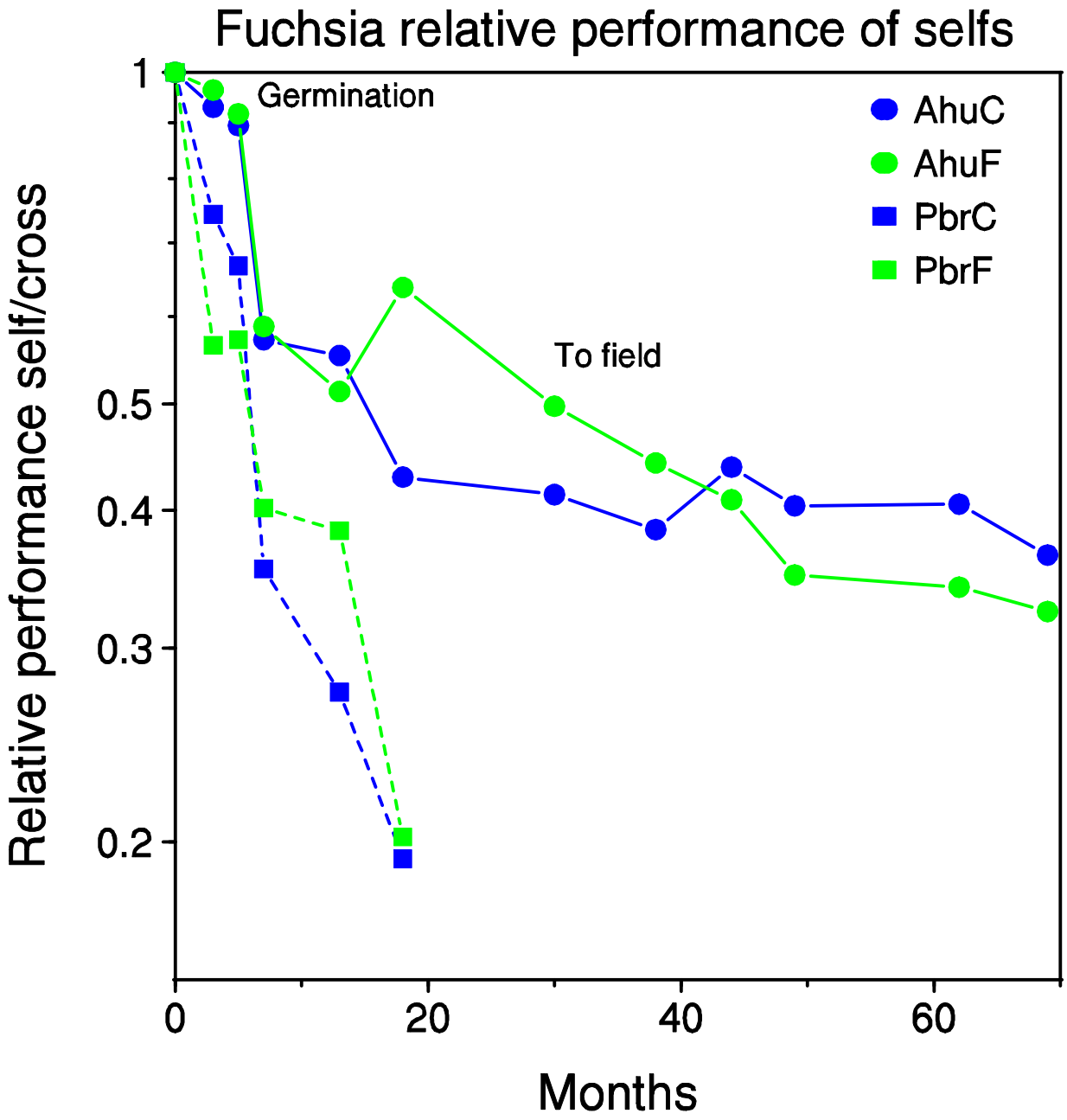
- Hand-pollinated flowers (crossed or selfed)
- Two sites (Canterbury, Nelson)
- Followed for 6 years
  - fruit set
  - germination
  - potted in glasshouse
  - planted into field

Selfs survived worse than both kinds of crosses (on females and hermaphrodites), at both sites



Selfed offspring were <40% as fit as crossed offspring (maintain females)

Very strong inbreeding depression at Pretty Bridge, more modest at Ahuriri



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Mitosis, stature and evolution of plant mating systems: low-Φ and high-Φ plants

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[3]*20224 Southwest 86th Court, Miami, FL 33189, USA*

- Scofield & Schultz 2006: in long lived plants, more mutations per generation, so inbreeding depression so severe that selfed offspring never survive to reproduce - may be futile

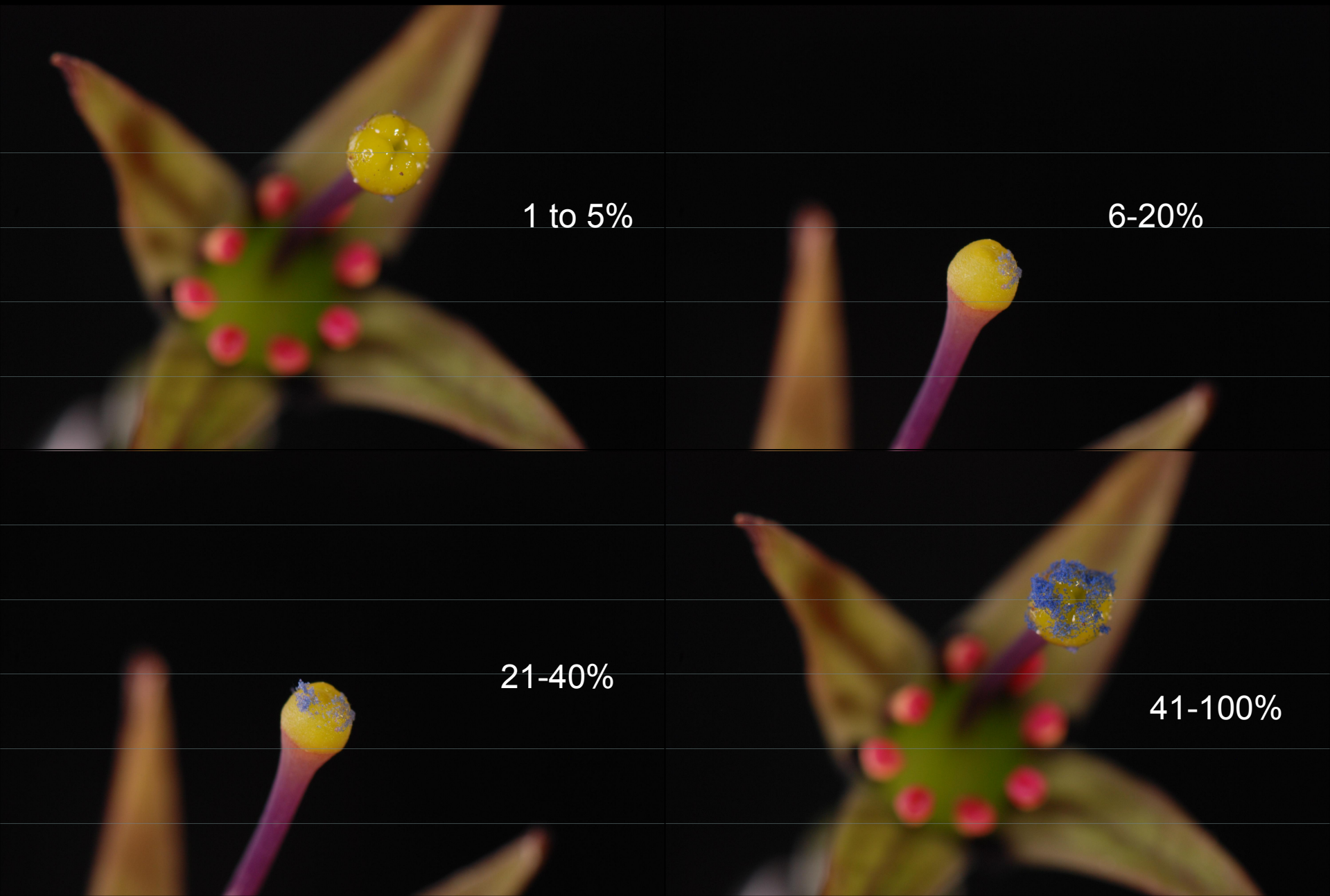
Consequences for *Fuchsia* of reduced densities of bird pollinators

- reduces seed set, especially on females
- this reduces the % of females in the population - could be lost
- could select for lower herkogamy in hermaphrodites
- hence, change in pollination may **change breeding system**
- also, high inbreeding depression suggests that the selfed offspring may be doomed - so **seeing seedlings is no guarantee of effective regeneration**

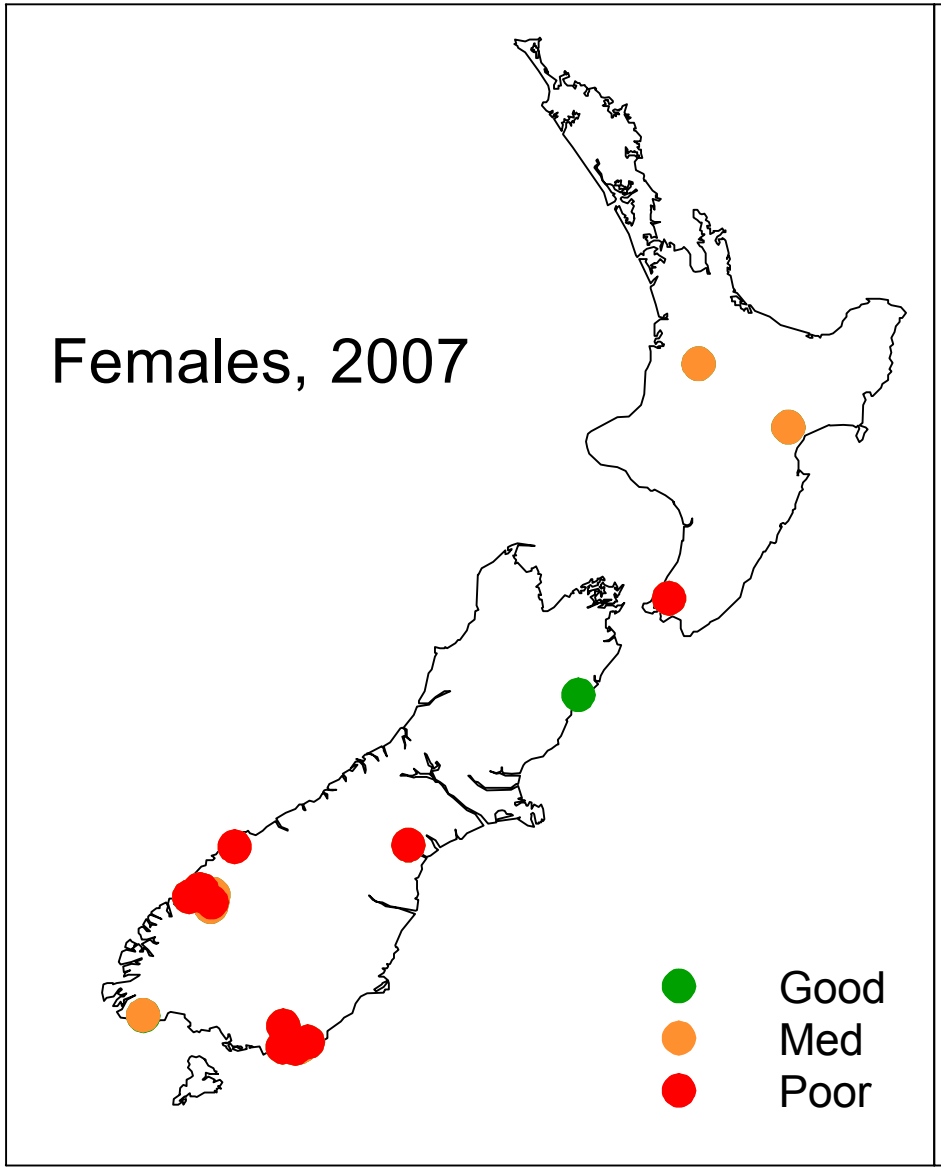
National pollination survey

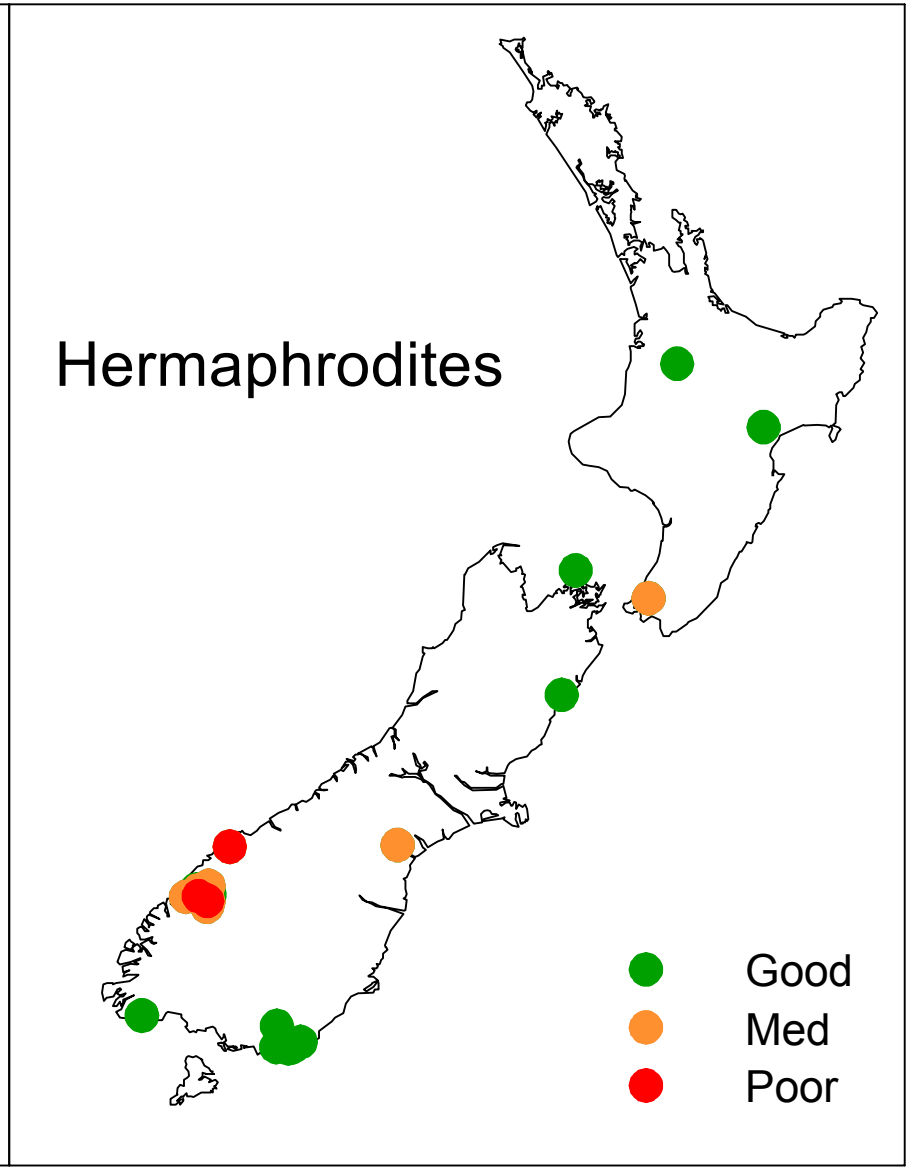
- Use visual scoring of blue *Fuchsia* pollen on the yellow stigma at a single visit to a site
- This gives good indication of pollinator service and fruit set
- Useful bio-indicator of mutualisms
- Started in spring 2007 and being repeated in 2008 - you can help!

Scoring Stigma Pollen Loads



2007 results: females suffering





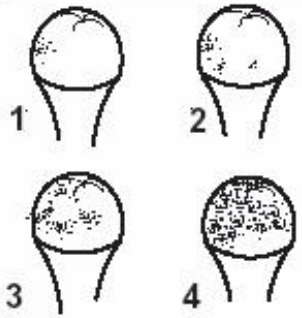
see www.biol.canterbury.ac.nz
and click on Quicklink on right side

National Pollination Survey

Fuchsia pollen load record sheet

Remember to use youngish flowers; they should be green to greenish/red in colour.

Site: .....
Longitude (Easting): .....
Latitude (Northing): .....
Altitude (optional): .....m asl
Date: .....
Recorder: .....
Hand lens used: .....yes .....no



Classes for the scoring the amount of blue pollen covering the stigma

0	= 0%	No pollen on the stigma
1	=1-5%	Only a few specks of pollen can be seen on the stigma
2	= 6-20%	Up to a fifth of the stigma is covered in pollen
3	= 21-40%	About a quarter, but under a half of the stigma is covered in pollen
4	= 41-100%	Lots of the stigma is covered in pollen

Hermaphrodite Plants. Flowers will have anthers covered in bright blue pollen

	Scores for amount of pollen on the stigma									
Plant	Flower 1	Flower 2	Flower 3	Flower 4	Flower 5	Flower 6	Flower 7	Flower 8	Flower 9	Flower 10
1										
2										

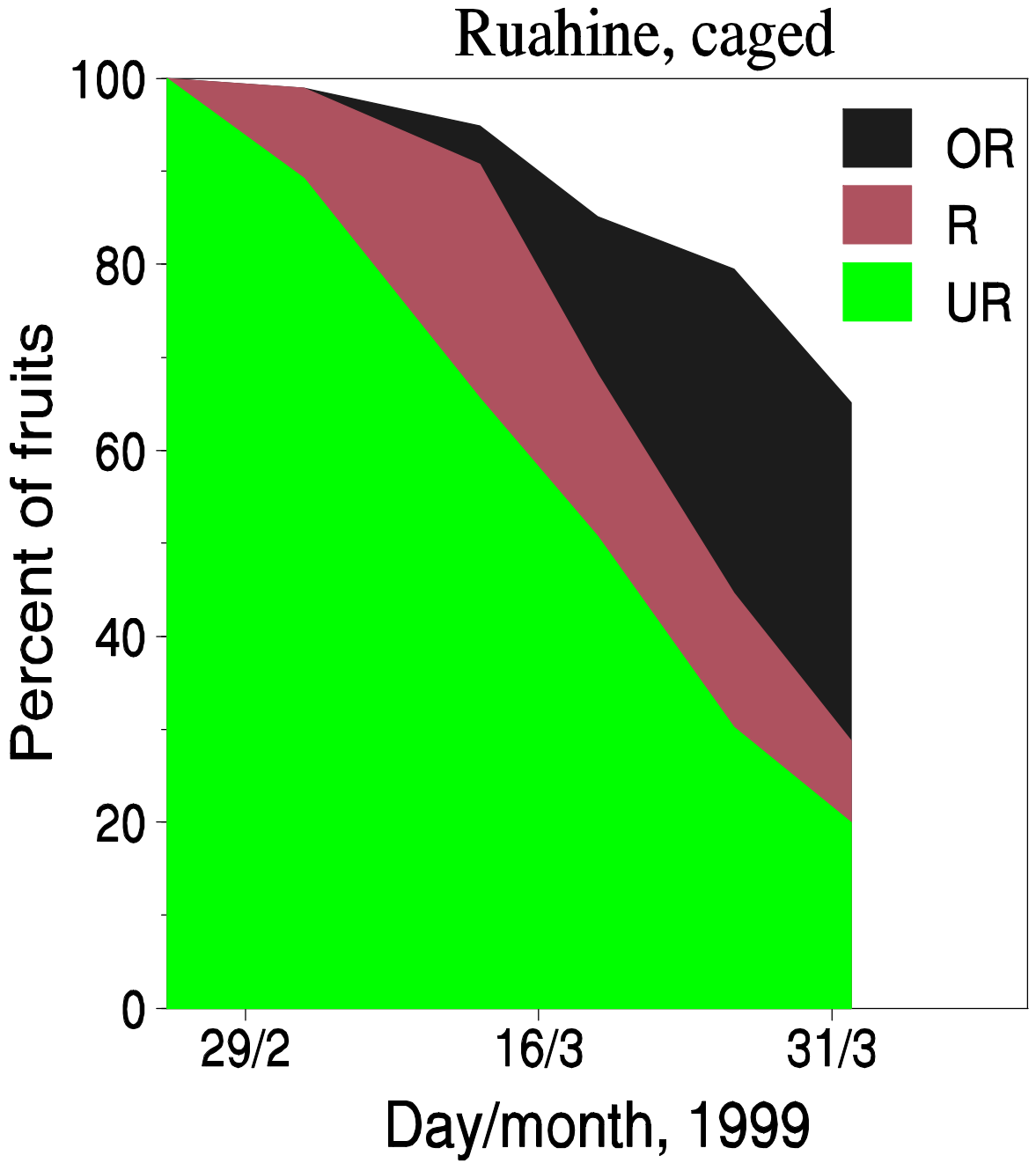
Dispersal

http://www.ngamanuimages.org.nz

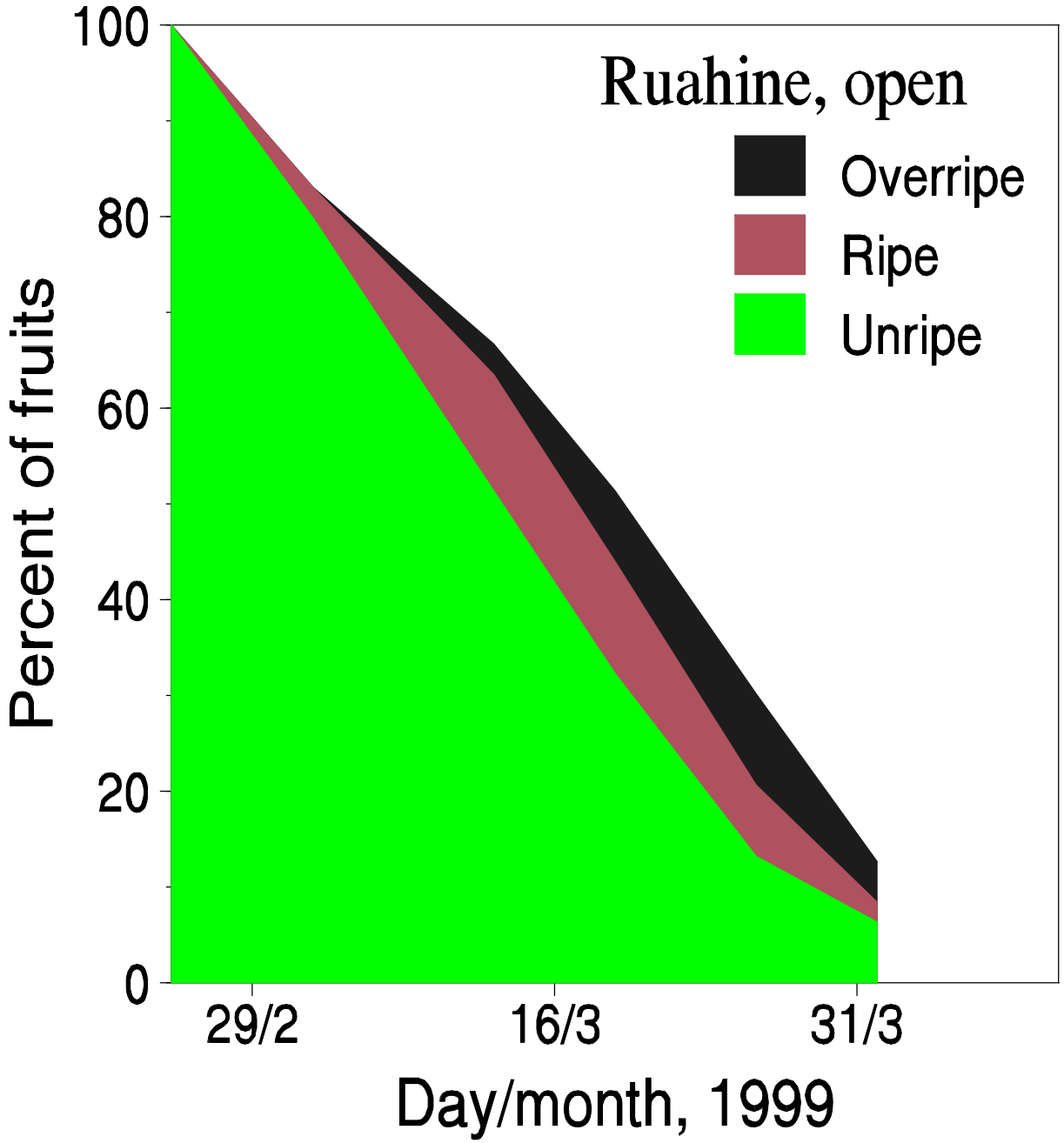
Fates of fruits followed, inside and outside cages

Scoring Fruits

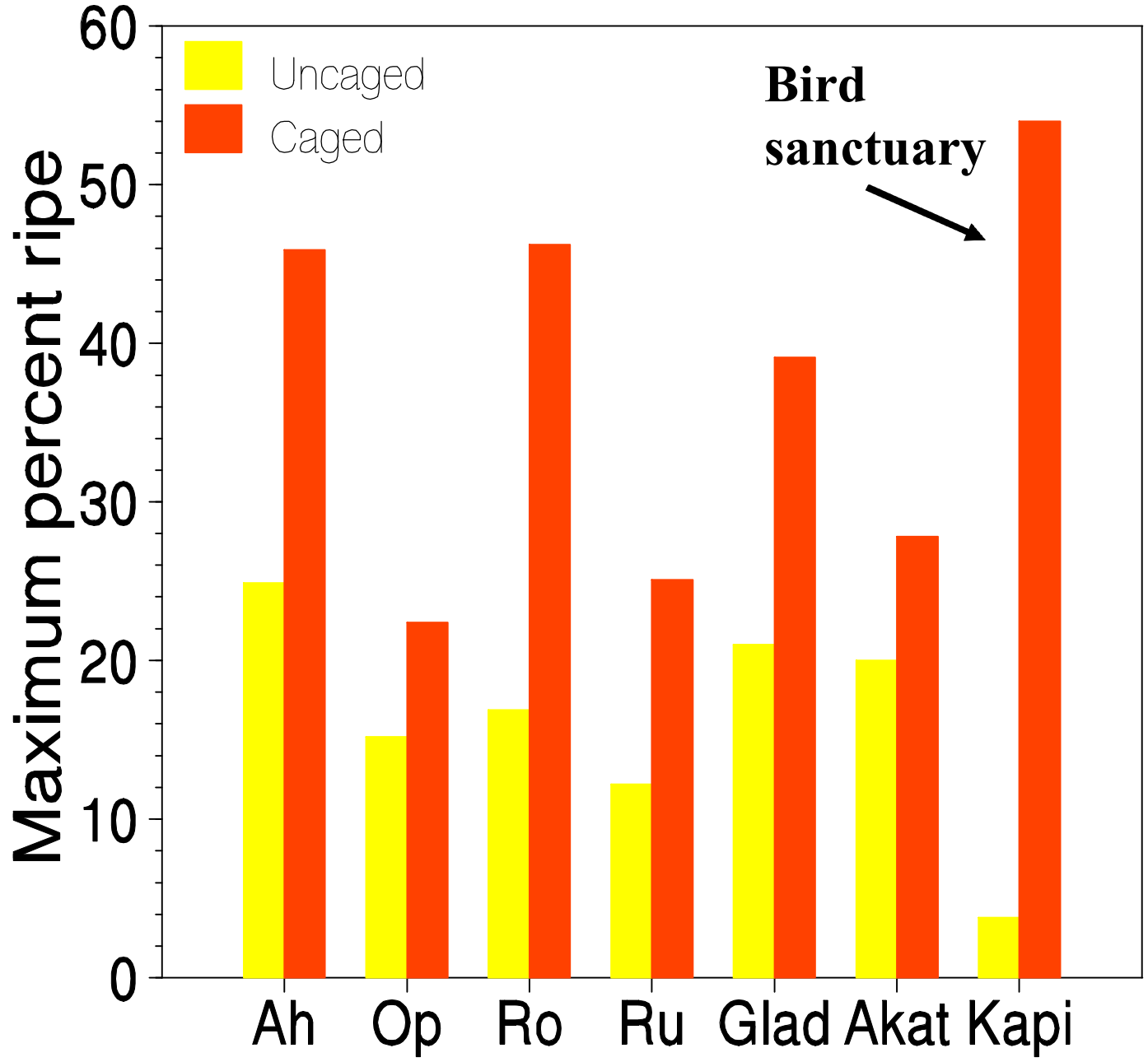
Fuchsia excorticata fruit ripening in cages



Fuchsia
not caged:
ripe fruits
did not
build up
on plants



Mainland dispersal rates were slower than on an island bird sanctuary
(Kate McNutt)



Dispersal Index

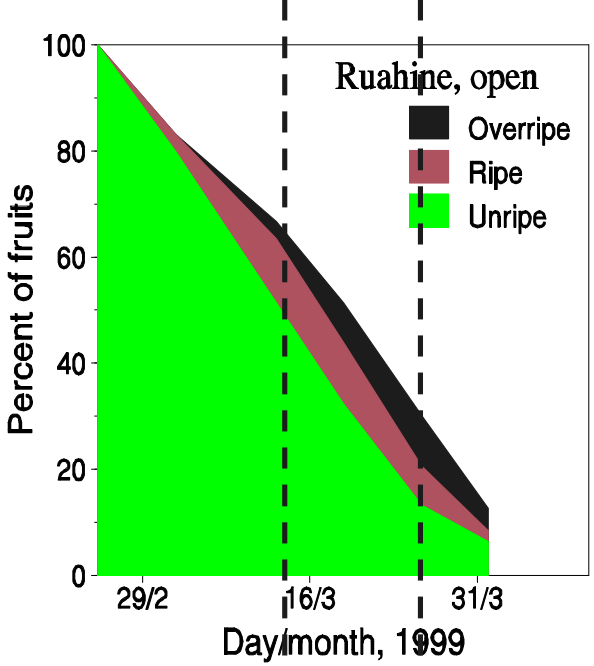
$$\frac{\text{unripe fruit}}{\text{(ripe \& overripe)}} \%$$

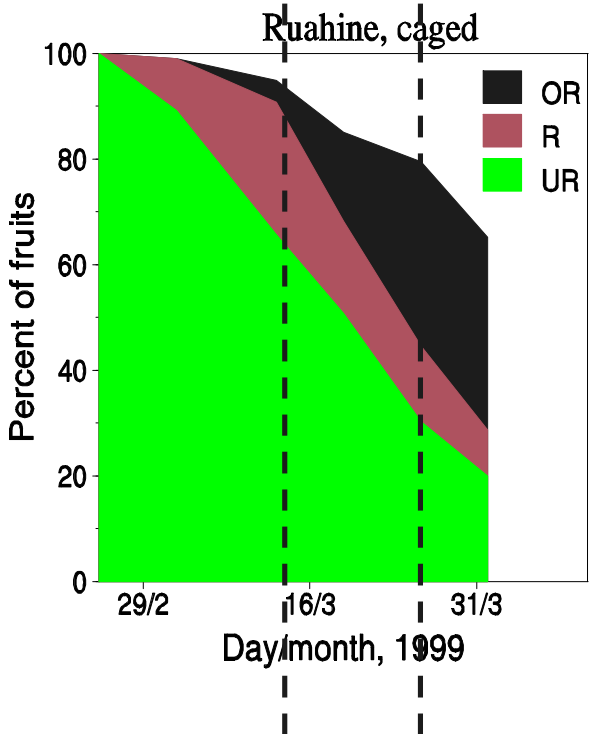
- Scored in middle of fruiting season on uncaged plants
- Fruits must have started to be taken or become overripe and green fruits must still be present
- No need to tag individual fruits

<40% unripe – poor dispersal

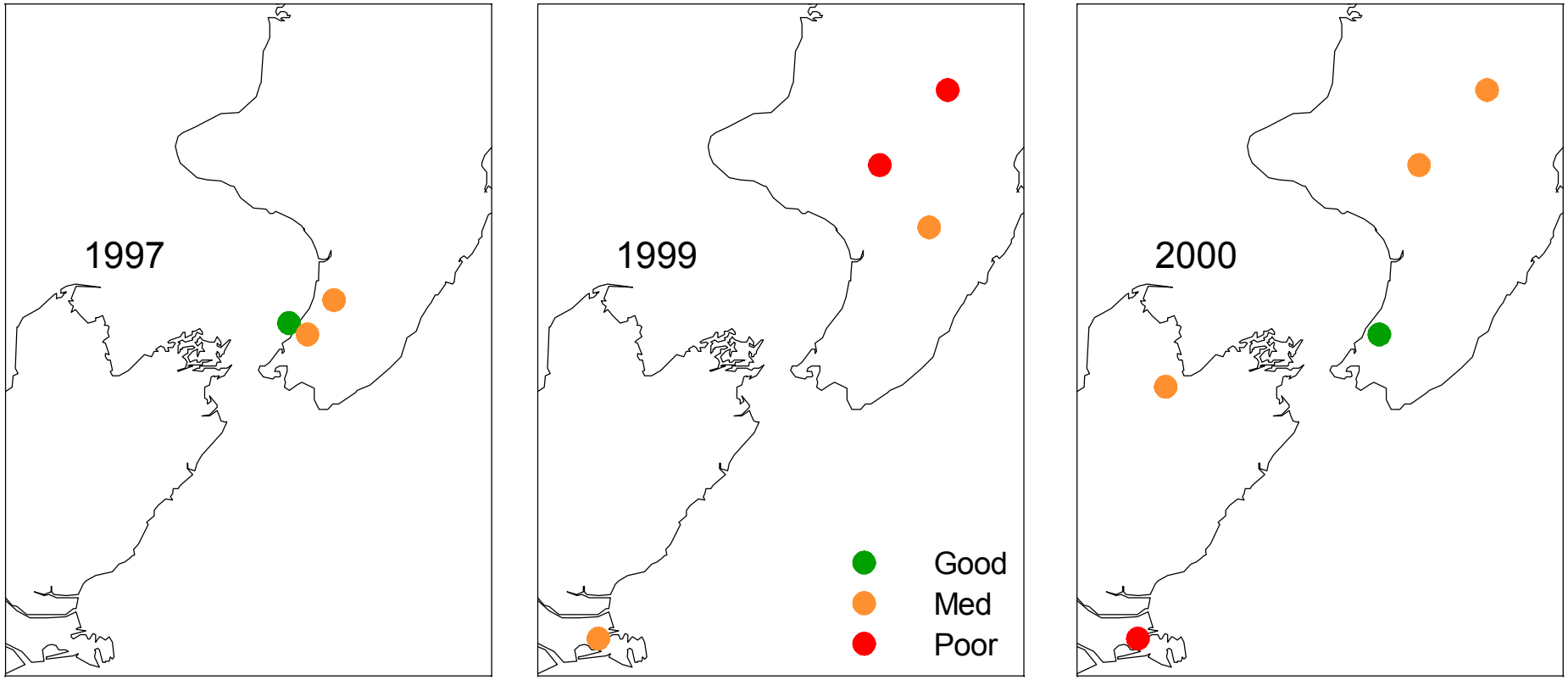
60-90% unripe – medium dispersal

90-100% unripe – good dispersal





Dispersal Index



- Mainland sites mostly score medium to poor
- Scores vary with year

Conclusions

- Both indices show that bird-plant mutualisms are not healthy over much of the mainland
- Apparently high hermaphrodite fruit set and abundant seedlings may mask an underlying inbreeding problem
- Only when female fruit set is high is pollination rate satisfactory
- It should be rare to see ripe fruits, very rare to see over-ripe fruits
- Herbivory from possums may be a more significant factor in the short-term