



# Biology and management of *Polygala myrtifolia*

Robin Adair  
Australis Biological  
Latrobe University, Botany Department

Australis Biological

vegetation | invasive species | management strategies | restoration

[www.australisbiological.com.au](http://www.australisbiological.com.au)

# Background



- Australis Biological
- Weed Sciences – Research Leader
- *Polygala* – 1996
- IX International Sym on Biocontrol of Weeds
- 1998 - *Chrysanthemoides*
- 1999-2004 – *Acacia*, Victorian Coastal Council - \$5000
- 2009-2012 – City Greater Geelong



# Building an understanding of Polygala

Essential for effective management

Strengths and weaknesses

Focus on weaknesses - control

Understand the strengths – resilience

Build effective control options

Biology, ecology (native and non-native), control options, integrated control

# Taxonomy

## *Polygala myrtifolia*

- *Polygala* is Greek meaning 'much' 'milk'
  - reputedly promotes secretion of milk by stock
- *myrtifolia* similarity to myrtle leaves
- *Polygalaceae* - 13 genera , 830 species
- (related to Tremandraceae, not Fabaceae)



*Bredemeyera* (6)



*Salomonina* (1)



*Comesperma volubile* (24)

# *Polygalaceae*



- *Polygala* is the largest genus – 300-725 species
- cosmopolitan (except NZ, Polynesia, Antarctica)
- centres of diversity – South Africa, Americas
- South Africa/Madagascar – 230 spp
- Australia – 44 native to northern Australia
- annuals
- 5 exotic species
- *P. myrtifolia*, *P. virgata*, *P. vulgaris* (Victoria)
- *P. japonica* (native)





*P. chamaebuxus grandiflora*



*P. senega* (Americas)



*P. vulgaris* - Europe



*P. sanguinea* USA



*P. cruciata* - USA



*P. calcarea* - Britain



*P. pauciflora* - USA



*P. alba* - USA

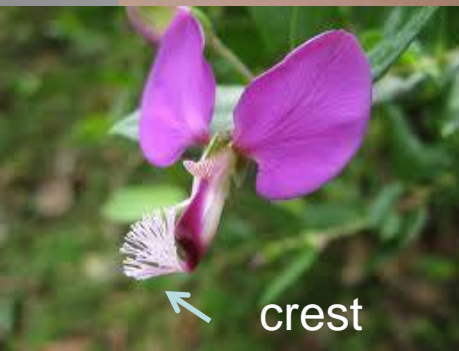
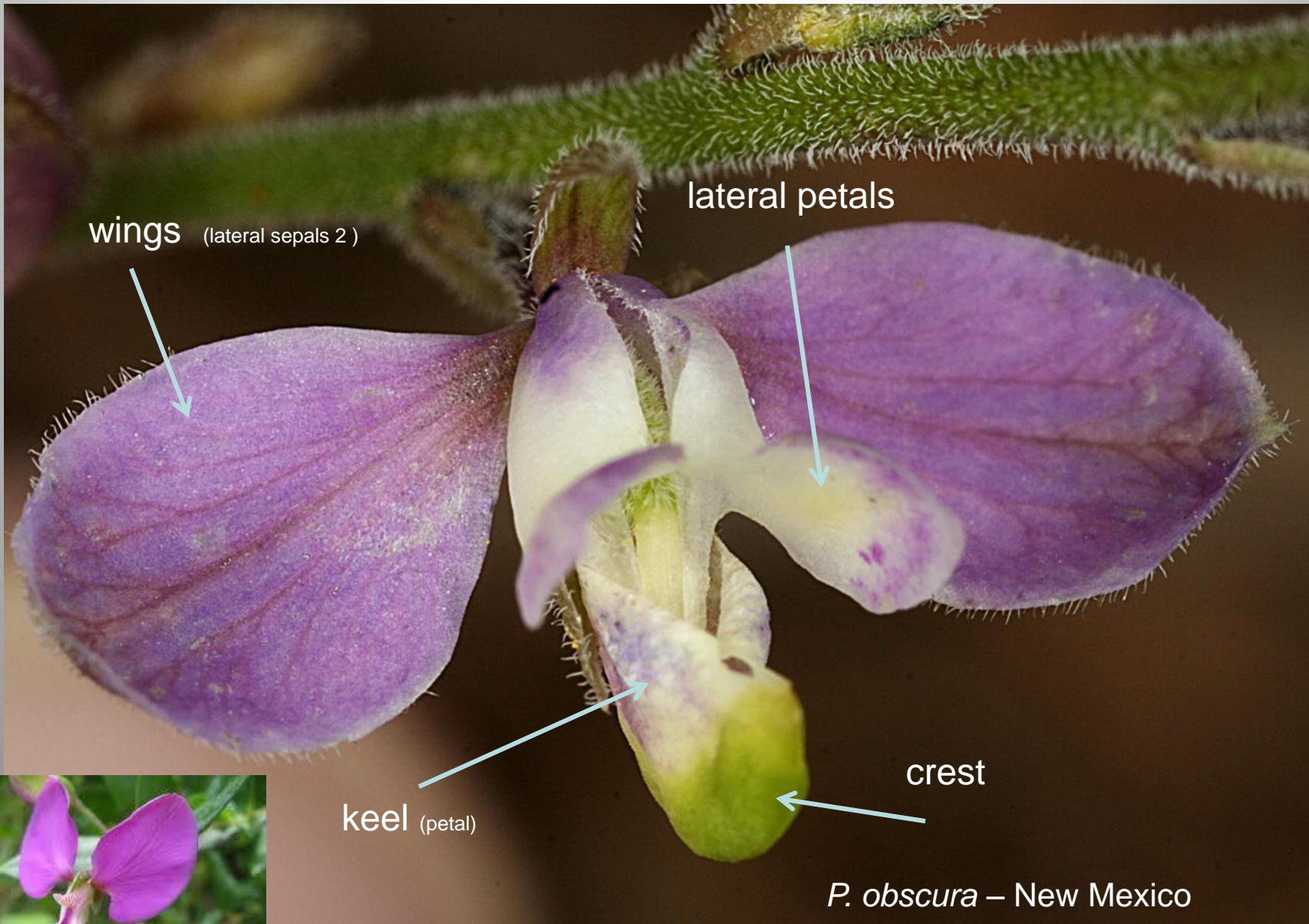




*Polygala japonica*



*P. isingii*



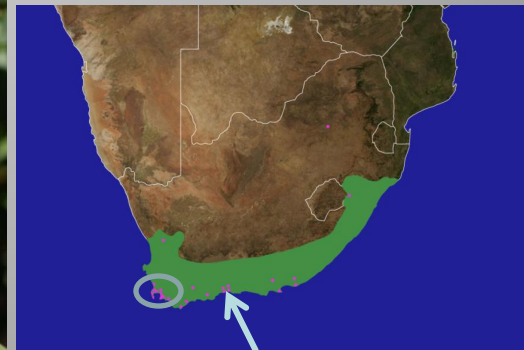




*Polygala virgata*



*P. myrtifolia* var. *myrtifolia*

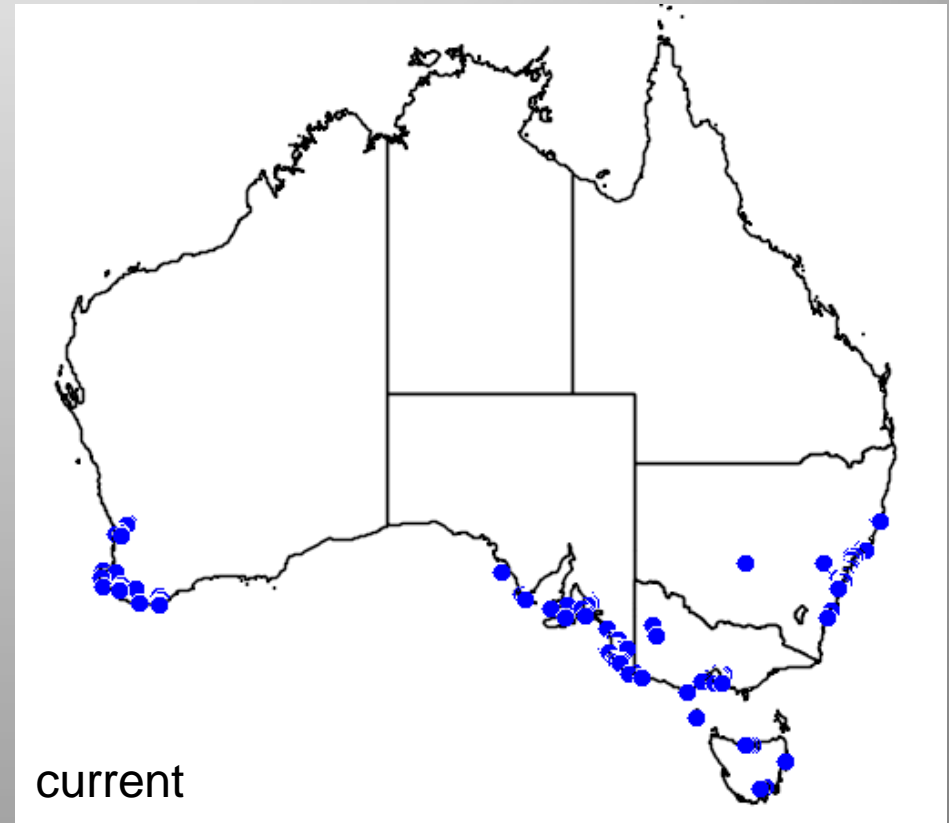
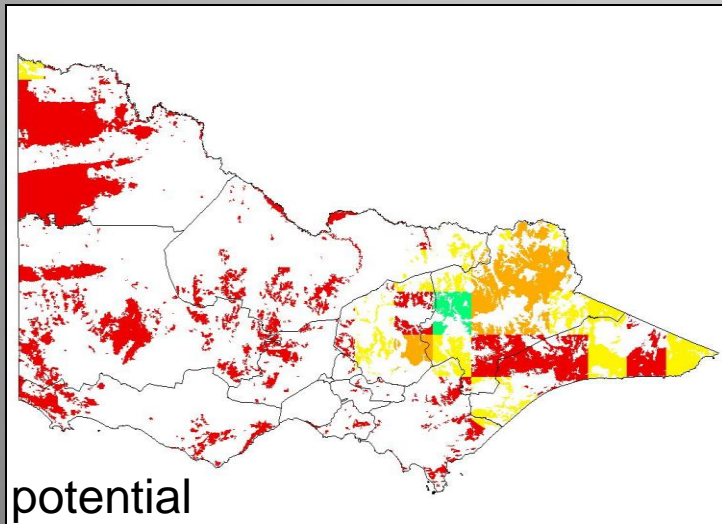


*P. myrtifolia* var. *grandiflora*

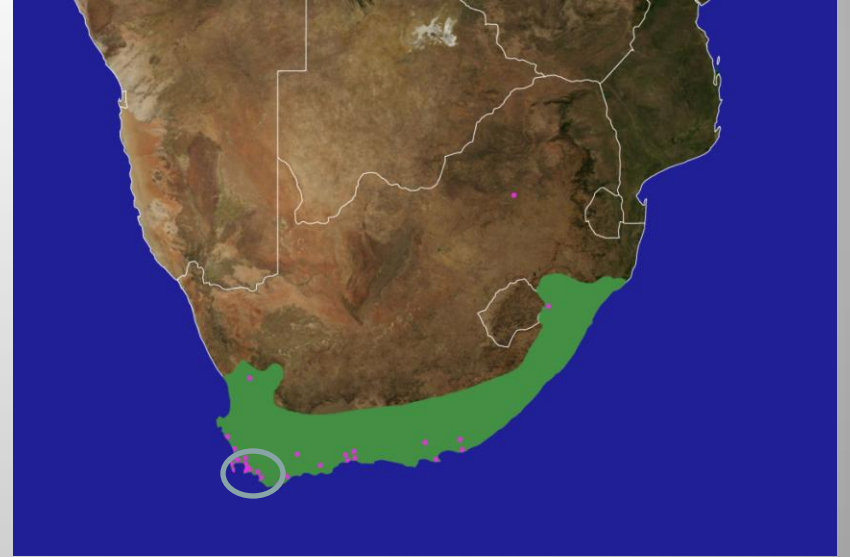


***P. myrtifolia*** – myrtle-leaf milkwort, Bellarine pea, boukappie, septemberbossie

- South African – uncommon in wild, common in horticulture
- high variability in South Africa
- not weedy in South Africa
- very weedy in Australia
- coastal vegetation at risk







*P. myrtifolia* – Betty's Bay



Ocean Grove 2010





# Invasion history

- Earliest record - nursery catalogues in Adelaide, 1845
- First collection – NSW , Hasting River ,1856
- South Australia the first collection, Adelaide, 1920
- Western Australia, Katanning, 1901
- Tasmania, Tarooma, 1946
  
- In Victoria, was introduced to Mt Eliza, 1851
- First herbarium collection - Brighton and Mentone, 1886
- Bellarine Peninsula, the earliest record is Point Lonsdale, 1912
- Mornington Peninsula, naturalization well established by 1943
- Not established until 1950s–1960s
- South-western Victoria, well-established prior to 1976
- Invaded Discovery Bay Coastal Park from a hedge on private land
- Earth moving equipment may have exacerbated spread, particularly along boundary firebreaks
- Spread rapid 1981 and 1990
- A major threat to biodiversity values







# Impacts

- loss of biodiversity - competition and allelopathy (no evidence)
- increased biomass and fire-fuel levels (no evidence)
- reduced accessibility
- no threat to agriculture
- host to Cucumber Mosaic Virus – threat to vegetable and ornamentals

# Impacts



State	Vegetation communities invaded	Species and vegetation communities at risk
Victoria	<p><b>Volcanic Plains Bioregion:</b> Heathy Dry Forest, Heathy Woodland, Coastal Dune Scrub, Coastal Headland Scrub, Coastal Tussock Grassland, Coastal Alkaline Scrub, Lowland Forest</p> <p><b>Otway Plain Bioregion:</b> Coastal Saltmarsh, Grassy Woodlands, Coastal Tussock Grassland, Coastal Dune Scrub and Grassland Mosaic, Bellarine Yellow-Gum Woodland, Limestone Grassy Woodland</p> <p><b>Warrnambool Plain Bioregion:</b> Herb-rich Foothill Forest, Coast Banksia Woodland</p> <p><b>Gippsland Plain Bioregion:</b> Moonah Woodland</p> <p><b>Glenside Plain Bioregion:</b> Heathy Woodland, Damp Sands Herb-rich Woodland</p> <p>Heathy Herb-rich Woodland</p> <p><b>Highlands - Southern Fall Bioregion:</b> Riparian Forest, Dry Forest</p> <p><b>Wimmera:</b> Low Rises Woodland</p>	<p><i>Acacia uncifolia</i>, <i>Adriana quadripartita</i>, <i>Caladenia calcicola</i>, <i>Caladenia insularis</i>, <i>Caladenia colorata</i>, <i>Corybas despectans</i>, <i>Eucalyptus leucoxyloides</i> ssp. <i>bellariensis</i>, <i>Poa poiformis</i> var. <i>ramifer</i>, <i>Prasophyllum litorale</i>, <i>Prasophyllum spicatum</i>, <i>Pterostylis cucullata</i>, <i>Taraxacum cygnorum</i></p> <p><b>Communities:</b> Coastal Moonah woodland, Bellarine Yellow-Gum Woodland, Limestone Grassy Woodland, Wimmera Low Rises Woodland</p>
South Australia	<p><i>Allocasuarina verticillata</i> Woodland, <i>Eucalyptus camaldulensis</i> var. <i>camaldulensis</i> Woodland, <i>Eucalyptus diversifolia</i> ssp. <i>diversifolia</i> Mallee Forest, <i>Eucalyptus diversifolia</i> ssp. <i>diversifolia</i> Mallee Woodland, <i>Eucalyptus fasciculosa</i> (mixed) Woodland, <i>Eucalyptus fasciculosa</i> Woodland, <i>Eucalyptus goniocalyx</i> ssp. <i>goniocalyx</i> (mixed) Woodland, <i>Eucalyptus obliqua</i> (mixed) Woodland, <i>Eucalyptus obliqua</i> Woodland, <i>Leucopogon parviflorus</i> (mixed) Shrubland &gt;1m, <i>Melaleuca brevifolia</i> Shrubland &gt;1m, <i>Melaleuca halmaturorum</i> Shrubland &gt;1m, <i>Melaleuca lanceolata</i> Shrubland &gt;1m, <i>Melaleuca lanceolata</i> Woodland, <i>Olearia axillaris</i> Shrubland &gt;1m</p>	<p><i>Acacia enterocarpa</i>, <i>Acacia pinguifolia</i>, <i>Acacia whibleyana</i>, <i>Acacia rhetinocarpa</i>, <i>Caladenia tensa</i>, <i>Caladenia argocalla</i>, <i>Caladenia behrii</i>, <i>Caladenia colorata</i>, <i>Caladenia richardsiorum</i>, <i>Caladenia rigida</i>, <i>Caladenia formosa</i>, <i>Correa calycina</i> var. <i>calycina</i>, <i>Dodonaea procumbens</i>, <i>Glycine latrobeana</i>, <i>Haloragis eyreana</i>, <i>Ixodia achillaeoides</i> ssp. <i>arenicola</i>, <i>Olearia pannosa</i> ssp. <i>pannosa</i>, <i>Pleuropappus phyllocalymmeus</i>, <i>Pomaderris halmaturina</i> ssp. <i>halmaturina</i>, <i>Prasophyllum frenchii</i>, <i>Prasophyllum pallidum</i>, <i>Prasophyllum pruinosum</i>, <i>Prostanthera calycina</i>, <i>Pterostylis cucullata</i>, <i>Pterostylis arenicola</i>, <i>Pterostylis tenuissima</i>, <i>Ptilotus beckerianus</i>, <i>Senecio macrocarpus</i>, <i>Stackhousia annua</i>, <i>Taraxacum cygnorum</i>, <i>Thelymitra epipactoides</i></p>
New South Wales	<p>Coastal Headland Scrub, Dry Dune Shrub Forest, Estuarine Wetland Scrub, Coastal Foothills Dry Shrub Forest</p>	<p><i>Acacia georgensis</i>, <i>Chamaesyce psamogeton</i>, <i>Correa baeuerlenii</i>, <i>Dracophyllum oceanicum</i>, <i>Pultenaea pedunculata</i>, <i>Prostanthera densa</i>, <i>Senecio spathulata</i> var. <i>attenuatus</i></p> <p><b>Communities:</b> Bangalay Sand Forest, Eastern Suburbs Banksia scrub, Swamp Oak Floodplain Forest, <i>Themeda</i> Grassland (sea-cliffs and coastal headlands)</p>
Western Australia	<p><i>Eucalyptus diversicolor</i> Tall Forest, <i>Eucalyptus calophylla</i> Forest-Woodland, <i>Agonis flexuosa</i> Woodland, <i>Eucalyptus marginata</i> Woodland, <i>Dryandra</i> Open Heath, Dense Coastal Heath, <i>Eucalyptus gomphocephala</i> Woodland, <i>Eucalyptus patens</i> Woodland, <i>Melaleuca</i> thicket</p>	<p><i>Asplenium obtusatum</i> subsp. <i>northlandicum</i>, <i>Caladenia busselliana</i>, <i>Caladenia caesarea</i> subsp. <i>maritima</i>, <i>Caladenia procera</i>, <i>Caladenia viridescens</i>, <i>Caladenia procera</i>, <i>Caladenia viridescens</i>, <i>Chorizema varium</i>, <i>Wurmbea calcicola</i></p> <p><b>Communities:</b> <i>Agonis flexuosa</i> Woodland</p>
Tasmania	<p>Dry coastal vegetation, <i>Allocasuarina</i> forest, <i>Acacia longifolia</i> scrub, <i>Melaleuca ericifolia</i> scrub, Stabilised dune communities, Coastal <i>Myoporum insulare</i> scrub</p>	<p><i>Brachyloma depressum</i>, <i>Lasiopetalum baueri</i>, <i>Pomaderris oraria</i>, <i>Veronica plebia</i>, <i>Zieria littoralis</i></p>

# Status of *Polygala*



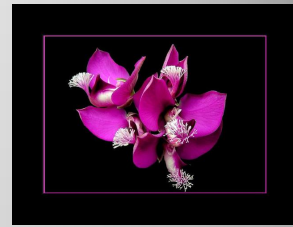
- currently undeclared any where in Australia
- NWR Phase 3b
  - two Vic CMAs recommended regionally controlled
  - all other Vic CMAs recommended restricted
- 3b Proposal - restricted in Victoria - abandoned
- South Australia – listing proposed
- control implications



# Management options



- **hand pulling**
- **herbicides**
- **fire**
- **biological**
- **integrated control**



- Hand pulling** – difficult for large plants, tedious for small plants
- effective
  - new incursions, isolated plants, sterile plants

- Herbicides**
- susceptible
  - cut and paint
  - metsulfuron methyl is effective, high non-target impacts
  - glyphosate is effective on both seedlings and mature plants
  - picloram-based gel on freshly cut stumps is effective

- Fire**
- fire-sensitive, high intensity fires are required
  - suppression of hot summer fires - contributed to expansion
  - canopy scorch needed

- Biological**
- low herbivory in Australia
  - potential realised in 1996
  - published 2010 ([www.australisbiological.com.au/publications](http://www.australisbiological.com.au/publications))
  - strong field of candidates



# Biological control



*Diaphorina petteyi* (flower psyllid)

*Duffoemydia barkeri* (longicorn beetle)







Cossidae red crown-moth







*Lasioptera* sp. (shoot gall midge)



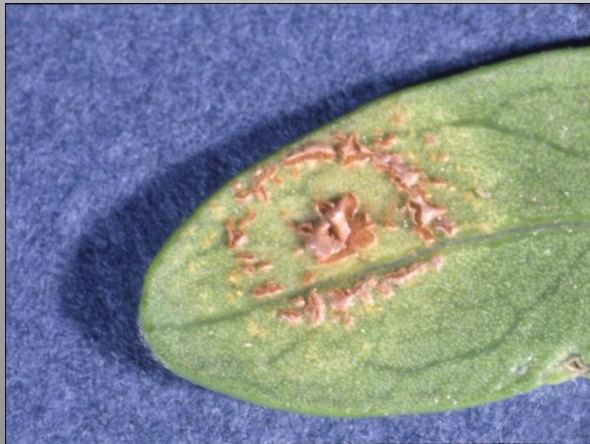




*Aceria myrtifoliae* (gall mite)



Agromyzid (leaf miner)



*Uredo polygaliae* (rust fungus)







Seedling regeneration following removal of adults

Control options:

Hand-pulling?

Herbicides?

Fire?

Natural events?

Point Nepean, Victoria



# Predicting control scenarios

- modelling - help select best control methods
- population responses
- need data - construct population models
- knowledge gaps – many
- e.g. seed longevity, soil-seed bank, seedling behaviour
- DPI/CGG/CfOC partnership – 2011
- useful for implementation

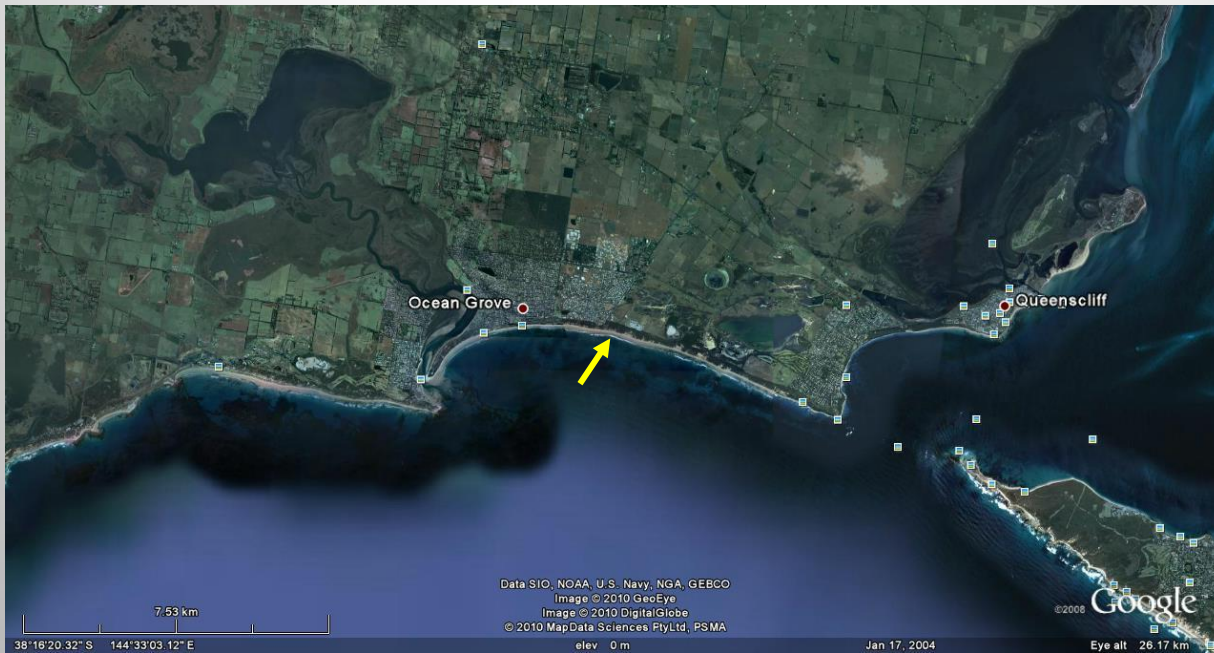
# Buckley Reserve project

a study designed to address knowledge gaps



Buckley Reserve, Ocean Grove









Buckley Reserve, Ocean Grove



# What data was collected

- plant densities
- age profiles
- phenology
- seed bank behaviour
- seedling survivorship
- seed fall
- post dispersal seed losses
- cleared vs canopy responses







# Population structure – Ocean Grove 2010

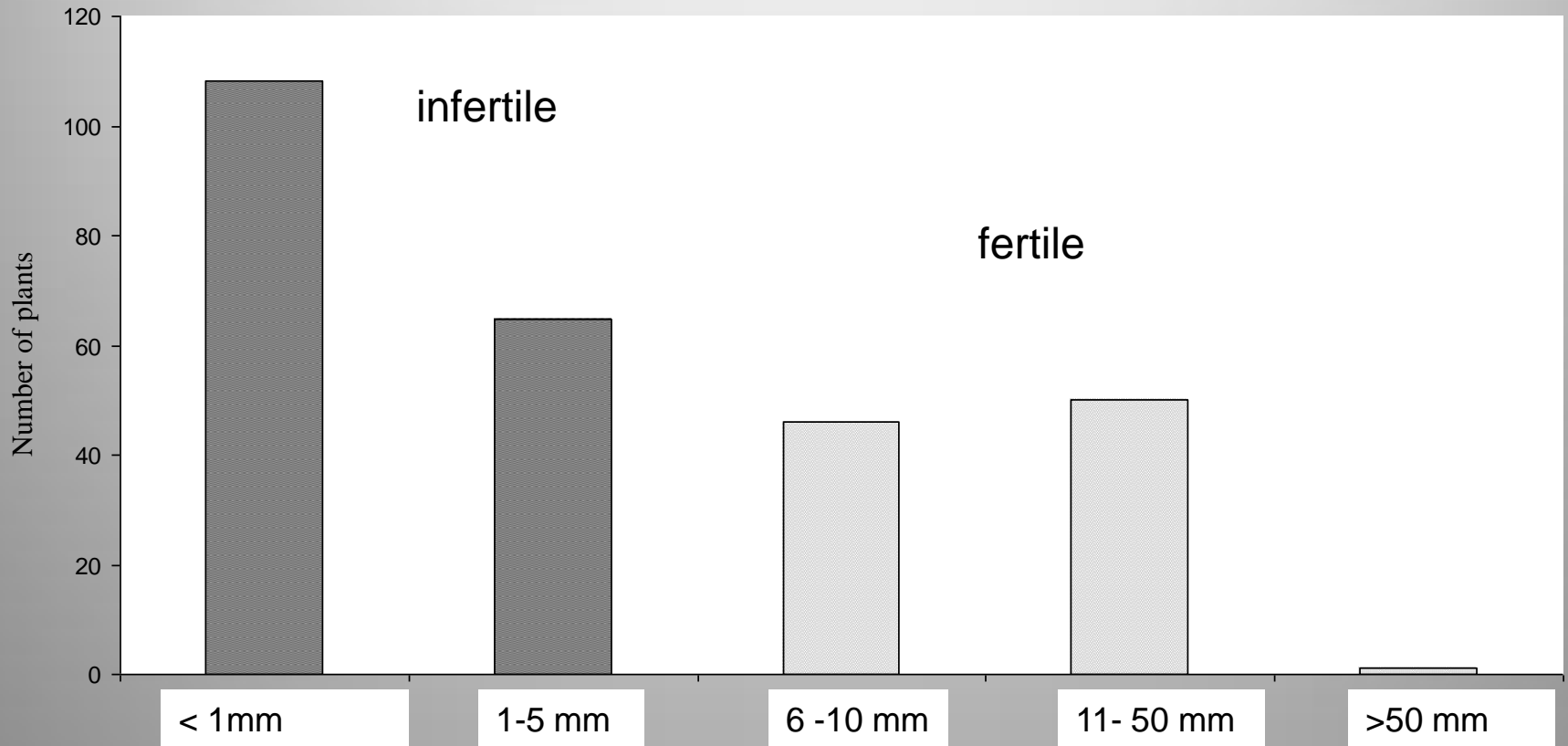
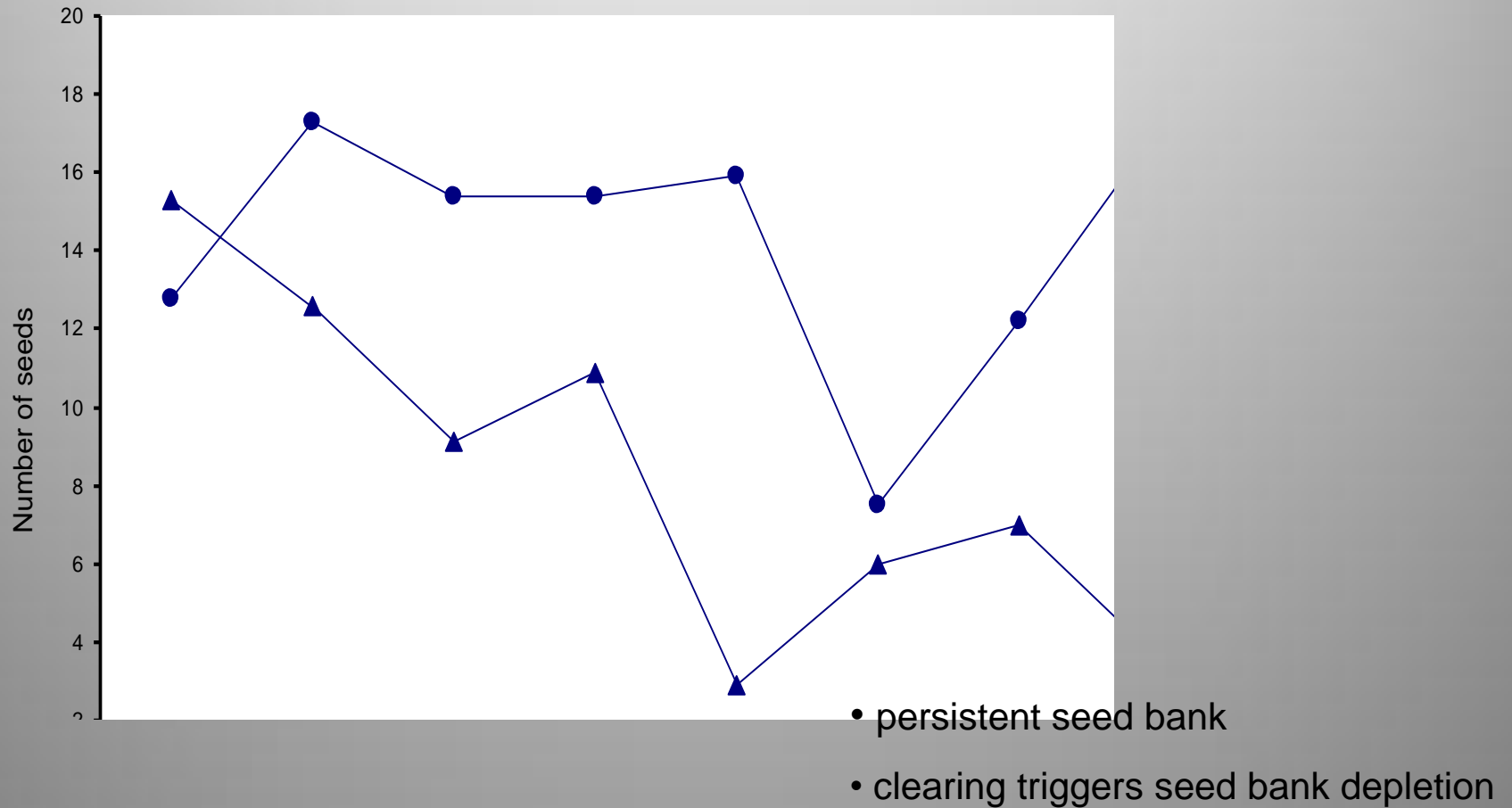


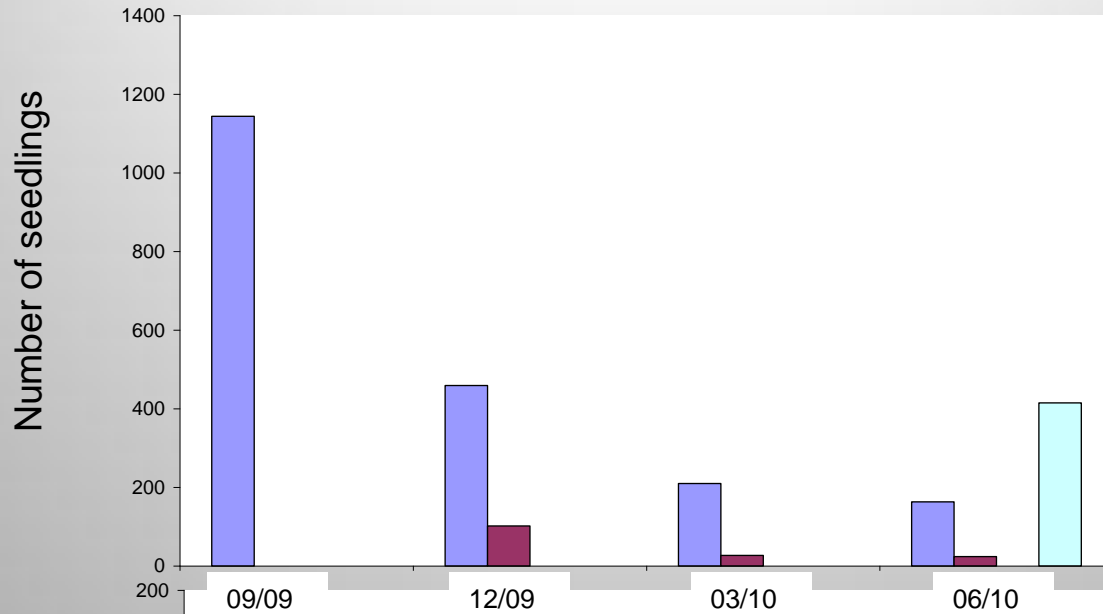
Figure 8. Number of *Polygala myrtifolia* seeds in soil from cleared (triangle) and uncleared (circle) plots. Data are mean number of seeds  $950 \text{ cm}^{-3}$





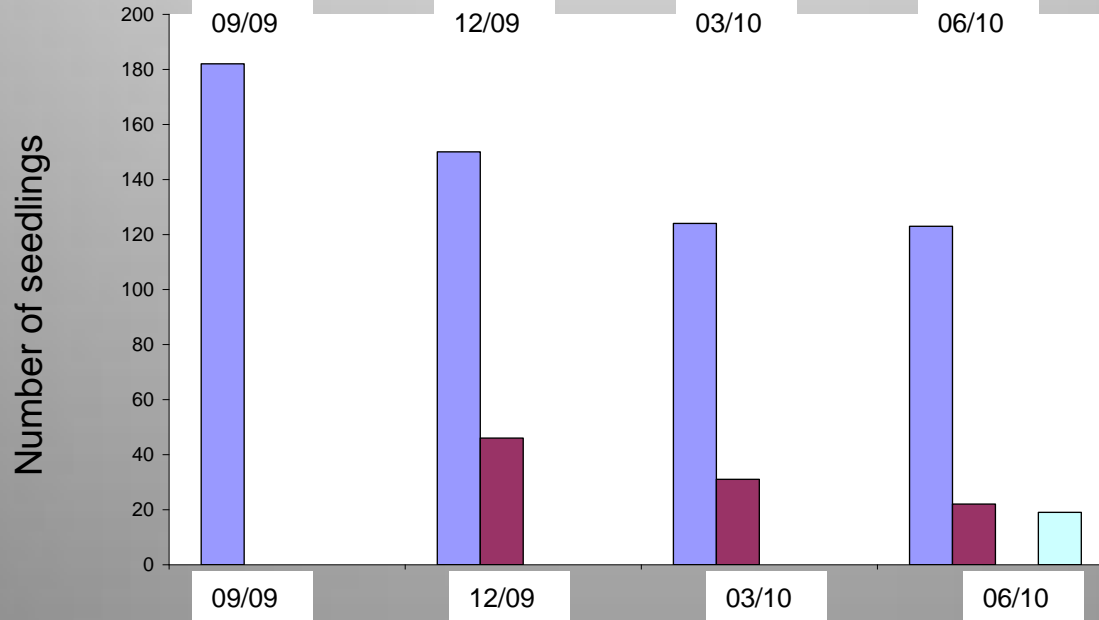
*P. myrtifolia* seedlings on cleared and control plots.  
Bar colours represent age cohorts over four seasons.

cleared

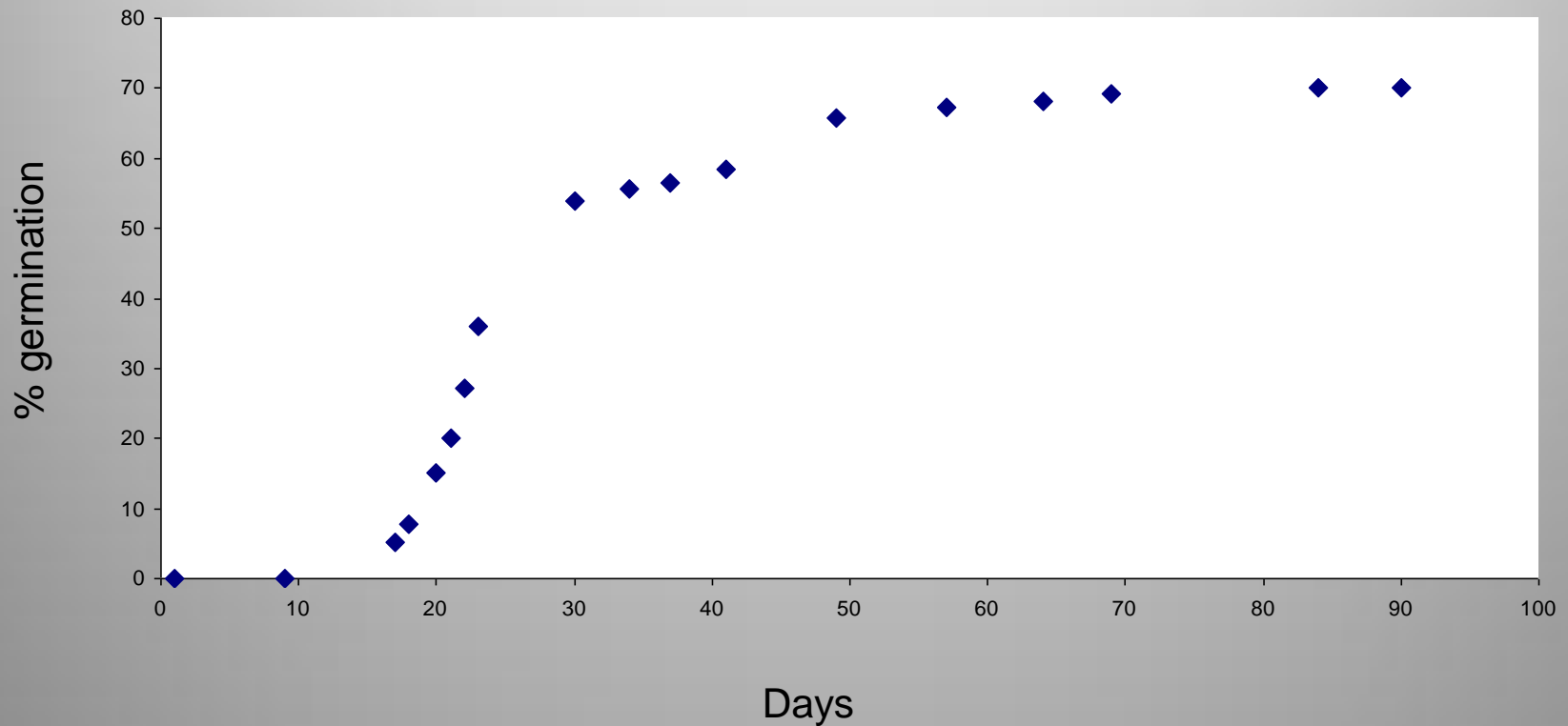


- high emergence on cleared plots
- large losses over summer
- Most germinate winter spring
- higher survivorship under canopies

canopy



## Accumulative germination of fresh *P. myrtifolia* seed



- high levels of viability in fresh seed
- germinates rapidly under ideal conditions
- very little innate dormancy





Seed collection trap

Rat exclusion fence





**High levels of seed mortality  
occur after seed fall**

pigeons (turtle doves, rats)

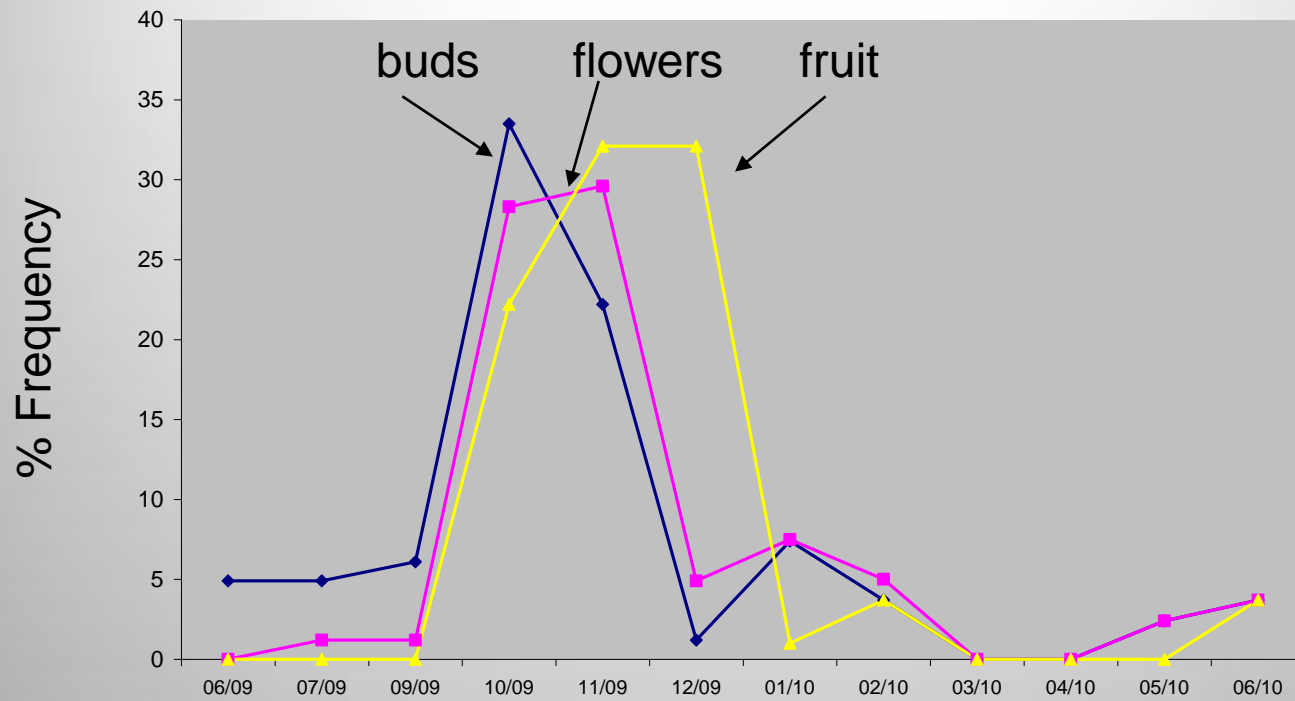
Ants carry seeds short distances  
and cache seeds

**High level of fertility**

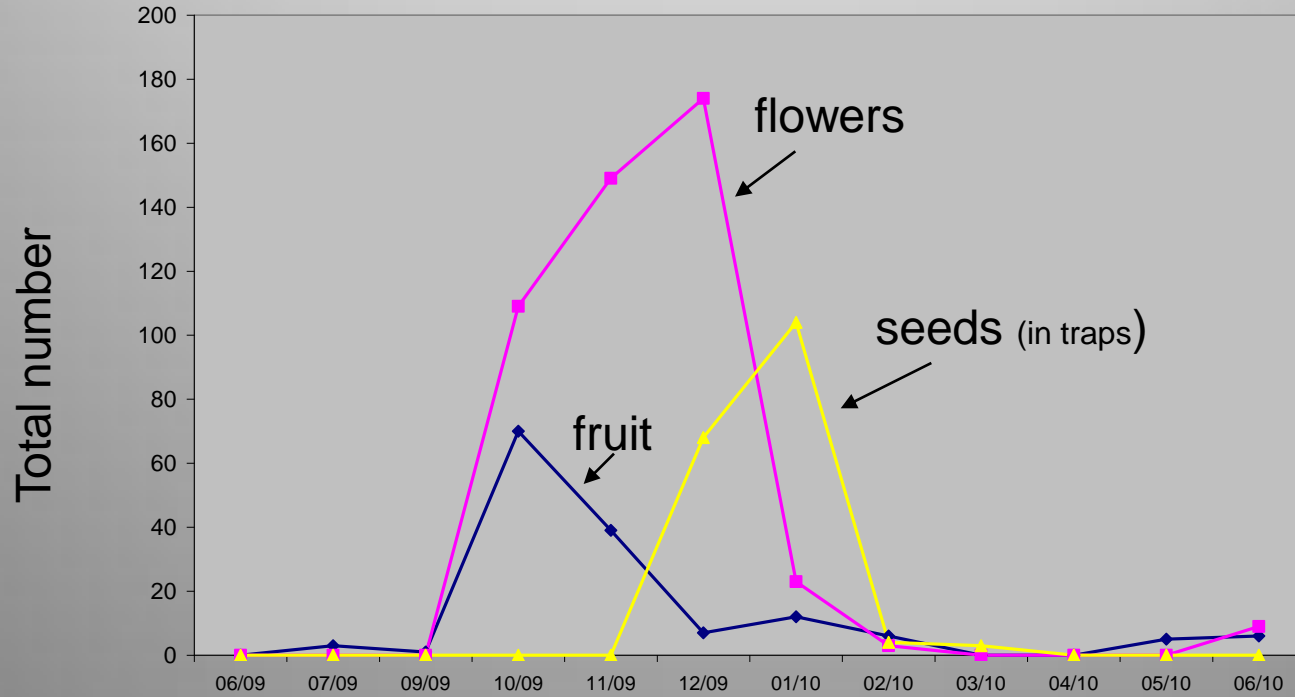
Most flowers are fertile and produce 2 seeds  
Flowering/fruitletting is very seasonal







- strong seasonality
- short peak period



- low seed output
- high flower failure (verify)

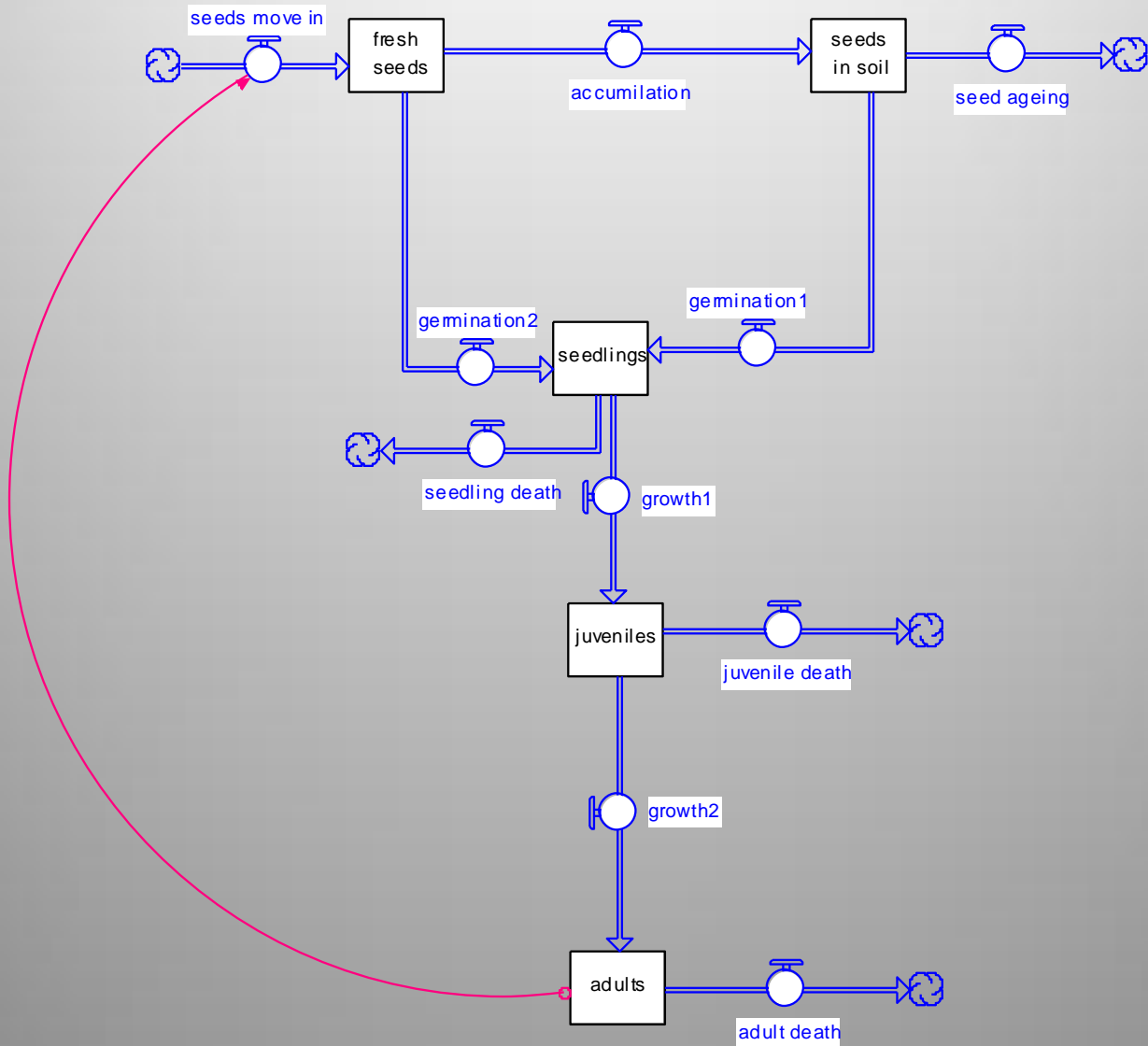
# Modelling

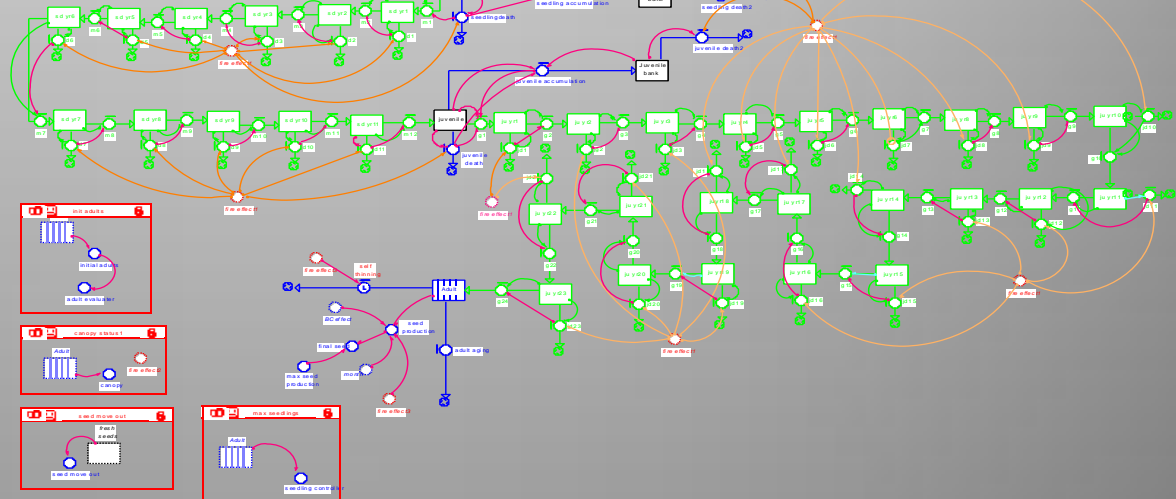
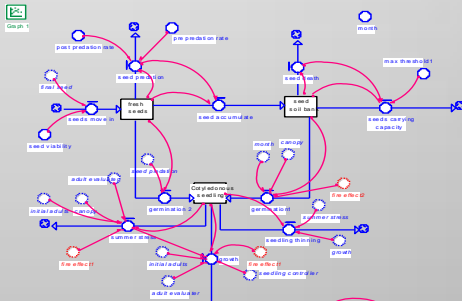
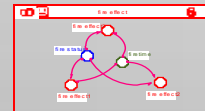
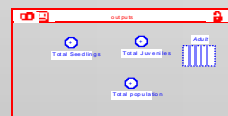
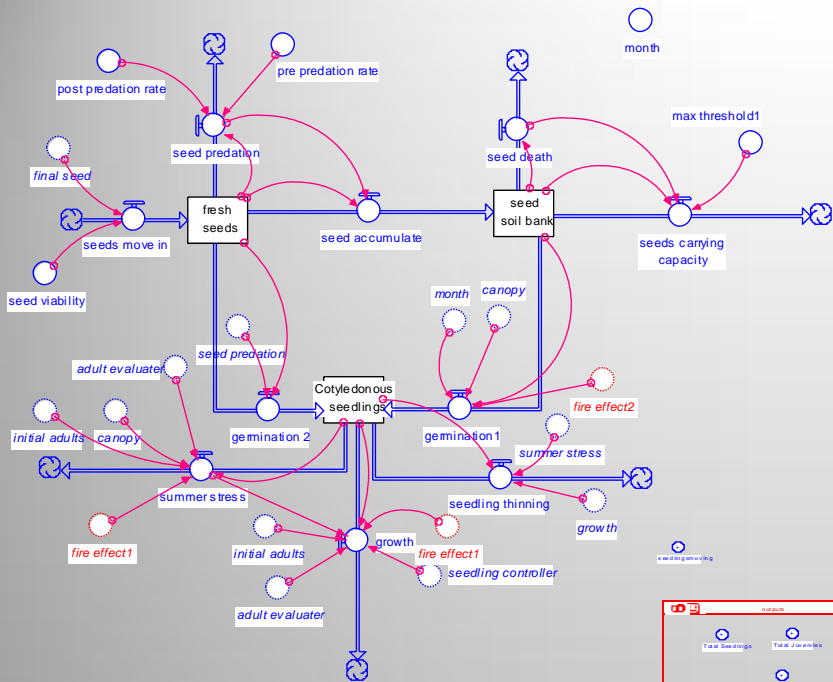


- Quick method - comparing different control options
- 6 months to develop
- Can run for any control method - press of a button
- Cut down years of trialling each control method
- Technology is available for realistic model (Stella software)
- Can test how well the model mimics real life
- Availability of information of Polygala population dynamics



model of a plant life cycle







## What does the model do?

We can compare the effects of different control methods

e.g. biocontrol by seed predator

Scenario 1 - 90% of seeds eaten

Scenario 2 - 50% of seeds eaten

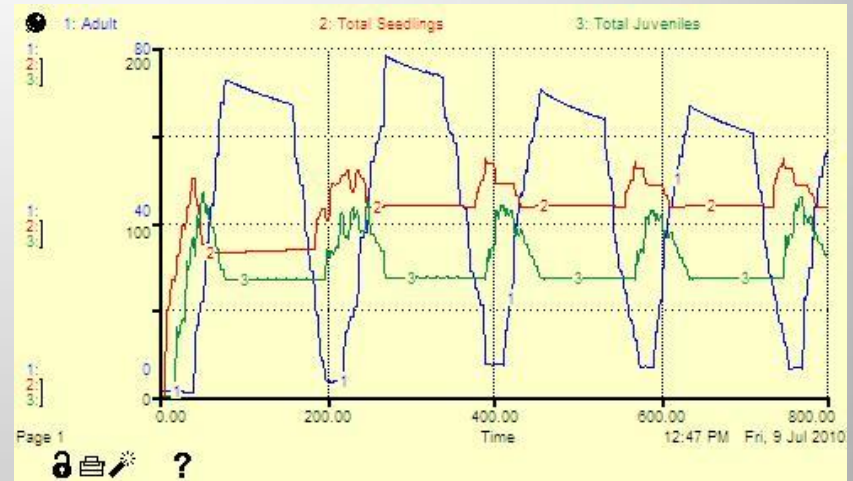
See model details @

(<http://forio.com/simulate/ratnapriya.gajaweera/polygala-hisped/run/>)

# Model Results



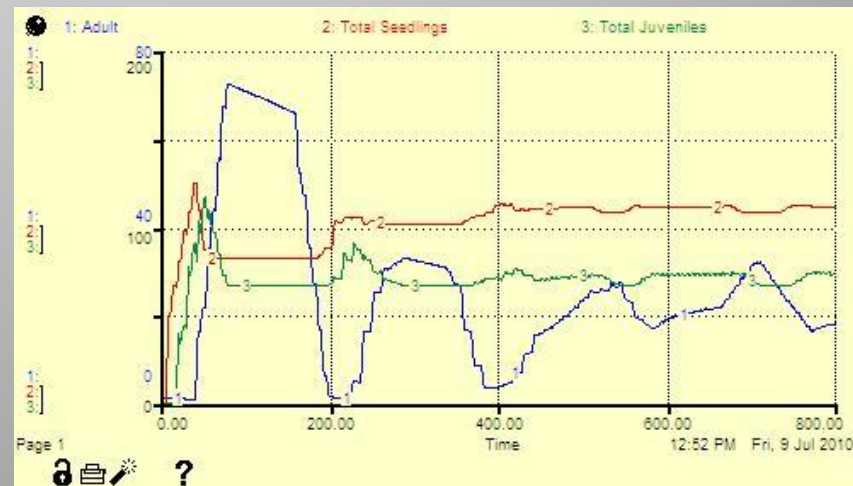
control



Cossidae

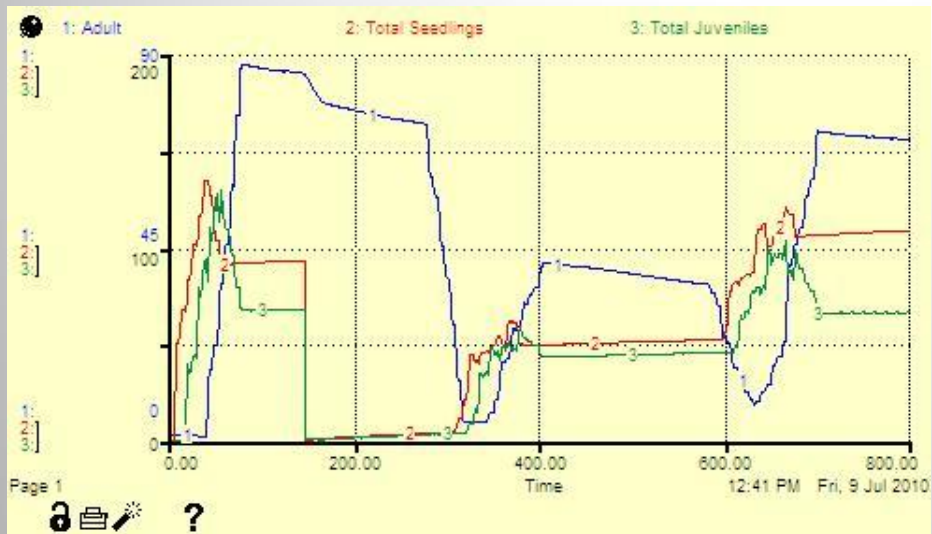


Cossidae + 50% seed



Cossidae + 90% seed





fire



fire + 90% seed removed

# Key Points

- high post dispersal seed mortality – pigeons and rodents
- seed banks are short-lived (5-10 yrs)
- soil pathogens and drought – kill seedlings
- high seedling mortality (summer)
- rapid seed bank depletion when canopy is opened
- 2 yrs to sexual maturity
- plants are susceptible to herbicides
- control activities easier after natural thinning
- a combination of control options is better than 1 alone







# Acknowledgements

City of Greater Geelong

Caring for our Country Program

Barwon Coast Committee of Management

Bev Wood

Troy Gallus

Glenelg-Hopkins CMA

**Australis Biological**

vegetation | invasive species | management strategies | restoration