



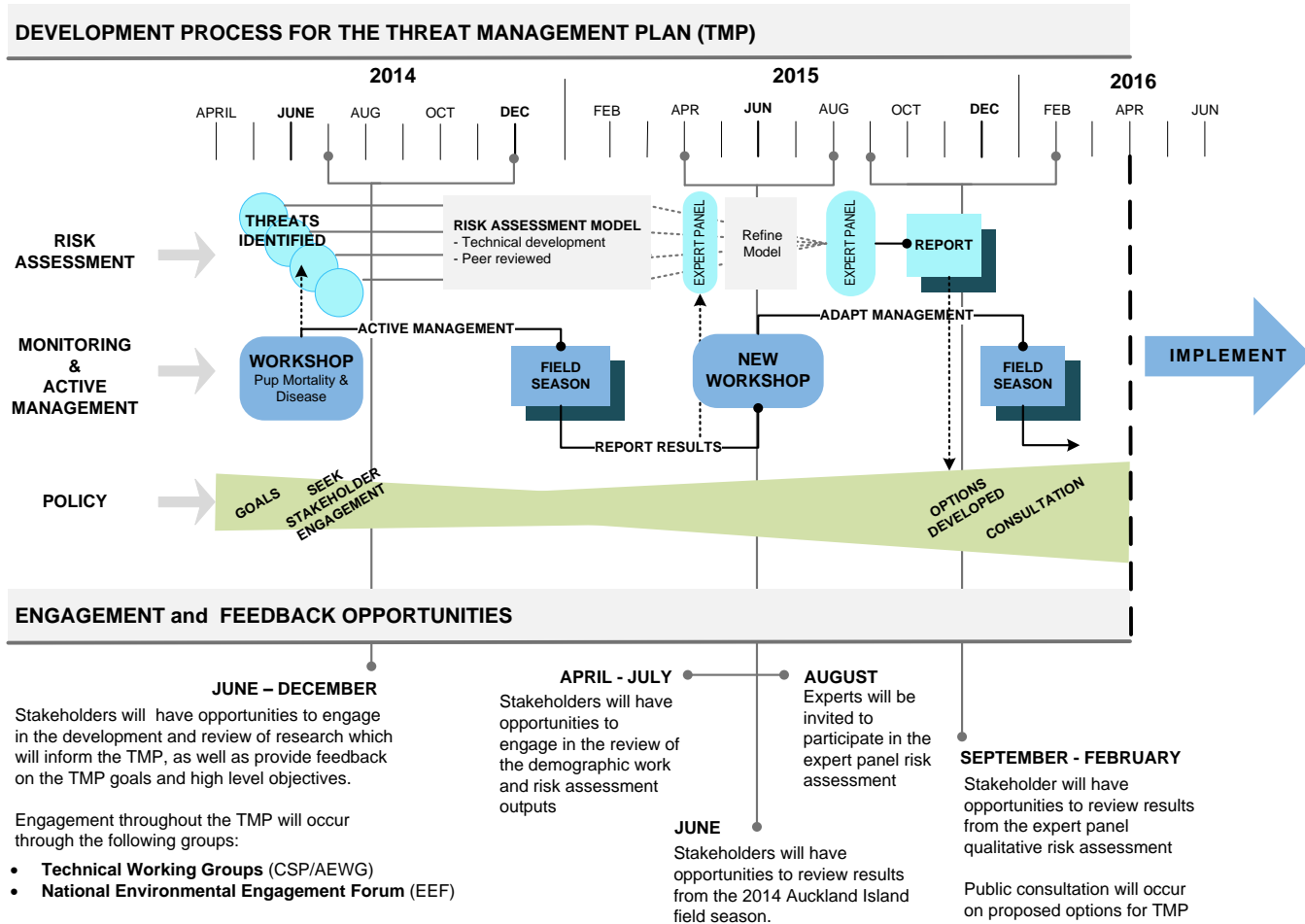
# NZ sea lion TMP quantitative risk assessment Revised demographic assessment and MCMC

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CSP/AEWG, 17<sup>th</sup> August 2015

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# NZSL TMP – risk assessment process



# Assessment methodology

For Auckland Islands & Otago Peninsula

## 1. Demographic assessment:

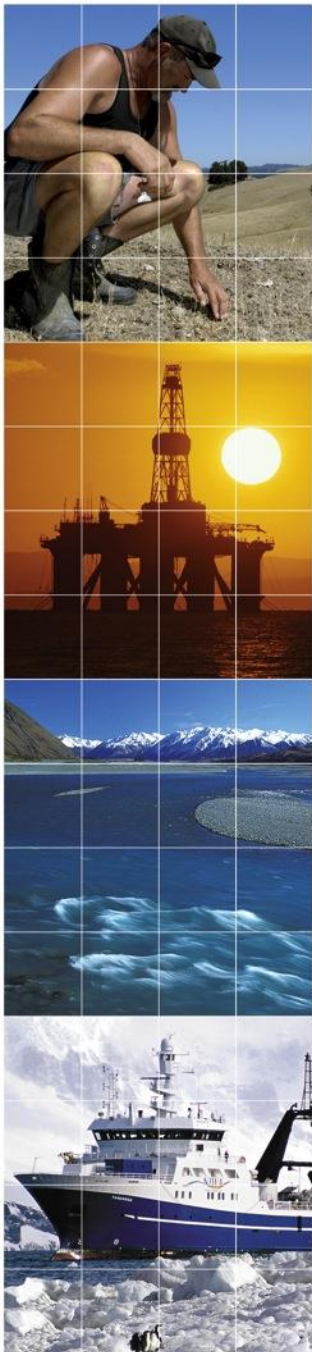
- Estimate current age distribution
- Demographic rates for projections

## 2. Projections from MPD run (Triage)

- Estimate parameters with upper level of threat then project forward 20 years
- Screen out threats that have low impact

## 3. Projections from MCMC run (high impact threats)

- Apply range of threat levels over 20 years (2017-2037)
- Relate distributions of projected mature n to criteria
- Repeat with mitigation measures



# Summary of observations

- Pup census:
  - Estimates assigned high confidence for Paul Breen's modelling
  - Sandy Bay 1966-2015 (1965/66-2014/15)
  - Auckland Islands 1995-2015
- Mark-resighting:
  - Extract from Dragonfly database
  - Sandy Bay females
  - Marked 1990-2014 & resighted 1998-2015 – females only
  - Distinction by mark type (brand, chip or flipper tag only)

# Summary of model at previous AEWG meeting

- Model period from 1960-2015
- Survival:
  - Separate estimates for age classes 0, 1, 2-5, 6-14 and 15+
  - Only age 0 and 6-14 survival were year-varying
- Pupping/maturation:
  - Year-varying pupping rate for age 8-14
  - 5 parameters gave pupping probability at ages 4, 5, 6, 7 and 15+ relative to 8+
- Resighting probability:
  - All year-varying or year-constant resighting probability, separate estimates depending on mark type
- Tag loss rate:
  - Functional form (3 parameters) gives age-varying probability of losing 1 flipper tag in a year; another parameter gives probably of losing 2 tags in a year

# Order of demographic model modification

- Effects of alternative census CVs
- Fitting to Auckland Islands age distribution & census
- Parameterisation of resighting probability

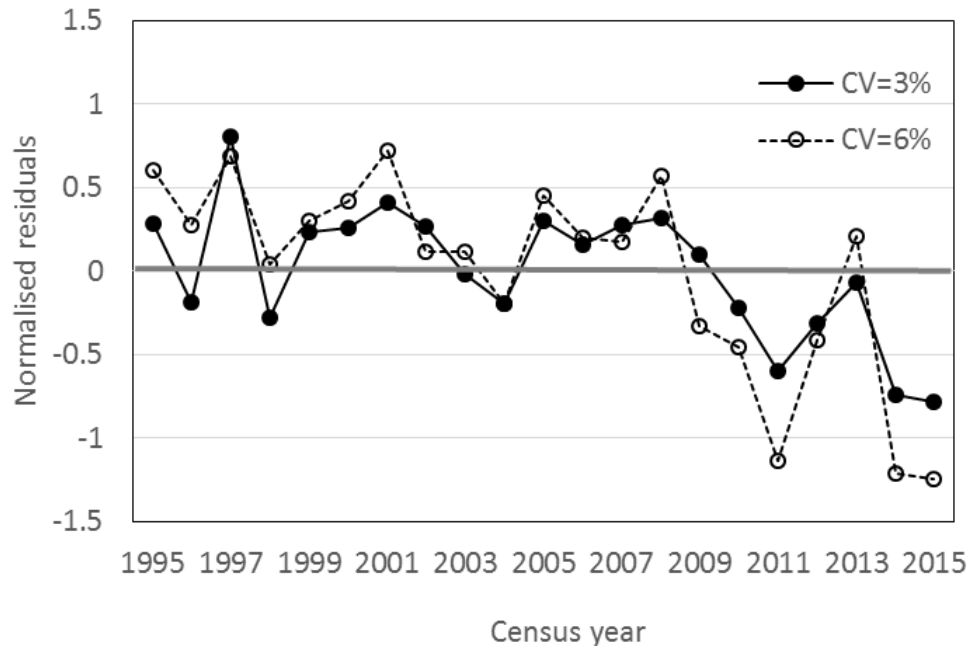
# Effects of alternative census CVs

# Alternative census CV

- Arbitrarily used CV of 6% for census in previous model runs
- AEWG suggested looking at sensitivity of normalised residuals to alternative census CV as means of selecting appropriate value



# Alternative census CV



- When using CV of 6%, tend to overestimate pup production after 2009
- This is improved when CV of 3% is used
- Adopted for all subsequent runs

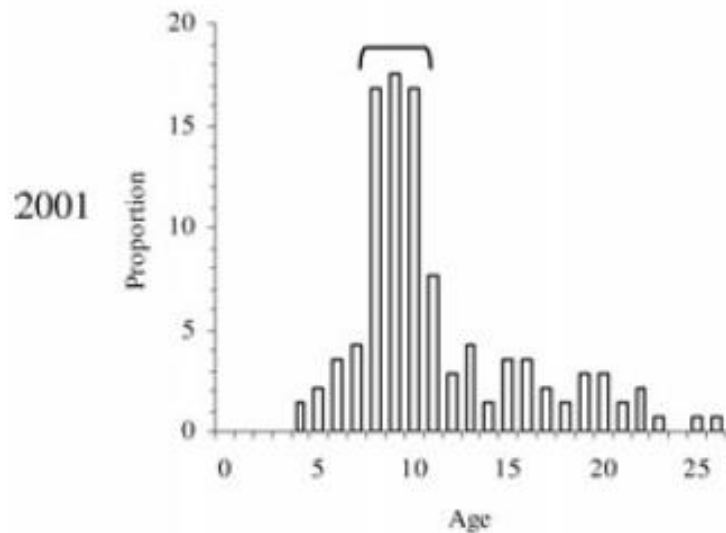
Fitting to Auckland Islands age distribution & census

# Census + Age observations

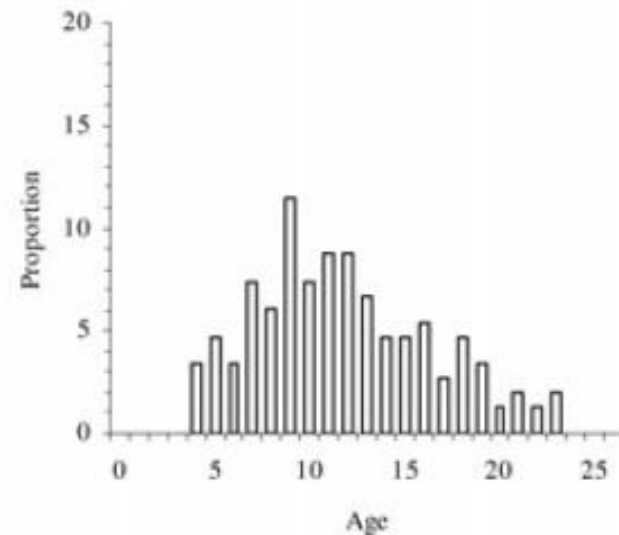
- Previous runs fit to SB MR, census and age composition of lactating females (puppers)
- MPI/DOC opted to change the main census series to Auckland Islands for assessment of threats
- Small decrease in likelihood (~4 units) when fitting to AI instead of SB
- AI series begins 1995 (SB was 1960s)

# Age composition Sandy Bay v Dundas

Simon Childerhouse's (2010) female ageing study indicated very different age composition at Dundas in 1998-2001



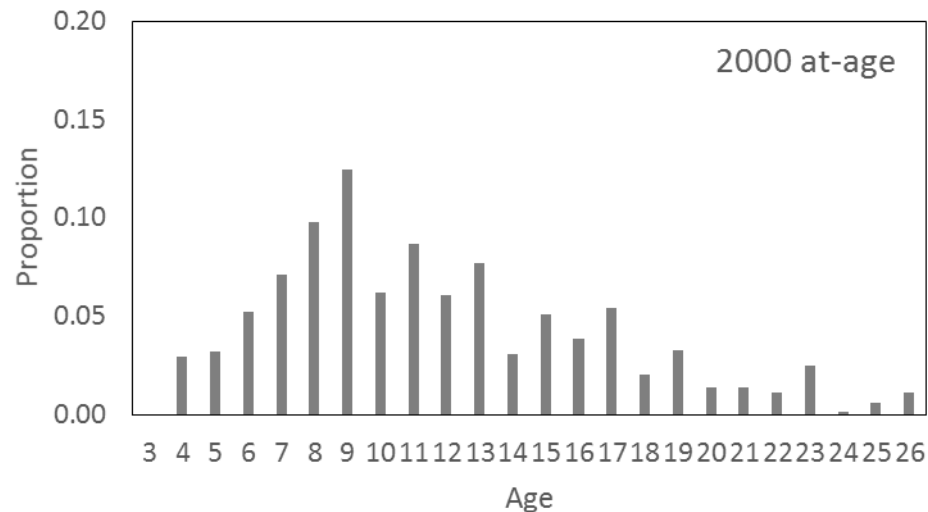
Sandy Bay



Dundas

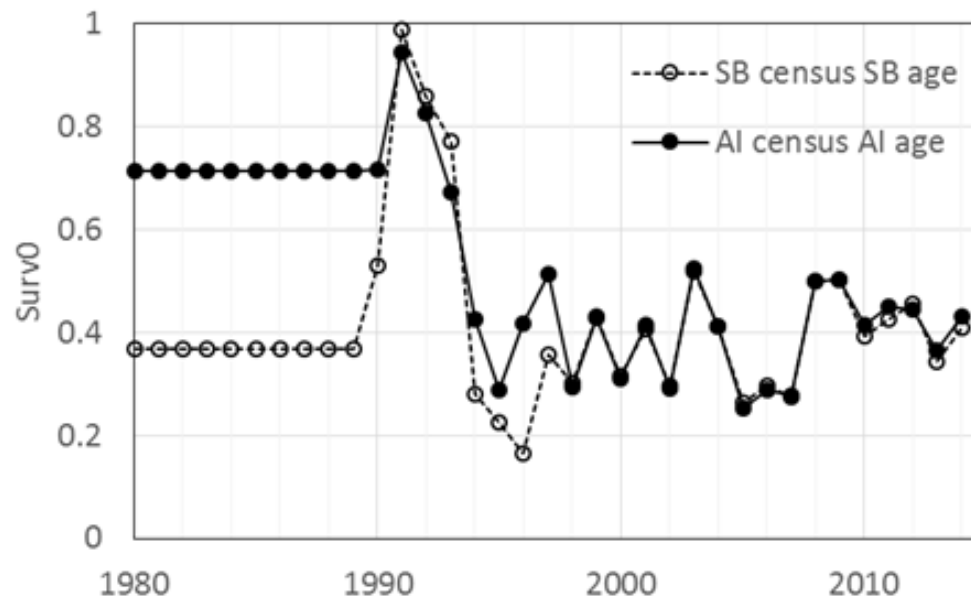
# Age composition Auckland Islands

- Combined series by multiplying proportion at age by pup production estimate in corresponding year to get numbers at age for each rookery
- These were then combined and proportion at-age recalculated (AI age)



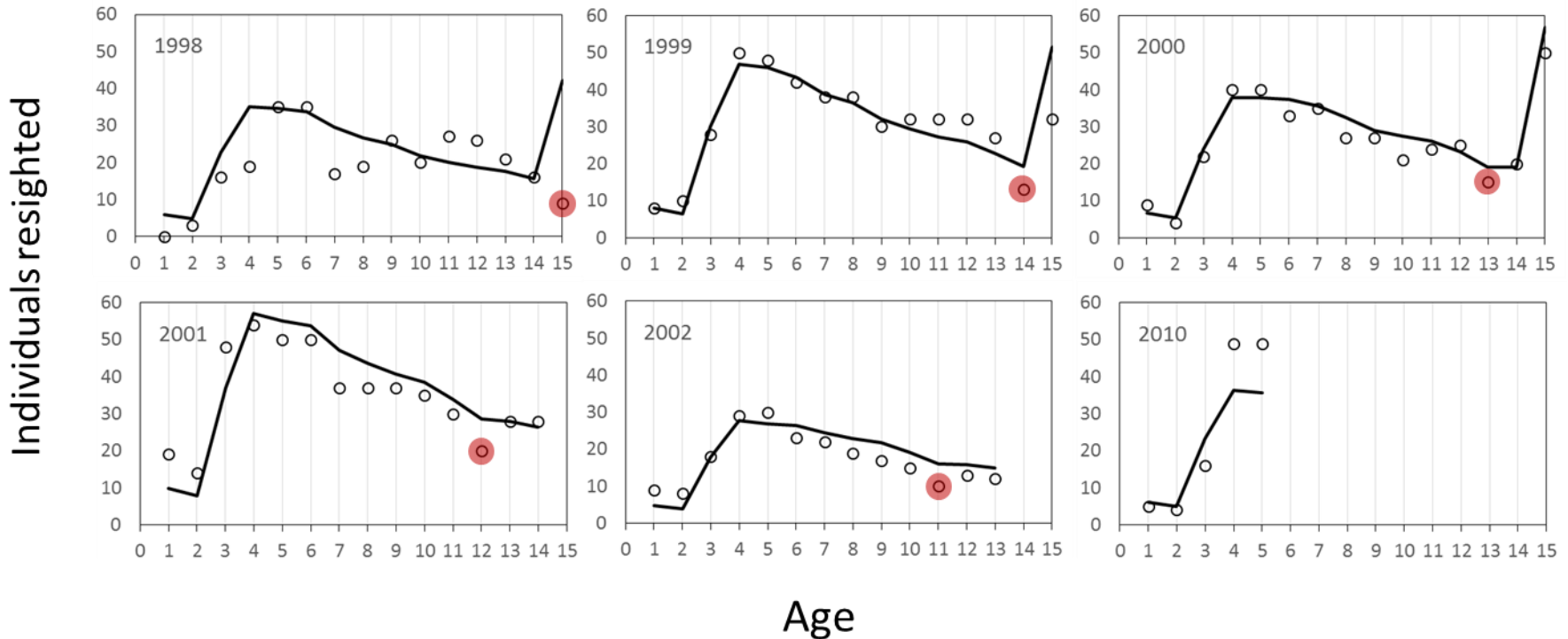
# Pup survival fitting to AI census + age

- Fitting to AI age had tiny effect on all parameters except pup survival and relative pupping rate at age 4
- Survival prior to 1990 greatly increased and slight increase 1994-1997
- Relative pupping rate at age 4 increased from  $\sim 0.1$  to  $\sim 0.2$



# Parameterisation of resighting probability

# Low resighting effort in 2013

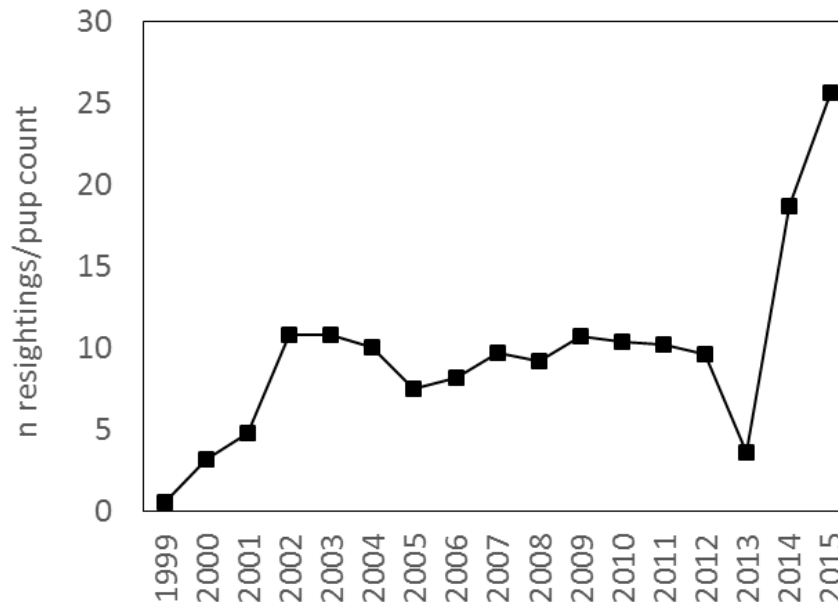


- Assumption of year-invariant resighting affects survival in later years
- Recommended we use year-varying parameters



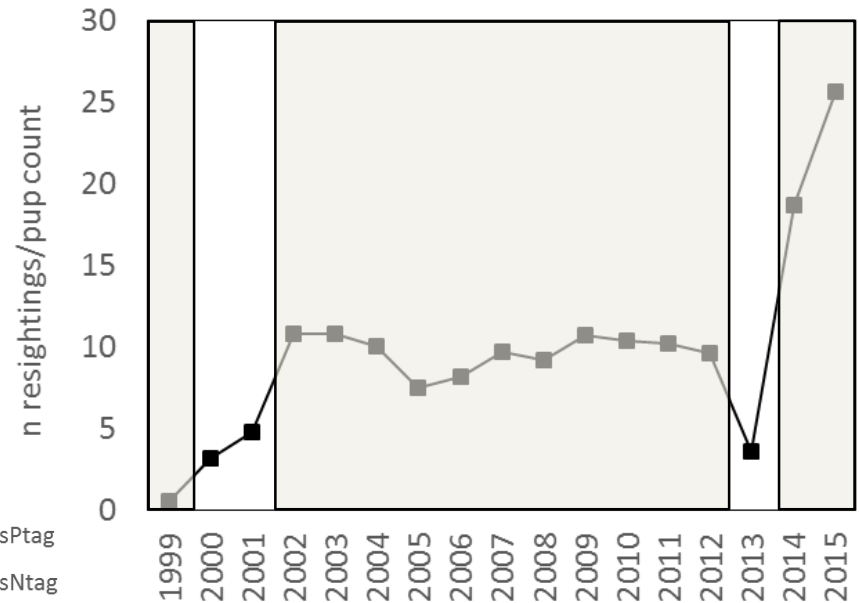
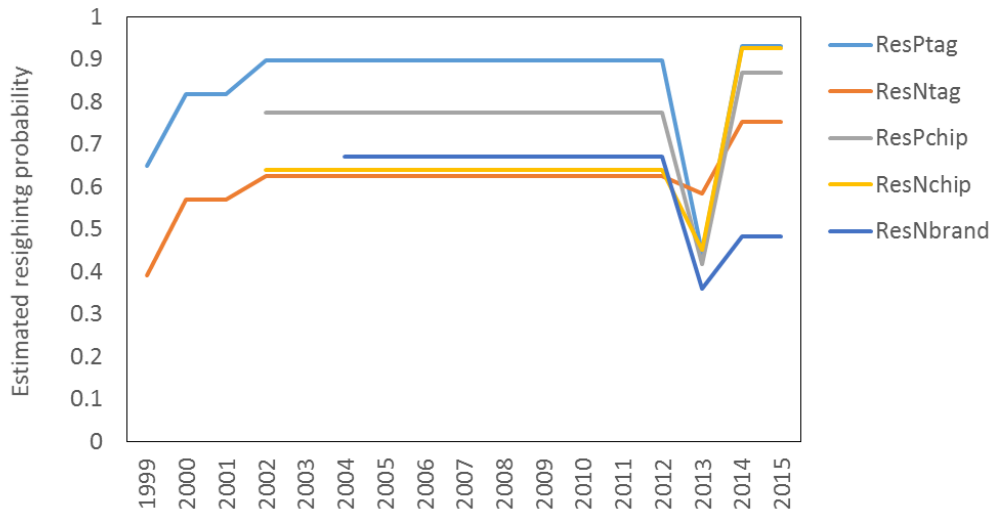
# Parameterisation of resighting probability

- Recommended actions:
  - Model run with year-varying parameters
- However:
  - Greatly increases number of potentially correlated parameters
  - Period with highly consistent resighting effort (e.g. 2002-2012)



# Parameterisation of year-varying resighting probability

- We elected to use year blocks: 1999, 2000-2001, 2002-2012, 2013, 2014-2015
- MPD estimates...



# MCMC – Auckland Islands

# MCMC run

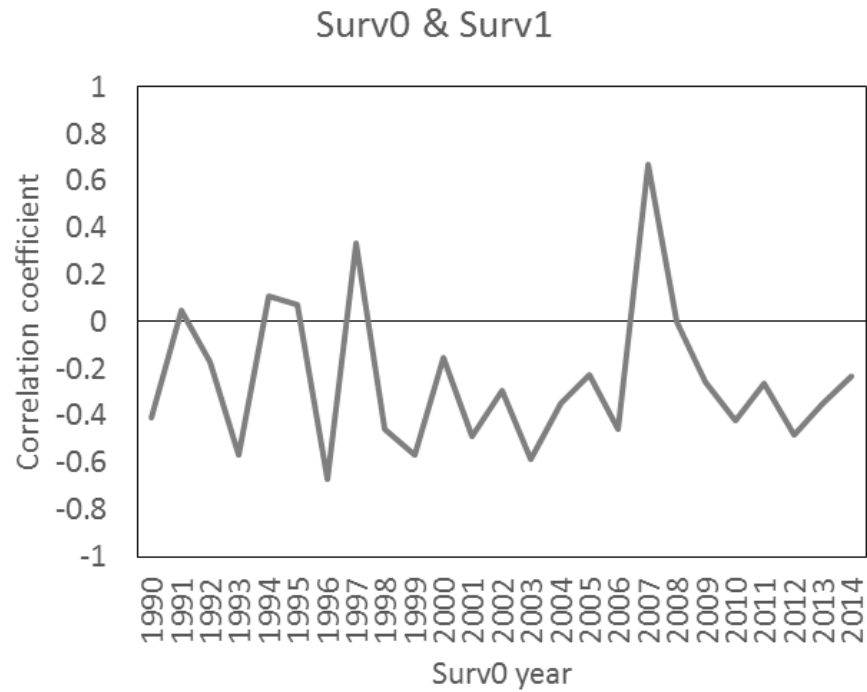
Model structure as previous AEWG, expect:

- Fit to Auckland Islands census (model start 1990) with CV of 3%
- Fit to Dundas/Sandy Bay age
- Resighting probability blocked for different year-groups
- Relative pupping rate age 15+ fixed to 1, as MPD run hit upper bound (same as age 8-14, effectively 8+)

# MCMC sampling

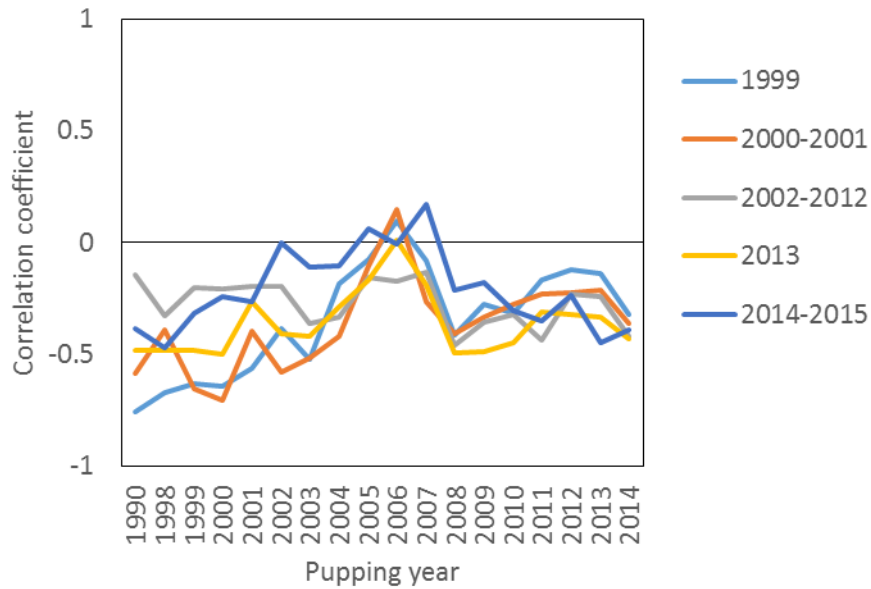
- Three chains with different starting values
- Currently ~50,000 iterations for each chain (still running)

# Parameter correlation

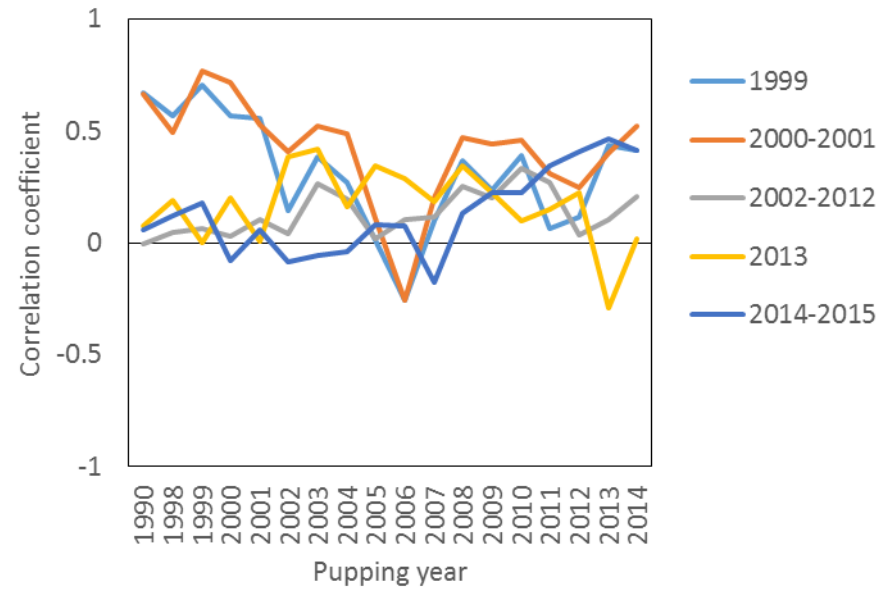


# Parameter correlation

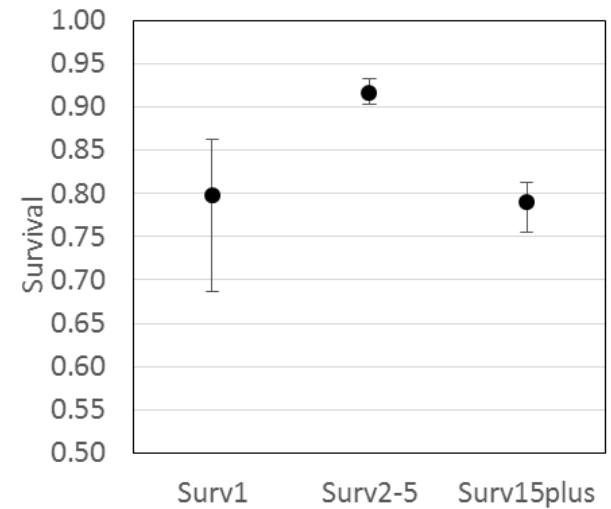
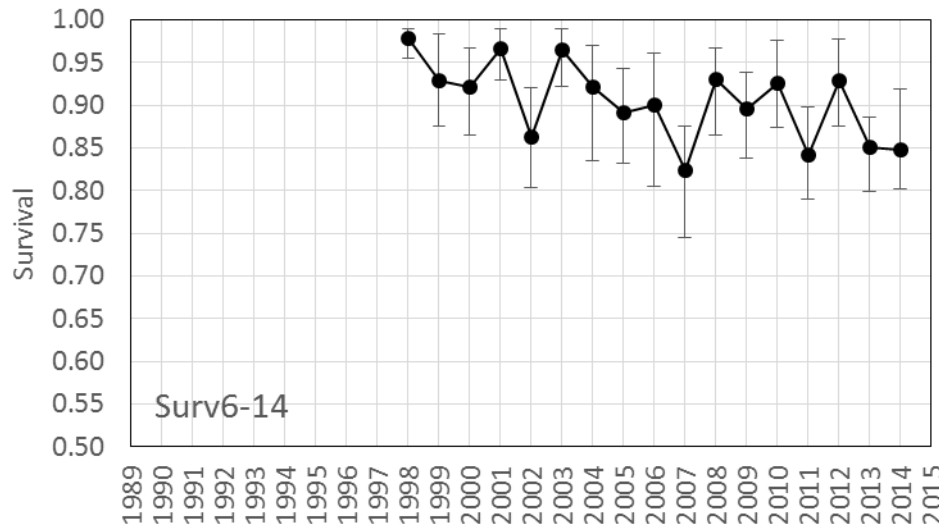
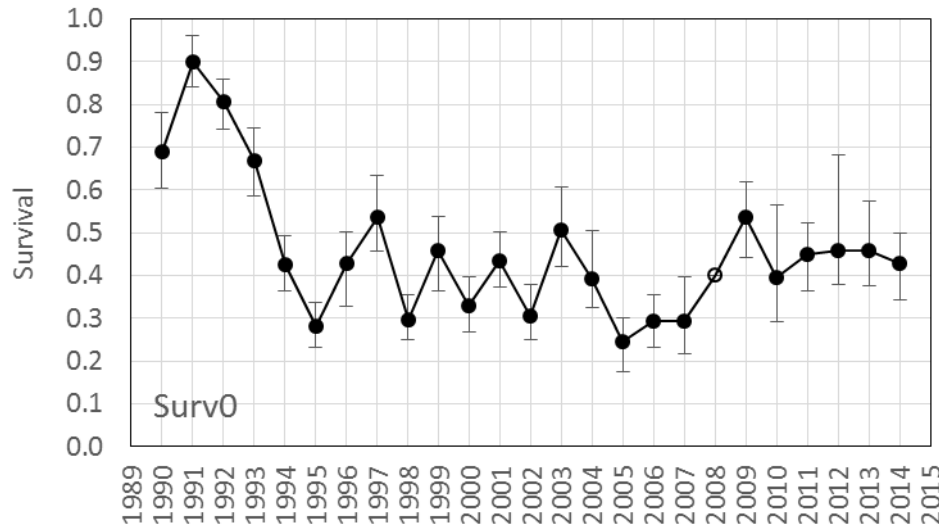
Probability pupping & resighting of puppies



Probability pupping & resighting of non-puppies

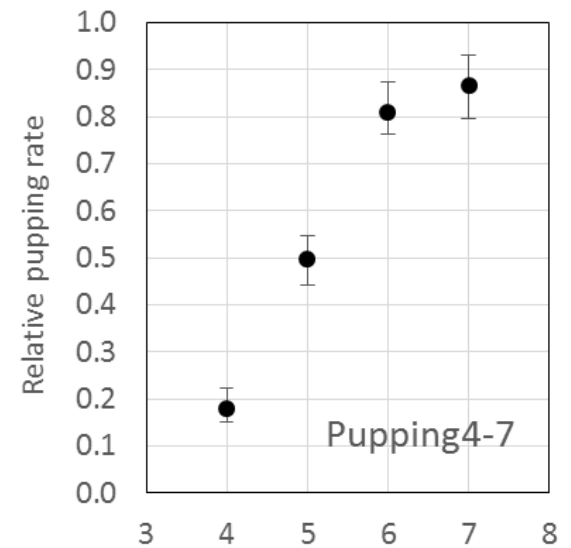
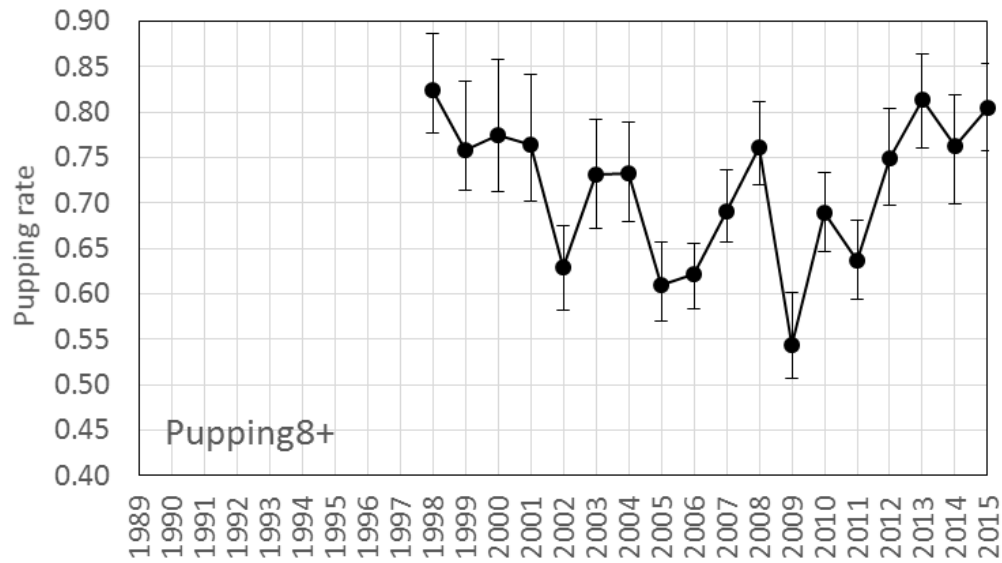


# MCMC outputs - Survival

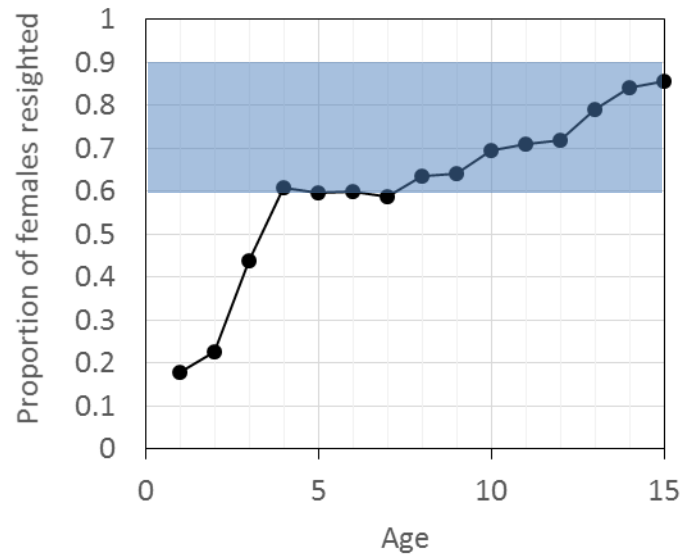
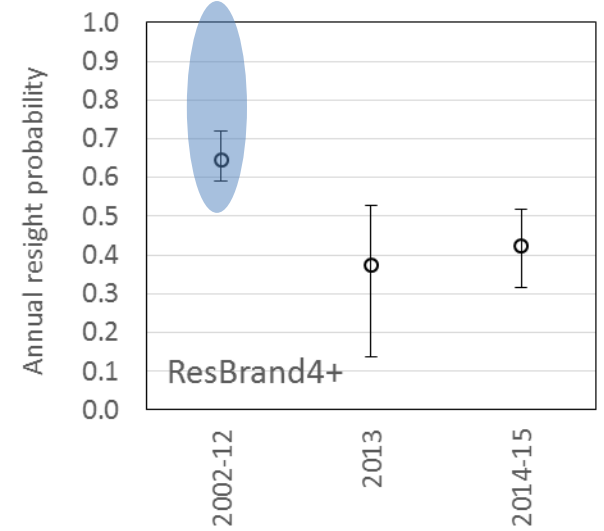
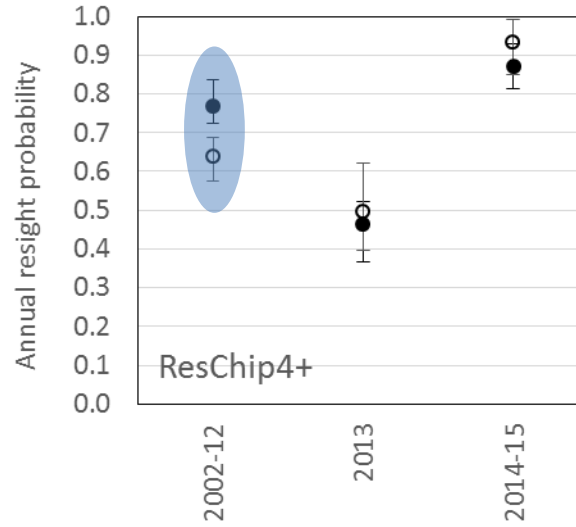
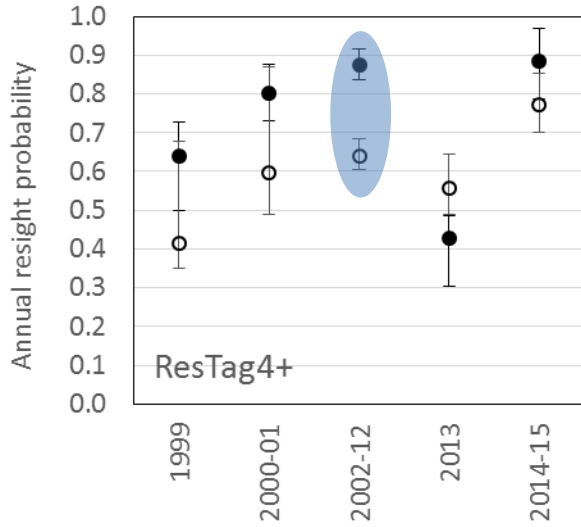




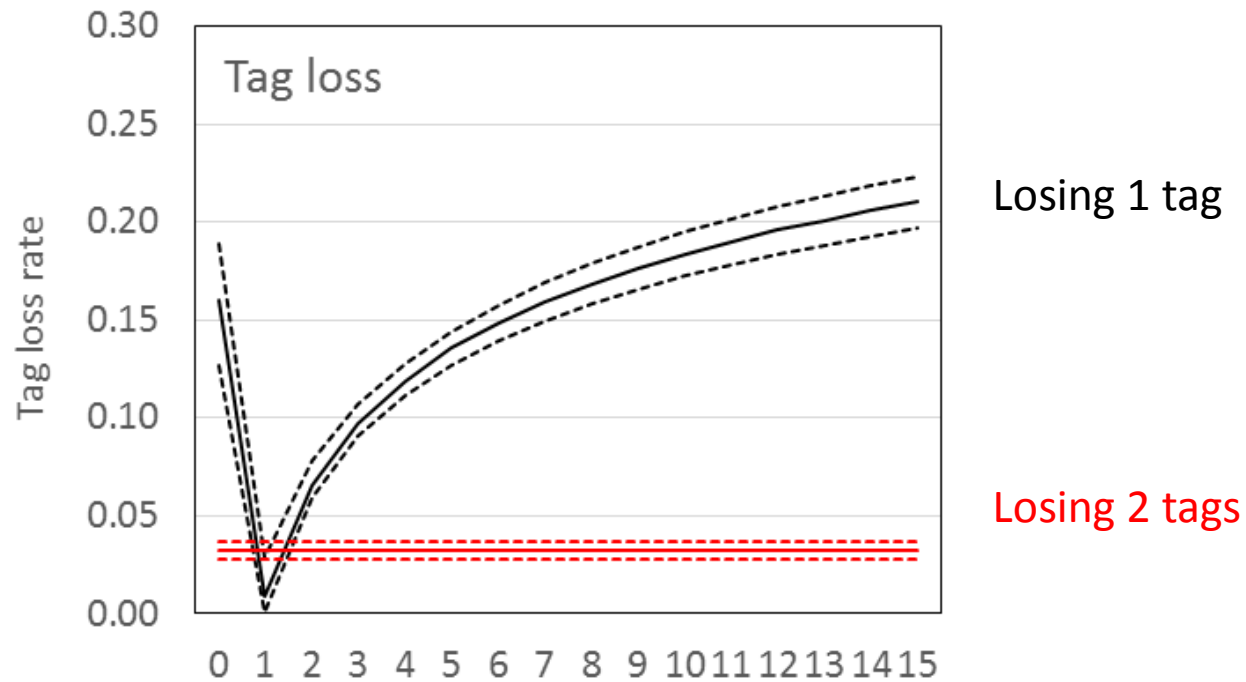
# MCMC outputs - Pupping



# MCMC outputs – Resighting probability

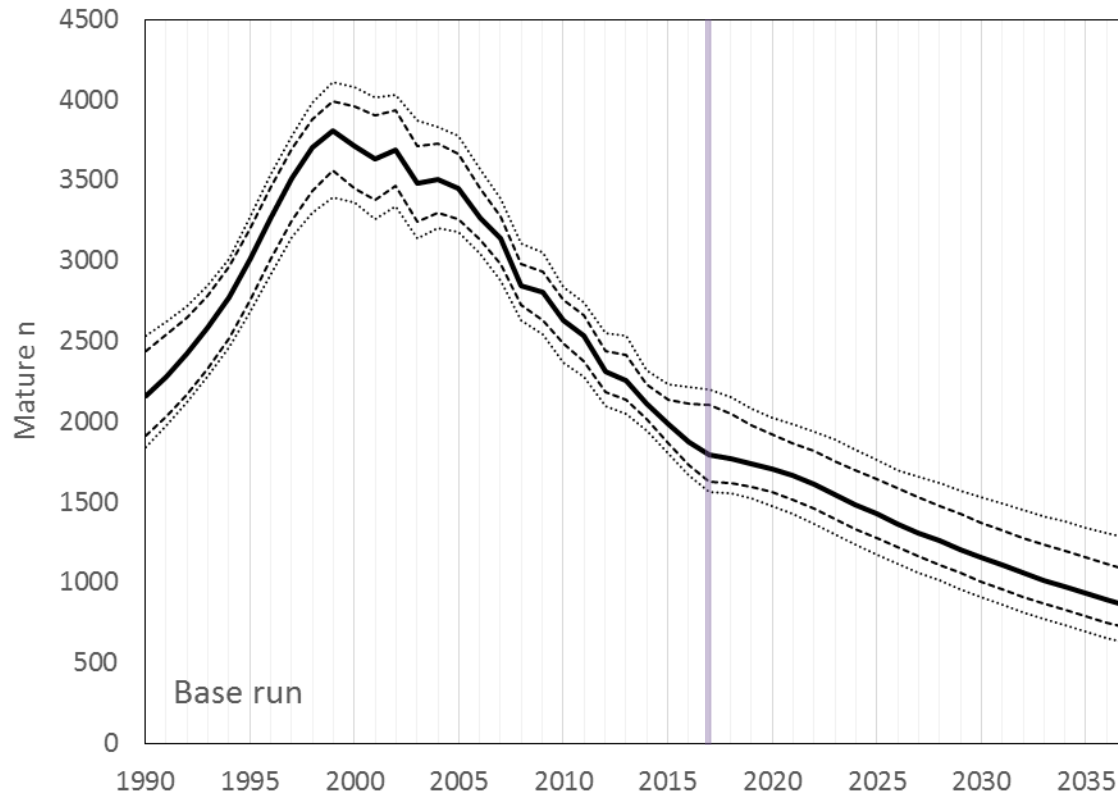


# MCMC outputs – Tag loss & $N_0$ (1990)



$N_0 = 1,780$  (1,640 – 1,970)

# Auckland Islands MCMC – Projection



$$\lambda_{2037} = 0.959 (0.952-0.968)$$
$$N_{2037} (\%N_{2017}) = 47\% (41-60)$$

# Actions still to be addressed

- Explore alternative rules for assigning pupping status
- Model runs from start of decline with/without threats
- Explore effects of phantom tags on parameter estimates
- Year subsets to assess model predictions v observed

# Otago Peninsula assessment

# Otago Peninsula assessment update

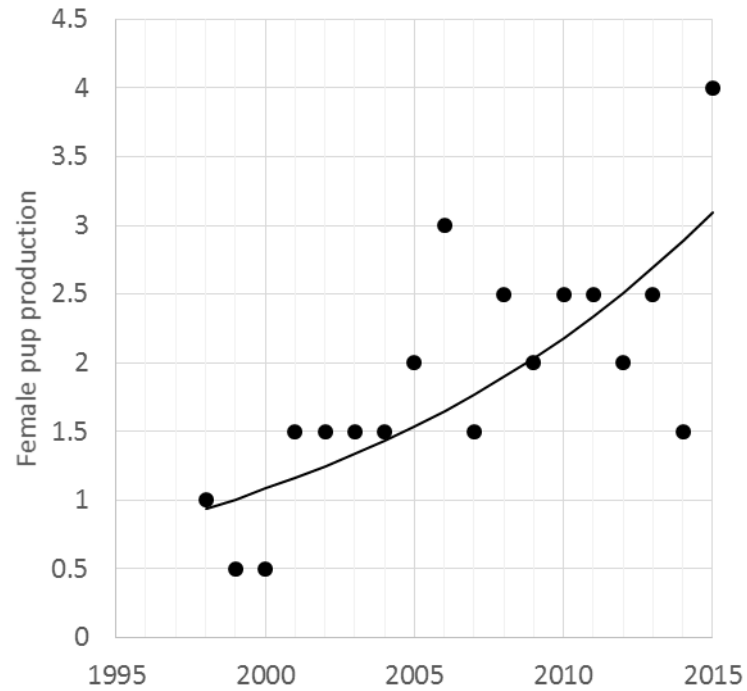
Added 2014/15 observations:

- 8 pups born
- Related to mothers (Sealion Trust family tree)

Changes to parameterisation for MCMC:

- Year-invariant parameters
- Survival ages 0, 1-5, 6-14 & 15+
- Combined resighting probability for ages 1+ immature & non-puppers
- Pupping rate age 7+; relative pupping rate age block 4-6
- Resight puppers fixed to 1 (MPD estimate at upper bound)

# Otago Peninsula – Fit to census

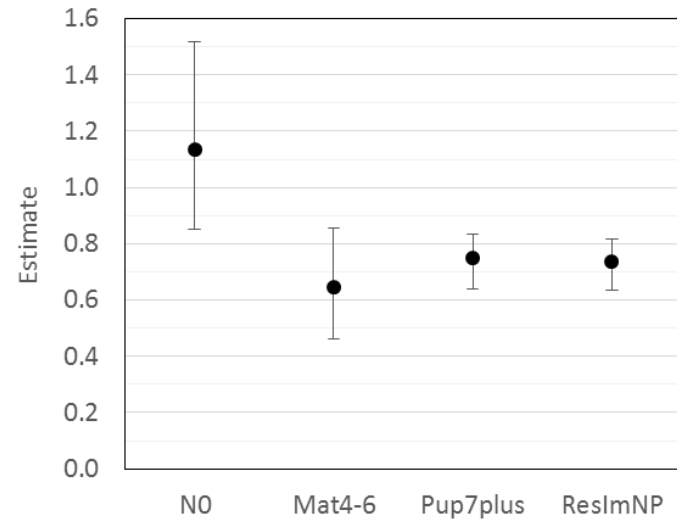
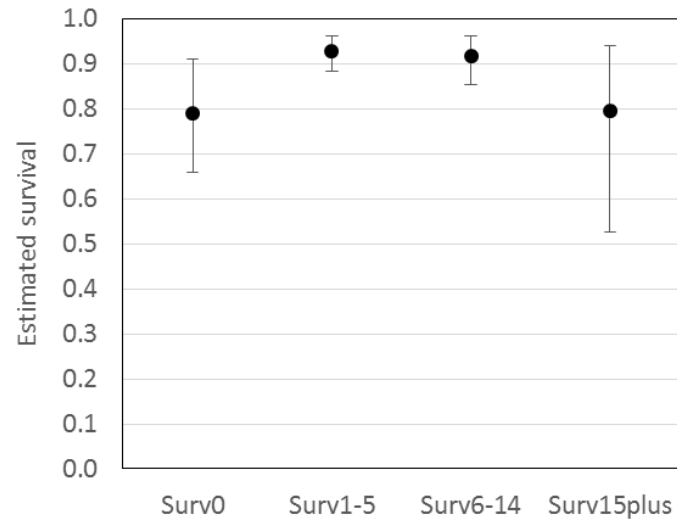




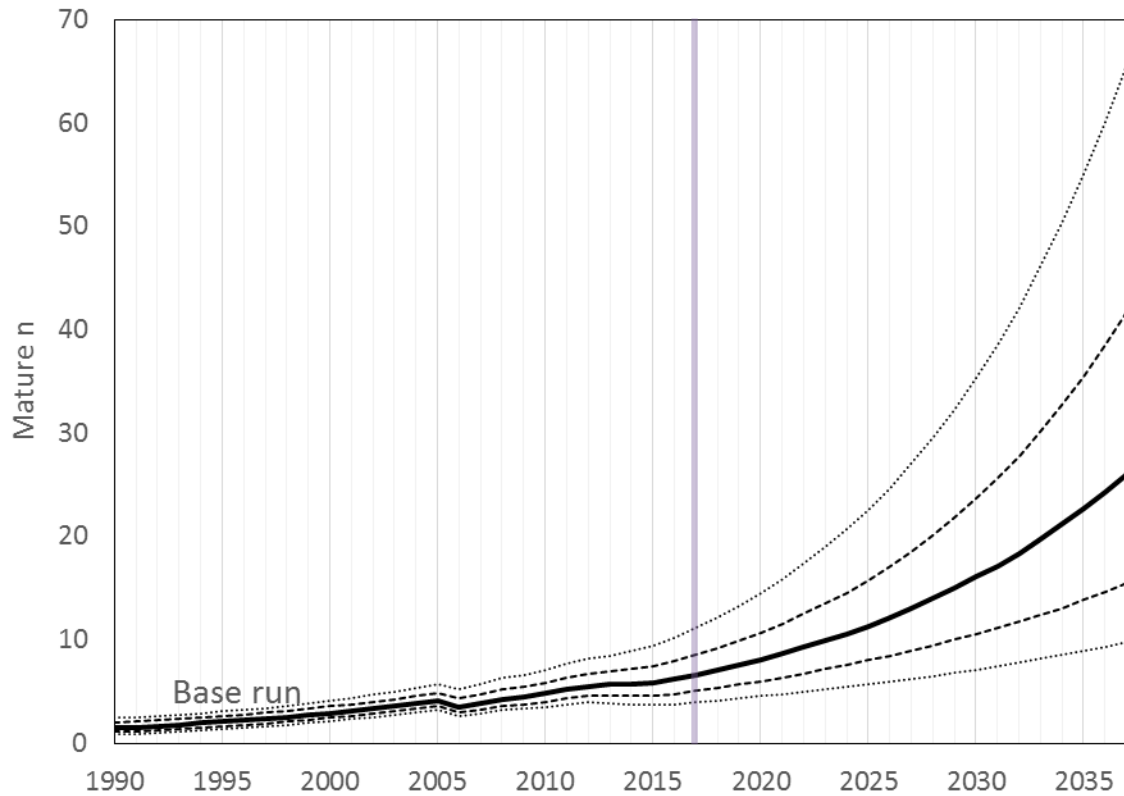
# Otago Peninsula MCMC parameter correlation assessment

	<b>Surv0</b>	<b>Surv1-5</b>	<b>Surv6-14</b>	<b>Surv15plus</b>	<b>Pup4-6</b>	<b>Pupp7plus</b>	<b>ReslmNP</b>
<b>N0</b>	-0.20	-0.27	-0.14	-0.10	0.04	-0.13	0.05
<b>Surv0</b>		-0.27	-0.34	0.06	-0.14	-0.07	-0.18
<b>Surv1-5</b>			-0.38	-0.19	-0.11	-0.11	0.05
<b>Surv6-14</b>				-0.16	0.07	-0.16	0.02
<b>Surv15plus</b>					-0.08	0.07	-0.04
<b>Pup4-6</b>						-0.40	0.15
<b>Pupp7plus</b>							-0.00

# Otago Peninsula MCMC – Fit to census (MPD) & estimates



# Otago Peninsula MCMC – projection



$\lambda_{2037} = 1.07 (1.05-1.09)$   
 $N_{2037} (\%N_{2017}) = 390\% (290-530)$

End of demographic assessment presentation