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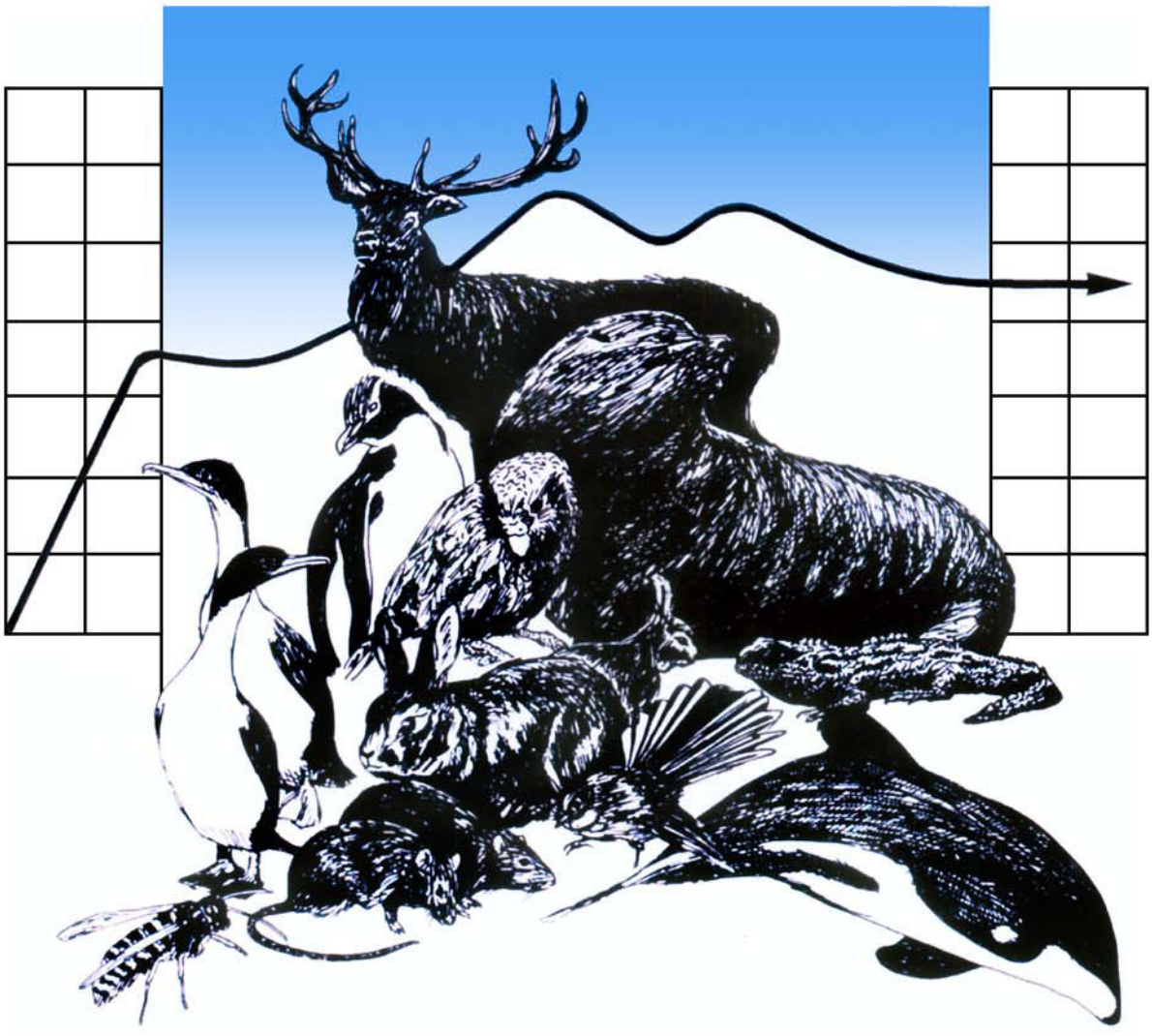

WILDLIFE MANAGEMENT

Kaki Release Strategies

Scenarios derived during a workshop at the
Department of Conservation Twizel Area
Office on 22 March 2012

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Explanatory Note

A total of seven kaki release strategies are presented separately below, as written up by the listed authors. Each of the six teams was given the same information relating to current wild and captive populations, wild survival rates for different cohorts, captive facility capacity, and wild and captive egg production annually. Specific budgetary implications were not included, but logistiocally unrealistic alternatives were eliminated during discussions. Each team was asked to design a release/management strategy for a four year period, detailing the numbers of each age class to be either released or kept in captivity each year.

Summary

Table 1. Four-year kaki release strategies (see text for details).

Strategy	Left to hatch in wild	Juvenile (3 months) release	Sub-adult (9 months) release	Immature (>1-<2 yrs old) release	Adult (2 years) release
1	0	0	62		24 every 2nd yr
2	0	20	70		10 Yr 1 & 2
3	0	0	75		25 Yr 1 & 2
4	0	50	50		0
5	0	40, 24, 24, 24	24, 18, 18, 18	18, 12, 18, 12	18, 18, 18, 18
6	40 eggs Yr 2	35	40		15 x 4 yrs
7	32 fledglings	0	68		10

Table 2. Estimated wild population outcomes for each proposed kai release strategy (see text for details)

Strategy	Year 1	Year 2	Year 3	Year 4	Notes
1	57	88	94	121	89% adult survival
2	51	67	83	98	0% recruitment of released sub-adults
3	51	66	80	93	With 0% adult recruitment
4	51	67	88	108	Not include Yr0 non-adults
5	51	78	95	112	Best case estimated rates
6	51+	66	75	85	With 0% adult recruitment
7	51	58	86	103	50% adult survival

Kaki release strategy 1 - Samantha Ray and Cayley Coughlin

The main idea behind this strategy is to release Kaki once they have reached either sub-adult stage (1 year) or release when they have reached adulthood (2 years). Previously juveniles were raised and released – however in this strategy, they are kept over a longer period of time until the sub-adult stage. Sub-adults are the main focus of this strategy over juveniles as they require the same aviary space and just a longer period of time (same amount of space, but does not interfere with eggs/increase in hatchlings but greater recruitment rate). Since there are no statistics on the survival and recruitment when releasing adult Kaki, a small sample of released Kaki at this age would be beneficial. This way, if the recruitment of Kaki was much greater than both sub-adult and juveniles, then it would be the best interest to optimize these benefits. Breeding pairs and juveniles are kept as a safe-guard of the captive breeding and wild populations. Another idea is to feed Kaki with dried insect mix to integrate them into the environment and reduce the time Kaki spend around the feeding bowls when they are released as there may be an increased chance of predation around the food bowls. If more breeding pairs are established in the wild, eggs could be released to wild Kaki pair to understand the survival and recruitment of the wild population without the Kaki population being negatively affected if in the worst case no eggs survive. In the first year, sub-adults are kept instead of juveniles (released after one year), along with the breeding pairs (their juveniles) and 24 Kaki that are not released until after the two year mark. Again, sub-adults would be released at the end of year two with the previous adult Kaki now also being released. This would repeat over the 4 year plan, with a greater number of birds being released at the end of year 2 and year 4. However, recruitment rate of the adult Kaki would not occur until one year after being released into the wild.

For this strategy the number of chicks allocated to release as either sub adults or adults was based on aviary space. Four aviaries are allocated to those released as adults (24 Kaki can be housed in total), nine aviaries were allocated for birds released as sub-adults (54 Kaki can be housed in total) and four breeding pairs which raise three chicks each (thus 12 more Kaki can be raised and released as sub adults). Thus only enough eggs to produce 78 chicks will be incubated.

In year one 24 chicks will be allocated to be raised as adults and 66 allocated to be released as sub adults. No individuals from the aviaries will be recruited in year one. Thus with a starting wild population of 57 in the wild and a recruitment rate of 0.89 the total number of adults in the wild at the end of year one will be 51.

In year two the 24 chicks raised to be released as adults in year one will be

released but not recruited until the following year. Also 66 more sub adults will be raised and released but not recruited. However the 66 sub-adults released in year one are now recruited. With a sub-adult recruitment rate of 0.29, 20 more adults will be recruited into the wild population. Thus there will be a total of 65 adults in the wild population.

In year three 66 sub-adults will be raised and released and 24 chicks will be allocated to be released as adults in the following year. The 24 adults released from last year will undergo recruitment as well as the 66 sub-adults released last year. The best case scenario involves a recruitment rate of 0.89 for the adult releases whereas the worst case scenario is a recruitment rate of 0. Therefore best case scenario there will be 99 adult birds in the wild population at the end of year three or worst case 78 adult birds in the wild.

In year four the 24 allocated for adult release in year three are now released but not recruited. 66 more chicks will be raised and released as sub-adults. The 66 released as sub-adults from the previous year undergo recruitment resulting in 20 more adult birds in the wild population. Thus in the best case scenario at the end of year four there will be 108 adult Kaki in the wild population, whereas worst case scenario there will be 89 adult Kaki in the wild. Depending on the success of the wild population, eggs being placed in wild Kaki nests may now become an option.

In year five, best case there will be 137 adults in the wild, worst case there will be 99 adult Kaki in the wild.

Kaki release strategy 2 - Claire Wilden and Jackie Spencer

Wild release: Fledglings Juveniles (3 mo) Sub-adults (9 mo) Adults (2 yrs)

Year 1	0	20	70	10
Year 2	0	20	70	10
Year 3	0	20	70	10
Year 4	0	20	70	10

With current practices the kaki population has reached a plateau. The need has risen to investigate ways of increasing kaki numbers without taking too much risk.

There is a 5% better recruitment rate between sub-adults then juveniles so we believe it is possible that releasing adult birds (2 years) may result in better survival rates. Whilst releasing only 10 adult birds after the first two years then 10 every year there after is a relative small sample we feel that we want to reduce risks and also the adult birds need to be kept in aviaries until 2 years and there could be problems with birds getting on. It may be difficult to house more adult birds at this stage when we don't know if this method is feasible.

The bulk of birds released will be kept at 9 months and 20 will be released a the juvenile phase and this will help to free up cages.

Predicted wild population using the above stategy

Wild pop. (0% released adult survival)

Wild pop. (100% released adult survival)

Year 1 51

Year 2 67

Year 3 83 92

Year 4 98 114

Kaki release strategy 3 - Kate Dyson and Elle Haag

Release 75 sub-adults and 25 adults, and accommodate adults by sub-dividing large aviaries (A1, A4, B1 and B4 in Twizel, and BS3 and BS1 in Christchurch.

Which age class should be released?

- Not eggs: Does not make sense to place eggs straight into the wild due to the high susceptibility of chicks to predation.
- Not juveniles: Should keep kaki six months more to increase recruitment by 5%, especially as this does not clash with breeding season.
- Sub-adults: There is good data supporting the high recruitment rate of sub-adults (n = 674)
- Adults: Should investigate potentially high recruitment of adults because current data is not convincing (small sample size), and it is possible that adults may be more resilient to predation due to a more robust body size and better antipredator responses.

How many of each class should be released?

- Not 50/50 sub-adults/adults: If adult recruitment is found to equal zero, then we are only contributing 14 individuals to the wild population each year. Therefore we need more sub-adults to ensure some recruitment if adult recruitment is found to be non-existent.
-75/25 sub-adults/adults: We will ensure an addition of 21 to the wild population each year from the sub-adults if adult recruitment is found to be zero (Figure 1). Also this is only 8 individuals less than if we had released 100 sub-adults, therefore we are sacrificing only 8 individuals to investigate a potentially much greater payoff of releasing adults.

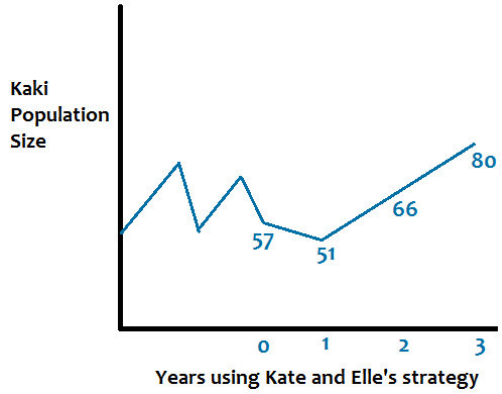

Figure 1. Worst-case scenario change in kaki population numbers using the release strategy of 75 sub-adults and 25 adults, assuming 0% adult recruitment

Kaki release strategy 4 -Leon Berard and Richard Laming

February of years 1-3: Release 50 juveniles into wild

September of years 1-3: Release 50 Sub-adults wild

This strategy will be both cost effective with two releases per year, and not crowd the aviaries. This will allow more research on factors which are affecting the low recruitment rate of juveniles and sub-adults. If the population is to recover to the point that it does not require intensive management then this recruitment rate will have to increase, therefore some research must be carried out to investigate various influences. These could include:

- Whether predators can predict routinely placed supplementary food placement
- Interactions of Kaki predators and the effect of decreasing the numbers of one or several species on the food web

The decision to release Kaki in large groups is based on the idea that flocking may act as an antipredator mechanism, increasing the vigilance of the flock so they can better avoid predators. Having a large group of similar aged kaki in the wild also encourages them to choose their own mates, rather than being artificially paired. This will remove the possibility that certain traits such as aggressiveness are being gradually removed from the population. Animal behaviour literature suggests that aggression and boldness may be correlated with each other, as well with an increased reproductive success. If this is the case then it may pay to limit interference with existing predator defence and mating behaviours.

Supplementary feeding of fertilised female Kaki, particularly in years of low natural prey biomass, may also enable them to invest more resources in their eggs, thus increasing their chances of the young surviving once released into the wild.

Predicted population numbers, based on 57 adult birds currently in wild:

End of year 1: 51 adults

End of year 2: 73 adults

End of year 3: 80 adults

End of year 4: 86 adults

(Note that these predictions do not take into account any juveniles or sub-adults currently in the wild, as well as excluding juveniles and sub-adults released in February and September of year four.)

Kaki release strategy 5 - Aniela Reid and Lisa van Halderen

We wanted to investigate whether releasing immature birds (birds which have been held in the aviary for 1 year, that is six months longer than the sub adults) would increase recruitment rate compared to sub adults. We also wanted to investigate the survival rate of released adult birds (birds which have been held in the aviary for 2 years) - in the past the survival rate has been shown to be 0, but this was based on a small sample size of 'unfit' birds (ones that didn't breed or show appropriate behaviour in the aviary)

As we did not know recruitment rates for either immature or adult birds, we hypothesized 3 different recruitment rate values based on different scenarios

Best case: we hypothesized that increased time in the aviary would be beneficial – it was shown from juvenile (24%) to sub adults (29%) there was an increase in recruitment rate of 5%. We used this to extrapolate the recruitment rates for immature birds (34%) and adult birds (39%)

Moderate Case: we based recruitment rates for immature and adult birds on the known sub-adult recruitment rate of 29%

Worst Case: that recruitment rates for immature and adults was 0% - therefore only juvenile and sub adults would be recruited into the wild population. This was based on the fact that the survival rate of those adults released was 0%.

Table 1: Management Plan: Number of released birds from the different age groups across 4 years. Based on 108 free aviary spaces (using the Christchurch aviary as well as the Twizel aviary) and 100 surviving hatchlings

	Year 1 release		Year 2 release		Year 3 release		Year 4 release	
	Feb	Sept	Feb	Sept	Feb	Sept	Feb	Sept
Arising from 1st year batch of 100 eggs	40 Juveniles	24 Sub Adults	18 Immature	18 Adults				
Arising from 2nd year batch of 100 eggs			24 Juveniles	18 Sub Adults	12 Immature	18 Adults		
Arising from 3rd year batch of 100 eggs					24 Juveniles	18 Sub Adults	18 Immature	18 A

Table 2: Recruitment Rates across different scenarios

Juvenile Recruitment Rate	0.24
Sub Adult Recruitment Rate	0.29
Immature Recruitment Rate Best Case Scenario	0.34
Immature Recruitment Rate Moderate Case Scenario (Based on Sub Adults)	0.29
Immature Recruitment Rate Worst Case Scenario	0
Adult Recruitment Rate Best Case Scenario	0.39
Adult Recruitment Rate Moderate Case Scenario (Based on Sub Adults)	0.29
Adult Recruitment Rate Worst Case Scenario	0
Adult Survival Rate	0.89

Table 3: Raw data of number of adults recruited and surv in the wild population with the different case scenarios

	1st year	2nd Year	3rd Year	4th Year
Worst Case	51	63	69	
Moderate Case	51	73	86	
Best Case	51	76	91	1

Kaki release strategy 6 - Kelly Frogley and Sam Haultain

Our strategy aims to increase wild kaki population numbers by focusing on four stages of kaki captive breeding development. We would aim to run our strategy for at least four years in order to get a more accurate estimate of the recruitment rate of four age classes of captive bred Kaki into the total wild adult population.

In year one, we would collect the available 160 eggs (wild and captive) of which 100 would fledge (62.5%). We would release 40 as juveniles, 45 as sub-adults and keep the remaining 15 birds in the aviary to release as adults after two years.

In year two, we assumed that we could once again collect 160 eggs and that we have space in the aviaries to accommodate up to 100 birds. Because we are holding 15 birds from year one, we only need to ensure 85 fledge. If we assume that 62.5% of the eggs fledge, we only need 136 eggs. The remaining 24 would be returned to the wild after incubation. During year two, we would release 35 juveniles, 35 sub-adults and at the end of the year we would release the 15 birds from year one, which would now be adults. Once again we would keep 15 new birds to be raised to adults and released the following year.

Years three and four would follow the same pattern as year two.

The number of wild eggs collected each year may vary with an increasing wild population. However, for this estimate we kept the total number of eggs collected to 160. Of the eggs returned to the wild in year one, the 4% recruitment was added to the total population after three years (two years to mature and one further year of survival).

Based on previous data we assumed a 0% survival rate of birds released as adults. If the survival rate of birds released as adults was in fact higher than 0%, our model would adjust for this after year four and the total surviving birds would be added to the total wild population one year after their release.

Y1 = 57 x 0.89 =**50**

Y2 = (Y1 + (40*0.25) + (45*0.29)) x 0.89 = **66**

Y3 = (Y2 + (35*0.25) + (35*0.29) + (15*0)) x 0.89 = **75**

Y4 = (Y3 + (35*0.25) + (35*0.29) + (15*0) + (24*0.04)) x 0.89 = **85**

Kaki release strategy 7 - Kate Hand and Jordan Lasenby

Our focus for the release strategy was maintaining a high level of recruitment using the best release strategy to date 29% recruitment from releasing sub-adults and increase our knowledge of wild recruitment. The reasons for this include 1). To determine if kaki can maintain a self-sustaining population in the wild as the only data is out of date (1978-1981) 2). Determine if the predator control operation is having a positive effect (particularly of fledging success). While the current recovery plan focuses on a holding pattern and increasing the population to 250 wild adults. It is important to keep looking forward and to start gaining knowledge if kaki can one day maintain a self-sustaining wild population.

Using the scenario of having 160 eggs which produced 100 fledging chicks, we decided to return the last batch of eggs (incubated and fertile) back to the wild parents. Assuming there are eight wild pairs a maximum of 32 eggs (four eggs each) would be returned. While this may seem like a large amount to "gamble" with, by keeping the remaining 68 approx. eggs to at least sub-adult it is predicted that the overall wild population will continue to increase by a minimum of 17 individuals per annum after the 2nd year. Assuming, based on previous but likely biased results of adult releases, the captive adults have a recruitment of 0% the yearly population estimates are Y1=51, Y2=53, Y3= 81 and Y4 = 99. A more opportunistic expected recruitment of 50% of adults would improve yearly estimates to Y1=51, Y2=58, Y3=86 and Y4 = 103.

By returning the last clutch of eggs back to the parents, this will free up space in the aviary for up to 10 birds to be kept till the age of two. This will also allow for flexibility as bird may need to be moved between enclosures due to fighting etc. The benefits of this include replacing older breeding pairs and always having the maximum of six breeding pairs in captivity. Excess birds can then be released as a pilot study. According to our calculations the numbers of bird we can keep to two years old was only 10, probably not enough to get reliable data however information on survival of adult birds could still be gathered. In hindsight increasing this number would allow for statistical analysis and more robust conclusions. We also discussed the novel idea of releasing paired birds (both new and older pairs), however after discussions with Liz we decided it was too risky loosing established captive pairs. Also our release sizes were too small and the effort needed to pair birds would outweigh any possible benefits.

Overall we feel this would allow investigation of both wild fledging survival and an indication of adult release success to help inform future strategy design.