'Instincts'

Orange-bellied Parrot (*Neophema chrysogaster)* Captive Management Using Biological Data

http://www.parrotbreeding.com.au/resources/orange-bellied-parrot-instincts/

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Abstract

The Orange-bellied Parrot is faced with a number of challenges and does not need the added potential pressure of reduced vigor and loss of instinct in their overall well-being. They must be bred fit enough to be able to fledge, as well as have enough muscle tone to soon after fly across the challenging Bass Strait, with excellent cognitive and sensory functions. This migration puts a huge pressure on the Orange-bellied Parrot physically, so if any organ is not performing at its optimum, this will act against the individual and hence the survival of the species.

This study examines the collection of biological data as a useful tool in determining pair compatibility and breeding success of an Orange-bellied Parrot population. This is possibly the most detailed and documented study on the breeding biology of Orange-bellied Parrots with a focus on embryonic development, to date.

We identified primary biological parameters then formulated a method for constant and consistent measurement and collection. By finding the means and noting abnormalities, the results indicate fitness of individuals or likelihood of survival and the compatibility of current pairings for producing viable offspring.
Biological data such as pair compatibility, embryonic growth and neonatal development can be used to optimize captive population management (especially those limited in genetic diversity). It enables observations of breeding such as pair interactions/suitability, as well as compatibility for producing viable offspring, to be taken into account for assessing future pairings. This can also help to clarify any pairings determined by mathematical algorithms, including those using mean kinship such as studbook management computer programs. Hence producing individuals with the best chance of thriving in reintroduction into their wild habitat.

A comparison was made with the eggs and chicks produced by the Orange-bellied Parrots and the rest of the Priam parrot collection. We found a similar fertility rate but a much higher embryonic and nestling death rate in the Orange-bellied Parrots. The data collected from the managed incubation indicated a lack of allantoic development within the egg and very few eggs pipping in the correct position for hatching. Both of these factors are likely to have contributed to the high embryonic death.

These development issues during incubation were not only specific to certain pairs, they occurred across all pairs and trios. The chicks that did survive past fledging however did achieve normal vein development during the incubation period and were produced by only two females.

Introduction

In nature, only the fittest individuals (those with vigor) of a species survive through the process of natural selection (Gill, 1995). Biological data such as egg quality, development of the embryo within the egg, hatching success, and chick development and survival can all indicate the compatibility of a breeding pair. Recording and analyzing this data enables one to predict which pairings of birds will produce fit, viable offspring and which produce young that are likely to suffer embryonic death, juvenile death, or any abnormalities throughout the chick's development, from egg to fledging (Batty, 1997). At Priam Psittaculture Centre, we are individually identifying all eggs produced by the Orange-bellied Parrots (OBP) for reintroduction into the wild. Observations and records are made throughout all aspects of OBP captive breeding, from egg laying to fledging.

Through recording biological data we are able to predict which individuals in a captive breeding program are likely to produce the healthiest, most viable offspring and thus target our resources towards maximizing their success. In a similar method to natural selection, if only the parents producing the viable chicks are selected to breed each year then the fitness of the overall captive population may be increased while using fewer resources than attempting to breed every possible pair. Methods such as these can be used to verify mathematical algorithms in studbook management computer programs.

These mathematical algorithms can be used to determine hypothetical pairings which aim to ensure as much diversity in the gene pool for a particular species as possible (Oliehoek, 2014). This is a very different aim to that of succeeding in the goal of flying across the Bass Strait before the age of one, then returning to find food, nest and reproduce. Perhaps by focusing only on the diversification of genetics in an attempt to ensure a statistical prevention of the loss of vital genes, we may be eliminating some of the necessary traits for survival.

At Priam, rigorous scientific methodology is applied to the collection and recording of biological data (such as individual egg identification linked with an exact time and date of lay and hatching) of every pair of birds in the collection (Voren and Jordan, 1992). Thus, the overall incubation and breeding success of the OBP collection at Priam can be compared to the results from the entire Priam psittacine collection (consisting of ~300 breeding birds, of which ~90% are IUCN Red listed species), for the same breeding season. This will help to indicate any anomalies specific to the OBP's, in contrast to those affecting the entire collection (e.g. seasonal variation, etc.).

Throughout the study we looked at the eggs produced by traditional pairs, one male and one female as well as those produced by trios, one male and two females in a breeding flight. The level of detail included monitoring the allantois (the blood vessel membrane within the egg (Brown, Robbins, 2002)) development with correlation to time (Harvey, 1993).

Method

The total number of individuals included in this breeding season was 20 OBP's, consisting of 8 males and 12 females. Of these there were four pairs in flights C1, C2, C7 and C8 and four trios in flights C3, C4, C5 and C6 set up in eight individual breeding flights. Each flight had access to a minimum of two nest boxes.

All breeding flights were suspended with metal dividers between flights preventing visual contact to any other flight. Each flight was approximately 900mm wide x 1200mm high x 2700mm long with 1/3 of the length covered and an enclosed service area for feeding, water and nest box access.

Nest boxes were checked on a daily basis once activity inside the boxes was observed and any eggs laid were substituted with a plastic artificial egg. Approximately seven days after the final egg of the first clutch was laid five females had their eggs removed to simulate a predation of the clutch and stimulate a second clutch in the season.

Each egg from the nest box was marked with a unique identifier called an egg number, written in pencil on the shell. The date and time as well as the unique identifier were recorded on the individual flight's data sheet at the rear of each aviary. The substituted eggs were taken to the incubation room to be processed. Processing of each egg involved taking a fresh weight of the egg, measuring length and breadth of the egg, and noting the presence/absence and size of an air cell, and the external shell condition. An egg lume was used to illuminate the inside of the egg. Any sign of fertility (allantoic vein development) was also noted and any cracks or holes in the eggshell were repaired with Cyanoacrylate (glue similar to vet bond).

For each egg collected the volume was also calculated and an estimated fresh weight if the egg was not recently laid. The density of the egg was also calculated and this can be used to estimate the lay date, if it was unknown (Appendix 1). The details of the incubator the egg was placed into was also noted and included model, serial number, parameters, temperature, humidity and turning regime.

The incubators used were the AB Newlife Mk 6 turning incubator (Temperature: 37.2°C ± 0.1°C, Relative humidity: ~70%), Octagon 20 (Temperature: 37.2°C, Relative humidity: 70% and 30%), AB Newlife Hatcher (Temperature: 36.5°C ± 0.1°C, Relative humidity: 60%). The AB Newlife turning incubator performed high frequency turning with 96 turns per day at 180° per turn.

Development of the egg inside the incubator was monitored for fertility, growth of the allantoic membrane, drawdown of the air cell and external pipping. At each of these stages the egg was weighed again to determine density, day of incubation period (based on an incubation period of 20.8 days and expected pipping of 18.2 days, based on the 2012 breeding season research results at Priam), percentage vein growth, and the percentage weight loss of the egg (Appendix 1). These factors determined when the egg was moved from the turning incubator (first 50% to 52% of incubation period) to the gradual rocking incubator, to the hatcher. The percentage weight loss of the egg determined the need for a high relative humidity incubator (70%) or a low relative humidity incubator (30%). If weight loss was too

low (below 10%) then the egg was moved to the low relative humidity incubator to create a greater weight loss and increase the chance of a successful hatch.

When the egg was moved from the turning incubator to the gradual rocking incubator, the air cell line was marked with a pencil to easily observe the commencement of the air cell drawdown. Once external pipping was observed in the shell, the site of pipping was marked and noted, as well as the second air cell line and the egg was moved to either the hatcher or back to the nest box to hatch and be parent reared. If the egg went to a nest box then it was placed into one with artificial eggs and was due to have eggs hatching at that time. One artificial egg was removed from the box when the hatching egg was introduced.

Those eggs placed into the hatcher in the incubation room were monitored during the hatching process for further drawdown, pipping, movement, heart rate and appearance of the allantois. Once a chick was successfully hatched out of the shell it would remain inside the hatcher until it had passed the first faeces and appeared dry and active. It was then transported inside an insulated box to the nursery facility for hatch weight measurement, neonatal documentation and hand rearing.

All chicks were placed immediately into a AB Newlife 75 MK 3 brooder inside the nursery, with a temperature of 35°C ±1.0°C and relative humidity of 60-70%. As the chick developed it was moved onto the next brooder, being approximately 1-2°C lower than the previous. After the fourth brooder the chick was then moved to a plastic tub in the nursery, kept warm with heat mats and partially covered on top. Chicks stayed in these tubs until fledging where they were moved into an outside flight adjoining the parent OBP flights.

All hand-reared chicks were weighed daily and all feeding data such as date and time of feed, quantity fed, food type, and crop status was recorded. The chicks were primarily fed Harrison's Neonate (20% solid) and Pretty Bird 22/10 Hand-rearing formula (25% solid). The overall development and any abnormalities of the chicks were also recorded.

Results

During the 2013 breeding season there was a total of 69 eggs laid, of these 58 were artificially incubated, six were parent incubated and five were broken/damaged and unable to be repaired and incubated.

The fertility rate for the entire sample was 59.4% (65% minus the broken eggs) (*n*=41 eggs) (Fig. 1), with the embryonic death (growth of the allantoic membrane ceases and recedes with at times a green coloration inside the egg) rate from fertile eggs being 71% (*n*=29 eggs) (Fig. 2).

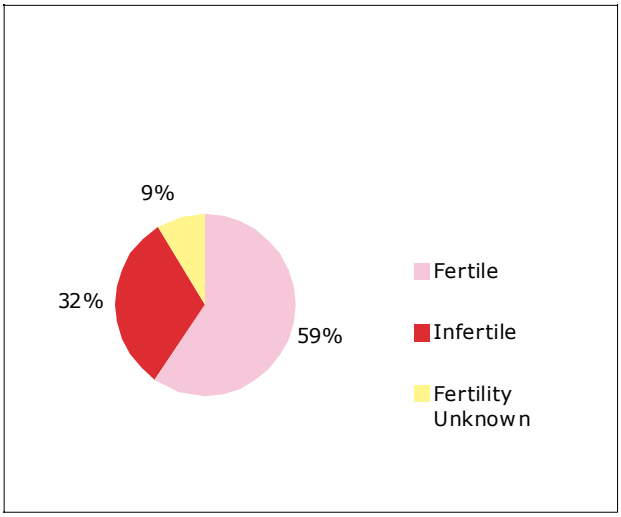

Figure 1. Fertility rate of the total OBP eggs laid during the 2013 breeding season.

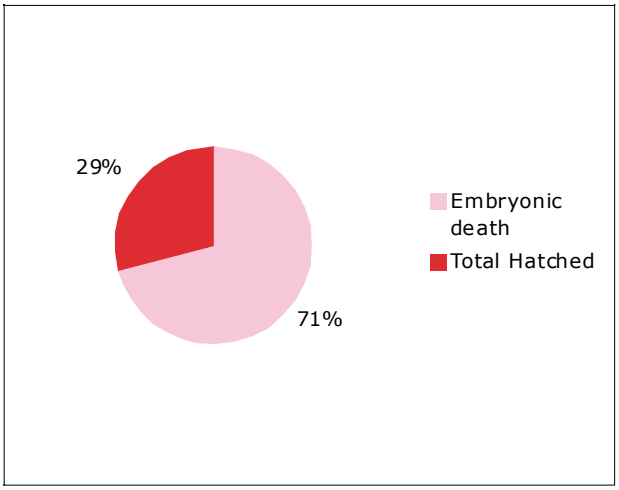

Figure 2. Comparison of the hatching success and embryonic death of all fertile OBP eggs laid during the 2013 breeding season.

Of the 53.7% (*n*=22 eggs) of fertile eggs that reached external pipping, 50% (*n*=11 eggs) pipped in the breach position (where the chicks head is at the pointed end of the egg, instead of the normal head position near the air cell at the rounded end of the egg), whilst 9% (*n*=2 eggs) pipped in the correct position (where the external piping is on the right hand side when looking at the egg vertically with the air cell at the top) for hatching, within the air cell (Fig. 3).

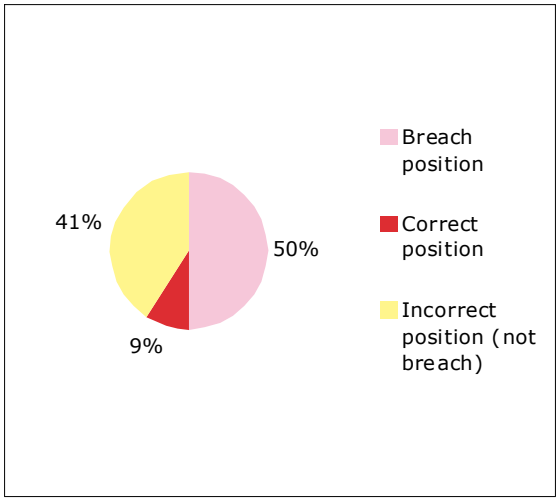

Figure 3. External pipping position of chick inside the egg of those OBP eggs that reached the external pipping stage of incubation.

The OBP eggs also did not reach the average (determined from many other psittacines) 100% allantoic membrane growth by 50-52% of incubation. Of the fertile eggs artificially incubated, 39% (*n*=11 eggs) never reached 100% vein development during the entire incubation period (Fig. 4). All flights with fertile eggs produced at least one egg that did not reach the 100% vein development (Fig. 5). All chicks that hatched successfully reached the 100% allantoic membrane development by 52% of the incubation time.

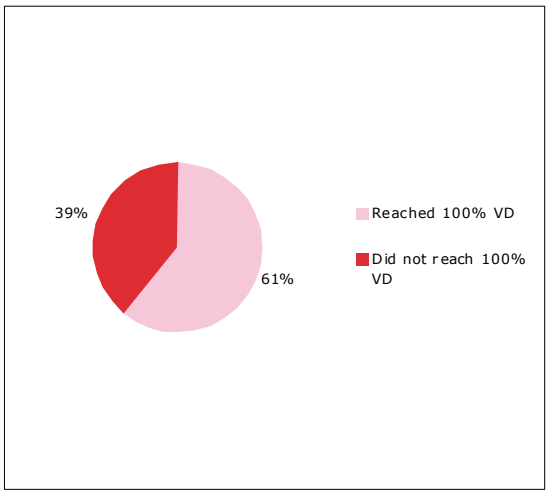

Figure 4. Allantoic membrane development (vein development (VD)) of the fertile eggs, at 52% of the incubation period.

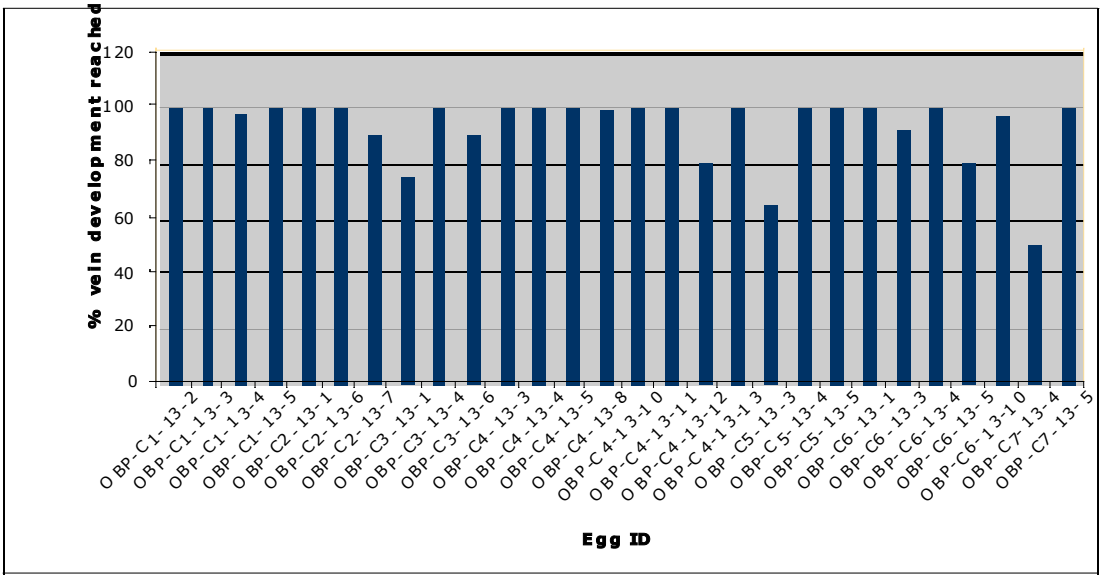

Figure 5. Percentage allantoic membrane development (vein development) reached at 52% of the incubation period for each fertile egg laid in each flight (C1-C7).

Flights C4 and C5, which both housed trios, were the only ones in which nestlings were produced that survived past fledging. Only one of the female OBPs in each flight produced the healthy young. The OBPs that did not produce any successfully hatched chicks were in flights C2, C3 and C7. The OBPs in C8 did not produce any fertile eggs.

From all of the fertile OBP eggs 29% (*n*=12 eggs) hatched successfully (Fig. 2) and of these 41.7% (*n*=5 chicks) of chicks were reared and survived past fledging (Fig. 6). The average OBP incubation period for this season was found to be 21.0 days, with external pipping at 18.8 days.

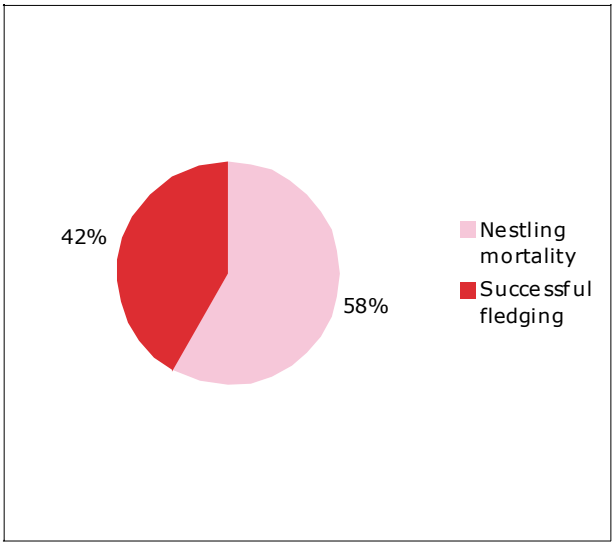

Figure 6. Comparison of the survival of all OBP nestlings.

Across the entire Priam parrot collection, excluding the OBPs, a total of 222 eggs were produced during the 2013 breeding season, with a fertility rate of 59% (*n*=129 eggs) and embryonic death rate of 29.8% (*n*=39 eggs) (Fig. 7).

From the fertile eggs produced by the Priam collection, 71.3% (*n*=92 eggs) hatched successfully and 92.4% (*n*=85 chicks) of the chicks survived past fledging (Fig. 7).

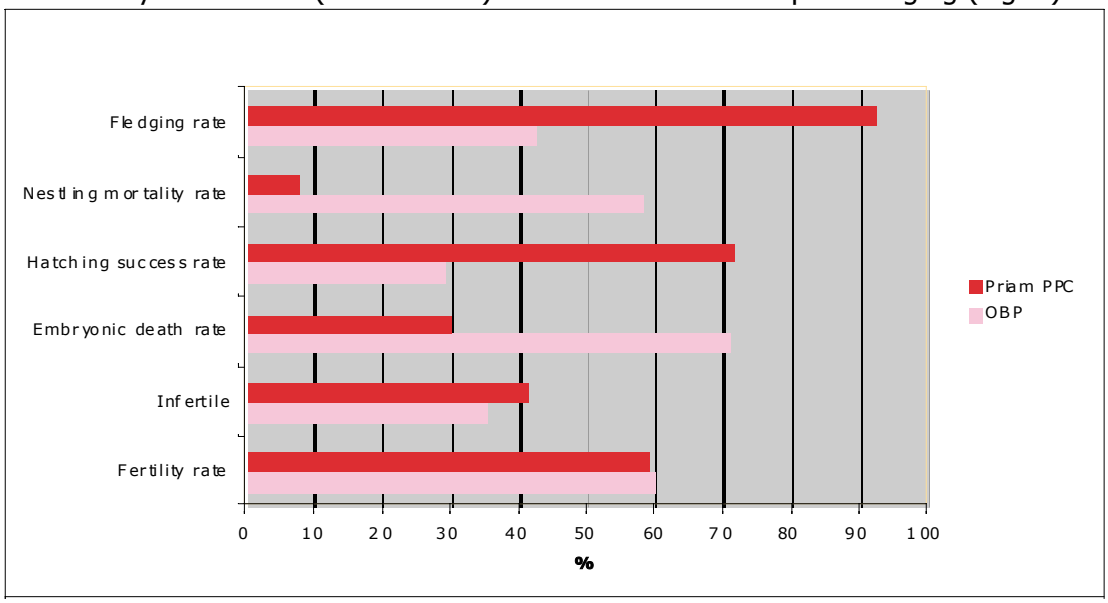

Figure 7. Comparison of the OBP (*n*=69 eggs) breeding, incubation and fledging success to the Priam parrot collection (*n*=222 eggs) for the 2013 breeding season.

Five OBP females were stimulated to double clutch by the removal of artificial eggs from the box, of these, three females laid a second clutch. One female laid a second clutch without any removal of the artificial eggs (Table 1). The two females that did not double clutch after removal of the eggs were both only one year of age.

Table 1. Number of eggs laid per female in each clutch and the average. Flights C3, C4, C5 and C6 contained a trio with 2 females.

Female in Flight	No. eggs in 1st clutch	No. eggs in 2nd clutch
C1	6	
C2	4	3
C3 (1)	6	
C3 (2)	4	
C4 (1)	5	4
C4 (2)	4	
C5	5	3
C6 (1)	5	4
C6 (2)	6	
C7	5	
C8	4	
Average	**4.909090909**	**3.5**

Discussion

The primary reason for collecting egg measurement data is to gain a picture of the biological health of the individual, pair and to increase hatching success, allowing for optimal management of environmental conditions for the developing chick, and early intervention if necessary (similar to a first term ultrasound in a mammal) (Jordan, 1989). This utilizes the limited resources (funding, facilities, time, etc.) more efficiently, from individual flight care to stud book recommendations.

Analysis of biological data in a captive population requires scientific procedure. Records of all useful data such as individual egg identification linked with an exact time and date are required as well as methods that are recognized globally (Voren and Jordan, 1992).

Measurements of allantoic growth, density changes, length, width and weight also give a snapshot of the female's health, possible dietary influences and pair genetic compatibility (Jordan, 1989). This technique has yielded extraordinary success in the captive management of many species of birds around the globe and adds a skill set that allows far greater success with little additional workload for these endangered species.

This sample produced a very high percentage of external pipping in the breach position and a very low percentage of eggs actually pipping in the correct position within the air cell. Along with the poor vein development this is likely to have contributed to such a low hatching rate.

From our previous incubation experience with other parrot species, assisted hatches are estimated at 0-1%, and always in the past a cause can be identified leading up to assisted hatch, usually involving eggs going over estimated incubation period time.

The OBP species in comparison to the other species bred at Priam produced eggs with a much higher embryonic death rate, more than double that of the Priam collection. This is similar to the fledging rate, in comparison the Priam collection fledged more than twice that of the OBPs housed at Priam. This would indicate the high mortality rate is specific to this collection of OBPs, given the same methods and equipment were used across all species bred at Priam.

From field research conducted by Mark Holdsworthy the mean incubation period for Orange-bellied Parrot eggs was 21.4 ± 0.8 days (n = 49 observed incubations) (Holdsworth, 2006). The average incubation period collected from the data presented here fell within the deviation from the observed average. In this sample the allantois developed much slower than expected or in some instances never reached 100% development. If the increase of temperature within the incubation process were to enable a more consistent allantoic vein development completion to 100%, we would also see the hatching time extend out of the observed wild incubation time frame. Similarly if we were to lower the temperature of incubation then there would be an extension of the length of the growth period towards the average, but at the detriment of the allantoic vein growth. Almost two thirds of the OBP eggs reached 100% allantoic development and these factors combined suggest that the incubation parameters used for incubating this sample did not influence the lack of vein development in the OBP's.

It is worthy of note that the average mean kinship of the OBP's at Priam is 0.075436842. This is considered higher than that of the founder population of OBPs in the current captive management group. The higher mean kinship indicates that the OBPs housed at Priam have a higher relatedness to the overall captive population and may influence their breeding success and offspring's vigor.

By releasing animals that have a low reproductive success rate we are placing on the wild population a pressure that may inhibit the breeding season. Individuals with a low fledgling success rate will still be competing for the consumption of limited food, nest sites, pairing partners at the cost/or detriment of other wild bred individuals. As those that are able to survive in the wild environment may pair with an individual that lacks vigor.

Biology can be used as a tool to determine the successful pairings that are derived from algorithms in studbook management programs. However, there is a need for quantifiable biological observations to be taken into consideration also when assessing the decisions made within these programs. This is crucial to enabling the establishment of a viable population that can be maintained into the future by the use of other algorithms that are able to optimize the use of a population in its recovery efforts. Most tools that are used in species population management are only able to usefully benefit sustainable management with the assumption that the outcomes will fall within an average representation of the species, not a deterioration and mutation of the species.

Conclusion

All Priam OBP breeding pairs and trios except for one pair produced fertile eggs (both birds in this pair were only one year of age) and of these, one pair and four trio's produced eggs that successfully hatched. Only half of the breeding flights successfully produced chicks. The chick mortality rate was more than half of all chicks hatched, with only two of the trios producing the successfully fledged chicks. This suggests these two trios should be considered to keep together in their current flight for future breeding, as they appear to be more compatible for producing viable offspring than the other 2 trios and 4 pairs.

Biology can be used to verify pair selection in collaboration with mean kinship and other science based data management tools.

However the accuracy of these findings would be improved by a larger sample size and a comparison to an OBP population with a much lower mean kinship, using the same methods presented in this study. Further research needs to focus on increasing the hatching success of OBPs, with an emphasis on allantoic development. This will then produce a greater sample size of nestlings to allow the progression of future research on the dietary influences within chick development and the species in general.

Appendix 1

Key Egg Incubation Formulas Units of Measurement: (all to 3 or 4 decimal places)

- Length (L) -Centimetres
- Weight (W) -Grams
- Time (T) -Days
- Volume (V) -Cubic Centimetres
- Density (D) -g/cm3/day

Calculation of an Incubation Time Period: **=**{[Time (mins)/60 + Time (hours)]/ 24} + days
E.g.
If Initial Start Time (T1) = 1350 Hrs 6/1/97 If Time of Period (T2) = 0715 Hrs 13/1/97
Therefore T1 – T2 = [(10/60 + 10)/24] + 6+[(15/60 +7)/24] = 0.424 + 6 + 0.302
= 6.726 days

Estimated Egg Fresh Weight (when unknown):
= Length x Breath x Breadth x 0.548

Daily Weight Loss Target Aim:
= (Fresh Laid Weight x Desired % Loss to pip) / Number of Days to Pip

Estimated % Weight Loss Trend at Time T (t)
= {{[(Fresh Weight – Actual Weight at T(t)) / T(t)] x Estimate Days to Pip} / Fresh Weight} x 100

Egg Volume: = Length x Breadth x Breadth x 0.51 **Egg Density:**= Egg Weight/ Egg Volume **Estimated Daily Change in Egg Density:**
= [Egg density at time T(1) – Egg Density at Time T(2)] / Time T(2) – Time T(1)

NB: Target Egg Daily Density Change should be a reduction of 0.006 g/cm3 /day NB: Normal Target Fresh Egg density = 1.075g/ cm3 NB: Target Hatch Weight = Approximately 65% of Fresh Egg Weight

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