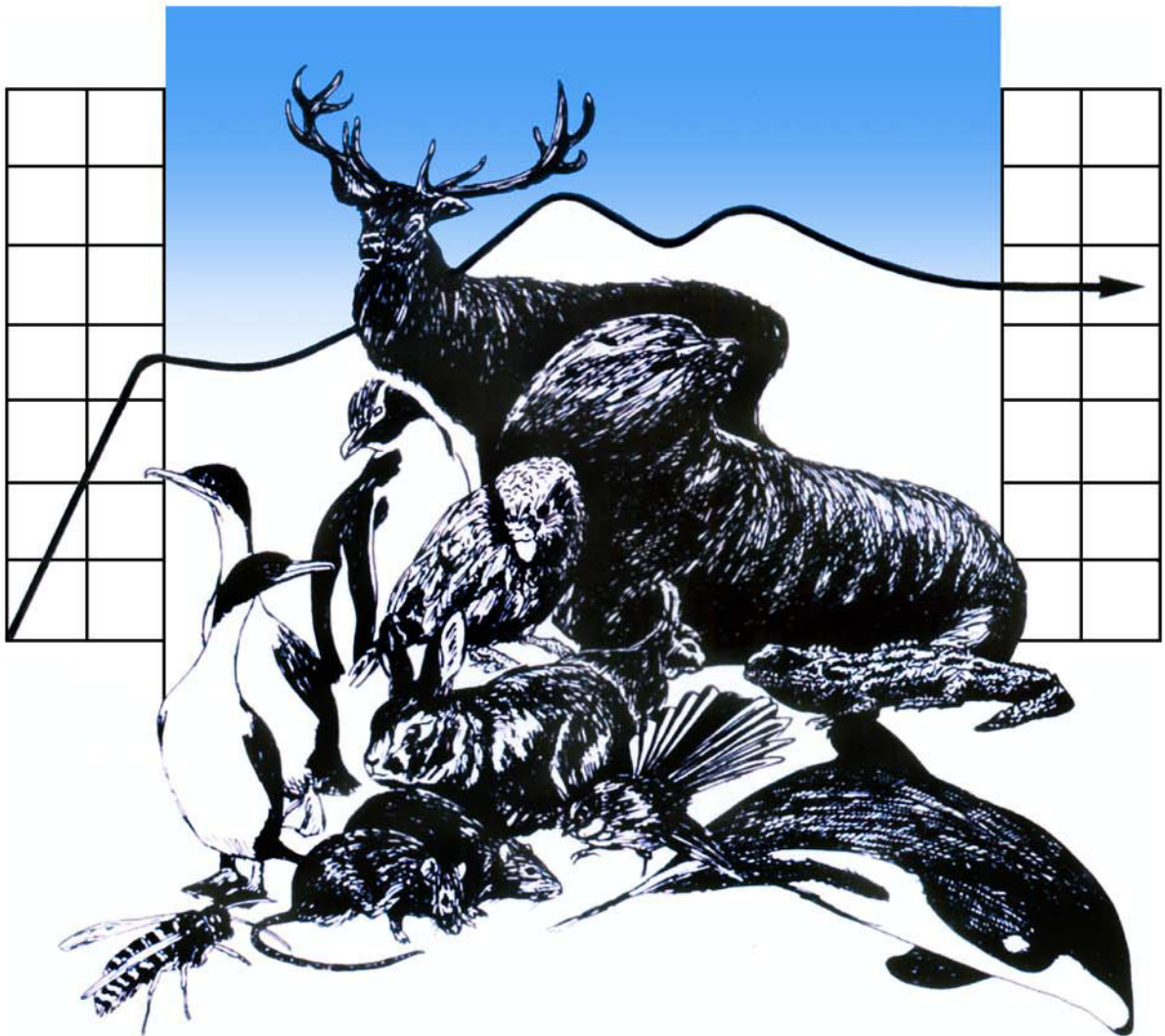




## DEPARTMENT OF ZOOLOGY



## WILDLIFE MANAGEMENT

**Egg Timer transmitters as a  
conservation management tool:  
Does the prototype kakapo Egg  
Timer transmitter accurately  
indicate the onset of nesting?**

**Jim Watts**

A report submitted in partial fulfilment of the  
Post-graduate Diploma in Wildlife Management

**University of Otago**

**2011**

University of Otago  
Department of Zoology  
P.O. Box 56, Dunedin  
New Zealand

5

Egg Timer transmitters as a  
conservation management tool:  
Does the prototype kakapo Egg  
10 Timer transmitter accurately indicate  
the onset of nesting?

15

**Jim O. Watts**

A research report submitted in partial fulfilment of the requirements of  
the Postgraduate diploma in Wildlife Management

20

**University of Otago**

**Year 2010**

25

30

35

## **Abstract**

40 The Egg Timer transmitter is a new technology being developed to detect the onset of incubation in the endangered kakapo after successful use on several species of kiwi. The transmitter measures daily kakapo activity levels and changes in activity can be used to identify incubation. This report examines the activity data of female kakapo during the 2011 kakapo breeding season on Codfish Island, New Zealand to test the ability of the Egg Timer transmitter to differentiate between non-nesting and 45 incubation activity. Overall, mean incubating activity was significantly lower than non-nesting activity. However, the Egg Timer transmitter was able to clearly indicate the onset of nesting for only two of the eight females that nested. Factors including high on-nest activity levels and a small incubation sample size contributed to outcome. Successful development of the Egg Timer transmitter will depend on its 50 ability to distinguish between different types of activity.

## **Acknowledgments**

55 The author would like to thank all the staff in the Kakapo Recovery Team on Codfish Island as well as the many volunteers who gave up their time to help out. Special thanks must also go to Shinichi Nakagawa for his statistical help with R.

## Table of Contents

60

<b>Introduction</b> .....	4
<b>Method</b> .....	6
Study Area.....	6
Egg Timer Data Collection .....	7
Statistical Analysis.....	8
<b>Results</b> .....	9
<b>Discussion</b> .....	15
<b>References</b> .....	18

65

70

## 75 **Introduction**

Wildlife management and conservation research are benefiting from smaller and smarter technology which is becoming increasingly tailored for use in these specific fields. One such technology is the Egg Timer transmitter. Developed by Wildtech  
80 New Zealand Ltd, it is revolutionising the way rare and threatened bird species are being monitored in New Zealand. The Egg Timer transmitter is a standard VHF transmitter embedded with Egg Timer software and includes an additional activity sensor. The activity sensor is a tiny cylinder with a ball inside of it. As the bird moves, the ball bounces around and creates small electrical impulses which indicate  
85 that the bird is active (TVNZ 2011). Using this activity sensor, Egg timer transmitters are able to collect and transmit information on how active a bird is each day. Egg Timer transmitters are species specific and must be developed independently for each species, based on an understanding of their active behaviours (J Wilks, Wildtech, 2011, pers. comm.).

90

At present Egg Timer transmitters have been successfully developed for several species of kiwi including the North Island brown kiwi and the endangered Rowi and Haast Tokoeka in the South Island (Foundation for Research Science and Technology (FRST) 2008). The Egg Timer transmitter has been developed so that when the  
95 software identifies that a kiwi is incubating (by a drop in activity) the transmitter changes pulse rate. It then transmits signals at 48 pulses per minute (ppm) to indicate incubation compared to the standard 30 ppm signal when the bird is not nesting (Brow et al. 2008). Additional information relating to a bird's activity can also be programmed into the transmitter. For the kiwi, Egg Timer transmitters can 'tell'  
100 researchers daily activity for up to seven days, when an egg was laid, how long it has been incubated for, and mean daily activity (Wildtech 2008a). An even newer transmitter for kiwis, the Chick Timer, can relay information on when an egg is laid, when a chick has hatched and even if a male is likely to abandon the nest (Wildtech 2009). All the information is transmitted through a series of audible VHF radio pulses,  
105 which are then counted to produce activity data.

To further improve kiwi monitoring, Wildtech New Zealand Ltd. has developed a computerised tracking system that is mounted to a Sky Ranger aircraft. The airborne technology automatically scans the kiwi habitat for all the birds, picking up data from their Egg Timer transmitters. It then identifies where each bird is located and whether or not it is nesting (Three News 2009). The concurrent use of Egg Timer and Sky Ranger technologies is saving kiwi researchers time and labour with one hour of Sky Ranger work replacing 45 days of field work (Three News 2009). Monitoring from a distance also means the birds are disturbed less, reducing the likelihood of a male kiwi abandoning the nest (FRST 2008). Proven as successful technology, Egg Timer transmitters are now being developed by Wildtech New Zealand Ltd. for takahe and kakapo (J Wilks, Wildtech, 2011, pers. comm.) with the latter being the focus of this study.

Kakapo (*Strigops habroptilus*) are a large, nocturnal, flightless parrot endemic to New Zealand. Once widely distributed throughout the main islands of New Zealand, kakapo numbers began to decline with the onset of human settlement. The decline can be attributed to habitat loss through land clearing, predation and competition from introduced mammals and hunting by humans (Cresswell 1996). The majority of the kakapo population can now only be found on Codfish Island (Whenua Hou) and Anchor Island with a few genetically over-represented males placed on other off-shore islands. With a population of only 129 birds, including the nine new chicks born during the 2011 breeding season, the kakapo is classified as ‘nationally critical’ by the New Zealand Threat Classification System (Miskelly et al. 2008) and ‘critically endangered’ by the International Union for Conservation of Nature (IUCN 2010). Kakapo are sporadic breeders, breeding every two to seven years to coincide with suitable abundances of certain fruit (Powlesland et al. 1992). Their small population size coupled with a slow reproductive rate has led to the kakapo being intensively managed to help increase reproduction success and chick survival (Powlesland et al. 2006). These efforts are carried out by the Kakapo Recovery Team which has employed a range of strategies, technology and equipment to help look after this rare species. Management includes supplementary feeding, artificial insemination, artificial incubation of eggs, hand-raising chicks, electronic monitoring at track & bowls and nests, personal night time nest-minders, translocations of birds

140 between islands and the attachment of VHF transmitters on each kakapo (Elliott et al.  
2001).

The purpose of this trial is to evaluate the ability of the pre-development kakapo  
Egg Timer to indicate the onset of nesting. As found with kiwi nesting activity  
145 (Wildtech 2008b), it is expected that the Egg Timer transmitter will record a decrease  
in the daily activity of kakapo once nesting has begun.

## Methods

### Study Area

150

Codfish Island/Whenua Hou, a nature reserve, is a small island three kilometers off  
the west coast of Stuart Island/Rakiura in southern New Zealand (46.47S, 167.38E).  
Completely free of predators and introduced mammals, Codfish Island acts as a  
1400ha island sanctuary that provides suitable habitat for kakapo to live and breed  
155 (Department of Conservation 2008). On Codfish Island there are 25 female kakapo  
that have the potential to breed. Egg Timer transmitters were fitted to 21 of the  
females in July and August 2010 with the remaining four having theirs attached in  
October 2010. Egg Timer transmitters were attached by means of a ‘backpack style  
harness’ such that the transmitters were hidden under the feathers. Egg Timer  
160 transmitters can store six days worth of data hence data was collected from each bird  
every six days. After a female had been identified as having mated, by showing up on  
data loggers near male’s bowls and by finding mating sign, their Egg Timer data was  
collected every three days (Eason 2010). This three day collection schedule also  
provided a way to cross check the data for any errors as there was three days of  
165 previously recorded data still stored on the transmitter. With the Egg Timer  
transmitters still being developed for the kakapo, it was important to be very accurate  
in collecting the data especially around the nesting period as this activity would be  
used in the Egg Timer development.

170

Each transmitter can be set to ‘roll over’ into a new 24 hour period at 8:00am.  
However, with some uncertainty surrounding the exact times the Egg Timers were set  
to ‘roll over’ and also if daylight saving had been considered, I collected all Egg



175 Timer data after 9:00am each day. This allowed ‘last nights’ activity data to be collected. Egg Timer signals were collected at previously tagged GPS (global positioning system) points, directional bearings taken and as well as the start time of data collection.

### **Egg Timer Data Collection**

180 Egg Timer transmitters send out a series of beeps which are picked up using a hand-held TR-4 receiver (Telonics<sup>TM</sup>, Arizona) and a three-element folding Yagi antenna (Sirtrack Ltd, New Zealand). The beeps are emitted as a sequence of 15 paired outputs with each output distinguished by two sets of fast beeps at 80 ppm. There is a short three second pause between the numbers in each set while each output is separated by  
185 5 slow beeps at 30ppm. After the 15<sup>th</sup> output there are three and a half minutes of continuous slow beeps at 30 ppm to indicate the end of the sequence. Overall the sequence takes ten minutes to run through after which it repeats itself (Eason 2010).

190 A complete sequence would look something like the example below with the vertical bar | representing 5 slow beeps between each output. Table 1 explains what each output gives information about (Eason 2010).

195 Start-7,2|8,11|8,6|5,8|7,6|6,2|5,10|7,5|6,4|3,11|6,3|4,9|2,7|2,7|5,2-End

200 To make sense of the data and to calculate the daily activity from the counted beeps, subtract two from each individual number in the set, put them together and multiply by ten. The first number represents the number of tens and the second number is the number of units (Wildtech 2008a). In the example above, the first output 7,2 becomes 50 which calculates to 500 minutes of activity yesterday using the primary algorithm. The second output 8,11 calculates to 690 minutes of activity two days ago and so forth. The primary and secondary algorithms are purely used in the development of the Egg Timer and calculate daily activity using a slightly different  
205 equation.

210

**Table 1:** Information relating to each of the 15 Egg Timer transmitter outputs. Outputs 1-6 represent daily activity for the primary algorithm while outputs 7-12 represent daily activity for the secondary algorithm.

---

1. Activity yesterday	9. Activity 3 days ago
2. Activity 2 days ago	10. Activity 4 days ago
3. Activity 3 days ago	11. Activity 5 days ago
4. Activity 4 days ago	12. Activity 6 days ago
5. Activity 5 days ago	13. Long trigger time of emergence
6. Activity 6 days ago	14. Hair trigger time of emergence
7. Activity yesterday	15. Battery life
8. Activity 2 days ago	

---

215

For the time of emergence (TOE) triggers (outputs 13 and 14), subtract two from each number and join them together. This will give you the number of hours, in regards to the time of data collection, when the bird got up and became active. The long TOE is set up to be triggered by activity periods greater than 50 minutes in length and indicates the start of the true active period. The Hair TOE is triggered

220 much more quickly by shorter bouts of activity but resets quickly as well (Eason 2010). An output of 2,7 indicates that the bird left its roost or nest and became active five hours ago. The battery life output is calculated in a similar way, however, it is measured in weeks. Therefore an output of 5,2 suggests there are 30 weeks left in the battery.

225

### Statistical Analysis

230

R version 2.11.0 (R Development Core Team 2010) was used for statistical analysis. The data collected was repeatedly collected from the same individuals so were not independent from each other. I used a nonlinear mixed effect model (Package nlme version 3.1-98) with Activity (minutes) as the response variable,

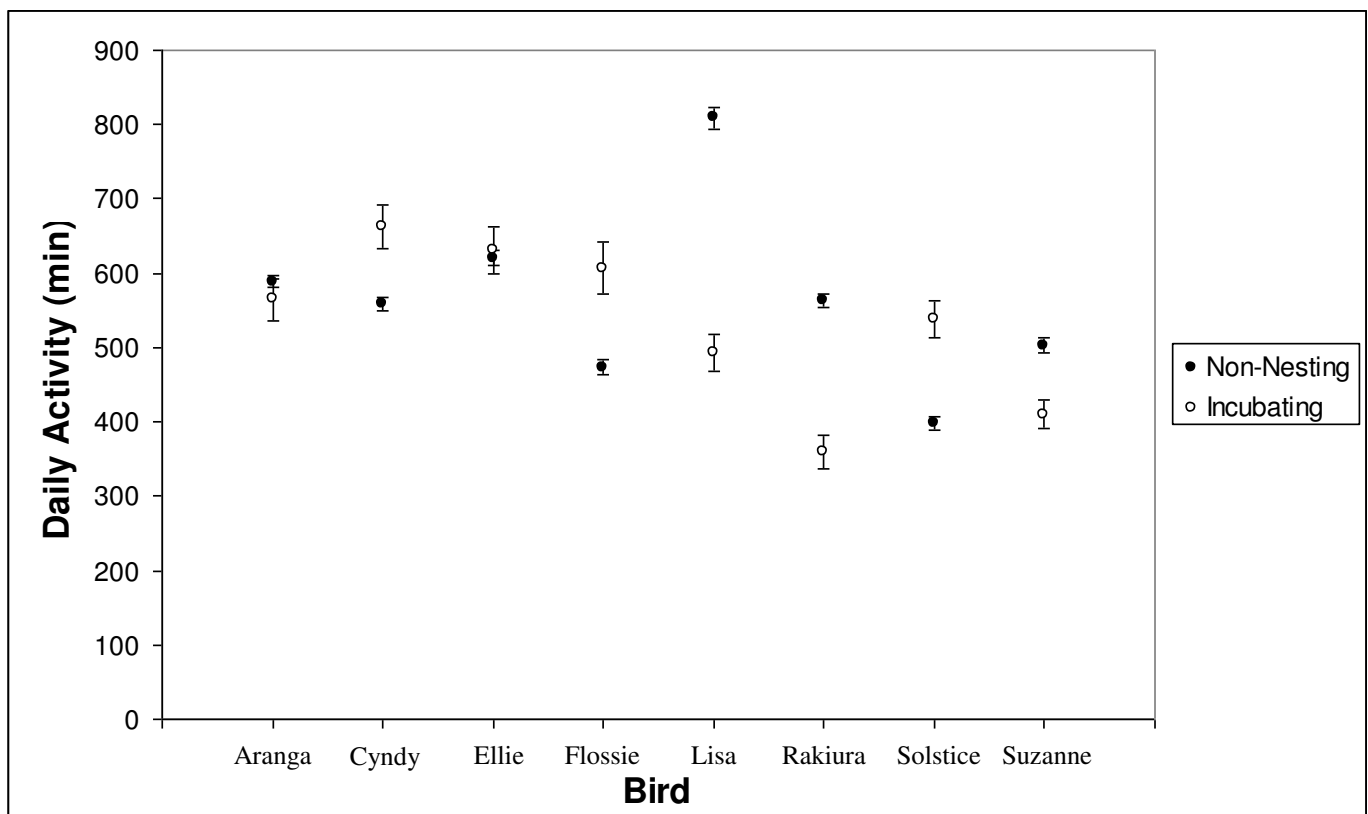
Time (non-nesting or incubating) as the fixed effect variable and BirdID (bird name) as the random effect variable. This allowed me to compare overall non-nesting activity to overall incubation activity.

235

## Results

From the 25 females capable of breeding on Codfish Island during the 2011 kakapo breeding season (January to February), 10 females mated, with eight of those laying and incubating eggs. The linear mixed effect model showed that overall there was a significant difference ( $T=13.79$   $p<0.001$ ) between the daily activity levels when birds were not nesting (mean=564.63 minutes, SE=35.46) and when birds began to incubate (mean=504.71 minutes, SE=36.61). The hypothesis was that when a female kakapo starts to incubate, her daily activity should drop and be less than that of her non-nesting activity. Figure 1 shows the differences between each nesting birds mean non-nesting daily activity and mean incubating daily activity.

245



250 **Figure 1:** The mean daily activity of eight breeding kakapo females during non-nesting and incubation periods.

Incubating activity was only significantly less than non-nesting activity for three females, Lisa, Rakiura and Suzanne. For Cyndy, Flossie and Solstice, they opposed the hypothesis and their activity actually increased during incubation. While  
255 Aranga and Ellie showed no real difference in activity between the two behavioural states.

With these results in mind, the ability of the Egg Timer transmitter (pre-development) to indicate the onset of incubation in kakapo varied widely between the  
260 eight birds that nested. The complete daily activity graphs of the three females (Lisa, Rakiura and Suzanne) whose activity did drop during incubation are shown in Figure 2. The Egg Timer output shows a clear differentiation between the non-nesting and incubation states for Lisa and Rakiura and just by looking at the graphs it is possible to conclude that these birds are incubating. Suzanne on the other hand, her incubation  
265 state is not so obvious and from her graph it would be hard to predict that she is incubating as her activity is quite uniform. The complete activity graphs for the remaining six kakapo that did not show significant drops in activity between non-nesting and incubation are shown in Figure 3.

270 It is interesting to note, that in all cases, the females showed a 'peak' of activity very close to or right at the time of laying their first egg. This peak tended to be the highest amount of daily activity seen throughout the period since the Egg Timer transmitters were attached.

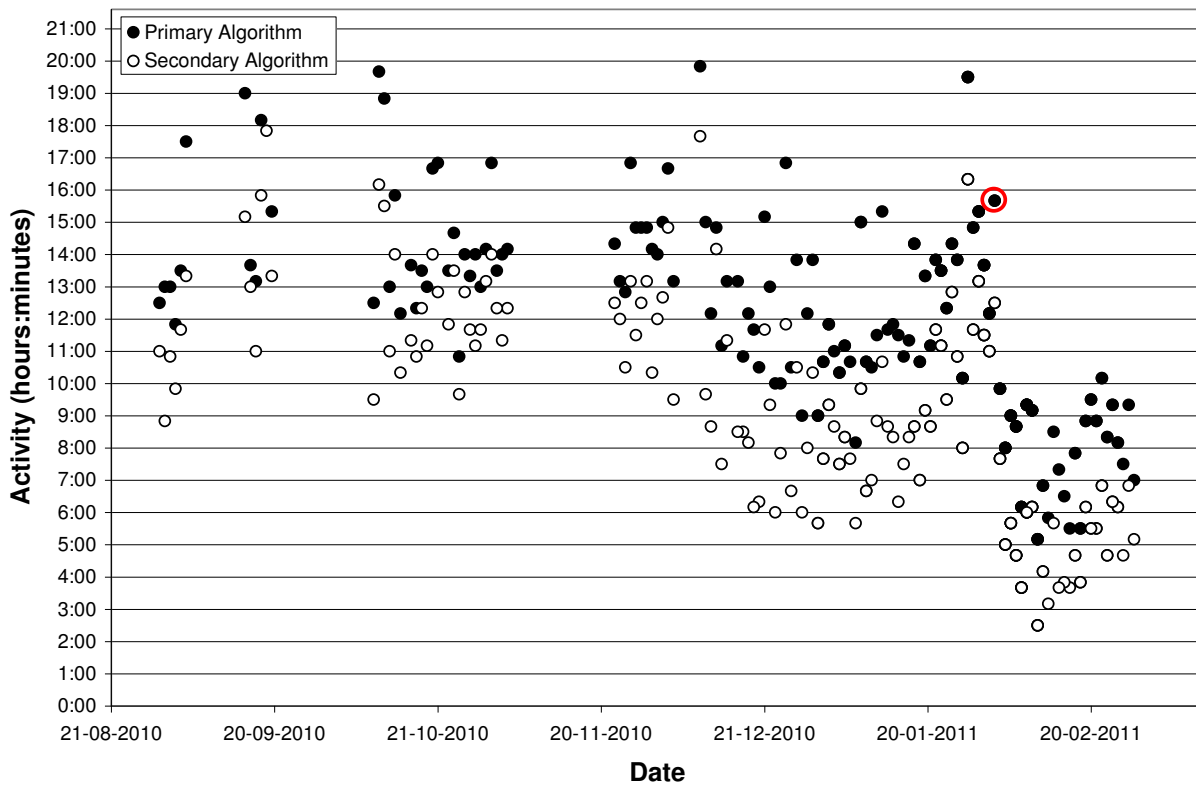
275

280

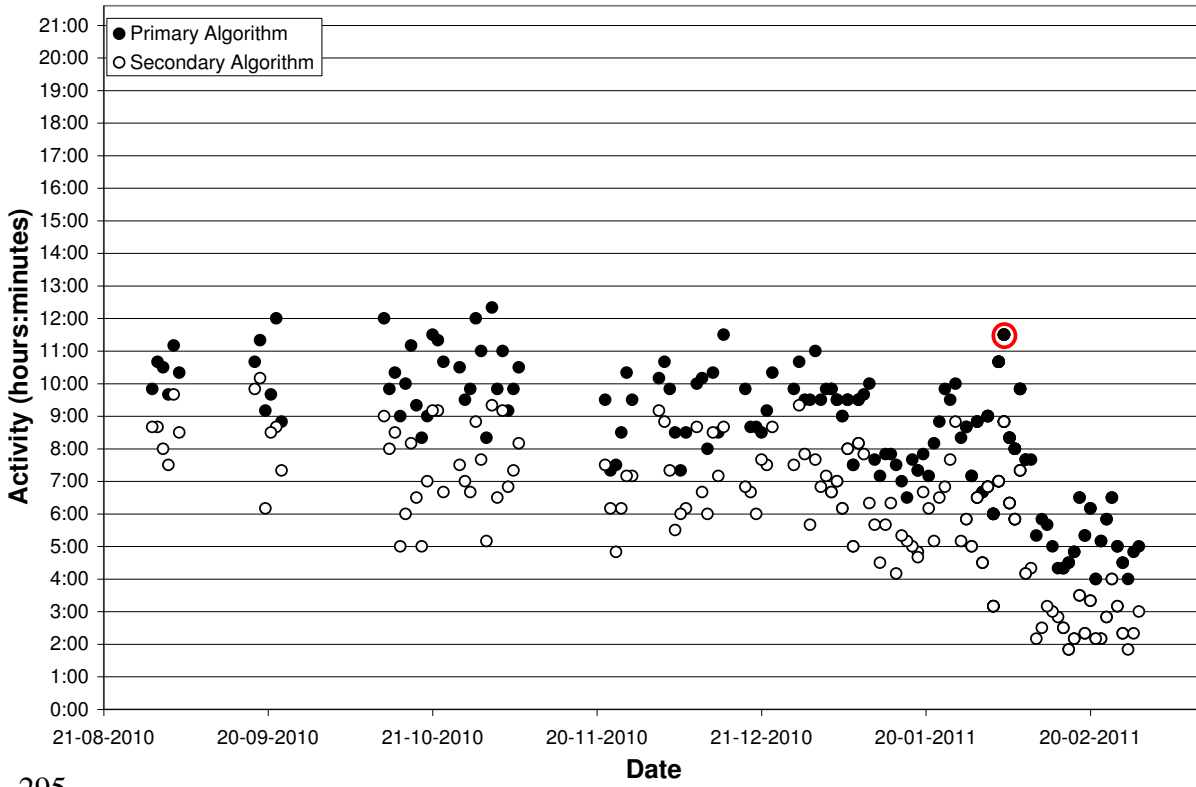
285

290

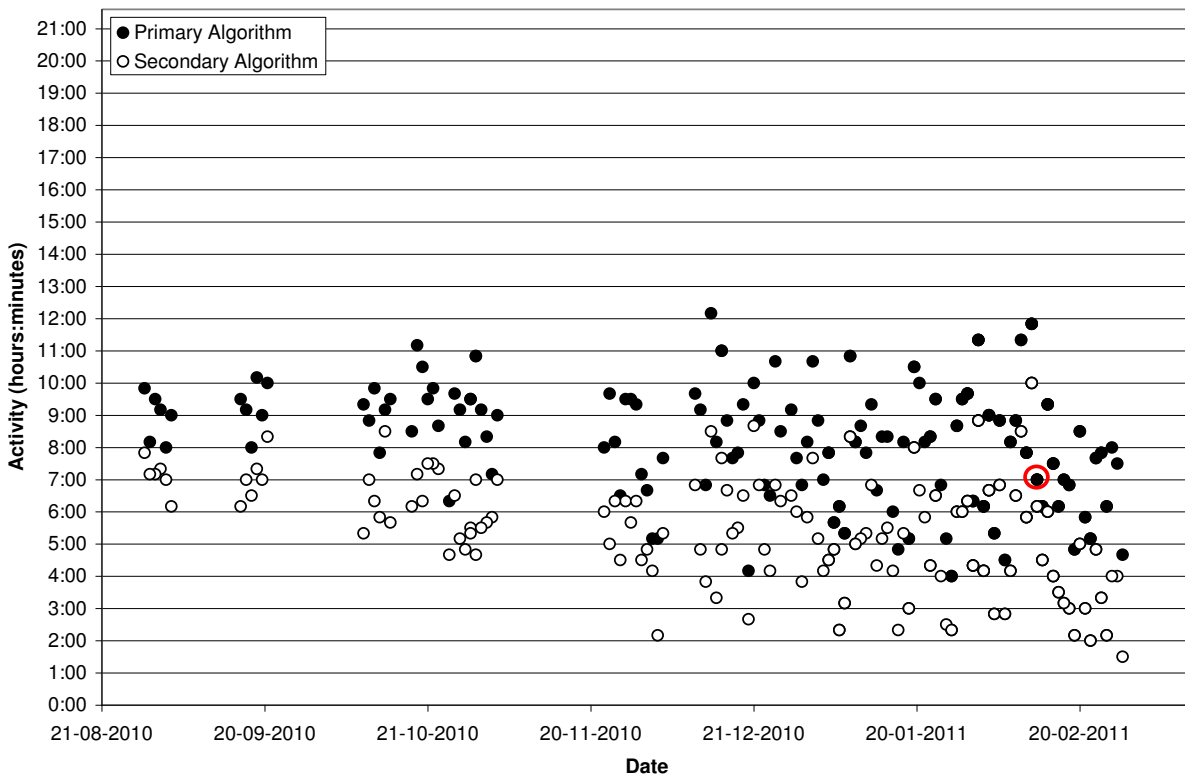
(A)



(B)



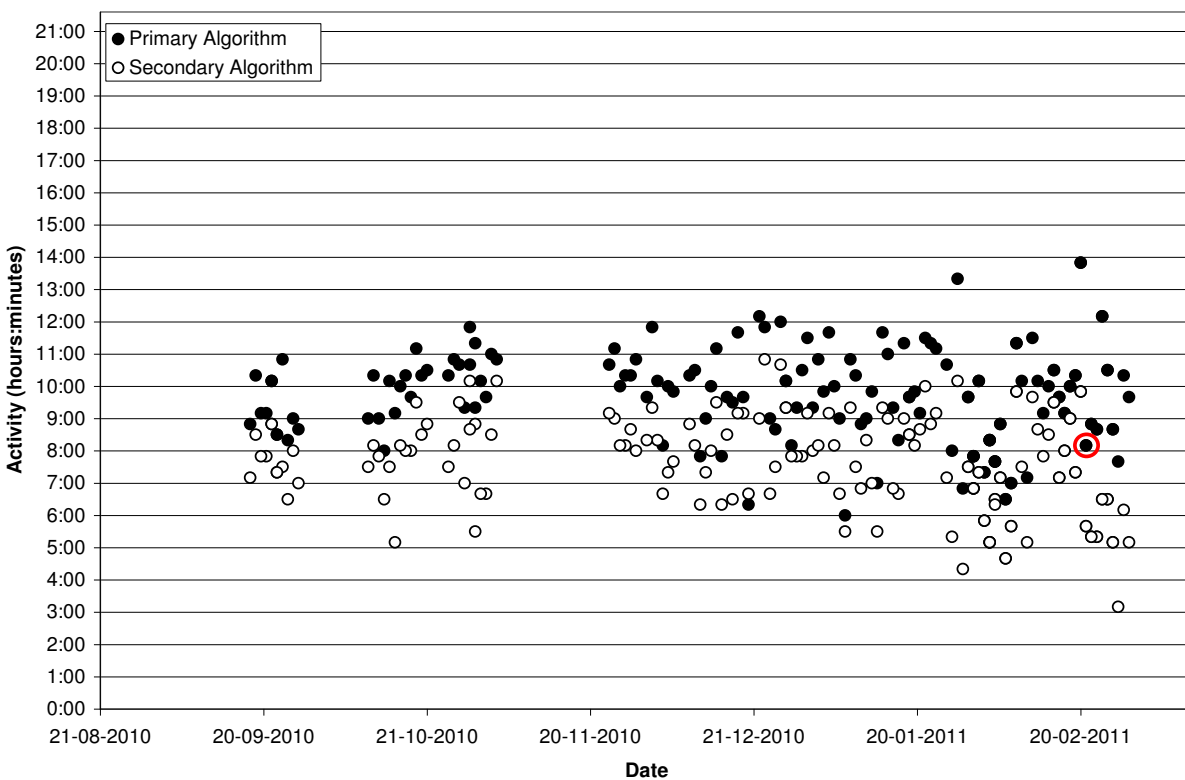
C) 300



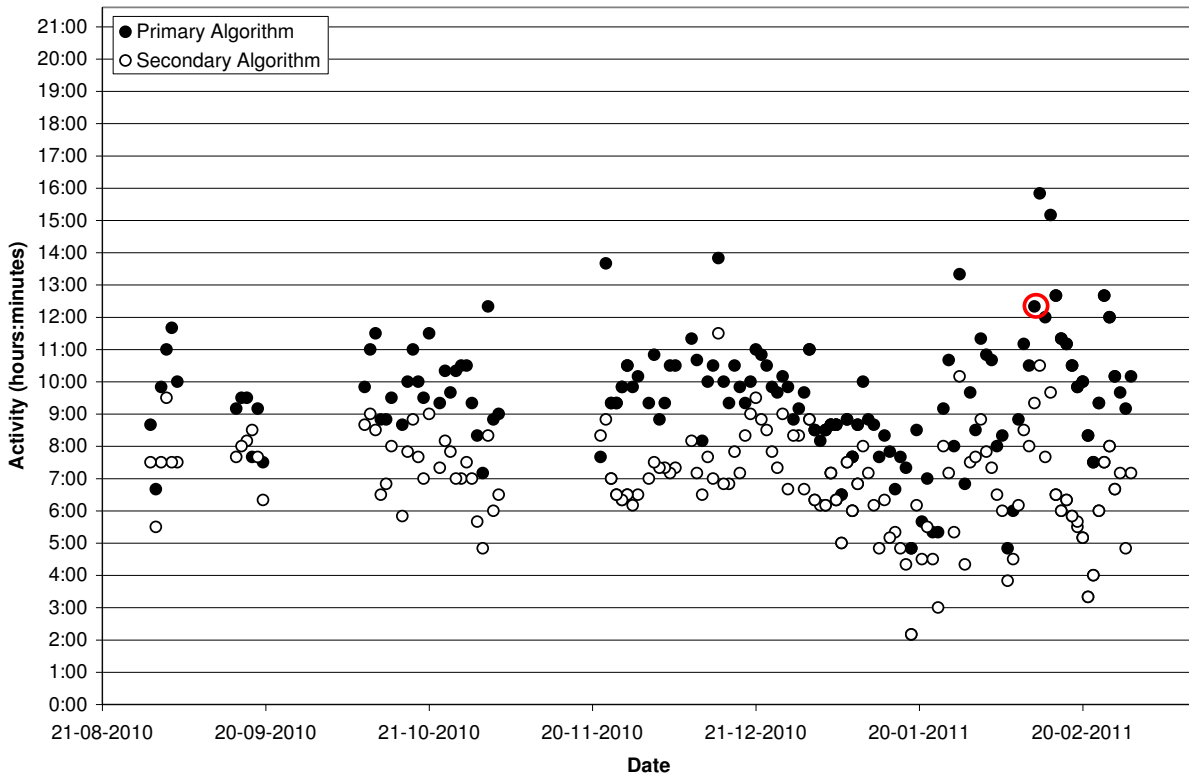
**Figure 2:** The overall daily activity patterns of A) Lisa, B) Rakiura and C) Suzanne throughout the course of the 2011 breeding season. The red circle indicates the date their first egg was laid and the start of incubation.

305

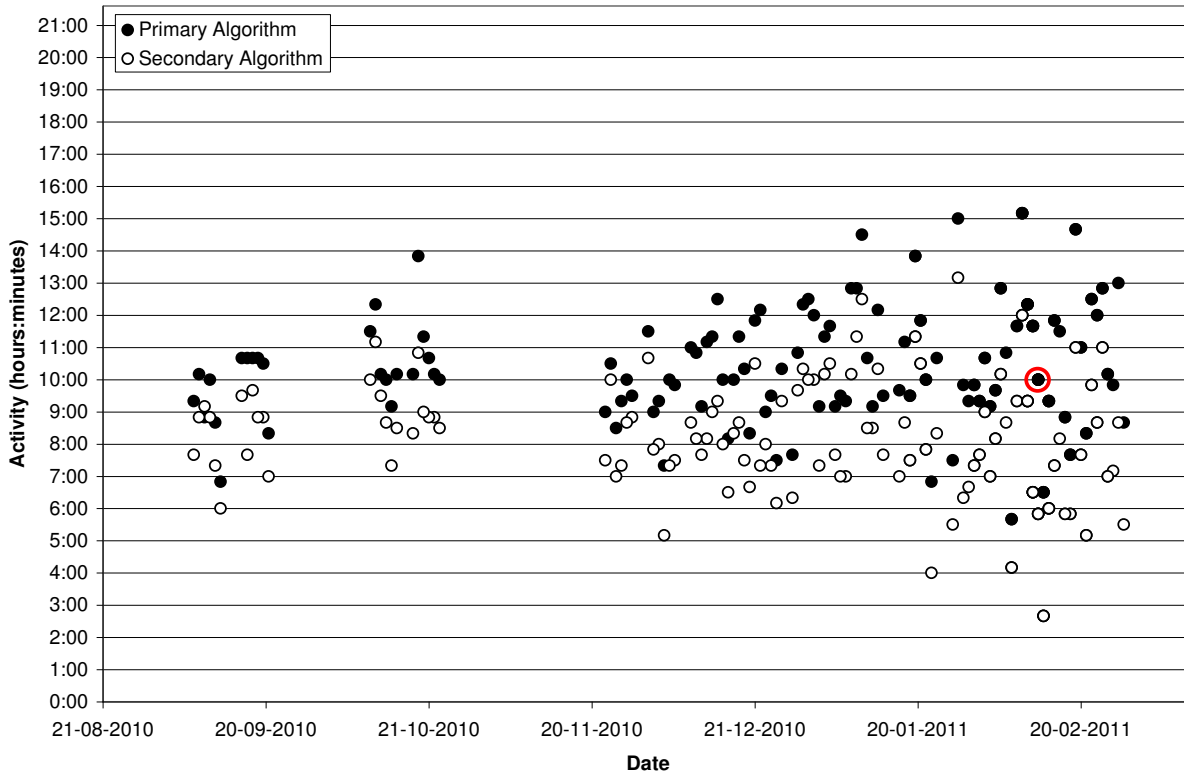
A)



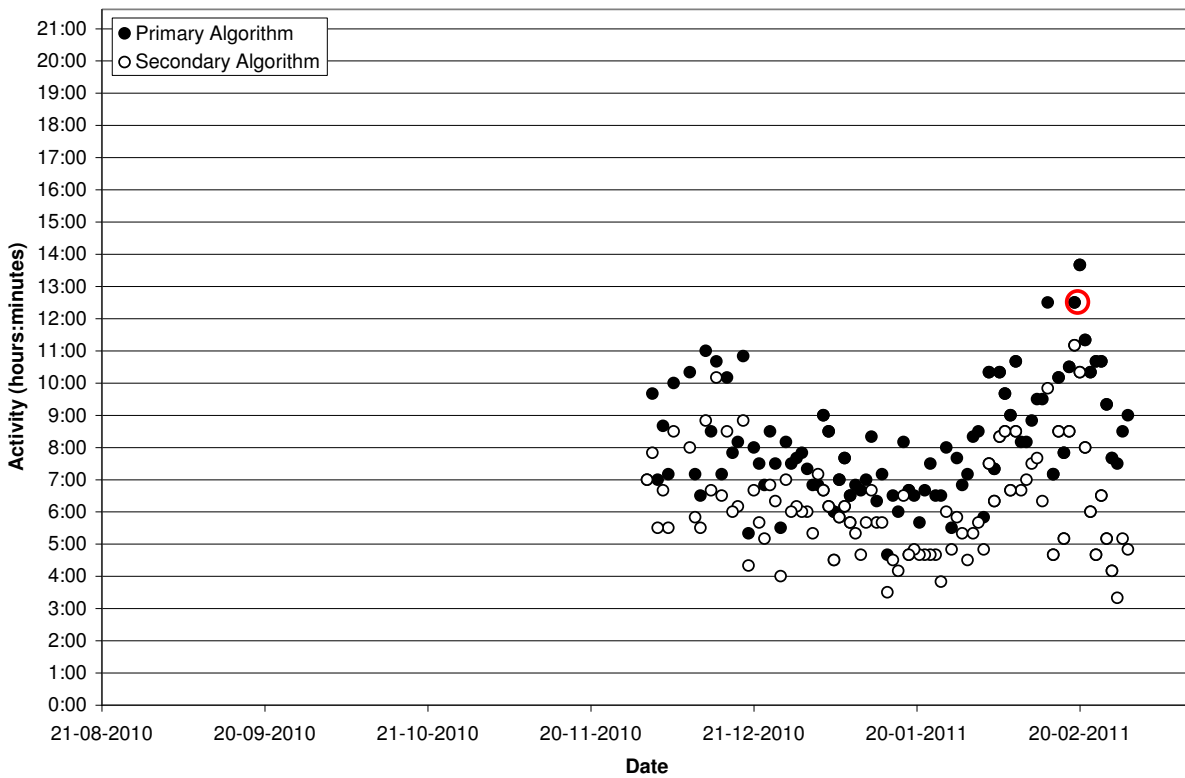
B)



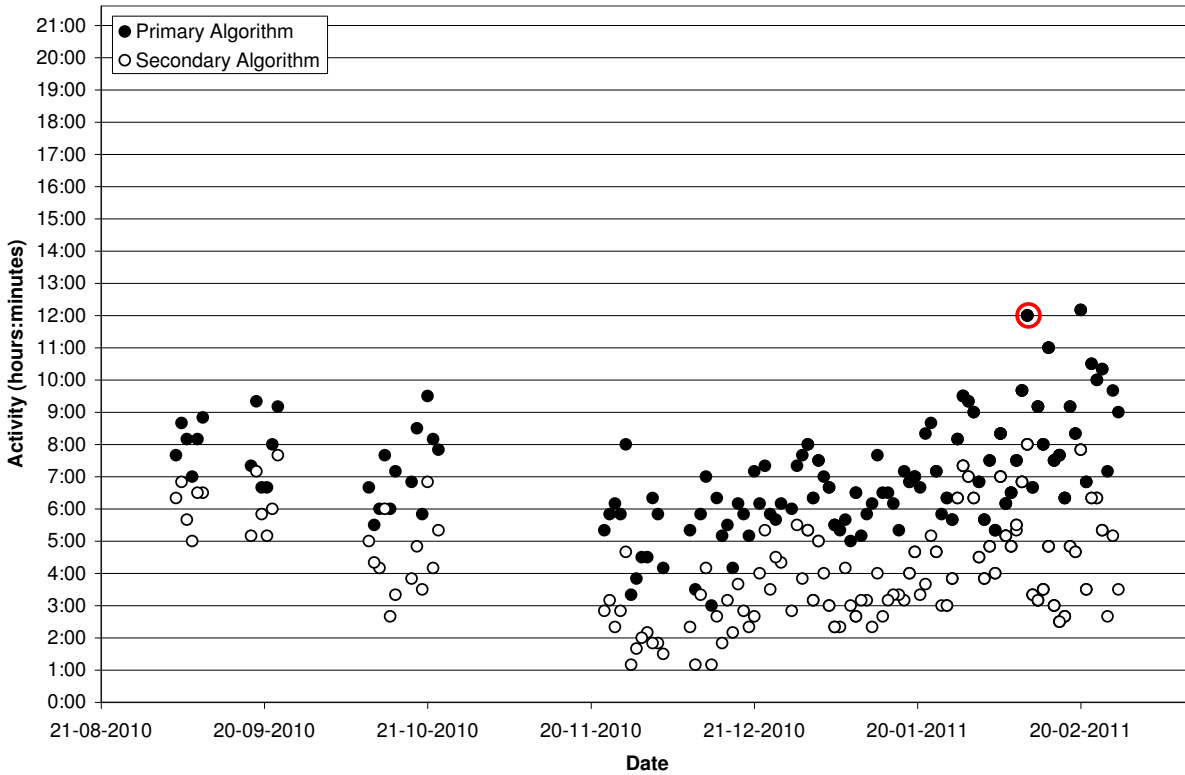
C) 310



D)



E)



320

**Figure 3:** The overall daily activity patterns of A) Aranga, B) Cyndy, C) Ellie, D) Flossie, and E) Solstice throughout the course of the 2011 breeding season. The red circle indicates the date their first egg was laid and the start of incubation.



## Discussion

325

The pre-development kakapo Egg Timer transmitter was able to detect the onset of incubation in two out of the eight nesting kakapo. The inability of the Egg Timer transmitter to detect incubation in the remaining six birds could be due the small sample size of incubating days compared to the notably greater number of non-nesting days (Table 2). This was due to the early attachment of the transmitters and also to the cessation of Egg Timer data collection at the beginning of March although the females were still incubating. Logically, the individuals that nested earlier (Lisa and Rakiura) are the individuals that have the most data on their incubating state. Incidentally, they are also the two birds for which the Egg Timer transmitter was able to indicate that the birds were incubating. However, if data collection had continued and a greater number of incubation days obtained, the Egg Timer transmitter may have also been able to indicate incubating activity more clearly for birds such as Cyndy and Flossie whose activity graphs show a downwards trend (Figure 3, B and D).

340

**Table 2:** Number of sample days for non-nesting and incubating periods for the 2011 nesting kakapo.

<b>Bird</b>	<b>Non-Nesting Days</b>	<b>Incubating Days</b>
Aranga	116	9
Cyndy	114	19
Ellie	96	17
Flossie	78	11
Lisa	102	27
Rakiura	99	26
Solstice	98	18
Suzanne	109	17

345

Camera recordings identify another reason why the Egg Timer output did not show the start of incubation for some birds. When kakapo are incubating they are not completely still but regularly preening their feathers, grubbing their nest, rolling their eggs and changing positions. Any small movement is detected by the sensitive activity sensor within the Egg Timer transmitter and logged as the bird being 'active' (A Bramley, Wildtech, 2011, pers. comm.). This explains why, on an activity graph, a bird that is incubating can still be as 'active' as when it was not nesting. Therefore it

350

is not always possible to clearly identify the onset of incubation using just the Egg  
Timer transmitter output. For the Egg timer transmitter to be successfully developed  
355 for the kakapo it must be able to differentiate between the different types of activity;  
foraging and nesting.

Each female shows a 'peak' of activity around the time of laying their first egg.  
The peak likely reflects nest preparation or a greater amount of time spent foraging to  
360 improve body condition in preparation for incubation. As this peak is common to each  
female it could be recognised as a 'behavioural signature' for the onset of incubation  
given its close timing to the first egg laying. Such behavioural signatures are used by  
the software engineers from Wildtech New Zealand Ltd to developed Egg Timer  
transmitters. The software is able to recognise these types of signatures in the data  
365 which then trigger the transmitter to indicate a bird is nesting (A Bramley, Wildtech,  
2011, pers. comm.).

The complete development of the Egg Timer transmitter for kakapo will be a  
great asset to the Kakapo Recovery Team. In past breeding seasons kakapo rangers  
370 would be out triangulating females every three days and once breeding was underway  
triangulations would occur every day to detect nesting (E Nye, 2011, pers. comm.).  
This is a huge amount of time and work which would be unnecessary with the  
development of the Egg Timer transmitter. The spare time could then be directed to  
other tasks or birds that need the management's attention. The Egg Timer transmitter  
375 will also remove the guess work involved in determining if a female is incubating.  
Kakapo nest around nine days after mating and in the past if a kakapo had been  
triangulated in the same area for seven days a close-approach was performed to see if  
she was nesting (Eason et al. 2006). The close approaches did not always confirm  
nests and they could contribute to a female abandoning a nesting attempt (J  
380 Ledington, 2011, pers. comm.).

At its current pre-development stage the Egg Timer transmitter has the  
potential to successfully indicate the onset of nesting in kakapo. Should there be any  
difficulties in being able differentiate between foraging activity and nesting activity,  
385 Wildtech and the Kakapo Recovery Team could look into some aspects of

accelerometers such as changes in velocity, animal orientation and distance covered (Lascelles et al. 2008) to help distinguish between the two activities.

390

## References

Brow, A.K, Bruce, T.A, Chisnall, D.T, Gasson, P.A, Leggett, S.A.; Paton, B.R., Hawes, M. 2008. Rotoiti Nature Recovery Project: Annual Report 2006-2007. Nelson Lakes Mainland Island, Nelson Lakes National Park. Department of Conservation, Nelson, New Zealand

Cresswell, M (compiler) 1996. Kakapo recovery plan 1996-2005. Threatened Species recovery Plan No. 21. Department of Conservation, Wellington, New Zealand

Department of Conservation 2008. Then and Now: Whenua Hou, or Codfish Island. Available at: [www.kakaporecovery.org.nz/index.php?option=com\\_content&view=article&id=130&Itemid=171](http://www.kakaporecovery.org.nz/index.php?option=com_content&view=article&id=130&Itemid=171). Access on 28 March 2011

R Development Core Team 2010. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria

Eason, D 2010. Monitoring kakapo with Egg Timer transmitters. Unpublished document.

Eason, D.K, Elliot, G.P, Merton, D.V, Jansen, P.W, Harper, G.A, Morrehouse, R.J 2006. Breeding biology of kakapo (*Strigops habroptilus*) in offshore island sanctuaries, 1990-2002. *Notornis* 53: 27-36

Elliot, G.P, Merton, D.V, Jansen, P.W 2001. Intensive management of a critically endangered species: the kakapo. *Biological Conservation* 99: 121-133

FRST 2008. Kiwi saver hits the mark. Available at: [www.frst.govt.nz/news/kiwisaver](http://www.frst.govt.nz/news/kiwisaver). Accessed on 28 March 2011

IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. Available at: [www.iucnredlist.org](http://www.iucnredlist.org). Accessed on 27 March 2011

Lascelles, B.D.X, Hansen, B.D, Thomson, A, Pierce, C.C, Boland, E, Smith, E.S 2008. Evaluation of a digitally integrated accelerometer-based activity monitor for the measurement of activity in cats. *Veterinary Anaesthesia and Analgesia*, 35: 173–183

Miskelly, C.M, Dowding, J.E, Elliot, G.P, Hitchmough, R.A, Powlesland, R.G, Robertson, H.A, Sagar, P.M, Scofield, R.P, Taylor, G.A 2008. Conservation status of New Zealand birds, 2008. *Notornis* 55: 117-135.

Powlesland, R.G, Lloyd, B.D, Best, H.A, Merton, D.V 1992. Breeding biology of the kakapo *Strigops habroptilus* on Stewart Island, New Zealand. *Ibis* 134: 361-373

Powlesland, R.G, Merton, D.V, Cockrem, J.F 2006. A parrot apart: the natural history of the kakapo (*Strigops habroptilus*), and the context of its conservation management. *Notornis* 53: 3-26

Three News 2009. 'Ear in the Air' helping to save rare South Island kiwi. Available at: [www.3news.co.nz/News/Weather/Ear-in-the-Air-helping-to-save-rare-South-Island-kiwi/tabid/422/articleID/87830/Default.aspx?ArticleID=87830](http://www.3news.co.nz/News/Weather/Ear-in-the-Air-helping-to-save-rare-South-Island-kiwi/tabid/422/articleID/87830/Default.aspx?ArticleID=87830). Accessed 28 March 2011

TVNZ 2011. Meet The Locals television series. Series 2 Episode 17-Wildtech. Available at: [www.tvnz.co.nz/meet-the-locals/meet-locals-s2009-e17-wildtech-video-2806764](http://www.tvnz.co.nz/meet-the-locals/meet-locals-s2009-e17-wildtech-video-2806764). Accessed on 28 March 2011

Wildtech 2008a. User manual for 'dual incubating' Egg Timer transmitters V4.2 and 5.0. Wildtech New Zealand Ltd, Havelock North, New Zealand.

Wildtech 2008b. "Chick Timer" transmitter field report. Unpublished document. Wildtech New Zealand Ltd, Havelock North, New Zealand

Wildtech 2009. User Manual for 'dual incubating' kiwi "Chick Timer" transmitters V4.4 Haast and V5.2 Rowi. Wildtech New Zealand Ltd, Havelock North, New Zealand

