Bird box size may correlate with clutch success through energy allocation in mountain bluebirds (*Sialia currucoides*).

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Abstract:

To maximize offspring potential and one's reproductive success, an organism's energy is prioritised on beneficial tasks. It has been verified that a limited amount of energy and time will limit the clutch size and success in a migratory bird, mountain bluebird (*Sialia currucoides*). It has been observed that some birds would fill up a cavity with branches. Such a task costs valuable energy and time in the short North-American season. In this study, I hypothesize that man-made bird box volume negatively correlates with mountain bluebird nest success. Numerous bird boxes with varying volume are installed and monitored along rural and farm roads near the Edmonton area. Any mountain bluebird nests data are gathered and linear regression analysis are performed. Insufficient sample size leads to inconclusive and statistically non-significant results.

Intro:

There are numerous migratory bird species during the short summer period in Canada to raise their young. In order for their eggs to successfully reach fledging, the parents need to find enough food to feed not only themselves but for their new born as well. Previous study showed that mountain bluebirds perform better and have bigger offs-springs when food is not limiting (Garcia, Merkle & Barclay, 1993). They showed a trade-off between self-preservation and off-spring care when energy is low. It would be safe to extrapolate that any other energy-consuming tasks would also decrease energy availability for the young. Another study also suggested that clutch size is influenced by nest cavity bottom area (Karlsson & Nilsson, 1977). In this investigation, I hypothesize that mountain bluebirds would perform worse reproductively if their energy is reduced in nest building or maintenance, thus having less energy for young-care. The number of eggs and fledglings are predicted to be low if the box volume is big and vice-versa.

To investigate this, numerous bird boxes were monitored throughout the summer season in area around Edmonton, Canada. Only the mountain bluebirds were focused during the investigation.

Materials and Methods:

A team of four interns with four designated area were mapped near the city of Edmonton, Alberta. Each member was given the task of evaluating the previous route and any old bird boxes. Any non-occupied boxes were replaced with new ones and monitored weekly throughout the summer season from mid-May to late-August. Two kinds of wooden boxes were installed: the first box type tagged "new" is 5175cm^3 (15x15x23cm) and the second box type tagged "tofield" is 6750cm^3 (18x15x25cm) large. There were pre-existing old bird boxes along the route with a volume of 7650cm^3 (17x18x25cm). All of the boxes used and observed have the same opening size of 4.7 cm in diameter which limits the species of residing birds. Any unusual boxes not part of the above descriptions had their dimensions individually taken. The boxes were installed near chest height on existing fence posts.

Figure 1. "New" bird box along rural road near Fort Saskatchewan, Canada. The box was put up in early summer and maintained throughout the season.

For each box, multiple information was taken, including location, species of bird, number of eggs, number of chicks/hatch, number of fledge, distance to nearest cover and surrounding habitat. The route was surveyed roughly every week with care. The data compiled together and only the mountain bluebird data were used for this investigation. The number of eggs and fledglings were focused on. They were statistically regressed in relation to the box.

Results:

Towards the end of August was when the bird boxes started to be cleared and subsequently cleaned for next year. The data gathered by each were shared with other members and tailored to suit personal preferences without changing any data. There were three residing species: mountain bluebirds (*Sialia currucoides*), tree swallows (*Tachycineta bicolor*) and house wrens (*Troglodytes aedon*). Overall, there were a total of 24 successful nesting of mountain bluebird in our routes. Some were subsequent nesting in the same box while some were replaced by other species. Most of the bluebirds were nesting in the old boxes and not many of the new boxes were used. The data pertinent to this investigation were summarized in Table 1.

Box	Box volume (cm^3)	#eggs	#fledge	fledge/egg ratio
N34	5175	4	4	1
N36	5175	6	6	1
N41	5175	6	6	1
T34	7650	6	6	1
T34	7650	5	5	1
T31	7650	7	7	1
T31	7650	6	6	1
RT	6048	6	6	1
TY	5152	4	3	0.75
T29	7650	6	6	1
T7	7650	2	0	0
E14	7650	5	5	1
E41	7650	5	5	1
E40	7650	3	3	1
E37	5175	5	5	1
B02	7650	6	6	1
B07	7650	6	6	1
B09	7650	6	6	1
B17	7650	6	6	1
B18	7650	5	5	1
S11	7650	4	4	1
S22	7650	5	5	1
S28	7650	5	0	0
S29	7650	6	0	0

Table 1. Summarized table of 24 bird boxes and their nesting data by mountain bluebirds around the Edmonton area. Data were derived from 4 colleagues. Only the information pertinent to this study is shown. For more explicit data, see appendices.

Using Table 1's data to compare the number of eggs, number of fledge and the ratio of fledge/eggs, three linear regression graphs were produced (Figure 2a, b and c). The number of eggs was not statistically correlated to the bird box volume ($R^2 = 0.0024$, $p = 0.821$). The number of fledgling was also not statistically correlated to the bird box volume as well ($R^2 = 0.0078$, $p = 0.681$). Finally, the ratio of fledglings to eggs was not statistically correlated as well to bird box volume ($R^2 = 0.0245$, $p = 0.465$).

Discussion:

We expected to see a negative linear relationship between box size (box volume) and the nest success (#eggs, #fledge and their ratio). The results were very inconclusive. Looking at the trend line in Figure 1a, there appears to be a slight increase in slope, which would suggest a positive relationship between box volume and number of eggs. Karlsson & Nilsson (1977) found a similar positive relationship between clutch number and nest cavity area and although it disagrees with our original hypothesis, our results are inconclusive. The R-squared value was too small to deem significant and the p-value was also too large to make the result statistically insignificant ($R^2 = 0.0024$. $p = 0.821$). For the number of fledgling and the ratio of eggs to fledglings in Figure 1b and 1c, both trend lines were slightly decreasing which would support our original prediction. Similarly, the small R-squared values and large p-values makes the results statistically insignificant (R^2 =0.0078, 0.0245. $p = 0.682, 0.465$ respectively). We were not able to reject the null hypothesis that the results arose through chance and all of our results are inconclusive. The hypothesis is neither rejected nor accepted.

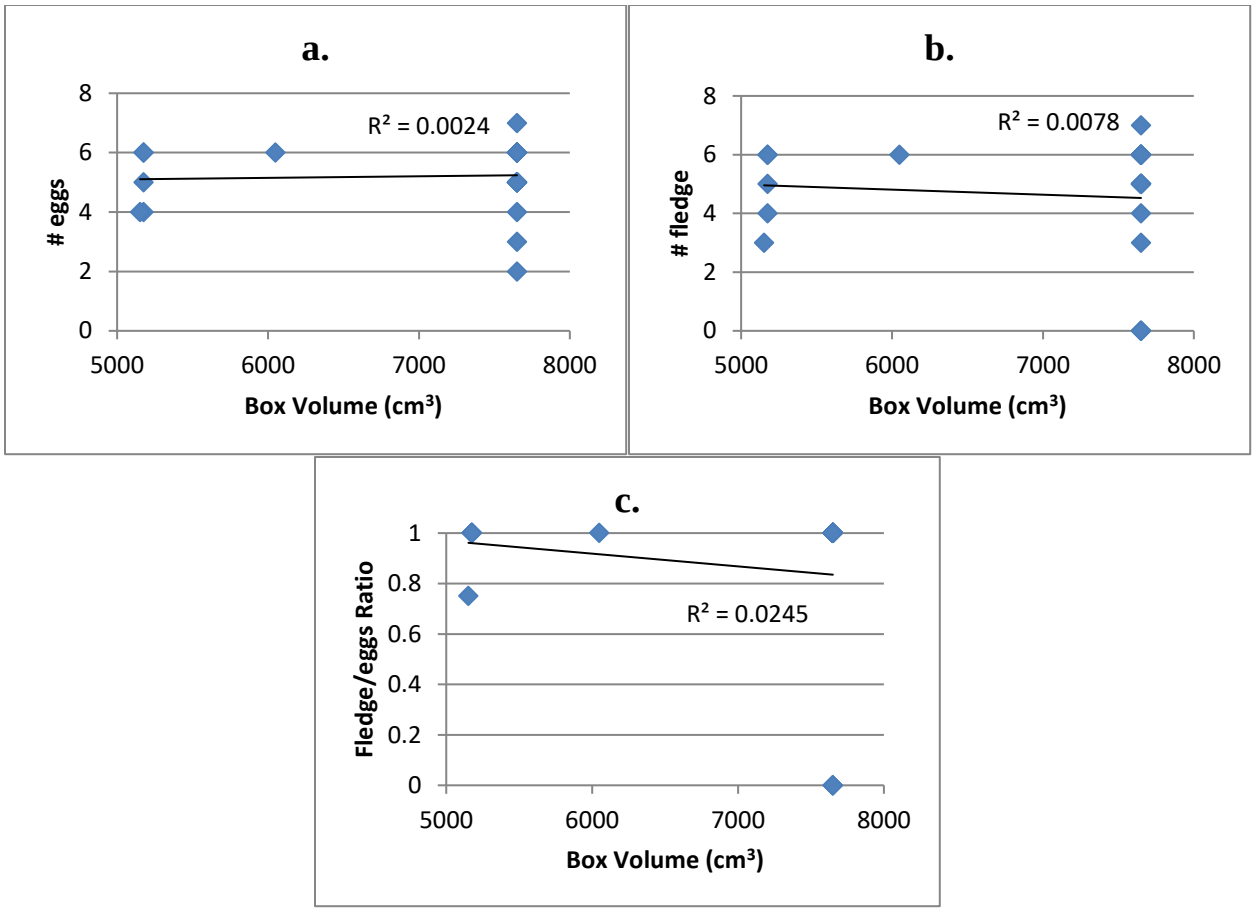

Figure 2. Linear regression graphs of bird box volume in relation to various mountain bluebird nest success indicators. a) Distribution of mountain bluebird eggs in different box sizes. b) Distribution of mountain bluebird fledglings in different box sizes. c) Distribution of mountain bluebird fledglings to eggs ratio in different box sizes.

These results could have been obtained due to many reasons. The first inadequacy of this investigation is the low sample size. In total, only 24 nests were used in the final calculations, despite hundreds of available boxes. A previous study have shown that mountain bluebirds prefer the same nest box types from their previous successful years or the same box type from which they were born (Herlugson, 1981). The combination of early nesting season and new box types may have deterred them from nesting in our monitored boxes.

Figure 3. Mountain bluebird fledglings in bird box along rural road near Fort Saskatchewan. Four near-fledge individuals were banded and seen at the time of photograph.

Another flaw in the investigation was the existence of old boxes which were almost filled to the top with old nests debris. That reduced the actual volume of the box and may have contributed to the inconclusive results. The mountain bluebirds could however not fill their nest all the way even if the box was empty at the beginning. In Figure 3, the box is seen to be only partially filled by the nest and that leaves the fledglings plenty of room for activity. This is opposite to the house wrens observed in our route since they filled the whole box up with branches and nest materials (Figure 4). Any viewpoint would be that the box size is independent from nest success. The relationship between the number of eggs or fledgling and box volume may be constant, as seen by the near flat trend lines in Figure 2a, 1b and 1c. Then again, our results were statistically insignificant to draw any conclusions. The final flaw in our investigation is the size of the bird boxes. Due to building constraints, there were only two types of bird boxes of similar sizes. In addition, the new boxes and the other boxes present in the route were perhaps too similar in volume.

I recognize the numerous flaws in my investigation and the shortfall of my investigative method. With the obtained result, my original hypothesis and predictions are not supported nor falsified. The small sample size lowered the statistical power which did not allow us to reject the null hypothesis. Future investigations should gather larger data samples and allow more differences in box volume in order to fully determine the relationship between next success and box size.

Figure 4. House wren chicks in bird box along rural road near Fort Saskatchewan, Canada. Not part of the mountain bluebird study but still maintained in the grid.

Reference:

Garcia, P. F. J., Merkle, M. S. & Barclay, R. M. R. (1993). Energy allocation to reproduction and maintenance in mountain bluebirds (*Sialia currucoides*): a food supplementation experiment. *Canadian Journal of Zoology, 71*, 2352-2357.

Herlugson, C. J. (1981). Nest selection in mountain bluebirds. *Condor, 83*, 252-255.

Karlsson, J. & Nilsson S. G. (1977). The influence of nest-box area on clutch size in some hole-nesting passerines. *IBIS, 119*, 207-211.

Appendices:

Box #	Location (km)	Roadside	Faces	Species	egg, warm/col	#Chicks	# Feldge	Box size	or distance	North	East	West	South	Comments (banded, dead, etc.)
F11	0.1 S of T564 on RR213A	E	S	tres	?	5	5	tofield	3	pasture	pasture	pasture	pasture	banded & empty
F11x	0.2 S of T564 on RR213A	E	W	howr	1+	2	2		15	pasture	pasture	pasture	pasture	empty
F12	0.3 S of T564 on 213A	E	W	howr /howr	1/6 hot	0/6	0/6		3	pasture	pasture	pasture	pasture	empty / empty
F12X	0.4	E	W	tres	5 hot	5	5	t	10	pasture	pasture	pasture	pasture	empty
F13	0.45	E	S	tres	3+	6	6	t	10	pasture	pasture	pasture	pasture	banded & empty
F13X	0.9	E	W	tres	6 hot	6	6	t	10	forest	pasture	pasture	pasture	empty
T34	1	E	SW	mobl /mobl	6/5 hot	6/5	6/5		0	pasture	pasture	pasture	pasture	empty/ banded & empty
F14	1.2	E	W	tres/	1+	0	0		100	pasture	pasture	pasture	pasture	empty
F14X	1.25	E	W	howr	6 hot	6	6		50	pasture	pasture	pasture	pasture	empty
T27	1.6	E	SW	tres/ howr	4+/ 6 hot	5/ 4+	5/6	old	3	pasture	pasture	forest	pasture	banded/ empty
F15	2	E	W	tres /howr	1+/6 hot	0/6	0/5	t	10	pasture	pasture	forest	pasture	empty/ empty 1 egg
F15X	2.1	E	W	howr	4 hot	4	4		30	pasture	pasture	forest	pasture	empty
T22	2.4	E	W	tres/ howr	2+/ 5 hot	6/3+	6/5	old	10	pasture	pasture	forest	pasture	banded & empty/ empty
F16	2.8	E	W	tres	?	6	6		100	pasture	pasture	pasture	pasture	banded & empty
F16X	2.85	E	W	howr	7 hot	5	5	t	10	pasture	forest	pasture	forest	banded & empty
F17	3.1	E	SW	howr	7 hot	5+	6	t	1	forest	pasture	forest	pasture	banded & empty
Unnumbered		E	SW					old		pasture	pasture	pasture	pasture	WASP NEST! AVOID!
F17X	3.2	E	NW	tres	5+ hot	6	6		15	pasture	pasture	pasture	pasture	empty
T32	0.1 E of RR213A on T562	N	S	howr	6 hot	6	6	old	2	pasture	pasture	pasture	forest	banded & empty
F1	0.15	N	SE	tres	1 hot	4	4		5	pasture	pasture	pasture	forest	empty
F1X	0.2	N	S	tres	2 cold	0	0	t	5	pasture	pasture	pasture	forest	empty
F2	0.25	N	S	tres	?	3+	4	t	2	pasture	pasture	pasture	forest	empty
F2X	0.3	N	S	howr	2 hot	2	2	t	5	pasture	pasture	pasture	forest	empty 3 eggs
F3	0.35	N	SE	howr	8 hot	7	7		0	forest	forest	pasture	forest	banded & empty
F3X	0.5	N	S	howr	5 hot	5	5		10	forest	forest	pasture	forest	banded & empty
F4	0.65	N	SE	howr	8 hot	8	8	t	2	forest	forest	forest	forest	empty
T31	0 S of T562 on RR213	E	W	mobl /mobl	7/6 hot	7/6	7/6	old	2	pasture	forest	forest	forest	empty / banded & empty
F5	0.1	E	W	tres	1 cold	0	0		5	pasture	swamp	swamp	swamp	empty
F6	0.4	E	SW						20	swamp	forest	pasture	pasture	
F6X	0.45	E	W	tres	5 hot	5	5	t	100	forest	forest	pasture	pasture	empty
RT	1.2	W	E	mobl / tres	? /6 cold	6 /0	6/0	private	5	industrial	pasture	pasture	pasture	empty / empty and 6 eggs
TX	1.3	W	E	tres	?	4	4	priv	100	pasture	pasture	pasture	pasture	empty
TY	1.4	W	E	tres/ mobl	?/ 1 hot	?/3	6/3	priv	100	pasture	pasture	forest	pasture	banded/ banded & empty (1 egg)
F7X	1.9	W	NE					t	30	pasture	forest	pasture	swamp	
F7	2.0	W	NE	tres	?	4+	6		10	pasture	swamp	swamp	swamp	empty
T18	2.2	W	SE	tres	6	6	6	old	30	swamp	forest	pasture	swamp	banded & empty
T30	2.3	W	SE	tres	3+	7	7	old		pasture	swamp	swamp	swamp	water hazard
F8	2.5	W	NE	tres	1+	5	4	t	20	swamp	swamp	forest	swamp	empty with 1 dead chick
F8X	3.2	W	E	tres	?	?	?		20	swamp	swamp	swamp	swamp	water hazard
F9	0.2 E of RR214 on T560	S	NE	tres	2+ hot	6	7		5	swamp	pasture	pasture	pasture	empty
F10	0.3	N	S	tres	6 hot	4+	5		15	pasture	pasture	pasture	pasture	empty
T45	0.4	N	S	tres	2	5	?	old	30	forest	forest	forest	forest	water hazard
F18	1	N	S	tres	?	6	6		20	forest	swamp	pasture	pasture	empty
F18X	1.1	N	S					t	10	forest	pasture	forest	pasture	
F19	1.15	S	NE	tres	?	5	5	t	10	forest	pasture	pasture	pasture	banded & empty
F19X	1.3	N	S	tres	5 hot	2+	5	t	50	forest	swamp	pasture	pasture	empty
T29	1.2	N	S	mobl /howr	6/ 5 hot	6/5	6/ 5	o	10	forest	pasture	forest	pasture	empty/ empty 1 egg
F20	1.4	N	S	howr	5 hot	3	3		50	forest	swamp	pasture	pasture	banded & empty
F22	1.1 N of T554 on RR214	W	E						100	pasture	road	pasture	pasture	
F21	1.1	W	E	tres	1	6	6		50	pasture	road	pasture	pasture	empty
R5	0.6 W of RR214 on T554	N	S	tres	?	5	5	priv	100	pasture	forest	pasture	pasture	empty
F23	0.7	N	S					t	200	pasture	pasture	pasture	pasture	
T7	0.8	N	S	tres/ mobl	5/2 hot	?/0	?/0	old	50	pasture	pasture	pasture	pasture	empty/ empty
F24	0.85	N	S						20	pasture	pasture	pasture	pasture	
T6	0.9	N	S	tres	2	6	6	old	1	pasture	pasture	pasture	pasture	parasite worms, empty
F25	0.9	N	SE					t	20	pasture	pasture	pasture	pasture	
F26	1	N	SW	tres	4+ hot	3	3		50	pasture	pasture	pasture	pasture	empty
F28	1.1	N	S					t	40	pasture	pasture	pasture	pasture	
F29	1.15	N	SE	howr	3 hot	5	5		10	pasture	pasture	pasture	pasture	banded & empty
RU	1.3	N	S	howr	6 hot	7		priv	100	pasture	pasture	pasture	pasture	empty
F30	1.35	N	SW						40	forest	pasture	pasture	pasture	
RV	1.45	N	S	tres	5	6	6	priv	200	pasture	pasture	pasture	pasture	empty
RW	1.55	N	S					priv	50	pasture	pasture	pasture	pasture	
F31	0.1 W of RR215 on T554	N	S	howr	2	1	1	t	40	pasture	pasture	forest	forest	feldged
F32	0.2	N	S	howr	6 hot	6	6		30	forest	forest	forest	forest	empty
RZ	0.3	N	S	howr/ howr	?/6 hot	7/ 5	7/5	t	2	forest	forest	forest	forest	empty/ empty
F33	0.4	N	S	howr	7 hot	8	8		15	forest	forest	forest	forest	empty
F34	0.5	N	S	howr	5 hot	5	5	t	10	forest	forest	forest	forest	empty
R1	0.6	N	S	tres	?	?	6	priv	0	forest	forest	swamp	forest	banded & empty
unnumbered	0.7	N	S					priv	0	swamp	swamp	swamp	forest	water hazard
R8	0.8	N	S	tres	?	6	6	priv	5	forest	forest	forest	forest	empty
R2	0.9	N	S	tres	?	7	7	priv	0	forest	forest	forest	forest	banded & empty
R3	1.0	N	S	tres/ howr	?/3 hot	7/4	7/ 0	priv	10	forest	forest	forest	forest	empty/ 4 dead chicks
R4	1.1	N	S	tres	8 hot	7	7	priv	2	pasture	forest	forest	pasture	empty

Old # / New	Box Location	Roads	Faces	Species	#eggs/	#Fledge	Box	Proximity	Description of surrounding habitat (qualitative)	Comments (banded,
Y18 / E15	0.5 N of HW16 on RR175	E	W	TRES	U	U		>500 m	Agricultural Land with Pond	
E37 / E14	0.7 N of HW16 on RR175	E	SW	MOBL	5 / 5	5	Old	> 500 m	Agricultural Land	
E38 / E16	0.2 N of HW 16 on RR175	W	NE	TRES	6 / 6	6	Old	70 m	Agricultural Land	
E39 / E17	0.6 N of HW16 on RR180	E	SW	HOWR	0 / 0	0	Old	20 m	Agricultural Land near Trees	
E45 / E19	0.4 E of RR180 on T534	S	N	TRES	U	U		1 m	Agricultural Land near Trees	
E46 / E20	0.1 S of 540 on RR180	W	SW	TRES	8 / 8	8		200 m	Agricutural Land	
E47 / E21	0.6 N of T540 on RR 180	E	SW	N/A	0 / 0	0		100 m	Agricultural Land (with pipeline construction)	
E48 / E22	0.8 N of T540 on RR180	W	E	HOWR	U	U		2 m	Agricultural Land (with pipeline construction),	
E49 / E24	0.2 W of RR180 on T540	S	NW	TRES	3	0	Old	4 m	Agricultural Land near Trees	
E50 / E25	0.8 W of RR180 on 540	N	S	TRES	7 / 7	7	Old	> 500 m	Agricultural Land	
E21 / E35	0.2 N of 16 on RR181	E	S	TRES	U / 5	0		6 m	Agricultural Land with Pond and near Trees	4 chicks dead,
Y13 / E34	0.4 N of HW16 on RR181	E	W	HOWR	5 / 5	5	Old	6 m	Agricultural Land near Trees	
X13 / E34x	0.4 N of HW16 on RR181	E	NW	TRES	5 / 3	3	Old	6 m	Agricultural Land near Trees	
96-1 / E33	1.4 N of HW16 on RR181	E	N	TRES	6 / 6	6	Old	8 m	Agricultural Land near Trees	6 chicks banded
96-1 / E33x	1.4 N of HW16 on RR181	E	S	N/A	N/A	N/A		8 m	Agricultural Land near Trees	
E40 / E32	2.7 N of 16 on RR181	W	SE	N/A	N/A	N/A	Old	0 m	Agricultural Land in Trees	
Y15 / E30	1.2 N of T534 on RR181	W	NE	HOWR	0 / 0	0		> 500 m	Agricultural Land	
X15 / E31	1.2 N of T534 on RR181	W	E	TRES	6 / 6	6		> 500 m	Agricultural Land	Mother banded
Y16 / E29	1.8 N of T534 on RR181	W	E	TRES	U	U	Old	5 m	Agricultural Land near Trees and across from	
V7 / E27	0.3 E of RR181 on T540	N	SE	HOWR	U	U	Old	0 m	Agricultural Land in Trees	
V8 / E28	0.3 E of RR181 on T540	N	SE	TRES	U	U		0 m	Agricultural Land in Trees	
E41 / E26	0.5 E of RR181 on T540	N	S	TRES	7 / 6	6	Old	100 m	Agricultural Land	
X16 / E43	0.8 N of T534 on RR182	E	W	N/A	0 / 0	0		2 m	Agricultural Land near Trees	
New - E 42		W	SE	TRES	7 / 6	6		6 m	Agricultural Land near Trees	
E43 / E41	1.2 N of 534 on RR182	W	E	MOBL	5 / 5	5	Old	50 m	Agricultural Land	
E42 / E40	1.6 N of T534 on RR182	W	E	MOBL	3 / 3	U	Old	0 m	Agricultural Land in Trees	
V9 / E44	1.0 S of 534 on RR182	W	E	TRES	5 / 5	5		> 500 m	Agricultural Land	Mother banded
V10 / E45	1.0 S of 534 on RR182	W	SE	N/A	0 / 0	0		> 500 m	Agricultural Land	
E34 / E46	1.3 S of T534 on RR182	W	E	TRES	4 / 3	3		3 m	Agricultural Land near Trees	
Y17 / E47	1.8 S of T534 on RR182	E	W	TRES	U	U		100 m	Agricultural Land	
X17 / E48	1.8 S of T534 on RR182	E	NW	N/A	N/A	N/A		100 m	Agricultural Land	Empty box
? / E49	2.1 S of T534 on RR182	E	SE	TRES	6 / 6	6		50 m	Agricultural Land	
V12 / E50	3.1 S of T534 on RR182	W	SE	TRES	U	U	Old	10 m	Agricultural Land	
E51 / E36	0.6 W of RR181 on 534	S	N	HOWR	U	U	Old	> 500 m	Agricultural Land	
96-2 / E37	0.7 W of R181 on T534	S	NE	MOBL	5 / 5	5		> 500 m	Agricultural Land	
X35 / E38	1.1 W of 181 on T534	N	S	HOWR	U	U	Old	3 m	Agricultural Land in Trees	
Y35 / E39	1.1 W of 181 on T534	N	SE	HOWR	U	U	Old	3 m	Agricultural Land in Trees	
X6 / E 53	0.1 W of RR182 on T534	S	N	N/A	N/A	N/A		50 m	Agricultural Land	Empty Box
E35 / E 54	0.4 W of R182 on T534	S	E	TRES	U	U		10 m	Agricultural Land near Trees	
? / E 55	0.6 W of R182 on T534	N	S	HOWR	5 / 5	5		6 m	Agricultural Land near Trees	
? / E 56	0.6 W of R182 on T534	N	S	TRES	6 / 6	6		6 m	Agricultural Land near Trees	
X23 / E 57	0.4 S of T534 on RR183	W	E	TRES	5 / 4	3	Old	60 m	Agricultural Land	
X4 / E 58	1.45 S of T534 on R183	E	W	TRES	4 / 0	0		0 m	Agricultural Land in Trees	Predation
Y4 / E 59	1.45 S of T534 on R183	E	W	HOWR	0 / 0	0	Old	3 m	Agricultural Land near Trees	
E22 / E 60	2.1 S of T534 on RR183	E	E	TRES	5 / 5	5		150 m	Agricultural Land	
? / E 3	0.5 S of HW 16 on 855	W	E	N/A	N/A	N/A		> 500 m	Agricultural Land	Empty box
95-1 / E10	1.8 S of HW16 on 855	E	N	TRES	U	U		300 m	Agricultural Land	
95-1 / E9	1.8 S of HW16 on 855	E	S	TRES	0 / 0	0		300 m	Agricultural Land	
E53 / E8	1.7 S of HW 16 on 855	E	SW	TRES	0 / 0	0		6 m	Agricultural Land	
X30 / E7	1.1 S of HW16 on 855	E	W	TRES	0 / 0	0		10 m	Agricultural Land	
Y30 / E6	1.1 S of HW16 on 855	E	W	TRES	6 / 5	5		10 m	Agricultural Land	
E52 / E4	1.0 S of 16 on 855	W	SE	TRES	6 / 6	6		8 m	Agricultural Land	
? / E5	1.0 S of 16 on 855	E	W	N/A	N/A	N/A		6 m	Agricultural Land	Empty box
E54 / E2	1.7 N of HW16 on RR171	E	SW	TRES	U	U		0 m	Agricultural Land with Wetland and Trees	
E61 / E1	2.5N of HW16 on R171	W	E	TRES	7 / 6	6		2 m	Agricultural Land	
X31 / E12	0.3 W of RR174 on HW16	N	S	TRES	0 / 0	0	Old	400 m	Agricultural Field on N side of Hwy 16	
New - E 11	0.2 W of RR 174 on HW16	N	SW	TRES	5 / 0	0		20 m	Agricultural Land on N side of Hwy 16	
? / E 13	70 yrds E of 175 on HW16	N	SE	TRES	U	U		200 m	In ditch between gravel road and N side of Hwy	
? / E 51	20 yrds W of 182 on 16	N	SE	TRES	0	0		> 500 m	Agricultural Land	
? / E 52	0.5 W of RR182 on HW16	N	SE	N/A	N/A	N/A		> 500 m	Agricultural Land	Empty box
? / E 61	0.7 W of RR183 on HW16	N	SE	N/A	N/A	N/A		100 m	Agricultural Land N of Hwy 16	Empty box
? / E 62	1.4 W of RR183 on HW16	N	SE	TRES	5 / 5	5		75 m	Agricultural Land	
X33 / E 65	0.5 W of RR192 on HW16	N	S	TRES	5 / 5	0		50 m	Agricultural Land N of Hwy 16	All chicks died
X32 / E 66	0.9 W of R192 on HW16	N	EW	TRES	0 / 0	0		2 m	Agricultural Land N of Hwy 16 near Trees	
V13 / E 67	0.2 N of HW 16 on RR195	W	S	TRES	0 / 0	0	Old	15 m	Agricultural Land	
V15 / E 68	Across from grain elevator at on HW16	N	S	HOWR	0 / 0	0		75 m	Wetland N of Hwy 16	
E60 / E72	0.9 E of RR212 on HW16	S	NE	TRES	2 / 2	2	Old	10 m	Agricultural Land S of Hwy 16 near Trees	
E57 / E69	0.4 E of RR215 on HW16	S	NE	TRES	5 / 5	5	Old	30 m	Agricultural Land S of Hwy 16	
E58 / E70	0.6 E of RR215 on HW16	S	NE	TRES	U	U	Old	12 m	Agricultural Land S of Hwy 16 near Trees	
E59 / E71	0.8 E of 215 on HW16	S	NE	TRES	5 / 5	5		12 m	Agricultural Land S of Hwy 16 near Trees	
New - E 63	0.2 W of RR184	N	E	N/A	N/A	N/A		1 m	Agricultural Land with Wetland near Trees	Empty box
New - E 64	0.4 W of 834	N	S	N/A	N/A	N/A		20 m	Agricultural Land	Empty box

Box	Box Location	Roadsi	Facin	Species	# Eggs	# hatched	# Fledged	Box Type	Distance to	North	East	West	South
B01	South of BBO guest parking lot	N/A	SE	HOWR/HOWR	7/6	7/6	7/6	Old	2m	Forest	Forest	Pasture	Pasture, water
B02	0.7km S of T510 on RR183	E	W	MOBL	6	6	6	Old	100m	Forest	Pasture	Road, pasture	Pasture
B03	0.8km S of T510 on RR183	E	W	TRES	6	5	5	New	110m	Forest	Pasture	Road, pasture	Pasture
B04	1.2km S of T510 on RR183	W	SE	TRES	5	5	5	Old	over 200m	Pasture	Pasture	Pasture	Pasture
B05	1.4km S of T510 on RR183	W	SE	TRES	5	5	5	Old	100m	Pasture	Road, pasture	Pasture	Road, Pasture
B06	0.3km W of RR183 on T505	N	S	TRES	6	6	6	Old	25m	Pasture	Pasture	Pasture	Road, water
B07	0.6km W of RR183 on T505	N	S	MOBL	6	6	6	Old	20m	Pasture	Pasture	Pasture	Road, water
B08	0.9km W of RR183 on T505	W	SE	TRES	5	5	5	Old	25m	Pasture	Pasture	Pasture	Road, pasture
B09	0.5km N of T505 on RR184	E	SW	MOBL	6	6	6	Old	1m	Pasture	Pasture	Road, pasture	Pasture
B10	0.6km N of T505 on RR184	E	W	TRES	5	5	5	New	25m	Pasture	Pasture	Road, pasture	Pasture
B11	0.05km N of T510 on RR184A	W	E	HOWR	6	6	6	Tofield	50m	Pasture	Road, pasture	Pasture	Pasture, road
B12	0.2km N of T510 on RR184A	W	E					Tofield	15m	Pasture	Road, pasture	Pasture	Forest
B13	0.2km N of T510 on RR184A	W	E	TRES	6	NEST		Tofield	20m	Pasture	Road, pasture	Pasture	Forest
B14	0.4km N of T510 on RR184A	W	E	TRES	8	8	8	Tofield	100m	Pasture	Road, pasture	Pasture	Pasture
B15	0.4km N of T510 on RR184A	W	E					Tofield	100m	Pasture	Road, pasture	Pasture	Pasture
B16	0.4km N of T510 off of RR184A in	E	S					Tofield	150m	Pasture	Pasture, cattle lock	Road, pasture	Pasture
B17	0.4km N of T510 off of RR184A in	E	S	MOBL/MOBL	6/5	/5	/5	Old	150m	Pasture	Pasture, cattle lock	Road, pasture	Pasture
B18	0.4km N of T510 off of RR184A in	E	N					Tofield	150m	Pasture	Pasture, cattle lock	Road, pasture	Pasture
B19	0.4km N of T510 off of RR184A in	E	S					Tofield	150m	Pasture	Pasture, cattle lock	Road, pasture	Pasture
B20	0.4km N of T510 off of RR184A in	E	S					Tofield	150m	Pasture	Pasture, cattle lock	Road, pasture	Pasture
B21	0.4km N of T510 off of RR184A in	E	S	TRES				Tofield	150m	Pasture	Pasture, cattle lock	Road, pasture	Pasture
B22	0.4km N of T510 off of RR184A in	E	S	TRES	6	6	6	Tofield	150m	Pasture	Pasture, cattle lock	Road, pasture	Pasture
B23	0.5km N of T510 on RR184A	W	E					Tofield	30m	Pasture	Road, pasture	Pasture	Pasture
B24	0.5km N of T510 on RR184A	E	W					Tofield	30m	Pasture	Pasture	Road, pasture	Pasture
S01	HWY16 Eastbound Rest stop	S	NE	TRES	5	5	5	New	1m	Rest stop,	Pasture	Pasture	Pasture
S02	HWY16 Eastbound Rest stop	S	NW	TRES	6	6	5	New	25m	Rest stop,	Water	Pasture	Pasture
S03	HWY16 Eastbound Rest stop	S	NW					New	50m	Trees, HWY16	Pasture	Rest stop	Water
S04	0.3km S of T530 on RR184	E	SW	MOBL	6	5	5	Old	4m	Pasture	Forest	Pasture	Forest
S05	0.9km S of T530 on RR184	E	W	TRES	6	6	5	New	5m	Pasture	Pasture	Forest	Water, Pasture
S06	1.9km S of T530 on RR184	E	SW	TRES	4	4	4	New	10m	Pasture	Pasture	Pasture	Pasture
S07	0.5km W of RR184 on T524A	N	SE					Old	4m	Pasture	Forest	Pasture	Pasture
S08	0.5km W of RR184 on T524A	N	S	TRES	6	4	2	New	6m	Pasture	Forest	Pasture	Pasture
S09	0.7km W of RR184 on T524A	N	SE	TRES	5	4	4	New	1m	Pasture	Pasture	Pasture	Pasture
S10	0.7km W of RR184 on T524A	N	SE					New	1m	Pasture	Pasture	Pasture	Pasture
S11	0.05km E of RR184 on T524A	N	SE	MOBL/TRES	4/5	4/5	4/5	Old	20m	Pasture	Pasture	Pasture, water	Pasture
S12	0.4km E of RR184 on T524A	N	SE	TRES	5	5	5	New	8m	Pasture	Pasture	Pasture	Pasture
S13	0.4km E of RR184 on T524A	N	S	HOWR	8	7	7	New	2m	Pasture	Pasture	Pasture	Pasture
S14	0.5km E of RR184 on T524A	N	SE	TRES	7	7	7	New	20m	Pasture	Pasture	Pasture	Pasture
S15	0.5km E of RR184 on T524A	N	SE					New	20m	Pasture	Pasture	Pasture	Pasture
S16	0.7km E of RR184 on T524A	W	E	TRES	6	6	6	Old (L18cm,	30m	Pasture	Pasture	Pasture	Pasture
S17	0.9km E of RR184 on T524A	S	N	TRES	6	6	5	New	20m	Pasture	Pasture	Pasture	Pasture
S18	1.1km E of RR184 on T524A	S	N	TRES	6	4	4	New	7m	Pasture	Pasture	Pasture	Pasture
S19	1.4km E of RR184 on T524A	S	N	TRES	6	6	6	New	300m	Pasture	Pasture	Pasture	Pasture
S20	1.0km N of T524A on RR183	W	E					New	150m	Pasture	Pasture	Pasture	Pasture
S21	1.0km N of T524A on RR183	E	W	TRES	5	5	5	New	150m	Pasture	Pasture	Pasture	Pasture
S22	0.6km E of RR183 on T530	N	SE	MOBL/HOWR	5/6	5/0	5/0	Old	30m	Pasture	Pasture	Pasture	Pasture
S23	1.1km E of RR183 on T530	S	N	TRES	4	4	0	New	40m	Pasture	Pasture	Pasture	Pasture
S24	1.1km E of RR183 on T530	S	N					New	45m	Pasture	Pasture	Pasture	Pasture
S25	1.2km E of RR183 on T530	N	SE					Old	2m	Pasture	Pasture	Pasture	Pasture
S26	1.2km E of RR183 on T530	S	N	TRES	5	5	5	New	40m	Pasture	Pasture	Pasture	Pasture
S26X	1.4km E of RR183 on T530	N	S					Old	10m	Pasture	Pasture	Pasture	Pasture
S27	0.1km N of T530 on RR182	W	E	TRES	6	6	6	Old	5m	Pasture	Pasture	Pasture	Pasture
S28	0.3km E of RR182 on T530	N	S	MOBL	5	0	0	Old	5m	Pasture	Pasture	Pasture	Pasture, water
S29	1.2km E of RR182 on T530	N	S	MOBL	6	0	0	Old	6m	Pasture	Pasture	Pasture	Pasture, water
S30	1.2km E of RR182 on T530	N	SE					Old	8m	Pasture	Pasture	Pasture	Pasture, water
S31	0.7km S of T530 on RR181	E	W	TRES	5	5	5	New	10m	Pasture	Pasture	Forest	Forest
S32	0.7km S of T530 on RR181	N	SW	HOWR	7	7	7	New	1m	Pasture	Pasture	Forest	Forest
S33	0.8km S of T530 on RR181	W	E	TRES	6	6	6	New	1m	Pasture	Pasture	Forest	Forest
S34	0.8km S of T530 on RR181	E	W	TRES/HOWR	6/7	6/7	6/7	New	0m	Pasture	Pasture	Forest	Forest
S35	1.8km N of T530 on RR181	E	W					New	30m	Pasture	Pasture	Pasture	Pasture
S36	1.8km N of T530 on RR181	E	W	TRES	6	6	6	New	50m	Pasture	Pasture	Pasture	Pasture

Box #	Location (km)	Roadside	Faces	Species	#eggs/hatch	#fledge	Box type	Proximity to	North	South	East	West
N1	E of RR204 on TWP RD	N	S	TRES				2m	T	A	A	A
N2	E of RR204 on TWP RD	N	S	TRES				20m	A	T	T	A
N3	E of RR204 on TWP RD	N	S	TRES				20m	A	T	T	A
N4	E of RR204 on TWP RD 5	N	S	-								
N5	n E of RR204 on TWP RD	N	S	-				10m	T	T	T	A
N6	n E of RR204 on TWP RD	N	S	TRES				5m	T	T	T	T
N7	n E of RR204 on TWP RD	N	S	HOWR				5m	T	T	T	T
N8	n E of RR204 on TWP RD	N	S	TRES				50m	A	T	A	T
N9	n E of RR204 on TWP RD	N	S	TRES				10m	A	T	T	T
N10	N of TWP RD 550 on RR2	E	SW	TRES				20m	A	A	T	A
N11	N of TWP RD 550 on RR	E	SW	TRES				20m	T	T	T	T
N12	N of TWP RD 550 on RR	E	SW	-				20m	T	T	T	T
N13	N of TWP RD 550 on RR	E	SW	TRES				20m	T	T	T	T
N14	E of RR203 on TWP RD	N	S	TRES				20m	T	T	T	A
N15	n E of RR203 on TWP RD	N	S	TRES				20m	A	T	T	A
N16	n E of RR203 on TWP RD	N	S	HOWR				20m	A	T	T	A
N17	N of TWP RD 550 on RR2	W	SE	TRES				0m	T	T	T	T
N18	N of TWP RD 550 on RR	E	SW	TRES				2m	T	A	A	T
N19	N of TWP RD 550 on RR	W	E	TRES				0m	T	T	T	T
N20	n E of RR202 on TWP RD	N	SE	TRES				5m	A	T	T	A
N21	n E of RR202 on TWP RD	S	N	HOWR				5m	T	T	T	T
N22	n E of RR202 on TWP RD	N	S	HOWR				2m	T	T	A	M
N23	n E of RR202 on TWP RD	S	N	TRES				5m	T	T	T	T
N24a	n E of RR202 on TWP RD	N	S	TRES				50m	A	T	A	T
N24b	n E of RR202 on TWP RD	N	SW	TRES				30m	A	T	A	A
N25	n E of RR202 on TWP RD	S	N	HOWR				10m	A	T	T	T
N26	n E of RR202 on TWP RD	S	SE	TRES				30m	A	T	A	T
N27	n E of RR202 on TWP RD	N	S	TRES				20m	A	T	A	T
N28	n E of RR202 on TWP RD	N	SE	TRES				20m	A	T	T	A
N29	N of TWP RD 550 on HW	E	SW	TRES				0m	T	T	T	T
N30	E of HWY 831 on TWP R	N	S	TRES				20m	A	T	T	A
N31	E of HWY 831 on TWP R	S	N	HOWR				10m	A	T	T	T
N32	E of HWY 831 on TWP R	S	N	TRES				5m	A	T	T	T
N33	E of HWY 831 on TWP R	N	SW	TRES				0m	A	T	A	A
N34	E of HWY 831 on TWP R	N	S	MOBL	4	4		20m	A	T	A	A
N35	E of HWY 831 on TWP R	N	SE	TRES				5m	A	T	A	A
N36	E of HWY 831 on TWP R	N	SW	MOBL	6	unknown		10m	A	A	A	A
N37	E of HWY 831 on TWP R	N	S	TRES				20m	A	A	A	A
N38	E of HWY 831 on TWP R	N	S	TRES				65m	A	A	A	A
N39	E of HWY 831 on TWP R	N	SW	TRES				250m	A	A	A	A
N40	E of HWY 831 on TWP R	S	N	TRES				220m	A	A	A	A
N41	N of TWP RD 550 on RR	W	SE	MOBL	6	unknown		250m	A	A	A	A
N42	N of TWP RD 550 on RR	E	W	TRES				220m	A	A	A	A
N43	S of TWP RD 550 on RR	W	E	MOBL	unknown	unknown		30m	A	A	A	A
N44	S of TWP RD 550 on RR	E	W	TRES				20m	A	A	A	T
N45	S of TWP RD 550 on RR	W	E	TRES				20m	A	A	A	A
N46	S of TWP RD 550 on RR	W	E	TRES				10m	A	T	A	A
N47	S of TWP RD 550 on RR	W	E	TRES				5m	T	T	T	T
N48	S of TWP RD 550 on RR	E	SW	TRES				30m	A	A	A	T
N49	S of TWP RD 550 on RR	E	W	HOWR				5m	T	T	A	T
N50	S of TWP RD 550 on RR	E	W	TRES				5m	T	T	T	T
N51	S of TWP RD 550 on RR	E	SW	TRES				2m	T	T	T	T
N52	S of TWP RD 550 on RR	W	E	TRES				30m	A	A	T	A

eggs

Regression Statistics	
Multiple R	0.0487401751273232
R Square	0.0023756046714421
Adjusted R	-0.042970958752583
Standard Er	1.1655502831616
Observatior	24

ANOVA

	df	SS	MS	F	ignificance F
Regression	1	0.0711692	0.0711692	0.0523877553681	0.8210736
Residual	22	29.887164	1.3585075		
Total	23	29.958333			

	Coefficients	tandard Erro	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	4.83235872076321	1.6597849	2.9114367	0.0080901003107	1.3901755	8.2745419	1.3901755	8.2745419
X Variable 1	0.000053203954609	0.0002324	0.2288837	0.8210736004516	-0.000429	0.0005353	-0.000429	0.0005353

fledge

Regression Statistics	
Multiple R	0.0883284
R Square	0.0078019
Adjusted R	-0.037298
Standard Er	2.0766991
Observatior	24

ANOVA

	df	SS	MS	F	ignificance F
Regression	1	0.7460576	0.7460576	0.1729917	0.6814958
Residual	22	94.878942	4.3126792		
Total	23	95.625			

	Coefficients	standard Erro	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	5.8423033	2.9572931	1.9755577	0.0608811	-0.290747	11.975354	-0.290747	11.975354
X Variable 1	-0.000172	0.0004142	-0.415923	0.6814958	-0.001031	0.0006867	-0.001031	0.0006867

ratio

Regression Statistics	
Multiple R	0.156569914900169
R Square	0.024514138251846
Adjusted R	-0.019826128191252
Standard Er	0.340995205199824
Observatior	24

ANOVA

	df	SS	MS	F	ignificance F
Regression	1	0.0642858	0.0642858	0.5528640267263	0.4650172
Residual	22	2.5581101	0.1162777		
Total	23	2.6223958			

	Coefficients	tandard Erro	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1.22191380239449	0.4855893	2.5163526	0.0196517835915	0.2148633	2.2289643	0.2148633	2.2289643
X Variable 1	-0.000050565632414	0.000068	-0.743548	0.4650172097783	-0.000192	0.0000905	-0.000192	0.0000905

Box	Location (km)	Roadside	Face	Species	#eggs	#hatch	#fledge	Box Type	Cover proximity (m)	North	East	West	South	comments
N34	1.4 E of HWY 831 on T550	N	S	MOBL	4	unknown	4	new	20	agricultural	agricultural	agricultural	T	
N36	2.7 E of HWY 831 on T550	N	SW	MOBL	6	unknown	6	new	10	agricultural	agricultural	agricultural	agricultural	assumed 4 fledge since no dead found
N41	0.5 N of T550 on RR193N	W	SE	MOBL	6	unknown	6	new	250	agricultural	agricultural	agricultural	agricultural	assumed 6 fledge since no dead found
N43	0.1 S of T550 on RR194S	W	E	MOBL	unknown	unknown	unknown	new	30	agricultural	agricultural	agricultural	agricultural	eliminated as data point
T34	1 S of T564 on 213A	E	SW	MOBL	6	6	6	old	0	pasture	pasture	pasture	pasture	
T34	1 S of T564 on 213A	E	SW	MOBL	5	5	5	old	0	pasture	pasture	pasture	pasture	
T31	0 S of T562 on RR213	E	W	MOBL	7	7	7	old	2	pasture	forest	forest	forest	
T31	1 S of T562 on RR213	E	W	MOBL	6	6	6	old	2	pasture	forest	forest	forest	
RT	1.2 S of T562 on RR213	W	E	MOBL	6	6	6	private	5	industrial	pasture	pasture	pasture	assumed 6 eggs since no shells found
TY	1.4 S of T562 on RR213	W	E	MOBL	4	3	3	special	100	pasture	pasture	forest	pasture	1 dead egg found
T29	1.2 E of RR214 on T560	N	S	MOBL	6	6	6	old	10	forest	pasture	forest	pasture	
T7	0.8 W of RR214 on T554	N	S	MOBL	2	0	0	old	50	pasture	pasture	pasture	pasture	no fledge
E14	0.7 N of HW16 on RR175	E	SW	MOBL	5	5	5	Old	> 500	Agricultural Land				
E41	1.2 N of 534 on RR182	W	E	MOBL	5	5	5	Old	50	Agricultural Land				
E40	1.6 N of T534 on RR182	W	E	MOBL	3	3	unknown	Old	0	Agricultural Land in Trees				assumed 3 fledge since no dead found
E37	0.7 W of R181 on T534	S	NE	MOBL	5	5	5	new	> 500	Agricultural Land				
B02	0.7 S of T510 on RR183	E	W	MOBL	6	6	6	Old	100	Forest	Pasture	Road, pasture	Pasture	
B07	0.6 W of RR183 on T505	N	S	MOBL	6	6	6	Old	20	Pasture	Pasture	Pasture	Road, water	
B09	0.5 N of T505 on RR184	E	SW	MOBL	6	6	6	Old	1	Pasture	Pasture	Road, pasture	Pasture	
B17	0.4 N of T510 on RR184A	E	S	MOBL	6	unknown	6	Old	150	Pasture	Pasture, cattle lock	Road, pasture	Pasture	assumed 6 fledge since no dead found
B18	0.4 N of T510 on RR184A	E	S	MOBL	5	5	5	Old	150	Pasture	Pasture, cattle lock	Road, pasture	Pasture	
S11	0.05 E of RR184 on T524A	N	SE	MOBL	4	4	4	Old	20	Pasture	Pasture	Pasture, water	Pasture	
S22	0.6 E of RR183 on T530	N	SE	MOBL	5	5	5	Old	30	Pasture	Pasture	Pasture	Pasture	
S28	0.3 E of RR182 on T530	N	S	MOBL	5	0	0	Old	5	Pasture	Pasture	Pasture	Pasture, water	no fledge
S29	1.2 E of RR182 on T530	N	S	MOBL	6	0	0	Old	6	Pasture	Pasture	Pasture	Pasture, water	no fledge

box type	width	depth	height	cm^2
old	17	18	25	7650
new	15	15	23	5175
private	14	18	24	6048
special	16	14	23	5152