Response of Wild Trumpeter Swan (*Cygnus buccinator*) Broods to Wetland Drawdown and Changes in Food Abundance

Harry G. Lumsden[1, 3], Vernon G. Thomas[2], and Beren W. Robinson[2]

[1]144 Hillview Road, Aurora, Ontario L4G 2M5 Canada
[2]Department of Integrative Biology, College of Biological Science, University of Guelph, Guelph, Ontario N1G 2W1 Canada
[3]Corresponding author: theholtentwo@hotmail.com

Lumsden, Harry G., Vernon G. Thomas, and Beren W. Robinson. 2015. Response of wild Trumpeter Swan (*Cygnus buccinator*) broods to wetland drawdown and changes in food abundance. Canadian Field-Naturalist 129(4): 374–378.

A brief period of drawdown can stimulate wetland productivity and enhance the attractiveness of a site for breeding Trumpeter Swans (*Cygnus buccinator*) by providing a nutrient pulse. Drawdown of a pond in Aurora, Ontario, lasting about 8 weeks in late summer and fall 2009 followed by re-flooding increased the abundance of invertebrates, especially snails, in the following year. This response was ephemeral, lasting 1 year. Wild Trumpeter Swans and their cygnets responded by selective feeding the year after drawdown, despite the risk of predation by Snapping Turtles (*Chelydra serpentina*). There was a strong correlation between the feeding activity of two cygnets and the local abundance of snails in the pond in 2010. The nutritional content, especially protein, calcium, phosphorus, and magnesium, of a variety of abundant foods satisfied the requirements for skeletal growth and development and was higher than that of available commercial duck grower rations. The responsive feeding behaviours of the cygnets are typical of specific appetitive behaviour and suggest that swans rapidly exploit unpredictable nutrient fluxes in their local environment.

Key Words: Trumpeter Swan; *Cygnus buccinator*; cygnets; appetite; feeding behaviour; grass; snails; nutrients; drawdown

Introduction

The current continental range of the Trumpeter Swan (*Cygnus buccinator*) extends across habitats that are disturbed naturally by fire, drought, and flooding (Sibley 2000). These disturbances may disrupt the activities of swans in the short term, but they may also generate food pulses (Yang *et al*. 2008, 2010). The wide-scale significance of drought to waterbirds is well known (Murkin *et al.* 1982; Frederick and Ogden 2001), yet anthropogenic disturbances that mimic natural ones are less well understood. How such disturbances affect species composition of wetlands and the subsequent feeding behaviour of individual Trumpeter Swans has not been studied. We report on the selective feeding of cygnets the year following drawdown in a managed pond in 2009 and the availability and nutritional quality of their foods.

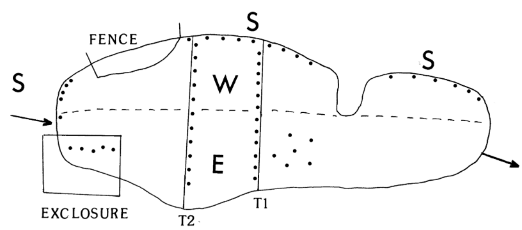

Figure 1. Diagram of the managed pond at Aurora, Ontario, used by breeding wild Trumpeter Swans (*Cygnus buccinator*). The direction of water flow through the pond is shown by arrows. Sampling transects (T1 and T2) across the pond were used to estimate invertebrate abundance from 2010 to 2013. Dots represent sampling sites in 2010. West, East, and Shore sectors are denoted by W, E, and S.

Study Area

A managed pond that can be drawn down and reflooded in Aurora, Ontario (44°00'N, 79°28'W) provided an opportunity to study how Trumpeter Swan behaviour responds to the effects of drawdown. Wild Trumpeter Swans have flown into this pond and raised broods from 2006 to 2014. The 0.4-ha pond is 60 cm deep; it is fed by a pipe from a creek at its southeast corner and drains through a pipe at its north end (Figure 1). In 2010, a small exclosure pen (water surface area 102 m^2) in the southeast corner of the pond supported clumps of rushes (*Juncus canadensis*), and a small exclosure (water surface area 76 m^2) on the west side protected a stand of Pickerelweed (*Pontederia cordata* L.). Elsewhere in the pond, swan grazing has eliminated all macrophytes. On the east side of the pond lies a mowed lawn on which wild Trumpeter Swan broods frequently graze.

The pond was drawn down to dryness in August 2009, 10 years after a previous drawdown. It was reflooded on 2 October the same year. It was drawn down and refilled again between 20 July and 30 September 2011.

Methods

To measure invertebrate abundance in three sectors of the pond (Figure 1), 10–12 mud samples were collected at marked 2-m intervals along two transects running east–west across the pond. Bottom samples were also collected within 0.5 m of the shore (n = 19 in 2010).

A contribution towards the cost of this publication has been provided by the Thomas Manning Memorial Fund of the Ottawa Field-Naturalist's Club.

The eastern shore was not sampled because the cygnets did not forage in the gravel substrate. Benthic invertebrates were sampled from the pond in the summer, 2010–2013, and in fall 2013 with a circular bucket (area 537.3 cm^2) from which the bottom had been removed. It was forced through the mud into the substrate to collect bottom samples. From 2.5 to 3.5 L of mud were collected for each sample, although near shore sometimes as little as 1 L was available. Sediments were washed through a 1.2-mm mesh screen, and invertebrates were counted and preserved. Live and dead snails were identified by the presence or absence of soft tissue. Invertebrate samples were identified by Dr. G. Mackie (Department of Integrative Biology, University of Guelph). Grass samples were collected from the lawn by mowing and raking. The protein, calcium, phosphorus, and magnesium content of both snails and grasses were analyzed routinely by Laboratory Services at the University of Guelph.

Activity budgets for cygnet feeding behaviour were recorded for 15 s every consecutive 2 minutes on land totalling 31.7 h between 4 and 12 July 2010, and on water by sector totalling 11.4 h between 11 and 29 August 2010. The brood moved freely from sector to sector. The East sector was 51.6% surface area, the West sector was 45.9% of the area, and a 0.5 m wide Shore sector covered 2.6% of the surface area. We calculated sector preference of each cygnet (distinguishable by plumage colour) from their daily scores for the East, West, and Shore sectors following Johnson (1980), and ranked the daily use of the three sectors for each cygnet over 17 observation days. Daily sector preferences for each cygnet were estimated as the difference between daily rank sector use scores and rank sector availability (assumed to remain constant) and then averaged over 17 days. A sector preference score of zero indicates that the sector was used in proportion to its available surface area. Negative scores indicate a greater relative preference than expected from its availability, and positive scores indicate greater avoidance.

To determine whether benthic snail density varied spatially, we divided samples into three sector categories and the exclosure area, where swans were unable to feed. We divided each transect at its centre into an eastern half (4–15 m from eastern shoreline) and western half (16–26 m from eastern shoreline). The Shore sector was along the shore on the west (n = 9), northwest (n = 6), and south (n = 4) sides of the pond. We first used an analysis of variance (ANOVA) to test for differences in mean snail counts between northwest, south, and west shore samples. We then tested for differences between the combined east transect halves, combined west transect halves, Shore (combining shore samples), and the western Exclosure. Post-hoc comparisons were then made among these categories using Tukey's honest significant difference test (a = 0.05). Snail counts were Poisson distributed and, thus, were transformed into their natural log to homogenize variance. Relative pond-sector preference by cygnets could not be statistically tested because the number of individuals observed was less than the number of sectors (Johnson 1980) and because cygnet activity showed considerable coordination causing pseudo-replication.

Results

Food abundance and swan response in 2010

In 2010, a brood of four cygnets hatched on a raft on 12 June; two subsequently disappeared. On 14 June, the remaining cygnets began to feed on duck grower pellets, but after 23 June did not accept them. Instead, they tipped and grubbed in the pond and grazed on the lawn.

Benthic sampling of invertebrates in late June showed abundant snails (Table 1), the majority of which were *Physella gyrina* (94%). Six other species of snails were present as well as clams (*Pisidium adamsi* and *Sphaerium simile*), and leeches (*Erpobdella punctata* and *Helobdella triserialis*). Samples also contained a few oligochaetes as well as a mix of other invertebrates, such as Anisoptera nymphs, Coleoptera and Chironomid larvae, and *Notonecta* spp. Although the cygnets probably ate some of these invertebrates, their combined biomass was much smaller than that of the snails. The pond supported abundant Fathead Minnows (*Pimephales promelus*), which were restored after drawdown. A few Creek Chub (*Semotilus atromaculatus*) were present in 2011. Snapping Turtles (*Chelydra serpentina*) and Painted Turtles (*Chrysemys picta*) were present throughout the study period. Activity budgets recorded over 31.7 h during 4–12 July showed that the cygnets were feeding during 36–52% of daylight hours (Figure 2). Water feeding was confined largely to late morning when the time devoted to it exceeded that of grazing on land.

This study had not been anticipated in 2009 when anecdotal evidence suggested snail scarcity. In 2010, snails were not distributed randomly among the three sectors of the pond. There was no significant difference in the mean number of snails between the south and west parts of the Shore ($F_{2,16}$ = 2.1, P = 0.16 [not significant]), and so these were combined to estimate Shore snail abundance. The mean number of snails differed significantly among the three sectors and the Exclosure ($F_{3,43}$ = 64.4, P < 0.0001, adjusted R^2 = 0.81). Multiple comparisons revealed that live snail density in the Shore sector (1434/m^2) was significantly higher than in the East (349/m^2) and the West sectors (100/m^2) (Table 1). Snail density was 3.5 times higher in the East sector than in the West sector and 1.8 times greater in the Exclosure (618/m^2) than in the adjacent East sector.

Activity budgets recorded during 11.4 h of grubbing time over 11–29 August indicated that the cygnets strongly preferred the Shore sector (relative sector preference −1.43), even though it was the least available sector in the pond based on its surface area (relative sector preferences: West 0.60 and East 0.82) (Figure 3). Mean cygnet preference for pond foraging sector was

TABLE 1. The abundance of snails in bottom mud in a pond in Aurora, Ontario, 2010–2013.

Year and sector	Sample size	Dates sampled	Number of snails				
			Live	Mean ± SD*	Dead	Mean ± SD	Live/m^2
2010							
East	13	27–30 July	225	18.7 ± 9.8a	111	9.2 ± 4.9	349
West	11	1–2 August	59	5.4 ± 2.7b	29	2.6 ± 1.3	100
Shore	19	13 August–9 September	1464	77.1 ± 21.6c	721	37.9 ± 10.6	1434
Exclosure	5	4–6 July	166	33.2 ± 11.5a	82	16.4 ± 6.0	618
2011							
East	12	27–30 July	3		83	6.9 ± 2.8	
West	10	2–3 August	2		42	4.2 ± 3.4	
Shore	12	16–24 August	10	0.8 ± 1.3	564	47.0 ± 20.2	15
2012							
East	10	28 July	1		23	2.3 ± 1.7	
West	10	29 July	1		9	0.9 ± 1.0	
Shore	10	30 July–1 August	2		172	17.2 ± 7.0	
2013							
East	11	26 July	0		16	1.5 ± 0.8	
West	11	28 July	0		5	0.5 ± 1.4	
Shore	10	29–31 July	1		201	20.1 ± 10.2	
Shore	10	17–22 October	61	6.1 ± 4.4	217	21.7 ± 19.9	

Note: SD = standard deviation.
*Values followed by different letters are significantly different from each other.

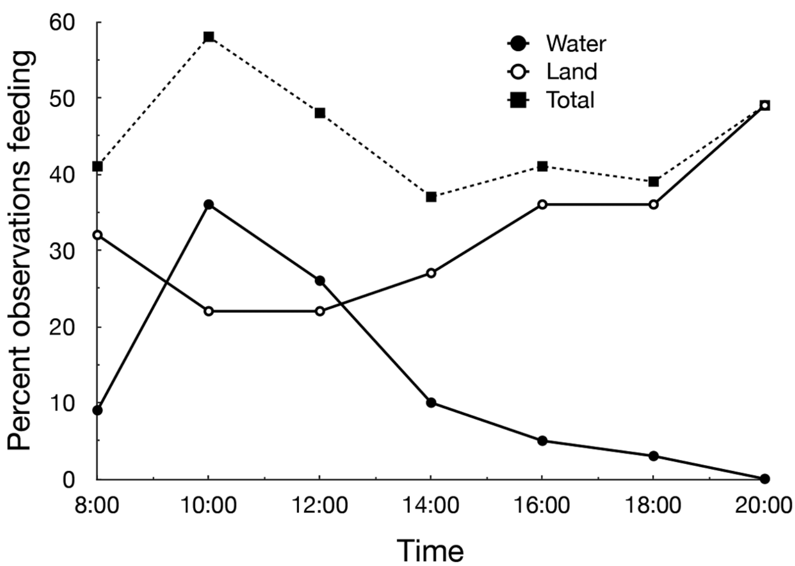

FIGURE 2. Activity budgets of approximately 7-week-old cygnets (*Cygnus buccinator*) in a managed pond at Aurora, Ontario. Values are the mean percentage of 15-s observations of cygnets feeding in water or on land from 4 to 12 July 2010.

strongly related to local snail abundance ($r = -0.885$, $P < 0.0001$). Thus, the cygnets more than satisfied their calcium requirements by eating snails. The absence of foraging in the natal pond in 2011 and 2012, when virtually only dead snails were available, suggests that the cygnets sought live snails, which contained more protein although less, but adequate, calcium. Their protein needs were satisfied by grazing on the lawn, as grasses contained 22.6% protein (Table 2).

Food abundance and swan response in 2011, 2012, and 2013

In 2011, the breeding pair hatched four cygnets, but two disappeared. In 2012, they hatched two cygnets, but one disappeared (see Lumsden 2013). Six cygnets hatched in 2013, but 2 disappeared.

In 2011, the snail population in the pond collapsed; the ratio of live to dead snails in samples was only 1:46. In 2012, it was 1:51 and, in July 2013, 1:222 (Table 1).

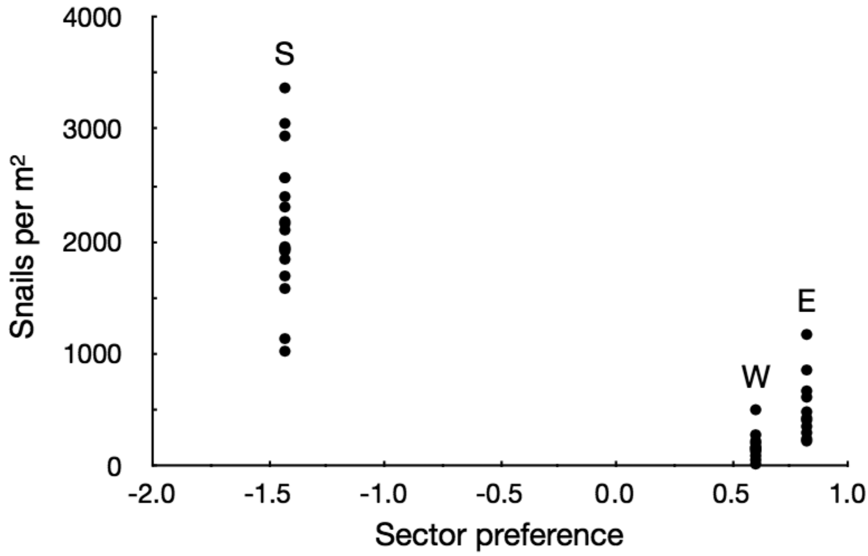

FIGURE 3. Relation between relative pond sector preference by approximately 11-week-old cygnets (*Cygnus buccinator*) in 2010 and the abundance of live and dead snails (per m^2 substrate) for Shore (S), West (W) and East (E) sectors. A preference value of 0 indicates that the sector is used in proportion to its available surface area. Negative values indicate greater relative preference for the sector, and positive values indicated greater avoidance.

TABLE 2. Nutrient analysis (dry mass basis) of duck grower pellets, grass, and snails in a pond in Aurora, Ontario, in 2010.

Food source	Protein, %	Calcium, %	Phosphorus, %	Magnesium, %
2010				
Duck grower pellets	15.0	0.85	0.70	0.05
Snails, live and dead	6.9	24.00	0.04	0.21
Grasses	22.6	0.68	0.34	0.18
2013				
Snails, live	10.3	18.20	0.21	0.09

Within 2 days of hatching, the broods moved to other ponds where they fed on *Lemna*. In 2011, they refused all offerings of duck grower pellets in July but returned to the lawn to graze and to the raft to roost. In late July 2012, the surviving cygnet accepted a single meal of duck grower pellets; in August, offered pellets were seldom eaten. In 2013, four of the six cygnets that hatched were fed on duck grower pellets three times a day. The adults appeared, initially, to feed on *Spirogyra*, attractive because it contains 23.3% protein.

Discussion

The drawdown of the pond had a significant effect on the quantity of invertebrates. Following drawdown and oxidation of the substrate, the restored water levels stimulated a significant pulse of snails. They were most plentiful in the Shore sector and least abundant in the West sector. These differences in snail abundance may have been influenced by the flow of fertile creek water superimposed on the effect of drawdown. The Shore sector, which was the only one with a burden of detritus on which snails also feed (Burch 1982), contained the greatest number of live snails (1434/m^2). Harper and Bolen (1996) and Collias and Collias (1963) have identified *Lemna* and the associated detritus as an important habitat for macroinvertebrates, such as snails. We suggest that detritus largely sustained the snails independent of drawdown, and cygnets exploited this abundance while it lasted.

Although the pond was drawn down for a second time in 2011, no pulse of snails developed. Because of flow-through, the fertile waters from the 2009 drawdown had presumably been flushed out. It is likely that no residual fertility was available for release in the substrate following the second drawdown.

Among birds, appetitive is an evolved searching behaviour that can be either innate or learned. The chicken’s appetitive for calcium, for example, appears to result from learning, reinforced by taste and digestional satisfaction (Hughes and Wood-Gush 1971). However, Tordoff (2001) believed that calcium appetite has both innate and learned components.

The Aurora broods demonstrated a strong appetite for the most nutritious food available and rejected what was merely good, such as the duck grower pellets. Throughout their range, Trumpeter Swans use wetlands in which there appears to be enough food, but the quality as it appears to the swans may vary from acceptable to inadequate. Their selective foraging and appetitive skills ensure that both adults and cygnets locate foods that are sufficiently nutritious for growth and survival, especially in habitats susceptible to periodic droughts.

Acknowledgements

We thank Diana Lumsden for typing many drafts of this paper, Dr. Gerry Mackie, Department of Integrative Biology, University of Guelph, for identifying the pond invertebrates, and Angus Norman, who provided references.

Literature Cited

Burch, J. B. 1982. Freshwater Snails (Mollusca: Gastropoda) of North America. Environmental Monitoring and Support Laboratory, Office of Research and Development, Environmental Protection Agency, Cincinnati, Ohio, USA.

Collias, N. E., and **E. C. Collias.** 1963. Selective feeding by wild ducklings of different species. Wilson Bulletin 75: 6–14.

Frederick, P. C., and **J. C. Ogden.** 2001. Pulsed breeding of long-legged wading birds and the importance of infrequent severe drought conditions in the Florida Everglades. Wetlands 21: 484–491.

Harper, C. A., and **E. G. Bolen.** 1996. Duckweed (Lemnaceae) as habitat for macroinvertebrates in eastern North Carolina. Wetlands 16: 240–244.

Hughes, B. O., and **D. G. M. Wood-Gush.** 1971. A specific appetite for calcium in domestic chickens. Animal Behaviour 19: 490–499.

Johnson, D. H. 1980. The comparison of usage and availability measurements for evaluating resource preference. Ecology 61: 65–71.

Lumsden, H. G. 2013. Trumpeter Swan (*Cygnus buccinator*) behaviour, interactions with Snapping Turtles (*Chelydra serpentina*), and their Pleistocene history. Canadian Field-Naturalist 127: 138–145.

Murkin, H. R., R. M. Kaminski, and **R. D. Titman.** 1982. Responses by dabbling ducks and aquatic invertebrates to an experimentally manipulated cattail marsh. Canadian Journal of Zoology 60: 2324–2332.

Sibley, D. A. 2000. National Audubon Society: The Sibley Guide to Birds. Alfred A. Knopf, New York, New York, USA.

Tordoff, M. G. 2001. Calcium: taste, intake and appetite. Physiological Reviews 81: 1567–1597.

Yang, L. H., J. L. Bastow, K. O. Spence, and **A. N. Wright.** 2008. What can we learn from resource pulses? Ecology 89: 621–634.

Yang, L. H., K. F. Edwards, J. E. Byrnes, J. L. Bastow, A. N. Wright, and **K. O. Spence.** 2010. A meta-analysis of resource pulse-consumer interactions. Ecological Monographs 80: 125–151.

Received 15 October 2014
Accepted 27 July 2015