

# DIVE BEHAVIOUR OF TWO SYMPATRIC, PLANKTIVOROUS ALCIDS

Kyle Elliott<sup>1</sup> and Akiko Shoji<sup>2</sup>

<sup>1</sup>Department of Biology, University of Manitoba, Winnipeg, MB

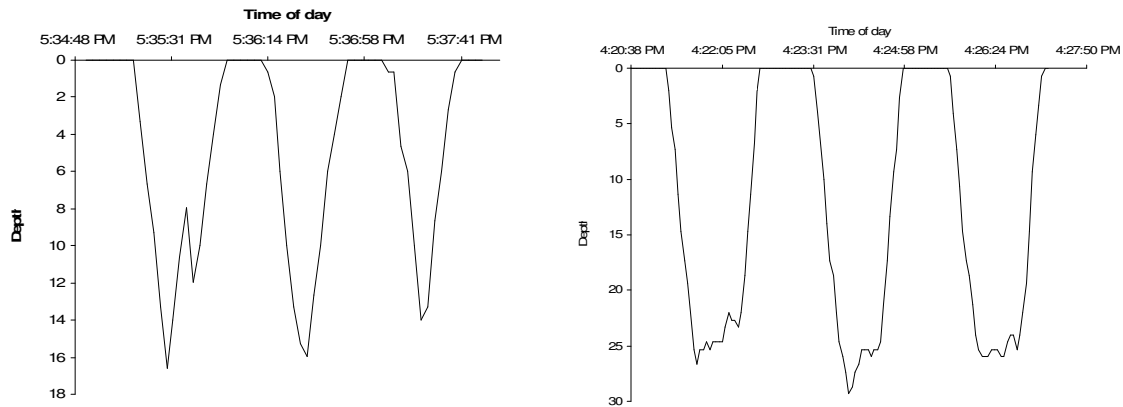
<sup>2</sup>Department of Biology, University of Ottawa, Ottawa, ON

Although the dive behaviour of the larger alcids has been well-described (over twenty articles on the dive behaviour of Thick-billed Murres alone), the dive behaviour of planktivorous alcids has never been described using time-depth recorders, with the exception of some limited data on the Little Auk *Alle alle*. This is a major gap in our knowledge of the auks, as the majority of alcids are planktivorous. A dozen species of small, planktivorous alcids (*Aethia*, *Cyclorhynchus*, *Ptychoramphus* and *Synthliboramphus* spp.) dominate the North Pacific seabird community. In the largely planktivorous genus *Synthliboramphus*, three of the four species are considered Threatened, yet the at-sea behaviour of all four species is very poorly known (Gaston and Jones 1998).

To learn something about the dive behaviour of two species of planktivorous alcids,

Ancient Murrelet *Synthliboramphus antiquus* and Cassin's Auklet *Ptychoramphus aleuticus*, we initiated a preliminary study at Reef Island, Haida Gwaii, BC. In May 2008, we attached time-depth-temperature recorders (Lotek 1100s) to three Ancient Murrelet and one Cassin's Auklet and maximum-depth recorders to four Ancients Murrelets and two Cassin's Auklets. All birds were incubating. The devices recorded for 55 hours.

Maximum dive depth averaged  $32 \pm 3$  (SD) m for murrelets and  $28 \pm 1$  m for auklets. The auklet made 218 dives in one day, averaging  $46 \pm 20$  s (max = 87 s) in duration. The murrelets made 568 dives per day, averaging  $23 \pm 12$  s (max = 60 s) in duration. An earlier study showed that auklets averaged 28 m (max = 43 m) during chick-rearing with most of the time spent between 3 and 13 m.



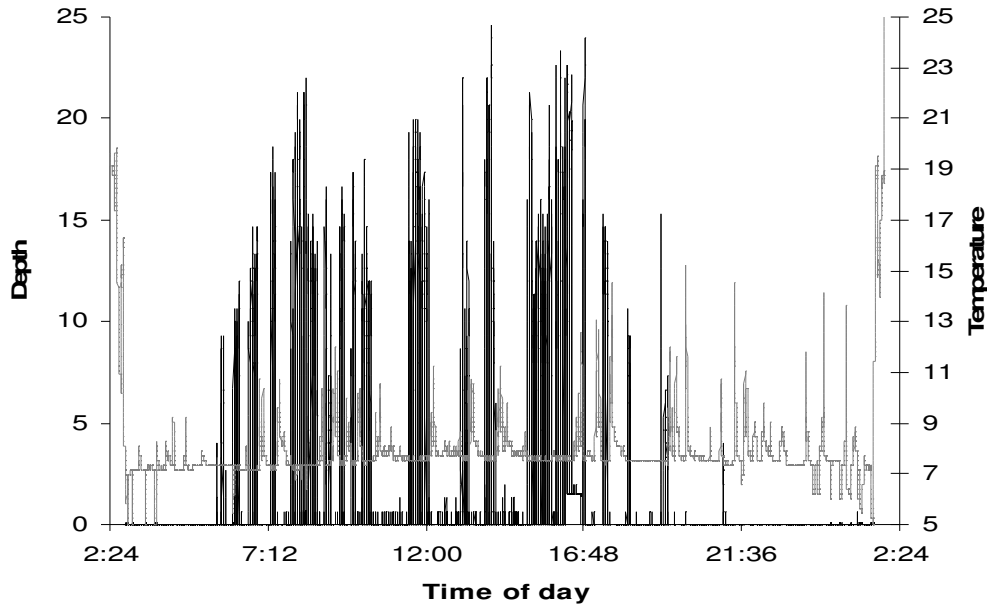
**Figure 1**  
Typical dive profiles for a (a) murrelet and (b) auklet. Note the difference in vertical scale.

Dive profiles for the Ancient Murrelets were usually V-shaped. The dives were very similar to those associated with Razorbills *Alca torda* and Rhinoceros Auklets

*Cerorhinca monocerata* feeding on sand lance and Thick-billed Murres feeding on pelagic prey, especially sand lance *Ammodytes* spp., amphipods and larval fish

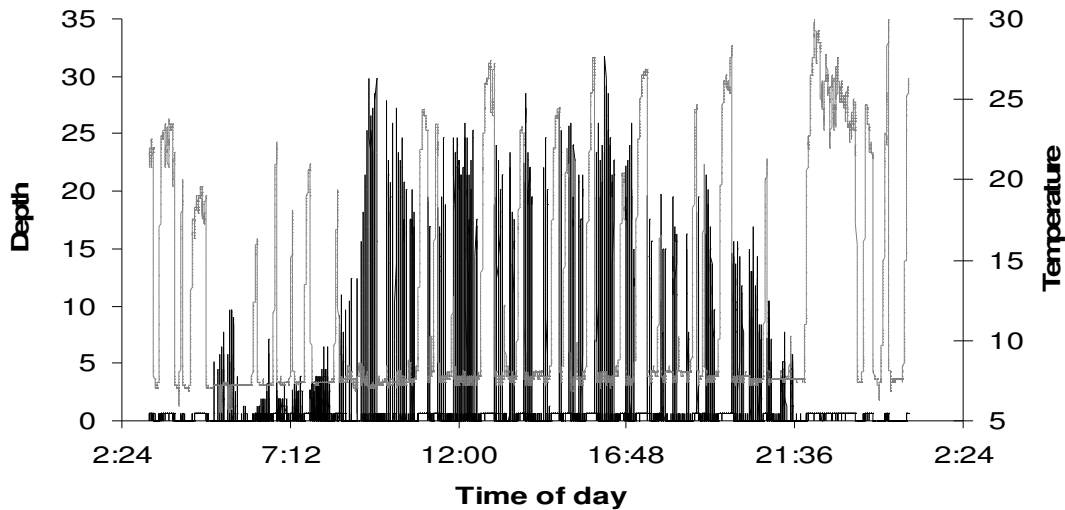
(Benvenuti *et al.* 2001, Kuroki *et al.* 2003, Elliott *et al.* 2008). We suggest that the murrelets were feeding predominately on planktonic larval fish, especially sandlance, and euphasiids. Stomach contents from

Langara Island during early incubation were also dominated by euphasiids, while those later in the year were dominated by larval sandlance (Sealy 1975).



**Figure 2**

A day in the life of a Cassin's Auklet. Temperature shown in grey, depth in black. The large number of short flights makes it difficult to determine a foraging range.



**Figure 3**

A day in the life of an Ancient Murrelet. The logger suggests that the bird may have returned to the colony around 22:00—it did not actually switch over with its mate until 24 hours after the last time shown here.

Dive profiles for Cassin's were usually more U-shaped, with a flatter bottom, punctuated by wiggles. The ragged bottoms, with several wiggles, were similar to those associated with *Spheniscus* penguins feeding on schooling fish (Simeone and Wilson 2003). In that case, each wiggle represents a prey capture event (90% accuracy). We assumed that auklets were feeding predominately on schooling fish, as has been suggested from studies of adult regurgitations (Vermeer *et al.* 1985, Burger and Powell 1990).

In comparison to penguins, the maximum depths and dive profiles of 200g planktivorous alcids were very similar to 3 kg penguins (Takahashi *et al.* 2004). Thus, despite very differing morphology (smaller size, ability to fly), alcids appear to have similar dive abilities and foraging tactics for capturing marine prey as penguins at the other end of the world. The dive behavior

reported here is similar to that described for Dovekies in Greenland: maximum depth of about 26 m, average depth 10 m; average duration 52 s; most dives V-shaped; return flight times of 21 mins (Egevang *et al.* 2006).

To examine oxygen stores, we collected muscle (n = 5) and blood (n = 10) samples from non-breeding Ancient Murrelets and incubating Cassin's Auklets. Hemoglobin content and buffering capacity was high while myoglobin stores were low. The high blood oxygen levels and buffering capability suggests that these small divers are under strong selection to extend dive duration. In keeping with the longer dive durations and shorter surface pauses despite smaller size, auklets had relatively higher oxygen stores, except in the legs. Nonetheless, higher oxygen stores could also be due to the murrelets being non-breeders and the auklets being breeders.

**Table 1**  
**Comparison of respiratory blood chemistry in Cassin's Auklet, Ancient Murrelet and Thick-billed Murre**

<i>Species</i>	<i>Cassin's Auklet</i>	<i>Ancient Murrelet</i>	<i>Thick-billed Murre</i> <sup>1</sup>
Hematocrit	55 ± 2	50 ± 2	53 ± 2
Hemoglobin content (g/dL)	20.7 ± 0.6	19.6 ± 1.3	18.0 ± 1.8
Buffering capacity (μmol NaOH per unit pH)	72 ± 2	64 ± 2	
Myoglobin concentration –breast (g/dg)	10.6 ± 0.3	10.0 ± 0.2	19 ± 1
Myoglobin concentration –legs (g/dg)	8.0 ± 0.4	9.4 ± 0.5	
<b>Myoglobin concentration –heart (g/dg)</b>	<b>6.3 ± 0.3</b>	<b>6.1 ± 0.9</b>	

<sup>1</sup>Value for Thick-billed Murre *Uria lomvia* from Croll *et al.* 1992

Future research could include comparing the hematocrit values between non-breeding and incubating murrelets to see if oxygen levels differ between periods, obtaining oxygen stores for a non-diving Charadriiform bird (i.e. Black Oystercatcher *Haematopus bachmanni*) and obtaining a larger sample of dive records, perhaps by using 2.8g devices. Devices that record for >48 h would be particularly useful.

We conclude that time-depth recorders can provide valuable information about the prey items, prey capture tactics and foraging parameters (foraging radius, dive depths) of planktivorous alcids. Knowledge of how birds use the marine environment is important to develop marine conservation strategies that benefit seabirds. For example, the Gwaii Haanas National Marine Conservation Area, adjacent to the National Park and Reef Island, is currently in the planning phase; knowledge of what areas auklets and murrelets utilize could be useful for selecting areas to protect that maximize benefit to these birds.

### Acknowledgments

This project would not be possible without the field support from Tony Gaston and the lab support from K. Campbell. Jake Pattison, Kerry Woo and Motomi Yoneda provided excellent field assistance.

### REFERENCES

Benvenuti, S., Dall'Antonia, L., Lyngs, P. 2001. Foraging behaviour and time allocation of chick-rearing Razorbills (*Alca torda*) at Graesholmen, central Baltic Sea. *Ibis* 143: 402-412.

Burger, A.E., Powell, D.C. 1990. Diving depths and diet of Cassin's Auklet at Reef Island, British Columbia. *Canadian J. Zoology* 68: 1572-1577.

Croll, D.A., Gaston, A.J., Burger, A.E., Konnoff, D. 1992. Foraging behavior and physiological adaptation for diving in Thick-billed Murres. *Ecology* 73: 344-356.

Egevang, C., Harding, A., Grémillet, D., Merkel, F.R. 2006. Diving behavior of a planktivorous alcid, the Doveki (*Alle alle*) in Northeast Greenland. PSG Abstract.

Elliott, K.H., Woo, K., Gaston, A.J., Benvenuti, S., Dall'Antonia, L., Davoren, G.K. 2008. Seabird foraging behaviour indicates prey type. *Marine Ecology Progress Series* 354: 289-303.

Gaston, A.J. and Jones, I.L. 1998. *The Auks – Alcidae*. Oxford University Press: Oxford, UK.

Kuroki, M., Kato, A., Watanuki, Y., Niizuma, Y., Takahashi, A., Naito, Y. 2003. Diving behavior of an epipelagically feeding alcid, the Rhinoceros Auklet (*Cerorhinca monocerata*). *Canadian J. Zoology* 81: 1249-1256.

Sealy, S.G. 1975. Feeding ecology of the Ancient and Marbled Murrelet near Langara Island, British Columbia. *Canadian J. Zoology* 53: 418-433.

Simeone, A. and Wilson, R.P. 2003. In-depth studies of Magellanic Penguin (*Spheniscus magellanicus*) foraging: can we estimate prey consumption by perturbations in the dive profile? *Marine Biology* 143: 825-831.

Steen, H., Vøge, D., Broms, F., Falk-Petersen, S., Borge, J. 2007. Little auks (*Alle alle*) breeding in a High Arctic fjord system: bimodal foraging strategies as a response to poor food availability. *Polar Research* 26: 118-125.

Takahashi, A., Dunn, M.J., Trathan, P.N., Croxall, J.P., Wilson, R.P., Sato, K., Naito, Y. 2004. Krill-feeding behaviour in a Chinstrap Penguin *Pygoscelis antarctica* compared with fish-eating in Magellanic Penguins *Spheniscus magellanicus*: a pilot study. *Marine Ornithology* 32: 47-54.

Vermeer, K., Fulton, J.D., Sealy, S.G. 1985. Differential use of zooplankton prey by Ancient Murrelets and Cassin's Auklets in the Queen Charlotte Islands. *J. Plankton Research* 7: 443-459.

