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# THE MAXIMUM SWIMMING SPEED AND THEORETICAL FORAGING RANGE OF BREEDING LITTLE PENGUINS *Eudyptula minor* AT PHILLIP ISLAND, VICTORIA

PETER DANN[1] and J. M. CULLEN[2]

[1]Penguin Reserve Committee of Management, P.O. Box 403, Cowes, Phillip Island, Victoria 3922.
[2]Department of Zoology, Monash University, Clayton, Victoria 3168.

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Maximum swimming speed of Little Penguins varied from 4.0-8.5 km/h. Estimates indicate that penguins travelling in search of food at the most efficient level of energy consumption would not travel much faster than 2.6 km/h. The potential feeding range is probably about 20 km, when adults are feeding chicks and are absent during daylight.

## INTRODUCTION

There have been five periods of severe mortality of Little Penguins *Eudyptula minor* in southern Victoria between 1982 and 1986. Starvation was identified as the cause of death on two occasions (Harrigan, unpublished data). Associated with this apparent shortage of food has been the lower than average breeding success of penguins on Phillip Island from 1983 to 1985 and in 1987 (Dann, unpublished data).

Little Penguins are difficult to observe at sea and therefore little is known about foraging behaviour or feeding areas. Assessments of potential maximum foraging ranges of some species have been made by multiplying the swimming speed by the recorded absence away from the colony (usually during chick rearing), assuming that birds swim in a straight line on a constant heading (Croxall and Prince 1980, Williams and Siegfried 1980).

While there are some times of the year when the Little Penguins are away from the Island continuously for several days or weeks (Reilly and Cullen 1981), during chick rearing there are periods when adults return nightly. Their foraging range at this time may be of crucial importance for survival of the chicks.

There are three published estimates of the swimming speeds of Little Penguins. One estimate was made from a submarine (Norris 1965), another in a zoo enclosure (Clark and Bemis 1979) and one from a fishing boat (Barton 1979). There is a discrepancy of 10 kilometres per hour between these estimates and thus further information is required before any calculations can be made of foraging ranges. In this paper we present estimates of the maximum swimming speed of the Little Penguins and calculate probable foraging ranges for penguins breeding on the Summerland Peninsula, Phillip Island.

## METHODS

The maximum speeds of penguins were measured as they swam out to sea along a narrow cove (15 m wide × 19 m long) on the southern side of Summerland Peninsula, Phillip Island after being released individually at the edge of the water. The time taken to swim 19 m by 26 penguins was measured with a stopwatch. Of the 26 releases only eight birds travelled the 19 m in a straight line and the remaining 18 measurements were disregarded.

The birds were captured the previous night and held for several hours until release at first light. They were alarmed when released and presumably travelled at their maximum speed. One observer released the birds, the other timed them. Six of the measurements were of birds swimming the entire distance underwater (underwater sprint) and two of the birds were surface paddling. The trials were carried out on days when the wave height was low and unlikely to influence the swimming speeds significantly.

Most penguins leave the colony in the hour prior to dawn and arrive back at the colony in the first hour after dusk. The potential maximum

foraging range in a single day was calculated by multiplying the maximum speed by 50% of the period at sea (allowing for the return). The result is an overestimate as the birds would not swim at maximum speed, in a straight line or on a constant heading while feeding.

## RESULTS

The maximum speeds of Little Penguins surface paddling and underwater sprinting are shown in Table 1. The maximum speed of six underwater sprints ranged from 4.2 to 8.5 km/h and the two surface paddling speeds were 4.0 and 6.5 km/h, respectively.

The maximum daily ranges for return trips from the Summerland Peninsula as calculated from the product of the time at sea (range 11 h/day in July-16 h/day in January) and the swimming speeds (range 4.0-8.5 km/h) range from 22-68 km. However actual foraging ranges would be considerably less than these because the penguins would not be travelling at maximum speed for the whole period at sea, if at all.

From Wilson's (1985) data on the swimming speeds of the Jackass Penguin *Spheniscus demersus*, the ratio of the maximum underwater sprint speed to the usual travelling speed in birds apparently unaffected by observers was 2.61. A similar adjustment of the maximum underwater sprint (mean 6.4 km/h) of Little Penguins suggests that the probable travelling speed is 2.4 km/h.

At this speed the daily foraging range would vary from 14 km in June to 20 km in January. The latter estimate coincides with part of the breeding season of penguins on Phillip Island and has been used to construct the probable daily travel contours in Figure 1.

## DISCUSSION

### *Swimming speed*

The average of the maximum speeds for underwater sprinting was 6.4 km/h and for surface paddling was 5.3 km/h. There is considerable agreement between these and the observations of captive individuals by Clark and Bemis (1979) and the single measurement at sea of Barton (1979). Barton's (1979) measurement included both underwater sprinting and surface paddling and falls between the averages for the same presented here. Norris's (1965) record also relates to an individual swimming underwater and on the surface, but the speed estimated is far in excess of other calculations. It appears unlikely that a Little Penguin could travel three times faster than the apparent maximum recorded in three other studies (Table 1) and suggests that an error of measurement was made.

The estimated travelling speed (2.4 km/h) is supported by the observations of Baudinette and Gill (1985). Their data show a sharp increase in the mean oxygen consumption of Little Penguins swimming underwater between speeds of 2.6 and 3.0 km/h. It appears likely that penguins travelling in search of food at the most efficient level of energy consumption would not swim much faster than 2.6 km/h.

TABLE 1

The swimming speeds of Little Penguins *Eudyptula minor*.

| Type of activity | Maximum speed (km/h) | n | Distance (m) | Source |
|---|---|---|---|---|
| Underwater sprint | 6.4 (average) | 6 | 19 | Present study |
| Surface paddling | 5.3 (average) | 2 | 19 | Present study |
| Underwater travel | 5.7 | 1 | 90-100 | Barton (1979) |
| Underwater travel | 16.5 | 1 | — | Norris (1965) |
| Underwater sprint | 6.2 | — | 8-11 | Clark and Bemis (1979) |

The swimming speeds (underwater sprint) of the larger penguins are faster than those of the Little Penguins. The Jackass Penguin has been recorded swimming at 12.4 km/h (mean) with a maximum of 18.8 km/h (Wilson 1985); the Emperor Penguin *Aptenodytes fosteri* ranged between 5.4 and 9.6 km/h (Kooyman *et al.* 1971); the Adelie Penguin *Pygoscelis adeliae* at 7.1 km/h; the Macaroni Penguin *Eudyptes chrysolophus* at 8.2 km/h and the Rockhopper Penguin *Eudyptes chrysocome* at 7.8 km/h (Clark and Bemis 1979).

*Maximum foraging range*

The maximum range of a penguin while feeding is obviously much less than the range possible if it is assumed to travel at maximum speed. The actual measurement of the speed of penguins while travelling and feeding would provide better estimates of the potential feeding range but as these data are unavailable, a ratio of maximum speed to travelling speed has been used. The resulting estimate is a potential feeding range of about 20 km during the chick rearing period when feeding adults are only absent from the colony during daylight.

This limits feeding penguins at this time to an area bounded by Cape Schank on the Mornington Peninsula to the west, Tortoise Head on French Island to the north and Cape Woolamai on Phillip Island to the east. Evidently this area with its two islands and large marine embayment (Fig. 1) provides a long shoreline with associated inshore areas for potential feeding.

During the incubation period, the non-incubating adult goes to sea usually for long periods ranging from one to eight days (Dann, unpublished data). It is possible that the penguins travel around Mornington Peninsula and up into Port Phillip Bay during this period (Fig. 1). However, once penguins have young in the burrows, they are only absent from the colony for a day at a time and then the potential feeding range is dramatically reduced. In the poor breeding season 1984-85, when many chicks were starving, parents were absent for longer than usual, sometimes for four to five days (Dann, pers. obs.). Presumably food shortages at this time were causing the adults to search much wider areas than usual

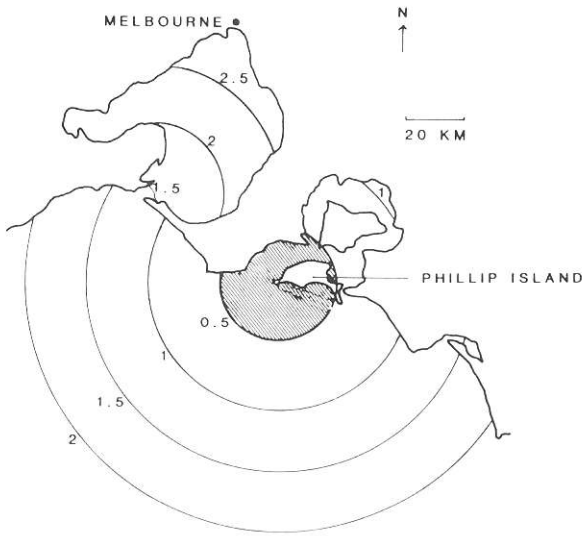


Figure 1. *The estimated foraging range of Little Penguins from the Summerland Peninsula, Phillip Island, Victoria. The shaded area represents the probable foraging range for penguins returning to the colony daily to feed chicks. The numbers indicate the number of days estimated for a penguin to travel that distance.*

in search of food. A study of the energetics of Little Penguins at Phillip Island in September 1984 (Costa *et al.* 1986) which showed that adult penguins were losing weight even when foraging, also suggests that food was in short supply or that the costs of acquiring it were greater than usual. The latter could have been the result of prey not being within the usual foraging range of penguins or rough weather causing greater energy expenditure during searching and feeding.

Flying seabirds are capable of travelling large distances in search of food (Furness 1978, Wingham 1985) but penguins obviously have much smaller daily foraging ranges and thus are more susceptible to local food shortages. The estimated foraging ranges of Little Penguins (20 km) on daily return trips to Phillip Island is similar to the 24.2 km estimated for Jackass Penguins by

Wilson (1985) using similar methods. Croxall *et al.* (1984) estimated mean maximum ranges of Gentoo Penguins *Pygoscelis papua* at South Georgia to be *c.* 10 kilometres on daily return trips while Macaroni, Adelie and Chinstrap Penguins *Pygoscelis antarctica* which are absent for one to three days could have foraging ranges of *c.* 80 km (Croxall *et al.* 1984); 80-120 km and 66-130 km (Lishman 1985), respectively.

Croxall *et al.* (1984) have noted that the determination of the feeding areas of penguins should be one of the more important directions of penguin research in the future and radio-telemetry has been used to measure actual ranges of some species (Trivelpiece *et al.* 1986). Clearly future work on the biology of Little Penguins on Phillip Island should address the measurement of actual foraging ranges using radio-telemetry.

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