Quantifying 'at sea' resting behaviour of Harbour seals –

clues to assessing foraging performance and habitat adaptation

Liebsch N.*, McMahon C. R., Wilson R. P., Adelung D.

Introduction:

Research investigating the resting behaviour of marine mammals, has centred on studies on captive animals. Three distinct behaviours within the different groups of marine mammals are, nonetheless, similar: resting at the surface, underwater 'swim-rest' and submerged inactive periods. However, they do not occur equally in all species and age classes. In contrast to cetaceans, all seals depend on the land for breeding and moulting but, importantly, not for resting. As seals exhibit prolonged periods of apnoea while resting on land, this raises the question of whether resting on land or at sea makes a difference.

In this study we focus on 'at sea' resting behaviour of Harbour seals in the eastern North Sea.

Results:

251 days of dive data were recorded and analyzed. Harbour seals primarily performed U-shaped dives (average: 90.2 %; SD: 9.59 %) while travelling and foraging along the relatively shallow bottom of the North Sea, hunting benthic prey.

Two distinct diving behaviours were apparent; active and passive dives (Fig.2).

To separate the 2 types, U-dives were first sorted by the frequency distribution of vertical velocities during the descent (Fig.3A) and 'slow descents' subsequently by the frequency distribution of the absolute value of the mean roll angle during the bottom phase (Fig.3B).

On average each Harbour seal remained passive for 5.8 % of the dives during a foraging trip (SD: 2.88 %; n = 32; Fig.4). The percentage of passive dives increases slightly with increasing foraging trip duration ($Y = 4.64406 + 0.22851X$; $R^2 = 0.049$; $P = 0.22521$; $n = 32$).

A closer look at the alternation between active and passive periods throughout a foraging trip reveals a very similar pattern in every trip (Fig. 5). According to this pattern, animals start their foraging trip with long durations of active dives (average active dive duration: 184.8 sec; SD: 64.6 sec), which clearly decrease continuously within less than a day. Following this decrease is a passive period (average passive dive duration: 237.0 sec; SD: 77.9 sec) with increasing dive durations, to values higher than the active start values. Once the highest values are reached, a period of active dives starts again with a decreasing tendency. Thus, throughout the foraging trip, longer active periods with decreasing dive durations alter with shorter passive periods with increasing dive durations.

Fig.4: Harbour seal resting on its side under water. Such behaviour can also be observed in captive animals – courtesy of Dr. Frederike Hanke.

Fig.1: Harbour seal equipped with a pop-up unit encapsulating a dead-reckoner and PTT as used in this study.

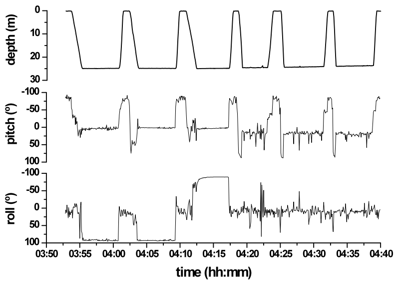

Fig.2: Typical examples of different activity patterns during U-dives. The first 3 dives are passive (resting) dives with low vertical velocity during descent and no movement with minimal or maximal roll angles during the bottom phase. The later 3 dives are active (foraging) dives with high vertical velocity during the descent and considerable movement in pitch and roll during the bottom phase.

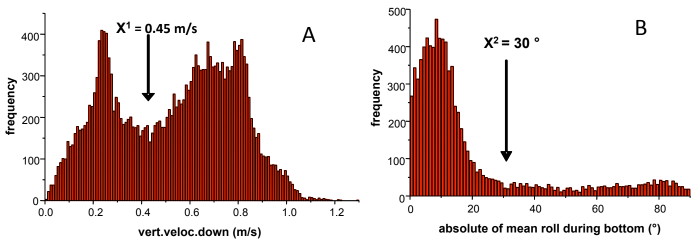

Fig.3: Frequency distribution of A) vertical velocity during descent as first criteria to distinguish between active and passive dives (> X^1 = active dives; U-dives only) and B) absolute value of mean roll angle during bottom phase as second criteria (> X^2 = passive dives; for all U-dives where vert.veloc.down < X^1).

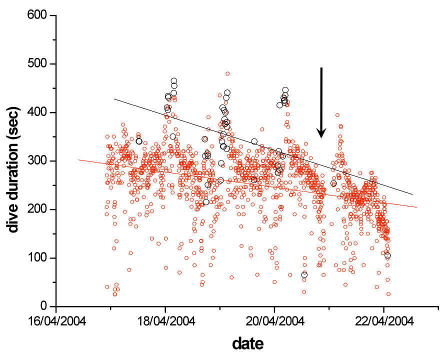

Fig.5: Example of duration of active (red circles) and passive (black circles) dives and their alternation during one foraging trip. Solid lines represent linear curve-fits of tendencies of the durations over the trip period (slope of linear fit = delta B) . Black arrow indicates extended surface interval.

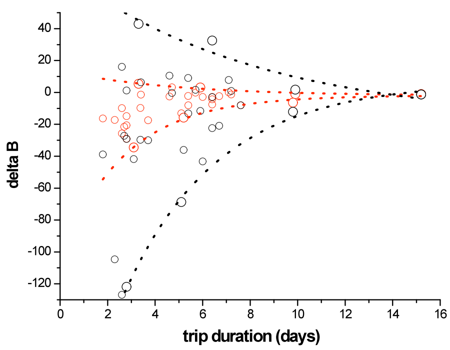

Fig.6: The slopes of the linear curve-fits (delta B) from each relationship (n = 32) of dive duration over the period of the foraging trip (see Fig.5) were plotted over trip duration for active (red) and for passive (black) dives. Dotted lines encompass the upper and lower edge of occurrences of delta Bs.

Materials & Methods:

Dive-data from 4 adult male Harbour seals (*phoca vitulina*), caught on the island of Rømø (55° 12' N, 8° 31' E, Denmark) were used for this study. Data included dive depth, tilt angles (pitch and roll) and a variety of other parameters, recorded at 5 second intervals.

Dive data were analyzed calculating surface intervals, duration of total dive, descent, bottom and ascent phases, vertical velocity during descent and ascent as well as the mean and standard deviation for pitch and roll during the various phases of each dive.

Discussion:

As each return trip back to land from the foraging grounds means a decrease in efficiency because seals have to cover a considerable distance through the Wadden Sea where prey is scarcely distributed, the question arises as to why they do that rather than resting at relatively regular intervals while out at sea?

The alternation between active and passive periods of diving over the duration of a foraging trip is an interesting discovery that might help resolve foraging strategies. Especially in the case of central place foragers, it is an important issue to understand their range and temporal limitations.

Seen over the duration of a foraging trip and consecutive periods of active and passive diving, the trends in dive durations over time (delta Bs = slope of linear fit - see Fig. 6) vary considerably within a certain envelope. On shorter trips, the delta Bs show a far wider range for active and passive dives compared to longer trips, where the values group closer around each other and closer to zero indicating an approach to 'steady-state' in which the seals maintain their efficiency and therefore theoretically seem to be independent of their haul-out spots on land (Fig. 6).

The low delta Bs – especially during shorter trips – represent a decrease in efficiency (shorter dives), indicating a certain state of exhaustion and/or decreasing capacity. So if a seal encounters sufficient prey to reach its food capacity in a short time, while perhaps using 'above average' rates of energy, this could result in a quick return to land to rest and digest. However, during longer trips, often also ranging further (data not shown), seals might have to be more energy efficient , especially if prey encounters are rare.

(ϕ) More details at:

http://eldiss.uni-kiel.de / macau/receive/ dissertation_diss_ 00001860

*corresponding author: n.liebsch@uq.edu.au