Humpback whale (*Megaptera novaeangliae*) mother and calf foraging behavior: insights from multi-sensor suction cup tags

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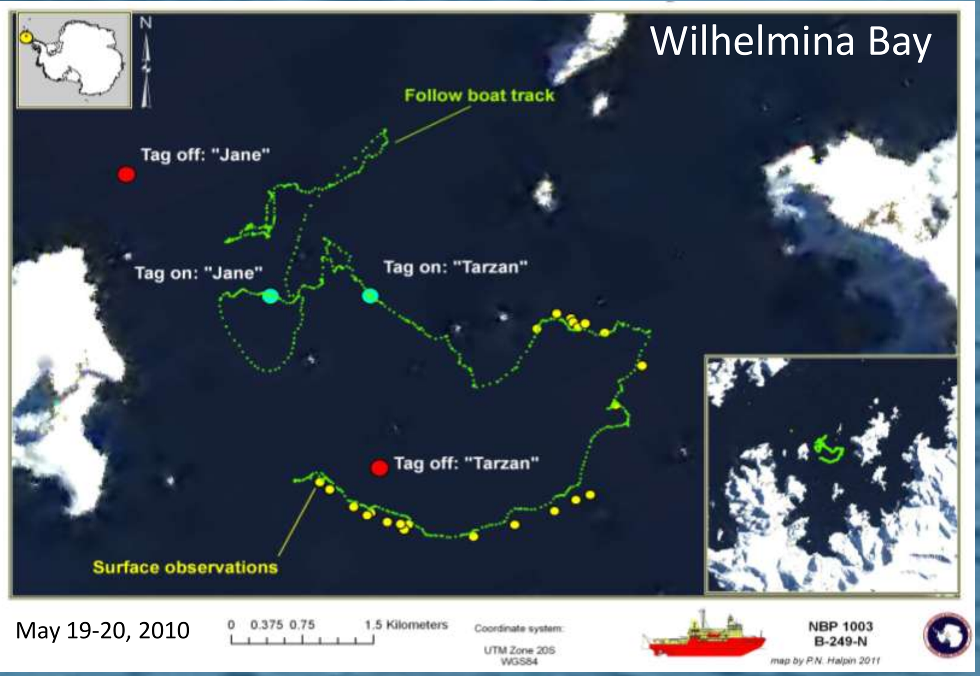
ABSTRACT

On May 19th, 2010 we attached non-invasive high-resolution digital acoustic recording tags (Dtags), which incorporate accelerometers, magnetometers, pressure and sound recording simultaneously to an adult humpback whale (*Megaptera novaeangliae*) and her calf foraging on euphausids in Wilhelmina Bay along the Western Antarctic Peninsula. The Dtags remained on the animals overnight and logged 20 hours of concurrent recordings. We used TrackPlot to make and synchronize a pseudo-track of each whale's dive behavior and movements. Using the acoustic flow noise recorded by the tag correlated with the signal from the tags accelerometer and changes in pressure, we documented extreme decelerations (ca. 2.5 $m \cdot s^{-2}$) indicative of foraging lunges on both tags. Both animals executed foraging lunges, however, the mother foraged more intensively than the calf throughout the tag records (N = 820 foraging lunges and N = 118, respectively). Additionally, the female foraged consistently throughout the night, while the calf executed 97.5% of its lunges between 17:00 and 22:05. The female's mean (± SD) inter-lunge interval was longer than the calf's (46.39 ± 8.01 sec, 33.72 ± 10.32 sec, respectively; $P < 0.001$) and was consistent throughout the night ($y = 0.03x + 45.62$, $r^2 = 0.0003$). When the calf was not foraging it would sometimes still dive in synchrony with its mother, who was actively lunging, while other times it would coast in the upper water column. While the animals appeared to be diving in synchrony with one another for much of the tag duration, we used the acoustic records of each Dtag to confirm if the animals were within close proximity of one another, e.g., a call from one whale recorded within <1 sec on the other's tag. Our results provide the first simultaneous Dtag records of balaenopterid mother and calf diving and foraging behavior.

METHODS

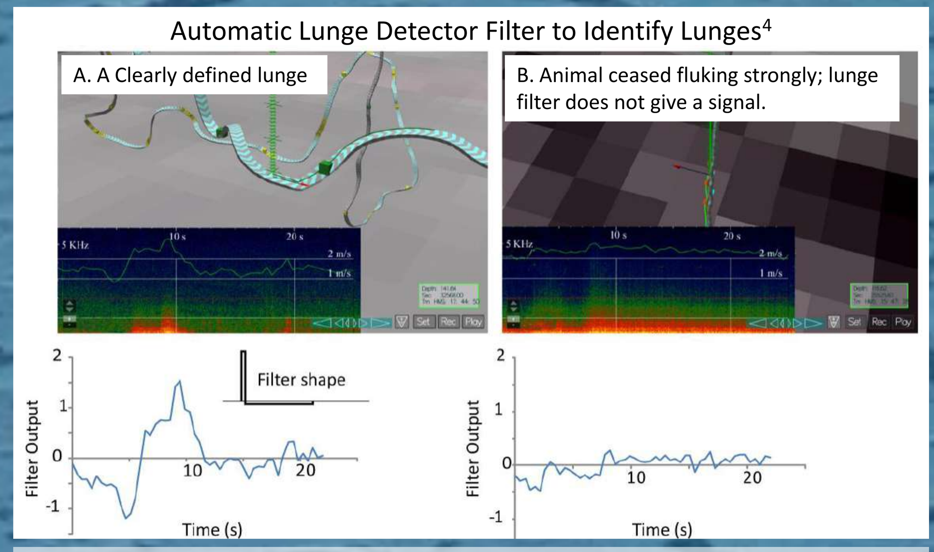


A) Dtag and suction cup attachment with VHF antenna visible at the bottom; B) successful tag attachment; C) Dtag attached to a humpback whale.

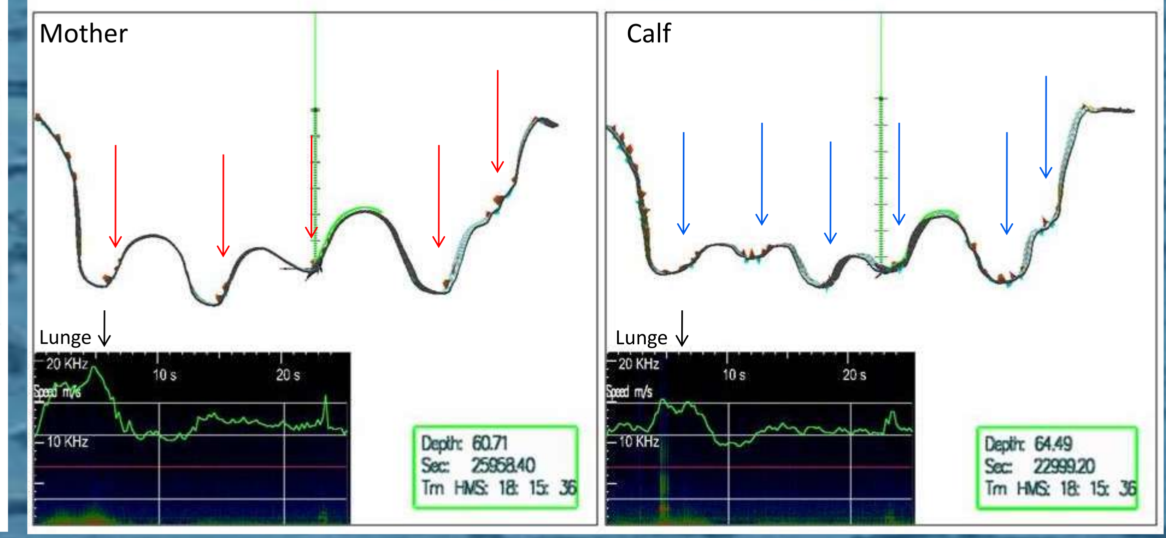
Dtags[1] were attached to a humpback whale mother and calf pair and logged 18 hours of concurrent recordings (11:55 am - 7:46 am). Depth, heading, pitch and roll were digitally recorded at 50 Hz and stored, synchronously, with audio data (sampling rate 96 kHz) on flash memory within the tag .

TrackPlot[2] was used to visualize and analyze the Dtag data. Foraging lunges were identified as a bout of fluking associated with a distinct speed maximum (determined from flow noise, marking a huge increase in drag as the animal's buccal cavity fills) and continued swimming throughout the lunge[3].

Automatic Lunge Detector Filter to Identify Lunges[4]



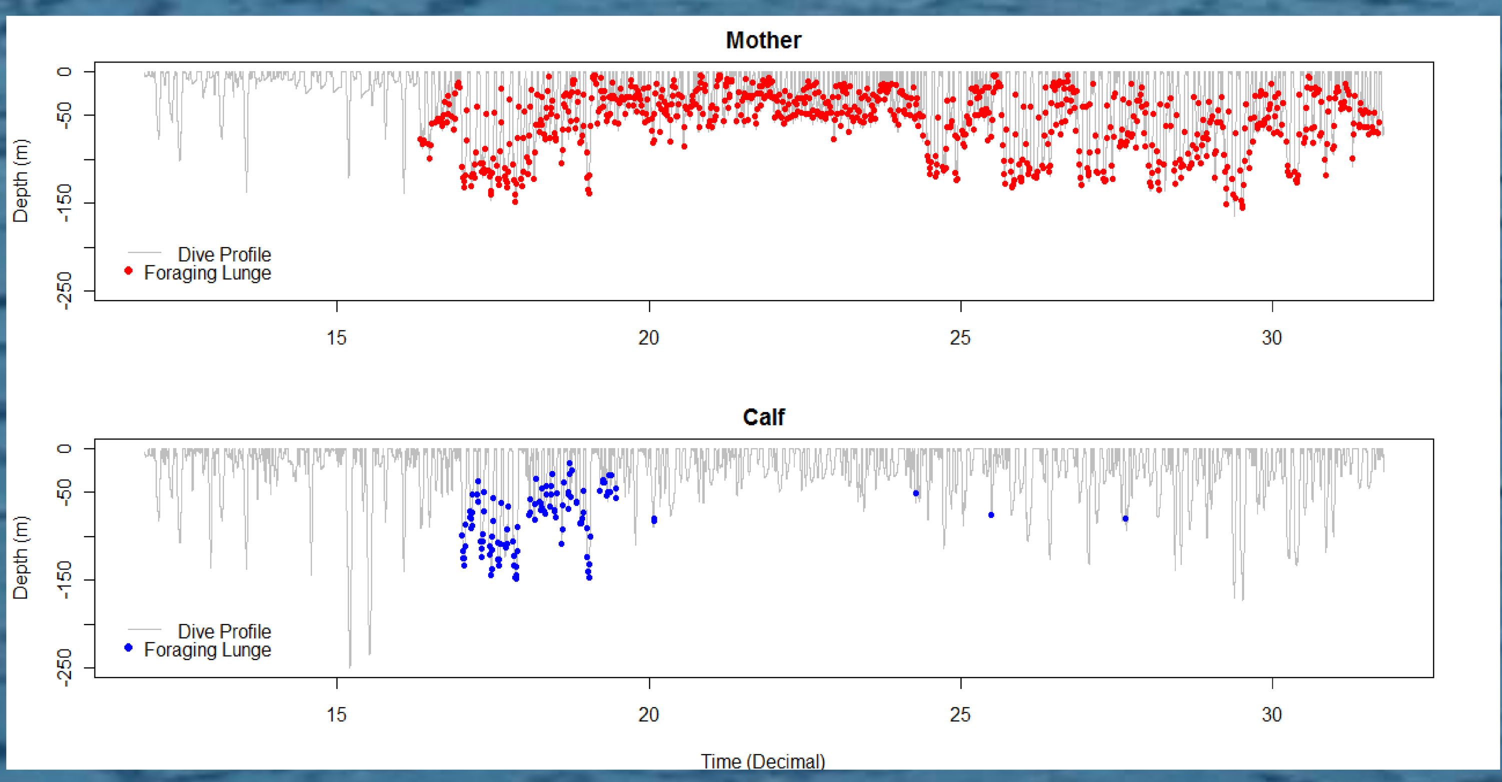
Tracks with associated acoustic spectrograms and filter output. The green plot overlaid on the spectrogram indicates estimated speed.

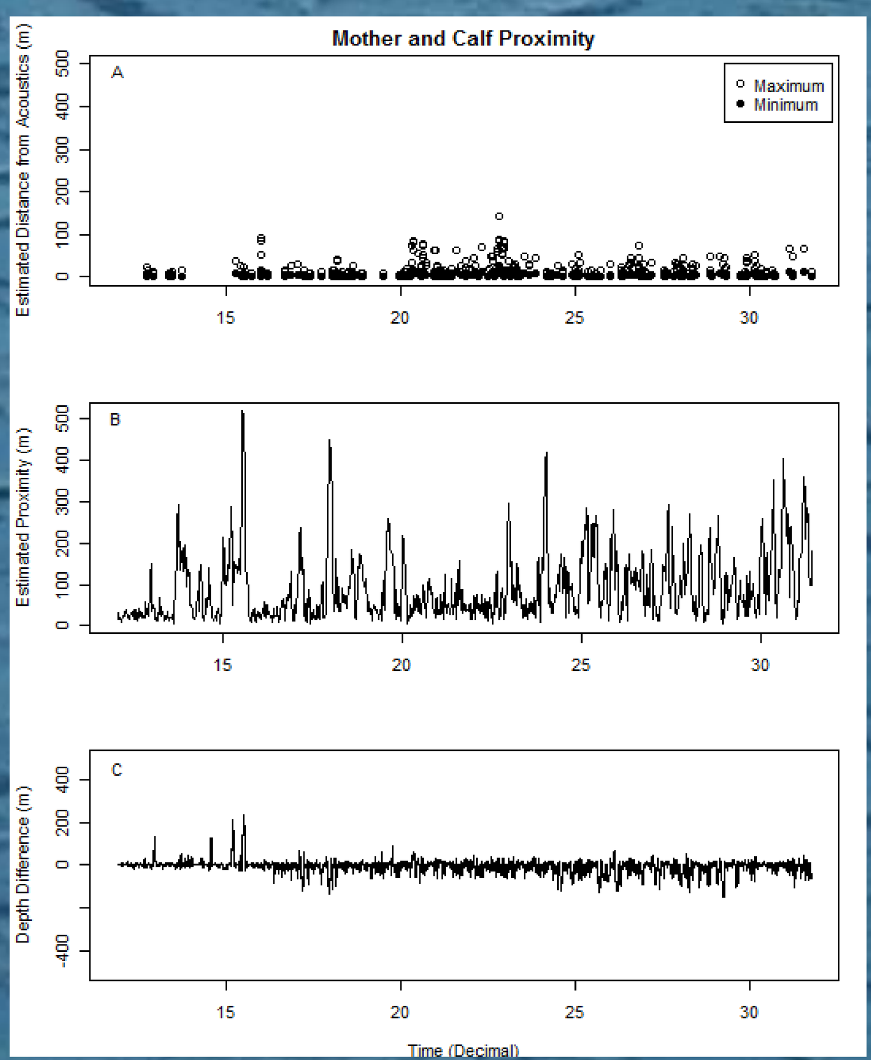


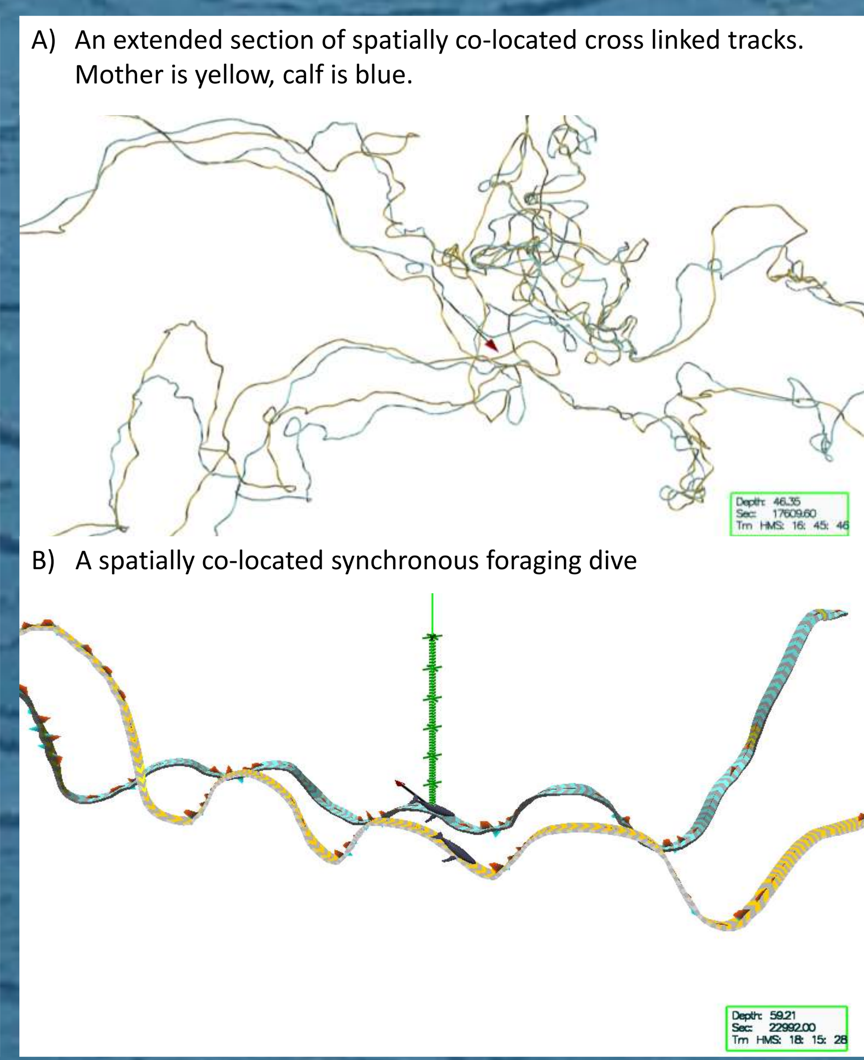
Synchronous foraging dive performed by mother and calf (note the mother lunges ~3 sec before her calf.) Arrows indicate locations where lunges were identified.

RESULTS

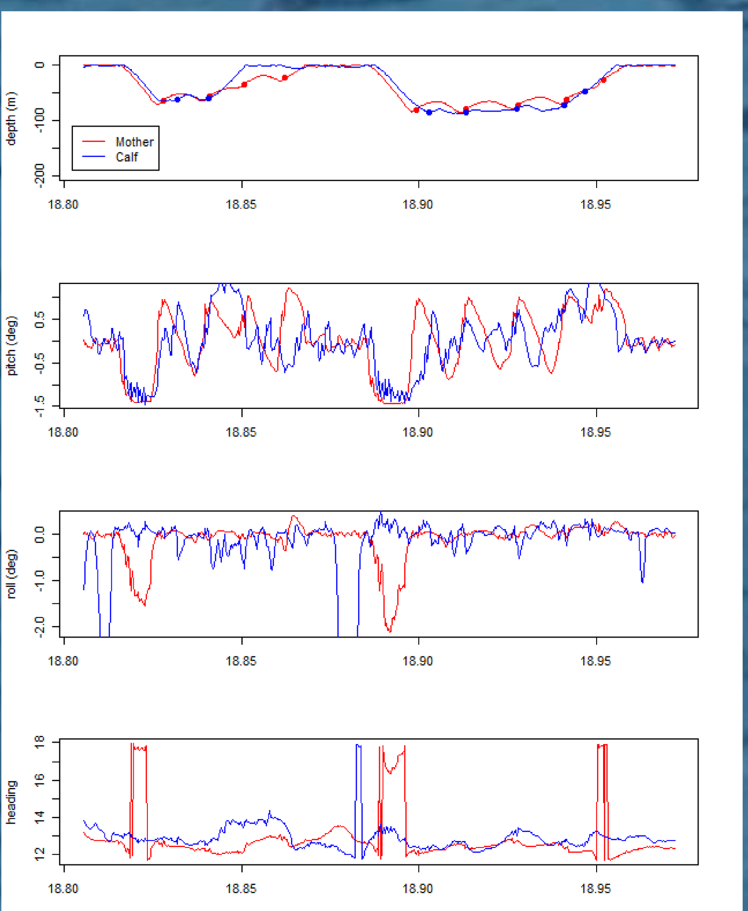
820 and 118 foraging lunges were detected for the mother and calf, respectively (right). The mother began to lunge around 16:20 and foraged continuously and regularly until her tag came off at 7:46 am (May 20). The calf, however, executed 97.5% of its lunges between 17:00 and 22:05.



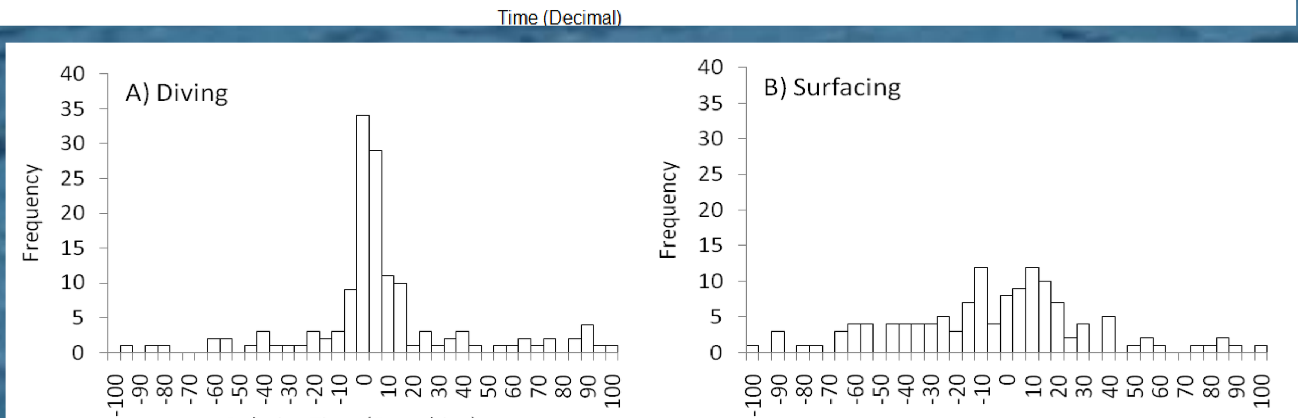




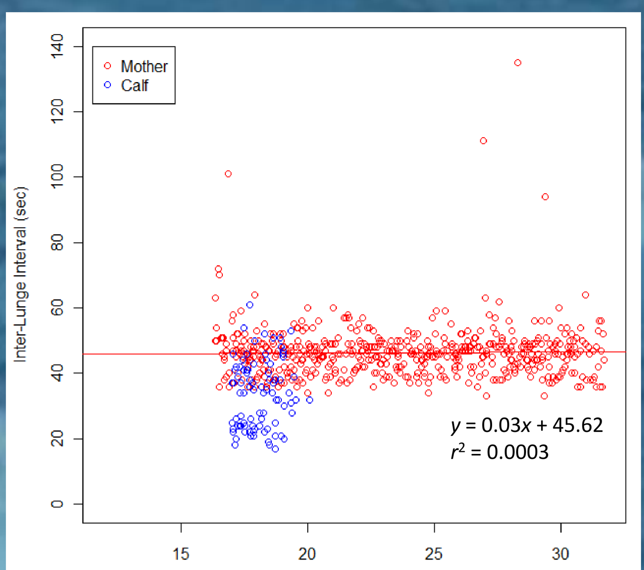
We estimated the proximity between mother and calf (left): A) vocalizations made by either animal captured on both tags were used to estimate the distance between animals based on a comparison of sound received levels (spherical spreading assumed); B) a dead reckoned track was created assimilating the acoustically determined tie points and a conservative estimate of proximity was determined; The result was a spatially co-located cross linked track (right); C) differences in depth were obtained from Dtags; negative values refer to when the mother was deeper than the calf, positive values refer to when she mother was shallower.



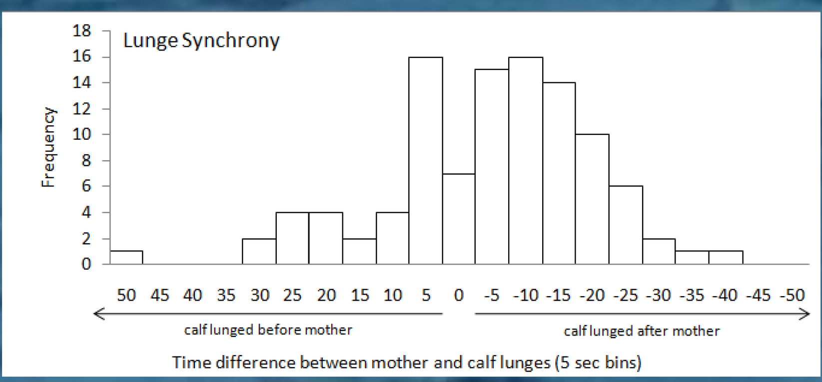
Two dives by the mother and calf demonstrating partial (left) and full synchronous foraging dives (right). 97.5% of the calf's lunges were executed during a synchronous foraging dive. Note that their pitch also corresponds to lunging events.



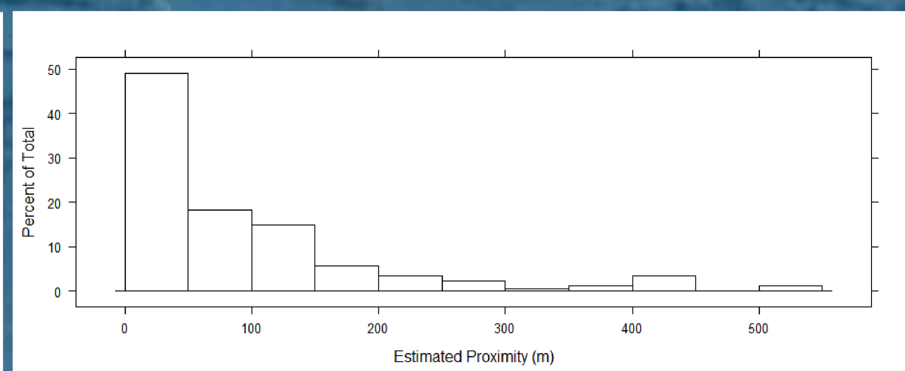
For all dives > 30 m, the pair dove within 20 sec of each other 65.8% of the time (A). Surfacings (B) were less synchronized and were related to the calf exhibiting shorter average dive times than the mother (mean ± SD: 209.86 ± 83.0, 213.8 ± 86.6, respectively) .



The mother did not alter her foraging behavior in respect to the calf's behavior. The mother's mean (± SD) within-dive inter-lunge interval (ILI) was consistent throughout the track record and was longer than the calf's (46.39 ± 8.01 sec, 33.72 ± 10.32 sec, respectively; $P < 0.001$).



74.6% of the calf's lunges were performed within ± 20 seconds of the mother's lunges.



Estimated proximity during 97.5% of the calf's lunges (17:00 to 20:05). The pair were within 100 m at least 64.7% of this time.

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