Sea Mammal Research Unit
Instrumentation

Accelerometer processing

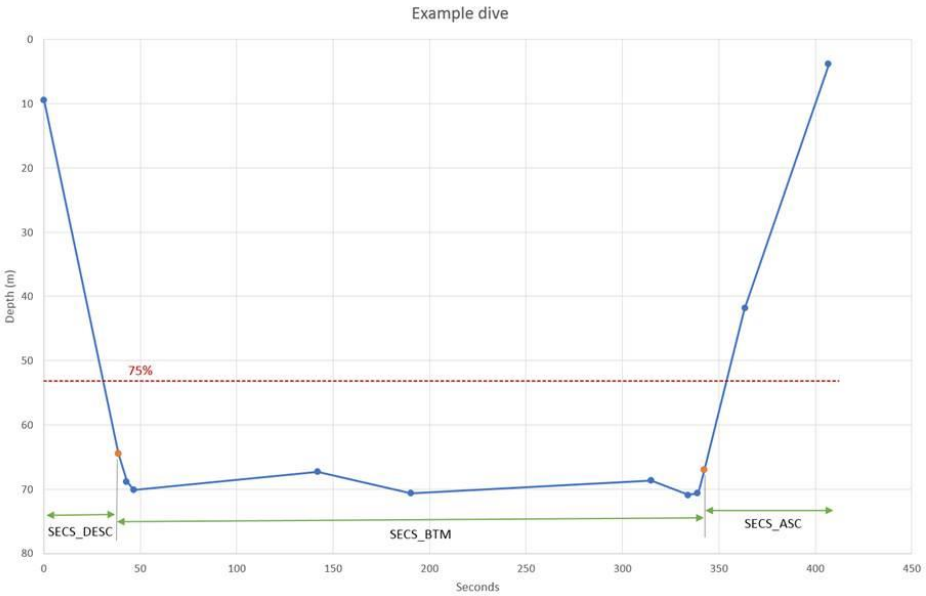
Basic 3-axis accelerometer settings

Sampling rate: 25 Hz
Resolution: 4 mg
Maximum range: ± 16 g

Throughout each dive, summary values of pitch, swimming effort and "prey capture attempts" (PCA) are derived from the accelerometer data for each second.
The dive is then split into three sections: descent, bottom and ascent. The 1-second summary values are further combined to create measures of pitch, swimming effort and PCA that are transmitted for each of the three sections.

Definition of Descent, Bottom and Ascent

A dive is split into three segments by this method:
Fit 12 broken-stick points (i.e. the depth at the first point below the dive threshold + 10 internal points + the final point before dive threshold)
Descent ends at the first internal point which is greater than 75% of maximum depth
Ascent is similar, but working back from the end of the dive: the ascent begins at the first internal point which is greater than 75% of max depth.
The duration of each phase is stored as SECS_DESC, SECS_BTM, SECS_ASC. The sum of these should be DIVE_DUR.



Pitch

Low-pass filter: < 0.2 Hz
Units: degrees
Database fields:

PITCH_DESC	PITCH_BTM	PITCH_ASC	The average pitch angle (degrees)

Swimming effort

Band-pass filter: 0.5 Hz – 1 Hz on Y (sway) axis
Swimming effort is the root-mean-square (RMS) of the filtered sway axis data
Units: g (9.8 m/s^2)

Dives shallower than 120m

Database fields:

SWIM_EFF_DESC	SWIM_EFF_BTM	SWIM_EFF_ASC	RMS swimming effort (g)
SECS_DESC	SECS_BTM	SECS_ASC	The duration of each section (s)
SWIM_EFF_WHOLE			RMS swimming effort for the whole dive (g)

Dives deeper than 120m

In deep dives, the SWIM_EFF_DESC, SWIM_EFF_BTM and SWIM_EFF_ASC fields are calculated only for depths > 80m to reduce the influence of uncompressed lung volume on the measurement.

Database fields:

SWIM_EFF_DESC	SWIM_EFF_BTM	SWIM_EFF_ASC	RMS swimming effort when depth > 80m (g)
SECS_DESC	SECS_BTM	SECS_ASC	The duration of each section where depth > 80m (s)
SWIM_EFF_WHOLE			RMS swimming effort for the whole dive (g)

Prey Capture Attempts (PCA)

Total Jerk (m/s^3) is calculated according to the method of Ydesen et al (2014):

> The jerk was computed as the differential of the acceleration for each axis and the total jerk was taken as the norm of the triaxial jerk (i.e. the square-root of the sum of the squared value in each axis) at each time instant. In Matlab, this is achieved with the following instruction:
>
> $$\text{Jerk} = \text{fs*sqrt(sum(diff(A).^2))}, \quad (1)$$
>
> where **A** is a three-column matrix containing the measured triaxial acceleration time series and f_s is the sampling rate in Hz. The RMS jerk was calculated as the square-root of the sum of the squared jerk over an averaging window of 250 ms.

What a jerk: prey engulfment revealed by high-rate, super-cranial accelerometry on a harbour seal (*Phoca vitulina*)
Kristina S. Ydesen, Danuta M. Wisniewska, Janni D. Hansen, Kristian Beedholm, Mark Johnson and Peter T. Madsen
The Journal of Experimental Biology (2014) 217, 2239-2243 doi:10.1242/jeb.100016

For each second, the tag compares the maximum value of RMS Jerk to a threshold of 250 m/s^3 to decide if a PCA event occurred in that second.

If RMS Jerk exceeds the threshold for several consecutive seconds they are all counted as a single PCA event.

Database fields:

PCA_DESC	PCA_BTM	PCA_ASC	Count of separate prey capture events detected (RMS Jerk > 250 m/s^3)

PCA diagnostics

Some tags that have a relatively high bandwidth data connection (i.e. not Argos tags) also transmit some further diagnostic fields that report the background level of the RMS Jerk metric and its maximum level. They are intended to allow the choice of PCA threshold value to be reviewed.
These fields are scaled so that 100 = the value of the threshold. So 50 = half the value of the threshold, 200 = double the value of the threshold etc. This arrangement is mainly for the convenience of transmitting the values – it is possible to change the threshold value without changing the way the diagnostic fields are formatted for transmission. To convert values of the diagnostic fields to m/s^3, multiply by 2.5 (= 250 m/s^3 / 100%)

PCA_MAX_DESC	PCA_MAX_BTM	PCA_MAX_ASC	Maximum Total Jerk (as % of 250 m/s^3)
PCA_MEAN_DESC	PCA_MEAN_BTM	PCA_MEAN_ASC	Average Total Jerk (as % of 250 m/s^3)