Energy expenditure calculations and assumptions

#### Resting energy expenditure

Energy consumption when resting in water is related to water temperature for postabsorptive (not digesting) female and subadult Australian and New Zealand fur seals (Ladds et al. 2017b). However, postprandial (digesting) resting metabolic rate (RMR) for pups of northern fur seal (*Callorhinus ursinus*) (Liwanag 2010) and juvenile South American fur seals (*Arctocephalus australis*) (Dassis et al. 2014) is 1.6 times the postabsorptive rate, lasting for around 3.5 hours. For simplicity, it was assumed that fur seals were postabsorptive while on land, and postprandial in the water.

Resting in water:

$EE\_{RMR}^{water}\left(l^{-1} O\_{2}\right)=1.6(0.02+0.02\left(water temp.\right)\left(duration\right))$ (1)

Unfortunately, no measure of juvenile Australian fur seals RMR on land has been made. In a separate study, the standard metabolic rate (SMR) was measured of a similarly sized New Zealand fur seal (47kg) over the course of a year (Ladds et al. 2017b), but these measurements were collected in water. As northern fur seal pups and southern sea lion subadult males both had ~30% lower RMR on land than in water (Donohue et al. 2000, Dassis et al. 2012), this assumption was applied to our RMR estimation on land. In addition, to account for a seasonal effect on SMR in New Zealand fur seals (Ladds et al. 2017b), a summer and a winter metabolic rate was calculated (Eq. 2.1-2.2).

Winter RMR on land:

$ EE\_{RMR}^{winter} \left(l^{-1} O\_{2}\right)=(0.41×0.7)(duration)$ (2.1)

Summer RMR on land:

$ EE\_{RMR}^{summer}\left(l^{-1} O\_{2}\right)=(0.53×0.7)(duration)$ (2.2)

#### Activity energy expenditure

Several attempts to derive the relationship between accelerometer output (ODBA or VeDBA) and energy expenditure have been made with mixed results (Fahlman et al. 2008b, Volpov et al. 2015b, Jeanniard-du-Dot et al. 2016). Recently this relationship has been demonstrated to fall into the “time-trap”, whereby any relationship observed is a result of time being related to itself (Halsey 2017, Ladds et al. 2017a). Therefore, instead of deriving activity energy expenditure from DBA, the time an animal spent active (foraging and travelling) was multiplied by the average energy expenditure (Ladds et al. 2016a). As yet, there have been no estimates of the cost of travelling on land for any pinniped, though experimentally the cost of movement on land is probably much greater than in water. In semi-aquatic water rats (*Hydromys chrysogaster*) the metabolic cost of running was around 13-40% more than swimming when moving at equal speeds, and for platypus (*Ornithorhynchus anatinus*), the cost of walking was 2.1 times the cost of swimming (Fish et al., 2001). As terrestrial locomotion in otariids is more similar to platypus than water rat, it was assumed that the cost of movement on land is twice that in water. As activity compensates for some of the additional costs of cold water (Liwanag et al. 2009) it was assumed that the energy expenditure for winter and summer was the same (Eq. 3.1).

Energy expended from activity (foraging and travelling):

$EE\_{active}^{water} \left(l^{-1} O\_{2}\right)=1.43(duration)$ (3.1)

$EE\_{active}^{land} \left(l^{-1} O\_{2}\right)=2(1.43\left(duration\right))$ (3.2)

#### Grooming energy expenditure

The energy expended from grooming was estimated to be between 1.5 and 2 times the postabsorptive RMR and between 0.9 and 1.2 times postprandial RMR in northern fur seal pups depending on activity level (Liwanag 2010). Considering our model generally only labelled active grooming, it was assumed that grooming had an energetic cost twice that of in-water RMR (Eq. 4.1-4.2).

Energy expended from grooming in winter in water:

$EE\_{groom}^{winter} \left(l^{-1} O\_{2}\right)=(0.41×2)(duration)$ (4.1)

Energy expended from grooming in summer in water:

$EE\_{groom}^{summer} \left(l^{-1} O\_{2}\right)=(0.53×2)(duration)$ (4.2)

For grooming on land fur seals were assumed to be postprandial so they were assumed to have the same energetic output as resting or slightly higher.