

THERMOREGULATION IN REHABILITATING HARBOR SEAL (*Phoca vitulina richardii*) PUPS: HOW CORE BODY TEMPERATURE AND SURFACE TEMPERATURE ARE ASSOCIATED WITH SIZE METRICS AND THE MANAGEMENT PRACTICE OF BATHING

Karisa N. Tang,^{1*+} Joseph K. Gaydos,¹ William Van Bonn,² Phillip H. Kass,³ Martin Haulena,⁴ Penny Harner⁵

¹The SeaDoc Society, Wildlife Health Center, University of California, Davis, School of Veterinary Medicine, Eastsound, WA, 98245, USA

²The Marine Mammal Center, Sausalito, CA, 94965, USA

³Department of Population Health and Reproduction, University of California, Davis, School of Veterinary Medicine, Davis, CA, 95616, USA

⁴Vancouver Aquarium, Vancouver, BC, V6G 3E2, Canada

⁵Wolf Hollow Wildlife Rehabilitation Center, Friday Harbor, WA, 98250, USA

ABSTRACT

Wild harbor seal (*Phoca vitulina richardii*) pups thermoregulate by hauling out of the water before they lose too much heat and expend too much energy. In rehabilitation, however, young pups are housed in dry areas, but placed in pools for swims. Decreased caloric value of milk replacer means rehabilitated pups reach weaning and release weight slower than wild ones. Increased metabolic expenditure due to bathing also could prolong the time needed to raise pups to release size.¹ Thermography, which measures surface temperature, is a promising method for studying thermoregulation in rehabilitating harbor seal pups. Previous studies in pinnipeds examined seasonal variation of body surface temperature, recovery after minor trauma, and locations of heat dumping over the body.^{2,3,4,5} We used thermography to study heat loss associated with standard seal rehabilitation bathing practices to see if bathing resulted in increased energy expenditure, potentially contributing to increasing time to release.

FLIR thermography cameras (models P65 and T400) were used to record thermal images and thoracic and flipper surface temperatures of harbor seal pups at Wolf Hollow Wildlife Rehabilitation Center (Washington) and The Vancouver Aquarium's Marine Mammal Rescue Centre (British Columbia) before and after swimming. Body temperature before and after swimming, weight, axillary girth, and straight length were recorded. A correlation matrix with Bonferonni adjustments for multiple comparisons and a mixed effects linear regression were used to determine relationships between variables.

No significant difference in core body temperature was measured with a short rectal probe compared to that measured with a 10cm rectal probe (P=0.431). For 23 animals studied, core body temperature did not differ (P=0.859) before and after bathing, suggesting that seals were capable of adequate thermoregulation in response to swimming. While core body temperature remained constant, surface temperature varied with the animal's size and whether it was dry or wet. As animal size (weight, length, girth) increased, the difference in body surface temperature

between wet and dry increased ($P=0.001$). This suggests that peripheral vasoconstriction during and after the bath was an important mechanism for maintaining core body temperature. Prior to baths, larger pups had a higher thoracic surface temperature when compared to smaller pups, suggesting dumping of excess heat ($P<0.001$). After swimming, larger pups had a lower thoracic surface temperature than smaller pups, suggesting adequate peripheral vasoconstriction and heat conservation.

These data suggest that swimming young rehabilitating harbor seal pups in 60-75°F water was within their thermoregulatory capacity. As pups grew, the difference between their surface temperatures before and after baths increased, suggesting a greater capability for thermoregulation in older and larger animals. Although not statistically significant overall, the core body temperature for some smaller pups did decrease after bathing, suggesting that while in general the practice of bathing is probably not a source of major energy expenditure, it could be for some small animals requiring increased vigilance while swimming these animals. Thermography is a useful non-invasive tool to measure body condition in rehabilitating marine mammals and more should be done to better quantify thermoregulatory capability of growing pinnipeds.

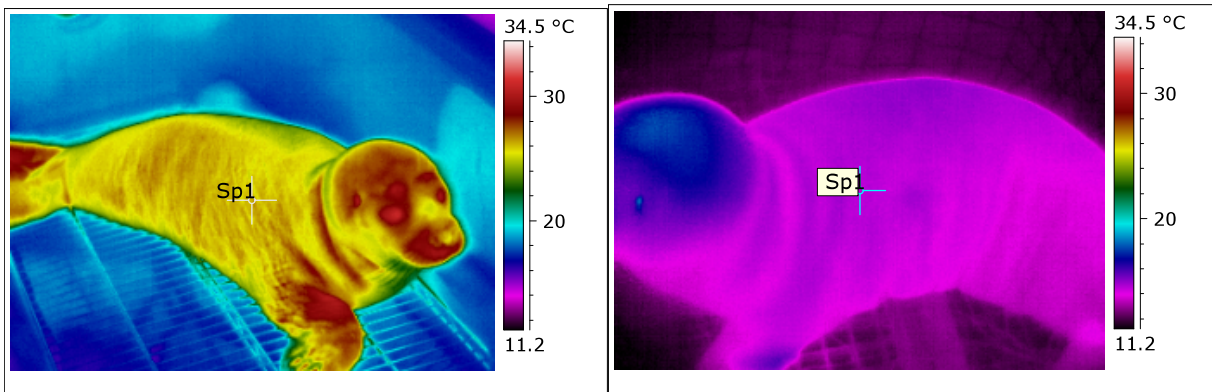


Figure 1a

Figure 1b

Figure 1: Dry pup (1a) with a mid-thoracic surface temperature of 26.3°C. The same pup is shown in Figure 1b after a 20 minute swim with a 14.5 °C thoracic surface temperature.

ACKNOWLEDGEMENTS

The authors thank FLIR and FLIR representatives Eric Flavin and Joseph Rocchio for the donated use of the T400 camera and for providing expert advice, and Philip Archie for the use of his FLIR P65 camera. The authors also thank Christine Parker of the SeaDoc Society, staff and volunteers at Wolf Hollow Rehabilitation Center, staff and volunteers at The Vancouver Aquarium Marine Mammal Rescue Centre, and staff and volunteers at Seattle Aquarium.

LITERATURE CITED

1. Gaydos, J, Vilchis, LI, Lance, MM, Jeffries, SJ, Thomas, A, Greenwood, V, Harner, P, Ziccardi, MH. 2012. Postrelease movement of rehabilitated harbor seal (*Phoca vitulina richardii*) pups compared with cohort-matched wild seal pups. *Marine Mammal Science*. DOI:10.1111/mms.12002.
2. Mauck, B, Bilgmann, K, Jones, D.D, Eysel, U, Dehnhardt, G. 2003. Thermal windows on the trunk of hauled-out seals: hot spots for thermoregulatory evaporation? *The Journal of Experimental Biology*. 206:1727-1738.
3. Nienaber, J, Thomton, J, Horning, M, Polasek, L, Mellish, J. 2010. Surface temperature patterns in seals and sea lions: A validation of temporal and spatial consistency. *Journal of Thermal Biology*. 35:435-440.
4. Norris, AL, Houser, DS, Crocker, DE. 2010. Environment and activity affect skin temperature in breeding adult male elephant seals (*Mirounga angustirostris*). *The Journal of Experimental Biology*. 213: 4205-4212.
5. Paterson, W, Pomeroy, PP, Sparling, CE, Moss, S, Thompson, D. 2011. Assessment of flipper tag site healing in gray seal pups using thermography. *Marine Mammal Science*. 27(2): 296-305.