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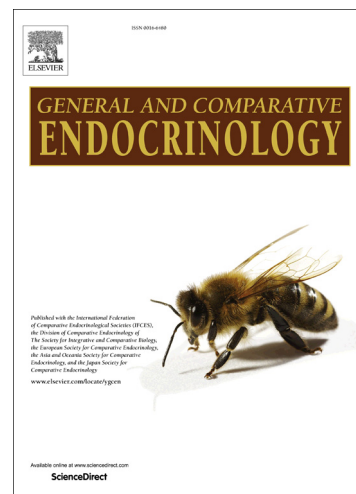
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Initial Validation of Blubber Cortisol and Progesterone as Indicators of Stress Response and Maturity in an Otariid; The California Sea Lion (*Zalophus californianus*)

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Abstract

Chronic stress can have detrimental effects on an individual's health and reproductive success. The use of cortisol quantification as an indicator of stress in free-ranging cetaceans and phocids is increasing but no studies have applied this technique on blubber in otariids. We measured cortisol concentrations in blubber samples obtained from California sea lions, *Zalophus californianus*, stranded in San Diego County and those incidentally killed in the California drift gillnet fishery. We also measured progesterone concentrations to assess female reproductive status and, in males, as a potential secondary measure of adrenal steroid production. Blubber cortisol and progesterone values were compared across demographic groups (sex and maturity), season and proportion blubber lipid extracted. Stranded animals ($247.3 \pm 70.767_{SE}$ ng/g blubber) had significantly higher cortisol concentrations compared to fishery bycaught ($8.1 \pm 2.108_{SE}$ ng/g blubber) animals. These findings are likely driven by inherent differences in the cause of death and associated nutritional state coupled with the mean duration of expiration for these two groups of animals (i.e. the duration from an animal's initial perception of the threat-to-self until death). The duration of transition from healthy state to death in stranded animals is on the order of many hours to weeks while in fishery bycaught animals, this transition occurs much more rapidly (i.e., seconds to tens of minutes). The presumed longer duration of the mortality event in stranded animals gives sufficient time for elevated cortisol to diffuse into the blubber. No significant differences between demographic groups, or season were found. However, blubber cortisol declined inversely with proportion blubber lipid extracted, suggesting utility in assessing long-term nutritional status. Blubber progesterone was significantly higher in mature females than immature females ($153.8 \pm 54.546_{SE}$ ng/g blubber and $9.7 \pm 3.60_{SE}$ ng/g blubber respectively), containing on average 15 times more progesterone, irrespective of pregnancy state. Additionally, a significant relationship between mean cortisol and progesterone was found in males with >35% blubber lipid ($p < 0.0001$). This study is an initial step in validating blubber cortisol and progesterone concentrations as a potential marker of stress response and reproductive state, respectively, in otariids. Especially when paired with dart biopsying, this

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