

Abstract

The western population of Steller sea lions (*Eumetopias jubatus*) (SSL) is a distinct segment currently listed as endangered. Given the high energy demand and rapid growth during the postnatal period of SSL pups, body condition was expected to influence circulating concentrations of hormones associated with nutritional status and fat mass (leptin), lipid and water metabolism (cortisol and aldosterone), and growth and metabolism (thyroxine and triiodothyronine). Blood samples were collected from SSL pups of known ages and sex. A body condition index (BCI) previously developed for SSL pups was applied to 61 wild SSL pups ranging in age from 5 to 38 days old. However, no relationship between BCI and circulating concentration of hormones quantified in the present study was detected. SSL pups sampled in the present study are larger on average than predicted by growth rates previously reported for SSL pups. Therefore, our findings are an indication that the pups sampled are from a healthy population of SSLs. Male pups were larger than female pups in body mass, standard length and axillary girth. Only cortisol and aldosterone concentrations showed differences between male and female pups with females having higher cortisol and lower aldosterone concentrations. Circulating concentrations of cortisol, total and free thyroxine, and total triiodothyronine were affected by the capture and handling inherently required in sampling wild pinnipeds. However, the overall variation due to those factors was low ($r^2 < 0.293$).



Materials and Methods

Animals and Body Condition Index

- Steller sea lion (SSL) pups (male=37, female=24) were measured, weighed, and blood sampled on June 30, 2005; July 3, 2007 and July 1, 2008.
- Body mass (BM) was measured to the nearest tenth of a kilogram using a hanging electronic scale. Standard length (SL) was measured as a straight line from tip-of-nose to tip-of-tail while the pup was lying on a straight board. Axillary girth (AG) was measured using a tape measure after the pup exhaled. A body condition index (BCI) was calculated by applying the stoutness-index [$BM/(-63.88 + 0.8966 \cdot SL)$] proposed by Trites and Jonker (2000).
- Blood samples (< 18 ml) were collected using standard aseptic techniques from the caudal gluteal vein.

Hormone RIAs

- Radioimmunoassay (RIA) kits were used to quantify cortisol, aldosterone, total and free thyroxine, total triiodothyronine and leptin concentrations in unextracted SSL serum.

Statistical Analysis

- The best model for each hormone was selected using a stepwise general linear model with an iterative process of comparing the full mixed effects model which included the categorical variables sex and collection method, with BCI or age as a continuous variable, and all interaction terms.

Trites, A.W., Jonker, R.A.H., 2000. Morphometric measurements and body condition of healthy and starving Steller sea lion pups (*Eumetopias jubatus*). *Aqu. Mammals*, 26, 151-157.

Results

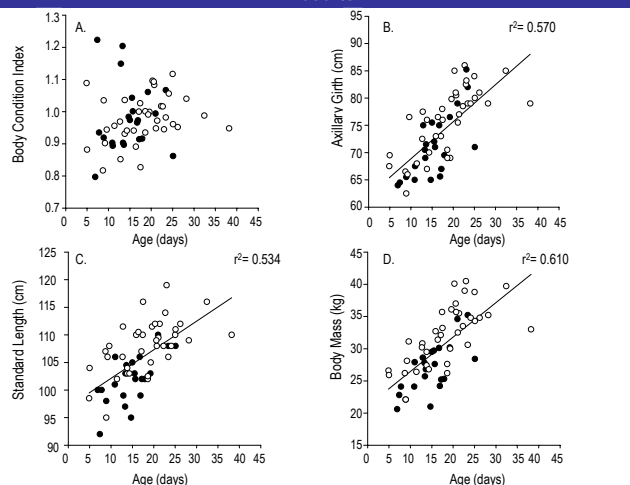


Figure 1. Morphometrics for individual pups by age are presented in (A) BCI, (B) axillary girth (cm), (C) standard length (cm), and (D) body mass (kg). (●) denotes female pups and (○) denotes males.

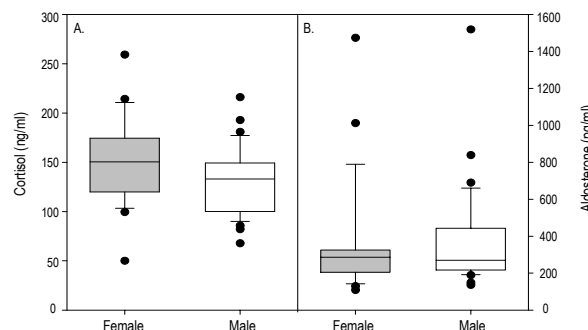


Figure 2. (A) Cortisol concentrations (ng/ml) and (B) aldosterone concentrations (pg/ml) by sex from 61 SSL pups. Box-plots indicate lower quartile (bottom line), middle quartile (box) including the median (line within box), upper quartile (upper line), and outliers (●).

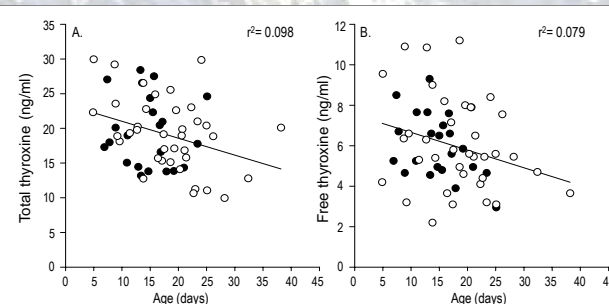


Figure 3. (A) Total thyroxine (ng/ml) and (B) free thyroxine (ng/ml) presented against age (days). (●) denotes female pups and (○) denotes males.

Results

- BCI was not related to pup age ($p=0.216$) or sex ($p=0.647$) (Fig 1A).
- Female pups were smaller than males in BM, SL, and AG ($p \leq 0.015$).
- SSL pups increased in BM, SL, and AG with age ($p < 0.001$) (Fig. 1) and females (14.7 ± 1.0 d) were on average younger than males (18.3 ± 1.2 d) ($p=0.025$).
- Circulating cortisol concentrations were higher in female (151.4 ± 9.2 ng/ml) than male (129.8 ± 5.6 ng/ml) pups ($p=0.037$) (Fig. 2A) but were not affected by BCI or age.
- Circulating concentrations of cortisol ($p < 0.001$) and thyroid hormones ($p \leq 0.012$) decreased when regressed against the elapsed time between arrival on the rookery and removal of pup from the holding corral for blood collection.
- Male pups (368.1 ± 41.6 pg/ml) had higher aldosterone concentrations ($p=0.015$) than females (357.0 ± 61.4 pg/ml) but aldosterone was not related to BCI ($p=0.055$).
- There was no detectable effect of BCI or sex on thyroid hormones. While total thyroxine ($p=0.015$) and free thyroxine ($p=0.031$) decreased with age (Fig. 3).
- Leptin (ng/ml HE) concentration was not related to BCI, sex or age.

Conclusions

- There was no relationship between BCI and any of the hormones quantified, possibly due to all pups sampled being healthy and within expected body condition.
- A significant difference in size between male and female pups was detected; however, only cortisol and aldosterone showed differences between male and female pups.
- Cortisol and thyroid hormones decreased when regressed against elapsed time; although the overall variation attributed to the elapsed time was low ($r^2 < 0.293$).
- Leptin concentrations were near the lower detection limit. Difficulty in quantifying leptin in SSLs has been previously reported with low concentrations or no correlation to body mass.



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