[15]). No samples from genotyped males, or from lactating, non-cycling, immature or post-reproductive females approached this P4 threshold. Comparisons of T concentrations were similarly used to separate pregnancies into early and late stages of gestation. T rises during pregnancy, albeit more slowly than P4. By mid-gestation, T concentrations in pregnant females are comparable to, if not higher than those observed only in adult males (but without a comparable rise in P4) [16] (see also results). Thus, high P4, low T samples were classified as from females in early gestation and high P4, high T samples were classified as from females in mid- to late-gestation. All samples from genotyped adult females at or above these P4 and T concentrations were classified as pregnant. Pregnancies were classified as successful if the female was subsequently observed with a live birth before 18 months from the time of sample collection. Otherwise, the pregnancies were classified as unsuccessful, representing a spontaneous abortion or an unobserved perinatal mortality.

2.5 Statistical analyses

All statistical analyses were performed using the software, JMP (SAS Institute, 2010). Log-transformed values were used for all hormone analyses. A general linear model (GLM) was used to distinguish reproductive and non-reproductive groups of each sex based on P4, T, T3, GC and T3/GC concentrations. Differences between groups were then tested using a chi-square contrast test.

The abundance and timing of Fraser River Chinook (FRC) was determined from 2008–2014 by Albion Test Fishery CPUE data (Catch Per Unit Effort, [41]), collected on a daily basis by an independent observer during spring, summer, and fall months. All correlations between hormone concentrations and fish abundance used Albion Test Fishery CPUE data lagged by 12 days from the time a sample was collected; the 12 day lag was derived from estimates of Chinook swim time from the study area to the test fishery, which was also in agreement with the lag time that resulted in the best fit model between prey abundance and nutritional hormones [5,8]. The CPUE data were $\log_{10}$ transformed to achieve normality. Early spring Columbia River Chinook abundance was also estimated from daily counts at the Bonneville dam [31] by calculating the area under the curve from Julian Day 100 to 140.

Vessel counts were taken every half hour (within 5 minutes of the half hour). Any vessels outside the 5 minute grace period were not counted. All boats within 0.5 mile of the killer whales were recorded by type (commercial whale watch, recreational, cargo, ferry, commercial fishing, enforcement, research, monitoring, and kayak or paddleboard) and activity (e.g., transiting, whale watching, fishing (lines in the water), acoustic, enforcing). A second (B) count was taken when a second nearby whale group was present (1–2 miles away) but outside of our initial count area, providing that the vessels and their activity could be clearly identified.

The correspondence between fish abundance and Julian date (i.e., the consecutive day of the year, ranging from 1 to 365) and vessel abundance and Julian date, across years, was established with a GLM, which allowed us to then use Julian date as proxies for fish and boat abundance in subsequent analyses. A GLM was used to separately predict T3 and GC by Julian date for all sampled individuals. The relation between early spring Columbia River salmon abundance and subsequent T3 and GC concentrations during that same year was also tested in those regressions. Finally, GLM was used to separately predict T3, GC and the T3/GC ratio, using Julian date as a polynomial and pregnancy type as independent variables. GC was included as a covariate whenever predicting T3, and vice versa, since both hormones respond to other in the regulation of energy balance. For T3, this was done by fitting T3 by GC, saving the residuals, and then using the residuals of that analysis in the final regression. For GC, the