BAYESIAN HIERARCHICAL MODELS FOR ESTIMATING HARBOR SEAL CHANGES IN PRINCE WILLIAM SOUND, ALASKA

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Bayesian hierarchical models were used to assess trends of harbor seals, Phoca vitulina richardsi, in Prince William Sound, Alaska, following the 1989 Exxon Valdez oil spill. Data consisted of 4-10 replicate observations per year at 25 sites over 12 years. In previous work, Poisson regression was used to adjust counts to a standardized date, time of day, and time relative to low tide. Then linear regression was used to assess trend for the adjusted counts. The whole procedure was bootstrapped to assess significance of trends. We found several problems with this method. First, the number of estimated parameters was very large. Second, we wished to develop models for each site, but it was difficult to combine trend estimates from each site into an overall assessment of trend. The Bayesian hierarchical model helped solve these problems by using a Poisson regression model for each of the 25 sites, where the mean of the Poisson distribution depended on the factors: 1) year, 2) time of year, 3) time of day, and 4) time relative to low tide, and then the 25 site parameters for each factor in the Poisson mean were given a normal distribution. Results showed that at most sites, 1) counts decreased yearly, 2) counts decreased throughout August and September, 3) counts decreased throughout the day, and 4) counts were at a maximum at 20 minutes after low tide; however, there was considerable variation among sites. To get overall trend we used a weighted average of the trend at each site, where the weights depended on the overall abundance of a site. The overall trend indicated a continued significant decrease in the harbor seal population. Comparison of methods showed similar parameter estimates, but the Bayesian hierarchical model allowed more flexible use of trend indices in a single statistical framework.

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ABSTRACTS

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