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Blue Whale (*Balaenoptera musculus*) behavior and group dynamics as observed from an aircraft off southern California 2008-2013

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Group behavior and interactions of endangered blue whales (*Balaenoptera musculus*) have not been systematically studied. We hypothesized that response variables of blue whale sighting rate, group type and cohesion differed by the explanatory variables behavior state, time of day, season, water depth and distance from shore. To address our hypotheses, we flew systematic line transect surveys in southern California and collected focal group data. Chi-square contingency table and G^2 analyses were used to assess statistical relationships between response and explanatory variables. Observation effort totaled 87,555 km involving 18 (1-week-long) aerial surveys spanning Jan-Dec 2008-2013. Seventy blue whale groups (117 individuals) were seen, ranging in size from 1-6 whales (mean = 1.7, SD = 1.20). Results supported our hypotheses that blue whale group characteristics were influenced by behavior state and spatio-temporal variables. Sighting rates were significantly highest during summer followed by spring, fall and winter ($p < p < 0.001$). Group type differed significantly by season: groups were seen only during summer but singles and pairs were seen spring through fall ($\chi^2 = 31.18$, $p < 0.001$). Groups and mother/calf pairs engaged predominantly in mill and slow travel/rest, while singles and pairs were only observed in medium/fast travel ($G^2 = 100.4$, $p < 0.001$). Behavior state differed significantly by time of day, group type, water depth and distance from shore. Mother/calf pairs and singles were found in deeper offshore waters than groups and pairs. Group cohesion and group size were positively correlated ($r^2 = 0.39$, $p < 0.05$): as group size increased whales became less cohesive and more spread out within groups. Our study suggests that group characteristics and behavior are sensitive to spatio-temporal factors. These parameters may serve as behavioral indices of anthropogenic disturbance to blue whales. Understanding influences on naturally occurring behavior is critical to differentiate potential impacts of growing human-related activities relative to concerns about blue whale population recovery.

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