EFFECTS OF ENVIRONMENTAL CONDITIONS ON OWL RESPONSES TO BROADCAST CALLS

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ABSTRACT: Understanding the effects of environmental conditions on the responses of birds to broadcast calls is important for planning call-response surveys to maximize the probability of detection. I looked for effects of environmental conditions (temperature, humidity, barometric pressure, and light level) on response rates of barred owls (*Strix varia*) and great horned owls (*Bubo virginianus*). Calls were broadcast on 23 nights under varying environmental conditions from 10 different sites. Significant correlations were found between barred owl response rates and light intensity, and between great horned owl response rates and barometric pressure.

Key words: barred owl, *Bubo virginianus*, call-response surveys, environmental conditions, great horned owl, *Strix varia*

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The goal of surveys is to maximize the number of individuals detected, thus minimizing variation in population estimates and maximizing precision and accuracy of estimates (Titus 1990, Becker et al. 1997). Call-response surveys are a common and effective way to census many bird species (Johnson et al. 1981). They are particularly helpful for detecting nocturnal birds such as owls, which are difficult to detect via visual surveys (Fuller and Mosher 1981, Johnson et al. 1981).

There are many ways to maximize detection rates in call-response surveys, such as conducting surveys in appropriate habitats and in times of the year when territories are defended most vigorously (Call 1978, Rohner and Doyle 1992). One additional way to maximize detection is to conduct surveys when environmental conditions are ideal for eliciting and detecting responses. For these reasons, surveys are usually not conducted in precipitation or high wind, as these can interfere with detection of broadcast calls by target species and detection of responses by observers (Wiley and Richards 1982). In addition, many studies have looked for correlations between environmental conditions and response rates, allowing researchers to plan surveys for conditions when responses are most likely. Indeed, many studies have found such correlations between environmental conditions and response rates (e.g., Carpenter 1987, Smith et al. 1987, Ganey 1990, Clark and Anderson 1997, Preston and Campbell 2002).

I set out to determine whether response rates for barred and great horned owls were related to any of four environmental conditions; temperature, humidity, barometric pressure, and light level. Barred owls and great horned owls are common, widespread species in North America which are of management concern because of their potential negative impact on spotted owls (*Strix occidentalis*) and their value as potential indicators of forest health (Hamer et al. 1994, Dark et al. 1998, Leskiw and Gutiérrez 1998, Hamer et al. 2001, Kelly et al. 2003, Peterson and Robins 2003).

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METHODS

Two 3.2-km transects were established along forested roads in Strafford County, New Hampshire (43°04'-43°08' N, 70°52'-70°55' W). Calls were broadcast every 0.8 km along the two transects, which is a similar distance to that used in other owl surveys, (Fuller and Mosher 1981, Takats et al. 2001), for a total of 10 sites. Distance between sites was measured along the road but approximates straight-line distance because the road did not deviate significantly from a straight line between sites. The survey was conducted on 23 nights from 31 March to 11 October 1999, starting 0.5 hr after sunset. Nights with precipitation and wind speeds over 32 km/hr were avoided as the noise associated with these factors could affect perception of the broadcast calls by the owls and/or detection of the owls' responses (Wiley and Richards 1982, Fuller and Mosher 1987).

Stimulus calls were copied from compact disc to cassette tape for broadcast (Elliot and Read 1998). While repeated use of a single recording has been criticized as pseudoreplication (Kroodsma et al. 2001), standardization of the broadcast was necessary to minimize inter-broadcast variation. Broadcasts were made from the cassette tape on a Magnavox AZ1000 stereo cassette player from a height of 1.5 m at full volume. At each site I broadcast 15 sec of barred owl calls and 15 sec of great horned owl calls separated by 15 sec of silence. This sequence was repeated once in each of 4 cardinal directions, for a total of 4 min of broadcast.

The number of owls responding was recorded during the 4 min broadcast period and during the following 8 min of silence. Multiple individuals at a given site could be identified through the use of several cues. First, on many occasions owls responding at a single site overlapped each other in time. Second, some responses could be identified from multiple owls if two responses occurred at distances that were too great and time intervals too short to be produced by a single moving owl. Third, multiple individuals could sometimes be detected based on sex, even when responses were nearby and did not overlap in time (Freeman 2000). On rare occasions when the number of individuals responding could not be counted with total confidence, I used the most conservative count. Temperature, humidity, and barometric pressure were recorded from a nearby weather station, just before and after each survey period, and before and after values were averaged to get a representative measure for each survey period. In addition, for each sampling period I recorded one representative measure of light intensity striking the surface of an open field using an International Light IL 700 Research Radiometer.

I used multiple linear regression to examine relationships between the total number of owls of each species responding each night and temperature, humidity, barometric pressure, and light level. Light level was log-transformed to meet assumptions of equal variance. I added variables to the model in a forward stepwise procedure. This analysis was repeated using the total number of sites at which any owls of each species were detected as the response variable, regardless of the number of owls responding at each site. Statistical analyses were conducted using S-Plus version 6.1 (Insightful Corporation 2002).

RESULTS

Of the four environmental conditions that were measured, only one pair (of six pairwise comparisons) was significantly correlated. Humidity was negatively correlated with light level ($R^2 = 0.24$, $P = 0.030$). However, this relationship was no longer significant after applying a Bonferroni correction for multiple tests.

Barred owls

An average of 0.35 barred owls was detected at each site on each night (Fig. 1A). When data from all sites were combined, there was a significant negative effect of light level on the number of barred owls detected (Fig. 2 $R^2 = 0.20$, $P = 0.047$). No other terms added significantly to the fit of the model (all $R^2 < 0.15$, all $P > 0.10$). Light level was also negatively related with the total number of sites at which at least 1 barred owl was detected (Fig. 3: $R^2 = 0.27$, $P = 0.019$). No other terms added significantly to the fit of the model (all $R^2 < 0.15$, all $P > 0.05$).

Great horned owls

An average of 0.16 great horned owls was detected at each site on each night (Fig 1B). When all sites were combined, there was a negative relationship between the number of great horned owls responding and barometric pressure (Fig. 4: $R^2 = 0.21$, $P = 0.026$). No other terms added significantly to the fit of the model (all $R^2 < 0.03$, all $P > 0.50$). There was no relationship between any of the environmental variables measured and the number of sites at which at least 1 great horned owl was detected (all $R^2 < 0.15$, all $P > 0.05$).

DISCUSSION

While it is an easy matter to determine environmental correlates of calling behavior, it is more difficult to determine the biological significance of these relationships. Because of the correlative nature of this and many other studies that look for the effects of environmental factors on calling behavior, any causal explanation must remain speculative. There is, however, at least one possible causal mechanism that could explain both of the results shown here: a negative relationship between barred owl response rate and light level, and a negative relationship between great horned owl response rate and barometric pressure. It is plausible that the activity of owls could be directly related to the activity of their prey species (Clarke 1983). Both humidity and light level are related to the activity of owl prey (e.g., Marten 1973, Clarke 1983, Longland and Price 1991). The difference in environmental variables affecting the activity of these two owl species may reflect differences in the effects of these environmental variables on the activity of these species' preferred prey.

Territories of barred owls and great horned owls seemed to overlap extensively in this study, since both barred and great horned owls both occurred at 7 of the 10 sites (Fig. 1A and 1B). Overlapping territories between these two species have been noted previously (Laidig and Dobkin 1995), but is in contrast to some reports (Houston et al. 1998). Previous researchers have found that barred owls may avoid great horned owls (Fuller 1979), so it is interesting to note that the methods used here, alternating barred and great horned owl calls, still elicited many barred owl responses. In fact, a similar number of barred owls responded per site as in previous surveys in this region (Smith 1975). This apparent lack of an effect of great horned owl calls on barred owl response behavior supports the findings of McGarigal and Fraser (1985), who found that broadcast great horned owl calls did not affect barred owl responses. It would be interesting to conduct a direct comparison between barred owl responses to the broadcast calls of barred owls only and responses to mixed barred and great horned owl calls, but such a direct comparison has not yet been attempted.

In conclusion, I found a negative correlation between barred owl response rate and light level, and a negative correlation between great horned owl response rate and humidity. While I can not infer causation from these correlative data, it is possible that these relationships are due to activity of prey species. More work should be done to confirm these relationships and to determine their

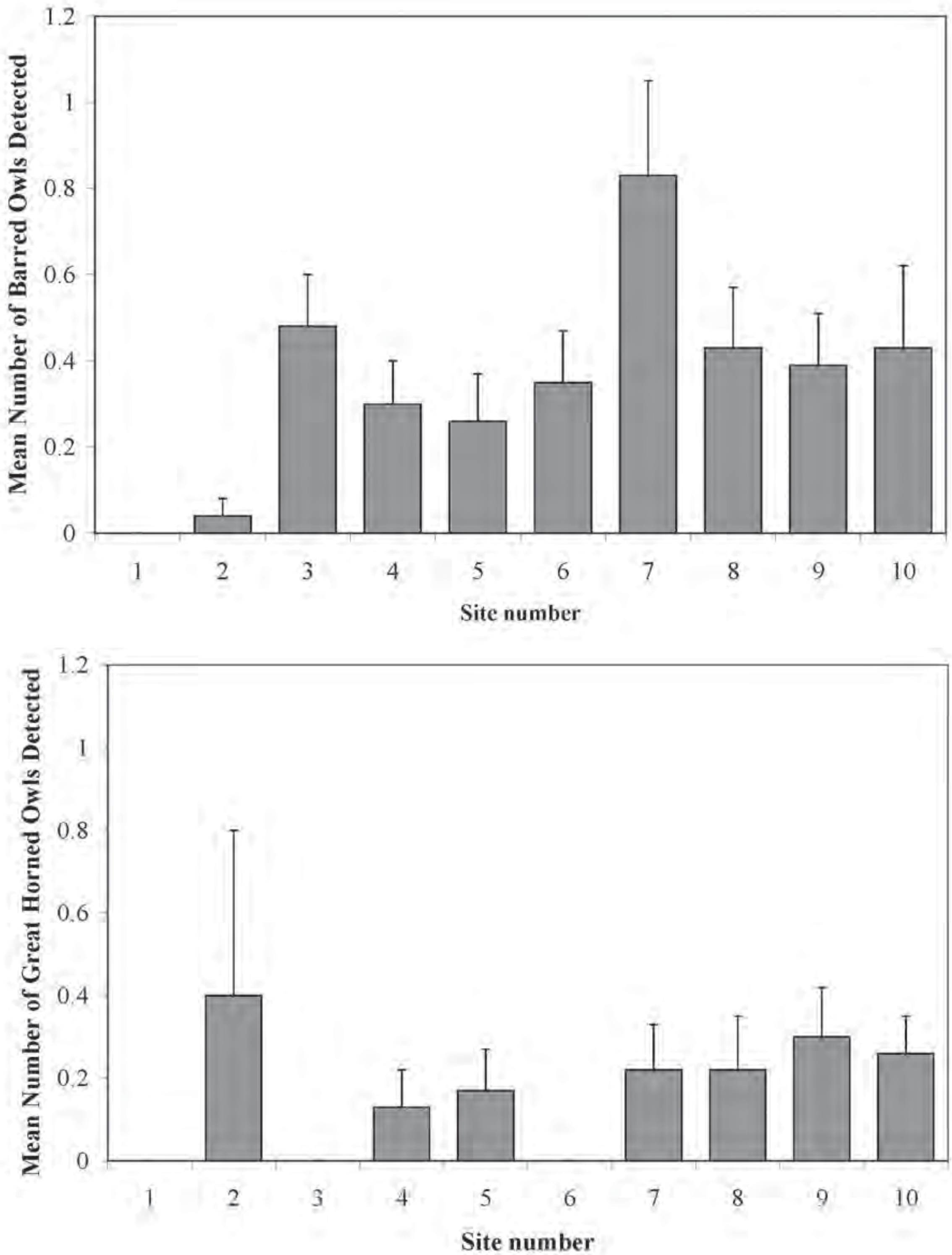

Figure 1 Mean numbers of barred owls (A) and great horned owls (B) detected at each of the ten sites. Bars represent standard errors.

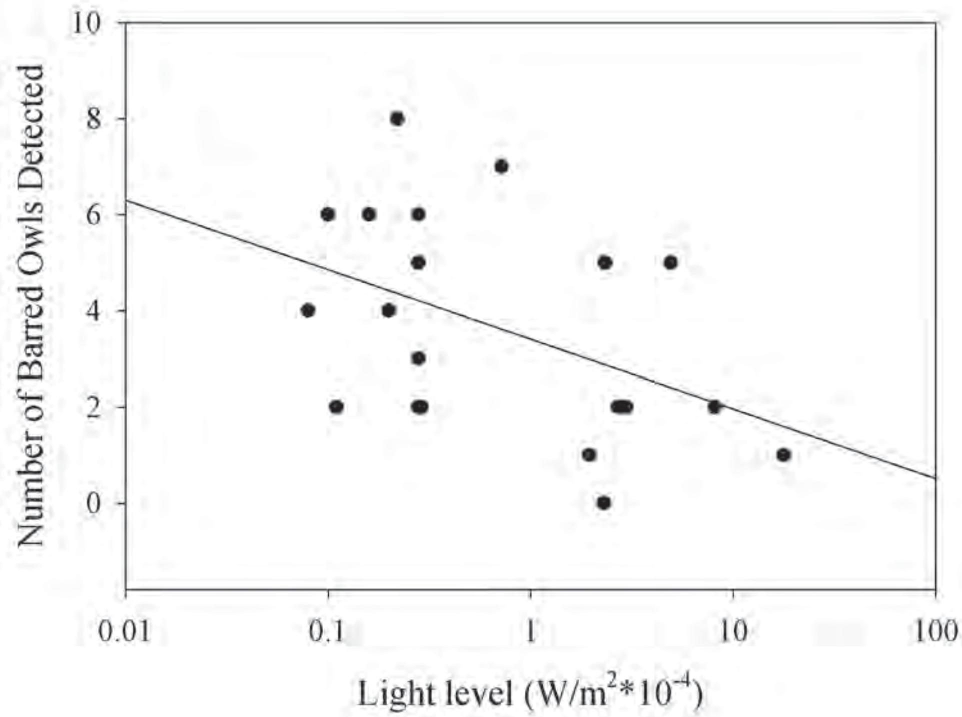

Figure 2. Total number of barred owls responding to broadcast calls as a function of light level. The best-fit line is described by the equation $Y = 3.41 - 0.63X$, where Y is the total number of barred owls that responded and X is the log of the light level.

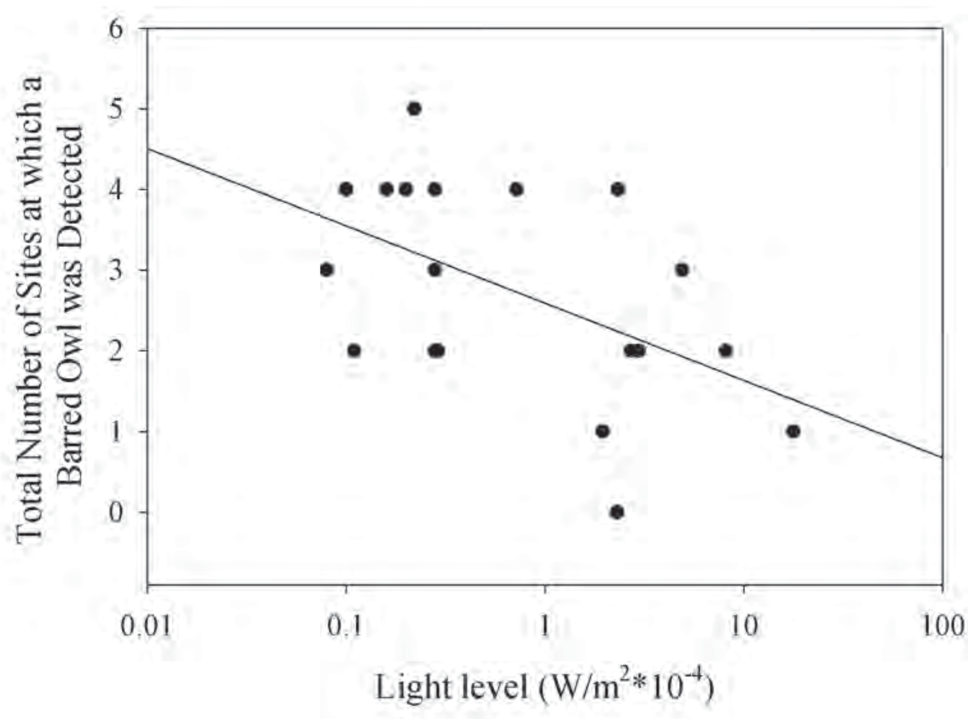

Figure 3. Total number of sites at which at least one barred owl responded as a function of light level. The best-fit line is described by the equation $Y = 2.59 - 0.42X$, where Y is the total number of sites at which at least one barred owl responded and X is the log of the light level.

causes. Response rates in New Hampshire forests may be maximized by surveying for barred owls on dark nights and for great horned owls on nights with low barometric pressure.

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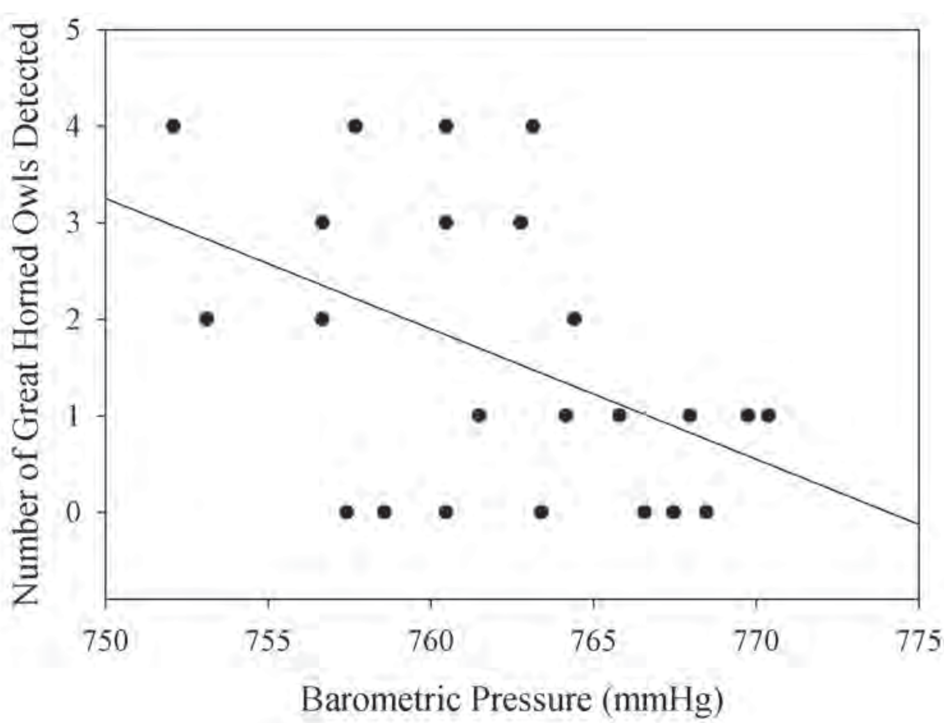

Figure 4: Total number of great horned owls responding to broadcast calls as a function of barometric pressure. The best-fit line is described by the equation $Y = 104.6 - 0.135X$, where Y is the total number of great horned owls responding and X is the barometric pressure.

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