

OCCUPANCY OF HABITATS BY MEXICAN SPOTTED OWLS IN RELATION TO EXPLOSIVE NOISE AND RECREATIONAL ACCESS AT LOS ALAMOS NATIONAL LABORATORY

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ABSTRACT: We examined 15 years of presence/absence data on the Mexican Spotted Owl (*Strix occidentalis lucida*) at Los Alamos National Laboratory in seven areas managed as Spotted Owl habitat and affected by two types of anthropogenic disturbances: human recreation and relatively frequent but brief impulse noises caused by explosives. On the basis of the percent of years each area was occupied (the occupancy rate), the type of disturbance had an apparent effect on habitat occupancy. The rate of occupancy of Spotted Owl habitat within 2.4 km of firing sites with restricted access was 31% while in habitat >2.4 km from firing sites in which recreational access was allowed it was 7%. These results suggest that the Spotted Owl's use of habitat at Los Alamos is not adversely affected by noise generated during explosives tests but may be adversely affected by recreational access.

The Los Alamos National Laboratory is a laboratory for national security operated for the Department of Energy's National Nuclear Security Administration. The steep-walled canyons of the Jemez Mountains within the laboratory's boundaries provide nesting habitat for the Mexican Spotted Owl (*Strix occidentalis lucida*). Under the Endangered Species Act, the U.S. Fish and Wildlife Service listed the subspecies as threatened in 1993 (USFWS 1993) and published a recovery plan for it in 1995 (USDI 1995). In the Jemez Mountains, Spotted Owls prefer to nest on cliff faces in canyons (J. A. Johnson and T. H. Johnson unpubl. data).

The effects of noise, especially noise alone without an accompanying physical or visual disturbance, on the Spotted Owl's habitat selection is not well understood. Many anthropogenic disturbances have been shown to affect birds of prey (Fyfe and Olendorff 1976). Delaney et al. (1999) examined the effects of helicopter noise on the Mexican Spotted Owl and found that the owls did not respond by flushing when helicopters were >105 m away. Johnson and Reynolds (2002) examined the effects of the noise of low-flying jet aircraft on the Mexican Spotted Owl and found that the owl's responses to low-flying F-16 jets did not exceed responses to natural events. Swarthout and Steidl (2001) examined behavioral responses of the Mexican Spotted Owl at varying distances to hikers and concluded that owls altered their behavior in the presence of a hiker at distances of up to 55 m. Further study (Swarthout and Steidl 2003) showed that high rates of hikers passing quickly near nests may be detrimental to the owls.

Part of the laboratory's operations includes detonation of a variety of explosives at fixed firing sites on the ground. Some of the Mexican Spotted Owl habitat within the laboratory is near active firing sites. Public access to these areas is prohibited, and work-related access is strictly limited. Other Spotted Owl habitat at the laboratory is not affected by explosives, but pe-

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destrian access is allowed within it, and the public as well as the laboratory's workforce uses it frequently. The purpose of this study was to compare rates of Spotted Owl occupancy at Los Alamos National Laboratory in areas near firing sites, subject to relatively frequent impulse noise from explosives, to that in areas not affected by testing of explosives but used for recreation.

STUDY AREA

Los Alamos National Laboratory and the associated towns of Los Alamos and White Rock are located in Los Alamos County, north-central New Mexico, approximately 100 km north-northeast of Albuquerque and 40 km northwest of Santa Fe. The 10,240-ha laboratory is situated on the Pajarito Plateau on the eastern flanks of the Jemez Mountains. Large portions of the site are relatively undisturbed by people because of access restrictions. Adjacent landowners include the U.S. Forest Service, the National Park Service, the county of Los Alamos, and the San Ildefonso Pueblo.

There are seven segments of canyons within the laboratory that are protected as Spotted Owl habitat. This habitat was initially identified as suitable through modeling of topography, elevation, and cover type in 1998. Hathcock and Haarmann (2008) developed a refined vegetation-based model of suitable habitat for the Jemez Mountains, and the boundaries of the habitat within the laboratory were redrawn in 2005 on the basis of a version of this model.

Los Alamos National Laboratory is more heavily developed than many areas typically considered Mexican Spotted Owl habitat. Approximately 12,000 people work on the site each day, and 18,000 people live in Los Alamos and White Rock. Some areas of the laboratory can be visited by the public on foot or by bike (but not by vehicle); in other areas public access is prohibited.

A large fraction of the 10,240 ha (more than one-third of the land area) forms safety buffers for the testing of explosives. The frequency of explosions at Los Alamos varies from 700 to 1200 experimental firings ("shots") annually. Some "shots" are contained, some are in open air, and the quantities and types of explosive materials vary. Access to the areas of the tests and associated safety buffers is highly restricted—there is no public access and limited access for workers.

Levels of noise resulting from detonation of explosives were measured in March of 1995 as part of the environmental impact statement for the Dual-Axis Radiographic Hydrodynamic Test Facility (DOE 1995). These measurements recorded the peak overpressure levels of 137 dB on a mesa directly above and 1180 m from a site occupied by Spotted Owls (DOE 1995). Peak overpressure measured in dB and noise levels measured in dB(A), scaled to the level of human hearing, are comparable because the A-scale weighting at 20 Hz is about -50 dB (ANSI 1971). This means that the A-scale noise levels at the site of the owls were above 80 dB(A), double the normal level of background noise in this vicinity, which averages 40 dB(A) (LANL 2000).

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METHODS

All of the Spotted Owl habitat identified within the laboratory is surveyed annually, with up to four surveys per year between late March and 31 August in each segment of canyon containing habitat. Surveys are halted if Spotted Owls are found; otherwise, they are continued until four surveys are completed. The surveys follow the required protocols established by the USFWS (2003) and are performed under permit by the laboratory's biologists.

Using ArcMap version 9.2 (ESRI, Redlands, CA), we identified which of the Spotted Owl habitats that either (1) were within 2.4 km of firing sites and disallowed recreational access or (2) were greater than 2.4 km from firing sites and allowed recreational access. The data are too sparse for statistical testing, so our inferences on whether habitat occupancy was related to the proximity of firing sites or public access are based on general descriptive statistics.

RESULTS

Of the seven areas of Spotted Owl habitat at Los Alamos National Laboratory, one has been occupied continuously since surveys began in 1995 through 2009. Two additional locations have been occupied intermittently from 2004 to 2009.

Four of the seven areas were within 2.4 km of the nearest firing site, and recreational access to them is not allowed. The other three areas were more than 2.4 km from the firing sites and is accessible for recreation to the public and/or the laboratory's workforce.

The 15 years of survey data pooled, the annual rate of occupancy of areas within 2.4 km of firing sites with no recreational access was 31%. In areas >2.4 km from firing sites with recreational access, the rate of occupancy was 7%.

DISCUSSION

Our results suggest that the Spotted Owl occupancy in areas of Los Alamos National Laboratory exposed to frequent impulse noise from explosions has not been affected negatively. In 1997, 69% of all territories in the Jemez Mountains were surveyed with 67% of those being occupied (T. H. Johnson unpubl. data preceding 1998). Compared to that in the surrounding Jemez Mountains, fecundity of the Spotted Owl in areas where explosives are tested at Los Alamos has been high, further suggesting that the owls are not adversely affected by the noise generated by tests of explosives tests at the current frequency. This inference corresponds with that of Ellis et al. (1991), who reported that noise from low-flying jet aircraft and sonic booms were never associated with reproductive failure of the various species of raptors they studied. Palmer et al. (2003) documented subtle effects of overflying jets on the parental behavior of the Peregrine Falcon (*Falco peregrinus*), but they found no evidence that the falcons' pattern of nest attendance differed by exposure to such overflights.

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On the other hand, our data do suggest that recreational access had a negative effect on the Spotted Owl's habitat. At Los Alamos, we have not found the owls occupying any part of a canyon that contains an access road in its bottom, either within or outside of the buffer area for tests of explosives. Our inferences, however, are based on the assumption that the seven areas of habitat considered suitable for the Spotted Owl are of equal quality and have an equal chance of being occupied. Furthermore, though extending over 15 years, our data are based on only two nesting pairs and one single owl, whose site tenacity may have inhibited them from shifting from site to site or outside the laboratory's boundary altogether.

The patterns we are seeing at Los Alamos indicate that noise from explosives testing has not been a deterrent in the Spotted Owl's nest-site selection but that disturbance in other forms, such as from vehicles driving along roads or persons walking through a nesting area, might be a deterrent. It is likely that the restrictions of access associated with firing sites have made the habitats within the buffer more desirable to the Spotted Owl than habitats in areas with more human disturbance.

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