



Responses of Mexican Spotted Owls to Low-flying Military Jet Aircraft

Charles L. Johnson
Richard T. Reynolds

Abstract—To investigate the effects of military fixed-wing aircraft training on the behavior of the endangered Mexican spotted owl (*Strix occidentalis lucida*), we subjected four adults and one juvenile owl to low-altitude, fixed-wing, jet aircraft overflight trials in Colorado in 1996 and 1997. Trials consisted of three sequential fly-bys, each at a greater aircraft speed and noise level, over owl territories in narrow and steep-walled canyons. All overflights were about 460 m above canyon rims, the lowest altitude allowed during training flights. Maximum noise levels, measured at one owl site, were 78, 92, and 95 dB (sound volume) for the first, second, and third fly-bys, respectively. Behaviors of owls during 25-second fly-by periods ranged from “no response” (no body movements) to “intermediate response” (sudden turning of head). The 25-second fly-by responses did not exceed behaviors (“no movement” to “change of roost”) exhibited by the owls during 10-minute pre- and postflight observation periods before and after each fly-by.

Keywords: fixed-wing, F-16 jet, Mexican spotted owl, disturbance, noise

About The Authors

Charles L. Johnson was a wildlife biologist with the Rocky Mountain Research Station in Fort Collins, CO. He completed a B.S. degree at Humboldt State University and an M.A. degree in biological science at the University of Northern Colorado. He is currently a wildlife biologist with ENSR in Fort Collins, CO.

Richard T. Reynolds is a research wildlife biologist at the Rocky Mountain Research Station in Fort Collins, CO. He completed B.S., M.S., and Ph.D. degrees at Oregon State University.

Introduction

To develop and maintain flight proficiency of pilots, the Colorado Air National Guard (COANG) makes approximately 3,300 year-round sorties (one flight, takeoff to landing) by fixed-wing, F-16 jet aircraft on the Fremont and La Veta military operating areas (MOA). The MOAs are located on the southern slope of Pikes Peak (Fremont MOA) and in the Wet and Sangre de Cristo Mountains (La Veta MOA) adjacent to the Fort Carson Military Base in south-central Colorado. In the montane portions of both MOAs, the Mexican spotted owl occurs only in deep, steep-walled, rocky canyons containing ponderosa pine and mixed-conifer forests (Johnson 1997). When combined, the Fremont and La Veta MOAs contained 72 percent (13 of 18) of all spotted owl territories found in Colorado during studies (1989 to 1997) of the owl's distribution and ecology at the northeastern limits of their distribution (Johnson 1997). Due to the importance of the MOAs to Colorado spotted owls, the few reports on the effects of aircraft on raptors (Delaney and others 1999; Holmes and others 1993), and an opportunity to direct jet aircraft flights over the few Mexican spotted owls in the MOAs, we subjected five Mexican spotted owls in four canyons in the Fremont and La Veta MOAs to low altitude F-16 flights in 1996 and 1997.

Study Area and Methods

The Fremont MOA, an area of about 490 km² ranging in elevation from 1,830 to 3,500 m, is located immediately west of Fort Carson, El Paso County, Colorado, and includes much of the south slope of Pikes Peak. The La Veta MOA, an area of about 5,180 km² ranging from 1,890 to 3,535 m elevation,

is 24.5 km south of the Fremont MOA and includes portions of the Wet and Sangre de Cristo Mountains. The montane areas in both MOAs contained ponderosa pine (*Pinus ponderosa*) forests at lower elevations and mixed-species forests containing ponderosa pine, Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), blue spruce (*Picea pungens*), quaking aspen (*Populus tremuloides*), and Gambel oak (*Quercus gamblii*) at higher elevations. Both MOAs were dissected with deep, narrow rocky canyons, some of which were annually occupied by spotted owls while other canyons were occupied only occasionally during our 9-year study (Johnson 1997).

To examine the effects of jet overflights on spotted owls, we recorded the behavioral responses of day-roosting owls to low-altitude jet (F-16) overflight trials in Colorado in 1996 and 1997. An overflight trial consisted of three separate, but same-day, fly-bys over each owl. Each fly-by was at sequentially greater aircraft speeds and sound levels: “enroute cruise” (speed approximately 300 knots), “2nd power setting” (approximately 425 knots), and “higher-power setting” (approximately 520 knots). We recorded the behavior of the roosting owls subjected to overflight trails during (1) a 10-minute period immediately prior to a fly-by, (2) during a 25-second fly-by period, and (3) during a 10-minute period immediately after each fly-by. All owls had been captured with noose poles, mist nets (Forsman 1983), or leg-hold traps (Johnson and Reynolds 1997) and fitted with tail-mounted transmitters from 24 hours (one owl) to greater than 30 days (all other owls) prior to the trials. On the day of a trial, owls were located on their day roosts with hand-held receivers. Owl behaviors were observed continuously during each fly-by period with binoculars and 20x scopes by two to four observers in at least two separate locations hidden by trees and shrubs between 30 and 100 m from the owls. Observers were at their observation positions more than 30 minutes prior to overflights to allow the owls to adjust to any disturbances related to our arrival. We used these observation distances and pretrial arrival times because spotted owls become accustomed to observers sitting quietly 25 to 50 m away in only 10 to 15 minutes (Sovern and others 1994).

Planned elapsed time between each sequential fly-by was 10 minutes between the end of the 10-minute postfly-by observation period and the beginning of the next 10-minute prefly-by observation period. Aircraft safety factors constrained our control of the speed sequencing of fly-bys; thus, slower aircraft speeds always preceded higher speeds. Pilots attempted each fly-by at 460 m above each canyon rim, the lowest altitude allowed during flight training; we could not determine the exact distances between owls and aircraft. All flights were across or perpendicular to the length of canyons and were directed via radio communication between the pilot and a COANG controller on the canyon rim directly above the owl’s roost. Owl behaviors during the 25-second fly-by periods were assigned to one of four categories: (1) “no response” (no discernible body movement); (2) “low response” (opening of eyes, slow head turn); (3) “intermediate response” (sudden movement of head, wing, or body); and (4) “high response” (flush or

change of roost). Owl behaviors during the 10-minute pre- and postfly-by observation periods were assigned to the following categories: (1) owl asleep, no discernible body movement; (2) eyes open, slow head turns, preening; (3) alert, sudden head turns; and (4) movement to new roost. These categories were equivalent to categories used for the owl responses during the 25-second fly-by.

Four territories containing a total of five different owls were subjected to overflight trials during the study: two adult females in two different territories and one adult male and his female fledgling in a third territory in 1996, and an adult male and a 1-year-old female in a fourth territory in 1997. Two of the five owls were subjected to overflight trails twice; one female, overflown in 1996, was tested in 1997 in the same territory where she was treated in 1996, and the fledgling tested in 1996 was again overflown as a 1-year-old (AHY) in 1997 in the fourth territory (above) where she had paired with an adult male. Thus, seven overflight trials were conducted in which five different owls were treated once and two owls twice. In 1996, a Larson-Davis Model 820 sound level meter, with an attached 1.3 cm condenser microphone covered with a 9.0 cm wind screen, was used to determine sound volumes (dB) and duration (seconds) of three sequential fly-bys at one territory only. We reported A-weighted decibels (dBA), a logarithmic measure of the magnitude of a sound that an average human hears. While BA may not be representative of the noise energy that spotted owls might hear (Delaney and others 1999), dBA occurs on most sound level meters and is ubiquitously used. We used likelihood ratio tests (exact methods due to small samples) (CYTEL 1998) to compare observed frequencies of owl behaviors during pre- and postflight 10-minute periods and responses during the 25-second fly-bys among aircraft power settings.

Results

During each overflight trial, owls were day roosting in trees (for example, Douglas-fir, quaking aspen, Gambel oak) or on rock walls of canyons between 200 and 300 m below the canyon rims. All overflights occurred between 1200 and 1600 hours Mountain Standard Time and between 27 and 29 August in 1996, and on July 4, 1997. Elapsed time between the end of a 10-minute postfly-by and the beginning of a 10-minute prefly-by observation period during fly-bys in a canyon varied from 10 to 40 minutes. Ambient temperatures during all overflight experiments ranged from 18 to 29 °C, and winds were calm to light. At the one canyon territory where durations and sound levels of fly-bys were measured with a sound level meter, sound duration for “enroute cruise” was 15.5 seconds and volume was 78 dBA, for “2nd power setting,” 19.0 second and 92 dBA, and for “higher-power setting,” 22.5 second and 95 dBA. During overflights trials while the sound levels were being recorded in this territory, a thunderstorm was in progress; intermittent light-to-heavy rain was falling, and numerous thunderclaps were recorded. Close thunderclaps had durations of 4.5 to 6.0 seconds and sound volumes between 62 and 87 dBA. Thunderstorms did

not occur during any of the other fly-by trials. Mean ambient or residual sound in the canyons was 61.2 dBA (range = 56.4 to 69.1 dBA, n = 4), excluding the thunderclaps measured in the one canyon.

In 17 (81 percent) of the 21 total fly-bys, only two (9.5 percent) owls showed a higher level of alertness during the post- than preflight 10-minute periods while two (9.5 percent) showed greater movement during the preflight than in the postflight 10-minute periods (table 1). While the numbers of same levels of behaviors by owls during the pre- and postflight periods increased with power setting, the increase was not significant ($P = 0.34$, $df = 4$). Of the two owls that showed greater movement during postflight periods, one changed roost trees (a 5-m flight) 5 minutes into the 10-minute postflight period for the “enroute cruise.” This change of roost appeared to be induced by the thunderstorm rain. The second owl also changed roost trees (a 15-m flight) 7 minutes into the 10-minute postflight observation period (“2nd power setting”). This owl moved from a roost in direct sunlight to a shaded roost site. Two other roost changes, both made by the fledgling owl in the 1996 trials, were observed during the 10-minute prefly-by period for the “enroute cruise.” Both of these roost changes appeared to result from the owl’s seeking protection from the thunderstorm rain and to escape the mobbing of small birds.

During the 25-second fly-by period for “enroute cruise,” one (14.3 percent) owl showed no response, four (57.1 percent) showed low responses (slow head turn), and two (28.6 percent) showed intermediate responses (sudden head turn toward origin of the sound). For the “2nd power setting,” two (28.6 percent) owls showed no response, three (42.8 percent) owls showed low response, and two (28.6 percent) showed intermediate response. For the “higher power setting,” two (28.6 percent) showed no response, two (28.6 percent) showed low response, and three (42.8 percent) owls showed intermediate response. None of the owls showed high response (flush) during any of the 25-second fly-by periods. Overall, there were no differences in observed and expected response levels during the 25-second fly-bys ($P = 0.92$, $df = 4$).

The female fledgling showed an intermediate response during each 25-second fly-by in 1996. However, when this owl was overflown on its new territory in 1997, it showed a low response during the 25-second “enroute cruise,” and no

responses during the 25-second fly-bys at the “2nd power” and “higher power setting.” While the fledgling changed roosts twice in the 10-minute prefly-by period (see above), it exhibited a mix of no responses and low responses to thunderclaps that occurred during the pre- and post- 10-minute observation periods in 1996. However, it responded at the intermediate level to each 25-second fly-by in that year. The greater responses to fly-bys versus thunder may be related to the duration of noise: 4.5 to 6.0 second for thunder versus 15.5 to 22.5 second for overflights. Noise duration was greater for overflights due to the approach and departure of the aircraft. The adult female owl treated in both years showed only a single response (“low” to “2nd power setting”) during the three 25-second fly-by periods in 1996. In 1997, however, she showed an intermediate response during all three 25-second fly-bys.

Discussion

The behaviors displayed by the five Mexican spotted owls between the time of our arrival near a roosting owl (always more than 30 minutes) and the beginning of the first 10-minute prefly-by observation periods in each overflight trial suggested that the owls had adjusted to our presence before 10-minute prefly-by trials were begun. With the possible exception of two roost changes made by two of the owls in the latter half of the 10-minute postfly-by observation periods, the behaviors of the owls during the pre- and postfly-by periods of the sequentially louder fly-bys, showed that the owls that responded at the second or third levels all very quickly returned to normal day-roosting behavior (sleeping, awake but quiet, preening). Delaney and others (1999) also noted a quick return to normal behavior by Mexican spotted owls after disturbance by helicopters. Because the two owls that changed roosts in the postfly-by periods in our study showed only “low” responses to the preceding 25-second fly-bys, we believed the two postfly-by changes of roosts were not directly caused by the fly-bys. However, the roost changes may have resulted from a residual alertness of the owls caused by the fly-bys. We expected the greatest responses from the owls during the 25-second fly-by periods. However, five (23.8 percent) of the 21 fly-bys produced no responses, nine (42.8 percent) produced low responses, and

Table 1—Number of behavior categories of five (two treated twice) Mexican spotted owls preceding and following three sequential jet fly-bys of increasing power and noise that (1) were greater in the 10-minute preflight observation period than in the 10-minute postflight observation period, (2) were the same in both periods, and (3) were greater in the post- versus preflight periods.

Fly-by	Owls	Pre > post	Pre = post	Post > pre
Enroute cruise	7	2	4	1
2nd power setting	7	-	6	1
Higher power setting	7	-	7	-
		2 (9.5 %)	17 (81.0 %)	2 (9.5 %)

seven (33.3 percent) produced intermediate responses; none produced high (flush) responses.

There was no consistent year-to-year pattern of responses during the 25-second fly-by periods of the two owls subjected to overflight trials in both study years. The adult female tested in both years exhibited higher response levels in 1997 than in 1996 during the 25-second fly-by periods. The higher 1997 responses of this female may have resulted from the owl's different roost locations in the 2 years. In 1996, the owl was roosting in the bottom of the main canyon 300 m below the canyon rim. Her 1997 roost was in a smaller side canyon, 55 m closer to the canyon rim and the aircraft. The fledgling that was overflown in 1996 responded at the intermediate level to all three 25-second fly-bys in that year. However, during the 1997 fly-bys, this 1-year-old owl responded with a "low" response to only the "enroute cruise;" she showed no response to the other two louder fly-bys. This owl's low responses in 1997 may have resulted from a year's habituation to military flights over the MOAs (see Delaney and others 1999 for possible habituation in spotted owls to helicopters and chainsaws). Alternatively, the higher response levels of this owl in the first year may have been due to an increased alertness of the owl caused by thunder, rain, and the mobbing by small birds during the overflight trials in 1996. It is not uncommon for spotted owls to change roosts during daylight hours in response to weather (rain, sun, temperature), mobbing birds, or attempts to capture prey (Forsman and others 1984; Johnson 1997; Sovern and others 1994).

Our observations of spotted owls exhibiting alert behavior (for example, sudden head turns), or even changing dayroosts, in the 10-minute pre-fly-by observation periods showed that owl responses to low altitude F-16 overflights did not exceed, and were often less than, responses to naturally occurring events. The relatively minor responses of spotted owls to fixed-wing jet aircraft flights near or at a minimum height of 460 m (plus distance from owl roost site to canyon rim) observed in this study are consistent with Delaney and others' (1999) finding that Mexican spotted owls in New Mexico exhibited no flush (change of roost) responses to noise when helicopters were farther than 105 m from roosting owls, and no alert (sudden head turn) responses when helicopters were greater than 660 m distant. Delaney and

others (1999) did show, however, that as the distance from helicopters to owls decreased, the severity of owl responses increased. The 460-m minimum flight altitude for fixed-wing jet aircraft training flights in this study prevented us from determining the effects of closer flights on the behavior of spotted owls or to determine the distance at which Mexican spotted owls consistently flush from low flying aircraft.

Acknowledgments

Eric Forsman, Teryl Grubb, Suzanne Joy, Rudy King, Brian Linkhart, Hildegard Reiser, and several unidentified reviewers provided useful comments on the manuscript. We thank Dick Masse, John Dronenburg, and pilots of the Colorado Air National Guard for the opportunity to experimentally treat owls, and T. Grubb for suggestions regarding table 1. Colorado Air National Guard and Fort Carson Department of Defense provided funding for this study.

Literature Cited

- CYTEL Software Corporation. 1998. StatXact 4 for Windows. Cambridge, MA.
- Delaney, D. K.; Grubb, T. G.; Beier, P.; Pater, L. L.; Reiser, M. H. 1999. Effects of helicopter noise on nesting Mexican spotted owls. *Journal of Wildlife Management*. 63: 60–76.
- Forsman, E. D. 1983. Methods and materials for locating and studying spotted owls. Gen. Tech. Rep. PNW-162. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 8 p.
- Forsman, E. D.; Meslow, E. C.; Wight, H. M. 1984. Distribution and biology of the spotted owl in Oregon. *Wildlife Monograph*. 87: 1–64.
- Holmes, T. L.; Knight, R. L.; Stegall, L.; Craig, G. R. 1993. Responses of wintering grassland raptors to human disturbance. *Wildlife Society Bulletin*. 21: 461–468.
- Johnson, C. L. 1997. Distribution, habitat, and ecology of the Mexican spotted owl in Colorado. Greeley, CO: University of Northern Colorado. 78 p. Thesis.
- Johnson, C. L.; Reynolds, R. T. 1997. A new trap design for capturing spotted owls. *Journal of Raptor Research*. 32: 181–182.
- Sovern, S. G.; Forsman, E. D.; Biswell, B. L.; Rolph, D. N.; Taylor, M. 1994. Diurnal behavior of the spotted owl in Washington. *Condor*. 96: 200–202.

You may order additional copies of this publication by sending your mailing information in label form through one of the following media. Please specify the publication title and series number.

Fort Collins Service Center
Telephone (970) 498-1392
FAX (970) 498-1396
E-mail rschneider@fs.fed.us
Web site <http://www.fs.fed.us/rm>
Mailing Address Publications Distribution
Rocky Mountain Research Station
240 West Prospect Road
Fort Collins, CO 80526

Natural Resources Research Center
2150 Centre Avenue, Building A
Fort Collins, CO 80526