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Methods and Materials, for Locating and Studying Spotted Owls

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Abstract

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Nocturnal calling surveys are the most effective and most frequently used technique for locating spotted owls. Roosts and general nest locations may be located during the day by calling in suspected roost or nest areas. Specific nest trees are located by: (1) baiting with a live mouse to induce owls to visit the nest, (2) calling in suspected nest areas to stimulate the female to call or fly from the nest, or (3) observing adults during prenesting displays. An effective technique for climbing large nest trees is to rig the tree with a climbing rope. Mechanical climbing aids are then used to ascend the rope. The principal method used to determine the diet is identification and enumeration of prey in regurgitated pellets. The most effective method of trapping spotted owls is with a noose pole. Other trapping methods include mist nets, bal-chatri traps, bow nets, and dip nets. Radio transmitters for long-term radiotelemetry studies are usually attached with a backpack harness; the antenna should be reinforced to keep it from crimping or breaking.

Keywords: Wildlife surveys, birds, owls (spotted).

Introduction

In recent years, a variety of methods for locating and studying spotted owls (*Strix occidentalis*) have been developed. Many of these techniques have spread by word-of-mouth among biologists but have not been well described in the literature. This manual describes the techniques that I (and other biologists) have found most effective for locating and studying spotted owls. I have written the manual with the inexperienced observer in mind, but it should be useful to experienced owl biologists as well.

Locating Spotted Owls

The most efficient way to locate spotted owls is to imitate their calls. Upon hearing a suspected intruder within their territories at night, most spotted owls respond by approaching the intruder and calling. Spotted owls are normally nocturnal but will also call during the day if vocally stimulated. During the day, however, response is usually limited to the immediate vicinity of the roost area. In contrast, owls will often fly long distances at night to confront an intruder. Most investigators use nocturnal calling surveys to determine the general location of a pair of owls; daytime calling surveys are used to locate nest and roost areas.

Spotted owl calls may be imitated vocally or played back on a tape recorder. Both methods are effective, but vocal imitations allow the investigator to dispense with such problems as malfunctioning tape recorders, poor recordings, broken tapes, and extra weight. If a tape recorder is used, an amplifier is generally unnecessary as long as the recorder has a good speaker and power output of 5 watts or more. Tape recordings of spotted owl calls are available from the Regional Offices of the **USDA** Forest Service in Oregon and California and from the Oregon State Office of the Bureau of Land Management, U.S. Department of the Interior.

The call most frequently used for locating spotted owls is a series of four hoots (*hoo—hoo - hoo—hoo!*) (Bent 1938, Forsman 1976, Ligon 1926). Spotted owls have a variety of other calls that can be used for survey work (Forsman 1976), but for most purposes, the four-note hooting series is adequate. Hooting calls should be repeated at intervals of 10 to 30 seconds. Some investigators insert an occasional run-on series of several calls in rapid succession.

Nocturnal Calling Surveys

The sampling approach **used** for surveying spotted owls depends on whether a complete count or an index of density is required. To obtain a complete count of all pairs in a given area, I select a network of roads and trails that allows complete coverage of the area and then drive or walk the roads and trails at night, stopping to imitate spotted owl calls at frequent intervals. "Complete coverage" of the area means that imitated calls can be heard from every spot within the survey area at least once during the survey. When working alone, I usually call from one spot for several minutes, then drive 0.3 to 0.8 km (0.2 to 0.5 mi) before stopping to call again. When working with another caller I use the "leapfrog" method; one caller proceeds on foot along a road while the other drives ahead about 0.8 km (0.5 mi), parks the vehicle, and proceeds on foot. Both callers walk in the same direction along the road, imitating spotted owl calls. On reaching the vehicle, the caller who was dropped off first drives it past the other caller about 0.8 km, parks, and again proceeds on foot. By continuously repeating this procedure, two people can cover a large area relatively fast.

Regardless of which method is used, some pairs will almost always be overlooked during a single pass through an area. For an accurate estimate of the number and distribution of pairs, therefore, it is usually necessary to survey an area several times. If a survey is repeated two or three times in one summer without revealing any additional pairs, it is usually safe to conclude that all pairs in the survey area have been located. For maximum accuracy, however, surveys should be repeated at least two summers in a row.

If time does not permit a complete survey, several methods can be used to determine the relative abundance of owls in different areas or cover types. One approach is to compare the average number of owls responding per unit length of road transect (Forsman and others 1977, Marcot and Gardetto 1980). Another approach is to compare the average number of owls responding per calling point or per unit time (Marcot and Gardetto 1980). Calling stations for the latter methods should be at least 0.8 km (0.5 mi) apart to reduce the chance of individual owls following the investigator

from one station to the next. If it is obvious that an owl has followed the investigator, that owl should not be counted again.

Calling surveys should be conducted between March and September. In winter, spotted owls become less vocal and are more difficult to locate. When possible, calling surveys should be conducted during fair weather. During stormy or windy weather, owls are usually more difficult to hear, and may become less responsive. The latter possibility has not been tested statistically, but many investigators with whom I have spoken agree that response rates generally decline during stormy weather. Most investigators also agree that response rates generally decline in years when the proportion of nonnesting pairs is high. This factor is difficult to compensate for except by repeating surveys in both good and poor nesting years.

During calling surveys, it frequently becomes necessary to interpret situations in which only one owl responds in a given area. In most cases, the investigator is interested in the number of resident pairs of owls, and the location of only one owl results in ambiguity about the presence of a pair. The only way to resolve this dilemma is to survey the area several times each year for at least 2 years in a row. This allows for the possibility that one member of a pair has died and will soon be replaced. If time is not available to document the existence of a pair, I recommend assuming that a pair is present in areas where single owls respond. In my experience, this assumption is correct most of the time. Marcot and Gardetto (1980) suggested that the types of calls given by spotted owls could be used to distinguish between paired and unpaired individuals and that it could be assumed that an owl was paired if it did not stop calling when spotted owl calls were imitated nearby; these assumptions have not been verified.

Locating Roosts

During the day, spotted owls retire to a secluded roost on a limb in a tree. Ledges in caves are also used as roosts in the Southwestern United States and in Mexico (Ligon 1926). To locate roosts, most investigators imitate spotted owl calls in suspected roost areas during the day until a response is elicited. The investigator then homes in on the owl. When the investigator is unfamiliar with the habits of a particular pair, the usual procedure is to expand the search for roosts outward from the area where owls responded at night. To conduct a thorough search for roosts, the investigator must systematically walk and call each drainage in an area in such a way as to be heard in all potential roost areas; calling from roads is rarely adequate because many roosts are located so far from roads that the owls cannot be detected.

If the objective is to locate as many roosts as possible, the investigator should look for signs of roosting under adjacent trees in each area where owls are found roosting. Indications that a tree has been used for roosting include the presence of white fecal material, regurgitated pellets, or molted feathers under the tree.

Locating Nests

Spotted owls lay eggs between March 1 and April 10; incubation lasts 30 ± 2 days and is performed entirely by the female. The young remain in the nest for about 34 days, leaving the nest in May or early June (Bent 1938, Forsman 1976). Attempts to locate nests, therefore, should be conducted between mid-March and early June.

In the Pacific Northwest, spotted owls nest almost exclusively in cavities or platforms in conifers (Forsman 1976, Forsman and others 1984). Nests in caves, potholes in cliffs, and cavities in hardwood trees have been observed in southern California and in the Southwest (Dickey 1914, Dunn 1901, Ligon 1926, Peyton 1909) but are rare in Oregon and Washington. Cavity nests in Oregon and Washington are most commonly located in living old-growth conifers with broken tops; nests in snags are relatively uncommon. Regardless of whether the tree is alive or dead, cavity nests are usually located inside the hollow top of the broken bole (fig. 1). Less frequently,



cavity nests are located in the midbole region in holes created when large limbs rip loose from the trunk. Old-growth nest trees with broken tops are usually characterized by secondary tops (limbs that grow upward to form one or more new tops after the original top breaks off) (fig. 1).

Platform nests used by spotted owls include stick structures constructed by other animals (hawks and woodrats, for example) and natural accumulations of debris on top of limbs (Bendire 1882, Forsman 1976, Gould 1977, Ligon 1926). Platforms selected for nesting are frequently located in dense clusters of deformed limbs caused by dwarf mistletoe (*Arceuthobium* spp.) infections (Forsman 1976, Ligon 1926). Although Bendire (1882) suggested that a pair of spotted owls constricted their own nest, I believe he was mistaken; I have never seen any evidence that spotted owls build their own nests.

During the nesting period, male spotted owls usually roost near their nests during the day while females incubate and brood the young. The key to locating a nest, therefore, is to first locate the male in his day roost. When the male is located, an effective method of locating the nest is to tether a live mouse on the ground in front of the owl, walk away a short distance, and observe the owl's behavior. If the owl is nesting, it will usually capture the mouse and carry it directly to the nest. Transfer of the mouse to the female may occur at the nest or on a limb near the nest. In contrast to nesting owls, nonnesting males (or females) will usually eat the mouse. A problem with this method of nest location is that nesting males will occasionally eat the mouse instead of taking it to the nest. For this reason, the baiting procedure should be repeated on at least two days before conclusions about nesting status are drawn. The baiting technique is also effective for locating owlets after they leave the nest; adults will usually carry freshly killed prey to their young if the young are roosting nearby.

Figure 1.—A typical spotted owl nest cavity in the broken top of an old-growth Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco). Note the large limbs that have grown upward to form secondary tops after the original top broke off.

Climbing Nest Trees

The mousetether I use for baiting spotted owls consists of a piece of braided stainless steel fishing leader 25 cm (10 inches) long with a small safety pin attached to one end and a stiff piece of clothes hanger wire attached to the other (fig. 2). The clothes hanger wire is pushed into the ground to anchor the tether. The safety pin is inserted through the skin on the nape of the mouse's neck so the owl can easily pull the mouse loose from the tether. While tethering the mouse, the investigator should draw the owl's attention to it by squeaking like a small mammal in distress.

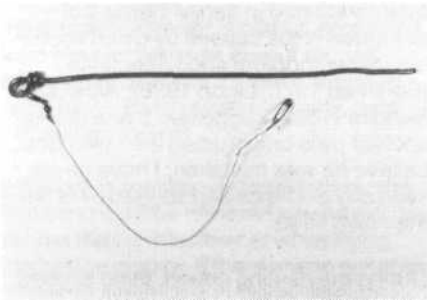


Figure 2.—A mousetether used for feeding live mice to spotted owls.

Another method of locating spotted owl nests is to locate a roosting male during the nesting season and then imitate spotted owl calls in the area where the male is roosting. If the nest is nearby, the stimulus of a suspected intruder will frequently cause the female to call from the nest or to leave the nest to challenge the intruder; in either case the nest will be revealed. One shortcoming of this method is that some females will not leave the nest or call despite persistent vocal stimulation. Another shortcoming of the vocal stimulation method is that it involves considerable harassment of nesting females; this method should, therefore, be used only as a last resort.

A third method of locating nests is to observe the behavior of paired adults during the period of nest selection (March to early April). For 2 to 6 weeks before the eggs are laid, most nesting pairs roost near their traditional nest sites. During the last 2 to 3 weeks before nesting begins, these pairs copulate and display near the nest each evening. Nest locations can be determined during the latter period by locating the owls during the day and then observing their behavior at dusk. Copulation usually occurs at dusk and is followed by a display in which one or both adults fly to a perch near the nest and give the nest call—a series of evenly spaced hooting notes that may continue almost nonstop for several minutes (Forsman 1976). Females often enter the nest during this display.

After the young fledge, nests become difficult to locate; however, owlets cannot fly well for 2 to 3 weeks after leaving the nest and generally remain nearby. The location of recently fledged young is, therefore, a good indication of the general nest location. Even after they become more mobile in July and August, most owlets continue to roost within several hundred meters of the nest during the day; however, occasional exceptions to this pattern of behavior make it unwise to use the location of owlets to infer where the nest is located after the young have been out of the nest more than about 2 weeks.

Because individual spotted owls may not nest every year, it may be necessary to wait a year or more before nests of specific pairs can be located. The only alternative is to infer from the behavior of the owls where the nest is located. Most nonnesting pairs frequently roost near their traditional nest sites during the spring and summer; a concentration of heavily used roosts may, therefore, indicate the general nest location. There are, however, occasional exceptions. For this reason, inferences about nest locations based solely on the roosting behavior of nonnesting pairs should be avoided.

Small nest trees can usually be climbed with conventional tree climbing spurs and a flip rope. An easier way to reach nests in large, old-growth conifers, however, is to rig the tree with a climbing rope, which can then be ascended with Jumars or one of the other ascending devices used by mountain climbers.^{1/} To rig nest trees, I use an archery bow equipped with a fishing spool to shoot a light line over the base of a strong limb near the nest. This line is then used to pull up a strong nylon cord (for example, parachute cord), which is used to pull up the climbing rope. It is sometimes necessary to climb an adjacent understory tree to get an unobstructed shot at a limb near the nest. The knot connecting the nylon cord and climbing rope should be wrapped with tape to keep it from snagging as it passes over the support limb. If nest trees are to be climbed more than once they can be left permanently rigged with a piece of nylon cord. Goggles or a face mask should be worn when nest trees are climbed because spotted owls often aggressively defend their nests.

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Determination of the Diet

The usual method used to determine the diet of spotted owls is to examine the contents of their pellets (a pellet is a regurgitated mass of indigestible prey remains). Prey in pellets are identified and enumerated based on the morphological characteristics and number of skulls, mandibles, leg bones, wings, and so forth, that are present. Prey biomass is estimated by multiplying the number of individuals of each species consumed by the mean weight of the species. Some problems associated with dietary analyses based on pellet contents are: (1) Soft-bodied insects tend to be underestimated because their remains are almost entirely digested; and (2) the remains of large mammals or birds may appear in several pellets, either because the animal was too large to eat in one meal or because several owls (for example, adults and their young) fed on the same animal. One reviewer suggested that enumeration of vertebrate prey in pellets should be based only on the number of skulls present, thereby avoiding the possibility of counting large prey more than once. I disagree with this approach mainly because it may result in an underestimate of large prey in the diet; this inadequacy and other inadequacies with the skull-only approach to pellet analysis have been noted by Marti (1974), Mikkola (1970), and Southern (1954). A less conservative approach is to combine all pellets collected from a given roost area at each visit and to enumerate the prey based on the skeletal parts that generate the highest count for each species in the sample. If several roosts are used by the same owl(s) during the period of pellet collection, pellets from all the roosts should be combined for analysis. In many instances, a group of pellets collected from a roost will contain old, weathered pellets as well as more recent pellets. These different pellet "age" groups can be analyzed separately because there is no danger that the remains of a single prey animal will occur in both old and recent pellets.

Another method of collecting data on the diet of spotted owls is to observe the owls during the day to see if they have prey cached nearby. Spotted owls commonly cache uneaten prey on limbs or on the ground near their roosts (Forsman 1976, Huey 1913). The main drawback to this method is that large prey are often cached and eaten in several meals, whereas small prey such as mice are usually eaten in one meal. As a result, analyses of the diet based on cached prey tend to be biased in favor of large prey.

Trapping Spotted Owls

Spotted owls are relatively easy to capture during the day. A variety of trapping techniques are available and may be used interchangeably, depending on the preference of the investigator.

The most efficient method for trapping spotted owls is a noose pole. Materials needed to construct a noose pole include a very stiff surf casting rod about 3.4 m (11 ft) long, a fly fishing reel, a spool of 18-kg (40-lb) test monofilament fishing line (a gray color is best), a piece of soft copper wire, some scraps of cork or hard rubber, and two split rings about 3 mm (3/16 inch) in diameter. Figure 3 illustrates the construction of the noose pole.

To noose an owl, I use a mouse on a tether to first lure the owl to a perch near the ground. Then, while an assistant continues to distract the owl with the live

mouse, I slip the noose over the owl's head and gently pull the noose tight. When the noose is pulled tight it pulls out of the slits in the cork or rubber noose supports (fig. 3). The owl is then lowered to the ground as quickly as possible and restrained. The two split rings, which are tied about 95 cm (3-3/4 inches) apart on the monofilament line, act as a stop mechanism to keep the noose from choking the owl (fig. 3). The fishing reel is used to keep the monofilament line neatly coiled when it is not in use.

Aside from its efficiency, the greatest advantage of the noose pole method is that spotted owls do not learn to associate the tethered mouse with the noose, and thus do not become trap shy. The noose pole method does not harm the owl in any way, as long as the owl is not left hanging from the noose.

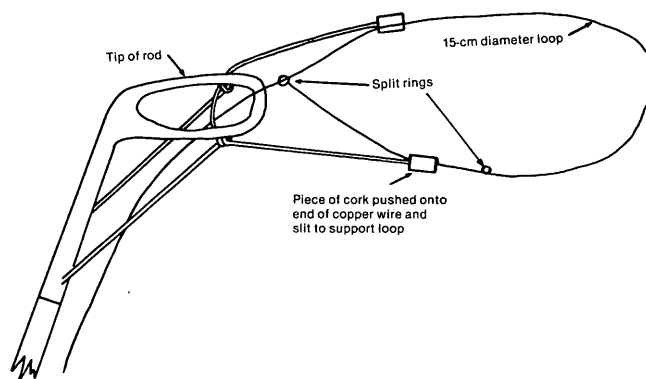


Figure 3.—A noose pole used to capture spotted owls.

Radiotelemetry and Visual Markers

Another method of trapping spotted owls is to lure them into a mist net with a live mouse for bait. A standard four-panel mist net with 10-cm (4-inch) mesh is used; the net should be relatively short (5-6 m; 15-20 ft), as longer nets are difficult to set up in dense forests. If the owl is roosting on a hillside, the net should be set just downhill from the owl and at right angles to the slope. A live mouse is then tethered to the ground about 1 m (3 ft) uphill from the net, between the owl and the net. As soon as the investigator walks away a few paces, the owl will usually fly downhill, grab the mouse, and fly into the net (spotted owls almost always fly downhill after capturing prey on the ground). The net is placed downhill from the owl because even if the owl bounces back out of the net it will often continue to try to escape downhill, and will reenter the net.

If the owl is roosting on level terrain, the mouse should be tethered behind the net so that the owl hits the net while flying toward the mouse. If there are no suitable places to set the net in the immediate roost area, the investigator can frequently lure the owl to a new perch by walking away a short distance and making squeaking sounds from behind a tree. Usually, the owl will fly over to explore the source of the sound and can be trapped in the new location.

Other types of traps used to capture spotted owls include bow nets (Beebe and Webster 1964), bal-chatri traps (Berger and Hamerstrom 1962), and dip nets. One reviewer suggested that bal-chatri traps were just as effective as the mist net method and were easier to use. I have had good success using bow nets to trap spotted owls except that occasional individuals flew in and out of the trap so quickly they avoided capture.

To attach radio transmitters to spotted owls, I use a backpack harness like that described by Dunstan (1972). The harness is made from tubular teflon ribbon that is 6 mm ($\frac{1}{4}$ inch) wide (Bally Ribbon Mills, Bally, PA 19503; see footnote 1). To make the transmitter harness, cut two pieces of teflon ribbon about 35 cm (14 inches) long and attach them to the bottom of the transmitter with a strong layer of acrylic (fig. 4). These two straps are then looped around the owl's body in front of and behind the wing and sewn together over the breast (fig. 5). The loops are held together over the breast by a short strap, which is also used to take up slack in the body loops; the harness should be snug enough to keep the transmitter from flopping around, but not so tight that it constricts breathing or movement. I usually sew the front body loop before going to the field so that it can be slipped over the head of the owl (fig. 4). Then, all that is necessary in the field is to sew the ends of the posterior body loop together and connect the two loops with the breast strap. The circumference of the pre-sewn front loop should be 23 to 24 cm (9.5 inches) for spotted owls.

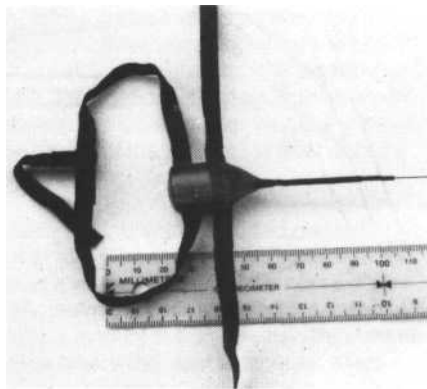


Figure 4.—A radio transmitter ready to install on a spotted owl. The antenna has been reinforced around the base with heat-shrink tubing and the battery and transmitter have been encapsulated in waterproof acrylic. The front loop of the harness has been pre-sewn so that it can be slipped over the head of the owl. The short strap attached to the front loop is used to connect the front and rear loops together. This transmitter package weighed 21 grams.



Figure 5.—Attaching a transmitter to a spotted owl. The piece of nylon material under the harness straps was used to keep feathers out of the way while the loops were sewn together.

Transmitter antennas should be reinforced at the base so they do not become crimped or broken. Dunstan (1972) used a small spring to reinforce antennas; another alternative is to encapsulate the base of the antenna in two or three layers of heat-shrink tubing, as shown in figure 4.

To track radio-tagged owls at night, I use a hand-held yagi antenna and a whip antenna mounted on a vehicle. The whip antenna is used to determine when an owl is within receiving distance; the hand-held antenna is used to triangulate the position of the owl or to home in on the owl. More sophisticated receiving systems such as fixed antennas and null-peak antennas are not particularly effective or practical in the rugged terrain and dense forests occupied by spotted owls.

Before a radiotelemetry study is conducted, it is necessary to obtain a radio frequency clearance from the U.S. Federal Communications Commission, Washington, D.C. In addition, all studies that involve the marking of migratory birds must be approved by the U.S. Department of the Interior Fish and Wildlife Service Bird Banding Office, Patuxent, Maryland, and the State wildlife agency in the State where the research is conducted. The current policy of the Bird Banding Office is that transmitters used on birds should weigh no more than 3 percent of body weight. To be within the 3-percent limit, transmitters used on spotted owls should not exceed 20 g (0.71 oz) for males and 23 g (0.81 oz.) for females. If possible, transmitters should be removed after a study is completed.

Barred Owls and Spotted Owls

As far as I have been able to determine, leg banding is the only method other than radiotelemetry that has been used to mark spotted owls. Leg bands are of limited value as visual markers because they become obscured by the feathers on the leg. Patagial wing markers and feather imping (grafting a distinctively marked feather into the shaft of a primary or rectrix) (Schemnitz 1980) have not been tried on spotted owls, but they should be effective marking techniques.

In recent years, the barred owl (*Strix varia*) has begun to invade the range of the spotted owl (Taylor and Forsman 1976). Because barred owls and spotted owls are similar in appearance and sound somewhat alike, investigators should become familiar with the calls and appearance of both species. In addition to differences in their plumage and calls, spotted and barred owls behave differently when approached by humans during the day; barred owls usually flee when approached closely, whereas spotted owls show little sign of fear.

Sightings of barred owls in Oregon and California should be carefully documented and reported so that investigators will be able to track the range expansion of the species in the future. The effect of the barred owl invasion on spotted owl populations is unknown.

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