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Tools and Technology

Removing Barred Owls from Local Areas: Techniques and Feasibility

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ABSTRACT The barred owl (*Strix varia*) has invaded the range of the northern spotted owl (*S. occidentalis caurina*) over the past century. The Northern Spotted Owl Recovery Plan recommended removal experiments to assess both the effect of barred owls on spotted owls and the feasibility of initiating some form of barred owl control to enhance recovery of the northern spotted owl. Concern has been raised that such experiments will be neither feasible nor cost-effective. To assess these and other concerns, we conducted lethal removal of barred owls within 3 areas totaling 85,205 ha in northern California, USA. We collected 73 of 81 territorial barred owls detected from 2009 to 2012 during 122 field visits. It took an average of 2 hr 23 min to collect each barred owl from the time of arrival at a site to the time a collected bird was completely processed for field data. Most barred owls were collected within one-half hour of arrival at a site. Lethal removal of barred owls was rapid, technically feasible, and cost-effective. We provide recommendations for techniques we found to be effective. © 2013 The Wildlife Society.

KEY WORDS barred owl, California, lethal removal, northern spotted owl, *Strix occidentalis caurina*, *Strix varia*.

Enormous effort over the past 3 decades has been devoted to conserving the northern spotted owl (*Strix occidentalis caurina*; USFWS 1990, 2011; Gutiérrez et al. 1995). The invasion of the barred owl (*S. varia*) into the Pacific Northwest has raised concern about its impact on spotted owls (Gutiérrez et al. 2007). Barred owls are larger and apparently more aggressive than spotted owls, overlap in food and habitat with spotted owls, and hybridize with them, which makes them a potential threat to spotted owls (Gutiérrez et al. 2007, Van Lanen et al. 2011). These concerns, coupled with declining trends in spotted owls concomitant with increasing trends in barred owl populations (Forsman et al. 2011), prompted the U.S. Fish and Wildlife Service to recognize the barred owl as a primary threat to the northern spotted owl, and recommend removal experiments to test the hypothesis that barred owls were causing the observed decline of northern spotted owl and to examine the feasibility of controlling barred owls (USFWS 2012). The recommendation to conduct experiments has been criticized by some as being, among other things, precedent-setting, costly, ineffective, and distracting to scientists (Livezey 2010, Rosenberg et al. 2012). To address cost and feasibility concerns, we removed barred owls on a portion of Green Diamond Resource Company's (hereafter, Green Diamond) long-term northern spotted owl demographic area where barred owls have been increasing and spotted owls have been decreasing in recent years. Thus, our primary objective in this paper was to evaluate the feasibility of removing barred owls. Our secondary objective was to estimate costs of lethal removal within the context of a removal experiment.

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STUDY AREA

We conducted our study within Green Diamond's commercially managed timberlands in Humboldt and Del Norte counties, in coastal northern California, USA. The study area was approximately 150,000 ha of forest composed predominantly of coast redwood (*Sequoia sempervirens*), Douglas-fir (*Pseudotsuga menziesii*), and various hardwood species, including tanoak (*Notholithocarpus densiflorus*), madrone (*Arbutus menziesii*), California bay (*Umbellularia californica*), and red alder (*Alnus rubra*). These forests were primarily second and third-growth forests that were mostly logged on a 50- to 60-year rotation. The primary silviculture was clearcut and single-tree selection harvest within riparian zones and other sensitive areas. Many forest stands contained a substantial component of older, residual trees (Hunter and Bond 2001).

We monitored the northern spotted owl population since 1990 as part of a Habitat Conservation Plan approved by the U.S. Fish and Wildlife Service. Because we were interested in the effect of the barred owl invasion on spotted owls, we divided our study area into 3 treatment areas where

barred owls were removed and 3 paired control areas that had vegetation and management histories similar to the treatment areas where barred owls were not removed. Consequently, our removal areas (3 treatment areas) totaled 85,032 ha and were the only areas considered for evaluation of barred owl removal techniques and feasibility.

METHODS

We initially collected 9 barred owls in 2006 for DNA samples and scientific specimens, but we recorded neither effort nor cost of removal. In 2009, we began recording time effort and removal costs as part of a pilot study to evaluate the feasibility of removing barred owls as a prelude to evaluating the impact of barred owls on spotted owls on private land. We were permitted to collect 20 barred owls during this pilot study. Following an evaluation by the U.S. Fish and Wildlife Service of our removal data from this pilot study, L. V. Diller was authorized to continue lethal removal in 2010 of up to 70 barred owls over a 3-year period, with no more than 30 individuals removed in any given year.

We detected barred owls as a byproduct of standard surveys to locate spotted owls from 1990 to 2009 as part of Green Diamond's demographic study (Forsman et al. 2011). However, because these surveys were designed to detect spotted owls, we likely underestimated the number and location of barred owls (Wiens et al. 2011). Therefore, we began barred owl-specific surveys in 2009. During our barred owl surveys, we first broadcast spotted owl lure calls for 8 min, followed by a broadcast of barred owl lure calls for 10 min if no spotted owls had responded to initial lure broadcasts. We broadcast spotted owl calls first to reduce the potential of interspecific interactions between the 2 species. When we removed barred owls, we conducted barred owl-specific surveys to assess re-colonization at removal sites (adapted from Forsman 1983 and Bierregaard et al. 2008).

If a barred owl was detected during any survey, we returned to the site to locate it. If that location was in a historical spotted owl territory, we first broadcast spotted owl calls. If spotted owls were present, we did not attempt to lure barred owls. If spotted owls did not respond within approximately 400 m of our location, we assumed there were no spotted owls present at the local site. We then broadcast a repertoire of barred owl lure calls, generally starting with male and female 2-phrased ("8-note") hoots and progressed to more agitated ascending ("series") hoots, pair duets, or "cackling calls" (Odom and Mennill 2010).

When we first began our study, we broadcast recordings using a variety of hand-held tape recorders that had either internal or external speakers. However, it appeared that some barred owls associated lure calls broadcast from hand-held recorders with the humans holding them and became wary. Thus, we switched from hand-held devices to a remotely controlled, high-quality device (Wildlife Technologies, Manchester, NH, KAS-2030ML and MA 15) to broadcast barred owl vocalizations. We suspended this device from a tree limb or above ground level (e.g., tree stump, road tailing pile) within an area that had an open understory and unobstructed perch sites for owls.

When preparing to shoot a barred owl, field personnel first positioned themselves 20–30 m (the preferred shooting range) from the calling device to avoid the potential for owls to associate the lure calls with humans. Personnel used visual and (in most cases) auditory cues to make positive identification of the species when an owl came to the lure. Once a positive identification of a barred owl was made while it perched on a branch, we collected the individual(s) using either a 20- or 12-gauge shotgun having a full choke bore. To insure a quick and humane death while retaining a good specimen for scientific purposes, we used low-brass (low-velocity) number 8 shot-shells for birds within 20 m and high-brass (high-velocity) number 6 shot-shells for birds 20–30 m distant. During later collections, we used a specially designed, 12-gauge "quiet gun" (http://www.dillerdesign.com/quietgun/). This gun was designed to reduce the sound volume when concern for human disturbance was important.

Initially, we used a headlamp and open sights to shoot birds, but this proved challenging. We later equipped the shotgun with an illuminated "aimpoint" (Burris SpeedBead; Burris Company, Greeley, CO) and flashlight to ensure accurate shots at night. A trained bird dog accompanied collectors to ensure that we located barred owls that fell into dense vegetation at night. We made museum study skins of all birds and accessioned them at the California Academy of Sciences collections. We also collected stomach contents, tissue samples, and blood samples from most specimens to support a variety of studies.

We only removed territorial barred owls, because our long-term goal was to assess impacts of territorial barred owls on spotted owls (Wiens 2012) and our permits authorized a limited number of collections. We identified a territorial owl by its behavior, which included aggressive hooting, flying to the source of the lure call, stooping on the calling device, and "limb crashing" (landing with force on a limb such that it made a loud sound). We removed any territorial barred owl encountered, regardless of whether the individuals were near or in a historical spotted owl territory. As conditions of our permits, we did not collect any barred owl that was either brooding or raising young.

The cumulative time of all visits to a site to collect individuals was calculated to depict effort. We recorded the total removal time as beginning with arrival by vehicle at a location at or near the owl site and ending when leaving the location. Activities at the site potentially included the following: walk to the actual collection site, set up the equipment and initiate calling, kill and recover the barred owl(s), do initial field processing (e.g., collect oral, cloacal and blood samples, and record basic field data), and broadcasting additional lure calls after owls were processed to determine whether other territorial barred owls were in the area. Thus, we considered the time from arriving at a site until leaving that site as a "visit." We also recorded the time from arrival at the site to a shot being taken, which eliminated the discretionary and variable time associated with field-processing the specimen and doing additional calling (see Discussion Section for estimated costs). We did not record the time needed to conduct general spotted owl

surveys for Green Diamond's spotted owl demographic study. We collected the first barred owl that arrived in response to the lure calls and that also presented a safe opportunity for collection (this was almost always the same individual). We assessed the distribution of "time to shot" for both males and females for normality. To test whether females responded more quickly than males to lure calls, we used a 2-sample test on the time to a shot for males and females. We used D'Agostino's K^2 test to evaluate normality of distributions by responding males and females (NCSS 2004, LLC, Kaysville, UT). We used a natural log transformation to correct for non-normality in shot time (see Fig. 1).

RESULTS

One person (L.V. Diller) made 122 field visits to collect 73 of 81 barred owl detected from 2009 to 2012 (Table 1). It took 173.8 hr to collect and field process the 73 barred owls for scientific specimens ($\bar{x} = 2.38$ hr [142.9 min], $\pm$8.040 SE, range = 5–295 min/barred owl collected). Of 8 owls we failed to collect after initial detection, we never detected any of them again during 16 repeat visits averaging 3 hr 7 min. Most owls (79.5%) were collected at dusk or after dark, but daytime collection at known owl sites was also effective and efficient.

We often heard spotted owls hooting (primarily 4-note hoots by males or agitated contact calls by females) when luring barred owls, but they never approached closer than several hundred meters so there was no concern about misidentifying them as a barred owl. Thus, no mistakes of species identity were made when collecting birds.

Thirty of thirty four females (88.2%) were collected on the first visit with 4 requiring a second visit to collect. In contrast, 28 of 37 males (75.7%) were collected on the first visit with 5, 3, and 1 male requiring 2, 3, and 4 additional visits, respectively. The mean time from arrival to making the shot (killing the owl) was 52.1 (SE = 7.47) min for females, which was significantly less ($T = -1.9613$, $P = 0.027$) than the mean of 80.5 (SE = 10.99) min for males. The time taken to collect an owl upon arrival at a site was positively skewed for both females and males (D'Agostino's K^2 test: $F = 3.761$, $P < 0.001$; $M = 3.173$, $P = 0.002$); that is, the majority of females and males were collected within 30 and 90 min of arrival, respectively (Fig. 1).

During the first year of the study, the majority of the owls collected were residents (birds present at a site for $\geq$1 breeding season prior to removal). In subsequent years most birds were colonizers (apparent new barred owls occupying a site following removal of birds from a site; Table 2).

DISCUSSION

The barred owl has invaded the range of the spotted owl, and multiple lines of evidence suggest that they present a serious threat to the conservation of the spotted owl (Gutiérrez et al. 2007, Forsman et al. 2011, Wiens 2012, Yackulic et al. 2012). Thus, removal experiments have been recommended in the northern spotted owl recovery plan (USFWS 2011, 2012) because they provide a causal test of the relationship between declining trends in northern spotted owl populations and increasing trends of barred owls. Despite scientific support for such experiments (Romesburg 1981), they are controversial based on assertions that removal experiments would be costly, difficult to accomplish, and would require continuous maintenance to address re-colonization of removal sites by barred owls (Livezey 2010, Rosenberg et al. 2012). These are reasonable concerns because efficacy of any potential removal experiment, and ultimately, a barred owl management strategy, must be feasible and not result in the death of unintended species (Caughley and Gunn 1996). Therefore, we provide an evaluation of the feasibility and cost of removing barred owls from large land areas that were part of a long-term spotted owl study. Our evaluation shows that removing barred owls can be both efficient and cost-effective, from which we conclude that removal experiments should not be technically challenging, but costs will vary depending on the context of the removal experiment (see below). Removal experiments will require maintenance control as previously suggested and as we show in Table 2, but the cost of

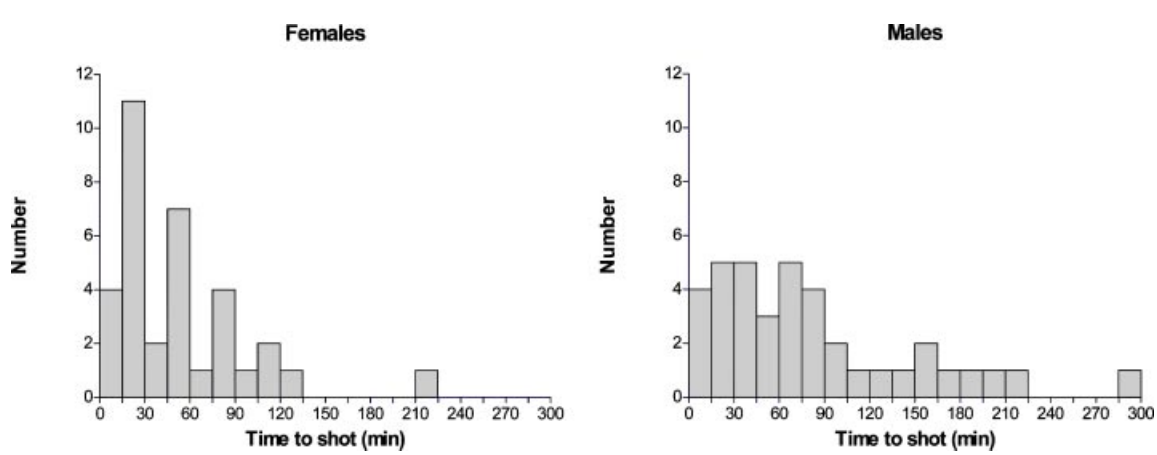

Figure 1. Distribution of "shot times" (cumulative time between arrival at the site and collection of the barred owl) for female and male barred owls collected on the Green Diamond Resource Company study area, California, USA, 2009–2012.

Table 1. Time or effort associated with collecting barred owls (BO) from treatment areas on Green Diamond Resource Company's ownership in coastal northern California, USA, 2009–2012.

Year	Visits[a]	Mean time/visit (min)	BO collected	Mean time/BO removed (min)
2009	33	77.2	20	127.4
2010	26	85.7	13	171.5
2011	23	104.5	18	133.5
2012	40	81.2	22	147.7
Total	122	85.5	73	142.9

[a] Visits are the total number of visits to a site; a visit includes only time at a site to remove and process owls.

maintenance removal should be less than the cost of original removal.

Removal Techniques

Barred owls often were wary when calling devices were hand-held. It appeared the owls associated the calling device with the person holding the device. When we used the remotely controlled calling device, we detected no such effect. They also became wary if they flew in to investigate lure calls but were not removed on the first visit.

During the first year of the study, one bird was shot at and cleanly missed twice when using open sights and a headlamp, but later collected. However, using an illuminated sight and flashlight attached to the barrel removed uncertainty of identification, provided a distinct aim-point and resulted in all remaining owls being collected with one shot. Collecting at dusk or night was more efficient because birds were generally more aggressive and likely to fly closer to challenge a simulated intruder (lure call) than during daytime. When barred owls investigated a lure call during the day, they often flew in without hooting and appeared to be much more wary about moving into the open where they could be more easily collected.

When we collected one member of a pair, its mate often flew away, but frequently returned after only a short time (10–15 min). We also found that owls flew higher into the canopy after they had investigated the source of the lure call. Thus, it was more difficult and time-consuming to lure them within gun range. Males tended to reduce calling or aggression if their mate was collected, but the reverse was not true.

Although we used a mid-sized gauge shotgun and mid-sized pellets in shot-shells, 100% of the owls were killed on the first shot once we adopted the illuminated gun-sight. The 12-gauge "quiet gun" proved superior to the 20-gauge with respect to collecting both members of a pair in quick succession because the owls did not react to the report of the gun despite being very close. In addition, the quiet gun minimized disturbance to human residents on property that was adjacent to our study area.

Feasibility of Barred Owl Removal

Barred owl removal was relatively quick, effective, and low-cost. Birds that were aggressive and strongly territorial were qualitatively easier to detect and remove than birds that appeared to be recolonizing a site because the latter were not as aggressive in territorial defense. Of the 73 barred owls collected, 46 (63.0%) responded as pairs, and in only one case did we fail to collect both members of a pair. This exception involved a pair of barred owls that had recently colonized a historical spotted owl site. After collecting the male, the female that had showed little evidence of territorial behavior prior to her mate being collected, flew off and was never seen at the site again.

At the beginning of our study and early within a nesting season, the birds we encountered were resident territorial birds that were highly vulnerable to removal because of their aggressive territorial behavior. Later in the study and late within the nesting season, we had to spend additional time surveying for potential colonizing barred owls because they tended not to be as aggressive in territorial defense. These less aggressive "colonizing" owls increased the time it took to search and collect because we visited sites a minimum of 3 additional times to ensure that no owls had recolonized the site. Many of these "follow up" surveys were combined with required general spotted owl surveys, so the additional effort was partially mitigated.

Table 2. Number of resident (R) and colonizer (C) barred owls collected from treatment areas on Green Diamond Resource Company's ownership in coastal northern California, USA, 2009–2012.

	Year								Totals		
	2009		2010		2011		2012				
Region	R	C	R	C	R	C	R	C	R	C	Row totals
Klamath	4	n/a[a]	0	2	0	5	0	5	4	12	16
Little River/Maple Cr	n/a[b]	n/a[b]	0	0	2	0	0	3	2	3	5
Korbel/Mad River	11	5	0	8	0	11	0	11	11	35	47
Salmon Creek	n/a[b]	n/a[b]	3	0	0	1	0	2	3	3	6
Resident totals	15		3		2		0		20		20
Colonizer totals		5		10		17		21		53	53

[a] n/a = not applicable because the resident owls were collected late in the season and there was no time for colonizers to settle on territory.
[b] n/a = not applicable because we did not collect barred owls in this area in 2009.

The cost of a removal experiment will depend on the context of the removal. If removal experiments are conducted on existing spotted owl demographic study areas with good road access such as ours, then the incremental cost of removal will be minimal. For example, we estimated our direct costs ranged between US$100 and $150/barred owl removed in all years. Furthermore, with good road access and private lands with gated access, we considered it safe for one person to conduct the removal visits. Livezey (2010) projected the costs of barred owl removal based on a series of assumptions of both direct and indirect costs of removal and then divided that cost by an assumed number of barred owls that would be removed. Thus, our estimated direct costs, just for removal, were not comparable to his estimated costs. Nevertheless, based on the effort to remove 73 owls (90% of detected resident barred owls in the area), the primary cost of doing a removal experiment will likely not be dependent on the actual cost of removing barred owls, but more likely on the costs associated with detection surveys of owls and other factors associated with conducting a field experiment.

Following removal of barred owl(s) from a site, we did not include as part of the barred owl removal costs the time required to conduct general surveys to determine whether or when the site was re-occupied by either spotted owls or territorial barred owls after the removal occurred. Thus, if removal experiments were conducted independently of existing northern spotted owl demography studies, then the costs would be higher as noted above. For comparison, we estimated that doing all the spotted and barred owl surveys, site visits, and other supporting activities for the Green Diamond northern spotted owl demography study averaged approximately 10,000 total person/hr/year on an approximate 162,000-ha study area. In addition to our collection and field processing time, we estimated that the average round-trip driving time to our removal sites was approximately 2 hr, which increased the total removal effort over the 4-year study to approximately 321 hr or 4.4 hr/barred owl collected. Thus, our removal costs were approximately <1% (321 hr/40,000 hr) of the total survey costs of the entire study. If the response variable in an experiment was restricted to site occupancy (no estimates of survival or fecundity), then costs would likely be substantially lower.

Thus, although estimating costs are elusive without context, our preliminary results demonstrate that the effort and cost associated with removal of barred owls is quite low. We believe our estimates of removal time to be conservative because it included a "learning curve" for developing techniques and the time necessary to process many of the collected specimens for other purposes.

Reoccupation of Sites Where Barred Owls Were Removed

Although our intent in this paper was to assess the efficacy of barred owl removal, we observed that barred owls tended to reoccupy sites from which other barred owls were removed. The tendency for new recruits to select the same sites made collecting newly established barred owls much more efficient. Thus, it was only necessary for us to monitor regularly a small portion of the total removal area to remove virtually all the new recruits that attempted to recolonize these sites. Reoccupation of sites by barred owls will likely vary based on proximity to and size of a source population and the presence of non-territorial owls, variation in annual reproductive success, availability of habitat, and size of the area from which barred owls have been removed. Each of these factors will differ depending on the circumstances associated with any proposed long-term removal strategy.

Although removing these colonizers only added a minor increment cost to our removal experiment, it suggests that any experiment or maintenance control program should consider continued removal costs associated with re-colonization. Such costs will vary based on the reasons stated above and the nature of the removal area (e.g., high-road-density vs. low-road-density areas). However, costs will likely be less than for the initial removal effort simply because the number of barred owls should decline with continued induced high adult mortality, which will reduce the number of potential recruits produced.

MANAGEMENT IMPLICATIONS

Before effecting control of one species to benefit another, it is essential to determine that the alleged species is actually responsible for the negative impacts, and whether the removal is technically feasible, cost-effective, and likely to result in the desired effect (Caughley and Gunn 1996). We found that barred owl removal was both technically feasible and cost-effective. Thus, we suggest that conducting removal experiments on existing spotted owl demographic study areas would be most cost-effective because demographic histories and locations of most spotted owls are known (Forsman et al. 2011). Removal experiments should provide the basis for determining whether removal of barred owls would result in the desired effect of a positive demographic response by spotted owls. We also recommend that personnel engaged in removal experiments be properly trained in owl species identification and firearms safety. Although we considered it safe for one person to do the removal visits on our study area, other study areas may warrant 2 people conducting field visits. We recommend using a remotely controlled device to broadcast barred owl lure calls and that this device be physically separated from removal personnel. For safety, efficiency, and humane removal of barred owls as part of a removal experiment, we recommend using a shotgun (no rifles) equipped with an illuminated gun-sight. We recommend non-toxic shot to lead shot, but not steel because it has a lower density than alternative nontoxic shot types. Finally, where the potential for negative interactions with the public exist, we recommend using a "silent shotgun."

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LITERATURE CITED

Bierregaard, R. O. Jr., E. S. Harrold, and M. A. McMillan. 2008. Behavioral conditioning and techniques for trapping barred owls (*Strix varia*). Journal of Raptor Research 43:210–214.

Caughley, G., and A. Gunn. 1996. Conservation biology in theory and practice. Blackwell Science, Cambridge, Massachusetts, USA.

Forsman, E. D. 1983. Methods and materials for locating and studying spotted owls. U.S. Department of Agriculture Forest Service General Technical Report PNW-162. Pacific Northwest Forest and Experiment Stations, Portland, Oregon, USA.

Forsman, E. D., R. G. Anthony, K. M. Dugger, E. M. Glenn, A. B. Franklin, G. C. White, C. J. Schwarz, K. P. Burnham, D. R. Anderson, J. D. Nichols, J. E. Hines, J. B. Lint, R. J. Davis, S. H. Ackers, L. S. Andrews, B. L. Biswell, P. C. Carlson, L. V. Diller, S. A. Gremel, D. R. Herter, J. M. Higley, R. B. Horn, J. A. Reid, J. Rockweit, J. Schaberl, T. J. Snetsinger, and S. G. Sovern. 2011. Population demography of northern spotted owls: 1985–2008. Studies in Avian Biology 40:1–118.

Gutiérrez, R. J., M. Cody, S. Courtney, and A. B. Franklin. 2007. The invasion of barred owls and its potential effect on the spotted owl: a conservation conundrum. Biological Invasions 9:181–196.

Gutiérrez, R. J., A. B. Franklin, and W. S. LaHaye. 1995. Spotted owl (*Strix occidentalis*). Account. 179 *in* A. Poole, and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, Pennsylvania, and The American Ornithologists' Union, Washington, D.C., USA.

Hunter, J. E., and M. L. Bond. 2001. Residual trees: wildlife associations and recommendations. Wildlife Society Bulletin 29:995–999.

Livezey, K. B. 2010. Killing barred owls to help spotted owls I: a global perspective. Northwestern Naturalist 91:107–133.

Odom, K. J., and D. J. Mennill. 2010. A quantitative description of the vocalizations and vocal activity of the barred owl. Condor 112:549–560.

Romesburg, H. C. 1981. Wildlife science: gaining reliable knowledge. Journal of Wildlife Management 45:293–313.

Rosenberg, K. K., D. G. Vesely, and J. A. Gervais. 2012. Maximizing endangered species research. Science 337:799.

U.S. Fish and Wildlife Service [USFWS]. 1990. The 1990 status review: northern spotted owl: *Strix occidentalis caurina*. U.S. Fish and Wildlife Service, Portland, Oregon, USA.

U.S. Fish and Wildlife Service [USFWS]. 2011. Revised recovery plan for the northern spotted owl (*Strix occidentalis caurina*). U.S. Fish and Wildlife Service, Portland, Oregon, USA.

U.S. Fish and Wildlife Service [USFWS]. 2012. Experimental removal of barred owls to benefit threatened northern spotted owls: daft EIS. U.S. Fish and Wildlife Service, Portland, Oregon, USA.

Van Lanen, N. J., A. B. Franklin, K. P. Huyvaert, R. F. Reiser, and P. C. Carlson. 2011. Who hits and hoots at whom? Potential for interference competition between barred and northern spotted owls. Biological Conservation 144:2194–2201.

Wiens, J. D. 2012. Competitive interactions and resource partitioning between northern spotted owls and barred owls in western Oregon. Dissertation, Oregon State University Corvallis, USA.

Wiens, J. D., R. G. Anthony, and E. D. Forsman. 2011. Barred owl occupancy surveys within the range of the northern spotted owl. Journal of Wildlife Management 75:531–538.

Yackulic, C. B., J. Reid, R. Davis, J. E. Hines, J. D. Nichols, and E. Forsman. 2012. Neighborhood and habitat effects on vital rates: expansion of the barred owl in the Oregon Coast Ranges. Ecology 93:1953–1966.

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