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REPRODUCTIVE SUCCESS OF SPOTTED OWLS SYMPATRIC WITH BARRED OWLS IN WESTERN WASHINGTON

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KEY WORDS: *Northern Spotted Owl*; Strix occidentalis caurina; *northern Barred Owl*; Strix varia varia; *competition*; *Washington*.

Northern Barred Owls (*Strix varia varia*) and northern Spotted Owls (*Strix occidentalis caurina*) in western Washington use similar forested habitats (Herter and Hicks 2000) and demonstrate some niche overlap in their predation upon small mammals (Hamer et al. 2001). Both owls also use similar tree cavities for nesting (Hamer 1988). Because Barred Owls are larger (Dunning 1992) and exhibit more pronounced territorial behavior (Hamer et al. 2001), many biologists have expressed concern that Barred Owls may pose a significant obstacle to the successful recovery of the threatened northern Spotted Owl. Kelly et al. (2003) found that Spotted Owl site occupancy was negatively affected by close proximity to Barred Owls in forests on the eastern slope of the Washington Cascades and on the Olympic Peninsula. Recently, Pearson and Livezey (2003) observed that the loss of mature forest habitat may reduce the survivability of Spotted Owls in the presence of Barred Owls. My study examined potential effects of Barred Owls on Spotted Owl reproductive success on the western slope of the Washington Cascades.

STUDY AREA AND METHODS

Located on the western slope of the Washington Cascades (ca. 47°–49°N, 121°–122°W), the Mount Baker-Snoqualmie National Forest (MBSNF) is ideally suited to evaluate effects of interactions between Spotted and Barred owls. The two species have co-occurred in this area for over 20 yr (Taylor and Forsman 1976). Spotted Owls in the MBSNF are near the northern limit of their range and are less productive than owls in warmer or drier parts of their range (Iverson 1996). Therefore, Spotted Owls in the MBSNF might be expected to be more vulnerable to potential exclusion by more aggressive Barred Owls.

Reproductive success is an important component of individual fitness. For the purposes of this study, I defined reproductive success as the production of young in one or more survey years. If competition (or predation) by Barred Owls were a significant threat to Spotted Owls, one would expect to see reduced reproductive success of Spotted Owl activity centers that are coincident with Barred Owls. Spotted Owl activity centers in this study were determined by a hierarchical system, with a nest site being the most reliable definition, followed by owls with young, consistent daytime location, and consistent nighttime location (U.S. Forest Service 1988). Using the mean annual home range estimate for Spotted Owls (3-km radius circle) and Barred Owls (1.5-km radius circle) in this area (Hamer 1988), it is very likely that Barred Owls found consistently within 2.5 km of Spotted Owl activity centers have home ranges that overlap those of Spotted

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Table 1. Spotted Owl activity-center occupancy, composition of older forest, and presence of Barred Owls: the presence of Barred Owls in Western Washington. BO++ = Barred Owl within 0.8 km, BO+ = Barred Owl within 2.5 km, BO− = Barred Owl not within 2.5 km. Site occupancy codes: S = single owl, PR = pair confirmed, PN = nesting pair, PF = pair with fledglings (number of owlets), 0 = unoccupied.

Spotted Owl Sites	Barred Owls	Status 1990	1991	1992	Elevation (m)	Older Forest (%)
121	BO+	PF (1)	PF (1)	PN	837	46.0
122	BO+	S	S	O	713	63.3
171	BO+	S	S	S	543	53.0
173	BO++	O	PF (1)	PN	744	53.8
192	BO+	S	S	S	992	—
202	BO++	O	O	O	744	50.4
217	BO+	PF (1)	O	PF (1)	1116	56.8
231	BO−	PR	PR	S	1054	40.3
267	BO+	S	PR	PF (1)	651	32.3
268	BO−	S	PR	S	868	20.7
269	BO−	S	S	S	868	41.5
514	BO++	S	PF (2)	PN	930	—
526	BO++	S	PR	PF (1)	930	—
631	BO−	PF (1)	S	PN	434	68.2
638	BO−	S	PR	PR	521	25.0
710	BO+	S	S	S	775	51.1
719	BO−	PN	PF (1)	PF (2)	992	24.8
727	BO+	S	S	PF (2)	977	36.2
731	BO+	S	S	PF (2)	806	34.9

Owls (T. Hamer pers. comm.). Based on this assumption, I compared reproductive success of Spotted Owl pairs with and without Barred Owls.

I surveyed 19 Spotted Owl activity centers in the MBSNF according to standard protocol (U.S. Forest Service 1988) for three consecutive years (1990–92). Surveys were conducted during the breeding season (15 March–31 August) using a vocal imitation or tape recording of Spotted Owl calls. Spotted Owl activity centers were surveyed at least three times in each year to determine status (unoccupied, single owl, or owl pair with or without fledglings). Barred Owls respond to Spotted Owl calls and were inventoried simultaneously (Dunbar et al. 1991). I did not make an effort to determine Barred Owl activity-center status, however.

The activity center was considered to be the center of a Spotted Owl home range. I used the MBSNF geographic information system to estimate the percent cover of older forest (trees >53 cm Diameter Breast Height) available to owls at each site within a 3-km radius of the activity center. The 3-km radius gives a good approximation of habitat available in Spotted Owl annual home ranges (Lehmkuhl and Raphael 1993). There was no timber harvesting (or other management activity) within 3 km of the activity centers during the years in which I surveyed them.

I used a contingency analysis and *G*-test (Zar 1984) to evaluate the effect of Barred Owl presence or absence on Spotted Owl reproductive success. Mann-Whitney *U*-tests (Zar 1984) were used to evaluate differences between means. All means are expressed ±SE. Alpha levels of all statistical tests were set at 0.05.

Results and Discussion

Of the 19 Spotted Owl activity centers in this study, 13 had Barred Owls within 2.5 km (BO+) and six did not (BO−). Of the 13 BO+ activity centers, 8 (62%) fledged young successfully in at least one of the 3 yr, while only two (33%) of BO− activity centers were successful (Table 1). Spotted Owl reproductive success was independent of Barred Owl presence or absence (Contingency analysis, $G = 1.326$, $P = 0.25$).

The amount of older forest available to Spotted Owls varied substantially across all sites (range = 20.7–68.2%). The mean amount of older forest available at BO+ sites was 47.8 ± 3.2% and 36.8 ± 7.2% at BO− sites. There was no significant difference in amount of available older forest habitat between BO+ and BO− sites (Mann-Whitney test, $U_{0.05(2),6,10} = 49$, $U = 16$, $U' = 44$). Sixteen of the 19 activity centers were in the Pacific silver fir (*Abies amabilis*) elevation zone (Franklin and Dyrness 1973), while only three were in the lower elevation western hemlock (*Tsuga heterophylla*) zone. BO+ activity centers were at a mean elevation of 828 ± 43.6 m. The mean elevation of BO− activity centers (790 ± 103.6 m) was not significantly different (Mann-Whitney test, $U_{0.05(2),6,13} = 62$, $U = 39.5$, $U' = 38.5$).

Kelly et al. (2003) found a significant effect on Spotted Owl site occupancy when Barred Owls were within 0.8 km, but they did not report on the reproductive success of Spotted Owls. My *post-hoc* analysis of MBSNF Spotted Owl activity centers that had Barred Owls within 0.8 km (Table 1) revealed that three of the four sites were reproductively successful, averaging 1.3 ± 0.3 fledglings per site during the study period. Five of the remaining 9 BO+ activity centers were reproductively successful, averaging 1.8 ± 0.2 young per site. The two reproductive BO− sites averaged 2.0 ± 1.0 fledglings. There could be some effect of Barred Owls indicated by the inverse relationship between Barred Owl proximity and mean fledglings produced per site. But there were also an equal number of total owlets fledged comparing BO++ (Barred Owls within 0.8 km) and BO− sites.

Habitat qualities (other than amount of older forest) may account for some of the differences between my study and others. For example, Spotted Owl activity centers in Olympic National Park (S. Gremel pers. comm.) are more productive in the Pacific silver fir zone than activity centers in lower elevation forests. Similarly, most of the productive MBSNF Spotted Owl activity centers were found in the Pacific silver fir zone.

Niche differences may also help explain the success of Spotted Owls (BO+) in the MBSNF compared to other areas. The diet of Spotted Owls on the western slope of the Washington Cascades includes fewer flying squirrels (*Glaucomys sabrinus*) and more deer mice (*Peromyscus maniculatus*) and pikas (*Ochotona princeps*) than the diets of Spotted Owls in the Olympics and the eastern slope of the Washington Cascades (Forsman et al. 2001). Mean prey mass is also smaller for MBSNF owls than owls in the other two locations (Forsman et al. 2001).

Hamer et al. (2001) noted significant differences in foraging by Barred Owls and Spotted Owls in the MBSNF, with Barred Owls taking more diurnal animals and prey associated with wetter habitats. Spotted Owls also consume more arboreal and semi-arboreal mammals than Barred Owls (Forsman et al. 2001, Hamer et al. 2001), which may be related to the larger foot spread of Spotted Owls (Hamer 1988).

According to Mayr and Short (1970), Barred and Spotted owls diverged as separate species relatively recently. The exact origin of the two species is not known, but the modern range expansion of Barred Owls into the Pacific Northwest is not the first time these species have been sympatric. The historical ranges of Barred Owls and Spotted Owls overlap in Mexico's Sierra Madre Occidental (Johnsgard 2002), where they occupy the same forest types and elevation zones (Enríquez-Rocha et al. 1993). There are apparently significant enough niche and habitat differences to allow Barred Owls and Spotted Owls to coexist in at least some areas.

RESUMEN.—Diecinueve centros de actividad del Búho moteado en el Bosque Nacional Monte Baker-Snoqualmie fueron estudiados por tres años consecutivos (1990–92). La presencia de los Búhos barreteados fue determinada simultáneamente debido a que los búhos barreteados responden a los llamados del búho moteado usados durante los estudios. Trece de los centros de actividad de los búhos moteados tenían búhos barreteados dentro de 2.5 km y seis no. Sesenta y dos por ciento de los centros de actividad del búho moteado con búhos barreteados produjeron volantones en al menos uno de los tres años, pero únicamente 33% de los centros de actividad sin búhos barreteados tuvieron éxito reproductivo.

[Traducción de César Márquez]

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HISTORICAL AND CURRENT STATUS OF BREEDING AND WINTERING WESTERN BURROWING OWLS (*ATHENE CUNICULARIA HYPUGAEA*) IN TEXAS

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KEY WORDS: *Western Burrowing Owl*; Athene cunicularia hypugaea; *abundance*; *Breeding Bird Atlas*; *Breeding Bird Survey*; *Christmas Bird Count*; *population trend*; *Texas.*

The western Burrowing Owl (*Athene cunicularia hypugaea*) is one of 18 New World Burrowing Owl subspecies, and one of only two in North America. Designated Endangered in Canada and Threatened in Mexico, the Burrowing Owl is a U.S. Fish and Wildlife Service (USFWS 2001) Bird of Conservation Concern in Regions 1 (Pacific), 2 (Southwest), and 6 (Mountain-Prairie). It is state-listed as Threatened in Colorado, Endangered in Iowa and Minnesota, and has been additionally listed in 16 other U.S. states (Arizona, California, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming) as a species of special concern (James and Espie 1997, Sheffield 1997, USFWS 2001). Population declines and range contractions have been noted at various locations throughout North America, prompting calls for more information about the species' historic and current population status that may be used to guide conservation efforts (Holroyd et al. 2001). Such assessments have been done for owl populations in several U.S. states (e.g., Brown 2001, Korfanta et al. 2001, Martell et al. 2001, Murphy et al. 2001), Canada (Kirk and Hyslop 1998, Shyry et al. 2001), Mexico (Enriquez-Rocha et al. 1993), and North America as a whole (James and Ethier 1989), and they have documented declines in both breeding and wintering owl numbers.

One state that has not had an assessment of its Burrowing Owl population, however, is Texas. Importantly, Texas consistently accounts for a substantial portion of the overall North American owl population in the Breeding Bird Survey, Christmas Bird Counts, and in a recent wildlife agency survey (James and Espie 1997). Indeed, the highest reported relative abundances of overwintering owls come from Texas (USGS 2003), and Texas also supports a sizeable population during the breeding season (James and Espie 1997).

This oversight in the knowledge base was recently recognized, and an explicit call for research on the abundance of western Burrowing Owls in Texas was made (Wellicome and Holroyd 2001). In-depth studies on the coastal population are underway involving the USFWS, Canadian Wildlife Service, and Texas Parks & Wildlife (http://www.cerc.usgs.gov/frs_webs/gulf_coast/owls.htm). Given that declines in owl populations in the adjacent states of New Mexico and Oklahoma have been documented (Arrowood et al. 2001, Sheffield and Howery 2001) and that the owl has reportedly suffered from

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