

## RECENT RECORDS OF HYBRIDIZATION BETWEEN BARRED OWLS (*STRIX VARIA*) AND NORTHERN SPOTTED OWLS (*S. OCCIDENTALIS CAURINA*)

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**ABSTRACT.**—We summarized records of hybridization between Barred Owls (*Strix varia*) and Northern Spotted Owls (*S. occidentalis caurina*) in Washington and Oregon through 1999. A total of 47 hybrids were observed, including 17 F1s that were first detected as adults, 4 F1s that were banded as juveniles and subsequently recaptured as adults, 10 F1 juveniles, and 16 F2 juveniles. All confirmed cases of hybridization between Barred and Spotted owls involved male Spotted Owls paired with female Barred Owls. Ten F1 hybrids that backcrossed with Barred Owls produced a total of 15 young; 6 F1 hybrids that backcrossed with Spotted Owls produced only 1 young. Those differences may indicate that some combinations of sex and species are more compatible or more fertile than others, but more documentation is needed. Because F2 hybrids and subsequent generations are difficult to distinguish in the field from Barred or Spotted owls, genetic comparisons of blood or tissue samples may be needed to identify hybrids beyond the first generation. The small number of F1 hybrids detected during many years of extensive banding studies of Spotted Owls suggests that the isolating mechanisms that separate Barred and Spotted owls are normally sufficient to avoid hybridization between them. Direct competition between the two species for food and space is probably a much more serious threat to the Spotted Owl than hybridization. Received 14 July 2003, accepted 28 March 2004.

**RESUMEN.**—Resumimos los datos de hibridación entre *Strix varia* y *S. occidentalis caurina* en los estados de Washington y Oregon hasta 1999. Se observaron un total de 47 híbridos, incluyendo 17 F1 que se detectaron siendo ya adultos, 4 F1 que fueron anillados de jóvenes y recapturados posteriormente como adultos, y 10 F1 juveniles y 16 F2 juveniles. Todos los casos de hibridación confirmados entre *S. varia* y *S. occidentalis caurina* implicaban *S. occidentalis* machos emparejados con *S. varia* hembras. Diez híbridos F1 que retrocruzaron con *S. varia* produjeron un total de 15 crías; seis híbridos F1 que retrocruzaron con *S. occidentalis* sólo produjeron una cría. Estas diferencias pueden indicar que algunas combinaciones de sexo y especie son más compatibles o más fértiles que otras, pero se necesita más documentación. Puesto que los híbridos F2 y sus generaciones posteriores son difíciles de distinguir de *S. varia* y *S. occidentalis* en el campo, comparaciones genéticas de muestras de sangre o tejido pueden ser necesarias para identificar los híbridos más allá de la primera generación. El reducido número de híbridos F1 detectados durante muchos años de estudios extensivos de anillaje de *S. occidentalis* sugiere que los mecanismos de aislamiento que separan *S. varia* y *occidentalis* normalmente resultan ser suficientes para evitar la hibridación entre ellos. La competencia directa entre las dos especies por alimentación y hábitat es, probablemente, una amenaza mucho más seria para *S. occidentalis* que la hibridación.

HYBRIDIZATION BETWEEN Barred Owls (*Strix varia*) and Northern Spotted Owls (*S. occidentalis caurina*) is a recent phenomenon associated with westward expansion of the Barred Owl's range (Hamer et al. 1994). Historically, Barred Owls

occurred only in eastern North America (Bent 1938, Houston and McGowan 1999); in the early 1900s, they began to expand their range westward across Canada, and then moved southward into the Pacific Northwest (Grant 1966, Reichard 1974, Shea 1974, Boxall and Stepney 1982, Sharp 1989, American Ornithologists' Union 1998, Wright and Hayward 1998, Houston and McGowan 1999). Barred Owls were first detected within the range of the Northern Spotted Owl as early as 1973 in Washington (Taylor and

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Forsman 1976) and 1979 in Oregon (Harrington-Tweit et al. 1979). The Barred Owl's range now extends into central California and overlaps most of the range of the Northern Spotted Owl (Dark et al. 1998, Kelly et al. 2003). As Barred Owls have moved into areas occupied by Spotted Owls, there is evidence that they are displacing or even killing Spotted Owls (Leskiw and Gutiérrez 1998, Kelly et al. 2003, Pearson and Livezey 2003).

Northern Spotted Owls are currently listed as threatened under the Endangered Species Act (U.S. Department of the Interior 1990), primarily because of evidence that populations are declining as a result of habitat loss. The Barred Owl's invasion of much of the Northern Spotted Owl's range has led to concern that Spotted Owls may be further threatened by Barred Owls, through competition for space and resources (Hamer 1988, Hamer et al. 2001, Kelly et al. 2003) or through direct predation (Leskiw and Gutiérrez 1998). In addition, occasional observations of hybridization between Barred and Spotted owls (Hamer et al. 1994) have generated considerable interest regarding the extent of hybridization between the two species. Here, we summarize current knowledge regarding hybridization between Barred and Spotted owls and discuss possible implications for conservation of Spotted Owls.

#### STUDY AREA AND METHODS

Our summary of hybrid owls is based on a review of all available data from surveys of Spotted Owls in Oregon and Washington in 1970–1999, including records of >9,000 owls banded during demographic studies and extensive survey data compiled by federal and state land-management agencies and private groups or individuals (Kelly 1999, Kelly et al. 2003). Most hybrids were located during demographic studies of Spotted Owls (Forsman et al. 1996); the primary survey method in those studies was use of a vocal lure (vocal imitation or playback of Spotted Owl calls) to stimulate owls to defend their territories (Reid et al. 1999). The majority of Spotted Owl territories in each demographic study area were surveyed at least three times each year to locate and confirm banded owls and determine the nesting status and number of young produced by each pair (Franklin et al. 1996). Spotted Owls and hybrids were usually captured and banded so that they could be relocated in subsequent years to determine their survival and reproductive rates (Franklin et al. 1996). Although Barred Owls and hybrids were not the target of the surveys, they were

responsive to Spotted Owl calls and were often detected (Hamer 1988, Dunbar et al. 1991, Kelly et al. 2003). In fact, surveyors in some regions recorded more responses from Barred Owls than from Spotted Owls (Dunbar et al. 1991). When adult F1 hybrids responded during surveys, they were identified on the basis of their unique vocalizations and plumage (Hamer et al. 1994). Juvenile F1 or F2 hybrids were identified by their plumage or by documenting the species of their parents. In some cases, Barred Owl–Spotted Owl pairs or hybrids were monitored for multiple years as part of long-term demographic studies. For territories where hybridization was confirmed, we summarized the data by sex and species of all adult and juvenile owls observed. Number of hybrid observations used here differs slightly from Kelly (1999), because we obtained more data and excluded some audio observations that had no visual confirmation.

#### RESULTS

Evidence of hybridization was detected at 28 locations, including 6 territories where Barred Owls paired with Spotted Owls, 17 territories where adult F1 hybrids paired with Barred or Spotted owls, 4 territories where F1 hybrids were observed but pair status was unknown, and 1 location where a juvenile F1 hybrid was located during dispersal but neither parent was observed (Table 1). A total of 47 hybrids were observed, including 17 F1s that were first detected as adults, 4 F1s that were first detected as juveniles and subsequently recaptured as adults, 10 F1 juveniles, and 16 F2 juveniles (Table 1). In Washington, 6 F1 adults and 4 F1 juveniles were found between 1986 and 1998. One of the F1 adults was originally banded as a juvenile in 1986 and resighted as an adult in 1991, 292 km from its natal site (Forsman et al. 2002). In Oregon, 15 F1 adults, 6 F1 juveniles, and 16 F2 juveniles were found between 1987 and 1999. Three of the F1 adults were banded as juveniles.

All juvenile F1 hybrids whose parents were confirmed were produced by male Spotted Owls paired with female Barred Owls (Table 1). Of 16 F2 juveniles observed, all but 1 were produced by F1 hybrids that backcrossed with Barred Owls (Table 1). Although the majority of F2 hybrids were produced by male hybrids that backcrossed with female Barred Owls, estimates of the number of juveniles produced per survey year by F1 hybrids were similar, regardless of whether hybrids backcrossed with male or female Barred Owls (Table 1). Of the 13

TABLE 1. Records of hybridization between Barred and Northern Spotted owls in Washington and Oregon during 1970–1999, including numbers of hybrid juveniles produced by various species combinations.

Number of owl territories	Species combination found at each territory			Number of survey years <sup>a</sup>	Number of juveniles produced	Number of juveniles per survey year
	Male	Female	Unknown sex			
6	Spotted	Barred		13	13 F1 <sup>b</sup>	1.00
4	Barred	F1		4	2 F2	0.50
3	Spotted	F1		8	0	0
1	Both	F1 <sup>c</sup>		7	0	0
6	F1	Barred		21	13 F2	0.61
3	F1	Spotted		6	1 F2	0.16
1	F1	Unknown		2	0	0
1	F1			1	0	0
2			F1	2	0	0
1	Unknown	Unknown			1 F1 <sup>d</sup>	

<sup>a</sup> Total number of years that territories in column 1 were sampled. Survey years were not necessarily consecutive within territories, and may not have been concurrent between territories.

<sup>b</sup> Four juvenile hybrids in this category were later recaptured as adults and are also included in the male and female columns.

<sup>c</sup> This female F1 hybrid was banded as a juvenile in 1986, dispersed 292 km, and subsequently paired with a Spotted Owl for at least two years, then was paired with a Barred Owl for at least two years.

<sup>d</sup> This juvenile F1 hybrid was observed during dispersal. The location where it was produced was unknown.

F2 juveniles produced by male hybrids paired with female Barred Owls, 8 were produced by a single pair during a total of 9 survey years; the other 5 were produced by 2 other pairs during a total of 5 survey years. At one territory, a female F1 hybrid was paired with a male Spotted Owl for at least two years, and subsequently paired with a male Barred Owl for at least two years, but no young were ever found. At three territories where male Spotted Owls paired with female F1 hybrids, no young were detected in a total of eight survey years (Table 1).

DISCUSSION

In the period 1970–1999, we and other researchers searched for Northern Spotted Owls throughout most of the forested regions of the Pacific Northwest and banded >9,000 Spotted Owls. During the same period, Barred Owls were detected in or near many territories occupied by Spotted Owls (Kelly et al. 2003). The fact that so few hybrids were found during that period suggests that hybridization between Barred and Spotted owls is a relatively rare event. However, it is possible that hybridization is more common than indicated by our data, because hybrid backcrosses are difficult to identify and may not have been correctly identified in all cases. More information is needed on plumage attributes and vocalizations of backcrosses to determine the extent to which the progeny of

different combinations of backcrosses can be correctly identified from visual and audio cues. Blood and tissue samples should be collected from all suspected hybrids to assist in correct identification, because that may prove the only reliable way to identify hybrids beyond the F1 generation (Haig et al. 2004).

Given the small number of F1 hybrids detected to date, there is little evidence that hybridization between Barred and Spotted owls is a serious threat to either species. The situation seems to be a classic example of effective isolating mechanisms resulting in low levels of hybridization between populations (Mayr 1963, Short 1969). If that is the case, hybridization could actually decline as Barred Owls become more numerous and have increased access to conspecific mates (Mayr 1963, Cody 1969). Thus, we believe that hybridization between Barred and Spotted owls is an interesting biological phenomenon that is probably inconsequential, compared with the real threat—direct competition between the two species for food and space (Dunbar et al. 1991, Leskiw and Gutiérrez 1998, Hamer et al. 2001, Kelly et al. 2003, Pearson and Livezey 2003).

Our results raise some interesting questions regarding compatibility of Barred and Spotted owls and fitness of hybrids. For example, all confirmed pairings between Barred and Spotted owls involved a male Spotted Owl with a female Barred Owl. That pairing may be

more compatible than pairings between female Spotted Owls and male Barred Owls because the normal pattern of reversed sexual size-dimorphism is retained in the first case (female Barred owls are larger than male Spotted Owls) but not in the latter (male Barred Owls are as large as or larger than female Spotted Owls). Another interesting finding of the present study is that pairings between F1 hybrids and Barred Owls produced particularly high numbers of young, relative to F1 hybrids paired with Spotted Owls. Whether that trend is attributable to differences in compatibility between different sexual or hybrid combinations or is the result of small sample size or sampling bias is unknown and will only become clear with more data.

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