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The Effects of Management Practices on Grassland Birds—Wilson's Phalarope (*Phalaropus tricolor*)

Chapter J of

The Effects of Management Practices on Grassland Birds

Professional Paper 1842–J

U.S. Department of the Interior
U.S. Geological Survey

Cover. Wilson's Phalarope. Photograph by David O. Lambeth, used with permission.
Background photograph: Northern mixed-grass prairie in North Dakota, by Rick Bohn, used with permission.

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By Jill A. Shaffer,[1] Lawrence D. Igl,[1] Douglas H. Johnson,[1] Christopher M. Goldade,[1,2] Amy L. Zimmerman,[1] and Betty R. Euliss[1]

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The Effects of Management Practices on Grassland Birds

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U.S. Department of the Interior
U.S. Geological Survey

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Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
hectare (ha)	2.471	acre
hectare (ha)	0.003861	square mile (mi^2)
square kilometer (km^2)	0.3861	square mile (mi^2)
	Mass	
microgram (µg)	0.00000003527	ounce (oz)
gram (g)	0.03527	ounce (oz)

Abbreviations

CRP	Conservation Reserve Program
DNC	dense nesting cover
PPR	Prairie Pothole Region
spp.	species (applies to two or more species within the genus)

Acknowledgments

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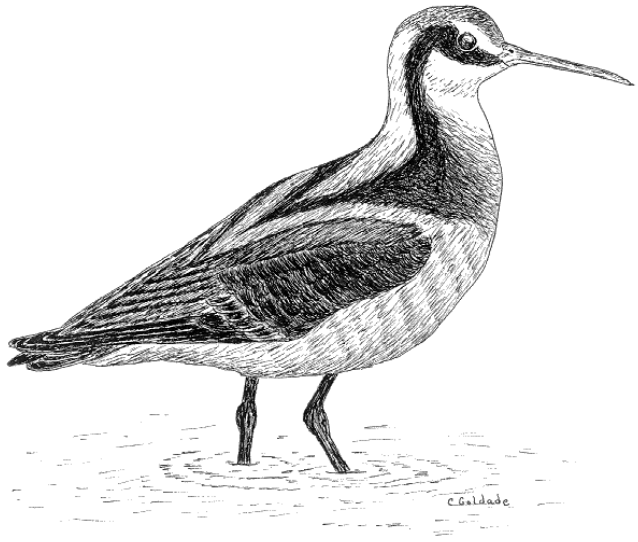
Capsule Statement

The key to Wilson's Phalarope (*Phalaropus tricolor*) management is providing wetland complexes containing suitable wetland characteristics (that is, open water, emergent vegetation, and open shoreline) and upland habitat (native grassland or tame hayland) throughout the breeding season. Wilson's Phalaropes have been reported to use habitats with 15–32 centimeters (cm) average vegetation height, 8–18 cm visual obstruction reading, 45–53 percent grass cover, 19–22 percent forb cover, and less than (<) 3 cm litter depth. The descriptions of key vegetation characteristics are provided in table J1 (after the "References" section). Vernacular and scientific names of plants and animals follow the Integrated Taxonomic Information System (https://www.itis.gov).



Wilson's Phalarope. Illustration by Christopher M. Goldade, U.S. Geological Survey.

Breeding Range

Wilson's Phalaropes breed from the southern Yukon Territories through British Columbia, south-central Alberta and southern Manitoba; south to central California, southern Nevada, southern Colorado, northern New Mexico, and northern Texas; and east to central Kansas, northwestern Iowa, and northwestern Minnesota. They also breed from eastern Wisconsin and northeastern Illinois, east to Michigan, northern Ohio, eastern Ontario, and northern New York (National Geographic Society, 2011). The relative densities of Wilson's Phalarope in the United States and southern Canada, based on North American Breeding Bird Survey data (Sauer and others, 2014), are shown in figure J1 (not all geographic places mentioned in report are shown on figure).

Suitable Habitat

Wilson's Phalaropes use fresh and alkali wetlands with three characteristics: open water, emergent vegetation, and open shoreline (Saunders, 1914; Stewart and Kantrud, 1965; Hohn, 1967; Stewart, 1975; Prescott and others, 1995; Naugle, 1997). The species uses a wide variety of habitats, including wetlands, wet meadows, upland grasslands, standing stubble, and road rights-of-way (Roberts, 1932; Bent, 1962; Hohn, 1967; Higgins, 1975; Stewart, 1975; Murray, 1983; Bomberger, 1984; Colwell, 1987; Colwell and Oring, 1990; Einemann, 1991; Faanes and Lingle, 1995; Dinsmore and Schuster, 1997; Naugle and others, 2001). Wilson's Phalaropes occasionally inhabit Conservation Reserve Program (CRP) fields, dense nesting cover (DNC), and Wildlife Management Areas (Svedarsky, 1992; Johnson and Schwartz, 1993; Prescott and others, 1993; Wiens, 2007). In Alberta, the species used grassy areas free of cattails (*Typha* species [spp.]) and sedges (*Carex* spp.) (Hohn, 1967). In the Midwest region of the United

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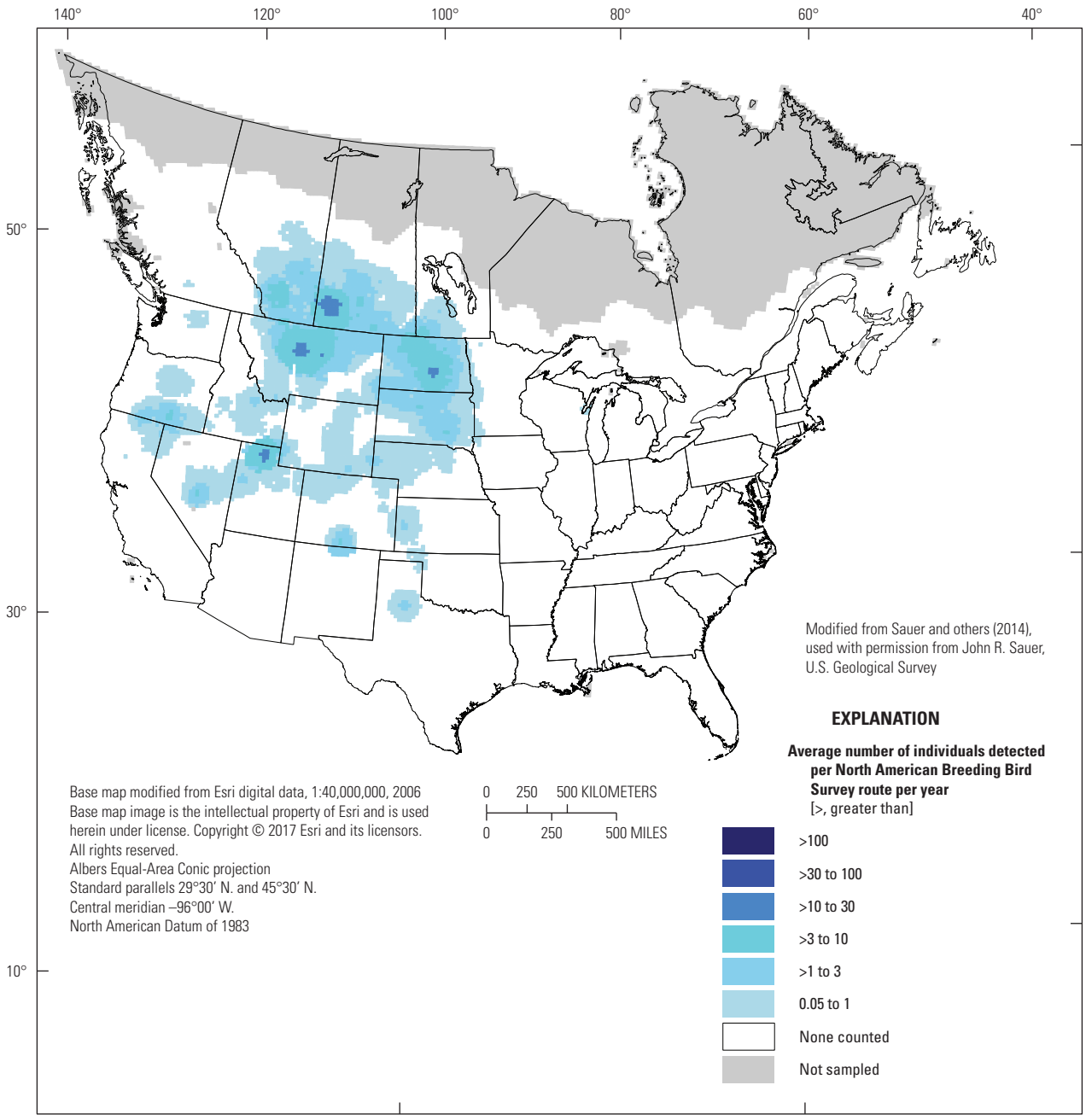

Figure J1. Breeding distribution of the Wilson's Phalarope (*Phalaropus tricolor*) in the United States and southern Canada, based on North American Breeding Bird Survey (BBS) data, 2008–12. The BBS abundance map provides only an approximation of breeding range edges.

States, the species occurred in the wet-meadow zones of permanent or semipermanent wetlands and foraged in open water at depths up to about 30 cm (Eldridge, 1992).

Suitable wetland types range from fresh to saline and vary widely in size and permanence (Stewart and Kantrud, 1965; Stewart, 1975; Kantrud and Stewart, 1984). In the Prairie Pothole Region (PPR) of eastern Montana, North Dakota, and South Dakota, Niemuth and others (2012) evaluated wetland characteristics that affected the detection and the number of Wilson's Phalaropes; the species was more likely to be observed, and observed at higher numbers, on brackish or saline wetlands than on freshwater wetlands. In a study of wetlands throughout the PPR of North Dakota and South Dakota, Wilson's Phalaropes were more likely to be observed in alkali or permanent wetlands than in temporary, seasonal, or semipermanent wetlands (Igl and others, 2017). Within the North Dakota PPR, Wilson's Phalarope densities were highest in wetlands with frequently tilled soils, followed by temporary, seasonal, semipermanent, fen, alkali, and permanent wetlands (Kantrud and Stewart, 1984). Wilson's Phalaropes often

occupied the peripheral low-prairie and wet-meadow areas of most classes of wetlands in North Dakota. In another North Dakota study, the highest densities of Wilson's Phalaropes were found on seasonal wetlands with closed stands of emergent cover, such as common spikerush (*Eleocharis palustris*), or with clumps of emergent cover interspersed with open water (Stewart and Kantrud, 1965). High densities also were found on brackish or saline semipermanent wetlands with closed stands of emergent cover, with clumps of emergent cover interspersed with open water, or with peripheral bands of emergent cover encircling expanses of open water. The use by spring-migrating Wilson's Phalaropes of temporary and seasonal wetlands within agricultural fields in the Drift Prairie of eastern North Dakota was evaluated by Niemuth and others (2006). Wilson's Phalaropes were more likely to use seasonal and undrained wetlands than temporary or drained wetlands, and to use wetlands with sparse amounts of tall, emergent vegetation than densely vegetated wetlands with tall, emergent vegetation; presence of Wilson's Phalaropes was positively related to the number of times a wetland basin contained water during 9 or 10 visits. In South Dakota, Wilson's Phalaropes most frequently occurred on temporary and seasonal wetlands and on stock ponds, but were also were seen on ephemeral and semipermanent wetlands, intermittent streams, dugouts, and wetlands with tilled soil bottoms; no phalaropes were seen on permanent streams (Weber and others, 1982). In Colorado, Wilson's Phalaropes preferred seasonal wetlands and habitats dominated by baltic rush (*Juncus balticus*), sedges, and grasses <40 cm tall more than semipermanent wetlands, habitats dominated by cattail (*Typha* spp.) and softstem bulrush (*Schoenoplectus tabernaemontani*) greater than (>) 40 cm tall, inland saltgrass (*Distichlis spicata*) habitats, or upland shrub habitats (Laubhan and Gammonley, 2000; Gammonley and Laubhan, 2002).

Wilson's Phalarope occurrence and abundance are influenced by local wetland characteristics. Niemuth and others (2012) reported that detections and number of Wilson's Phalaropes were positively related to the proportion of wetland inundated by water and negatively related to certain wetland cover classes that characterized the amount and configuration of emergent vegetation. Detections and number of Wilson's Phalaropes were negatively related to the full spectrum of cover classes, from the one extreme indicating wetlands with closed stands of tall (>25 cm) emergent vegetation and with no open water or bare soil, to the other extreme of wetlands entirely inundated with water and with no emergent vegetation or bare soil. Detections were positively related to the percentage of shoreline with an upland vegetative buffer greater than or equal (≥) to 25 meters (m) wide and to width of mudflats. In a study in North Dakota and South Dakota, Wilson's Phalarope probability of occurrence was positively associated with wetland cover classes characterized by scattered-to-open water and with open water or bare soil covering anywhere from 5 to >95 percent of the wetland area (Niemuth and others, 2013). Probability of occurrence increased curvilinearly with wet area of basin. In a survey of 1,190 wetlands in the PPR of North Dakota and South Dakota, Igl and others (2017) recorded phalaropes in 97 wetlands that were characterized as having an average of 45 percent open water, 25 percent emergent vegetation, 25 percent wet meadow, and 5 percent shore/mudflat. In South Dakota, the occurrence of Wilson's Phalaropes was positively associated with the area of surface water within a wetland basin and the percentage of grazed shoreline (Weber, 1978). In eastern South Dakota, the probability of occurrence of Wilson's Phalaropes in semipermanent wetlands was positively related to the number of emergent hydrophyte species (for example, willow [*Salix* spp.]) constituting ≥10 percent of the vegetated wetland area (Naugle, 1997; Naugle and others, 2001). The probability of occurrence of Wilson's Phalaropes in semipermanent and seasonal wetlands was negatively related to wetlands dominated by thick-stemmed plants (for example, cattail and river bulrush [*Bolboschoenus fluviatilis*]). In a second study in eastern South Dakota, the occurrence of Wilson's Phalaropes was negatively related to wetlands surrounded by trees (Naugle and others, 1999).

Wilson's Phalaropes nest in upland habitats near wetlands, typically <100 m from shoreline (Hohn, 1967; Hatch, 1971; Bomberger, 1984; Colwell and Oring, 1990; Eldridge, 1992). In Alberta, Saskatchewan, and North Dakota, Wilson's Phalaropes nested in grasses of various heights on islands or in wet-meadow zones around lakes and wetlands; in Saskatchewan, brood rearing occurred in patches of foxtail barley (*Hordeum jubatum*) (Bent, 1962; Hohn, 1967; Kagarise, 1979; Colwell, 1987). In another Saskatchewan study, the species nested in heavily grazed uplands with patches of western snowberry (*Symphoricarpos occidentalis*) (Colwell, 1987). In Saskatchewan, nest sites had taller, denser, and more homogeneous vegetation and less bare ground than randomly selected sites (Colwell and Oring, 1990). Nest success (that is, nests that hatched at least one chick) and the number of days that clutches survived were not related to vegetation concealment at nests (Colwell, 1992). In Manitoba, Montana, North Dakota, and South Dakota, the species nested in areas with >50 percent litter and with low, sparse cover, and they avoided areas with 100 percent visual obstruction at ≥20 cm or effective vegetation height >46 cm (Kantrud and Higgins, 1992). Dominant vegetation at nests included Kentucky bluegrass (*Poa pratensis*), needlegrass (*Achnatherum* spp. and *Stipa* spp.), wheatgrass (formerly *Agropyron* spp.), sedges, baltic rush, northern reedgrass (*Calamagrostis stricta* spp. *inexpansa*), and inland saltgrass. In North Dakota, Wilson's Phalaropes selected nest sites in short, sparse vegetation in native grasslands (Wiens, 2007). Nest sites had less litter and forb coverage than randomly selected sites and visual obstruction was lower in DNC fields, but higher in grazed pastures, than randomly selected sites. The species appeared to avoid potential nest sites dominated by invasive plant species. In North Dakota and Iowa, Wilson's Phalaropes nested in wetlands associated with river flood plains (Murray, 1983; Koenig, 1984). In Iowa, Wilson's Phalaropes nested on a small mound of vegetation near a wetland (Dinsmore and Schuster, 1997). In Nebraska, the species nested near a saline wetland in a stand of foxtail barley

(Einemann, 1991) and in wet sedge meadows (Faanes and Lingle, 1995). In the Nebraska sandhills, nest sites had shorter vegetation than random sites (Bomberger, 1984). The species nested near wet-meadow zones around wetlands; vegetation height was more important in nest-site selection than was distance to water. Average distance from nests to wetlands ranged from 4.2 to 4.6 m, and nearest wetlands to nests ranged from an average of 32 to 44 hectares (ha) in basin surface area.

Nest-site selection varies seasonally; Wilson's Phalaropes nest in upland vegetation early in the breeding season and wet-meadow vegetation later in the season (Colwell and Oring, 1990). They also exhibit annual variation in nest-site selection, moving to deeper, more permanent wetlands in dry years (Hohn, 1967; Colwell, 1991).

Area Requirements and Landscape Associations

Wilson's Phalaropes may be area sensitive and be sensitive to features of the landscape surrounding suitable habitat. In the northern Great Plains, Wilson's Phalaropes were absent in patches of CRP grassland that were <50 ha (Johnson and Igl, 2001). Highest abundances occurred in large (>8 ha) wetlands (Prescott and others, 1995). Of 97 wetlands in the PPR of North Dakota and South Dakota in which Wilson's Phalaropes were observed, average wetland size was 13 ha (Igl and others, 2017). Landscape composition within 800 m of these wetlands was 56 percent grassland, 20 percent agricultural, 19 percent wetland, and 5 percent other; average number of wetlands within 800 m of these wetlands was 25. At a landscape level, Wilson's Phalarope occurrence in the PPR of eastern Montana, North Dakota, and South Dakota was positively related to the percentage of grassland within 800 m of a survey point consisting of native grassland, forb, or scattered low shrubs; to percentage of area within 800 m consisting of temporary, seasonal, semipermanent, and permanent wetlands; and to wetland perimeter (Niemuth and others, 2012). The number of Wilson's Phalaropes was curvilinearly related to wetland perimeter and negatively related to the number of different water regimes for wetlands (that is, number of wetland types) in the landscape. The use by spring-migrating Wilson's Phalaropes of temporary and seasonal wetlands within agricultural fields in the Drift Prairie of North Dakota was evaluated by Niemuth and others (2006). Wilson's Phalaropes selected wetlands with large perimeters and their presence was positively associated with the percentage of the landscape within 800 m of sampled wetlands that was occupied by semipermanent and permanent wetlands. In South Dakota, the occurrence of Wilson's Phalaropes was positively associated with the area of alfalfa (*Medicago sativa*) hayland within each quarter section (that is, 0.65 ha) surrounding focal wetlands (Weber, 1978). In eastern South Dakota, the probability of occurrence of Wilson's Phalaropes in semipermanent wetlands was positively related to the proportion of untilled uplands near nesting wetlands (Naugle, 1997).

In North Dakota tallgrass prairies, occurrence of Wilson's Phalarope was positively associated with wetland and grass cover and negatively associated with woodland cover at the 100-m scale (Cunningham and Johnson, 2006). Occurrence was negatively associated with tree cover at the 1,600-m scale. In stock ponds in western South Dakota, abundance of Wilson's Phalaropes was 3.5 times greater in 25.9 square kilometer (km^2) landscapes dominated by grasslands than in landscapes dominated by cropland (May and others, 2002). Grassland landscapes contained <5 percent cropland compared to intensively farmed landscapes that contained >75 percent cropland. In semipermanent and seasonal wetlands in South Dakota, Wilson's Phalarope occurrence was positively related to the area of wetland and grassland within 25.9 km^2 landscapes surrounding surveyed wetlands (Naugle and others, 2001).

Brood Parasitism by Cowbirds and Other Species

The Wilson's Phalarope is an accidental and unsuitable host of the Brown-headed Cowbird (*Molothrus ater*) (Friedmann, 1963; Hatch, 1971). The few records of parasitism are summarized in Shaffer and others (2019). In North Dakota, none of 21 nests were parasitized (M. Winter, WissenLeben e.V., Raisting, Germany, and D.H. Johnson, unpub. data). In Saskatchewan, 1 percent of 386 nests were parasitized by Brown-headed Cowbirds (Colwell and Jehl, 1994). Two records of multiple parasitism have been reported (Friedmann, 1963); Williams and Trowbridge (1939) found two parasitized Wilson's Phalarope nests, each containing four Wilson's Phalarope eggs and two Brown-headed Cowbird eggs.

Breeding-Season Phenology and Site Fidelity

In the central and northern Great Plains (Minnesota, Nebraska, and North Dakota), Wilson's Phalaropes arrive on the breeding grounds from mid-April to early May and depart from mid-August to early September (Roberts, 1932; Howe, 1972; Johnsgard, 1980; Murray, 1983). In Alberta, Manitoba, and Saskatchewan, Wilson's Phalaropes arrive on the breeding grounds from late April to early May and remain until early September (Hohn, 1967; Maher, 1974; Reynolds and others, 1986; Colwell, 1987; Colwell and Oring, 1988a, 1988b). Females arrive on the breeding grounds earlier than males (Reynolds and others, 1986; Colwell, 1987), and commonly depart from breeding areas earlier than males, usually from early June to early July (Hohn, 1967; Howe, 1972; Colwell, 1987; Colwell and Oring, 1988a). Wilson's Phalaropes may

renest after nest failure, and females are capable of laying multiple clutches (Colwell and Jehl, 1994). Polyandry was first documented in the species in Saskatchewan, where a color-banded female laid two clutches with two individual males (Colwell, 1986; Colwell, 1987). Philopatry is uncommon in Wilson's Phalaropes, although males return to breeding areas in successive years more often than females (Colwell, 1987; Colwell and Oring, 1988c). Of 154 adult male phalaropes banded over 4 years in Saskatchewan, 16 percent returned to their previous breeding area in successive years, whereas only 2 percent of 69 banded adult females returned (Colwell, 1987).

Species' Response to Management

Wilson's Phalaropes nest in idle, hayed, or grazed grasslands adjacent to wetlands (Hohn, 1967; Kantrud and Higgins, 1992). In North Dakota, Wilson's Phalaropes nested at higher densities in hayland mowed the previous year than in grazed areas (Kantrud, 1981). Idle grasslands and previously grazed areas provided habitat for nesting, but areas with cattle present during the breeding season were less suitable (Renken, 1983; Renken and Dinsmore, 1987; Kantrud and Higgins, 1992). In Alberta, Wilson's Phalaropes were present in deferred-grazed (grazed after July 15) native pasture (Prescott and others, 1993). Nesting occurred in areas that were moderately grazed in Nebraska (Faanes and Lingle, 1995) and heavily grazed in Saskatchewan (Colwell, 1987). In South Dakota stock ponds, grazing by cattle limited the growth of thick-stemmed emergent vegetation that was not conducive for Wilson's Phalarope nesting (May and others, 2002). Although Wilson's Phalaropes occasionally nested in cropland (small-grain stubble) in North Dakota (Higgins, 1975), native grassland was preferred over cropland and tame grassland in southern Canada and the northern United States (Owens and Myres, 1973; Eldridge, 1992; Kantrud and Higgins, 1992). Johnson and Schwartz (1993) reported that Wilson's Phalaropes were present in low numbers in CRP fields in the northern Great Plains (North Dakota, South Dakota, and eastern Montana). In Saskatchewan aspen parkland, Wilson's Phalaropes were observed in DNC that contained wetlands (Prescott and others, 1993, 1995).

Irrigation activities resulting in high mineral concentrations or that require the control of mosquitos (*Culicidae*) can be detrimental to Wilson's Phalaropes. In Wyoming, irrigation over soils with a high selenium content caused leaching of selenium from the soil to the groundwater. Selenium discharge from wetland basins was related to intensity of irrigation (measured by the area of irrigated land) and the concentration of selenium in the groundwater. High selenium levels in lakes appeared to cause high selenium levels in the eggs (>13 micrograms per gram [µg/g]) and livers (>30 µg/g) of adult Wilson's Phalaropes (See and others, 1992). One dead adult bird had a liver selenium content of >30 µg/g, a level associated with biological risk. Average selenium concentrations of >13 µg/g dry weight were associated with embryo deformities. Of 6 eggs collected over 2 years, selenium concentrations ranged from 5 to 19.9 µg/g dry weight and averaged 11.7 µg/g dry weight. Also in Wyoming, mortality of Wilson's Phalarope was observed after fenthion, a chemical used to control mosquitoes, was aerially applied at a rate of 47 grams per hectare to an irrigated meadow (DeWeese and others, 1983). Fenthion is a cholinesterase inhibitor, and activity of brain cholinesterase was significantly lower for 15 days after application in Wilson's Phalaropes collected from treated areas than in Wilson's Phalaropes from control areas.

Niemuth and others (2013) examined the influence of two wind facilities on Wilson's Phalaropes in North Dakota and South Dakota for 3 years. The species did not appear to avoid wetland basins within 805 m of wind turbines at either facility, although occurrence was slightly and consistently lower at one facility, possibly because that facility was located primarily in cropland and the other facility in grassland. In Montana, Malcolm (1982) reported cases of Wilson's Phalaropes fatally colliding with a power transmission line, which was constructed over a wetland that was intermittently flooded. Highest mortality rates occurred during August and September during the fall migration period.

Management Recommendations from the Literature

Wilson's Phalaropes will benefit from protecting wetlands from drainage (Niemuth and others, 2006). Colwell and Jehl (1994) highlighted the importance of preventing diversion of water from saline lakes and wetlands in western staging areas. Johnson (1996) stressed the value of preserving and restoring wetlands. Several authors have emphasized the importance of protecting wetland complexes containing seasonal and semipermanent wetlands to provide suitable habitat during wet and dry years (Kantrud and Stewart, 1984; Colwell and Oring, 1988b; Niemuth and others, 2006). Wilson's Phalaropes exhibit annual variation in nest-site selection, moving to deeper, more permanent wetlands in dry years (Hohn, 1967; Colwell, 1991).

Colwell and Oring (1988b) recommended preserving wet-meadow areas near deeper wetlands during the breeding season, which may facilitate adults moving their precocial young from nests to wetlands by decreasing overland travel distance. Wilson's Phalaropes nest in upland vegetation early in the breeding season and wet-meadow vegetation later in the season (Colwell and Oring, 1990).

Colwell and Oring (1988b) emphasized that shorebird needs should be considered when creating impoundments for waterfowl, including providing gentle inclines on nesting islands and beaches. Wilson's Phalaropes in Alberta, Saskatchewan, and North Dakota nested on islands or in wet-meadow zones around lakes and wetlands (Bent, 1962; Hohn, 1967; Kagarise, 1979).

Wilson's Phalaropes will benefit from easement programs that discourage the conversion of grasslands to cropland (May and others, 2002), that discourage the planting of trees (Cunningham and Johnson, 2006), and that discourage wetland drainage (Niemuth and others, 2006). Phalaropes also will benefit from planting DNC fields to native grass species and controlling invasive species, where feasible (Wiens, 2007). Naugle and others (1999) recommended controlling or eliminating woody vegetation around wetlands.

Burning, mowing, or grazing can be used to improve nesting habitat (Eldridge, 1992). However, Kantrud and Higgins (1992) emphasized that nesting habitat should not be disturbed (for example, drained, mowed, burned, or heavily grazed) during the breeding season, which generally extends from early May to late July. Prescott and others (1993) recommended deferring livestock grazing until after July 15 in pastures that contain wetlands important to breeding Wilson's Phalaropes (Prescott and others, 1993). Idle grasslands and previously grazed areas provide suitable habitat for nesting, but areas with cattle present during the breeding season are less suitable (Renken, 1983; Renken and Dinsmore, 1987; Kantrud and Higgins, 1992). In Alberta, Wilson's Phalaropes were present in deferred-grazed (grazed after July 15) native pasture (Prescott and others, 1993).

Malcolm (1982) recommended that power lines should not be constructed through or within 1 kilometer of known historical high-water marks of wetlands or dry basins known to hold water intermittently. Similarly, power lines should not be constructed through flight lines or heavily used waterbird migration routes (Malcolm, 1982).

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Table J1. Measured values of vegetation structure and composition in Wilson's Phalarope (*Phalaropus tricolor*) breeding habitat by study. The parenthetical descriptors following authorship and year in the "Study" column indicate that the vegetation measurements were taken in locations or under conditions specified in the descriptor; no descriptor implies that measurements were taken within the general study area.

[cm, centimeter; %, percent; --, no data; DNC, dense nesting cover; WMA, Wildlife Management Area]

Study	State or province	Habitat	Management practice or treatment	Vegetation height (cm)	Vegetation height-density (cm)	Grass cover (%)	Forb cover (%)	Shrub cover (%)	Bare ground cover (%)	Litter cover (%)	Litter depth (cm)
Bomberger, 1984[a] (nests)	Nebraska	Mixed-grass prairie, shortgrass prairie	--	25.6–31.7	--	99.9	--	--	17.6–22.5	--	0.7
Kantrud and Higgins, 1992 (nests)	Manitoba, Montana, North Dakota, South Dakota	Multiple	Multiple	--	8[b], 17[c]	--	--	--	--	48[d]	--
Renken, 1983[e]	North Dakota	Tame grassland (DNC)	Idle, grazed	--	12[b]	67.9	26.4	7.5	0	99.3	2.3
Svedarsky, 1992 (nests)	Minnesota	Tame grassland (WMA)	--	17[f]	11[b]	--	--	--	--	--	--
Wiens, 2007 (nests)	North Dakota	Tame grassland (DNC), pasture	Multiple	15	16[b]	45	19	--	--	--	1.5
Wiens, 2007 (field)	North Dakota	Tame grassland (DNC), pasture	Multiple	--	18[b]	53	22	--	--	--	2.0

[a]The sum of the percentages is greater than 100%, based on unclear methods.

[b]Visual obstruction reading (Robel and others, 1970).

[c]Effective vegetation height.

[d]Standing dead vegetation.

[e]The sum of the percentages is greater than 100%, based on the modified point-quadrat technique of Wiens (1969).

[f]Grass height.

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