Response of Waterbirds to Number of Wetlands in the Prairie Pothole Region of North Dakota, U.S.A.

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Abstract.—We examined the relationship between number of wetlands and occurrence of five waterbird and one waterfowl species in the Prairie Pothole Region of North Dakota, USA, from 1980-2000. Data from 13 Breeding Bird Survey routes provided an index to regional density and distribution of Pied-billed Grebe (*Podilymbus podiceps*), Black Tern (*Chlidonias niger*), American Bittern (*Botaurus lentiginosus*), Northern Pintail (*Anas acuta*), Sora (*Porzana carolina*), and American Coot (*Fulica americana*), while 69 segments from annual Waterfowl Breeding Ground Population and Habitat Surveys provided an index to regional wetland availability. Numbers of wetlands and birds varied among years, and density and distribution of all six species showed a strong positive correlation with number of wetlands. Correlations were weaker when the number of wetlands was lagged one year, suggesting that waterbird distributions shift in response to water availability rather than respond locally. Spatial and temporal variation of waterbird habitat and numbers should be considered in monitoring and management of waterbirds in the Prairie Pothole Region. *Received 20 July 2002, accepted 8 October 2002.*

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The breeding distribution and density of many species of waterfowl in North America are influenced by the number and condition of wetlands (Smith 1970; Stewart and Kantrud 1973; Brewster *et al.* 1976). The relationship between waterfowl numbers and wetland availability is particularly evident in the Prairie Pothole Region (PPR) of North America, which is characterized by numerous small wetland basins. The number of these basins containing water and the breeding waterfowl the basins attract vary dramatically among years, depending on precipitation, soil moisture, and frost seal (Stewart and Kantrud 1973; Ruwaldt *et al.* 1979; Krapu *et al.* 1997). To account for temporal and spatial changes in waterfowl distribution, numbers of wetlands and waterfowl are recorded in annual waterfowl breeding ground surveys in North America conducted by the U.S. Fish and Wildlife Service (Smith 1995). Understanding the relationship between number of wetlands and waterfowl density and distribution is critical to the monitoring and management of waterfowl in the PPR (Reynolds 1987; Krapu *et al.* 1997; Cox *et al.* 2000).

The effect of annual wetland availability on breeding distribution and density of other species of waterbirds (e.g., rails, grebes, herons) in the PPR is poorly understood relative to waterfowl. Numbers of American Coot (*Fulica americana*) in different regions are positively correlated with the number of wetlands present in each region (Alisauskas and Arnold 1994). Changes in Black Tern (*Chlidonias niger*) numbers in the Prairie Provinces of Canada are correlated with changes in Mallard (*Anas platyrhynchos*) numbers, which is likely a parallel response to availability of wetlands (Peterjohn and Sauer 1997). Distribution and population size are poorly known for many waterbird species (see Melvin and Gibbs 1994; Reid *et al.* 1994; Tacha *et al.* 1994; Ribic *et al.* 1999); understanding the response of waterbirds to wetland availability may be vital to developing and interpreting population assessment and monitoring programs for these species.

Fluctuations in waterbird numbers in response to wetland availability may be particularly important in the PPR. Precipitation in the PPR is notoriously variable, impacting local numbers of a variety of bird species ranging from Northern Pintail (*Anas acuta*; Hestbeck 1995) to Le Conte's Sparrow (*Ammodramus leconteii*; Igl and Johnson 1999). Also, the PPR harbors a large proportion of the North American breeding range of several species of waterbirds, including Horned Grebe (*Podiceps auritus*), Pied-billed Grebe (*Podilymbus podiceps*), American Bittern (*Botaurus lentiginosus*), American Coot, Sora (*Porzana carolina*), and Black Tern (Sauer *et al.* 2001). Understanding the influence of water availability on these species in the PPR is critical to understanding regional and continental waterbird population trends.

We investigated relationships between regional indices of distribution and abundance for five waterbird species (Pied-billed Grebe, Black Tern, American Bittern, Sora, and American Coot) and an index to wetland numbers in the PPR using data from the Breeding Bird Survey (BBS) and wetland counts from annual Waterfowl Breeding Ground Population and Habitat Surveys, also known as Breeding Ground Surveys (BGS). We also included Northern Pintail as a benchmark in our analysis, as its response to wetland availability has been well documented (Smith 1970; Hestbeck 1995). We treat the analysis as an exploratory effort to identify relationships and suggest hypotheses regarding the response of waterbirds to wetland availability in the PPR.

STUDY AREA AND METHODS

Every May, aerial survey biologists from the United States Fish and Wildlife Service's Division of Migratory Bird Management sample wetlands and breeding waterfowl along BGS transects. We analyzed relationships between wetland numbers and waterbird presence from 1980-2000 in BGS Stratum 45, which is located in north-central North Dakota (Fig. 1), and is one of 52 traditional BGS strata throughout the north-central contiguous United States, Canada, and Alaska (Smith 1995). This stratum and time period had good coverage by BBS routes and is in the core range for the species of interest. We chose not to combine information from several waterfowl survey strata, as pooling data from larger geographic areas could average out local differences in precipitation levels and the response of waterbirds to subsequent changes in wetland availability.

Wetland Sampling

Wetland numbers were estimated annually as part of the BGS. Aerial transects were flown 30-50 m above the ground at approximately 190 km/h along seven east-west transects. Each transect was divided into 29-km sampling units called segments; Stratum 45 contained 69 segments. An observer in the aircraft counted Type III, IV, and V wetlands (Shaw and Fredine 1956) within 200 m of the transect line on the right side of the aircraft. Wetlands judged to hold water for less than 21 days were not counted. Exact counts of wetlands were difficult because of restricted visibility due to vegetation, changes in observers, and aggregation and partition of wetlands caused by varying water levels. However, numbers were adjusted annually using visibility correction factors derived from subsets of segments sampled at the same time by ground observers. The same methods were used throughout the survey period and we treat estimates of wetland numbers as an index to wetland availability.

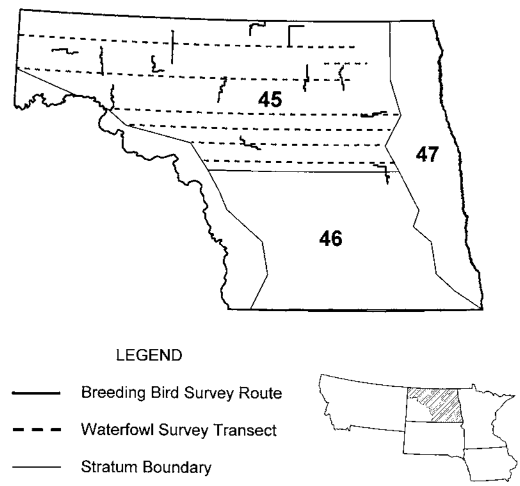

Figure 1. Locations of Breeding Ground Survey strata 45, 46, and 47 in northeastern North Dakota along with 13 BBS routes and 7 BGS transects in Stratum 45.

Bird Sampling

We used BBS route data available electronically from the Patuxent Wildlife Research Center (http://www.mp2-pwrc.usgs.gov/bbs/retrieval/menu.cfm). BBS data were gathered along standardized survey routes, each of which was 40 km long with 50 designated sample points, or stops, 0.8 km apart (Fig. 1). All birds seen or heard within 0.4 km of each stop were recorded during a 3-minute period (Bystrak 1981). The location and number of stops along BBS routes did not change, allowing comparisons to be made among years. Routes were sampled in the same manner during the breeding season each year, although some routes were not sampled every year. Because of sampling biases, the BBS provides an index, rather than an estimate of numbers for birds (Bystrak 1981), but this index is useful for monitoring trends.

For each year from 1980-2000, we analyzed BBS data at three levels of response for each species: the mean number of birds per route, the mean number of stops with birds per route, and the percentage of routes with at least one bird present. These provided rough indices of density per route, distribution along routes, and distribution within the region. Because some BBS routes within the stratum were not sampled every year and some routes encompassed few wetlands (unpublished data) that could harbor waterbirds, only routes with at least one bird present were included when calculating number of birds per route and number of stops with birds. In two instances when no birds of a target species were detected on any of the routes in the stratum, 0 was entered for each level of response. Because some data were not normally distributed, Spearman's rank correlation was used to assess the strength of associations between the number of May ponds and each level of response for each species. Bird numbers might change locally in response to habitat quantity and quality rather than shift spatially because of wetland availability. Because this response would not immediately be evident, we also assessed associations between the number of May ponds lagged by one year and the three levels of response for each species.

RESULTS

The number of May ponds estimated to be present in Stratum 45 from 1980-2000 ranged from 59,100 in 1991 to 895,500 in 1999 ($\bar{x}$ = 352,000; Fig. 2). The number of BBS routes surveyed in the stratum during the period ranged from six to 13 ($\bar{x}$ = 10.1). In 1991, the year with the lowest estimated number of wetlands in Stratum 45 during the sample period, the six species included in the analysis were detected at 0.0-1.8% of 500 stops along the ten BBS routes conducted that year (Table 1). In 1999, the year with the highest estimated number of wetlands, the six species included in this analysis were present at 8.8-28.6% of 650 stops in the 13 BBS routes conducted in Stratum 45 that year (Table 1). The six species considered showed strong positive correlations with May pond numbers for each level of response, with all $r_s \geq 0.54$ ($P < 0.01$; Table 2, Fig. 2). The three levels of response were positively correlated in many cases, but provide evidence that the response of waterbirds to wetland availability can be detected at different scales. With the single exception of the percentage of routes on which Pied-billed Grebe was detected, all correlations between May pond numbers and the three levels of response were weaker when lagged by one year (Table 2).

DISCUSSION

Our results indicate that pond numbers strongly influence numbers of several species of waterbirds in the PPR. However, the mechanisms underlying the observed patterns are unknown. It is likely, as with some waterfowl species (Hestbeck 1995; Miller and Duncan 1999), that migrating waterbirds seek out areas with wetland conditions suitable for breeding, and that distribution and density throughout the region shift annually relative to water availability. If this is the case, additional patterns may be present across a larger geographic area. Associations between birds and wetlands may be stronger in those portions of the breeding range birds first encounter on migration, as birds will cease migrating and settle on breeding territories if they find suitable conditions ("short-stopping") or move on if conditions are not suitable, regardless of suitability further along their migration path ("overflight"). If overall numbers are stable, geographic shifts in distributions should balance out (i.e., low numbers in one area should correlate with higher numbers in other areas; see also Peterjohn and Sauer [1997]).

Patterns of distribution and density also may be influenced by factors other than water. For example, wetland use and settling patterns of Mallard decreased in some portions of the PPR because of increased area of cropland (Krapu *et al.* 1997). Waterbirds may be similarly affected by changes in surrounding landscapes, especially species such as American Bittern, which sometimes nests in upland grasses (Duebbert and Lokemoen 1977). Response to wetland availability also may vary depending on species, natural history, degree of philopatry, and dependence on wetlands for nesting and foraging.

The results of this analysis are correlative and are influenced by the coarse temporal and spatial resolution of sampling. Assuming a relationship between pond numbers and bird numbers truly exists, the relationship would be more accurately described if the temporal and spatial sampling windows matched, i.e., ponds and birds were counted at the same time and place, and if surveys took place during the peak vocalization period, which will vary among species. Along these lines, it is possible that apparent changes in waterbird numbers may be influenced by reduced vocalization during periods of reduced wetland availability and breeding potential.

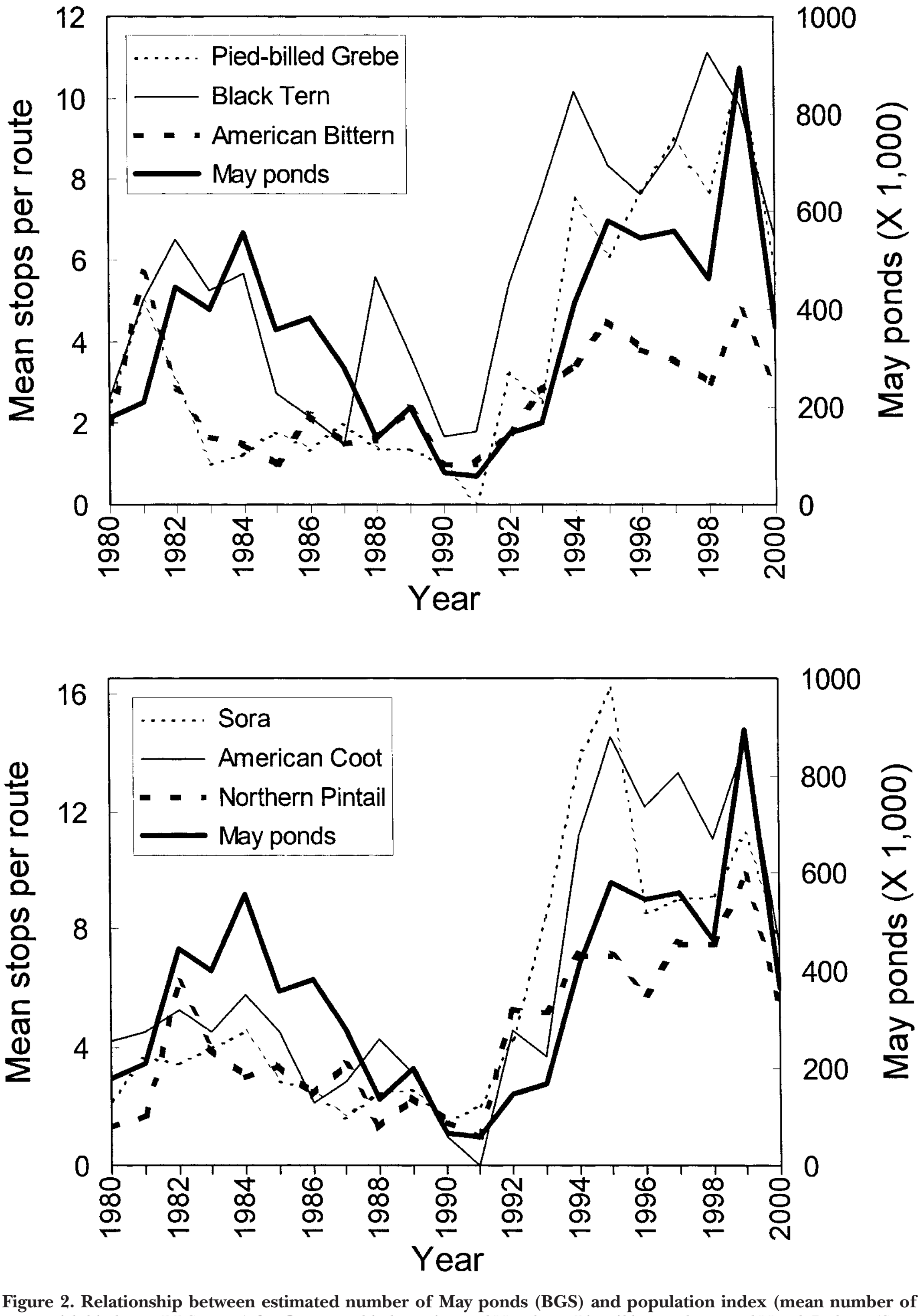

Figure 2. Relationship between estimated number of May ponds (BGS) and population index (mean number of stops with birds per BBS route) for five waterbird species and Northern Pintail in north-central North Dakota (Stratum 45), 1980-2000.

Table 1. Percentage of sample points at which waterbird species were detected and mean number of birds detected per route for BBS routes conducted in 1991 (N = 10) and 1999 (N = 13) in BGS Stratum 45 in north-central North Dakota. During the survey period, wetland numbers were lowest and highest in 1991 and 1999, respectively.

	Percentage of stops		Mean birds per route	
Species	1991	1999	1991	1999
Pied-billed Grebe	0.0	19.7	0.0	12.2
Black Tern	1.8	16.6	1.7	40.2
American Bittern	0.4	8.8	0.2	5.1
Sora	0.4	22.5	0.2	16.6
American Coot	0.0	28.6	0.0	41.2
Northern Pintail	0.8	18.2	0.7	18.9

Implications for Monitoring and Management

Our results have implications for monitoring and management of waterbirds in the PPR. Wetlands, and therefore wetland birds, are thought to be poorly sampled by the BBS (Bystrak 1981). But some species of waterbirds are well represented on BBS routes in our region (Table 1), which has numerous small wetlands in proximity to the roads on which BBS surveys are conducted. In fact, some BBS stops in North Dakota have 26 wetland basins within 400 m or up to 77% of the area within 400 m covered by wetland basins mapped by the National Wetlands Inventory (unpublished data). Secretive or rare waterbirds such as Yellow Rail (*Coturnicops noveboracensis*) and colonial waterbirds such as Western Grebe (*Aechmophorus occidentalis*) are detected infrequently on BBS routes in our study area, although both breed there (Stewart 1975) and Western Grebe is commonly observed on BGS in North and South Dakota east of the Missouri River (J. W. Solberg, personal observation). Species such as these might require different sampling methods (e.g., night-time surveys, call-playback, visits to colonies) to adequately determine presence and density. However, presence of all waterbird species is likely influenced by water availability, and resultant redistribution of birds to areas with water may confound apparent population trends.

Management of waterbird habitat in the PPR should consider that wetland numbers, water levels, landscape characteristics, and waterbird populations are not stable in space or time. Consequently, wetlands must be protected and managed over large geographic areas to ensure that suitable habitat is available under different precipitation regimes, which may vary among and within regions. Protecting a diversity of wetland types within each region may be necessary to meet habitat preferences of different species and provide suitable habitat at different water levels. Conservation strategies should also consider variability in waterbird habitat and numbers. Habitat models used in conservation planning should be based on multiple years of data and provide some indication of the variability of a system and how frequently habitat is likely to be suitable. Similarly, monitor-

Table 2. Spearman's rank correlation between May pond numbers and three population indices (mean number of birds per route, mean number of stops with birds per route, and percentage of routes with birds) for five waterbird species and Northern Pintail in North Dakota, 1980-2000 (all P < 0.01). Values in parentheses represent Spearman's correlation between May pond numbers lagged one year and the same three population indices.

	Pied-billed Grebe	Black Tern	American Bittern	Sora	American Coot	Northern Pintail
Birds per route	0.63 (0.40)	0.62 (0.35)	0.55 (0.20)	0.70 (0.35)	0.73 (0.55)	0.65 (0.40)
Stops per route	0.61 (0.43)	0.68 (0.38)	0.61 (0.26)	0.75 (0.39)	0.83 (0.56)	0.77 (0.45)
Percent of routes	0.69 (0.76)	0.54 (0.43)	0.66 (0.54)	0.83 (0.66)	0.85 (0.77)	0.73 (0.28)

ing efforts and conservation plans need to consider broad-scale and local patterns of spatial and temporal variability in distribution and density, as well as factors that influence productivity of waterbirds. Understanding changes in waterbird distribution and density in response to wetland availability is critical to waterbird monitoring and management.

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