The northern pintail in North America: status and conservation needs of a struggling population

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The number of northern pintails (*Anas acuta*) in North America continues to be low despite substantially improved wetland habitat conditions as recorded by the May Breeding Population and Habitat Survey (May Survey, United States Fish and Wildlife Service [USFWS] 1998; Figure 1). In 1993–97, following extended drought during the 1980s and early 1990s, favorable precipitation patterns returned to the critical waterfowl nesting areas of the northern Great Plains of the United States (U.S.) and Canada (USFWS 1997), the area known as the Prairie Pothole Region (PPR, Bellrose 1980). Historically, when the number of wetlands (May ponds) counted on the May Survey increased in the PPR, pintail breeding populations (BPOP) also increased (e.g., Smith 1970). However, even though May ponds attained record high levels in 1996 and 1997, the expected increase in pintail populations did not occur (Figure 1). Even after a 30% increase in the BPOP between 1996 and 1997, pintails remained 19% below the long-term average and 36% below the North American Waterfowl Management Plan (NAWMP) goal of 5.6 million (USFWS et al. 1994); additionally, peaks and lows in pintail BPOP have been successively lower since 1955–56 (Figure 1). In contrast, all other PPR-nesting dabbling ducks (tribe *Anatini*) rebounded in the 1990s to levels that exceeded objectives set by NAWMP (USFWS 1997). The minimal recovery of pintails is perplexing, given the very large populations attained during previous periods of abundant May ponds (Figure 1).

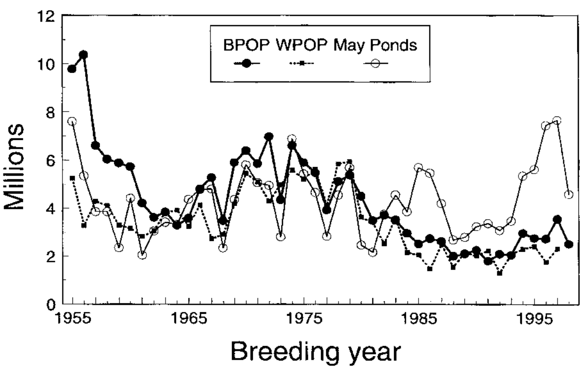

Figure 1. Northern pintail breeding population indices (BPOP, all strata) and unadjusted May ponds (strata 26–49) from the annual May Breeding Population and Habitat Survey and the midwinter population inventory (WPOP) for breeding years 1955–98.

We review status of pintail BPOP and wintering populations, and aspects of survival, recruitment, and changes in PPR land-use that best seem to explain the serious decline of pintails. We conclude with recommendations for conservation and research designed to remedy factors limiting population growth. The USFWS, Office of Migratory Bird Management, Laurel, Maryland, provided data for analyses. For BPOP, we used data through spring 1998. For winter indices, age ratios, and harvest, we used data through breeding year 1997 (fall–winter 1997–98). We used unadjusted May ponds, rather than the more commonly used adjusted May ponds (Smith 1995) because Raveling and Heitmeyer (1989) found a greater correlation between pintail population parameters and unadjusted than adjusted May ponds and because data for unadjusted May ponds are available beginning in 1955, compared to 1961 for adjusted ponds (Smith 1995).

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Nesting regions and population status

The most important pintail nesting regions include the PPR of Canada (Alberta, Saskatchewan, Manitoba; survey strata 26–40) and the U.S. (Montana, North and South Dakota; survey strata 41–49), and the forest and tundra habitats of Alaska, Yukon, and the western Northwest Territories (survey strata 1–13, see Smith 1995 for strata location). These strata normally account for 85–98% of all pintails recorded on the surveys, and stratum 32 in Saskatchewan (prairie) is particularly important, having contained 16–29% of total BPOP in wet years (from Smith 1995). During the 1950s to early 1980s, pintail BPOPs typically exceeded May ponds; however, since 1982, May ponds have exceeded the BPOP (Figure 1). As a result, pintail BPOP only loosely correlates with May ponds over the long term (1955–1998, r=0.36, df=42, P<0.02), and the correlation was stronger for 1955–82 (r=0.70, df=26, P<0.001) than 1982–98 (r=0.54, df=15, P<0.05); pintails are no longer as strongly attracted to the PPR.

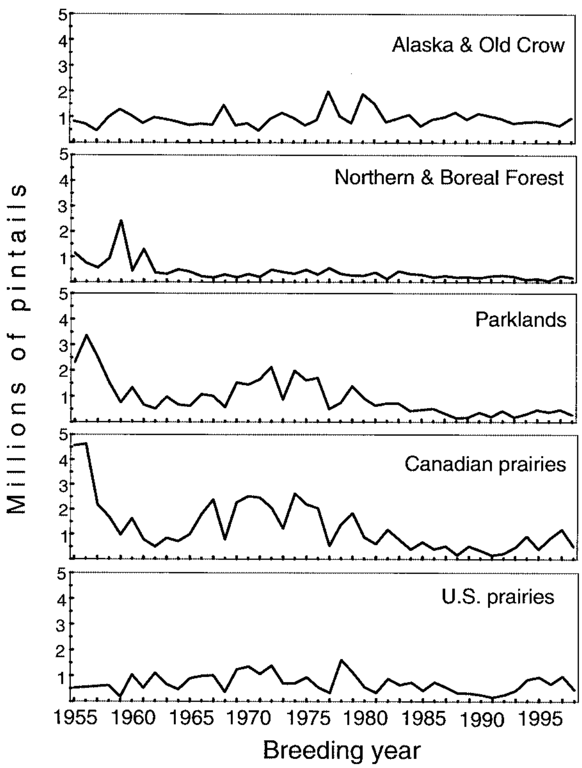

Figure 2. Northern pintail breeding population indices (BPOP) by survey region from the annual May Breeding Population and Habitat Survey in North America, 1955–98. (Note: U.S. prairie data for 1955 to the early 1960s are statistical estimates.)

Long-term trends in pintail BPOP vary by surveyed region (Figure 2). Canadian prairie and parklands each had very high BPOPs in the 1950s and 1970s and lower ones in the 1960s and 1980s–90s. However, as May ponds increased markedly beginning in the mid-1990s, pintails increased moderately in Canadian prairie but not at all in parklands. In northern forested regions, pintails were unusually abundant only in the late 1950s, with lowest numbers in the 1990s. Pintails were numerous in U.S. prairie (Dakotas and Montana) during the 1970s, declined in the 1980s and early 1990s, but then recovered to near-1970s levels by 1997.

Historical pintail BPOP density (pintails/km^2) correlated positively with total and local pond counts in the PPR, but correlations were lower in parklands than prairie (Johnson and Grier 1988). In northern areas, breeding density correlated negatively with total May ponds (Johnson and Grier 1988) because pintails migrate north during droughts in the PPR (Hansen and McKnight 1964, Smith 1970, Derksen and Eldridge 1980). We updated pintails/km^2 (BPOP/area of strata [area provided in Smith 1995]) and also estimated density as pintails/pond (BPOP/May ponds). The long-term patterns of both measures of density, especially pintails/km^2 and pintails/pond in prairie, reflect the trend in BPOP (Figure 3). We found that pintails/pond in prairie strata routinely exceeded that in parkland strata and especially so prior to 1980 (Figure 3*a*). Pintails/km^2 tended to be greater in parklands because of a greater density of ponds (Bellrose 1980), but this relationship switched in the early 1990s (Figure 3*b*).

Both measures of pintail BPOP density have typically been greater in Canadian than U.S. prairie (Figures 3*c*, *d*) and densities in the 2 countries are only moderately correlated (pintails/pond: r=0.58, df=42, P<0.001; pintails/km^2: r=0.35, df=42, P<0.02). These differences were particularly noteworthy in the 1950s and 1960–70s, both periods of abundant ponds and large BPOPs. However, in the early 1960s and mid-1980s to early 1990s, densities were similar in both countries because of large declines in Canadian prairie. The large increase in May ponds in the mid-1990s (Figure 1) did not result in a relative and substantial increase in pintail densities in Canadian or U.S. prairie (Figure 3*c*, *d*).

The Pacific Flyway is the largest conduit for pintails in North America. During fall migration, most pintails from key nesting regions migrate primarily to California, followed by Texas, Louisiana, Arkansas,

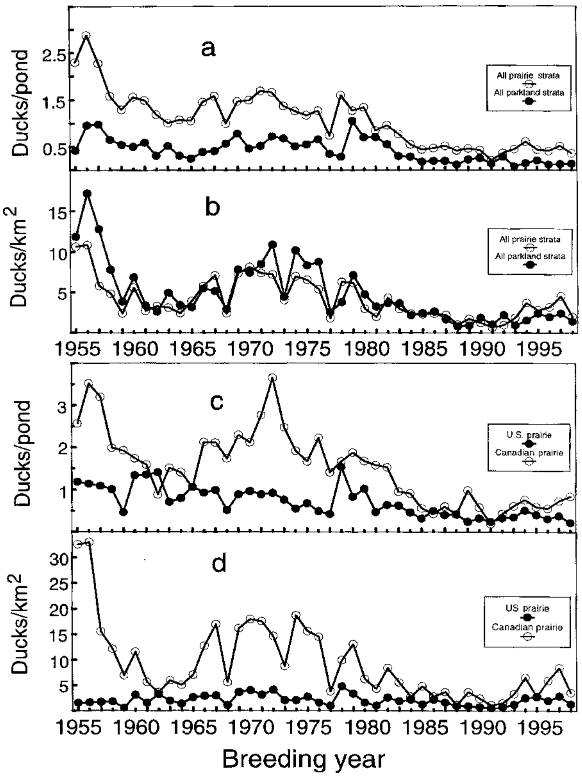

Figure 3. The density of breeding northern pintails in all prairie and parkland strata (labeled "*a*" and "*b*") and in U.S. and Canadian prairie strata (labeled "*c*" and "*d*"), estimated as pintails/km^2 and pintails/pond using annual May Breeding Population and Habitat Survey data, 1955–98.

and Mexico, with only small numbers to the southern Atlantic Coast (Bellrose 1980). Pintails show a greater fidelity for the Central Valley of California (80% returning in succeeding years) than to Puget Sound, Chesapeake Bay, and Gulf Coast wintering regions (two-thirds returning, Hestbeck 1993*a*). Because of winter fidelity, habitat conditions on these key wintering areas can potentially affect population status directly. The long-term trend of the continental winter population (WPOP; Midwinter Inventory, USFWS, Office of Migratory Bird Management, Laurel, Md., unpublished data) correlates moderately with the BPOP from 1955 to 1997 (r=0.67, df=41, P<0.001) and strongly from 1957 to 1997 (large BPOPs in 1955–56 were not accompanied by large WPOPs, r=0.85, df=41, P<0.001).

Explanations for poor pintail status

Why hasn't the North American pintail population responded more strongly to the record increase in May ponds in the 1990s? Apparently, the root of the problem is chronic, because pintails failed to respond to increased numbers of ponds even in the mid-1980s (Figure 1). The causes stem from reduced survival, inadequate recruitment of young ducks into the adult population, or both. Reduced survival could result from increased loss of adults and fledged juveniles to disease, predators, or high harvest rate. Inadequate recruitment could result from low nest success, hen success, brood success, or all 3; disproportionate increases of May ponds in strata not important to pintails; deterioration of winter habitat conditions; or significant loss or alteration of nesting habitat over a wide area. We examine each of these potential explanations.

Survival

Pintail harvest. The pintail has been a major harvest species only in the Pacific Flyway (Figure 4), and pintails compose an important percentage of the duck harvest only in California, Texas, Louisiana (Martin and Padding 1998), and Mexico (Kramer 1995). Canadian pintail harvest averages only about 9% of that in the U.S. (Martin and Padding 1998), and Mexican harvest is insignificant (Kramer 1995). U.S. pintail harvest was very correlated with continental BPOP (r=0.93, df=35, P<0.001) and WPOP (r=0.85, df=35, P<0.001) from hunting season 1961–62 (the first year of harvest data acquisition) to 1997–98. Direct recovery rates of adult pintails are typically low, having been <2% of recent Pacific Flyway preseason bandings (Dubovsky 1996), 2.1–3.8% for preseason-banded adult males in Saskatchewan (Anderson and Sterling 1974), and generally <4% for winter (postseason) bandings (Hestbeck 1993*b*). Harvest rate was <3% for adult

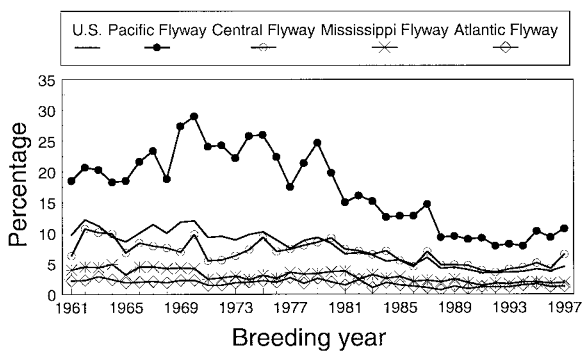

Figure 4. Northern pintail harvests as percentages of total duck harvest for the U.S. and for each flyway, breeding years 1961–97.

pintails banded preseason in southern Alberta and Saskatchewan and the Missouri River Basin just before liberalization of regulations in 1994 (USFWS and Canadian Wildlife Service 1992). Raveling and Heitmeyer (1989) found that percentage change in pintail BPOP was more strongly related to spring habitat variables than to harvest. Thus, only a relatively small proportion of the fall flight of pintails is harvested annually under restrictive or liberal hunting regulations.

Natural mortality. Predation is a major source of mortality for pintails during the nesting season. Sargeant et al. (1984) found that pintails had the greatest red fox (*Vulpes vulpes*) predation rate index relative to other ducks; about 75% of pintails killed in North Dakota were hens and red fox killed about 1 nesting female pintail/km^2, a large proportion relative to nesting densities in U.S. prairie (see Figure 3*d*). The red fox also is an important predator of nesting pintails in Alaska (J. B. Grand, United States Geological Survey, Alaska Biological Science Center, Anchorage, personal communication).

Avian botulism (*Clostridium botulinum*) and cholera (*Pasturella multocida*) are the diseases most often diagnosed in ducks, and 13–40% of carcasses collected in the U.S. and Canada have been pintails (see Austin and Miller 1995, Pybus and Eslinger 1996). Cholera is chronic continent-wide (Friend 1987), and although botulism is not a new problem on the prairies (reports date from the 1920s), very large losses have occurred recently in Canada and the U.S. For example, losses at Pakowki (Alberta), Old Wives (Saskatchewan), and Whitewater (Manitoba) Lakes in 1997 likely exceeded 350,000 pintails (G. A. Wobeser, Canadian Cooperative Wildlife Health Centre, Saskatoon, Sask., unpublished report, January 1998), and 100,000 died in the Bear River marshes in Utah (T. W. Aldrich, Utah State Division of Wildlife Resources, Salt Lake City, Ut., personal communication). These losses occurred mainly after nesting and before the hunting season and could have depressed pintail WPOP and harvest (Pybus and Eslinger 1996). Pacific Flyway WPOP would be affected disproportionately because >half of the pintails originating from the botulism areas migrate to California and other western states (Low 1949, Van Den Akker and Wilson 1949, Dubovsky 1996).

Survival rates. Despite harvest, predation, and disease mortality, pintails tend to survive at high annual rates relative to other dabbling ducks (Bellrose 1980, Rienecker 1987, Hestbeck 1993*b*), and Hestbeck (1995*b*) showed that pintail survival during 1980–92 was generally greater than or equivalent to earlier periods characterized by larger BPOPs (Figure 1). This suggests that mortality has not contributed to the decline of pintails. Adult survival rate had a greater influence than recruitment on modeled pintail population growth in an Alaskan study (Flint et al. 1997), but we do not know whether this same relationship holds in the PPR. High survival would seem to benefit pintails, but continued low BPOP suggests that recruitment has been too inconsistent to produce sustained and rapid population growth when habitat improved.

Recruitment

Inherent breeding biology. Pintails tend to lay clutches 1 to 2 eggs smaller than other dabbling ducks (7.0–7.6 eggs in Alaska and 6.0–8.3 in the PPR, see review by Austin and Miller 1995). Pintails nest relatively early in the season (Higgins 1977, Bellrose 1980, Duncan 1987*a*, Greenwood et al. 1995, Grand et al. 1997), and poor weather (Krapu 1977, Greenwood et al. 1995) and greater predation at a time of limited prey and sparse nest cover (Crabtree and Wolfe 1988, Greenwood et al. 1995, Beauchamp et al. 1996*a*) often cause nests to be unsuccessful. In the PPR, pintails show a stronger predilection to nest in sparse cover, burned areas, and grain stubble than do other species (Milonski 1958, Keith 1961, Higgins 1977, Klett et al. 1988, Greenwood et al. 1995, Table 1), and they can nest relatively farther from water (Keith 1961, Bellrose 1980, Duncan 1987*b*). Use of sparse cover and dispersed nesting, which contributes to nesting in stubble fields over vast areas, may make nests vulnerable to loss. In Alaska, fewer habitat types are available and pintails and other dabbling ducks nest in meadows (Minto Flats [Petrula 1994]) or slough banks (Yukon– Kuskokwim Delta [Grand et al. 1997], Table 1).

Nest success and causes of nest loss. A wide array of mammalian and avian species prey on pintail nests (Sargeant et al. 1984, Petrula 1994, Sargeant et al. 1995, Flint and Grand 1996). Additionally, the California gull (*Larus californicus*) may be a significant new predator of pintail nests in Alberta (G. R. Stewart, Ducks Unlimited Canada, Edmonton, Alta., personal communication), and flooding destroys nests in Alaska (Petrula 1994, Flint and Grand 1996). Nest success (Mayfield 1961) of pintails in the PPR has been only 7–10% in large, modern studies (Table 2), but even these esti-

Table 1. Proportionate use of cropland and untilled upland habitats for nesting by northern pintails and other ducks in the prairies of Canada and the United States and in Alaska.

	Percentage of use				
Habitat type	Pintail	Mallard	Blue-winged teal	Shoveler	Gadwall
Canadian and United States prairies and parklands[a]					
Cropland[b]	34–74	5–10	0–23[c]	0–28[c]	0–5
Untilled uplands[d]	26–66	90–95	78–99	72–99	95–99
Alaska					
Meadow[e]	68–95	49–93	——	73–99	——
Other[e,f]	5–32	7–51	——	1–27	——
Slough banks[g]	69	——	——	——	——
Shoreline[g]	22	——	——	——	——

[a] Data from Milonski 1958, Higgins 1977, Klett et al. 1988, Greenwood et al. 1995.

[b] Cropland: standing stubble, mulched stubble, summer fallow, growing grain; any annually tilled lands.

[c] Cropland use is in growing grain for these species (Higgins 1977).

[d] Untilled uplands: native grasslands, haylands, pastures, odd areas, rights-of-way, brush, etc.

[e] Data from Petrula (1994).

[f] Floating vegetation, boreal forest, alder–willow thicket, black spruce bog, mixed shrub.

[g] Data from Grand et al. 1997.

mates are likely biased high because most PPR nesting studies have included few nests in grain stubble (Beauchamp et al. 1996*a*), where large numbers of pintails nest, albeit unsuccessfully (Milonski 1958, Higgins 1977, Klett et al. 1988, Greenwood et al. 1995). Because of this trait, the pintail is the only species in which agricultural activities, primarily cultivation (Milonski 1958, Higgins 1977), cause major nest losses (Table 3).

In the Dakotas, predators reduced nest success of all ducks to <10% on scattered federal waterfowl production areas (e.g., Sargeant et al. 1995), and success has been only marginally better in planted cover (e.g., Klett et al. 1988, McKinnon and Duncan 1999). Species differences in nest success within habitats are seldom statistically significant (Klett et al. 1988, Greenwood et al. 1995), and these levels of nest success are less than the 15% necessary to maintain stable populations (Klett et al. 1988). However, in large, unbroken tracts of grazed grasslands in Montana, where few predators were present, duck productivity equated to nest success of 45–60% (Ball et al. 1995), and high nest success also was achieved in vast Conservation Reserve Program (CRP) lands in the Dakotas (Reynolds et al. 1994). In Alaska, nest success of pintails has ranged from only 2–4% at Minto Flats (Petrula 1994) to 11–43% on the Yukon Delta (Flint and Grand 1996). The former estimate would not sustain local populations.

In the PPR, apparent nest success of pintails was similar to that of other ducks in early studies, but recent Mayfield estimates have usually been lower than for other ducks (Table 2). Beauchamp et al. (1996*a*) found that nest success of all studied species declined since the 1930s, but pintails nested less successfully than the others. Although predation causes most losses of pintail nests in uncultivated uplands, ranging from 29 to 67% in the PPR (Milonski 1958, Keith 1961, Klett et al. 1988, Greenwood et al. 1995) and 36 to 70% in Alaska (Petrula 1994, Flint and Grand 1996, Table 3), Beauchamp et al. (1996*b*) concluded that decreasing nest success since the 1930s may not have

Table 2. Nest success of northern pintails and other duck species, where several species were studied simultaneously, during the 1950s and 1960s compared to the 1980s and 1990s in Canada and the United States.

	Nest success rate (%)					
	Early studies (Apparent rate)			Recent studies (Mayfield rate)		
Species	Keith 1961	Stoudt 1971	Smith 1971	Klett et al. 1988	Greenwood et al. 1995	Petrula 1994
Northern pintail	48	43	40	7–10	7	3.8
Mallard	33	42	31	6–8	11	11.6
Blue-winged Teal	48	32	41	11–17	15	—
Northern Shoveler	50	50	—	10–16	12	5.3
American wigeon	25	9	—	—	—	10.6
Green-winged Teal	25	39	—	—	—	13.5
Gadwall	16	31	—	12–16	14	9.5

Table 3. Percentage of destroyed pintail and other duck nests lost to various mortality sources.

	Percentage of nests				
Species/Location	Predation	Agriculture	Flooding	Other	Source
Pintail					
Alberta	46	0	0	6	Keith 1961
Prairie Canada	65	17	0	12	Greenwood et al. 1995
Manitoba	29	56	4	12	Milonski 1958
Prairie U.S.	67	22	0	3	Klett et al. 1988
Alaska	46–64	0	0–23	0–8	Petrula 1994
Alaska	36–70	0	1–15	10–12	Flint & Grand 1996
Others					
Alberta	55	0	0	13	Keith 1961
Prairie Canada	72	2–3	0	15	Greenwood et al. 1995
Prairie U.S.	79–82	4–7	0	4–5	Klett et al. 1988
Alaska	34–73	0	0–26	0–4	Petrula 1994

resulted directly from increasing predation over time.

The proportion of hens that renest after loss of the initial nest is similar for mallards (*Anas platyrhynchos*) and pintails (Table 4); however, few pintails make more than 2 attempts, whereas mallards are more persistent. Therefore, late spring rains following dry winters may provide adequate wetlands for mallards (Bellrose 1980), but would not assist pintails, which continue northward if their primary nesting areas are initially dry. Ultimately, this trait results in lower nest success where loss of first nests is very high, such as for pintails in stubble fields. Low nest success and minimal renesting of pintails lead us to believe that pintail hen success (proportion of hens that hatch >1 egg) is lower than for mallards.

Brood and duckling survival. Ducklings from widely dispersed nests in the PPR do not suffer high predation rates while moving to water (Duncan 1983, 1987*b*), but in Alaska, predation by the glaucous gull (*Larus hyperboreus*) takes a great toll during overwater movements to distant brood areas (Grand and Flint 1996*a*, Grand et al. 1997). Pintail brood survival (at least 1 duckling surviving) was estimated at 29% and 72-88% in Alberta (Duncan 1986, Guyn and Clark 1999) and 18-45% in Alaska (Grand and Flint 1996*a*). These values encompass the 34-70% for PPR mallards (Ball et al. 1975, Talent et al. 1983, Orthmeyer and Ball 1990, Rotella and Ratti 1992). Pintail duckling survival was 4-14% in Alaska (Grand and Flint 1996*a*) and 42-65% in Alberta (Guyn and Clark 1999), bracketing mallard duckling survival in the PPR (22-40%, Talent et al. 1983, Orthmeyer and Ball 1990, Rotella and Ratti 1992). Thus, pintail broods and ducklings probably survive at rates comparable to those of other species.

Age ratios in the harvest. Harvest age ratios (young:adult) provide an approximation of recruitment, and ratios have typically been lower for pintails than for other dabbling ducks (Padding et al. 1998), seeming to verify relatively low recruitment rates in pintails. Ratios averaged greatest in the

Table 4. Renesting rates (percentage of hens that attempt to renest at least once) and renesting frequency (number of times hens attempt to renest) of northern pintails and mallards.

Species/Location	Renest rate (%)	Renest frequency	Sources
Pintail			
Alaska	56	2 (actual)	Grand & Flint 1996*b*
Alaska	31[a]	2 (actual)	Esler & Grand 1994
Manitoba	25–40	2–3 (actual)	Sowls 1955
Manitoba	29–43[b]	Not reported	Milonski 1958
Alberta	0–4	1–2 (actual)	Duncan 1987*a*
Alberta	46	—	K. Guyn, unpublished data
North Dakota	56	—	G. Krapu, unpublished data
Mallard			
Various	30–57	>5 (maximum)	Bellrose 1980
Mallard			
Parkland Canada	—	1.1–2.9 (means)	Paquette et al. 1997
Mallard			
Alberta	60–81[c]	1-6	Rotella et al. 1993

[a] Proportion of collected hens that showed signs of previous nesting.
[b] Proportion of nests located that were classed as renests based on date.
[c] Mallards with abdominal implanted and sutured backpack radiotransmitters only.

1960s, generally increased from 1961 to 1969, then declined, but trends are not evident thereafter until the marked increase in 1997 (Figure 5). Smith (1970) demonstrated how pintail age ratios increased as the proportion of pintails increased in southern Alberta and Saskatchewan during 1961–68 (r>0.90). However, Hestbeck (1995*a*, *b*;1996) updated the analyses through the early 1990s to determine whether a disproportionate increase in recruitment occurred in wet years on the prairies when proportionately more pintails were present. He concluded that this never had been true for the eastern 3 flyways and is no longer true for the Pacific Flyway and that PPR recruitment rates had declined to those in northern areas. Flint and Grand (1996) verified that pintail recruitment in Alaska was equal to that in the PPR. However, age ratios increased in the mid-1990s, especially 1997 (Figure 5), showing that pintails can still be productive when wetland conditions (May ponds) are extraordinary. Even so, pintail BPOP fell steadily from 1972 to 1991, suggesting that recruitment was generally not sufficient to maintain the large populations observed in the early 1970s; further, BPOP declined markedly in 1998 despite high age ratios in 1997 (Figure 1).

Distribution of ponds. To determine whether dramatic increases in May ponds in the 1990s occurred in strata critical to pintail population growth, we categorized as pintail-rich strata those that had pintail breeding population densities (ducks/km^2) in the first and second quartile, as presented by Johnson and Grier (1988), together with >100,000 breeding pintails on a regular basis during the 1970s (Smith 1995), the last period of pintail abundance. Strata that met these criteria included Alberta 26–29, Saskatchewan 30–35, Montana 41, North Dakota 45 and 46, and South Dakota 48. Strata 26, 30, 31, 34, and 35 are located in the parklands and the others are in prairie (Smith 1995). We examined abundance of May ponds and BPOP within prairie and parkland strata separately to determine whether they were included in the overall increased counts of May ponds from 1994–97.

In pintail-rich prairie strata, pintail BPOP increased moderately through 1997, but fell below May ponds after 1982. Concurrently, May ponds reached record high levels during 1994–97, and the gap between May ponds and BPOP widened some-

Table 5. Decade means of age ratios (young:adult) in the harvest of northern pintails and other ducks (sexes combined; United States Fish and Wildlife Service, Office of Migratory Bird Management, Laurel, Md., unpublished data).

	Age ratios (young:adult)			
	1961–69	1970–79	1980–89	1990–97
Northern pintail	1.26	1.12	0.93	1.07
Mallard	1.31	1.23	1.12	1.02
Blue-winged teal	2.12	2.30	1.86	2.02
Gadwall	1.74	1.59	1.16	1.29
Green-winged teal	1.67	1.82	1.64	1.53
American wigeon	1.65	1.65	1.31	1.21

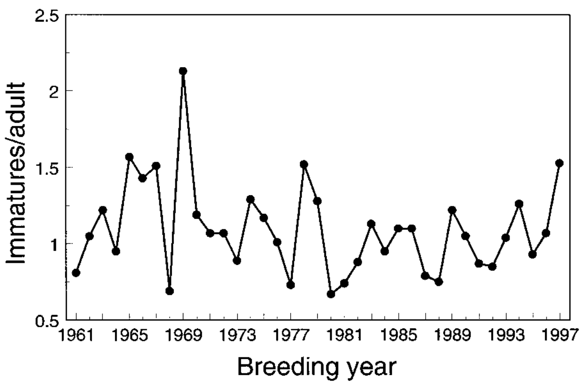

Figure 5. Northern pintail harvest age ratios in the United States, breeding years 1961-97.

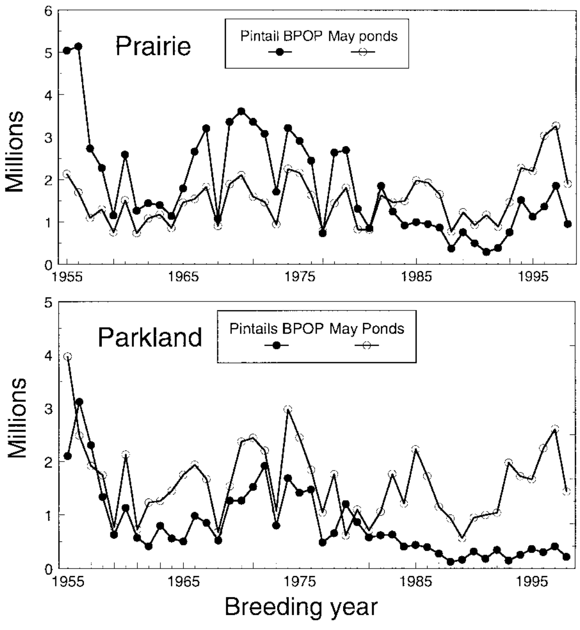

Figure 6. Northern pintail breeding population indices (BPOP) and unadjusted May ponds in pintail-rich prairie strata (27–29, 32, 33, 41, 45, 46, 48) in Alberta, Saskatchewan, Montana, North Dakota, and South Dakota and pintail-rich parkland strata (26, 30, 31, 34, 35) in Alberta and Saskatchewan, breeding years 1955-98.

what (Figure 6). Thus, pintails increased to levels considerably lower than expected in prairie, given the historical relationship between pintail BPOP and May ponds. In pintail-rich parkland strata, May ponds in 1993–96 reached levels similar to those of the 1960s and 1970s and increased to the third greatest ever recorded in 1997; however, pintail BPOP failed to increase, and the gap between May ponds and BPOP widened markedly (Figure 6). May ponds and pintail BPOP have decoupled in the parklands. Therefore, May ponds did increase in those strata most important to pintail production, but the response by pintails was well below expectations.

May ponds have been much more abundant in Saskatchewan than in either the U.S. or in Alberta (Figure 7), demonstrating the potential importance of that province to pintail production. Before 1998, May ponds increased to historically high levels in Saskatchewan and Alberta parkland and prairie, consistent with earlier periods of large pintail BPOP, and in 1997, May ponds in U.S. pintail-rich strata increased to levels twice that ever recorded (Figure 7); however, pintail BPOP barely increased in 1997. These data suggest that probability is low for further increases in ponds in all regions, and future increases in pintail BPOP will not result from

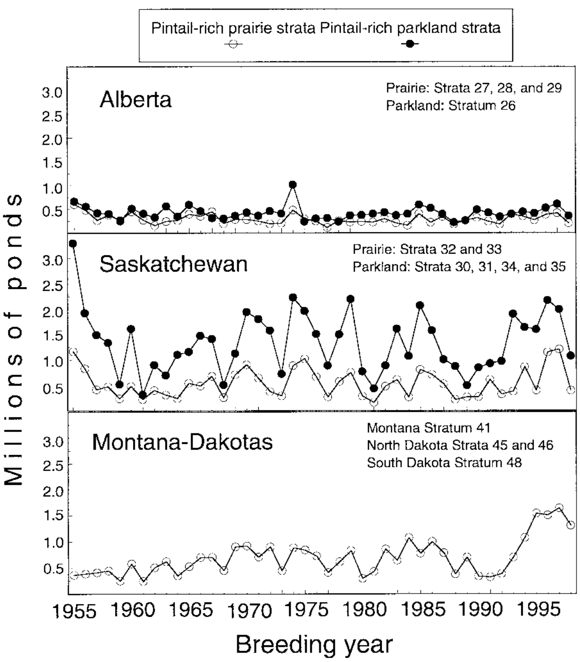

Figure 7. Unadjusted May ponds in pintail-rich prairie and parkland strata in Alberta, Saskatchewan, and United States prairies (Montana, North and South Dakota), breeding years 1955-98.

an increasing number of May ponds. Further, the disproportionate divergence between May ponds and BPOP in pintail-rich parkland versus prairie strata strongly suggests that pintails must "fill" prairie habitats before "spilling over" into the parklands. This explains the large numbers of pintails in both prairie and parklands in the 1950s and 1970s. Pintails prefer prairie habitats for nesting and prairie can support many more pintails than now are present.

Winter habitat effect on recruitment. Pintails arrive on nesting grounds with fat reserves obtained from foraging on winter and spring migration areas (Krapu 1974, Mann and Sedinger 1993, Esler and Grand 1994). These reserves support initial clutch production in mallards (Krapu 1981) and presumably in pintails. Mallard hens in relatively better condition may nest earlier, devote more days to egg laying and incubation, and produce more nests (J. H. Devries, Ducks Unlimited Canada, unpublished data); therefore, winter habitat probably affects pintail recruitment under certain circumstances (Raveling and Heitmeyer 1989). NAWMP projects have improved winter habitat in the Pacific Flyway (Williams 1996), and more extensive habitats in California (1997 progress report of the Central Valley Habitat Joint Venture, Sacramento, Calif., unpublished data) could positively impact pintail BPOP (Raveling and Heitmeyer 1989). We caution, however, that marshes important to pintails along the Gulf Coast continue to deteriorate (B. C. Wilson, Gulf Coast Joint Venture, Lafayette, La., unpublished data), and the effect on pintail BPOP is unknown.

Conversion of grasslands to cultivated agriculture. Bethke and Nudds (1995) compared duck BPOPs in Canadian PPR to the influence of climatological and agricultural variables since the 1950s. Their analysis estimated a "deficit" of 1.6 million pintails (and large deficits of other species) in 1989, or 45% of predicted abundance, based on the historical relationship between pintail BPOP and wetland conditions (May ponds and conserved soil moisture) during 1955–74. They concluded that duck deficits resulted from continued westward expansion of small grain agriculture in the Canadian PPR, which eliminated upland nesting habitats (native prairie), and that proportionate loss of these habitats was similar during 1950–70 (9–53% among strata) and 1970–90 (5–67% among strata). M. W. Miller and T. D. Nudds (unpublished data) updated the analysis through 1996, including data for United States PPR, and found pintail deficits in both countries, but they were >350% larger in Canada. The investigators attributed the regional disparity to the positive effects of CRP in the United States, where nest success of ducks was relatively high (Reynolds et al. 1994), and the absence of such an analog in Canada.

Conclusions and recommendations

The steady conversion of grasslands to cultivation in the western Canadian PPR since the 1950s and 1970s has markedly reduced the extent of safe upland nesting habitat, thereby reducing pintail productivity to levels below the threshold needed to maintain populations. Grain stubble attracts large numbers of pintails to nest in the early spring, and cultivation destroys virtually all nests. Additionally, Greenwood et al. (1995) and Boyd (1985) showed how nest success of prairie ducks, even those that don't nest in cropland, declined as the proportion of cropland increased in the landscape because suitable nest sites in scattered grasslands and planted cover were rare and predators more efficient. Most wetlands in the PPR have been impacted by agriculture (Boyd 1985, Turner et al. 1987), and more than 85% of the region has been cultivated (Millar 1989). Because pintails do not renest persistently, there is little potential to recover from these large-scale losses of first nesting attempts. The logical outcomes have been steady decline of the BPOP and failed recruitment in response to record May ponds in the 1990s. Although mallards and pintails suffer relatively severe predation rates, mallards rarely nest in stubble and the mallard BPOP now exceeds the NAWMP objective. Therefore, the stubble-nesting characteristic probably is most responsible for the failure of pintails to recover.

Restoration of pintail abundance must target Canadian prairie, not parklands, and, as CRP in the United States, must focus on restoration and protection of upland nesting habitat, not wetlands. Further, continuing pintail deficits suggest that restoration of large populations will require application of conservation measures at a landscape scale. Habitat management for pintail recovery in the cultivated, grain-growing regions of the PPR must: 1) protect existing mixed-grass prairie critical to pintail nesting; 2) restore vast areas of grassland in Canadian prairie analogous to CRP in the U.S. or the now-inactive Canadian Permanent Cover Program (CPCP, Perlich 1992); 3) continue to develop ranching practices in existing mixed-grass prairie that provide productive pintail nesting habitat while supporting cattle; and 4) encourage cultivation practices that emphasize no-till grain, fall-seeded crops, and direct-seeding of spring-seeded crops to assist nesting in stubble. Research and evaluation must be incorporated into programs to guide pintail population enhancement cost-effectively, and biologically appropriate and socially acceptable predator management programs that complement habitat initiatives may need to be considered.

Grain subsidies have recently been eliminated in Canada (Wettlaufer 1996). Partners of the Prairie Habitat Joint Venture (Canada) and Prairie Pothole Joint Venture (U.S.) of NAWMP could take advantage of this economic situation and implement programs in PPR Canada to protect existing grasslands and plant perennial cover instead of annual crops (CRP or CPCP models, Andrews 1996), as well as reduce impacts on pintails of spring cultivation (e.g., no-till seeding, fall-seeded crops; Ducks Unlimited Canada, unpublished data). Programs need to be expanded that integrate enhanced pintail production with improved cattle grazing practices and discourage conversion of grasslands to croplands in existing mixed-grass prairie of southern Alberta and Saskatchewan (Sankowski et al. 1987). Programs that maintain grazing can provide productive nesting habitat for pintails and, because of their low cost, can be more broadly applied at a landscape level than programs that exclude agricultural use. In the United States, CRP must be preserved when the 10-year contract cycle ends.

If pintail BPOP continues to decline despite excellent wetland conditions and application of new upland habitat programs, then predator management may have to be considered. Sargeant (1996) emphasized that managers could not ignore predation, the most important factor in the PPR affecting recruitment rates other than drought (for pintails, of course, we must add nest losses from farming activities in stubble fields). The problem is that small parcels of uncultivated upland habitats often yield few ducks because so many nests are taken by predators (Garrettson et al. 1996, Sargeant 1996, McKinnon and Duncan 1999). As a result, achievement of BPOP objectives for pintails may not be possible without reducing predation losses (P. Arnold, United States Prairie Pothole Joint Venture, unpublished report). Only recently did

Northern pintails nest in harvested grain stubble more frequently than any other waterfowl species; unfortunately, this trait places their nests at great risk for loss by cultivation associated with spring seeding of grain crops. Photo by Bill Peterson.

Reynolds et al. (1994) show that large blocks of planted grasslands (i.e., CRP) could raise duck production adequate to increase populations, and Ball et al. (1995) verified this in large contiguous tracts of grazed native grasslands. But, if additional landscape-scale habitat programs cannot be implemented or do not increase pintail populations, what choices are there other than to manage predators? This is controversial because of social and biological concerns (Ball 1996), but control effectively increases recruitment of ducks and other birds (Ball 1996, Garrettson et al. 1996, Sargeant 1996). Short of direct removal of predators over large areas at low intensity (Garrettson et al. 1996), other expansive predator management (Sargeant 1996) might consist of increasing coyotes (*Canis latrans*) to suppress smaller, more efficient predators (Sargeant et al. 1993, Sovada et al. 1995). This would offer the best chance of success for pintails, because localized intensive efforts would not match the pintails' characteristic dispersed nesting. To attract public support (Ball 1996), predator management must complement habitat management (Garrettson et al. 1996) and benefit other ground-nesting birds (Reynolds et al. 1994).

Research and evaluation must insure that pintail objectives are achieved cost-effectively (e.g., Anderson et al. 1996, Cox and Afton 1998). A reliable life-cycle model is needed, expanding upon existing production models (Carlson et al. 1993, Flint et al. 1997), to identify data gaps and provide a basis to evaluate management actions. Extensive, long-term field studies are critical to assess pintail distribution and recruitment in important PPR and northern (e.g., Alaska) nesting regions. Studies are needed to better determine proportion and success of pintails nesting in croplands. The role of winter and spring habitats in supporting recruitment of pintails needs to be critically examined. Managers need to know how efficiently the May Survey accounts for pintails in wet and drought years in the PPR and whether types I and II ponds (sheet water, temporary water, small wet areas in fields [Smith 1995]) could be used to better predict pintail BPOP. We support recent USFWS initiatives to comprehensively monitor waterfowl habitat, including uplands, on a large geographic scale (Johnson 1998).

The proportion of the pintail BPOP annually exposed to perennial botulism lakes needs to be estimated, and species, sex and age composition, molt status, seasonality, and regions affected must continue to be quantified to measure the total impact on pintail status in North America. Efforts to examine cost-effectiveness of disease management to reduce or prevent large-scale botulism losses need to continue (Pybus and Eslinger 1996; Wildlife Health Centre Newsletter, Saskatoon, Winter 1998, unpublished data).

Managers should monitor and evaluate agricultural trends in the PPR and important pintail migration and wintering areas. The new strip-harvest technique (Bennett et al. 1993) reduces foraging opportunities for pintails in rice (Miller and Wylie 1997); cotton farming has moved into the Sacramento Valley in California (Cline 1995), threatening the waterfowl-friendly rice industry; and rice acreage has decreased>30% since 1980 in Texas (Patterson 1997).

Ultimately, managers must determine how to achieve the NAWMP population objective for pintails under average wetland conditions, because the

Northern pintails form pairs during winter, a behavior facilitated by extensive quality wetland and agricultural habitats. Photo by Gary Kramer.

unusual 4-year wet period (1994–97), together with NAWMP programs, did not do so. The failure to recover prior to 1998 also means the pintail BPOP would likely sink below the previous record low if a new dry period extends several years; spring 1998 was very dry in pintail range (USFWS 1998), demonstrating that drought or average conditions always return. The USFWS will close the pintail hunting season if the BPOP declines to $\leq$1.5 million and the projected fall flight is <2 million (USFWS, Office of Migratory Bird Management, Laurel, Md., unpublished report). The next prolonged drought in the PPR could well result in such a situation.

We hope our realistic assessment of pintail status and recovery potential provokes thoughtful debate and leads to refreshing innovation in pintail conservation programs that produce the greater rate of recruitment needed to increase the BPOP. We are convinced this approach is superior to basing habitat and population goals on past population levels (Boyd 1991) achieved under recruitment potential that no longer exists. Failure to respond appropriately to the pintail situation may not guarantee threatened-species status for this duck, but it will guarantee the status quo, which is not acceptable.

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