Migration Chronology of Waterfowl in the Southern High Plains of Texas

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Abstract.—Migration chronology was quantified for 15 waterfowl species on 58 playa wetlands in the Southern High Plains of Texas from February 2004 through April 2006. Abundance of each species was estimated on playas once every two weeks during the nonbreeding season (16 August to 30 April); presence of ice was also recorded. Dabbling ducks were most common (N = 250,668) and most tended to exhibit either a bimodal migration pattern (lower abundance in winter than during fall and spring passage) or a unimodal pattern (one defined peak). Abundance of the most common dabbling ducks was skewed toward late winter and spring. Most species of diving ducks (N = 15,128) tended to exhibit irregular migration patterns. Canada Geese (both *Branta canadensis* and *B. hutchinsii*, N = 15,347) had an abundance pattern that gradually increased, peaking in midwinter, and then decreased, which is typical for a terminal wintering area. Ice was most common on playas during the first half of December, which coincided with the lowest winter abundance in dabbling ducks. Data from this study will support management efforts focused on playa wetlands, including the development of population goals and habitat objectives that span the entire non-breeding season. *Received 26 August 2007, Accepted 11 February 2008.*

Key words.—dabbling ducks, diving ducks, geese, migration chronology, playas, Southern High Plains, Texas, wintering waterfowl.

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Migration of waterfowl has long been of interest to ornithologists and waterfowl biologists (e.g., Lincoln 1935; Hochbaum 1955; Bellrose 1957). Early research focused largely on movements and distribution of birds during migration (e.g., Crissey 1955; Bellrose and Sieh 1960; Weller 1964) and on orientation mechanisms (Bellrose 1958, 1963). Recent research has been more varied, addressing such topics as the influence of migration on population demographics (Anderson *et al.* 1992; Iverson and Esler 2006), physiological and behavioral adaptations related to migration (Faraci 1991; Clausen *et al.* 2003; Arzel *et al.* 2007), and inter- and intra-specific migration strategies (Jeske 1996; Prop *et al.* 2003; Arzel *et al.* 2006, 2007).

Despite these efforts, quantitative information describing migration chronology for most major migration and wintering areas in North America is relatively scarce. Bellrose (1980) described the migration chronology of individual waterfowl species for broad geographic regions across the continent, but subsequent studies have typically addressed single species (e.g., Hitchcock *et al.* 1993) or have been for isolated areas (e.g., individual wildlife refuges) and these data are not readily accessible. Yet, such information is critical for conservation planning as demonstrated for wintering Northern Pintails (*Anas acuta*) in the Sacramento Valley, California, (Miller and Newton 1999) and for waterfowl wintering in coastal areas of Texas and Louisiana (Esslinger and Wilson 2001).

We documented the migration chronology of 15 waterfowl species using playa wetlands in the Southern High Plains of Texas. Playas are small, shallow ephemeral wetlands that reach their highest densities in Southern High Plains (Bolen *et al.* 1989b; Smith 2003). Because of the importance of playas as habitat to nonbreeding waterfowl, this region is considered the second most important wintering area in the Central Flyway (Bellrose 1980; U.S. Fish and Wildlife Service 2005) and may be the most important area for certain species (Bergan and Smith 1993).

Obenberger (1982 in Bolen *et al.* 1989a) described migration chronology for four common species of dabbling ducks (*Anas* spp.) wintering in this region during the early 1980s. Simpson *et al.* (1981) also described migration chronology of ducks in the Southern High Plains, but species were grouped, significantly lessening the value of the data for conservation planning. Additionally, surface water in the region has declined greatly since the two studies were conducted due to improved irrigation practices and loss of playas (Smith 2003), so seasonal abundance patterns of waterfowl may have changed.

METHODS

Study Area

Playas are the dominant wetland feature of the Southern High Plains and an estimated 19,340 occur in Texas (Bolen *et al.* 1989a, 1989b). Playas are shallow, generally circular basins within closed watersheds; they average 6.3 ha and experience unpredictable, dynamic wet/dry cycles (Guthery and Bryant 1982; Bolen *et al.* 1989b). Haukos and Smith (1992, 1994) described playas as perhaps the most ephemeral of North America's wetlands. Playas fill intermittently by intense rainfall events associated with isolated thunderstorms, although some receive water from municipal or irrigation runoff (Bolen *et al.* 1989b; Haukos and Smith 1992, 2004). Most rainfall in the Southern High Plains occurs during April-June and September-October, averaging from 33 to 45 cm annually (Bolen *et al.* 1989b).

Playas comprise the primary wetland habitat used by waterfowl in this region (Nelson *et al.* 1983; Bolen *et al.* 1989a; Smith 2003). Mid-winter waterfowl surveys conducted from 2001-2006 result in an average of 216,663 ducks and 135,819 geese occurring in the Texas Playa Lakes Region during early January (Texas Parks and Wildlife Department, unpublished). These estimates are considerably less than those often cited for this area (Nelson *et al.* 1983; U.S. Fish and Wildlife Service 1988; Bolen *et al.* 1989a); however, survey methodology changed greatly in 2001 and playa function has also diminished since the earlier estimates (Smith 2003; U.S. Fish and Wildlife Service 2005). Playas also host a multitude of migrant shorebirds, Sandhill Crane (*Grus canadensis*), and other wildlife (Smith 2003). Upland habitats in the region include agricultural lands (cotton, corn, sorghum and other irrigated and non-irrigated agriculture crops), native shortgrass prairie, and formerly tilled lands now enrolled in the Conservation Reserve Program (i.e., planted back to native or non-native grasses) (Haukos and Smith 1994).

The Southern High Plains area of Texas (Fig. 1) largely corresponds to portions of both the Playa Lakes Region and Bird Conservation Region 18 (i.e., Shortgrass Prairie Region) that lie south of the Canadian River. The Playa Lakes Region is considered a habitat area of major concern within the North American Waterfowl Management Plan (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1986). The Texas portion of Bird Conservation Region 18 of the North American Bird Conservation Initiative is also a planning unit of the Playa Lakes Joint Venture (PLJV).

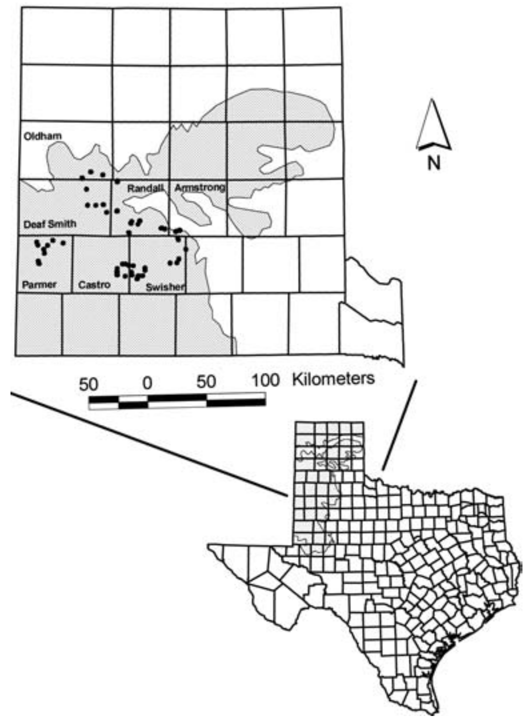

Figure 1. Location of survey playas (filled dots) on the Southern High Plains (shaded area) of Texas. Labels indicate county names. Waterfowl on playas were surveyed from February 2004 through April 2006.

Data Collection

Four survey routes were established containing twelve to 17 playas each (58 total); these routes included playas in seven counties (Fig. 1). Surveys were initiated in February 2004 during an extreme drought period; so the first route was established in an area where the only known wet playas remained from limited rains the previous fall. Indeed, a wet-playa index estimated during January 2004 suggested less than one percent of Texas playas held water (U.S. Fish and Wildlife Service 2005). Subsequent routes were established in response to playas filled by thunderstorms that occurred after the surveys started (two routes in September 2004 and one route in August 2005). All surveys ceased 30 April 2006.

Attempts were made to confine as much of each route as possible to paved roads so that surveys could be conducted under all weather conditions. Playas were chosen that could be viewed from roads with binoculars or a spotting scope. The only other condition was that a playa had to contain water at that time the route was established to be included. Although some of surveyed playas received periodic runoff from crop irrigation or confined animal feeding operations, no routes included playas that were artificially permanent due to year round inflows from agriculture or municipal runoff. Playas were not surveyed when they were dry.

Once a route was established, attempts were made to survey playas once every two weeks from 16 August-30 April. Surveys were started at sunrise and generally completed around noon, although completion times were later when large numbers of birds were present. Waterfowl were recorded by species and counted. Waterfowl flying over playas were not counted unless surveyors caused them to flush. When possible, each individual bird was counted. However, for some surveys, bird numbers were estimated by counting the number of waterfowl observed in the field-of-view and then multiplying that count by the number of fields needed to cover the flock. After the estimated number of waterfowl present was obtained, the playa was scanned again and the percentage of each species present was estimated. That percentage was then multiplied by the total number present on the playa to obtain species-specific estimates. Because of the difficulty of separating them visually in the field, Canada (*Branta canadensis*) and Cackling Geese (*B. hutchinsii*) were combined, and hereafter referred to collectively as Canada Geese. Ice conditions on playas also were estimated on each survey; coverage was recorded as 0-75% ice coverage or >75% ice coverage. A relatively high threshold (75%) was chosen because significant loss of surface water to ice may be associated with short-term depressions in the abundance of waterfowl using playas (Whyte and Bolen 1988).

To estimate migration chronology, the PLJV's biweekly (1-15 and 16-30/31), waterfowl habitat conservation planning periods were used (B. Sullivan, PLJV, unpublished). For each species, numbers were averaged across all playas to obtain a "species-specific per playa average" for each biweekly period. These species-specific, per playa averages were then averaged across years. Almost all playas experienced dry periods, some extended, and there were periods when only a small number of wet playas were available on a given route. No attempts were made to test for playa, route, or year-to-year specific differences.

Biweekly, per playa averages were expressed as a proportion for each species (i.e., per playa averages for each biweekly period were summed through the non-breeding season, and each biweekly period's value was then divided by that sum). Converting data to proportions allowed for easier comparisons of temporal trends across species with vastly different relative abundances; additionally, the PLJV can easily incorporate proportional chronology data into its biological planning efforts (B. Sullivan, PLJV, pers. comm.). For species with less than 100 observations, migration chronology was not quantified.

Migration patterns of each species were classified according to the distribution of their proportions through time; classifications closely followed those of Quan *et al.* (2002). Waterfowl classified as "passage migrants" were absent for four or more consecutive biweekly periods between fall and spring passage. Birds classified as "bimodal migrants" exhibited a migration pattern where the five biweekly winter periods (16 November-31 January) had an average proportion that was less than one-half of either the fall or spring peak, whichever was lower. To obtain peak periods, the highest two consecutive biweekly proportions from the fall, and the highest two from the spring, were averaged. For example, Northern Shoveler (*Anas clypeata*) fall peak averaged 0.075 and spring peak averaged 0.105; Northern Shoveler was classified as a bimodal migrant because its average proportion over the winter period was less than one-half of its fall peak. Waterfowl with a one distinct peak, defined as three consecutive biweekly periods where all proportions are higher in value than any others, were classified as "unimodal." Species that fit more than one defined pattern were categorized as bimodal rather unimodal migrants. All other birds were classified as having an "irregular" migration pattern.

RESULTS

The availability of playas containing water varied greatly from year to year due to variation in precipitation. Playa surveys were initiated in February 2004, a period preceded by the eighth driest year (2003) on record (National Weather Service 2007a), and continued through April 2006. Between 1 February-30 April 2004, nine playas were surveyed a total of 36 times. Between 16 August 2004 and 30 April 2005, 43 playas were surveyed a total of 481 times, and from 16 August 2005 through 30 April 2006, 46 playas were surveyed a total of 256 times. In total, 58 playas were included in surveys. Rainfall data indicate that 2004 was the ninth wettest year on record (National Weather Service 2007b) and that 2005 was the 15th driest (National Weather Service 2007c).

Twenty-three waterfowl species were observed on playas (Table 1) and migration chronology was quantified for eight species of dabbling ducks (Fig. 2), five species of diving ducks (Fig. 3), and two species of geese (Fig. 4). Dabbling ducks were most common (N = 250,668), followed by geese (N = 26,465) and diving ducks (N = 15,128). Four species, Gadwall (*Anas strepera*), American Green-winged Teal (*A. crecca*), American Wigeon (*A. americana*), and Northern Shoveler, exhibited a bimodal migration pattern. Blue-winged Teal (*A. discors*) and Ruddy Duck (*Oxyura jamaicensis*) had patterns typical of passage migrants and Mallard (*Anas platyrhynchos*), Cinnamon Teal (*A. cyanoptera*), Northern Pintail (*A. actuta*), and Canada Geese had a unimodal pattern. Redhead (*Aythya americana*), Canvasback (*A. valisineria*), Lesser Scaup (*A. affinis*), Ring-necked Duck (*A. collaris*), and Lesser Snow Geese (*Chen caerulescens*) had irregular migration patterns. Ice coverage on playas peaked during the first two weeks of December (Fig. 4). Migration chronology was not described for species with less than 100 observations.

Table 1. Number of waterfowl observed using 58 playa wetlands (surveyed a total of 773 times) in the Southern High Plains of Texas from 16 August-30 April during surveys conducted from February 2004 through April 2006. Canada Goose (*Branta canadensis*) and Cackling Goose (*B. hutchinsii*) numbers were combined during surveys.

Species	Scientific name	Number
Northern Pintail	*Anas acuta*	109,500
American Green-winged Teal	*Anas crecca*	58,167
Mallard	*Anas platyrhynchos*	39,071
American Wigeon	*Anas americana*	21,650
Canada Goose	*Branta canadensis*	15,347
Northern Shoveler	*Anas clypeata*	13,285
Lesser Snow Goose	*Chen caerulescens*	11,063
Blue-winged Teal	*Anas discors*	7,268
Redhead	*Aythya americana*	6,615
Ruddy Duck	*Oxyura jamaicensis*	4,145
Canvasback	*Aythya valisineria*	2,046
Lesser Scaup	*Aythya affinis*	1,236
Gadwall	*Anas strepera*	1,120
Ring-necked Duck	*Aythya collaris*	1,064
Cinnamon Teal	*Anas cyanoptera*	605
Ross's Goose	*Chen rossii*	45
Bufflehead	*Bucephala albeola*	19
Greater White-fronted Goose	*Anser albifrons*	10
Wood Duck	*Aix sponsa*	9
Hooded Merganser	*Lophodytes cucullatus*	4
Common Goldeneye	*Bucephala clangula*	3
Eurasian Wigeon[1]	*Anas penelope*	2
Common Merganser	*Mergus merganser*	1

[1]Eurasian Wigeon are accidental to the Southern High Plains (Seyffert 2001).

DISCUSSION

All dabbling ducks, except Blue-winged Teal, could either be described as having bimodal or unimodal migration patterns. Blue-winged Teal had a pattern of migration similar to that of a passage migrant (absent during winter), which was expected, as the Southern High Plains lies north of their winter range (Rohwer *et al.* 2002). Mallards, Cinnamon Teal and Northern Pintail had unimodal migration patterns strongly skewed towards late winter and spring. Similarly, even though American Green-winged Teal and Gadwall were classified as bimodal migrants, their abundance tended to be greatest during spring.

Obenberger (1982) found that overall, dabbling ducks in the Southern High Plains exhibited a bimodal pattern of migration chronology. In contrast to our results, however, Obenberger (1982) observed that migration phenology of Northern Pintail and American Green-winged Teal peaked in November, with numbers that were at least double those of spring highs. Differences are likely related to two reasons. First, there has been an overall decrease in available surface water, including water found in playas, tail-water pits (small man-made ponds associated with irrigation systems), and reservoirs, between the two studies. Many of the playas evaluated by Obenberger (1982) received runoff from irrigation, as did most playas across farmed regions of the Southern High Plains at that time (Guthery *et al.* 1984). Emphasis on water conservation and a significant decline in availability of groundwater has led to a decrease in the amount of irrigation water that playas receive and has made them more rainfall dependent (Smith 2003). The second reason for possible differences in migration phenology is that playas have suffered significant sedimentation, which has altered their hydrologic patterns, potential productivity, and wetland functions (Smith 2003).

After their initial increase in abundance coinciding with fall migration, all dabbling

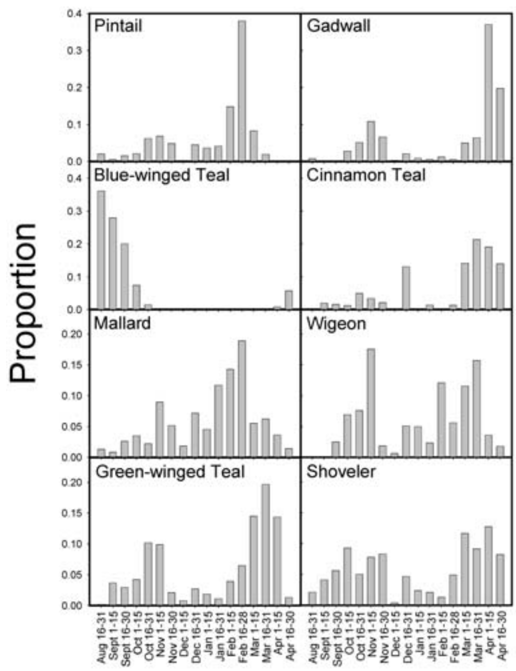

Figure 2. Average biweekly proportion of Northern Pintail, Gadwall, Blue-winged Teal, Cinnamon Teal, Mallard, American Wigeon, American Green-winged Teal, and Northern Shoveler on playa wetlands in the Southern High Plains of Texas from February 2004 through April 2006.

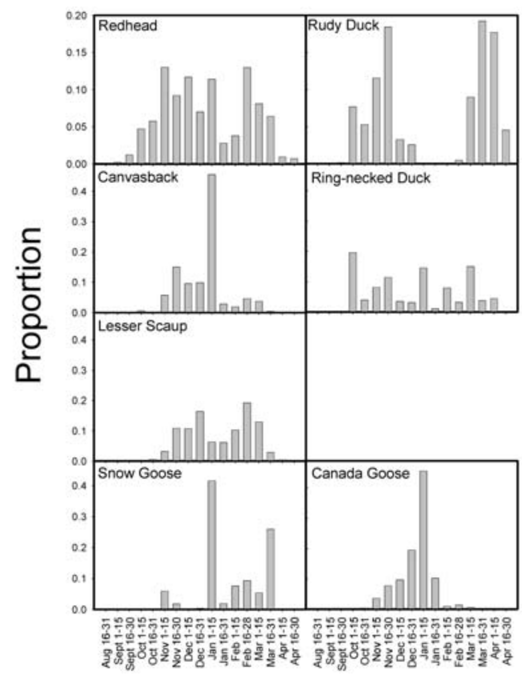

Figure 3. Average biweekly proportion of Redhead, Rudy Duck, Canvasback, Ring-necked Duck, Lesser Scaup, Lesser Snow Goose, and Canada Goose on playa wetlands in the Southern High Plains of Texas from February 2004 through April 2006.

ducks reached their lowest point or were completely absent during the first two weeks of December. This decline in dabbling duck numbers might reflect the first temporary, and most severe, freeze-up of playas. Interestingly, survival of Northern Pintails wintering in the Playa Lakes Region declines during this period (Moon and Haukos 2006). Moon and Haukos (2006) partially attributed this drop in survival to harassment and stress (i.e., increased movements) associated with hunting pressure, as hunting effort for Ring-necked Pheasant (*Phasianus colchicus*) and other game birds is frequently concentrated around playas. However, severe cold, particularly freezing playas, has been associated with lowered survival, possible mortality, and retreat flights (temporary movements to more favorable conditions) in several species that winter in the Southern High Plains (Bennett and Bolen 1978; Whyte and Bolen 1988; Bergan and Smith 1993).

Blue-winged Teal abundance on playas was much lower in the spring (1 February-30 April) relative to the fall (16 August-15 November); proportions observed in each period totaled 0.07 and 0.93, respectively. This may suggest different fall and spring migration paths, which this species is not known to have (Rohwer *et al.* 2002). In contrast to Blue-winged Teal, several dabbling ducks reached their peak abundance during late winter or spring. Nutrients gained prior to and during spring migration play a role in recruitment of waterfowl populations (Raveling and Heitmeyer 1989; Krapu and Reinecke 1992; Guillemain *et al.* 2007). Our data suggest forage availability for dabbling ducks using playas may be most important during this time. Several studies have focused on the foods available to waterfowl in playas during fall and early winter (e.g., Haukos and Smith 1993; Sheeley and Smith 1989; Anderson and Smith 1998, 1999), but

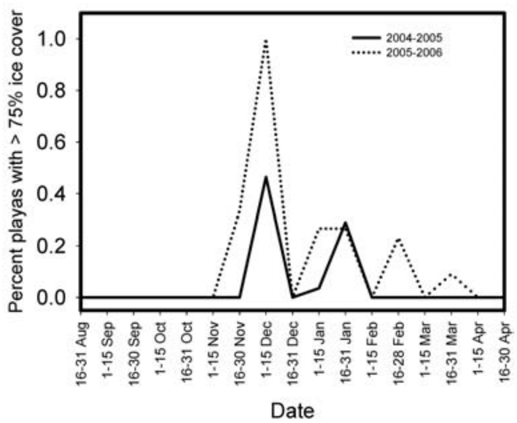

Figure 4. Percent of playa wetlands with significant (>75%) ice coverage, as observed during biweekly surveys of waterfowl in the Southern High Plains of Texas during the winters of 2004-2005 and 2005-2006.

none have addressed food availability during spring with respect to waterfowl. There is a general consensus that food resources within playas are depleted by early winter (Baldassarre and Bolen 1984; Bolen *et al.* 1989a; Smith and Sheeley 1993; Moon and Haukos 2006). It is likely, however, that some natural food resources may increase during spring. In a study of foods available to migrating shorebirds using playas, Davis and Smith (1998) found invertebrates densities increased in spring. Similarly, biomass of aquatic invertebrates in other habitats is known to increase in late winter (Manley *et al.* 2004).

With the exception of Ruddy Duck, which had the phenology of a passage migrant, migration chronology of all diving ducks was classified as irregular. This could be an artifact of the relatively small number of each species observed. However, it may also be due to the differences in food resources utilized by diving ducks, and the way those resources were distributed seasonally, compared to foods utilized by dabbling ducks.

The Southern High Plains is the southernmost wintering area for the shortgrass prairie population (*Branta canadensis parvipes*, *B. c. moffitti*, and *B. c. hutchinsii*; Bellrose 1980) of Canada Geese. The latter of these, however, was recently reclassified as a separate species, Cackling Goose (*B. h. hutchinsii*), by the American Ornithologists' Union (Banks *et al.* 2004), but was combined with Canada Geese in this study because of the difficulty of visually separating it from the others. The migration pattern of Canada Geese gradually increased and then decreased, peaking in mid-winter. This is the migration chronology expected on a terminal wintering site. Lesser Snow Geese had an irregular migration pattern, but chronology of this species may not have been described well. Lesser Snow Geese traditionally concentrate around wetlands that are permanent (WPJ, pers. obs.) and such wetlands were not included in surveys. Likewise, surveys were conducted in morning hours, when geese are often field feeding and not using playas.

Although the general migration patterns of waterfowl are interesting, the data's greatest potential will be to support planning efforts focused on playa conservation. Some wintering ground joint ventures (partnerships) working under the auspices of the North American Waterfowl Management Plan (North American Waterfowl Management Plan, Plan Committee 2004) have been able to link temporal population objectives, such as those coinciding with mid-winter waterfowl surveys, to migration chronology data to develop population and habitat goals that span migration and wintering periods (Esslinger and Wilson 2001; Wilson and Esslinger 2002). Similarly, migration chronology has been used to refine carrying capacity models for Redheads and Northern Pintails on critical wintering areas (Michot 1997; Miller and Newton 1999). Although the Southern High Plains has long been viewed as an important wintering area (Bellrose 1980), data from this study suggest the region is more important to spring migrants than it is to wintering waterfowl; incorporating this migration chronology information into ongoing planning efforts by the Playa Lakes Joint Venture will likely bear this out.

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