SpATS

SPATIAL AND TEMPORAL VARIATION IN NESTING SUCCESS OF PRAIRIE DUCKS

PRELIMINARY RESULTS FROM THE 2011 STUDY AREA AT MASEFIELD, SASKATCHEWAN

R. B. Emery, D. W. Howerter, L. M. Armstrong,
M. G. Anderson, and J. H. Devries

Ducks Unlimited Canada
Institute for Wetland and Waterfowl Research
Box 1160, Stonewall, Manitoba, R0C 2Z0, CANADA

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INTRODUCTION

The Spatial and Temporal Variation in Nesting Success of Prairie Ducks Study (SpATS) is examining how nesting success of prairie waterfowl varies in relation to landscape composition throughout Prairie Canada, providing key feedback to enhance planning tool predictions. Planning tools, specifically The Waterfowl Productivity Model (WPM), have been developed to guide DUC's conservation program delivery under the North American Waterfowl Management Plan. The WPM is a spatially explicit model using data specific to the Canadian Prairies and linking duck populations, habitat amount and composition, and nest survival at landscape scales.

Several levels of spatial and temporal replication are designed into the study. We delineated four broad sub-regions (one characterized as Prairie biome and three as Parkland biome) in the Canadian portion of the Prairie Pothole Region (PPR) and then identified 7 smaller study areas within each sub-region of which 5 were randomly selected for monitoring. Within these 20 study areas (Figure 1), 120 41- km^2 (16- mi^2) study sites differing in waterfowl density/perennial cover categories (medium [M; 20-40 pairs/mi^2] or high [H; > 40 pairs/mi^2] predicted waterfowl pair densities in an average year, combined with low [L; <30%], medium [M; 30-60%], or high [H; > 60%] estimated proportions of perennial cover) were randomly selected for more intensive investigation (6 study sites per study area). Most data collection occurs on 8 quarter-sections (65 ha; focal quarters) within each study site randomly selected to represent the 4 most common land-use types in the Canadian PPR (2 quarter-sections each of annual cropland, hayland, natural cover [tame or native pastures and/or large areas of natural idled cover], and planted cover, as available).

Original plans were to visit each study site twice between 2002 and 2012 - at time intervals that varied from 1 to 9 years. Ideally this time span would allow temporal replication of data collection over individual landscapes and sampling over an entire wet/dry cycle. Since 2002, all 120 study sites have been visited once; 60 study sites have been visited twice.

Results from a mid-project review conducted in 2008 to assess whether continuing SpATS data collection through 2012, as originally planned, would change inferences we would draw from subsequent analyses indicated that collecting additional data would not improve our confidence in estimates of the Parkland perennial cover effect. However, additional data would improve confidence in the estimated Prairie biome effect. As a result of the review research efforts were scaled back beginning in 2009 to focus solely on Prairie dominated areas with a revised data collection end date of 2011.

This report presents preliminary results from the final SpATS study area: Masefield, Saskatchewan, visited in 2011 (Figure 2). The study area encompassed 6 study sites first visited in 2003. Study sites are characterized in Appendix A; habitat and land-use classification for each study site is summarized in Appendix B. In figures, tables, and text, stratification codes used to select study sites are defined as follows: ML = medium ducks, low cover; MM = medium ducks, medium cover; MH = medium ducks, high cover; HL = high ducks, low cover; HM = high ducks, medium cover; HH = high ducks, high cover (see footnotes, Appendix A). For a detailed description of the study rationale/design see Institute for Wetland and Waterfowl Research (2002). A detailed description of study methods is available in Institute for Wetland and Waterfowl Research (2011). For yearly progress reports see Emery et al. (2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, and 2011). For a summary of results from all sites studied to date see Appendix E.

2011 REVIEW

A deeper than average snowpack combined with higher than average spring precipitation resulted in excellent wetland conditions throughout the region, including at all SpATS study sites. Cooler than average temperatures in April and May combined with several late-season (April) snowstorms delayed the arrival of 'spring'; the town of East-End, Saskatchewan, located just north of the study area had 73cm of snow on the ground on April 13, 2011 (Environment Canada, unpublished data). Duck pair densities were less than anticipated, especially at higher elevation study sites (e.g., ROB, SHA and WIL) where wetlands remained frozen into early May. We surmise that excellent wetland conditions elsewhere in the PPR combined with spring's late arrival in southwestern Saskatchewan resulted in pairs settling elsewhere. The wet cool conditions delayed seeding of annual cropland and/or land remained unseeded. Later-nesting ducks responded positively to the excellent wetland conditions with a strong nesting and re-nesting effort. Nesting success was higher later in the season. Overall nesting success was estimated at 21% exceeding the levels (between 12 to 20%) thought necessary to maintain stable duck populations.

In 2011 SpATS cooperated with a study of northern pintail duckling survival (D. Johns, Pintail Duckling Survival Study; Devries and Howerter 2009). To deter predators the study fenced northern pintail nests found by the SpATS crew; they trapped and radio-marked nesting hens late in incubation, monitored brood movements, and counted ducklings.

2011 DATA SETS

Breeding Pair Surveys

Two waterfowl pair surveys (Dzubin 1969) were conducted on each focal quarter at all study sites (first survey/second survey: May 2-4/May 30-June 1). All wetlands on each focal quarter were surveyed.

Indicated breeding pair estimates (pairs/mi^2; Wishart 1983) are presented in Table 1. Pair densities for species modeled by the WPM (blue-winged teal, gadwall, mallard, northern pintail, northern shoveler, canvasback, and redhead) are summarized in Figure 3. Since the WPM was developed to represent long-term averages, we expect estimates from individual years to differ from predictions as wetland conditions vary.

Double-observer counts were conducted on 2 randomly selected focal quarters at each study site during both the first and second pair surveys. Two observers, working in tandem, independently surveyed each wetland. Pair and wetland inundation estimates from the designated 'primary' observer were used for figures and tables in this report.

Wetland Classification

All wetlands on focal quarters were visited in July (July 18-20) and classified to permanency class and cover type following Stewart and Kantrud (1971) (Table 2). Type I wetlands were not recorded. Wetlands in cropland, hayland and planted cover, where wetland vegetation had been destroyed by cultivation, were assigned permanency class 'T' to signify a tillage basin.

Wetland Inundation

We estimated the fraction of the total wetland basin that was flooded (wetland inundation) for all wetlands on focal quarters (Figure 4). Three wetland inundation surveys were conducted: one during each pair survey, and one during wetland classification. Wetland inundation was recorded on a scale of 0-5 (0 = totally dry; 1 = 1-25% flooded; 2 = 26-50% flooded; 3 = 51-75% flooded; 4 = 76-100% flooded; 5 = water overflowing basin and inundating upland vegetation). The 'normal' wetland inundation pattern in prairie Canada is declining inundation as the nesting season progresses due to late spring/summer evapotranspiration being greater than precipitation.

Interannual variations in pair density, and in wetland inundation at the beginning of the nesting season, were variable among study sites between when sites were first visited in 2003 and 2011 (Figure 5).

Nesting Success

We searched for nests 3 times at 3-week intervals on all focal quarters. Nest searches began May 8 and ended July 13. We found nests using ATV cable–chain drags (Klett et al. 1986), ATV rope drags, by walking and dragging a rope between 2 observers, or by striking the vegetation with willow switches. All habitats other than wooded habitats, the flooded portions of wetlands, and planted cropland were searched; cereal stubble was searched using ATV rope drags at all sites. We revisited nests at approximately 10-day intervals until nest fates were determined. Point estimates of nesting success were derived using the Mayfield method as modified by Johnson (1979).

Nesting success in 2011 at Masefield was 21.0% (n=227 nests; range: 16.0-27.6%). Nesting success by study site, year of visit, and by habitat and species by study site, is summarized in Figure 6, and in Appendices C and D, respectively.

Vegetation Height and Visual Obstruction Readings

To characterize temporal changes in vegetation during the nesting season, we measured vegetation height and visual obstruction of vegetation (VOR) along three permanent transects established in each habitat in which we searched for nests. Transects were 40 meters long with sampling stations every 10 meters. Vegetation height was estimated using a 30 cm clear Plexiglas disc (Higgins and Barker 1982). We estimated VOR at each station using a 5 x 150 cm Robel pole (Robel et al. 1970). Vegetation height and VOR were measured once at the beginning (early), and once at the end (late) of the nesting season. In addition vegetation height and VOR were measured in hayland midway through the nesting season prior to the earliest estimated haying date (mid; ~ June 21). Vegetation height and VOR were not measured at study sites that were not searched for nests. Mean vegetation height and VOR by habitat type for all years of the study combined (2002-2011) is presented in Figure 7. Vegetation height and VOR were also measured at each nest site.

We measured vegetation along the same transects as when the sites were first visited. New transects were established only when old transects were no longer useable due to cultivation, flooding, etc., or when new habitat types were identified.

Predator and Small Mammal Sightings

Predator and small mammal (mice, voles and shrews) sightings on each study site were recorded from the start of pair counts (early May) through to the end of wetland classification (mid-July; Table 3). We recorded the number of places a predator species was sighted, rather than the number of individual predators, to minimize the influence of sighting grouped predators (Sargeant et al. 1993). We recorded numbers of small mammals sighted using a scale of 0-7 (0 = None, 1 = 1-2, 2 = 3-5, 3 = 6-10, 4 = 11-25, 5 = 26-50, 6 = 51-100, 7 = >100).

Habitat Classification

We used habitat and land-use information ground-truthed during the field season in conjunction with SPOT imagery (2.5m panchromatic; acquisition dates: BRA and SHA – July 9; CLI, ROB, TUR, and WIL – July 15; all 2011) to update our existing Geographical Information System (GIS). Target resolution was ≤ 0.09ha (i.e., ≤ 0.22 acres). All information is integrated into a GIS to allow thorough analyses of relationships between landscape attributes and waterfowl population processes. Digitizing has been completed at all study sites nest searched from 2002 to 2010.

In 2007 we reclassified some study sites to Prairie Biome that were previously classified as Parkland Biome. Prairie Biome now includes the mixed grassland, moist mixed grassland, fescue grassland, and Cypress upland ecoregions; Parkland Biome includes the aspen parkland, boreal transition, and southwest Manitoba upland ecoregions (previously it also included the moist mixed grassland ecoregion) (Ecological Stratification Working Group 1996).

Modeling Nesting Success

We are awaiting the completion of digitizing 2011 study sites before modeling 2011 nesting success as a function of the amount of nesting cover on the landscape. Modeling methods, preliminary results, and management implications, based on the first nine years (2002-2010) of SpATS data, is reported in the 2010 SpATS Progress Report (Emery et al. 2011). Our results provide support for the hypothesis that nesting success is positively related to the amount of perennial cover in the landscape. We found that nesting success at sites with > 35% perennial cover may be meeting or exceeding the levels thought necessary to maintain stable duck populations - between 12 to 20% - while nesting success at sites with < 35% perennial cover is lower. We observed no evidence that density-dependence--evident at continental scales--arises through mechanisms operating locally on nesting success. Further analysis will help clarify these patterns**.** Patterns observed in this study are being incorporated into decision-support tools used to guide habitat management activities throughout the Canadian portion of the PPR.

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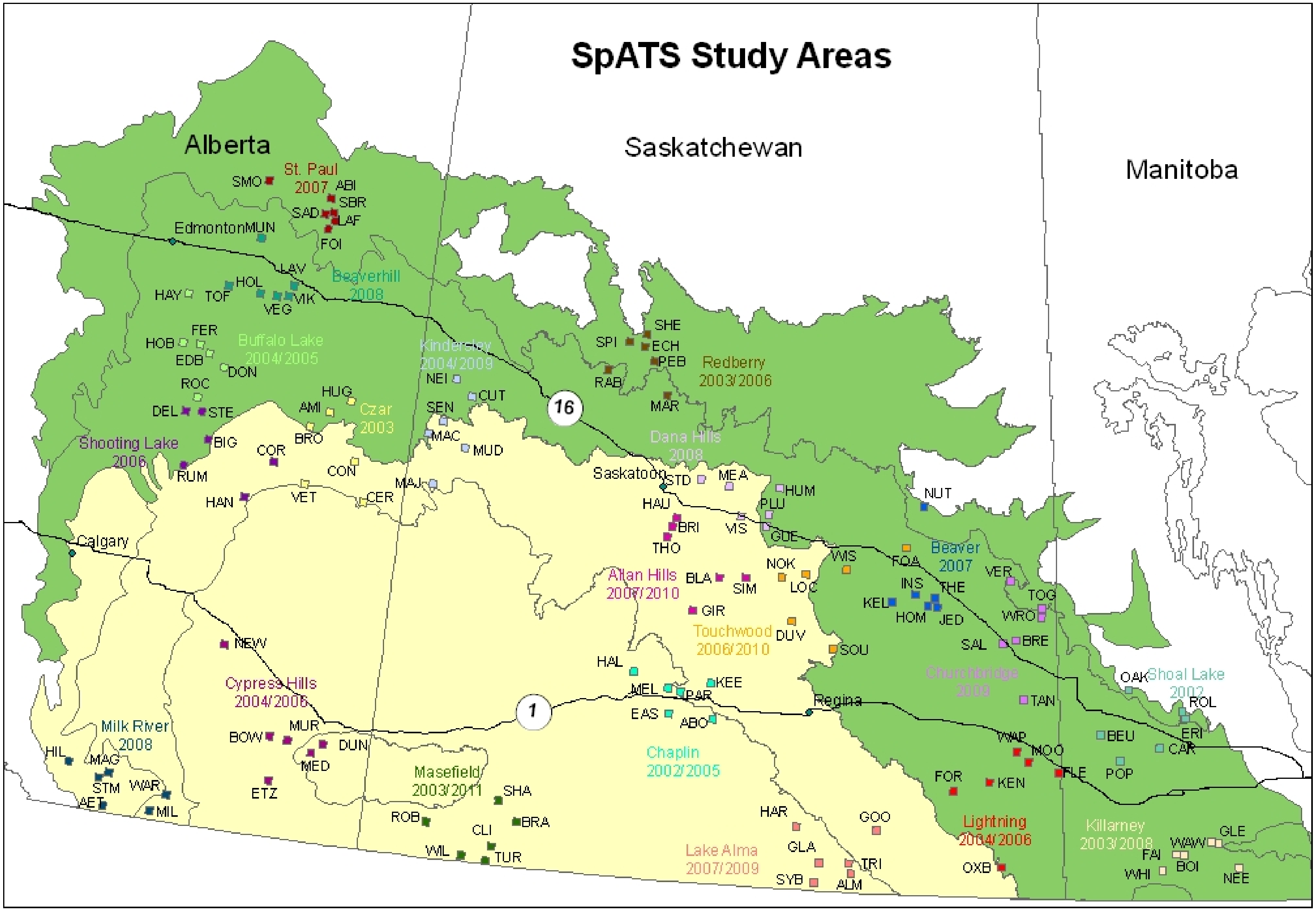


Figure 1. SpATS study areas (i.e., Allan Hills), study years (i.e., 2007/2010), and corresponding study sites (i.e., BLA; closed squares [41 km^2]), overlaid on Prairie (tan) and Parkland (green) Biomes.

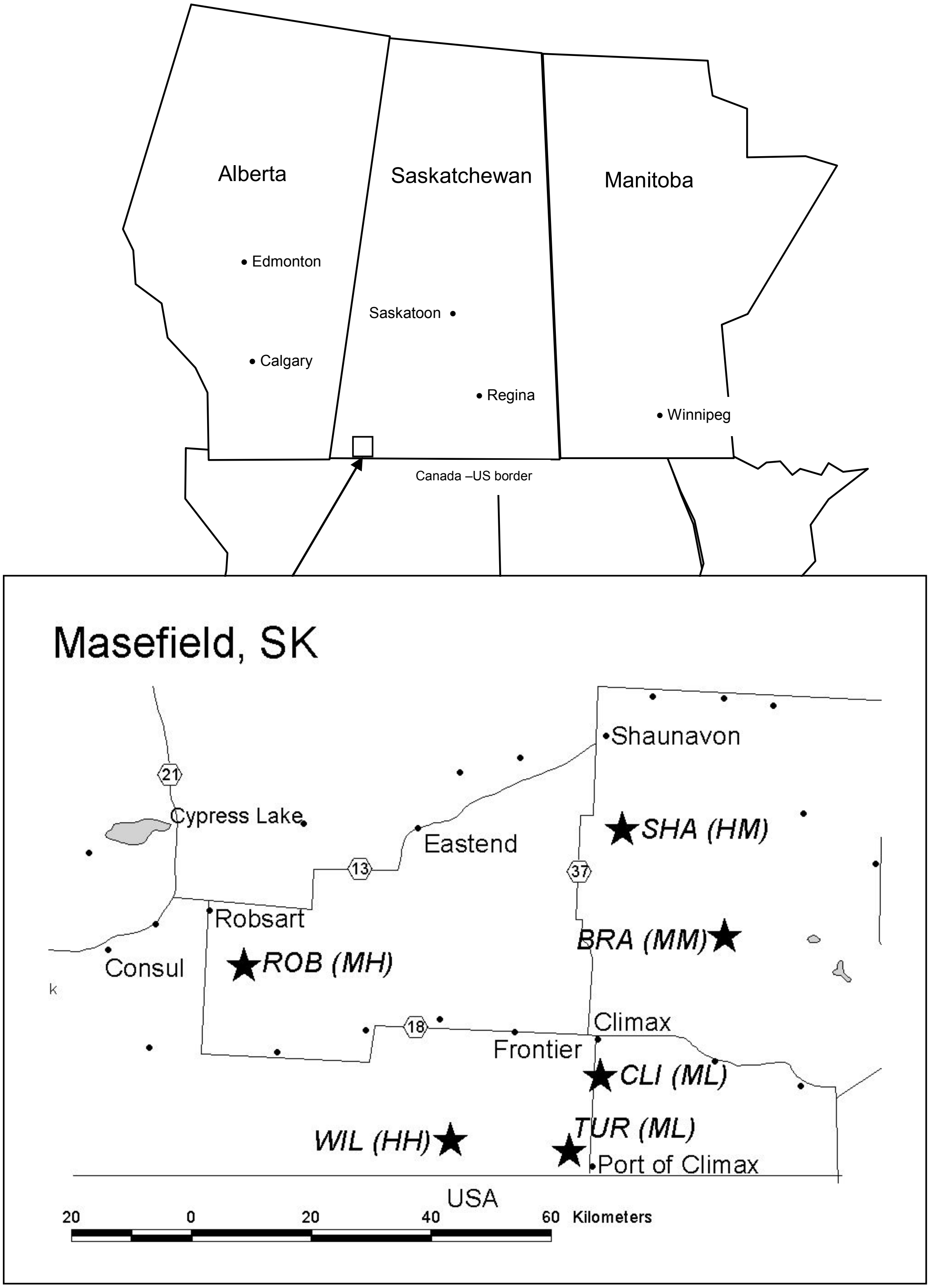


Figure 2. Location of the 2011 SpATS study sites (inset – closed stars) in Prairie Canada.

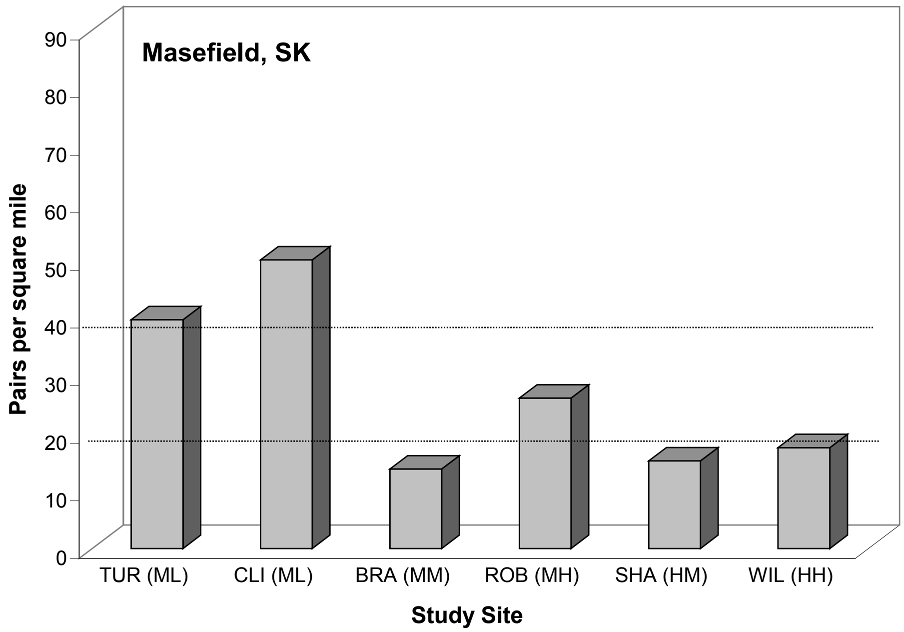


Figure 3. Observed waterfowl pair densities (pairs/mi^2) for Waterfowl Productivity Model species (blue-winged teal, gadwall, mallard, northern pintail, northern shoveler, canvasback, and redhead), for the Masefield, SK, study area, 2011. Dashed horizontal lines delineate waterfowl density stratification categories used during study site selection (Medium Ducks = 20-40 pairs/mi^2, High Ducks = > 40 pairs/mi^2).

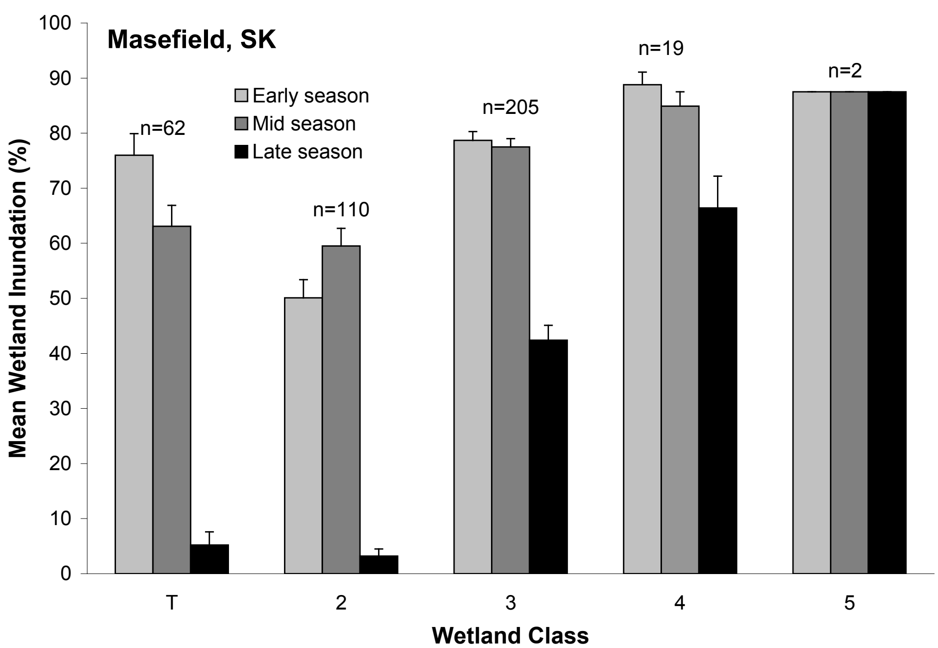
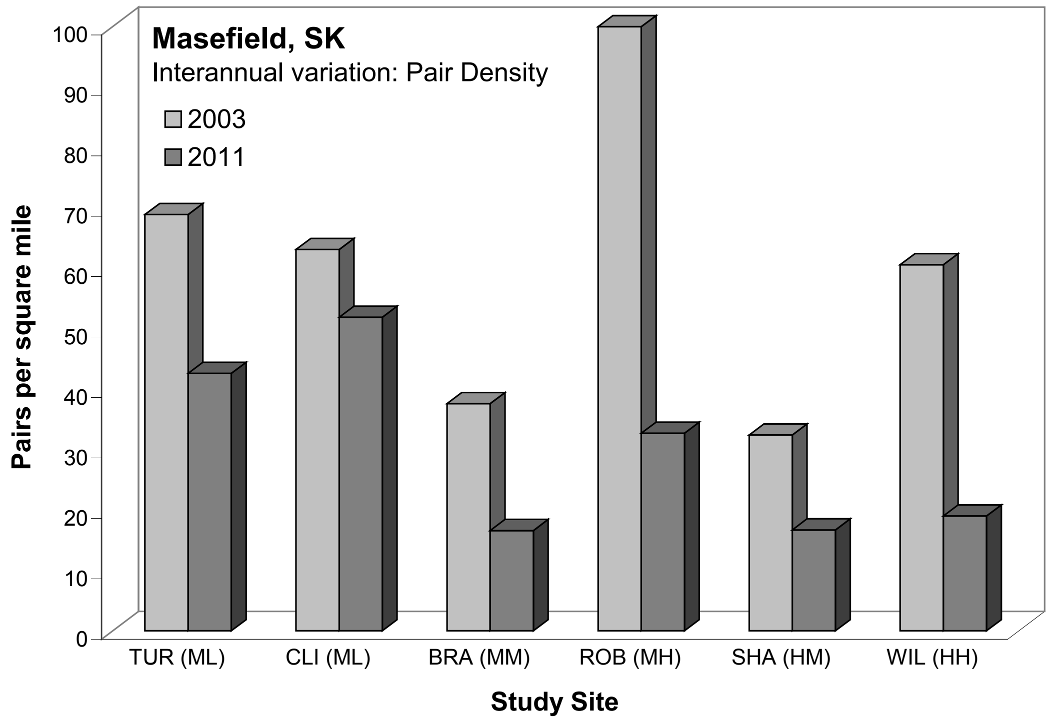


Figure 4. Mean wetland inundation (n=number of basins) and standard errors (+1), by wetland class, for the Masefield, SK, study area, 2011. Wetland inundation surveys occurred during the 1st pair survey (early season), 2nd pair survey (mid season) and wetland classification (late season). Wetland inundation was estimated for each wetland basin on a scale of 0-5 (0 = totally dry; 1 = 1-25% flooded; 2 = 26-50% flooded; 3 = 51-75% flooded; 4 = 76-100% flooded; 5 = water overflowing basin and inundating upland vegetation). We assigned the midpoint of each category (0 = 0, 1 = 12.5, 2 = 37.5, 3 = 62.5, 4 = 87.5, 5 = 112.5) as the % wetland inundation.



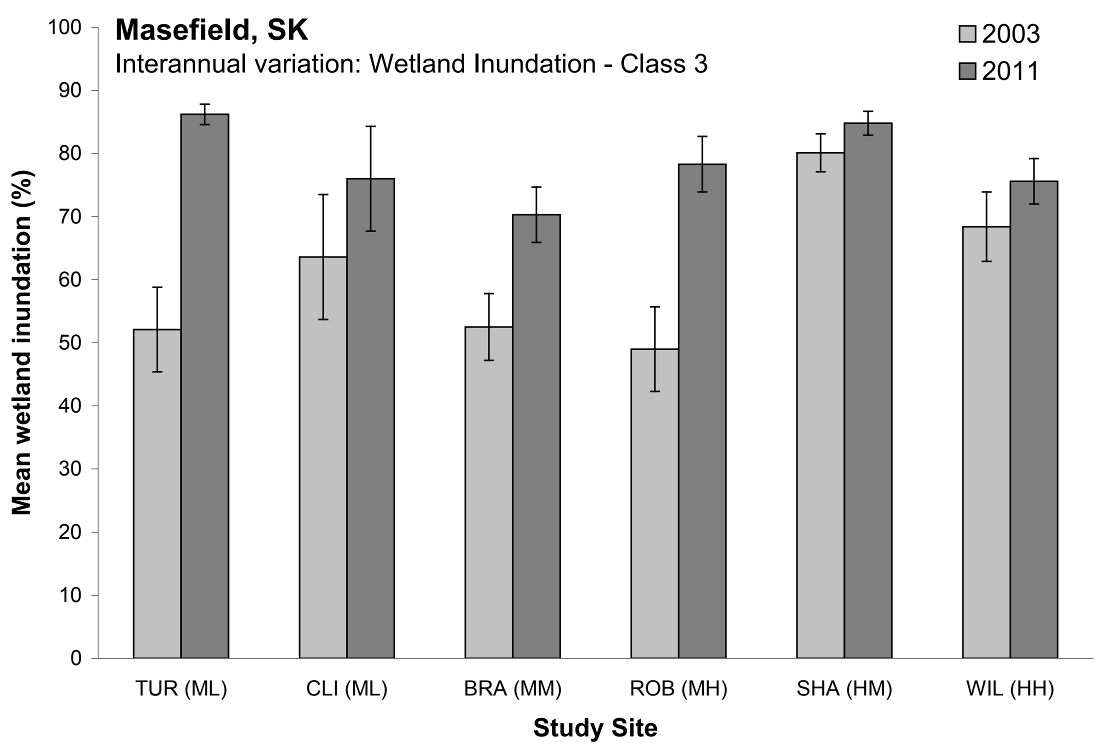
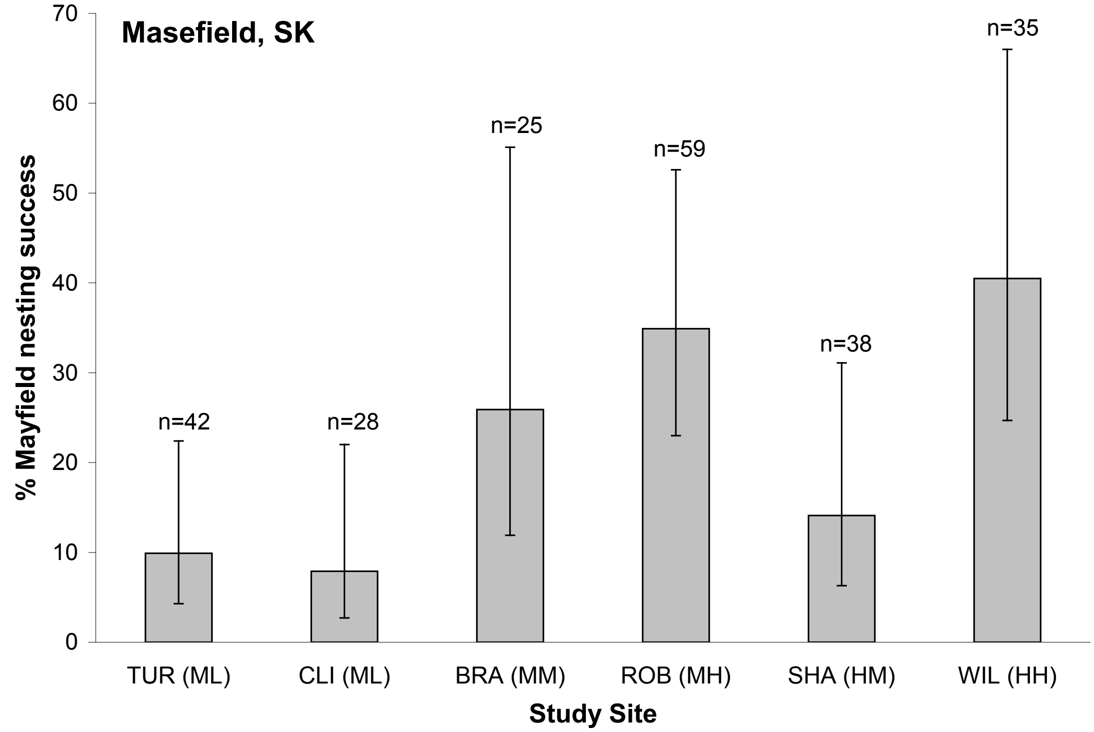


Figure 5. Interannual variation in observed waterfowl pair densities (all species; pairs/mi^2) and interannual variation in average wetland inundation of Class III wetlands at the start of the nesting season (%; ± 1 standard error) for the Masefield, SK, study area.



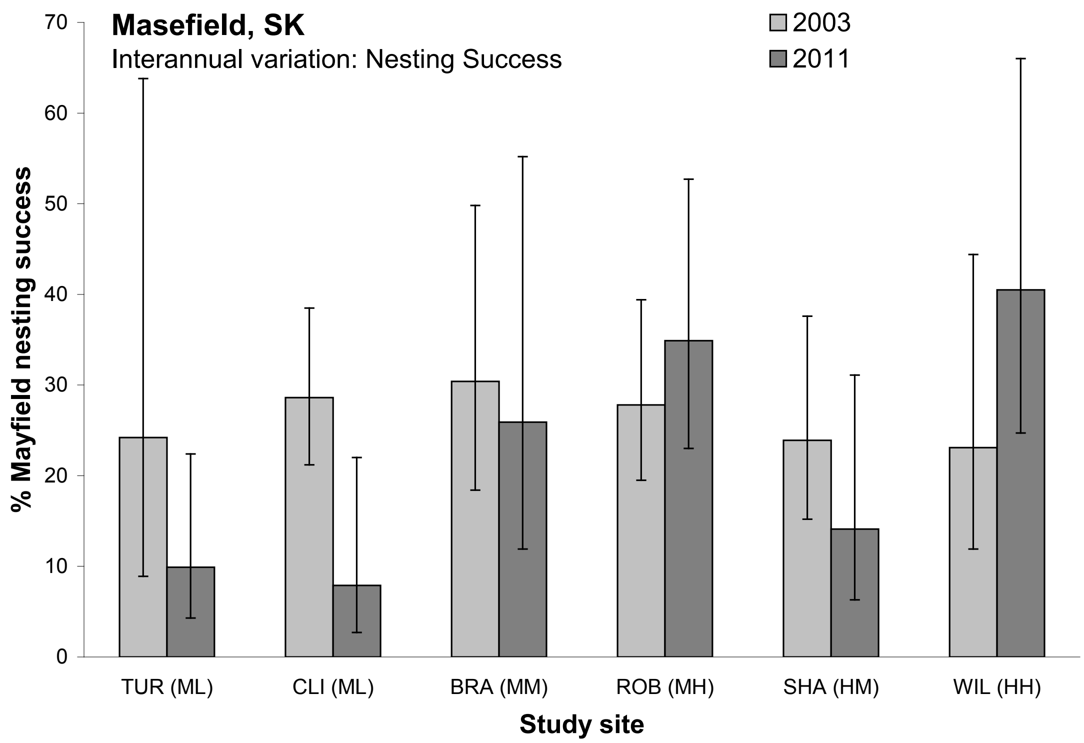
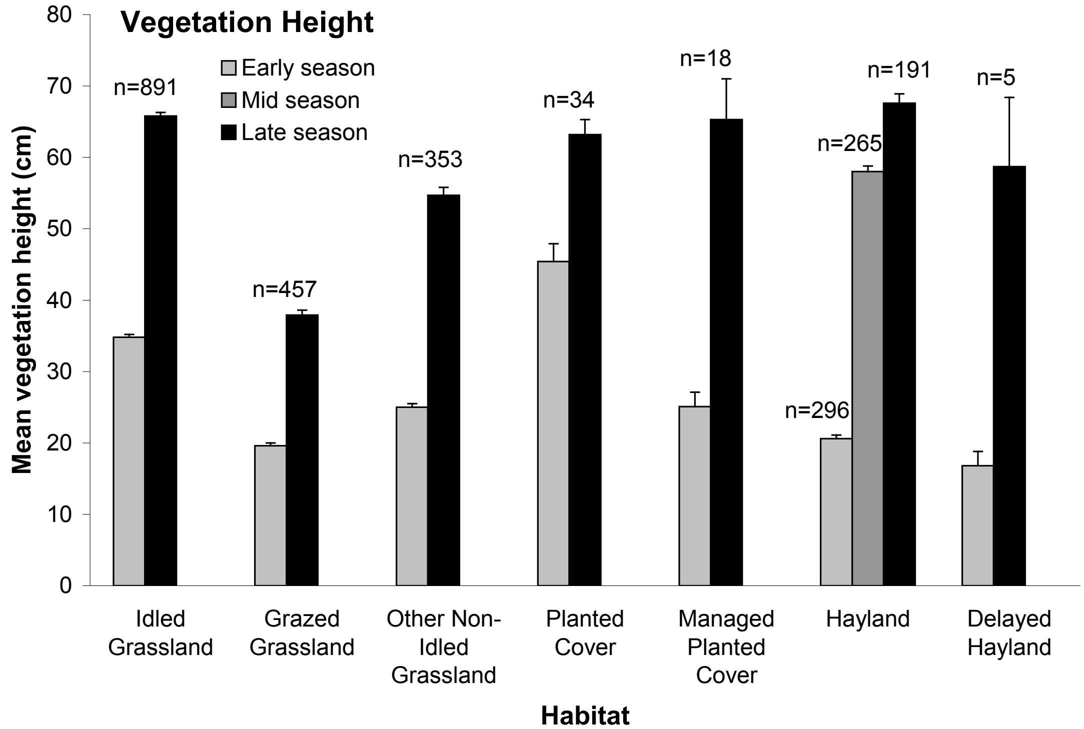


Figure 6. Mayfield nesting success estimates (%; n=number of nests) and 95% confidence intervals (±) for the Masefield, SK, study area, 2011, and interannual variation in nesting success (%; 95% confidence intervals). Estimates were calculated using the Mayfield method as modified by Johnson (1979).



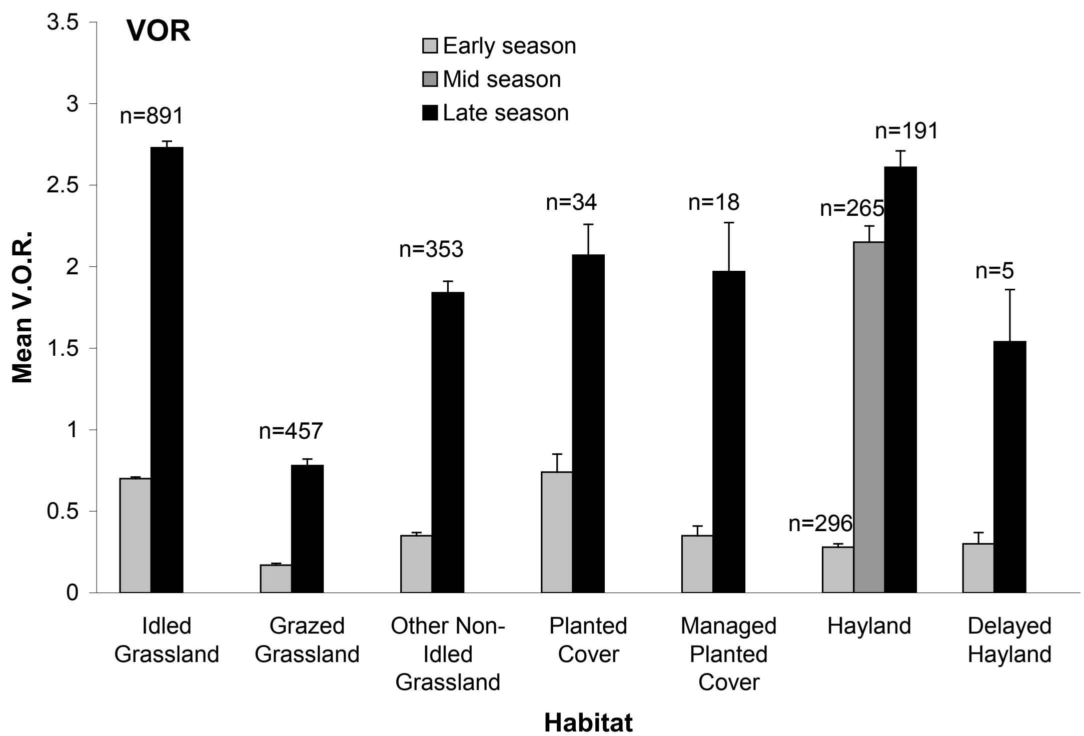


Figure 7. Mean vegetation height (cm) and visual obstruction reading (VOR) for focal quarters, 2002-2011 (+1 standard error; n = number of focal quarters). Survey dates: early season – May, mid season – around June 21, late season – late June to late July. Idled Grassland was idled during the year of study and the previous year; Grazed Grassland was grazed during the year of study and the previous year; most Other Non-Idled Grassland was idled during the year of study but had been grazed or mowed during the previous year; Managed Planted Cover was hayed or grazed during the year prior to study; Delayed Hayland was hayed after July 15 during the year of study. Vegetation measurements in Hayland and Delayed Hayland were done prior to haying.

Table 1. Waterfowl pair densities (pairs/mi^2) for the Masefield, SK, study area, 2011. Waterfowl Productivity Model species are shaded.

Masefield, SK

	Study Site					
Species	**TUR** (ML)	**CLI** (ML)	**BRA** (MM)	**ROB** (MH)	**SHA** (HM)	**WIL** (HH)
Dabblers						
American Wigeon	0.5	0	1.0	2.5	1.5	1.5
Blue-winged Teal	3.3	6.0	6.3	4.3	1.5	2.0
Gadwall	1.0	2.5	0	6.5	3.5	1.5
Green-winged Teal	0.5	1.0	1.3	2.3	0	0
Mallard	7.3	6.4	1.5	0.5	4.5	0.5
Northern Pintail	17.0	26.8	3.5	4.0	4.2	6.5
Northern Shoveler	9.9	5.3	2.5	10.5	1.0	7.0
IBP [a] - Dabblers	**39.5**	**48.0**	**16.1**	**30.6**	**16.2**	**19.0**
Divers						
Bufflehead	0	0	0	1.0	0	0
Canvasback	0.3	2.6	0	0	0.5	0
Hooded Merganser	0.3	0	0.5	0	0	0
Lesser Scaup	0	0	0	0.8	0	0
Redhead	0.9	0.5	0	0.3	0	0
Ring-necked Duck	0	0	0	0	0	0
Ruddy Duck	1.6	0.8	0	0	0	0
IBP - Divers	**3.1**	**3.9**	**0.5**	**2.1**	**0.5**	**0**
IBP – All Ducks	**42.6**	**51.9**	**16.6**	**32.7**	**16.7**	**19.0**

[a] IBP = Indicated Breeding Pairs (pairs/mi^2)

Table 2. Distribution of wetland types (Stewart and Kantrud 1971) found at the Masefield, SK, study area, 2011. Data are from the 8 focal quarters at each study site.

Masefield, SK

	Study Site											
Wetland Type (Class)	**TUR** (ML)		**CLI** (ML)		**BRA** (MM)		**ROB** (MH)		**SHA** (HM)		**WIL** (HH)	
	n	%	n	%	n	%	n	%	n	%	n	%
Tilled (T)	28	31	6	9	7	9	0	0	47	44	5	6
Temporary (II)	15	17	35	54	23	29	36	61	7	7	24	30
Seasonal (III)	41	46	14	22	48	61	22	37	50	47	50	62
Semipermanent (IV)	5	6	10	15	1	1	1	2	1	1	1	1
Permanent (V)	0	0	0	0	0	0	0	0	1	1	1	1
Total Wetlands	**89**		**65**		**79**		**59**		**106**		**81**	

Table 3. Predator and small mammal sighting rates (observations per hour)[a] at the Masefield, SK, study area, 2011.

Masefield, SK

Species	Study Site					
	TUR (ML)	**CLI** (ML)	**BRA** (MM)	**ROB** (MH)	**SHA** (HM)	**WIL** (HH)
Mammalian						
Badger	0	0.0065	0.0056	0.0017	0.0108	0.0141
Raccoon	0	0	0	0	0	0
Striped skunk	0	0	0.0028	0	0	0
Mink	0	0	0	0	0	0
Weasels	0	0	0	0	0.0043	0.0018
Franklin's ground squirrel	0	0	0	0	0	0
Red fox	0	0	0	0	0.0043	0
Coyote	0.0035	0.0324	0.0448	0.0035	0.0432	0.0281
Avian – Owls/Raptors						
Great horned owl	0	0.0097	0	0	0.0022	0
Red-tailed hawk	0.0035	0.0129	0.0140	0.0087	0.0086	0.0088
Northern harrier	0.0174	0.0227	0.0280	0.0329	0.0108	0.0351
Swainson's hawk	0.0313	0.1264	0.0700	0.0520	0.0821	0.0369
Avian – Corvids						
American crow	0	0.0129	0.0308	0.0087	0.0086	0.0070
Black-billed magpie	0	0.0259	0.0056	0	0.0238	0.0018
Common raven	0	0	0.0112	0	0	0.0018
Gulls	0.0694	0.1974	0.0308	0.0104	0.0281	0.0176
Small Mammals[b]	0.1215	0.2039	0.1120	0.0459	0.0788	0.0826

[a] Observer hours – TUR: 288, CLI: 309, BRA: 357, ROB: 577, SHA: 463, WIL: 569; observation dates – 5/02-7/20.

[b] Small mammal (mice, vole, shrew) observations were recorded on a scale of 0-7 (0 = none, 1 = 1-2, 2 = 3-5, 3 = 6-10, 4 = 11-25, 5 = 26-50, 6 = 51-100, 7 = >100). We assigned the midpoint of each category (0 = 0, 1 = 1.5, 2 = 4, 3 = 8, 4 = 18, 5 = 38, 6 = 75.5, 7 = 150) as the number of small mammals sighted to facilitate calculation of small mammal sightings per hour.

Appendix A. Stratification category, ecological description, latitude and longitude of study sites, and dominant land-use types on focal quarter sections (n = 8 at each study site), at the Masefield, SK, study area, 2011.

					Dominant land-use type[a] (# of focal quarter sections)			
Study Site[b]	**Stratification Category**[c]	**Habitat sub-region**[d]	**Latitude**	**Longitude**	annual cropland	hayland	natural cover	planted cover
Masefield, SK (Prairie Biome, Mixed Grassland Ecoregion[e]**)**								
TUR	Medium ducks/Low cover (ML)	Frenchman R. Plateau	49º 02'	108º 26'	8	0	0	0
CLI	Medium ducks/Low cover (ML)	Frenchman R. Plateau	49º 09'	108º 23'	4	0	4	0
BRA	Medium ducks/Medium cover (MM)	Frenchman R. Plateau	49º 22'	108º 06'	5	1	2	0
ROB	Medium ducks/High cover (MH)	Outlaw Coulee Upland	49º 17'	109º 12'	0	0	8	0
SHA	High ducks/Medium cover (HM)	Wood River Plain	49º 31'	108º 21'	2	2	4	0
WIL	High ducks/High cover (HH)	Boundary Plateau	49º 03'	108º 44'	0	2	6	0

[a] Dominant land-use type – land-use occurs on > 50% of quarter section:
Annual Cropland: Areas that are planted annually to grain or row crops, or that are plowed and left fallow, or contain crop residue from the previous growing season.
Hayland: Areas that have been plowed and seeded to grasses and/or legumes and are hayed annually for forage production.
Natural Cover: Areas vegetated with various mixtures of grasses (introduced and native), forbs, and woody plants (trees and shrubs). Areas may be idled, grazed or hayed.
Planted Cover: Mixtures of grasses and legumes planted for wildlife cover or soil conservation.
[b] The same focal quarters were investigated in 2011 as in the first year of study.
[c] Stratification category: Medium ducks = 20-40 pairs/mi^2, High ducks = > 40 pairs/mi^2 (species = blue-winged teal, gadwall, mallard, northern pintail, northern shoveler, canvasback and redhead). The predicted waterfowl pair densities used for stratifying study sites were generated by DUC's Prairie Pothole Region Waterfowl Productivity Model (DUC unpublished) using long-term data from the Canadian Wildlife Service/United States Fish and Wildlife Service breeding waterfowl survey (segment-level; Environment Canada, unpublished), DUC's Wetland Habitat Inventory (DUC unpublished data), and the Canada Land Inventory for Waterfowl Capability (see Canada Land Inventory 1981). Low cover = < 30% perennial cover, Medium cover = 30-60% perennial cover, High cover = > 60% perennial cover. Predicted proportions of perennial cover on study sites were derived from the Prairie Farm Rehabilitation Administration (PFRA) Western Grain Transition Payment Program land cover dataset and are based on Landsat imagery from the mid-1990's (PFRA, unpublished).
[d] Poston et al. 1990.
[e] Ecological Stratification Working Group 1996

Appendix B. Estimates of land-use types (%) at the Masefield, SK, study area.

	Study Site					
Land-Use Type[a]	**TUR** (ML)	**CLI** (ML)	**BRA**[b] (MM)	**ROB**[c] (MH)	**SHA** (HM)	**WIL** (HH)
Cropland	**89**	**79**	**42**	**3**	**42**	**18**
Hay	0	4	9	0	7	1
Natural[d]	10	14	48	96	50	81
Planted Cover	0	0	0	0	0	0
Woodland	T[e]	T	T	0	T	0
Perennial Cover – Total %[f]	**10**	**18**	**57**	**96**	**57**	**82**
Other[g]	1	2	1	1	1	T

[a] Estimates were digitized from 2003 1:40,000 black and white aerial photography.
[b] Includes 13 quarter-sections (W½-14, 15, 16, N½-17, and NE18-05-16 W3) within the AAFC/PFRA Val Marie Community Pasture.
[c] Includes 4 quarter-sections (E½-O1 and E½-12-04-25 W3) within the AAFC/PFRA Reno #1 Community Pasture
[d] Natural includes grassland, shrubland, and wetland vegetation.
[e] T (trace) indicates that land-use type was < 0.5%.
[f] Perennial cover was calculated over the total area of each study site, including open water.
[g] Other includes town sites, unvegetated areas, open water, etc.

Appendix C. Mayfield nesting success estimates (%NS) by habitat type for the Masefield, SK, study area, 2011.

Habitat Type[a]	Study Site								
	TUR (ML)			**CLI** (ML)			**BRA** (MM)		
	n[b]	%NS	95%CI	n	%NS	95%CI	n	%NS	95%CI
Cropland	29	5.2	1.5-17.5	3	<0.1	0-94.3	4	53.3	15.2-100
Grassland	13	23.4	8.4-63.1	21	9.2	2.9-28.1	17	17.6	5.6-53.8
Hayland	-	-	-	4	15.6	1.8-100	3	53.0	14.9-100
Wetland	-	-	-	-	-	-	1	15.9	0.4-100
All Nests	**42**	**9.9**	**4.3-22.4**	**28**	**7.9**	**2.8-22.0**	**25**	**25.9**	**12.0-55.2**
	ROB (MH)			**SHA** (HM)			**WIL** (HH)		
	n	%NS	95%CI	n	%NS	95%CI	n	%NS	95%CI
Cropland	-	-	-	9	10.8	1.5-72.0	-	-	-
Grassland	59	34.9	23.0-52.6	19	29.7	13.3-65.0	9	20.6	4.2-93.6
Hayland	-	-	-	9	1.8	0.1-26.1	26	46.8	28.4-76.6
Wetland	-	-	-	1	<0.1	0-100	-	-	-
All Nests	**59**	**34.9**	**23.0-52.6**	**38**	**14.1**	**6.3-31.1**	**35**	**40.5**	**24.7-66.0**

[a] habitat type is within a 1-m radius around the nest:
Grassland. Areas vegetated with various mixtures of grasses (introduced and native), forbs, and short (< 2m tall) woody plants (aerial cover of woody plants < 30%).
Hayland. Areas that have been ploughed and seeded to grasses and/or legumes and are hayed annually.
Cropland. Areas that are tilled and planted to grain or row crops, or that are plowed and left fallow, or contain crop residue from the previous growing season.
Other. Includes habitats, such as town sites, cemeteries, campgrounds, cottage areas, and unvegetated areas such as push piles, rock piles, equipment, oil/gas rigs, stacks of hay bales, etc., that don't fit into any of the other habitat categories listed .
Planted Cover. Mixtures of grasses and legumes planted for waterfowl nesting cover.
Woodland. Areas with woody plants (trees or tall shrubs) ≥ 2 m in height and having an aerial coverage ≥ 30%.
Wetland. All areas, regardless of size, mapped as wetland according to definitions in Cowardin et al. (1979).
[b] n = number of nests

Appendix D. Mayfield nesting success estimates (%NS) by species for the Masefield, SK, study area, 2011.

Species	**Study Site**								
	TUR (ML)			**CLI** (ML)			**BRA** (MM)		
	n[a]	%NS	95%CI	n	%NS	95%CI	n	%NS	95%CI
Blue-winged Teal	5	36.2	11.3-100	3	26.7	4.1-100	4	2.7	0.1-78.3
Gadwall	3	25.3	1.7-100	6	9.4	1.3-70.4	3	100	100-100
Green-winged Teal	-	-	-	-	-	-	-	-	-
Lesser Scaup	-	-	-	-	-	-	1	<0.1	0-100
Mallard	6	6.6	0.7-66.2	2	2.0	<0.1-100	2	100	100-100
Northern Pintail[b]	22	6.3	1.2-23.8	10	1.4	<0.1-23.8	8	19.4	2.3-100
Northern Shoveler	6	7.2	0.1-67.0	7	14.3	2.9-65.5	7	26.5	7.0-95.0
Unknown	-	-	-	-	-	-	-	-	-
All Nests	**42**	**9.9**	**4.3-22.4**	**28**	**7.9**	**2.8-22.0**	**25**	**25.9**	**12.0-55.2**
	ROB (MH)			**SHA** (HM)			**WIL** (HH)		
	n	%NS	95%CI	n	%NS	95%CI	n	%NS	95%CI
Blue-winged Teal	18	42.4	22.3-79.6	9	31.7	10.1-96.0	6	72.7	38.6-100
Gadwall	8	60.8	31.3-100	6	32.7	9.7-100	6	100	100-100
Green-winged Teal	-	-	-	1	0.1	<0.1-100	-	-	-
Lesser Scaup	1	100	100-100	-	-	-	-	-	-
Mallard	3	53.5	16.2-100	5	6.9	0.5-86.4	1	8.2	0.1-100
Northern Pintail	15	24.3	5.8-82.1	14	4.5	0.4-32.2	16	11.5	2.0-49.7
Northern Shoveler	13	20.9	7.4-57.3	3	15.9	1.1-100	6	42.9	16.2-100
Unknown	1	<0.1	0-100	-	-	-	-	-	-
All Nests	**59**	**34.9**	**23.0-52.6**	**38**	**14.1**	**6.3-31.1**	**35**	**40.5**	**24.7-66.0**

[a] n = number of nests.
[b] includes all northern pintail nests provided to the Pintail Duckling Survival Study

Appendix E. Summary of SpATS study sites, 2002-2011.

Study Area	Year(s)	Study Site	Biome	Pair density – *Anas sp.* (pairs/mi^2)		Nests[a]		Nesting Success (%)[b]		Wetland inundation (%)[c]		Herbaceous cover (%)[d]		Perennial cover (%)	
Shoal Lake, MB	2002	BEU	Parkland	50.6		29		6.5		23.9		21.8		28.5	
	2002	POP	Parkland	118.4		124		8.9		23.2		37.9		43.3	
	2002	OAK	Parkland	79.9		46		5.9		32.1		53.0		81.3	
	2002	CAR	Parkland	45.9		46		5.5		54.2		23.3		28.8	
	2002	ERI	Parkland	104.9		67		6.1		48.8		39.9		49.1	
	2002	ROL	Parkland	41.4		16		15.0		45.3		44.2		67.7	
Chaplin, SK	2002/2005	KEE	Prairie	2.5	31.9	-	17	-	24.9	0	37.5	7.8	10.4	8.3	10.8
	2002/2005	ABO	Prairie	2.5	35.8	-	48	-	14.3	2.6	38.9	63.7	66.1	64.0	66.4
	2002/2005	PAR	Prairie	7.0	28.6	-	28	-	11.0	0	24.7	70.8	77.0	70.9	77.2
	2002/2005	HAL	Prairie	16.4	21.4	23	41	23.5	22.2	0.4	19.1	28.8	31.6	29.4	32.2
	2002/2005	EAS	Prairie	50.4	97.7	63	211	16.3	24.6	10.4	32.6	53.7	57.6	54.0	57.9
	2002/2005	MEL	Prairie	1.5	44.7	-	58	-	41.6	1.0	51.7	87.4	93.2	87.5	93.3
Czar, AB	2003	HUG	Parkland	5.4		-		-		8.8		22.1		28.4	
	2003	CER	Prairie	6.0		-		-		16.8		59.3		60.8	
	2003	VET	Prairie	17.5		-		-		54.2		88.5		92.4	
	2003	BRO	Parkland	10.6		-		-		23.4		18.2		25.6	
	2003	AMI	Parkland	7.5		-		-		26.4		45.4		59.8	
	2003	CON	Prairie	10.5		-		-		10.9		66.2		73.3	
Masefield, SK	2003/2011	TUR	Prairie	67.6	42.6	18	42	24.2	9.9	52.1	86.2	9.8	-	9.8	-
	2003/2011	CLI	Prairie	61.1	51.9	131	28	28.6	7.9	63.6	76.0	18.6	-	18.7	-
	2003/2011	BRA	Prairie	33.5	16.6	40	25	30.4	25.9	52.5	70.3	57.4	-	57.4	-
	2003/2011	ROB	Prairie	97.9	32.7	104	59	27.8	34.9	49.0	77.8	97.2	-	97.2	-
	2003/2011	SHA	Prairie	31.4	16.7	63	38	23.9	14.1	80.1	84.8	56.7	-	56.8	-
	2003/2011	WIL	Prairie	60.1	19.0	39	35	23.1	40.5	68.4	75.6	81.6	-	81.6	-
Redberry, SK	2003/2006	MAR	Parkland	4.0	46.4	-	41	-	3.3	26.3	61.8	6.1	11.0	8.2	13.0
	2003/2006	PEB	Parkland	27.7	31.6	19	22	16.8	20.2	17.5	64.8	57.6	56.1	76.9	75.6
	2003/2006	SHE	Parkland	5.0	26.8	-	-	-	-	25.0	54.4	47.0	-	85.5	-
	2003/2006	ECH	Parkland	17.5	51.2	7	42	74.6	5.0	17.2	52.6	41.7	43.6	53.2	55.2
	2003/2006	RAB	Parkland	13.4	60.6	3	37	53.6	17.6	15.3	79.9	44.1	43.9	78.8	79.8
	2003/2006	SPI	Parkland	30.8	47.1	23	41	15.3	17.0	20.5	67.8	57.0	55.2	95.3	94.2
Killarney, MB	2003/2008	FAI	Parkland	25.4	13.7	17	10	7.6	2.1	29.9	2.0	19.2	16.0	20.0	16.7
	2003/2008	NEE	Parkland	60.5	44.0	42	31	18.0	8.9	18.1	9.4	55.5	56.4	68.3	69.4
	2003/2008	WAW	Parkland	45.1	23.4	49	38	13.7	23.2	21.9	4.2	53.1	52.7	88.4	87.7
	2003/2008	BOI	Parkland	24.1	11.7	13	11	13.7	6.2	25.6	6.5	21.1	20.3	22.0	21.2
	2003/2008	GLE	Parkland	67.1	61.0	71	92	7.3	26.9	9.4	0.0	67.0	68.6	72.0	73.4
	2003/2008	WHI	Parkland	54.5	7.5	60	-	27.0	-	-	0.0	87.1	-	87.5	-

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Appendix E. - continued

Study Area	Year	Study Site	Biome	Pair density – *Anas sp.* (pairs/mi ^{2})		Nests		Nesting Success (%)		Wetland inundation (%)		Herbaceous cover (%)		Perennial cover (%)	
Buffalo Lake, AB	2004/2005	FER	Parkland	6.5	28.9	-	16	-	6.9	1.8	64.0	20.0	20.9	26.0	26.9
	2004/2005	EDB	Parkland	25.8	33.2	11	20	6.9	24.7	6.0	50.6	24.4	24.6	28.9	29.1
	2004/2005	DON	Parkland	4.0	41.6	-	28	-	21.4	2.7	62.3	33.2	34.3	39.5	40.3
	2004/2005	ROC	Parkland	2.0	52.3	-	28	-	13.6	1.4	65.5	21.4	26.3	25.3	30.2
	2004/2005	HOB	Parkland	42.6	36.9	20	37	13.8	19.6	7.7	61.8	34.3	34.6	45.4	45.6
	2004/2005	HAY	Parkland	23.7	52.0	3	49	18.6	17.4	6.7	29.2	78.0	78.4	85.5	85.8
Cypress Hills, AB	2004/2006	BOW	Prairie	68.5	29.0	28	8	11.0	20.9	48.2	54.7	12.3	11.8	12.5	12.0
	2004/2006	ETZ	Prairie	12.3	8.4	28	12	46.2	22.5	43.8	37.5	34.4	34.2	34.4	34.2
	2004/2006	MED	Prairie	16.5	22.5	14	5	24.2	0.3	21.9	70.8	70.8	70.8	73.0	73.0
	2004/2006	NEW	Prairie	34.2	58.6	98	81	48.0	23.9	14.6	12.5	98.1	97.5	98.1	97.5
	2004/2006	DUN	Prairie	7.5	22.9	-	17	-	39.6	37.5	29.7	66.8	68.2	67.0	68.4
	2004/2006	MUR	Prairie	214.7	210.4	113	58	43.2	27.8	75.0	33.3	67.4	68.7	69.3	70.7
Kindersley, SK	2004/2009	MAC	Parkland	2.0	12.6	-	7	-	0.3	26.2	21.0	8.0	8.6	10.3	10.9
	2004/2009	CUT	Parkland	5.4	34.3	-	28	-	11.9	55.0	18.5	28.7	27.8	37.8	37.1
	2004/2009	NEI	Parkland	4.5	13.5	-	-	-	-	22.5	4.1	48.9	-	87.8	-
	2004/2009	MUD	Prairie	3.5	31.5	-	10	-	3.1	6.9	2.9	13.9	15.4	15.0	16.3
	2004/2009	MAJ	Prairie	3.0	28.0	-	9	-	0.8	5.0	8.3	26.9	25.3	30.3	28.6
	2004/2009	SEN	Prairie	2.0	6.0	-	-	-	-	1.3	0	52.0	-	66.9	-
Lightning, SK	2004/2006	FLE	Parkland	49.4	40.3	25	17	3.5	24.7	13.2	69.4	30.6	29.3	33.8	32.5
	2004/2006	MOO	Parkland	58.1	35.6	22	18	11.3	16.9	6.0	26.2	59.2	59.2	72.8	72.8
	2004/2006	WAP	Parkland	17.7	23.6	5	21	3.5	5.6	18.4	52.6	73.0	73.4	86.2	86.4
	2004/2006	OXB	Parkland	68.6	62.6	19	58	2.1	21.2	4.2	23.6	29.8	29.7	33.3	33.2
	2004/2006	KEN	Parkland	54.7	60.1	68	53	19.4	31.4	12.0	49.6	53.5	53.9	73.4	73.8
	2004/2006	FOR	Parkland	24.9	30.5	11	22	5.6	7.5	5.4	25.0	63.7	64.0	79.3	79.6
Churchbridge, SK	2005	VER	Parkland	19.4		14		22.8		43.1		19.6		26.4	
	2005	TAN	Parkland	33.8		29		7.3		54.8		54.0		74.9	
	2005	TOG	Parkland	2.9		-		-		17.8		41.8		84.9	
	2005	BRE	Parkland	18.6		34		11.7		39.8		44.6		53.4	
	2005	SAL	Parkland	28.4		36		13.6		52.9		49.0		55.6	
	2005	WRO	Parkland	42.6		19		9.9		20.1		38.3		78.0	
Touchwood Hills, SK	2005	FOA	Parkland	17.7		18		14.1		25.2		46.1		31.7	
	2005/2010	LOC	Prairie	58.5	59.5	126	102	12.9	16.5	31.7	25.0	65.5	63.0	66.9	64.2
	2005/2010	DUV	Prairie	44.1	51.8	14	21	17.0	10.9	43.0	63.3	45.4	44.9	84.3	85.5
	2005/2010	SOU	Prairie	43.8	23.2	30	13	17.8	23.8	54.7	23.4	32.5	33.6	34.9	36.5
	2005	WIS	Parkland	73.1		64		12.0		42.1		44.4		67.7	
	2005/2010	NOK	Prairie	28.1	86.3	68	166	13.8	10.0	15.9	40.0	77.4	78.5	77.9	78.9

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Appendix E. - continued

Study Area	Year	Study Site	Biome	Pair density – *Anas sp.* (pairs/mi ^{2})	Nests	Nesting Success (%)	Wetland inundation (%)	Herbaceous cover (%)	Perennial cover (%)
Shooting Lake, AB	2006	RUM	Parkland	51.0	21	9.9	54.4	33.1	39.1
	2006	DEL	Parkland	21.2	26	21.0	42.5	29.5	32.6
	2006	COR	Parkland	29.5	-	-	39.6	90.6	92.9
	2006	HAN	Parkland	35.0	36	21.8	43.1	46.4	47.7
	2006	STE	Parkland	34.5	30	19.2	26.9	38.2	47.8
	2006	BIG	Parkland	40.5	17	42.1	34.4	57.8	69.4
St. Paul, AB	2007	SBR	Parkland	66.2	16	1.1	77.3	34.7	38.1
	2007	SAD	Parkland	34.3	20	14.3	76.1	22.9	30.4
	2007	FOI	Parkland	17.2	14	10.9	59.5	45.7	66.0
	2007	ABI	Parkland	25.9	18	5.6	70.5	62.3	84.7
	2007	LAF	Parkland	33.0	19	9.9	72.0	60.3	71.2
	2007	SMO	Parkland	32.8	16	11.4	65.8	47.3	80.7
Allan Hills, SK	2007/2010	SIM	Prairie	35.1 / 37.9	75 / 45	7.5 / 13.1	39.8 / 33.8	31.9 / 33.1	34.3 / 35.8
	2007	HAU	Prairie	54.9	47	14.8	52.9	56.7	59.5
	2007	THO	Prairie	78.8	39	7.5	29.2	78.6	87.5
	2007	GIR	Prairie	42.3	32	2.4	64.2	16.3	16.7
	2007/2010	BLA	Prairie	78.1 / 52.4	118 / 52	10.7 / 24.3	82.7 / 61.8	49.5 / 49.7	50.8 / 51.1
	2007	BRI	Prairie	52.2	38	13.0	55.4	53.1	62.5
Beaver, SK	2007	NUT	Parkland	47.3	33	5.1	64.0	26.3	29.0
	2007	JED	Parkland	25.5	27	5.5	42.8	46.3	73.5
	2007	THE	Parkland	25.0	32	24.6	60.0	57.0	88.6
	2007	KEL	Parkland	74.9	34	2.2	62.5	40.0	46.8
	2007	INS	Parkland	54.5	36	13.7	60.6	41.5	72.2
	2007	HOM	Parkland	42.5	23	0.9	67.5	32.2	83.3
Lake Alma, SK	2007/2009	HAR	Prairie	14.3 / 42.1	12 / 40	37.7 / 4.5	14.1 / 56.1	23.1 / 21.9	23.3 / 22.3
	2007/2009	SYB	Prairie	6.8 / 33.7	- / 28	- / 10.2	19.2 / 68.8	78.6 / 81.6	78.7 / 81.7
	2007/2009	GOO	Prairie	14.9 / 36.5	26 / 23	20.0 / 10.3	18.3 / 65.4	83.4 / 83.1	83.9 / 84.3
	2007/2009	TRI	Prairie	27.6 / 55.0	17 / 61	0.5 / 6.3	26.9 / 80.4	28.4 / 28.2	29.1 / 28.8
	2007/2009	ALM	Prairie	22.2 / 62.2	19 / 84	20.4 / 26.1	24.3 / 72.5	56.6 / 58.8	56.9 / 59.2
	2007/2009	GLA	Prairie	15.6 / 46.0	11 / 45	15.9 / 23.0	25.4 / 74.8	96.0 / 97.0	96.0 / 97.1
Beaverhill, AB	2008	MUN	Parkland	22.5	26	3.1	57.7	29.1	34.8
	2008	TOF	Parkland	23.2	19	10.3	45.8	26.8	32.7
	2008	VEG	Parkland	41.6	27	9.6	71.6	51.3	56.4
	2008	LAV	Parkland	111.0	33	3.0	65.0	22.6	27.0
	2008	HOL	Parkland	35.5	26	14.7	33.3	32.9	37.9
	2008	VIK	Parkland	45.1	53	5.4	76.8	45.0	47.0

Appendix E continued next page …

Appendix E. - continued

Study Area	**Year**	**Study Site**	**Biome**	**Pair density – *Anas sp.* (pairs/mi ^{2})**	**Nests**	**Nesting Success (%)**	**Wetland inundation (%)**	**Herbaceous cover (%)**	**Perennial cover (%)**
Milk River, AB	2008	STM	Prairie	10.4	14	16.2	48.2	27.7	27.9
	2008	MAG	Prairie	19.2	26	13.5	6.3	18.8	19.1
	2008	MIL	Prairie	37.9	3	0.1	20.8	61.8	61.8
	2008	HIL	Prairie	28.7	14	5.1	21.9	68.3	69.2
	2008	AET	Prairie	58.3	45	12.1	34.9	55.6	55.7
	2008	WAR[e]	Prairie	36.8	15	23.2	-	-	-
Dana Hills, SK	2008	HUM	Parkland	41.6	43	3.1	54.9	15.6	19.8
	2008	PLU	Parkland	32.1	15	12.7	19.6	60.0	69.9
	2008	GUE	Parkland	70.2	42	8.6	16.3	75.9	82.4
	2008	VIS	Prairie	78.6	138	3.6	25.3	22.2	22.7
	2008	MEA	Prairie	112.3	126	10.7	27.9	34.8	56.2
	2008	STD	Prairie	124.6	107	4.8	53.8	54.8	62.2

[a] Number of nests; dashes (-) indicates study sites that were not searched for nests due to low pair densities.
[b] Mayfield nesting success estimates (Johnson 1979).
[c] Average wetland inundation value (%) for Class III wetlands (Stewart and Kantrud 1971) during the 1st pair survey. This is an estimate of the average % each basin is flooded. These values are presented to characterize the wetness/dryness of each study site at the beginning of the nesting season. There were no class III wetlands at WHI in 2003.
[d] Herbaceous cover includes grassland, hayland, planted cover, and wetland vegetation; perennial cover includes herbaceous cover plus woodland. Percent herbaceous and perennial cover were calculated over the total area of a study site, excluding open water; dashes (-) indicate study sites where digitized habitat data is not yet available. Values were digitized from aerial photographs (1st site visit) or SPOT imagery (2nd site visit) taken during the year of study.
[e] At WAR a third nest search was not conducted, nest monitoring ceased on 6/20/08, and no wetlands were classified.