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Nest Parasitism on Constructed Islands in Northwestern North Dakota

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ABSTRACT -- Parasitism of duck nests can reduce host productivity. We examined effects of nest parasitism on success of host nests found on constructed islands in the Fuller-Big Meadows marsh in northwestern North Dakota from 1994 to 2000. We found 1642 duck nests of 10 species on 25 0.3-ha islands. Nine-hundred-seventy (59%) of the 1642 nests were parasitized, of which 87% were parasitized by redheads (*Aythya americana*). The observed parasitism rate was greater than 50% in four of seven years and was highest in 1997 (81%, n = 252). Mallard (*Anas platyrhynchos*) nests tended to have a higher probability of being parasitized than did nests of other species. The number of parasitic eggs laid per nest varied annually and was greatest in years with highest rates of parasitism (1997, 1999, and 2000). Among duck species, lesser scaup (*Aythya affinis*) nests contained the greatest number of parasitic eggs. From 1994 to 2000, nest success declined (97% Mayfield nest success in 1994 vs. 28% in 2000) whereas abandonment rates increased (2% in 1994 to 52% in 2000). Data revealed no evidence of a relationship between the probability of nest abandonment and incidence of parasitism.

Key words: *Anas platyrhynchos*, *Aythya americana*, constructed island, mallard, nest parasitism, nest success, North Dakota, redhead.

Low recruitment is the principal factor affecting populations of prairie-nesting ducks and, in turn, predation on nesting females, eggs, and ducklings is the primary contributing factor affecting recruitment (Johnson and Sargeant 1977, Cowardin et al. 1985, Greenwood et al. 1995). Physical barriers (e.g., water surrounding islands) protect duck nests from most species of mid-sized and larger mammalian predators and are recognized as an effective tool for reducing rates of nest depredation (Giroux 1981, Higgins 1986, Lokemoen and Woodward 1992). Management of natural islands and construction and management of new islands are tools used to increase recruitment rates of ducks (Hammond and Mann 1956, Bellrose and Low 1978, Aufforth et al. 1990, Lokemoen and Messmer 1994).

Ducks readily nest on islands, where high reproductive success and philopatry often result in higher nest densities than on mainland areas (Giroux 1981, Duebbert et al. 1983, Aufforth et al. 1990). However, in situations where dense aggregations of nesting ducks occur, high nest parasitism rates can reduce host productivity (Joyner 1976, Talent et al. 1981, Lokemoen 1991, Sorenson 1997). Parasitism generally reduces productivity of nesting hens because it contributes to abandonment of nests, egg displacement from nest bowls, inefficient incubation, and ovulation might be suppressed in host females (Weller 1959, Joyner 1976, Giroux 1981, Talent et al. 1981, Sayler 1996, Sorenson 1997).

Among North American ducks, the redhead (*Aythya americana*) is most widely known to parasitize nests of other duck species (e.g., Weller 1959, Olson 1964, Sugden 1980, Sorenson 1991, 1997, 1998). Most studies have focused on redhead parasitism in overwater nesting situations (Talent et al. 1981, Joyner 1983, Sayler 1996, Sorenson 1997, 1998). Redhead nest parasitism on constructed nesting islands is poorly documented; the only published study is that of Giroux (1981) from research conducted in southeastern Alberta.

Parasitic redheads tend to select host nests initiated prior to or during the redhead's normal nesting period (Giroux 1981, Sayler 1996). Mallard (*Anas platyrhynchos*) nests are thus especially vulnerable to parasitism by redheads (Joyner 1976, Giroux 1981, Talent et al. 1981). Parasitism occurs frequently on natural islands or in narrow strips of vegetation where high nest densities facilitate the location of host nests by parasitic hens (Johnson 1978, Stoudt 1982, Hines and Mitchell 1984, Sayler 1985, Sorenson 1997). The complex of small islands in the Fuller-Big Meadows (hereafter Big Meadows) marsh in northwestern North Dakota provides a unique example of the effects of nest parasitism on duck production on constructed islands. We summarize parasitism rates and nest success estimates of duck nests on 25 small (0.3 ha each) islands constructed in the Big Meadows marsh in northwestern North Dakota from 1994 to 2000.

STUDY AREA

Big Meadows is located in Williams County, 2.2 km south of Hamlet, North Dakota (48° 33' 27"N, 103° 03' 22"W) within the Missouri Coteau physiographic region (Fig. 1, Bluemle 1991). Big Meadows is a 972-ha seasonal (Class III), slightly brackish (Subclass B) wetland (Stewart and Kantrud 1971). The marsh was dominated by sprangletop (*Scolochloa festucacea*), with lesser amounts of hardstem bulrush (*Schoenoplectus acutus*) present. Sago pondweed (*Stuckenia pectinatus*) was common there during one to two years following a dry cycle and common bladderwort (*Utricularia macrorhiza*) was common during two or more years of a wet cycle.

Marsh habitats for each year were mapped by digitizing color infrared aerial photography (1:20,000) with Map and Image Processing System software (Miller et al. 1990) and feature mapping habitats. Big Meadows marsh was dominated by emergent vegetation in 1994 (66% cover) and 1995 (81% cover). Following 1995 there was a general shift to more open water in the marsh. Following this shift, no trends in the amount of emergent vegetation and open water were apparent (52%, 42%, 52%, 37%, and 45% emergent vegetation cover in years 1996 to 2000, respectively). Depth of the marsh varied from 0.2 to 1.5 m. During the wettest years of 1997 and 1999, most of the marsh was 0.3 to 1 m deep.

Twenty-five 0.3-ha earthen islands were constructed in the marsh during the winter of 1986-1987. The islands were clustered (Fig. 1) with a mean distance between islands of 145 m. Following construction, the islands were seeded to a

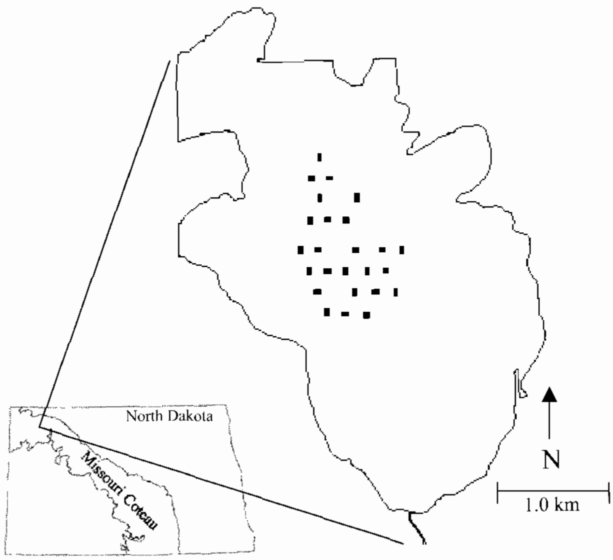

Figure 1. Twenty-five 0.3-ha nesting islands constructed in the winter of 1986-1987, Fuller-Big Meadows marsh, North Dakota.

mixture of intermediate wheatgrass (*Thinopyrum intermedium*), tall wheatgrass (*Thinopyrum ponticum*), alfalfa (*Medicago sativa*), and sweet clover (*Melilotus* sp.). During the early 1990's, smooth brome (*Bromus inermis*) and Canada thistle (*Cirsium arvense*) became the dominant plant species on the islands. Vegetation on islands was maintained in a relatively tall (0.3 to 0.8 m), dense condition by prescribed burning during the dormant season; five of the 25 islands were burned annually (different islands each year).

METHODS

Each year, we randomly selected 15 of 25 islands and conducted nest searches three or four times between late April and early July. Two to four persons walking about 1.2 m apart searched islands completely. Searchers used wooden lathes to move vegetation and locate concealed nests. Each nest was marked with a pin flag placed 0.6 m north of the nest. We identified duck nests via sightings of hen or by nest and egg characteristics (Broley 1950). Data recorded at each nest visit included species, hen presence/absence, nest status (normal, disturbed, or destroyed), number of host eggs, number of parasitic eggs, incubation stage of eggs, nest fate, and number of eggs hatched. Nests were revisited about every three weeks to determine fates. Nests were considered successful if at least one host egg hatched. Field investigators assigned causes of nest failure (depredation, weather, parasitism, livestock, investigator activity, and unknown). Nest initiation dates were estimated by backdating the number of days of incubation plus one day for each egg in the clutch. We report the mean number of nests per ha per year. The proportion of nests parasitized was calculated by year and by species per year. We did not determine incidence of intraspecific parasitism.

We used logistic regression (Allison 1999) to predict rates of nest parasitism as a function of species (S), nest initiation date (I), and year (Y) and the interactions of these terms. Probabilities of nest parasitism, estimated from the most plausible logistic regression model, were plotted against nest initiation dates for the range of nest initiation dates observed for each species. We recorded the known maximum number of parasitic eggs laid per parasitized nest. We tested the effects of year and species on the square-root transformation of these data with a two-way ANOVA (SAS Institute Incorporated 1999). Four models were tested; year, species, and year*species interaction; main effects only; year only; and species only. Species included in the analysis were mallard, gadwall (*Anas strepera*), blue-winged teal (*Anas discors*), northern shoveler (*Anas clypeata*), northern pintail (*Anas acuta*), and lesser scaup (*Aythya affinis*). We did not include other species because of small sample sizes. Least squares means of the number of parasitic eggs per parasitized nest are presented. Because nest visits were three weeks apart, means for the number of parasitic eggs laid per nest were considered conservative estimates.

Daily survival rates (DSR) of duck nests were estimated for each year and species with the Mayfield method (Mayfield 1961) as modified by Johnson (1979). Nests that contained only nonviable eggs, nests that failed due to investigator activity, or nests that were no longer active (e.g., abandoned prior to discovery) were excluded from analyses. Infrequent nest checks and our inability to determine exact dates of parasitic events made it difficult to perform statistical analyses on the relation between DSR and parasitism. The Mayfield method assumes equal DSR among nests (Mayfield 1961), but we suspected differences between parasitized and unparasitized nests. Therefore, we calculated Mayfield nest success for unparasitized nests only, parasitized nests only, and for all nests, regardless of parasitic status. We present trends in nest success over the period of study for each of these three categories. We used logistic regression (Allison 1999) to predict the probability of nest abandonment as a function of year, parasitism, and their interaction.

We calculated Akaike's information criterion (AIC) for each model we considered for each analysis listed above (Akaike 1992). AIC was used to rank models from most to least plausible in each case (Burnham and Anderson 1998).

RESULTS

We found 1642 nests of 10 duck species on the islands from 1994 to 2000: 39% (638) mallard, 23% (384) gadwall, 14% (227) blue-winged teal, 7% (119) lesser scaup, 6% (100) northern pintail, and 6% (93) northern shoveler. Nests of less common species included 3% (42) redhead, 2% (27) American wigeon (*Anas americana*), less than 1% (5) green-winged teal (*Anas crecca*), less than 1% (3) canvasback (*Aythya valisineria*), less than 1% (3) unidentified, and less than 1% (1) ruddy duck (*Oxyura jamaicensis*). Mean numbers of nests per ha found on islands each year were 32, 58, 71, 56, 56, 30, and 58 nests/ha (1994 to 2000, respectively). These represent minimum numbers of nests, as we did not find every nest because of limits of our data collection methods, thus we could not calculate precise estimates of density for analyses.

Nine-hundred-seventy (59%) nests were parasitized, of which 87% were parasitized by redheads. Mallards, gadwalls, and northern shovelers each laid eggs in three nests of other species. Lesser scaup laid eggs in nine nests of other species, blue-winged teal laid eggs in two nests of other species, and canvasback laid eggs in one nest of another species. The parasitic species was not identified at 102 (11%) parasitized nests. Parasitism rates were greater than 50% in 1996, 1997, 1999, and 2000 (Table 1). Parasitism rate was highest in 1997 (81%, $n = 252$).

Nest parasitism was best predicted by a model containing main effects of species, initiation date, and year, and interaction of I*S, I*I*S, and S*Y. Under the

Table 1. Total numbers (n) of nests by species and percent (%) of host species nests that were parasitized by year, Fuller-Big Meadows marsh islands, North Dakota, 1994 to 2000.

	1994		1995		1996		1997		1998		1999		2000	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Mallard	35	69	103	56	131	73	99	82	103	65	64	66	103	85
Gadwall	22	32	60	20	81	38	63	86	75	32	36	67	47	45
Blue-winged teal	11	36	17	24	42	52	25	60	33	39	13	54	86	72
Lesser scaup	6	17	9	33	28	71	37	92	21	38	11	73	7	57
Northern shoveler	16	63	24	38	21	71	14	100	8	50	3	67	7	100
Northern pintail	37	51	28	29	21	38	3	33	5	60	1	100	5	60
All nests[a]	146	47	259	38	339	59	252	81	250	49	134	63	262	72

[a] Category includes nests of species listed in the table and American wigeon, canvasback, green-winged teal, redhead, ruddy duck, and unidentified.

selected model, mallard nests on Big Meadows islands were at greater risk of parasitism than other species in most years (Fig. 2). In the second half of the nesting season in 1997 and 1999, gadwall and lesser scaup nests had greater probabilities of being parasitized than mallard nests. From 1998 to 2000, the earliest initiated blue-winged teal nests had greater probabilities of being parasitized than mallard nests. In 1997, blue-winged teal nests had greater probabilities of being parasitized in the earliest and latest portions of the species' nesting period than nests initiated in the middle of the nesting period.

The model containing main effects of year and species best explained the variation in the number of parasitic eggs laid in parasitized nests. Number of parasitic eggs found in parasitized nests ranged from 1 to 25. The estimated mean number of parasitic eggs laid per parasitized nest was greatest in 1997 (6.4, SE = 0.3, n = 199), followed by 1999 (6.2, SE = 0.4, n = 84), 2000 (5.1, SE = 0.3, n = 185), 1998 (4.4, SE = 0.4, n = 119), 1994 (4.2, SE = 0.5, n = 66), 1996 (3.5, SE = 0.3, n = 192), and 1995 (3.2, SE = 0.4, n = 94). Lesser scaup nests contained the greatest mean number of parasitic eggs (6.5, SE = 0.4, n = 78), followed by mallard nests (5.3, SE = 0.2, n = 456), blue-winged teal nests (5.1, SE = 0.4, n = 127), northern shoveler nests (4.3, SE = 0.5, n = 61), northern pintail nests (3.6, SE = 0.6, n = 43), and gadwall nests (3.4, SE = 0.3, n = 173).

Fifteen hundred fifty-eight nests fit the criteria for calculating Mayfield nest success. At least one host egg hatched in 990 of 1558 nests. As expected, predation generally was not a major cause of nest failure. However, in 1995, 1996, and 1999, predators (raccoon [*Procyon lotor*] and mink [*Mustela vison*]) visited several islands as determined by tracks and sign at nests, and caused greater than 25% of failed nests in those years. Mayfield nest success was relatively high from 1994 to 1996, but declined sharply in 1997 (Fig. 3), which coincided with the year that nest parasitism rates were highest (Table 2). Following 1997, nest success rates remained lower than years prior to 1997. A declining trend in nest success estimates was observed in both parasitized and unparasitized nests over the seven-year period and both parasitized and unparasitized nests experienced relatively low success from 1997 to 2000 (Fig. 3). Nest success was slightly greater for parasitized than unparasitized nests. Overall abandonment rates for all nests rose sharply in 1997 and remained above 40% through 2000 (Fig. 3). The model containing main effects of year and parasitism best predicted the probability of nest abandonment. However, model results did not show a significant difference in the probability of nest abandonment between parasitized and unparasitized nests.

DISCUSSION

The small sizes of islands we sampled might have contributed to high rates of nest parasitism. In North Dakota, Lokemoen (1991) found that more nests were

Table 2. Total number (n) of nests and Mayfield nest success estimates (%) for unparasitized (U) nests, parasitized (P) nests, and all (total) nests of host species, Fuller-Big Meadows marsh islands, North Dakota, 1994 to 2000.

		1994		1995		1996		1997		1998		1999		2000	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Mallard	Total	34	94	97	85	124	74	97	43	98	58	63	11	102	41
	U	11	72	42	74	32	44	18	22	32	42	22	3	15	20
	P	23	100	55	94	92	85	79	48	66	66	41	18	87	46
Gadwall	Total	20	100	54	94	75	73	61	39	72	22	32	13	47	41
	U	13	100	44	96	45	72	9	37	48	26	9	5	26	35
	P	7	100	10	82	30	75	52	39	24	15	23	18	21	51
Blue-winged Teal	Total	9	100	11	51	40	45	25	15	30	23	13	8	86	13
	U	5	100	9	53	19	65	10	27	19	26	6	5	24	30
	P	4	100	2	45	21	29	15	9	11	18	7	6	62	9
Lesser Scaup	Total	5	100	7	100	27	81	37	12	20	11	10	3	7	26
	U	4	100	5	100	8	81	3	18	13	14	3	8	3	54
	P	1	100	2	100	19	82	34	11	7	7	7	2	4	10
Northern Shoveler	Total	16	100	21	91	21	78	13	24	8	39	3	9	7	6
	U	6	100	14	100	6	100	0	0	4	62	1	1	0	0
	P	10	100	7	75	15	71	13	24	4	17	2	18	7	6

Table 2 continued.

		1994		1995		1996		1997		1998		1999		2000	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Northern Pintail	Total	35	100	27	79	20	74	3	18	5	61	1	0	5	12
	U	17	100	19	67	12	61	2	35	2	13	0	0	2	33
	P	18	100	8	100	8	100	1	1	3	100	1	0	3	5
Other[a]	Total	16	87	12	85	14	76	10	14	5	19	6	35	7	36
	U	13	83	9	81	6	73	5	1	2	24	5	30	3	20
	P	3	100	3	100	8	79	5	45	3	16	1	100	4	56
All nests	Total	135	97	229	86	321	71	246	30	238	35	128	11	261	28
	U	69	94	142	83	128	64	47	22	120	29	46	5	73	30
	P	66	100	87	90	193	75	199	33	118	41	82	15	188	27

[a] Other includes American wigeon, canvasback, green-winged teal, redhead, ruddy duck, and unidentified.

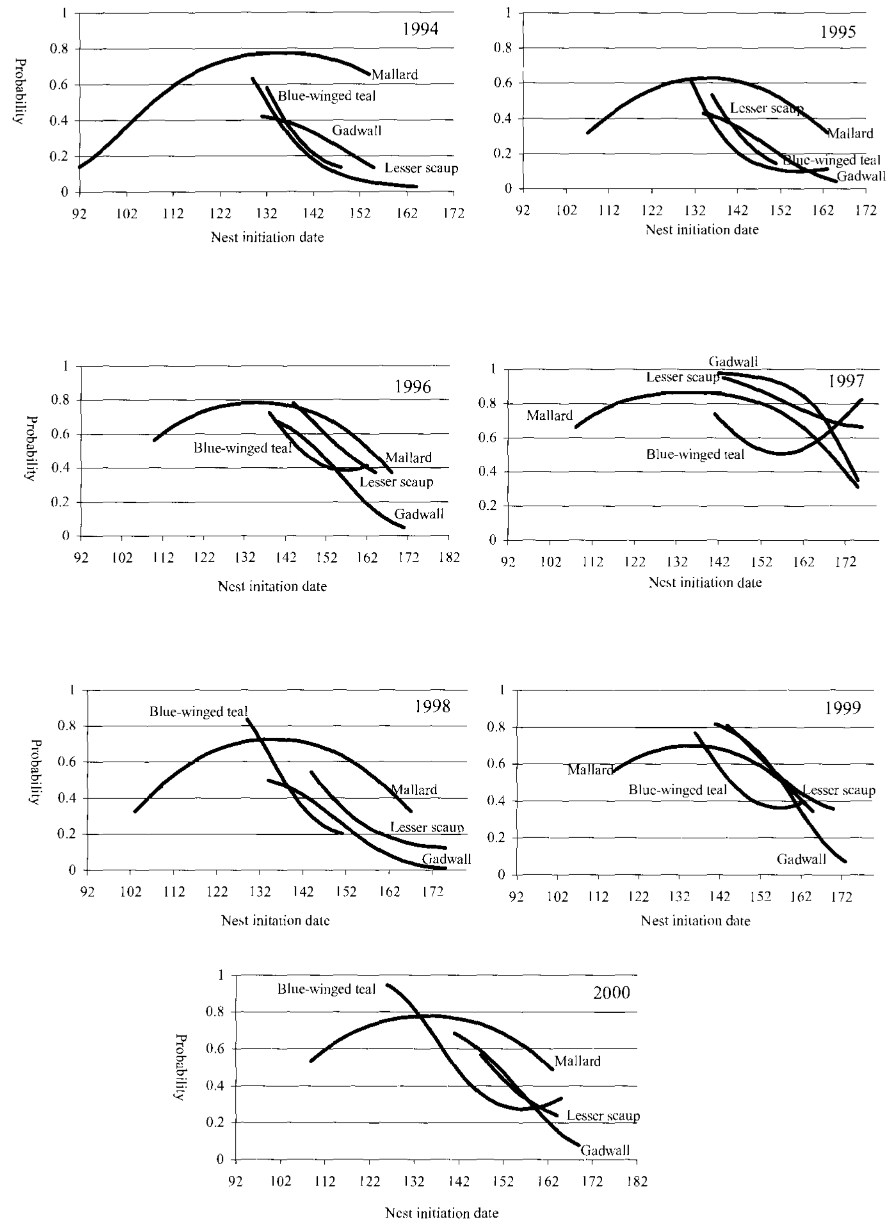

Figure 2. Probabilities of nest parasitism (logistic regression) for mallard, gadwall, blue-winged teal, and lesser scaup in relation to nest initiation date, Fuller-Big Meadows marsh islands, North Dakota, 1994 to 2000.

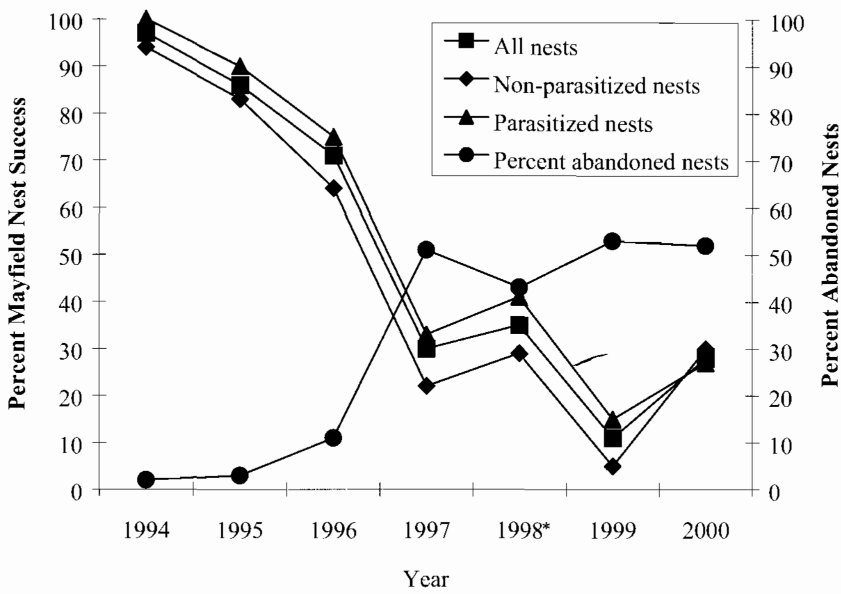

Figure 3. Mayfield nest success for parasitized, unparasitized, and all nests combined and nest abandonment rates, Fuller-Big Meadows marsh islands, North Dakota, 1994 to 2000. * Of 69 abandoned nests in 1998, 33 were thought to have been abandoned due to a 6-day period of cold temperatures and steady rain that occurred from 16 to 22 June.

parasitized on islands than on peninsulas. The greater mean distance of nests from water and the larger size of peninsulas made nests on peninsulas less accessible to parasitic hens than nests on islands. Similarly, parasitized nests in Manitoba were closer to shore than unparasitized nests (Giroux 1981). Although distances of nests from shore were not measured for our study, the maximum distance of any nest from shore was never greater than 12 m.

High parasitism rates on Big Meadows islands also might have been the result of returning redhead females to previously successful nest sites. Johnson (1978) found that 70% of 23 adult females and 12% of 92 yearling females returned to a Manitoba study area in subsequent years. Lokemoen (1991) suggested that increased numbers of redheads on islands in North Dakota were the result of adult females returning to sites where they had nested successfully, and also their young homing to these natal areas. Densities of redheads on Big Meadows were not assessed during the years of our study, so relations between the densities of redhead and parasitism rates could not be determined. Although we have no data on nests located in emergent vegetation, we speculate that as emergent vegetation cover declined, available nesting habitat for redheads in emergent vegetation also declined. The years with the least percent cover of emergent vegetation, 1997, 1999, and 2000, coincided with the years with the highest rates of nest parasitism.

Mallard nests on Big Meadow islands were at greater risk of parasitism than were nests of other species. Giroux (1981) also found that mallard nests were parasitized more frequently than nests of other species. Giroux (1981) suggested that mallard nests were more susceptible to nest parasitism because mallard nest initiations closely coincided with the period of parasitic egg laying by redheads and nests were located closer to shore than nests of other species. Mallards began nesting earlier than most species on Big Meadows islands and continued to nest through late June. The probability of nest parasitism might have been higher for mallards than other species on Big Meadow islands due to their long nesting period.

In North Dakota, Lokemoen (1991) found that the mean number of parasitic eggs per nest was greater for islands than peninsulas where rates of parasitism were less. In our study, numbers of parasitic eggs found in parasitized nests were greater in those years in which rates of parasitism were highest (1997, 1999, and 2000). We found that lesser scaup had the greatest mean number of parasitic eggs laid per nest. Giroux (1981) also found that lesser scaup nests contained the greatest number of parasitic eggs.

Estimates of nest success were slightly greater for parasitized than unparasitized nests. This was contrary to our expectations. Possibly successful nests were more likely to be parasitized because they remained active for a longer period of time than unsuccessful nests. Sayler (1985) noted that parasitism rates were higher the longer a nest was active. We did not find a significant relationship between parasitism and the probability of nest abandonment. Studies have shown lower nest success and/or increased abandonment rates for parasitized than for unparasitized nests (Weller 1959, Lokemoen 1991, Sorenson 1997), but other studies found no differences in nest success or rates of abandonment between parasitized and unparasitized nests (Joyner 1976, Talent et al. 1981, Bouffard 1983). Possibly females attending nests that were not parasitized were harassed by redhead hens or high nest densities led to strife among conspecifics, which might have contributed to increased abandonment rates of both parasitized and unparasitized nests. This could be a possible scenario because the combination of small island size and high nest density (relative to upland nests and larger islands; see Oetting and Dixon 1975, Giroux 1981). These factors might have increased the chance of encounters between redheads seeking nests to parasitize and females of other species tending nests.

MANAGEMENT IMPLICATIONS

Islands were built in the Big Meadows to increase duck production by reducing the effects of predation; however through the period of study, nest success declined dramatically on the islands and benefits of the islands to area ducks were less than expected. There is a need for a more refined study of the factors contributing to the decline in nest success on the islands at Big Meadows. Using time-lapse photography as a direct method of monitoring nests might be one way to discover the causes of nest failure (Sayler 1996, Sorenson 1990, 1997). Erecting barrier fences around some of the islands might be a less expensive (estimated cost of $150/barrier) method to determine whether harassment by redheads in particular (i.e., redheads usually walk onto islands) is contributing to the decline in nest success. For example, fences constructed of 0.5-m tall, 5- x 10-cm mesh galvanized wire, with escape funnels for juvenile waterfowl, could be placed just above the high water line to avoid damage from ice and waves. We predict that dabbling ducks such as mallard would continue to access fenced nesting islands by flying, just as they did at upland predator exclosures (Lokemoen et al. 1982, Greenwood et al. 1990), but that redheads, which normally walk onto islands, would not. Specific mechanisms of redhead parasitism, including relationships to breeding densities and return rates, need to be better understood.

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