Nest Success and Duckling Survival of Greater Scaup, *Aythya marila,* at Grassy Island, New Brunswick

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Nesting biology and duckling survival of Greater Scaup (*Aythya marila*) at Grassy Island on the Saint John River in southern New Brunswick were compared between 1995 and 1996. Grassy Island in New Brunswick is an area that is notably removed from other scaup breeding areas, being located farther south from main breeding areas in North America. The Mayfield estimates of nest success were 61% and 21% in 1995 and 1996, respectively. Mean daily survival rates were 0.99 in 1995 and 0.96 in 1996 and were significantly different ($t = 4.86$, $P < 0.001$). Duckling survival was estimated to range from 38 to 54% in 1995, and was 8% in 1996. The lower breeding success in 1996 may have been due to factors associated with decreased temperatures and increased precipitation, but the fact that the breeding location is atypical to other Greater Scaup breeding areas should not be overlooked.

Key Words: Greater Scaup, *Aythya marila*, nest success, duckling survival, New Brunswick.

Duckling mortality is usually greatest in the first one to two weeks post-hatch and can influence duckling recruitment. Variation in nesting success of Mallards (*Anas platyrhynchos*) influenced changes in annual population size more than any other criterion (Hoekman et al. 2002). Additionally, Flint et al. (2006) found that scaup productivity explained more variation in population trends than adult survival. Therefore, relatively small changes in nesting success have the ability to result in large decreases in recruitment. Identifying reasons behind failed nest attempts throughout the range of Greater Scaup (*Aythya marila)* is important, particularly in isolated breeding areas that are not well studied (Austin et al. 2000).

Duckling mortality has been associated with poor weather (Blums et al. 2002; Jonsson et al. 2009). Ducklings of most species have poor thermoregulatory capabilities and are vulnerable to cold and wet situations. Weather may indirectly increase mortality rates of ducklings by reducing their ability to feed (Hilden 1964) or by altering their behavior, possibly resulting in an increased risk of predation (Mendenhall and Milne 1985). During our study in 1996, the late incubation, hatching and early brood rearing periods (July through early August) of Greater Scaup nesting at Grassy Island, New Brunswick were significantly cooler and wetter than 1995 (Smith 1999). Precipitation in 1996 was more than double the observed value in 1995 (National Climate Data and Information Archive 2008). Concurrent with the higher precipitation (Figure 1) were rising water levels (approximately 1 m higher in 1996) which flooded nests and altered brood rearing habitat (Smith 1999). We examine the nesting biology and duckling survival of Greater Scaup in this far-removed southernmost breeding area (McAlpine et al. 1988) and discuss how environmental attributes may have influenced their nesting success.

Study Area

The study was conducted on the Saint John River at Oak Point, in southern New Brunswick (45°31'N, 66°05'W). The surrounding area is deltaic in character containing several islands, coves, and extensive beds of aquatic vegetation (Choate 1973*). River levels fluctuate over 2.5 m seasonally and fluctuations of 6 m have been recorded (Choate 1973*). Nesting data were collected from Grassy Island (45°31'N, 66°04'W), a low-lying 32 ha island located 0.7 km offshore from Oak Point. Island vegetation was dominated by grasses (*Calamagrostis* spp., *Phalaris* spp.), forbs (predominantly *Lythrum salicaria*), sedges (*Carex* and *Cyperus* spp.), a few small stands of shrubs (*Cornus* and *Alnus* spp.) and trees (*Fraxinus* and *Acer* spp.). The island is submerged annually during spring flooding (A. Smith, personal observation). Common Terns (*Sterna hirundo*), Ring-billed Gulls (*Larus delawarensis*) and Great Black-backed Gulls (*L. marinus*) also nest on the island. This location is removed and farther south of the larger breeding area for Greater Scaup.

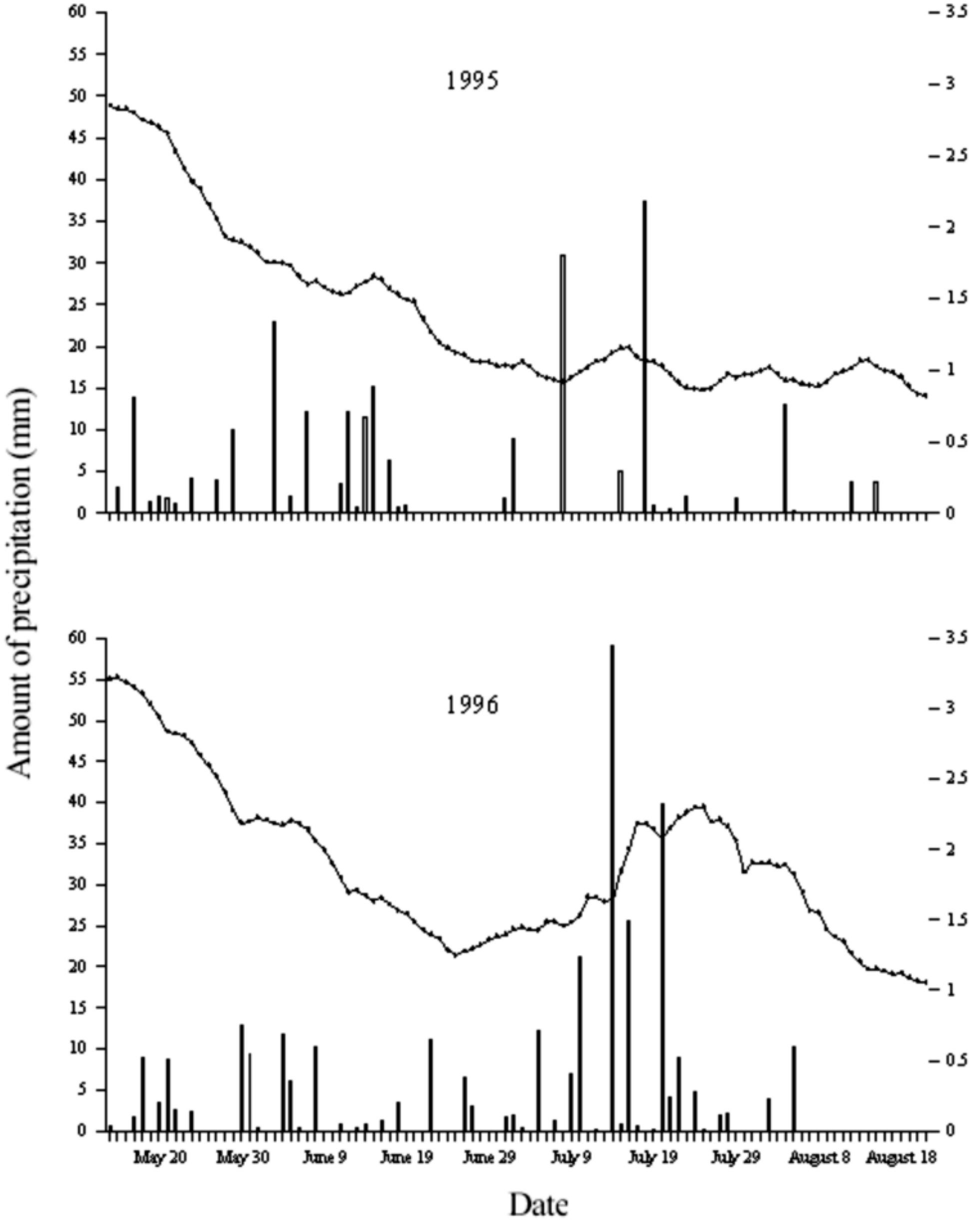

FIGURE 1: Precipitation (bars) and water levels (lines) at Oak Point, New Brunswick during the 1995 and 1996 Greater Scaup breeding seasons.

Methods

Scaup nest sites were found by systematic searches conducted by 5 to 10 people during mid-morning (Gloutney et al. 1993), on four dates in 1995 (15, 22, 27 June and 6 July), three dates in 1996 (18, 25 June and 3 July) and opportunistically when conducting other field work. Nests were mapped and relative nest elevation was estimated. All nests were monitored to determine their fate. When females flushed from nests, researchers covered the eggs with down and other nest material, and placed a string on top of the eggs. If on a subsequent visit the string had not been moved (i.e., indicating that the female had not returned to the nest), it was assumed that the bird had abandoned the nest (Klett et al. 1986). Nest initiation was estimated by backdating from hatch dates or an age estimated by candling; or if found during laying, by counting the number of eggs (assuming one egg laid per day; Weller

TABLE 1. Fate of Greater Scaup nests found on Grassy Island, New Brunswick in 1995 and 1996.

	1995		1996	
Fate	n	%	n	%
Abandoned	22	19.3	41	36
Hatched	61	53.5	32	28.1
Depredated	4	3.5	17	14.9
Flooded	0	0	7	6.1
Abandoned due to researchers[a]	3	2.6	2	1.8
Abandoned or perished due to trapping, marking or radio tagging[b]	14	12.3	13	11.4
Unknown[c]	10	8.8	2	1.8

[a] Nests were abandoned during laying or early incubation, most likely due to nest checking activities.
[b] During 1995, 14 nests were abandoned due to trapping and nasal marking. During 1996, 9 nests were abandoned due to trapping, marking and radio-tagging activities, and 4 hens died during radio-implant operations.
[c] Nests were lost so their fate was unknown.

1956). Incubation was assumed to last 27 days (Johnsgard 1975; Bellrose 1980). Clutch size was defined as the maximum number of eggs observed in a nest. We considered nests with >12 eggs as dump or community nests, and these were excluded from clutch size analysis (Weller et al. 1969). Eggs that did not hatch, and were not thought to be from parasitic laying, were counted as unhatched. No distinction was made between infertile and unviable eggs.

Nest success was estimated using the modified Mayfield method, and daily survival rates were compared using a t-test (Mayfield 1961, 1975; Johnson 1979; Klett et al. 1986). Dates of nest abandonment were rarely known so they were estimated by adding the number of days of probable exposure as determined by the modified Mayfield method, to the last date the nest was observed to be viable (Klett et al. 1986). Probable exposure equaled half of the interval between the last date the nest was viable, and the date when nest fate was determined or the estimated hatch date, whichever was less. If the interval was > 14 days, it was multiplied by 0.4 instead of 0.5 (Johnson 1979). Nest age at abandonment was determined by subtracting the date of nest initiation from the date of abandonment. Nests that were destroyed due to flooding were considered separately from abandoned nests.

The frequencies of hatching, abandonment and predation were compared between years using a chi-square test of independence. Between-year differences in variables were tested with Wilcoxon rank-sum test. Tests of skewness were used to compare the distribution of nest- initiation dates, hatch dates and abandonment dates, and nest age at abandonment between years (Snedecor and Cochran 1967). Nests of unknown fate or failed due to researcher activities were not included in analyses of abandoned nests.

In 1995, nine brood surveys were conducted by boat between 13 and 31 August. In 1996, 6 brood surveys were conducted by boat between 13 and 21 August. All surveys were conducted during daylight hours. A regular route was followed and ducklings counted from vantage points at known brood-rearing areas and opportunistically. Brood surveys were also conducted from airplane during mid-morning on 28 August 1995 and 16 August 1996. When a brood was observed, it was circled until species, and number of adults and young, could be verified by two observers.

During 1996, seven nests were found on Rush (45°30'N, 66°05'W) and Hog (45°33'N, 66°01'W) Islands located near Grassy Island. Two of the seven nests hatched a total of 12 eggs. Those islands were not searched in 1995. To account for duckling production from those islands in 1995, the number of nests found in 1996 (7) was multiplied by median clutch size (9), and percentage of eggs hatched (47%) from nests on Grassy Island in 1995 for an estimated 30 hatched eggs. The two islands were searched only once each so it was likely that some nests were missed. Therefore, these estimates should be considered the minimum production of ducklings.

The ratio of ducklings observed in mid to late August to eggs hatched was used as a rough estimate of duckling survival. A chi-square test was used to compare survival between the two years of the study.

Results

A total of 114 nests were found on Grassy Island in both 1995 and 1996. The Mayfield estimate of nest success was 61% in 1995 and 21% in 1996. Mean daily survival rates of 0.99 (SE = ±0.003) in 1995 and 0.96 (SE= ±0.005) in 1996 were significantly different (t = 4.86, $P < 0.001$). Fewer nests hatched, and more were abandoned and preyed upon in 1996 than expected when compared to 1995 ($X^2 = 22.78$, $P < 0.001$; Table 1). The date of abandonment was positively skewed in 1995 ($P < 0.05$), but was negatively skewed in 1996 ($P < 0.05$; Figure 2).

In 1995, 426 eggs hatched on Grassy Island. An estimated minimum hatch of 30 eggs on other islands resulted in a minimum total hatch of 456 eggs. Number of scaup ducklings observed during boat surveys ranged from 70 to 179. A survey conducted on 31

TABLE 2. Some statistics from greater scaup nests found on Grassy Island, New Brunswick in 1995 and 1996.

Characteristic[a]	1995 N	1995 Mean	1995 SE	1996 n	1996 Mean	1996 SE
Fall clutch size	99	8.74	0.15	101	8.83	0.17
Unhatched eggs/hatched clutch	60	1.43	0.20	32	1.69	0.34
Relative nest elevation (m)	104	0.86	0.02	114	0.89	0.02
Date of nest initiation*	109	June 14	0.78	106	June 16	0.81
Date of nest abandonment	22	July 8	2.64	39	July 11	2.45
Age at nest abandonment	21	20.32	1.95	36	24.46	1.34
Hatch date	60	July 19	0.97	32	July 19	1.18

[a] Differences between years were not significant using a Wilcoxon rank sum test unless indicated.
* p<0.05

TABLE 3. Weather conditions in southern New Brunswick during the Greater Scaup breeding season 1995 and 1996.

	1995 Mean	1995 SE	1996 Mean	1996 SE	Test
Season (n = 99, 96) [a]					
Mean daily temperature (ºC)	16.56	0.38	15.65	0.35	z = -1.91
Mean daily precipitation (mm)	2.43	0.61	3.25	0.85	z = 1.09
Mean daily wind speed (km/hr)	9.65	0.39	11.60	0.55	z = 2.43*
Mean daily water level (m)	1.39	0.06	1.82	0.10	z = 6.21***
Prelaying (n = 14, 14)					
Mean daily temperature (ºC)	10.61	0.58	10.64	0.90	t = -0.03
Mean daily precipitation (mm)	2.25	0.97	3.44	1.21	z = -0.10
Mean daily wind speed (km/hr)	9.88	1.22	13.86	1.75	t = -1.87
Mean daily water level (m)	2.56	0.07	2.65	0.08	t = -0.86
Laying (n = 37, 39)					
Mean daily temperature (ºC)	15.73	0.47	15.03	0.39	t = 1.15
Mean daily precipitation (mm)	2.96	0.91	2.07	0.59	z = -0.24
Mean daily wind speed (km/hr)	10.03	0.69	12.33	0.73	t = -2.29*
Mean daily water level (m)	1.47	0.05	1.64	0.05	z = -1.34
Early Incubation (n = 29, 25)					
Mean daily temperature (ºC)	16.81	0.49	14.79	0.52	t = 2.85**
Mean daily precipitation (mm)	2.14	0.80	1.77	0.67	z = 0.65
Mean daily wind speed (km/hr)	9.93	0.79	12.45	1.00	t = -1.99
Mean daily water level (m)	1.28	0.05	1.45	0.03	z = 2.13*
Late Incubation (n = 29, 25)					
Mean daily temperature (ºC)	18.94	0.44	17.37	0.34	t = 2.78**
Mean daily precipitation (mm)	3.17	1.67	7.04	2.92	z = 1.98*
Mean daily wind speed (km/hr)	9.25	0.60	12.18	1.03	z = 2.19*
Mean daily water level (m)	0.98	0.02	1.96	0.07	z = 6.28***
Hatching (n = 31, 26)					
Mean daily temperature (ºC)	18.83	0.41	17.28	0.34	t = 2.82**
Mean daily precipitation (mm)	2.96	1.57	6.92	2.81	z = 2.30*
Mean daily wind speed (km/hr)	9.55	0.60	11.98	1.01	z = 1.73
Mean daily water level (m)	0.98	0.01	1.96	0.05	z = 6.45***
Early Brood Rearing (n = 23, 23)					
Mean daily temperature (ºC)	18.90	0.46	17.37	0.37	t = 2.59*
Mean daily precipitation (mm)	3.33	2.05	7.65	3.15	z = -2.37*
Mean daily wind speed (km/hr)	9.10	0.74	12.68	1.06	z = -2.44*
Mean daily water level (m)	0.99	0.01	1.97	0.07	z= -5.80***
Late Brood Rearing (n = 23, 22)					
Mean daily temperature (ºC)	18.85	0.53	18.17	0.46	t = 0.96
Mean daily precipitation (mm)	0.98	0.59	0.64	0.49	z = -1.03
Mean daily wind speed (km/hr)	9.67	0.72	7.74	0.88	z = -1.98*
Mean daily water level (m)	0.96	0.01	1.44	0.07	z = 5.64***

[a] n is the number of days in the period 1995 and 1996 respectively.
* p<0.05, **p<0.01, ***p<0.0001

August recorded 175 ducklings. A total of 244 ducklings was counted on 28 August 28 in an airplane survey. Duckling survival (based on 456 eggs hatched) ranged from an estimated 38.4% (assuming 175 ducklings survived) to 53.5% (assuming 244 ducklings survived).

In 1996, 226 eggs hatched on Grassy Island plus a minimum of 12 more on other islands for a total of 238. Number of scaup ducklings observed during boat surveys ranged from 2 to 18. Two broods totaling 16 ducklings were observed during an airplane survey on 16 August. Based on their numbers and locations, duckling production in 1996 was estimated to be approximately 20 individuals, representing a survival rate of 8.4 %. Compared to 1995, far fewer ducklings survived to fledging than expected in 1996 ($X^2 = 42.70$, $P < 0.001$). The late incubation, hatching and early brood-rearing stages (July through early August) during 1996 were significantly cooler and wetter (Figure 1; Table 3) than 1995 (Smith 1999).

Discussion

We present information on Greater Scaup nest success and duckling survival at their southernmost breeding location. Duckling survival was lower in 1996 than 1995. The difference in nesting success between 1995 and 1996 was possibly due to cooler temperatures and high precipitation causing high water levels during late incubation and hatching periods in 1996. Seven nests were destroyed by flooding in 1996, and several were observed that had material added to raise them (i.e., cone nests; Hilden 1964). Almost twice as many nests were abandoned in 1996 compared to 1995. In 1996, females may have abandoned their nests late in incubation out of necessity in order to devote more time to feeding and self-maintenance (Korschgen 1977; Ankney and MacInnes 1978; Gloutney and Clark 1991). Other studies have found similar results when studying other duck species during poor weather conditions (Bengtson 1972; Makepeace and Patterson 1980; Mendenhall and Milne 1985; Walker et al. 2005).

The increased mortality of ducklings in 1996 may have been due to decreased foraging opportunities caused by inclement weather. During the first few days of life, diving ducklings generally feed on the surface (Bengtson 1971, 1972; Sugden 1973; Hill and Ellis 1984). Invertebrate production and emergence may have been reduced during 1996 (Sjoberg and Danell 1982; Anderson and Wallace 1984). Furthermore, flooding delayed the growth of emergent bulrush (*Scirpus* spp.) and sedge stands which are used for brood-rearing (A. Smith personal observation). These areas would normally provide shelter and hold invertebrate food during bad weather (Hilden 1964, Sjoberg and Danell 1982). Also, the seeds of sedges can be an important food to Greater Scaup ducklings (Bengtson 1971).

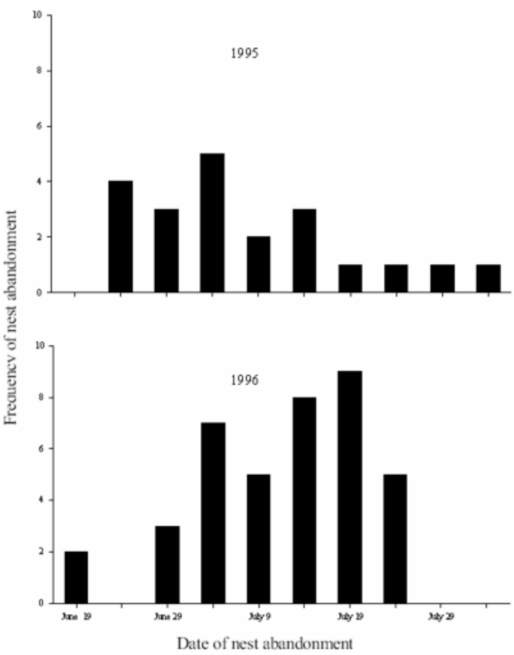

FIGURE 2. Estimated date of nest abandonment by Greater Scaup nesting at Grassy Island, New Brunswick, in 1996 and 1996 (grouped into 5 day periods).

The low temperatures, high precipitation, and high water levels on the Saint John River in 1996 negatively influenced the breeding success of additional bird species. Breeding activity of Yellow Rails (*Coturnicops noveboracensis*) at the Grand Lake Meadows upriver from our study site, ceased after their habitat was flooded (Kehoe et al. 2000). Yellow Warblers (*Dendroica petechia*) suffered decreased nesting success compared to 1995 at several sites in southern New Brunswick (S. Makepeace, New Brunswick Department of Natural Resources and Energy, Fredericton, New Brunswick, unpublished data).

Many species distribution boundaries are dictated by temperature and precipitation. As this study site is the southernmost breeding area for Greater Scaup in North America (McAlpine et al. 1988), determining whether climate change is shifting these boundaries could be an area of future research.

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