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Progress Notes contain *interim* data and conclusions and are presented as a service to other wildlife biologists and agencies.

Appraisal of autumn Canvasback populations and harvest on the Delta Marsh during 1977 and 1978

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Introduction

Drought conditions in Manitoba between July 1976 and April 1977 were the worst in 96 years. As a result, the number of May ponds had decreased by 45% and breeding duck populations by 53% in the spring of 1977 (Manitoba Waterfowl Technical Committee (MWTC) 1977).

The Canvasback (*Aythya valisineria*) was one of the most severely affected species; breeding numbers in southern Manitoba declined from 120 000 in 1976 to 60 000 in 1977 (MWTC 1977). Thus, with low breeding numbers in 1977, waterfowl managers in Manitoba were concerned that the fall harvest would be made up largely of adults, thereby depleting the breeding stock for the following spring, as suggested by Hochbaum (1947).

Breeding conditions in 1978, as measured by the 108% increase in May ponds, were vastly improved over 1977 (Caswell *et al.* 1978). Although Canvasback numbers in southern Manitoba remained below normal, and the 1978 breeding population was 35% lower than that of 1977 (Caswell *et al.* 1978), they made a strong early nesting effort and production was much better than it had been during the 1977 drought (M.G. Anderson, pers. commun.).

Manitoba's heavily hunted Delta Marsh (50°11'N; 98°19'W) periodically supports large numbers of post-breeding Canvasback, which concentrate there with juveniles after nesting in the pothole country. From 1969 to 1977, 46% of the estimated harvest of Canvasback in Manitoba occurred in this degree block (Hochbaum, 1979). In 1973, under drought conditions similar to those in 1976 and 1977, Canvasback were abundant in the marsh, comprising 45.6% (22 304 birds) (Hochbaum and Caldwell 1977) of the total duck population there on 4 October, or 10% of the North American population of 210 000 in January 1974 (Reeves *et al.* 1976). In that year, sago pondweed (*Potamogeton pectinatus*), a principal food of Canvasback (Bartonek and Hickey 1969) was abundant (Anderson and Jones 1976).

To protect the Canvasback by giving them time to migrate, the opening of hunting in 1973 on the Delta Waterfowl Control Area was delayed until 8 October.

However, Canvasback do not leave Delta until mid October, regardless of weather (Hochbaum 1959), and the kill that year was still substantial. They made up 8.2% of the total observed bag (Caldwell 1973), even though a bag limit of one per day was in effect. Because Hochbaum and Caldwell (1977) found that hunters did not refrain from shooting Canvasback, but killed the species in proportion to its density (Hochbaum 1976), they recommended that in years of reduced populations duck hunting on the Delta Marsh should not open until after 15 October.

The variables that affect Canvasback harvests on the Delta Marsh are poorly understood. In 1977, the MWTC recommended a 17 October opening for duck hunting at Delta to curtail an anticipated large kill of Canvasback there during a year of poor production. Senior federal and provincial wildlife managers rejected this proposal. The present study was initiated in response to an identified management need, namely to increase our understanding of hunters and the factors influencing Canvasback kill on the Delta Marsh under a variety of habitat conditions and population levels, and thus to elucidate the options for regulating yields.

Methods

Our methods were similar to those used by Hochbaum and Caldwell (1977). These were to observe hunters' behaviour, estimate the number and species composition of waterfowl and number of hunters on the marsh, and assess the weekly waterfowl kill by species, sex, and age.

We monitored hunters' behaviour from spy blinds located about 90 m from them. Our observers assumed the role of hunters in order not to influence the behaviour of hunters being studied. We recorded the following data for each hunter when they encountered ducks within shotgun-killing range (<35 m): (1) species, (2) flock size, (3) minimum approach distance, (4) number of shots, and (5) numbers of birds crippled (hit but not retrieved) and killed (retrieved). We also noted total observation time per party and the number of hunters per party. These observations were made between 3-18 October 1977 and 2-20 October 1978. We used the data to determine the hunters' selectivity and effort, and the vulnerability of Canvasback and other species to hunting.

The Manitoba Department of Mines, Natural Resources, and Environment flew aerial surveys between 28 September and 12 November 1977, and 27 September and 9 November 1978. They made the survey flights once a week along east-west section lines at an altitude of 30 m and ground speed of 110 km/h. Only birds within 200 m of one side of the aircraft were counted. They covered about 14% of the marsh and estimated total populations by extrapolation. In the mornings, on 3 days a week (usually Saturday, Monday, and Wednesday), they counted hunters'

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cars at all marsh landings and lodges, and used linear regression analysis to estimate the number of hunting parties on the marsh for days not flown. Ground counts of the number of hunters per party coupled with the aerial estimate gave an estimate of the total hunters on the marsh per week. They added 30% to the estimates to allow for afternoon hunters and those missed in aerial counts of vehicles (Manitoba Department of Mines, Natural Resources, and Environment 1968).

Between 2 October and 12 November, staff of the Delta Waterfowl Research Station surveyed the composition of the kill. On 3 or 4 days a week, they interviewed hunters at road checks, landings, and commercial lodges, and identified their ducks by species, sex, and age. Five lodges and two commercial pluckers saved one wing from each duck killed, and these were identified by means of the Carney (1964) techniques. Where possible, staff determined the success of each hunter and this, along with estimates of total hunters, provided an extrapolated weekly kill. Species composition of the bag then indicated a weekly estimate of kill of each species. Information on hunting violations and hunters' attitudes were recorded where possible.

Results

We watched 30 hunting parties during the 2 years for a total of 85.6 hunter-h. Of the hunters' encounters with ducks, 23% were with Canvasback (210 of 910 birds). They shot at 95% of Canvasback flights within range (<35 m) and at 91% of all ducks (Table 1). In 1977, hunters took 12.7 shots and 1.5 h of hunting per bird brought-to-bag. In 1978, they took 8.0 shots and 0.92 h (55 min) of hunting time per retrieved bird. Checks of hunters' bags showed an average of 1.62 birds each in 1977 and 3.38 in 1978, with averages of 2.4 h in 1977 and 3.1 h in 1978 for each hunting session.

Table 1
Hunters' selectivity of species of ducks passing within shotgun range (<35 m)—Delta Marsh, 1977-78

Species	No. flocks in range	No. flocks shot at	% flocks in range shot at
Mallard (<i>Anas platyrhynchos</i>)	39	39	100
Pintail (<i>Anas acuta</i>)	4	4	100
Shoveler (<i>Anas clypeata</i>)	28	21	75
Gadwall (<i>Anas strepera</i>)	6	5	83
Green-winged Teal (<i>Anas carolinensis</i>)	6	4	67
Redhead (<i>Aythya americana</i>)	30	27	90
Canvasback (<i>Aythya valisineria</i>)	61	58	95
Lesser Scaup (<i>Aythya affinis</i>)	68	62	91
Bufflehead (<i>Bucephala albeola</i>)	4	3	75
Ruddy Duck (<i>Oxyura jamaicensis rubida</i>)	6	6	100
Total	252	229	91

The loss for all ducks by crippling in 1977 was 28%. Only one of seven Canvasback downed that year was killed and, although it was shot close to hunters, they discarded it. The loss by crippling was higher in 1978 (47.1%) for all ducks; however, only 6 of 18 (33.3%) Canvasback shot were lost.

Canvasback had a probability of kill (ratio of birds downed to birds shot at) of 12% (Table 2), but it varied with flock size: the smaller the flock, the greater the chance of a bird being killed or crippled (Table 3), as Olson (1965) concluded. Flocks of one bird had a probability of kill of 40%, and flocks of two to three, 17%, but for flocks of more than six it was 5% (Table 3). We saw many large flocks with primarily adult males in flight, but few of these birds

Table 2
Percent of ducks downed of those shot at by hunters (probability of kill)—Delta Marsh, 1977-78

Species	No. birds shot at	No. birds hit	Probab. kill (%)
Mallard	136	24	18.0
Shoveler	54	19	35.2
Gadwall	51	4	7.8
Green-winged Teal	6	2	33.3
Wigeon	4	3	75.0
Redhead	104	9	8.7
Canvasback	210	25	11.9
Lesser Scaup	264	54	20.5
Ruddy Duck	22	4	27.3
Total	851	146	17.2

Table 3
Probability of kill (ratio of birds downed to birds fired at) of all duck species in different flock sizes—Delta Marsh, 1977-78

Flock size	No. birds	No. birds hit	Probab. kill (%)
1	152	61	40.0
2-3	248	43	17.0
4-6	219	34	16.0
7 or more	255	12	5.0

were lured to hunters. Small flocks of three or less were frequently attracted to hunters' decoys, and these birds appeared to be females, young-of-the-year, and pairs. The average flock size for Canvasbacks passing within killing range (<35m) of hunters during the 2 years was 2.0 (SD = 1.6).

Canvasback were not abundant on the marsh throughout the autumn of 1977. They rose from an estimated 768 on 9 August (2.2% of all ducks) to 5304 (11.3%) on 28 September. Numbers gradually declined to 2824 (9.2%) by 6 October and fell to 16 (0.2%) on 15 October following a large exodus on 14 October. After that date, no significant numbers of Canvasback (<100 birds) occurred on the marsh.

In contrast to 1977, the Canvasback was common on the Delta Marsh during the fall of 1978. The population began to build up during the last week of September, with an estimated 8900 birds on 27 September. Their numbers fell to 1150 during the opening weeks of hunting, then rose to 15 200, or 21% of all ducks pre-

Table 4
Numbers of hunters, their success rate, and estimates of numbers of ducks and Canvasback killed over the hunting season—Delta Marsh, 1977-78

Date	Hunters		Success per hunter* (ducks bagged)		Duck kill		Canvasback kill		Canvasback kill/total kill (%)	
	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978
Oct.										
3-8	2965	2280	1.52	3.48	5 152	16 795	368	1545	7.13	9.2
10-15	1950	1500	1.52	3.50	3 564	10 470	260	830	7.28	7.9
17-22	1410	1085	1.62	2.46	2 619	4 870	103	280	3.91	5.7
24-29	898	690	2.07	4.06	1 898	5 355	35	325	1.86	6.1
Nov.										
1-5	676	520	2.74	.60	1 637	3 040	20	0	1.23	0
7-12	187	145	0.35	3.00	118	935	0	20	0	2.1
Total	8086	6220	1.62	3.38	14 988	41 165	786	3000	5.63	7.3

* From hunters' bag checks.

sent on 13 October. Following a large migration on 16 October, Canvasback remained uncommon for the rest of the fall.

Duck hunting began on the Delta Marsh on 3 October in 1977. Clear and dry weather for most of the season resulted in a large turnout of hunters. Duck populations were relatively low (<28 000) compared with other recent years (Tacha and Jones 1976, Stewart *et al.* 1975), and the hunters' success was also low, averaging only 1.62 ducks per hunter per hunt over the season (Table 4). An estimated 6633 hunters harvested 14 988 birds; lower than the estimates for 1965 (15 480 birds), 1966 (35 045), 1975 (25 545), and 1976 (26 861) (Tacha and Jones 1976). In 1978, hunting began on 2 October and the harvest and success rate were higher than in 1977 (Table 4). An estimated 8086 hunters in 1978 killed an estimated 41 165 ducks, the largest kill on record.

In 1977, the estimated kill of 786 Canvasback ranked fifth with 5.63% of the total duck kill. This yield, although seemingly small, represented 28% of the peak fall population of Canvasback at Delta in that year. In 1978, Canvasback ranked third in the bag with an estimated kill of 3000 (7.3% of the total kill) (Table 4). This larger kill in 1978 represented only 20% of the peak population on 13 October. In 1977, 84% of the kill occurred during the first 2 weeks; in 1978, 79% occurred before 15 October (Table 4).

Age ratios in the bag checks suggest that 1977 was the poorest production year for waterfowl since 1972 (Table 5). Canvasback, Redhead (*Aythya americana*), and Gadwall (*Anas strepera*) had their lowest juvenile per adult ratios in 6 years, and all other species were near their 6-year lows. When similar drought conditions existed in 1973, age ratios were still well above those for all species in 1977 (Table 5). In 1978, all

Table 5
Number of hatching-year birds per adult observed in bag—Delta Marsh, 1972–78

Species	1978*	1977*	1976 [†]	1975 [‡]	1974 [§]	1973 [#]	1972 ^{//}
Mallard	1.43	0.73	1.00	0.66	1.72	0.91	0.98
Shoveler	2.22	2.13	1.97	2.15	5.00	2.90	—
Wigeon	1.79	2.56	2.12	1.69	3.31	3.66	—
Gadwall	1.06	0.67	1.40	1.52	1.62	1.55	1.96
Lesser Scaup	1.27	0.81	0.66	1.31	0.74	1.12	1.56
Redhead	1.75	0.63	2.00	2.95	5.48	1.74	4.23
Canvasback	1.72	0.98	1.97	1.42	2.30	1.92	1.06

* This study.
[†] Tacha and Jones 1976.
[‡] Stewart *et al.* 1975.
[§] Caldwell and Anderson 1974.
[#] Caldwell 1973.
^{//} Bailey 1972.

species except Wigeon (*Anas americana*) showed improved production (Table 5), reflecting the more suitable breeding conditions. The Canvasback sex ratios in the bag were 0.8 and 1.05 males per female in 1977 and 1978, showing a higher female vulnerability, but significantly less than the ratio of 1.9 males per female that supported Olson's (1965) finding that females were more vulnerable than males ($\chi^2 = 20.17$, $df = 1$, 1977; and $\chi^2 = 10.19$, $df = 1$, 1978; $P < .05$).

Many hunters had difficulty in identifying their birds even in the hand, and thus species bag limits were largely ineffective. We observed 18 instances where hunters continued shooting at Canvasback after having their one legal bird. Hunters were also observed shooting Whistling Swans (*Cygnus columbianus*), Double-crested Cormorants (*Phalacrocorax auritus*), and Common Loons (*Gavia immer*). We also saw 6 Canvasback, 1 Redhead, and 14 Shoveler (*Anas clypeata*) that had been discarded in blinds.

Discussion and conclusions

Manitoba duck hunters have a significant impact on local Canvasback stocks. Hochbaum (1979) has shown that 21% of direct recoveries for juveniles banded within Manitoba are harvested in southern Manitoba. Canvasback kill at Delta Marsh accounts for 46% of that harvest for all age classes of Canvasback, and up to 76% of the estimated provincial kill has occurred at Delta during recent years (Hochbaum 1979). The high kill is due to peak populations occurring when hunting pressure is greatest, and also to the high vulnerability of this species. The estimated kill on the Delta Marsh has approached 30% of its peak populations. The impact of this kill on local populations is critical as adult hens, juveniles, and pairs, which occur in small flocks, bear the brunt of the harvest.

In 1977, a poor production year, the number of Canvasback on the Delta Marsh was low and the kill was small. However, the kill rate (percent of peak population harvested) was high (28%). In 1978, with greater numbers of Canvasback available, the harvest rate remained high (20%) and the kill increased despite the one-bird limit. What is needed is a means of predicting post-breeding use of the Delta Marsh by Canvasback. We can set effective hunting regulations and protect low populations on the basis of this information.

A decline in the standing crop of sago pondweed in 1977 (M.A. Anderson, pers. commun.) may be one reason why Canvasback did not congregate in large numbers at Delta. However, Anderson and Low (1976) estimated that even in low sago years a large surplus still existed for waterfowl use. Little is known about the factors limiting sago productivity. Anderson (1975), Anderson and Jones (1976), and Robel (1961) held that critical factors included water depth, turbidity affecting light transmission, soil nutrients, and degree of wave exposure. Robel (1962) and Hunt and Lutz (1959) considered water draw-down to be important.

Therefore, we believe in the need for long-term studies to determine the relationship, if any, between sago pondweed productivity and Canvasback abundance in the autumn. If it does exist, factors such as water depth could be managed either to encourage or discourage sago and thus the presence of Canvasback. Alternatively, if sago abundance could be determined during the summer, we might predict Canvasback use and regulate the hunting accordingly.

When Canvasback numbers decline, but they make heavy use of the Delta Marsh in the autumn, this species must be protected from severe hunting pressure to allow for a subsequent recovery of the population. To fulfil this goal, several alternatives exist in light of the fact that restrictive bag limits seem ineffective.

These are:

- (1) Delay opening of the hunting season until after 15 October to allow most of the Canvasback time to migrate.
- (2) Increase surveillance by enforcement officers of hunters' behaviour *in the marsh*.
- (3) Require hunters, before receiving licences, to meet standards of hunting ethics, rudimentary knowledge of waterfowl population dynamics, and skill in waterfowl identification.

It is our view that, in the short term, if we follow all or some of these alternative measures in conjunction with development and protection of nesting habitat, Manitoba's breeding stock of Canvasback can be adequately protected in Canada.

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