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This thesis is dedicated to my wife Patricia, and my parents, who experienced my education the way no one else did, and gave the kind of support no one else could.

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ABSTRACT

Short-billed Dowitcher *(Limnodromus griseus)* breeding biology was studied near Schefferville in central Quebec during 1978 and 1980. The climate, habitat, and shorebird community are described. Dowitchers arrive usually in small groups from the third week of May probably into the first week of June. The sexes appear to arrive simultaneously. Incubation begins in the first days of June; the incubation period is 21 days. Hatch occurs in the third week of June and young fledge in the last half of July. The advantage of having hatch occur in the period when surface-active prey are available for the young is believed to be the ultimate factor determining the timing of the nesting cycle. Declining food supplies on breeding and migration areas select for adults to time hatch as early as possible in this period of surface food availability.

Song is given from the time of first arrivals until mid July, occurring most frequently in late May and early June. Birds sing in a number of different contexts: sexual (display flights, aerial chases, localized display flights and song, copulation), 'greeting' (incubation changeovers), and as a displacement activity in alarm/disturbance situations. The song's primary function is believed to be mate acquisition; it is not interpreted as having a territorial function.

Prolonged incubation shifts, low frequency and irregular timing of changeovers, and restriction of feeding, resting, and preening activities to areas away from the nest area are believed to be anti-predator strategies designed to make nests very difficult to find.

Short-billed Dowitchers are believed to be monogamous and exhibit biparental care -- both sexes incubate; adult females depart soon after hatch, in late June and early July; adult males tend the brood until the young are at or near fledging, and depart in mid July; juveniles begin departing in August.

RESUMÉ

Cette étude sur la reproduction du Bécasseau roux *(Limnodromus griseus)* a été réalisée près de Schefferville, au Québec, de 1978 à 1980 inclusivement. On y décrit le climat et l'habitat de ces oiseaux de rivage. Les Bécasseaux arrivent par petits groupes vers la troisième semaine de mai jusqu'à la première semaine de juin. Mâles et femelles arrivent simultanément. L'incubation débute dans les premiers jours de juin et dure 21 jours. Les oisillons éclosent vers la troisième semaine de juin et prennent leur envol vers la fin juillet. La période de disponibilité des proies de surface semble constituer le facteur qui influence davantage les habitudes de nidification de l'espece.

Le chant des Bécasseaux roux peut être entendu dès l'arrivée des oiseaux et ce jusqu'à la mi-juillet bien que plus fréquemment entendu à la fin mai et au début de juin. Ils chantent en différentes circonstances: au cours de la parade nuptiale et des vol nuptiaux, au moment de la relève du mâle ou de la femelle pendant la couvée, en cas de dangers et lors des activités de déplacement. Le chant a surtout son importance durant la parade; il ne semble pas être relié à la territorialité.

Les sessions d'incubation prolongées, la faible fréquence et l'irregularité des relais des conjoints pendant l'incubation, la recherche de nourriture et les périodes de repos et de réarrangement du plumage loin des nids laissent croire qu'il s'agit là de stratégies ayant pour but de protéger les nids en déroutant les prédateurs éventuels.

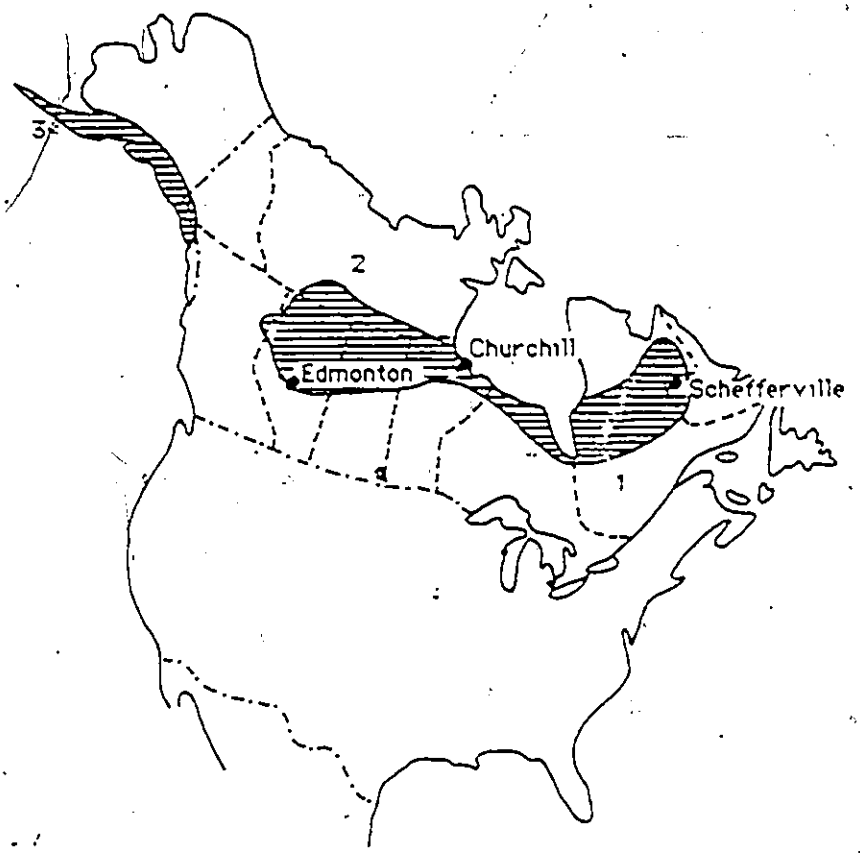
INTRODUCTION

Those shorebirds nesting in the boreal forest and subarctic regions have been among the most difficult to study of all North American shorebirds. The breeding biology of such species as the Solitary Sandpiper *(Tringa solitaria)*, Greater Yellowlegs *(Tringa melanoleuca)*, Lesser Yellowlegs *(Tringa flavipes)*, and Short-billed Dowitcher *(Limnodromus griseus)* remains poorly known. Yet these species are by no means rare or even uncommon. The relative inaccessibility of the subarctic and boreal regions has certainly impeded research. Many of the problems in studying these species, however, must be attributed to the shorebirds themselves. Their nests are extremely laborious to find, and their behaviour similarly difficult to observe and interpret.

This thesis deals with the results of a study of the breeding biology of the Short-billed Dowitcher, in central Quebec-Labrador. The study arose from the discovery, in 1977, of an accessible nesting population near Schefferville. In that year the first known nests and downy young of this population were found on a field trip to the Schefferville area by the National Museums of Canada. The opportunity to document aspects of the species' virtually unknown breeding biology, and to see where the dowitcher fit into the diverse array of shorebird breeding systems, prompted this study.

Literature Review

Most literature on the Short-billed Dowitcher has dealt with taxonomic problems in the *Limnodromus* genus. After Say reported on a long-billed western form of the dowitcher (James 1823), numerous authors endeavoured to clarify a resulting controversy regarding the geographic variation and taxonomy of the group. These controversies are summarized in Pitelka (1950). The following taxa are now recognized -- *L. griseus* (Short-billed Dowitcher), *L. scolopaceus* (Long-billed Dowitcher), and *L. semipalmatus* (Asiatic Dowitcher). The Short-billed Dowitcher is divided into three subspecies -- *L. g. griseus* (eastern), *L. g. hendersoni* (central), and *L. g. caurinus* (western) (see Fig. 1). Information on breeding and wintering ranges, and migration routes, are available in Cramp and Simmons (1983), Godfrey (1986), Johnsgard (1981), and Pitelka (1950). The nominate race studied in this thesis nests in interior Ungava and migrates, primarily along the Atlantic coast, to Carribbean and northeastern South American wintering grounds (Cramp and Simmons 1983; Pitelka 1950). Pitelka (1950) also reviewed and revised much information on geographic variation, sexual dimorphism, habitat selection, and moult. Some papers originally titled as dealing with the biology of the Long-billed Dowitcher, he re-identified as being on the Short-billed Dowitcher (e.g. Hurley 1932).



☐ Breeding Range:

1 - *Limnodromus griseus griseus*

2 - *L. g. hendersoni*

3 - *L. g. caurinus*

Other published studies of the Short-billed Dowitcher have investigated vocalizations and feeding habits, primarily away from the breeding grounds. Recently Miller et al. (1983) studied geographic variation in the dowitcher song among the three subspecies. Earlier descriptive notes on vocalizations of migrating birds come from Nichols and Harper (1916) and Nichols (1920). Following recognition of the Long-billed Dowitcher as a distinct species (A.O.U. 1957) papers have appeared dealing with the field identification of the two forms, particularly by call notes (Small 1958, Jehl 1963, and Wilds and Newlon 1983). Food and foraging behaviour papers include those by Sperry (1940), Burton (1972), Mallory and Schneider (1979), Baker and Baker (1973), and Baker (1977). The latter two are the only studies that looked at feeding behaviour on the breeding grounds.

"Practically nothing is known of the breeding biology of any dowitcher, least of all the nominate race." (Jehl 1963:258). Our knowledge , although better today primarily due to the efforts of Jehl and his coworkers (Jehl and Hussell 1966; Jehl and Smith 1970), is still rudimentary. No direct studies of its breeding biology had been done previous to this thesis. The first confirmed nestings of the Short-billed Dowitcher *(L. g. hendersoni)* were documented in 1924 (downy young) and 1925 (nest and eggs) in central Alberta (Rowan 1927). Rowan (1927:220) commented that "The nest of these trustful and confiding birds must be about the hardest of all shorebirds to find". Breeding evidence (young) was documented in 1930 for Churchill, Manitoba *(L. g. hendersoni)* (Rowan 1932; Taverner and Sutton 1934). Breeding evidence is also available for southern coastal Alaska *(L. g. caurinus)* (although some of these records were originally believed to be of *L. scolopaceus;* see Pitelka 1950:31) (Hurley 1932; Shortt 1939).

The breeding grounds of the nominate race remained unknown for much longer, although the existence of an 'eastern' dowitcher was recognized long before the Alberta nest discoveries (see Pitelka 1950). Todd (1963) summarized the history and problems that preceeded the Quebec discovery (see also Bent 1962). Two field trips by the National Museums of Canada, to Schefferville in central Quebec, provided the first breeding records for *L. g. griseus.* In 1958, recently fledged young were collected by Henri Ouellet and Raymond McNeil (Todd 1963). In 1977, Henri Ouellet and Richard Poulin discovered the first nest, eggs, and downy young. Randall (in Bannerman 1961) stated that Walter Raine had collected dowitcher eggs in Labrador, possibly in the early 1900's. Other since disproven Raine discoveries have made these data suspect (H. Ouellet and W.E. Godfrey, pers. comm.).

Almost all the available information on the nesting cycle of the Short-billed Dowitcher comes from observations in the localities mentioned above -- Alberta (e.g. Rowan 1927; Randall 1930; Randall, in Bannerman 1961); Churchill and area, Manitoba (e.g. Taverner and Sutton 1934; Shortt and Waller 1937;

Jehl and Hussell 1966; Jehl and Smith 1970); southern Alaska (e.g. Hurley 1932; Shortt 1939), and Schefferville, Quebec (e.g. Todd 1963). With the exception of Jehl and co-workers' papers, these are brief and anecdotal accounts from natural history expeditions. The only documentation of the length of the incubation period comes from one nest observed by Jehl and Hussell (1966). Jehl and Smith (1970) briefly outline the breeding season at Churchill, including chronology, roles of the sexes during nesting, habitat description, and clutch size.

Several important contributions that interpreted breeding biology from migration studies are Loftin (1962) and Jehl (1963). Loftin's work revealed that Short-billed Dowitchers summer commonly in Florida, and are primarily first-year birds. He suggested that it may be at least two years before dowitchers attain breeding ability. The first indication of the roles of the sexes in the Short-billed Dowitcher nesting cycle came from Jehl's investigation of fall migrant dowitchers in New Jersey. There he found that adult females preceeded adult males, with juveniles arriving last. This suggested that adult males remained on the nesting grounds to care for the young, while adult females departed soon after hatch occurred.

Summary accounts of Short-billed Dowitcher biology are available in Witherby et al. (1940), Bent (1962), Palmer (1967), Johnsgard (1981), and Cramp and Simmons (1983).

Purpose of the Study

Given that virtually nothing was known about the Short-billed Dowitcher's breeding biology, especially that of the nominate race, the original approach of this study was very broad -- to investigate as many aspects of breeding biology as possible. However, a smaller than expected population, equipment breakdowns, a freak mid June blizzard, and difficulties trapping individuals for banding stymied plans to study feeding habits, vocalizations, incubation schedules, and nest-site selection of colour-marked birds.

The goals of this study were to (1) describe various aspects of the Short-billed Dowitcher's nesting biology, because this was virtually unknown; (2) to see how these observations confirmed, refuted and supplemented earlier accounts, and (3) to examine where the breeding biology of this species fit into the diverse spectrum of shorebird breeding and social systems. More specifically, the goals were to describe the (1) nesting environment at Schefferville in terms of general habitat, climate, and shorebird community; (2) chronology of the nesting cycle; (3) song and early season behaviour (courtship, territoriality); (4) patterns of arrival, incubation and departure, and (5) mating system and parental care. Due to the difficulties encountered, these aims were met with limited success.

THE STUDY AREA

Field work was conducted near Schefferville, Quebec (54°48'N, 66°49'W; Fig. 1). Schefferville lies in the Labrador Trough -- a 30-80 km wide zone of late Precambrian sedimentary rocks that runs NW-SE for 650 km through the centre of the Quebec-Labrador peninsula, bordered to the east and west by the granite-gneiss rocks of the Canadian Shield. The average altitude in the Schefferville area is approximately 600m above sea level (ASL). Within the Labrador Trough, the landscape is a pattern of alternating parallel ridges and valleys, running NNW-SSE. The ridges rise up to 350m above broad flat valleys. Schefferville is in the zone of discontinuous permafrost; permafrost is restricted to the higher ridgetops.

In general, Schefferville experiences a continental climate, especially in winter, but with maritime-influenced summers. Due to heavy snowfall, spring is late and short. Late winter storms and overnight freezing temperatures occur regularly into early June, and less commonly thereafter. Open areas are snowfree usually in mid to late May. Woodlands may remain snow-covered into early June, and higher ridgetops well into August or all summer long in some years. Ice breakup on waterbodies occurs from mid May (shallow ponds, lake margins) to mid June (large lakes). Summer is cool, cloudy and rainy.

The Schefferville area lies within a major vegetational transition zone where the lichen woodlands of the northern part of the boreal forest are becoming interspersed with stretches of tundra. The vegetation is well diversified because it is in a transition zone, and because of the local geological and topographical variety. Woodlands, especially lichen woodlands, are a prominent feature of the landscape. Black spruce *(Picea mariana)* and white spruce *(P. glauca)* dominate, with larch *(Larix laricina)* occurring commonly also. Woodlands grow on the valleys and side slope areas. Shrubby heaths and tundra are found on the higher hilltops and ridges. Wetlands, lakes and rivers are widespread in the valleys.

The above summary has been compiled from Allington (1958, 1966), Barr and Wright (1981), Bird (1975), Fraser (1957), Hustich (1951), Lechowicz and Adams (1978), Tout (1964) and Waterway et al. (1984).

THE STUDY PLOT

Almost all observations were made in an approximately 3 sq km plot located 11km NE of Schefferville. The approximate centre of the plot is 54°51'N, 66°40.5'W or 19UFL494801 (U.T.M. grid

reference). This particular area was chosen because of its close proximity to Schefferville, road accessibility, shorebird habitat, and the nest discovery and other dowitcher observations made there in 1977. A second site (Annabelle Road site) was visited 6-17, and 27 July 1978 to observe a dowitcher nest, and briefly again on 1 August 1980. It is located approximately 26.5 km NNW of Schefferville (54°58.3' N, 67°7.6' W; 19UFL207931). All references to the study plot refer to the first site.

The study plot is a relatively flat area about 490 m ASL in elevation, situated in a broad valley. Although predominantly covered in woodlands, there is a high percentage cover of wetlands -- the most important habitat for shorebirds. Several lakes and a road are also in the plot. In the following descriptions, the broadly-defined vegetation classifications of Waterway et al. (1984) are used. Species lists are available in Hustich (1965), Mäkinen and Kallio (1980) and Waterway et al. (1984).

Both spruce-lichen woodlands and spruce-feather moss forests are found in the plot; the former on drier areas and the latter on wetter and more nutrient rich sites. Spruce trees in both woodland types average 7 m to 10 m in height. In lichen woodlands the trees are well-spaced over an almost solid ground cover of lichen and an understory of scattered shrubs. Spruce growth is more dense in feather moss forests, providing shade for a thick moss ground cover but sparse shrub layer.

Three relatively large lakes border the northeastern edge of the study plot and one lies at the northwest corner. Two small and shallow lakes are in the middle of the plot. All these lakes have little emergent vegetation; woodlands or wetlands border most shorelines. Several ponds of varying sizes are scattered throughout the plot. These are more associated with the wetland complexes and are described below.

In the study plot are wetland complexes that include patterned fens, sedge meadows, and ponds. Patterned fens (Fig. 2) are characterized by an alternating arrangement of roughly parallel ridges of peat (strings) and shallow, elongate depressions (flarks) or open-water pools (Foster 1984). The vegetation is sedge-dominated, though varying from being entirely a sedge association to one with an undergrowth of ericaceous shrubs and interspersed small (less than 5m high) larch and black spruce. Sedge meadows (Fig. 12) are relatively treeless areas, dominated by sedge growth, and often found on a quaking or floating surface. They are essentially without surface pattern. As summer progresses, water levels in the wetland complexes begin to drop noticeably. Peaty areas become exposed along some pond margins and a luxuriant sedge growth emerges in larger ponds (Fig. 3).

Short-billed Dowitchers were always found in wetland habitat, though no apparent preference for any specific type was noted.

Weather

For the reader who may not be familiar with the meteorological conditions at Schefferville, the author felt that a summary, highlighting the relation of weather conditions during the study to long-term averages, might help in the comprehension of this thesis.

This study was conducted in the spring and summer months (May to August) of 1978 and 1980. Table 1 compares 1978 and 1980, May to August, monthly temperature and precipitation data with long-term monthly records. The weather of both study periods was record-breaking. Both were remarkably warm and wet in comparison with long-term records (1955-1980; Barr and Wright 1981). Highest monthly records were established for mean temperature (May and June 1978, August 1980), rainfall (August 1978), snowfall (June 1978, May 1980), and total precipitation (August 1978). Near maximum figures were also reached for rainfall (June 1980) and total precipitation (May and June 1980). Interestingly, June 1978 was both the snowiest and warmest month ever recorded at Schefferville.

The following data on temperature and precipitation were taken from the records of the Atmospheric Environment Service located at the Schefferville airport. Temperature, cloud cover, wind speed and direction, approximate precipitation and general weather comments were also recorded at the study plot. Data on the 1978 and 1980 spring snow melts were obtained from the records of the McGill Subarctic Research Station located in Schefferville. McGill personnel set up a snow course consisting of a line of ten stakes beginning at the edge of a black spruce-lichen woods, crossing a string bog and continuing into more woods.

Summary of the 1978 field season (26 May-5 August).-- Open areas in and surrounding wetlands were relatively free of snow on 26 May, the first day of observations (Table 2). There was still much wet snow in the woods and along their margins. The surface of bare ground about wetlands and ponds was thawed but many of the water surfaces were still at least partially ice-covered. Breakup on the larger lakes did not occur until mid June (Table 3). Through late May and the first two weeks of June there were several light, wet snowfalls. Any accumulation was gone by the next day. Also in this period, several cold days and nights lightly froze puddle and ground surfaces (Fig. 4).

Beginning on 13 June there was a remarkable two and a half day blizzard. Snowfalls of 23.7 cm on 13 June and 21.6 cm on 14 June covered the ground with almost 0.5 m of snow, deeper still in drifts in the woods. Immediately following the storm's end midday on 15 June, the weather became sunny and very warm (Fig. 4). The highest temperature for the year (31.1°C) was reached on 20 June. Snow in open areas of the study plot was almost gone by 17 June; it lasted until 22 June in the shelter of the woods.

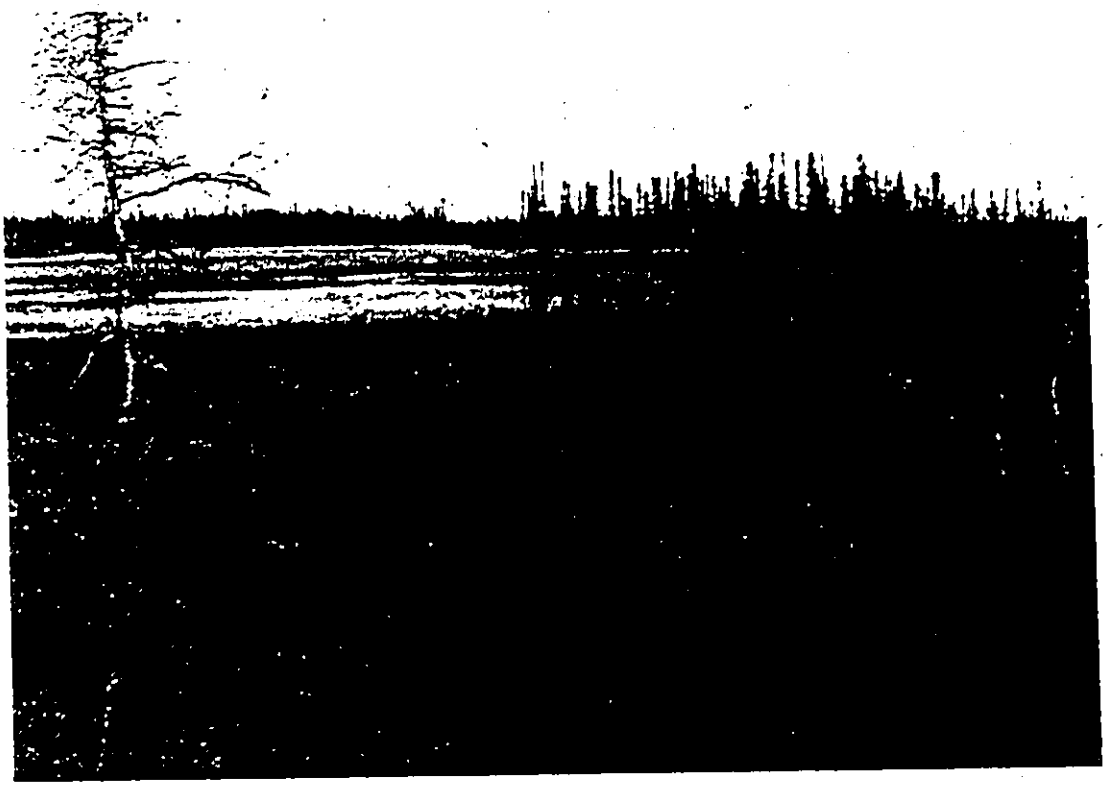


TABLE 1: Comparison of mean monthly temperatures, rainfall, snowfall, and total precipitation for 1978 and 1980, May-August, with 25-year (1955-1980) summary data (from Barr and Wright 1981).

	MAY	JUNE	JULY	AUGUST
TEMPERATURE (°C)				
mean	1.0	8.6	12.5	10.8
S.D.	2.21	1.91	1.07	1.43
max.	4.8	12.4	14.4	13.8
min.	-3.6	5.1	9.8	7.7
1978 mean	4.8	12.4	12.2	10.0
1980 mean	2.2	7.5	11.7	13.8
RAINFALL (mm)				
mean	25.5	69.3	99.7	96.3
S.D.	22.40	29.51	34.21	32.03
max.	84.7	118.6	177.8	168.2
min.	4.6	19.4	26.9	43.7
1978 total	13.5	19.4	112.9	168.2
1980 total	16.6	113.9	105.1	94.9
SNOWFALL (mm w.e.*)				
mean	27.1	7.6	0.4	2.7
S.D.	13.42	14.78	1.76	6.39
max.	53.4	71.3	9.0	26.9
min.	3.8	0.0	0.0	0.0
1978 total	28.2	71.3	0.0	2.6
1980 total	53.4	18.0	0.0	0.1
PRECIPITATION (mm w.e.*)				
mean	52.5	77.0	100.1	99.0
S.D.	23.60	31.91	34.62	33.30
max.	99.1	142.2	177.8	170.8
min.	17.0	25.9	26.9	43.7
1978 total	41.7	90.7	112.9	170.8
1980 total	89.9	131.9	105.1	95.0

* water equivalent

The duration of the 1978 field season, to 5 August, was relatively warm and rainy with temperatures gradually decreasing as August approached (Fig. 4).

Summary of 1980 field season (17 May-12 August).-- May 17 , the first day of observations, was sunny and relatively warm (daily high of 14°C). Ponds and other open treeless areas were virtually clear of snow and had been so for a week (Table 2). Edges of these areas, even sparsely treed fens, and the woodlands remained covered in 1 m or more of wet melting snow (Figs. 2 and 5). Although shallow pond margins were open, the deeper water of the ponds and lakes was still solidly ice-covered. Breakup on the larger lakes occurred in the first nine days of June (Table 3). Remnants of winter weather appeared through the last two weeks of the month. May 17-19, 25-28 and 31 had mixtures of snow, sleet and cold rain (Fig. 6). Most temperatures ranged from lows of -6°C at night to daytime highs of +6°C, with a maximum of 20°C on 31 May. Ponds and small lakes in the study plot were ice-free by 30 May. The woodlands became snowfree about this time also.

Extended periods of sunshine and warm temperatures dominated through June. Only four days were extremely rainy, and some snow in both trace and measureable amounts, did fall (Fig. 6). On 27 June a fall of 17 cm of wet snow occurred. This disappeared from the ground the following day, but the period from 25-28 June was in general cold, cloudy and wet.

July was relatively mild, but cloudy and rainy. Rainfall of 1 mm or more was recorded on 15 days of the month. Similar mild and wet weather continued to the end of observations on 12 August (Fig. 6).

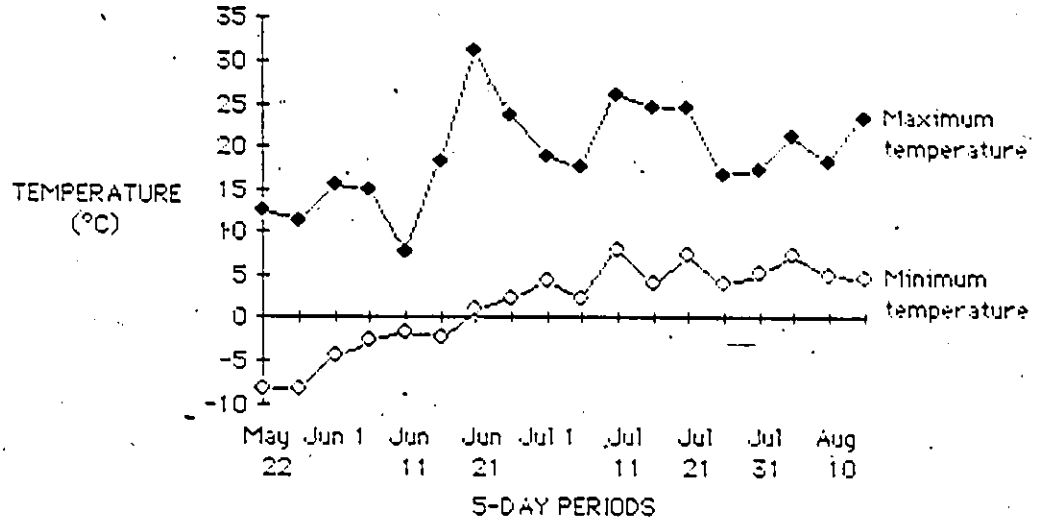
TABLE 2: Snowmelt in woodland and patterned fen habitats, spring 1978 and 1980, at Schefferville, Quebec. Data show snow depths along a staked snow course, not in my study plot. Courtesy of the McGill Subarctic Research Station.

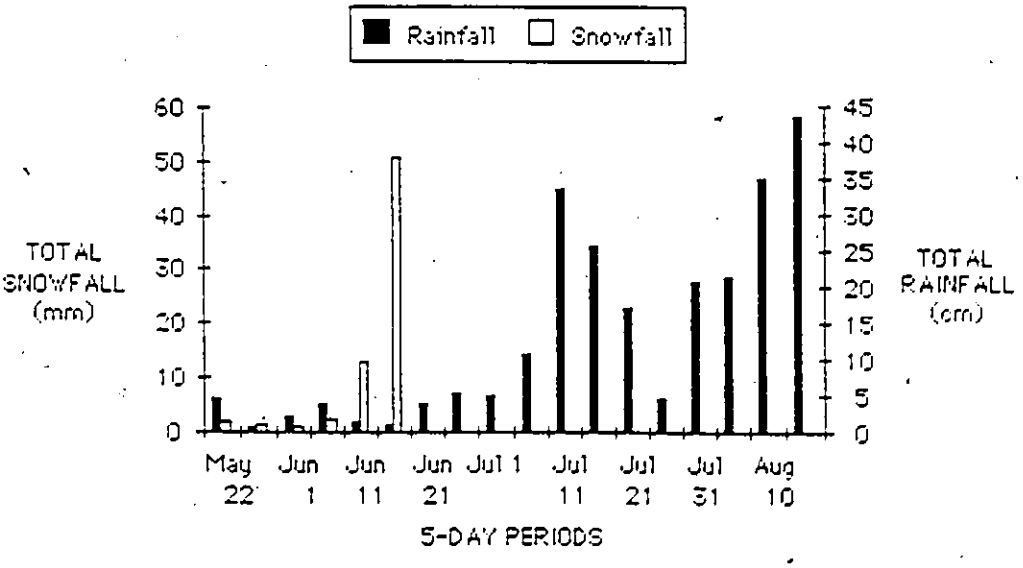
	SNOW DEPTH (cm)									
Stake Number	1	2	3	4	5	6	7	8	9	10
Stake Location	ledge woods	<---fen--->		ledge woods		into woods---------->				
DATE*										
1978: May 1	135.1	64.8	81.3	116.8	100.6	105.4	93.5	106.4	103.1	114.8
8	126.0	47.8	74.7	95.0	84.8	97.5	101.6	93.2	91.0	99.3
15	71.9	0.0	26.9	25.9	49.0	61.0	69.1	46.0	36.1	45.0
23	44.2	TR.*	TR.*	TR.*	25.9	40.9	49.0	23.1	17.0	23.9
1980: May 1	112.5	W.*	46.5	123.4	106.7	86.9	90.7	100.3	100.6	80.8
8	80.3	0.0	14.7	87.9	89.9	66.5	72.4	82.0	67.3	93.5
15	74.9	0.0	4.0	96.5	78.7	47.2	64.0	69.3	74.4	81.0
23	0.0	0.0	0.0	40.6	45.7	33.0	38.1	34.3	24.1	50.8
Jun 1	0.0	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	10.2

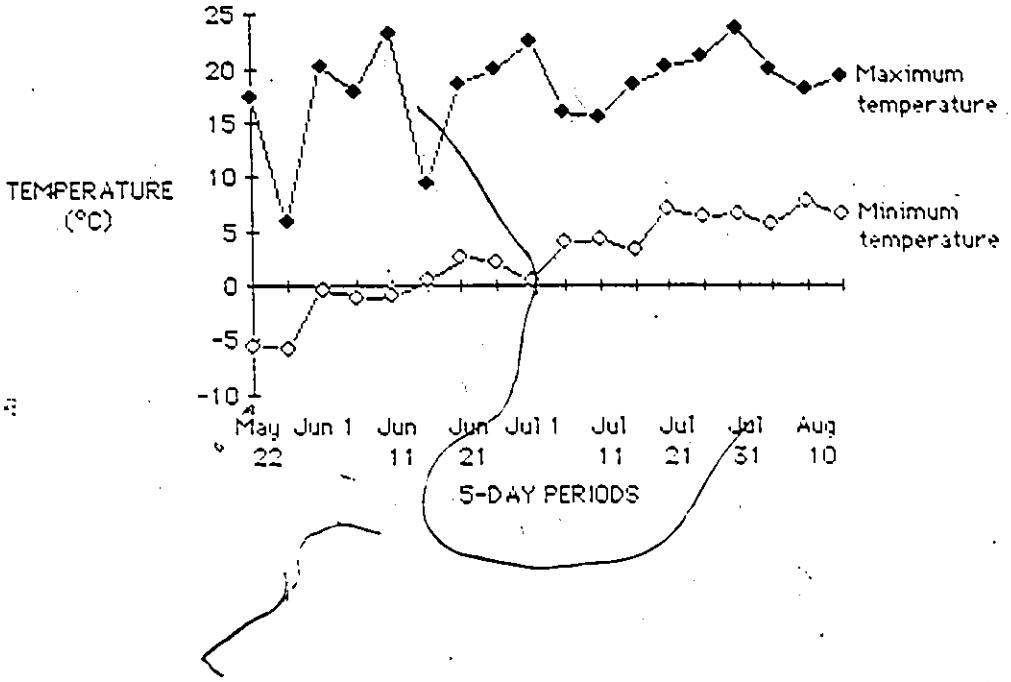
* TR=trace; W=water

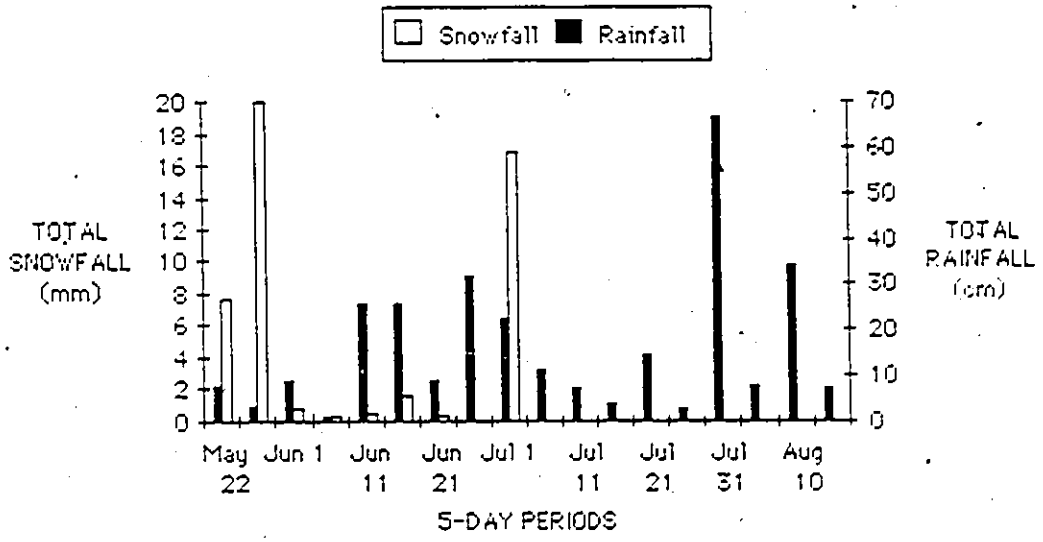
TABLE 3: Spring breakup on Knob Lake, located by the Schefferville town site, in 1978 and 1980. Data courtesy of the McGill Subarctic Research Station.

	Some leads and open water	Ice-free
1978	12 June	19 June
1980	5 June	9 June


TEMPERATURE
(°C)
35
30
25
20
15
10
5
0
-5
-10
Maximum
temperature
Minimum
temperature
May 22
Jun 1
Jun 11
Jun 21
Jul 1
Jul 11
Jul 21
Jul 31
Aug 10
5-DAY PERIODS


Rainfall
Snowfall
TOTAL
SNOWFALL
(mm)
60
50
40
30
20
10
0
45
40
35
30
25
20
15
10
5
0
TOTAL
RAINFALL
(cm)
May 22
Jun 1
Jun 11
Jun 21
Jul 1
Jul 11
Jul 21
Jul 31
Aug 10
5-DAY PERIODS


TEMPERATURE (°C)
25
20
15
10
5
0
-5
-10
Maximum temperature
Minimum temperature
May 22
Jun 1
Jun 11
Jun 21
Jul 1
Jul 11
Jul 21
Jul 31
Aug 10
5-DAY PERIODS


Snowfall
Rainfall
TOTAL SNOWFALL (mm)
TOTAL RAINFALL (cm)
20
18
16
14
12
10
8
6
4
2
0
70
60
50
40
30
20
10
0
May 22
Jun 1
Jun 11
Jun 21
Jul 1
Jul 11
Jul 21
Jul 31
Aug 10
5-DAY PERIODS

METHODS

Systematic field work was carried out 26 May-5 August 1978 and 17 May-12 August 1980; casual observations were made 15 June-12 July 1977. In terms of the dowitchers' local nesting cycle, these periods included observations from spring arrival, to August departure of the juveniles.

Observations were made almost daily during the study periods. Binoculars (9X36) were used primarily, and a spotting scope (15-60x zoom) occasionally. Details of observations were recorded as follows: date, observation period, location, weather, number and group size of birds, type of movements (flying, standing, etc.), activities (foraging, preening, etc.), type of vocalizations if given, habitat, and time of sighting -- for all shorebird species. In 1980 only, shorebird sightings were mapped on transparent overlays of an enlarged aerial photo of the study area.

Nests were found by using clues from the bird's behaviour to narrow the area to be searched, and by intensively searching large areas of suitable habitat by foot attempting to flush an incubating adult. No other methods were found successful.

Qualitative descriptions of the various habitats in the study plot and especially those used by shorebirds were recorded. Changes in the vegetation as the season progressed -- growth, flowering, cover -- were also noted and photographs taken. Similar notes were kept on insect abundances and potential avian and mammalian predators of dowitchers.

Trapping, measuring, and banding.-- Adults were trapped on the nest using a funnel-door, walk-in trap made of chicken wire. The trap was circular with a diameter of 50 cm and a height of 25 cm. It was placed over the nest such that the eggs were close to the funnel-door and with the entrance positioned in the direction from which the incubating adult had been observed to approach most often. The observer then hid nearby in the blind, waiting for the adult to return. If the adult was not in the trap and sitting on the eggs within ten minutes, the trap was removed and another attempt was made at least one day later. If the adult did return within ten minutes, it was allowed to warm the eggs for approximately five minutes before the observer approached the nest from the trap's door side. Although some adults took close to ten minutes to discover the entrance to the trap, only one of the four trapped took longer than ten minutes and had to be trapped on another day. No eggs were

damaged; this can occur when trapped adults step on eggs while trying to escape. Neither nest was deserted because of trapping of the adults, and hatch was 100% successful. One attempt was made to 'lasso' an incubating adult by placing a slip knot around the perimeter of the nest cup and running the draw string back to the blind. This proved unsuccessful.

Unsuccessful attempts were made to trap adults away from the nest. Mistnetting was briefly attempted in known feeding areas in both years. Hoop-nets of plastic tubing and fish netting were made to catch adults, also in feeding areas.

Downy chicks were captured at the nest immediately following hatch (six of eight hatched at two nests; one downy missed and one collected), and on two occasions after the young had left the nest (three downy chicks). No older young were captured.

Adults and chicks were weighed, measured and banded following capture. U.S. Fish and Wildlife Service aluminum bands and split-ring, solid-coloured plastic bands were used in individually distinct colour and leg combinations. Adults, and chicks only in 1978, were weighed with Pesola scales. Chicks at hatch in 1980 were weighed while still wet, on a triple beam balance; those chicks captured away from the nest in 1980 (two) were not weighed. Of nine chicks and four adult dowitchers banded in total, only the adults were resighted during the study, all in the summer of their banding.

Nest observations.-- At each of the three nests found in 1978 and 1980, a blind was erected approximately 4 m away. Prolonged observations of incubation behaviour and hatch were made from the blind in 1978 and 1980. Besides direct observations, a microphone with parabola and headphones were used in 1980 to listen for incubation switches during the darkness of night, from the blind. Although occasional sounds were heard from the nest area at night using the microphone, in all cases the same individual dowitcher was incubating at sunset the previous evening and at sunrise the following morning.

Eggs were measured (length, largest width) with calipers. They were numbered with tiny dots at one end, using an indelible-ink magic marker. The complete clutch of four eggs at the first nest discovered in 1978 was collected after desertion of the nest following the mid June blizzard.

Censusing.-- No standardized censusing was conducted in 1978, but three transects were regularly

censused in 1980. The three transects ranged in approximate length from 2-2.5 km. They were walked approximately weekly, in a zig-zag pattern within a transect width of 10 m (width so narrow because of habitat restrictions, i.e. ponds). The original plan had been to derive density-indices from on-transect counts. So few individuals were recorded within the transect width, however, that other methods had to be used to obtain a study plot population estimate. Mappings of sightings were used in combination with an intensive brood search through the entire study plot to arrive at an approximate number of nesting dowitchers and other shorebirds. In addition to the above census methods, daily counts were made in both 1978 and 1980.

RESULTS

The following is a compilation of both years' data and certain points must be remembered when combining the observations of 1978 and 1980. The mid June blizzard of 1978 was a very abnormal event at Schefferville (Table 1). It caused the desertion of nests and disruption of the entire nesting schedule. 1980 is considered to be the more typical year, in terms of weather and the nesting schedule.

SHOREBIRD COMMUNITY OF THE STUDY PLOT

Eight species of shorebirds were recorded in the study plot; six of these formed the shorebird community: Short-billed Dowitcher, Greater Yellowlegs, Solitary Sandpiper, Red-necked Phalarope *(Phalaropus lobatus)*, Common Snipe *(Gallinago gallinago)*, and Least Sandpiper *(Calidris minutilla)*. All were probable or confirmed breeders. Two other species, the Spotted Sandpiper *(Actitis macularia)* and the Semipalmated Plover *(Charadrius semipalmatus)*, were uncommon migrants and rare breeders in the study plot. Spotted Sandpipers are found commonly outside the boggy habitat of the study plot, in stream, river and lakeside habitats. Semipalmated Plovers were recorded nesting once, just outside the study plot, and were observed in small springtime flocks on a few occasions.

The numbers of breeding pairs of each of the six species comprising the shorebird community, are estimated as follows (in order of decreasing abundance):

Common Snipe	8-10 pairs
Short-billed Dowitcher	5-6 pairs
Greater Yellowlegs	3-4 pairs
Solitary Sandpiper	3-4 pairs
Least Sandpiper	3-4 pairs
Red-necked Phalarope	1-2 pairs

SEASONAL POPULATION TRENDS AND FLOCKING BEHAVIOUR

Population Trends

Seasonal changes in population size and detectability were estimated from transect counts conducted in 1980 only (Fig. 7). Generally, low numbers of individuals were seen on each census. Most counts had totals of four individuals or less; the two highest daily counts were of 11 and 9 dowitchers. Such low numbers made any apparent trends difficult to distinguish.

With the exception of transect 'C', the results show peak numbers detected in the last 10 days of May. By the beginning of June numbers detected were reduced and had started a gradual decline that continued through the remainder of the summer (Fig. 7). Numbers were usually very low. In July, the majority of counts had two birds or less. Transect 'C' had low counts on all censuses but showed a small increase in numbers to a minor peak of four individuals in late June, followed by a gradual decline thereafter.

Flocking Behaviour

The following data are divided into two groups. Flocking behaviour following the very abnormal blizzard in mid June 1978 is described separately from the more typical weather conditions encountered in 1980 and pre-storm 1978. These data include all observations, that is, not only sightings during transect counts but those made during regular field work as well. In figures 8 and 9, "% of sightings" refers to each separate observation, whether it be of one dowitcher or a flock of dowitchers. Percentage of birds ("% of birds") refers to the total number of birds from all sightings made in that time period. For example, if five separate encounters (sightings) of dowitchers were made in a day's field work, of 1, 1, 1, 2, and a flock of 10, most sightings (three of five, 60%) would be of birds alone (single birds), whereas most individuals (ten of fifteen, 67%) were in a flock.

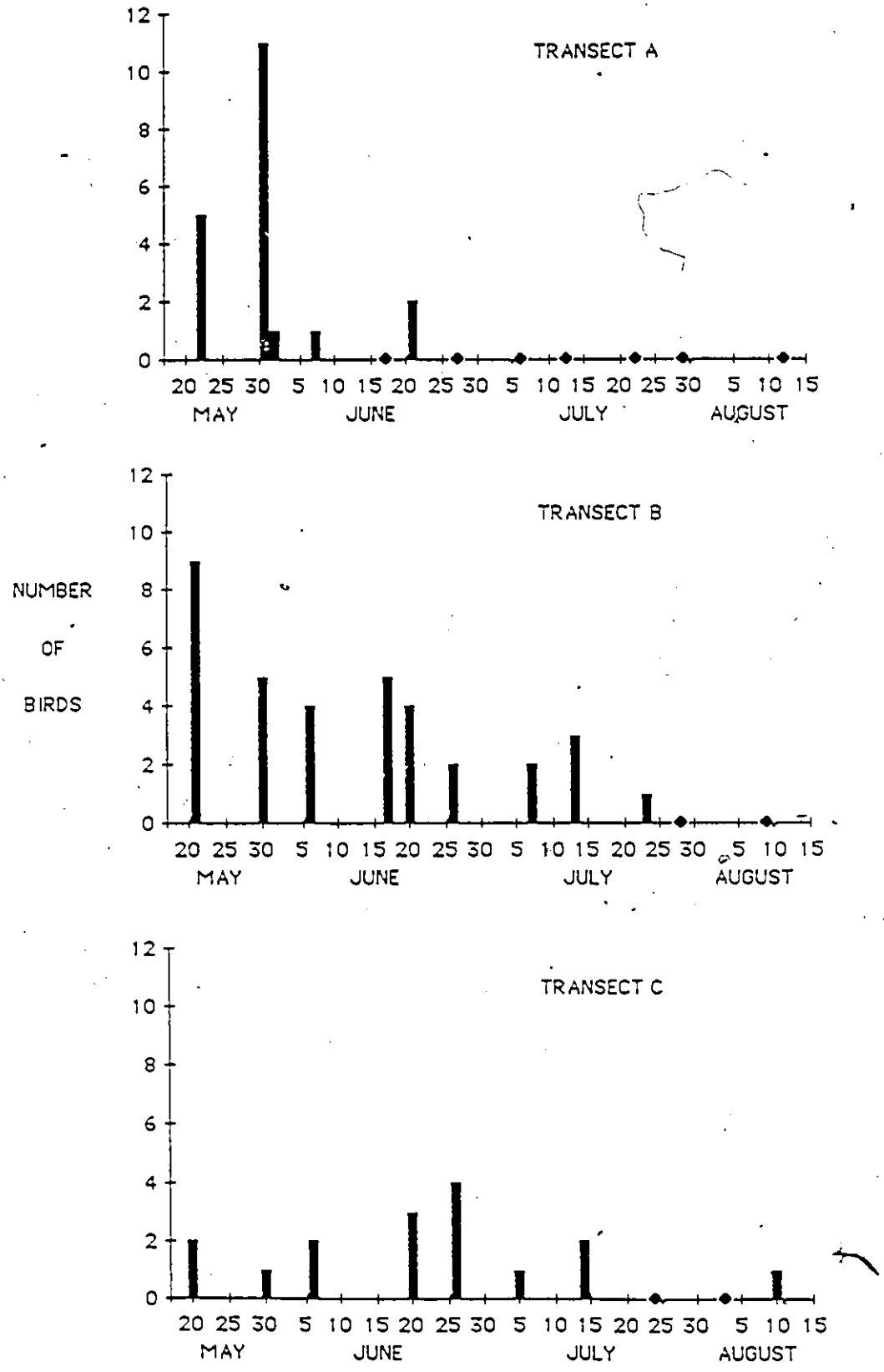
Pre-storm 1978, and 1980.-- Throughout the nesting cycle at Schefferville, Short-billed Dowitchers were typically seen alone or in two's (Figs. 8 and 9). Even during the arrival period the majority of sightings were of single birds and groups of two, although the majority of individuals were in fewer

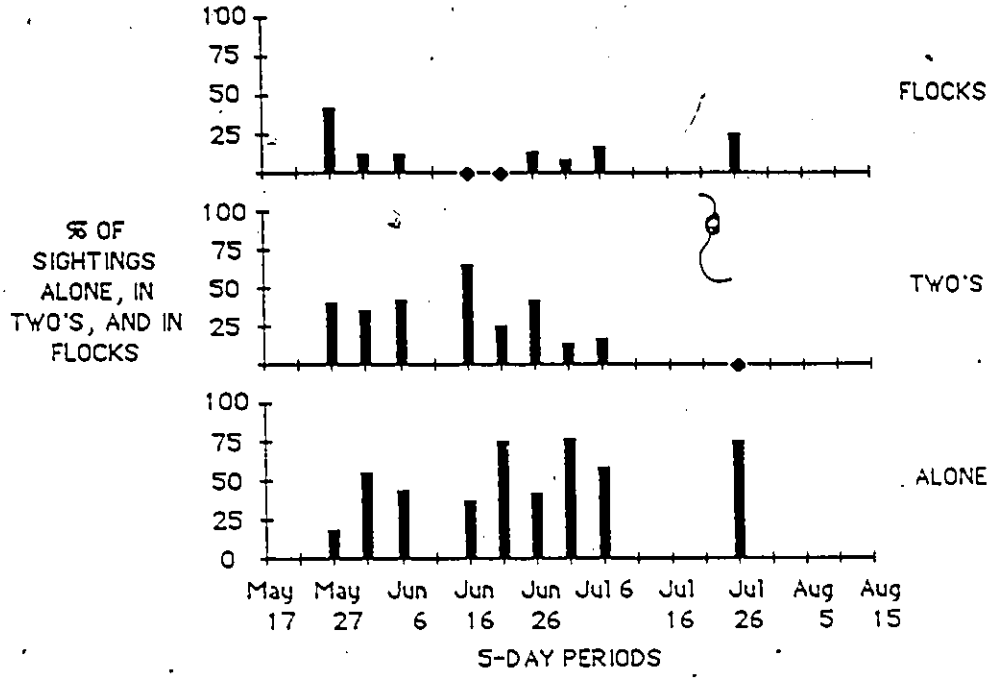
but larger groups.

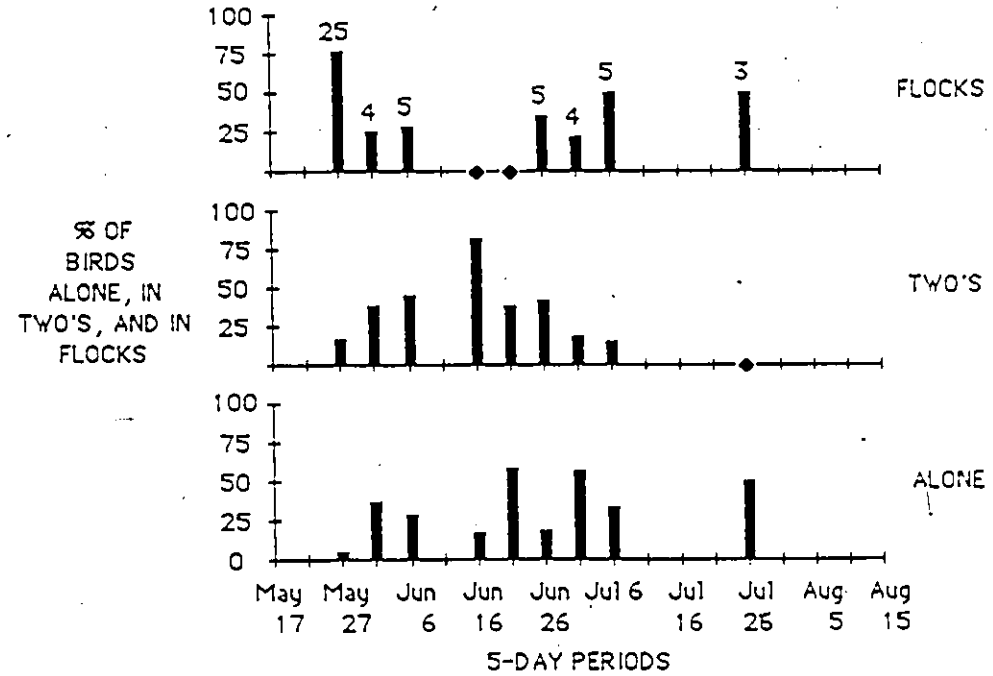
The comments in this paragraph refer to 1980 observations only (Fig. 9). Less than 10% of dowitchers were alone and less than 25% were in two's, following first arrivals in 1980 (18-22 May). Both the incidence and number of birds alone and in two's initially increased following this period. The percentage of birds alone increased steadily to 70% by 7-11 June, but appeared to decrease to and maintain a level of 45% through mid to late June (data for June are incomplete, however). The percentage of birds in two's also increased initially following arrival, and almost 50% of dowitchers were in groups of two between 28 May and 5 June. While the percentage of birds alone continued to increase, however, the percentage of birds in two's declined steadily. No groups of two were sighted in 1980 from 20 June to 3 August. All dowitchers sighted in the first 13 days of July were alone. While the majority of sightings for the remainder of July were of single birds, several small flocks were seen also. In August, more birds were in two's, relatively few were alone, and several flocks were seen.

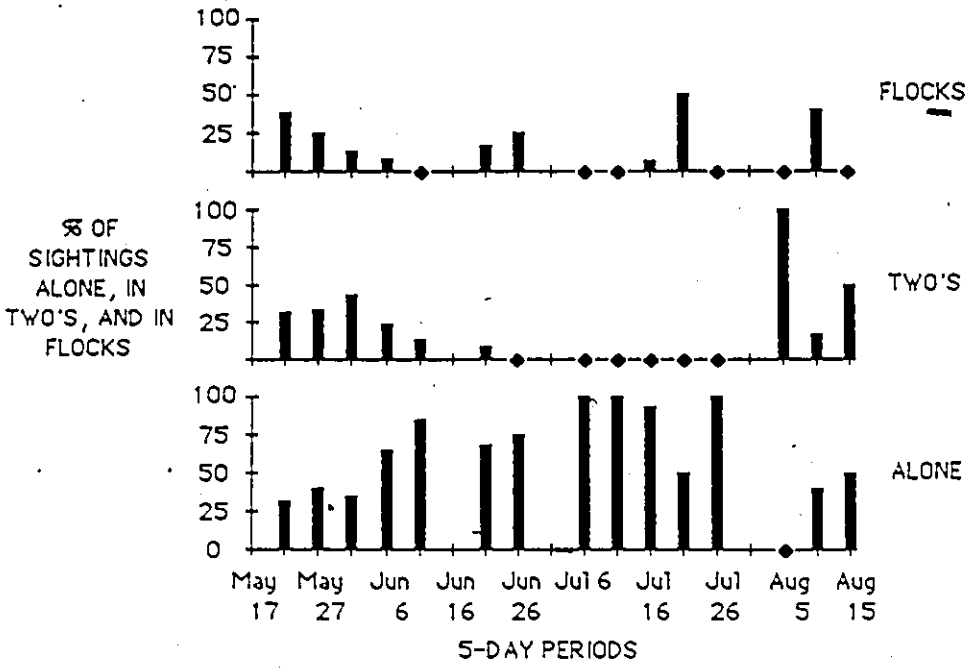
Most dowitchers were in flocks upon arrival in both years. These held as many as 25 birds until 27 May (1978; Fig. 8) but then declined steadily in size and occurrence. After 6 June 1980, flocks occurred in three distinct periods: 17-26 June, 12-20 July and 6-10 August (Fig. 9). None of these groups contained more than six birds.

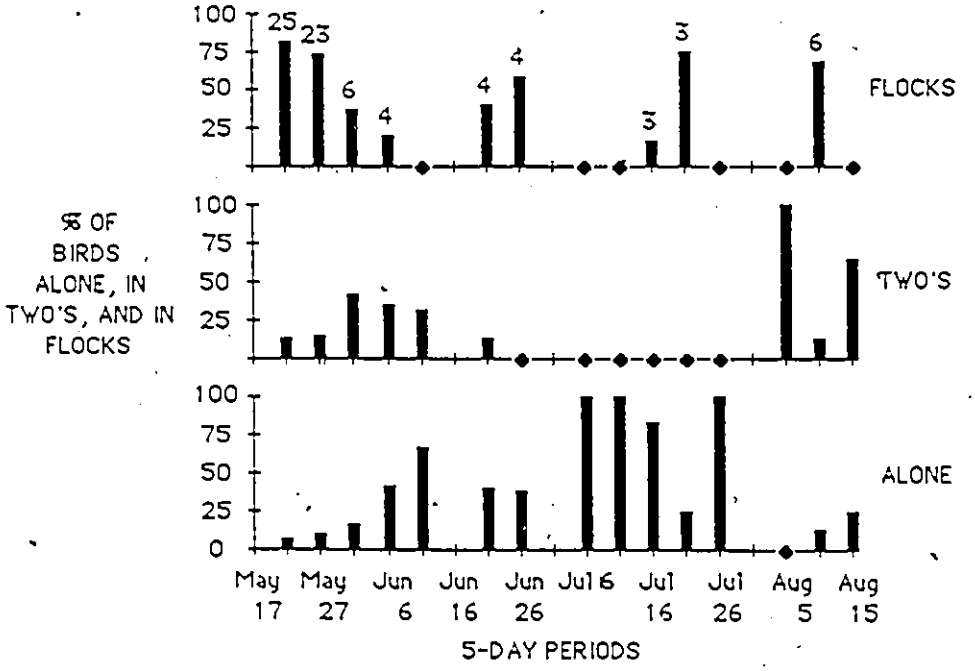
Post-storm 1978.-- Extended observations following the mid June blizzard are available only for the 16 June - 6 July period (Fig. 8). Following this either time was spent conducting nest watches, or very few dowitchers were seen. In this period most dowitchers were alone or in two's. The percentage of birds in two's was high (80%) initially following the storm and declined steadily thereafter to 6 July (20%) while the percentage of dowitchers alone was variable and ranged from 20-60%. The first post-storm flock was sighted on 22 June (five birds). Flocks of three, four and five birds were seen until 4 July, as the percentage of birds in flocks increased to 50%.


TRANSECT A
TRANSECT B
TRANSECT C
NUMBER OF BIRDS
0
2
4
6
8
10
12
20 25 30 5 10 15 20 25 30 5 10 15 20 25 30 5 10 15
MAY
JUNE
JULY
AUGUST


% OF SIGHTINGS ALONE, IN TWO'S, AND IN FLOCKS
100
75
50
25
FLOCKS
TWO'S
ALONE
0
May 17
May 27
Jun 6
Jun 16
Jun 26
Jul 6
Jul 16
Jul 26
Aug 5
Aug 15
5-DAY PERIODS


% OF BIRDS ALONE, IN TWO'S, AND IN FLOCKS
25
4
5
5
4
5
3
FLOCKS
TWO'S
ALONE
May 17
May 27
Jun 6
Jun 16
Jun 26
Jul 6
Jul 16
Jul 26
Aug 5
Aug 15
5-DAY PERIODS


100
75
50
25
FLOCKS
% OF SIGHTINGS ALONE, IN TWO'S, AND IN FLOCKS
TWO'S
ALONE
0
May 17
May 27
Jun 6
Jun 16
Jun 26
Jul 6
Jul 16
Jul 26
Aug 5
Aug 15
5-DAY PERIODS


100
75
50
25
25
23
6
4
4
4
3
3
6
FLOCKS
% OF BIRDS ALONE, IN TWO'S, AND IN FLOCKS
TWO'S
ALONE
0
May 17
May 27
Jun 6
Jun 16
Jun 26
Jul 6
Jul 16
Jul 26
Aug 5
Aug 15
5-DAY PERIODS

SONG AND RELATED BEHAVIOUR

The song of the Short-billed Dowitcher begins with several short, sharp, rapidly repeated 'tu' notes that introduce a rolling rising guttural trill followed by several 'cha' notes. The song is relatively loud and the sound carries over a long distance (1/3 to 1/2 km at least), especially when given in flight.

The group size of Short-billed Dowitchers in which songs were given, ranged from 1 to 23 birds. The larger flocks were observed in May, presumably migrating or newly-arrived birds in which several but not all individuals of the flock were observed to sing. Singing dowitchers were most frequently seen in two's.

Only one singing bird was collected: a male after giving a song on the ground. Observations of both birds of a group of two singing suggest that females may give the song also, but the data are inconclusive. Adult 'B' at the post-storm 1978 nest, and adult 'B' at the 1980 nest, both sang during incubation changeovers.

Short-billed Dowitchers at Schefferville were recorded singing from the first day of their observation (26 May 1978, 18 May 1980) through to mid July in both years of the study. The frequency of song was not uniform through this period, however. From 18-20 May 1980 there were few singing dowitchers. Songs were heard only from the occasional individual or pair, or from some of the individuals in larger flocks. Through the 21 May-7 June period, songs were heard almost daily. However, little activity, but especially an absence of vocal behaviour, was recorded on days of cold and stormy late-winter weather. No dowitchers were seen on 25 May, for example - a day of snow, sleet, and cold temperatures. In 1978, songs were noted almost daily through this same late May to early June period.

Singing activity was recorded throughout June but less frequently than in late May. Following hatch in 1980 (23 June) until 7 July, singing activity was much less frequent. During the following week to 14 July, however, there was a brief resurgence, but it was short-lived and no singing was noted after 14 July 1980.

The mid June storm in 1978 disrupted probably all dowitcher nesting schedules. Singing was regularly recorded after the blizzard, beginning the day following (16 June). Interestingly, the last

date that singing was noted in 1978 was also the same date as in 1980 -- 14 July.

Songs were observed being performed in different manners and in different contexts throughout the period of song occurrence. For example, the song of the dowitcher was given from the ground, treetops, low in the air, or high above the treetops. Descriptions of these and their occurrence follow.

Display flight.-- Early in the nesting season the song is occasionally associated with a display flight or aerial display, performed well above treetop level. The dowitcher flies along in normal flight with even, deep wingbeats. It flies silently or perhaps gives some intermittent short notes. Then, coinciding with the rapidly repeated 'tututu...' introduction notes, the dowitcher climbs slightly with quick, shallow, quivering wingbeats. This is followed immediately by a glide with the wings fully-extended or nearly so and set slightly below the horizontal as the 'trill-cha' song-units are given several times. There is a shallow drop in elevation while gliding.

In most instances, singing dowitchers were heard only and not seen. It is therefore difficult to determine some details of the performance of the aerial display. In 1978, display flights were observed between 27 May and 12 June, and on 16 and 27 June and 3 July following the mid June blizzard. In 1980, display flights were noted only in the period 23 May to 10 June, and on 17 June. In both years the frequency of display flights was greatest in late May and early June. Aerial displays were most often seen being performed by single dowitchers, and less often in groups of two; aerial displays were not seen associated with larger groups. Songs often occurred in flight without any accompanying display flight, but all display flights were performed with singing.

Localized aerial displays and song.-- Short-billed Dowitchers generally ranged widely during display flights. They did not patrol an area about the nest, for example. Typically aerial displays covered large areas, often probably of a square kilometer or greater, as the displaying dowitchers usually flew out of sight. Two prolonged observations were made, however, of localized aerial displays on 23 May and 2 June 1980. In both cases the behaviour was similar: a pattern of repeated songs with displays over one wetland area, followed by the dowitcher flying off then reappearing several minutes later to sing and display again, fly away, reappear and display, and so on. The

dowitcher occasionally plummeted out of the sky, appearing as though descending to land before disappearing behind treetops, only to reappear a few seconds later singing in display flight again. Once, the dowitcher was seen to land in the top of a dead spruce for a few seconds, fly off this perch dropping towards the ground and out of sight, then reappear several seconds later to continue song and aerial displays. These display series were observed for 17 minutes on 23 May and 36 minutes on 2 June.

Five minutes after the song and aerial displays stopped on 2 June 1980, two dowitchers were discovered on the ground nearby where the displaying dowitcher had earlier briefly landed once and had appeared to land several more times. One dowitcher was silent while the other gave 'whoot' calls for approximately 3 to 5 minutes. The calling dowitcher then lowered its head, spread its wings forward, fanned its tail horizontally and ran away from the observers through the sedges for some 2 m. The dowitcher gave one song-unit (trill with 'cha' notes) while running, then stopped and resumed the 'whoot' notes. The second bird stood silently nearby with no discernible reaction to this display. Both dowitchers later flushed, one first giving a few short calls as they flew by, then both birds giving songs without an associated aerial display as they were more distant. Presumably one of these dowitchers was later seen perched in a nearby treetop (the highest in the surrounding woods) giving the occasional song but without the rapid 'tutu...' introduction.

In summary, the display flight was usually wide-ranging and not localized, but when localized it was associated with a bird on the ground below. Aggression was not observed in association with the flight display.

Aerial chases.-- The behaviour of a group of dowitchers flying together was called a 'chase' based on the following characteristics: (a) the birds were relatively tightly grouped together, (b) they were flying relatively fast, and (c) their flightpath was not straight but zigzag in pattern with frequent sudden twists and turns.

In 1978, a total of four aerial chases was recorded, all in the 26-28 May period. A total of six aerial chases was observed in 1980, all in the period 21 May-6 June. Aerial chases involved groups of from two to six individuals. Singing occurred in nine of the ten observed chases, both with and without an associated display flight. When chases were observed to their end, when the participants

landed, vegetation concealed any subsequent behaviour. No banded dowitchers were observed in chases, and no individuals were collected.

Mounting/Copulation.-- Mounting was observed once in 1978 and once in 1980. On 28 May 1978 two dowitchers were encountered on the ground. One of the two sang on the ground several times before and once in flight after mounting the other dowitcher. On 31 May 1980 no song was given during a premount aerial chase, or during or after mounting.

Incubation changeover.-- Of seven changeovers observed at dowitcher nests, song was noted in only two instances. On 11 July 1978, the dowitcher ending its incubation shift sang as it flew away from the nest area. On 24 June 1980, the dowitcher on the nest sang briefly once, possibly in reaction to other nearby dowitcher song, and shortly before it left the nest and the other adult walked on.

Reactions.-- Songs, with or without aerial displays, were not observed to elicit agonistic behaviour from other dowitchers. Unless one interprets chases as such (see discussion) aggressive postures, displays, fleeing or attraction were not seen clearly associated with songs. Incubating and foraging dowitchers never obviously reacted to songs from overhead or otherwise nearby.

Alarm/Disturbed context.-- On several occasions when dowitchers flushed near the observer, or the observer was close to dowitchers on the ground, songs and short notes were given either on the ground, or in the air after flushing. The 'glide-with-set-wings' posture used in the aerial display, was once seen performed by three silent Short-billed Dowitchers associating with two Greater Yellowlegs that were scolding the observer. A display flight was given in this context but chases were never seen performed in alarm/disturbance contexts.

NESTING CYCLE

Arrival

No first arrivals data are available for 1978. Dowitchers were already present on 26 May, the

first day of observations. In 1980, Short-billed Dowitchers were first observed at Schefferville on 18 May. Observations began one day earlier, on the afternoon of 17 May. Weather conditions on 17 May were: maximum temperature of 13.8°C, minimum temperature of -0.8°C, 2 cm of snowfall, and 10 hours of total sunshine. These conditions were similar to, and in some cases better than, weather conditions later in May when dowitchers and other shorebirds were conspicuous by their flight and song activity. No shorebirds, not even Common Snipe, probably the most abundant shorebird in the study plot and readily detectable if "winnowing", were seen on 17 May.

The five dowitchers seen on 18 May 1980 were all flying overhead; none was seen on the ground or appearing as though descending to land. On the next day, however, 11 dowitchers were seen foraging about a pond. Most of the other shorebirds of the study plot shorebird community had arrived on 18 May also. These were the Greater Yellowlegs, Solitary Sandpiper, Least Sandpiper and Common Snipe. In 1980, Red-necked Phalaropes arrived later, on 24 May. Of the six species, Short-billed Dowitchers were the most concentrated (largest flocks) and the most conspicuous during that period. Common Snipe were also abundant but often inconspicuous unless displaying. These species were frequently seen in mixed species assemblages, feeding in snowfree ponds and along the pond margins. All apparently migrating or newly arriving groups of dowitchers, those flying overhead in larger flocks, consisted only of dowitchers, however.

Habitat use by arriving dowitchers was restricted to snowfree areas until the melt was completed in late May to early June. This meant that dowitchers initially fed, preened, and rested along pond margins and on the floating sedge mats of those ponds where these were snowfree. As the melt progressed, the dowitchers dispersed, especially into patterned fen (nesting) habitats. No dowitchers were observed along the shorelines of lakes during this period.

Two dowitchers were collected on 20 May 1980, and one bird from two on 21 May 1980 (Table 7). All three birds were males with enlarged testes and moderate body fat. The two collected on 20 May were feeding nearby each other, indicating that not all sightings of pairs in this period were of a male and a female.

Courtship, Nest-building, and Egg-laying

Late May to early June, between arrival and the commencement of incubation, was a period of

much vocal and flight activity. Songs, display flights and chases occurred at their highest seasonal frequencies. In addition, however, were the observations of 'tame' groups of two dowitchers -- birds that allowed close approach before flushing for only short distances. Observations were made of such groups of two, for 1.5 hours on 31 May 1980 and 1.25 hours on 6 June 1980. Behaviour was similar in both cases; both birds of each group of two: (a)stood or sat at or near a pond edge for the duration of the observation, (b)conducted maintenance behaviours -- foraged, preened, bathed, and rested with head tucked under wing, and (c)occasionally gave various short calls or a short song. On 6 June 1980, three separate such groups of two dowitchers were within approximately 10-15 m of each other; two of these groups were in plain sight of each other. No aggression was observed. No individuals were collected from such groups, and none was banded.

The only obviously agonistic behaviour that was noted in this period, or throughout either study season, occurred on 4 June 1978. Two foraging dowitchers were joined by another that flew in and landed nearby. Shortly after landing and occasionally in the next half hour, this bird was rushed at by both previously present dowitchers.

No observations were made of nest building activities by Short-billed Dowitchers. Of the four nests found, all but one were located on the ground on strings in patterned fens. The one exception was a nest found in a sedge meadow. These four nest sites are illustrated in Figs. 10 to 13.

The only nest for which any egg-laying information is available, was discovered on 30 May 1978. On that date it contained one egg and an adult was sitting on the nest. When the nest was checked next, on 1 June, three eggs were in the nest. At the subsequent nest check, at 12:55 h on 2 June, there were still three eggs. There was a full clutch of four eggs on the following visit, at 12:25 h on 3 June. Despite cold, windy and wet weather through this period, there were times when no dowitcher was on the nest (Fig. 14). This nest was in the same wetland area as a dowitcher nest discovered the previous year.

All four nests that were found, held completed clutches of four eggs each. Measurements of eggs from these nests are provided in Tables 4 and 5.

Incubation

Incubation data are available from three nests -- the two discovered in 1978, and the one found in

1980. Few observations are available for the 1977 nest. It was discovered on 24 June, by flushing the incubating adult. On 28 June the nest was empty, with evidence indicating a successful hatch.

All observations of these nests showed that an adult dowitcher was incubating essentially continuously (Figs. 14 to 16). The only three exceptions to this were absences noted (1) during egg-laying (see previous section); (2) briefly during the changeover of incubating birds; and (3) for 28 minutes when the incubating adult suddenly flushed, gave a broken-wing distraction display and mysteriously disappeared before returning (18 June 1980; Fig. 16). Timing of incubation changeover was variable. Seven changeovers were observed; they occurred from 0605 h to 2220 h (Figs. 14 to 16). No observations were made from the beginning to end of one incubation shift, however, individual adult dowitchers were observed to incubate for from approximately one hour to as long as 19 hours 35 minutes (Figs. 14 to 16).

On the nest adults could be quite active, particularly so when starring of the eggs began. Activities included preening, changing directions they faced, standing then resettling on the eggs, and giving various short calls. In the vicinity about the nest dowitcher activity was minimal. Once, during the egg-laying phase, an adult was observed foraging along a pond edge within approximately 100 m of a nest. This adult, although unbanded, had plumage characteristics similar to one of the nest adults. After completion of the clutch, however, no activity other than that of changeover visits was observed. The incubating dowitcher did not react to songs from dowitchers or other shorebirds nearby or overhead. The nest area was not observed being patrolled or used for feeding, preening, or resting.

Two different dowitchers were noted to incubate at each 1978 nest and the 1980 nest, presumably a male and a female. The fact that they were different individuals was determined by plumage differences and colour-banding. One individual was not observed to incubate only during the day and the other only at night, or in any other daily pattern (Figs. 14 to 16). Of a total of 15.75 hours of observation at the post-storm 1978 nest, adult 'A' incubated for 33% and adult 'B' for 67% of the time (Fig. 15). At the 1980 nest, adult 'A' incubated for 9% and adult 'B' for 91% of the total of 48.8 hours of observation (Fig. 16).

The following measurements were made of the two dowitchers incubating at the 1980 nest:

Adult 'A': WF= 151mm, BE= 64.3, BN= 56.5, BW= 3.4, TR= 34.3, tail= 54.0, weight= 97gm.

Adult 'B': WF= 148mm, BE= 54.2, BN= 46.0, BW= 3.0, TR= 35.0, tail= 53.0, weight= 125gm.

TABLE 4: Measurements of Short-billed Dowitcher eggs from Schefferville, Quebec.

	LENGTH (mm)	WIDTH (mm)[1]
SCHEFFERVILLE (n=12; 3 clutches)		
mean	40.5	29.4
range	39.1-41.7	28.3-30.5
s.d.	0.89	0.89

1. Width measured at the widest diameter.

TABLE 5: Weight change during incubation, and size of Short-billed Dowitcher eggs at the two nests found near Schefferville, Quebec in 1978.

NEST #1

egg[1]	1	A	B	4
length (mm)	40.0	41.7	41.5	41.5
width (mm)	28.9	29.5	29.3	29.3
weight (gm)				
June 1[2]	16.7	18.3	--	--
June 3	16.7	18.0	17.9	17.7
June 7	16.0	17.7	17.8	16.9
June 12	15.3	16.7	16.7	16.1

NEST #2

egg[1]	A	B	C	D
length (mm)	40.1	39.1	40.0	39.5
width (mm)	30.5	29.6	29.8	29.4
weight (gm)				
July 14[2]	16.3	15.1	15.9	15.1

1. When the sequence of laying is unknown, letters are used.

2. For the relationship of these dates to the day of incubation or the number of days to hatch, see Figure 14 (nest #1) and Figure 15 (nest #2).

Figure 14: 1978 - Incubation schedule at the Short-billed Dowitcher nest found before the mid June blizzard.

DATE	DAY OF INCUBATION		TIME OF DAY 2	4	6	8	10	12	14	16	18	20	22	24
MAY 30		1 EGG							X(?)					
31														
JUN 1		3 EGGS					0		X(?)					
2		3 EGGS							0					
3	1	4 EGGS, FULL CLUTCH							X(A)					
4	2						X(B)							
5	3													
6	4													
7	5							X(B)						
8	6													
9	7													
10	8									X(A)				
11	9													
12	10							X(B)						
13	11	BLIZZARD					I——— B ———I							
14	12	BLIZZARD												
15	13	BLIZZARD												
16	14	NEST FOUND DESERTED								0				

X = visit to nest by observer at which an adult was on the nest.

0 = visit to nest by observer at which no adult was on the nest.

I---I = prolonged observations of nest from blind.

A, B = indicate which adult was on the nest. ? = adult unknown.

Figure 15: 1978 - Incubation schedule at the Short-billed Dowitcher nest found after the mid June blizzard.

DATE	DAYS TO HATCH	TIME OF DAY (2 4 6 8 10 12 14 16 18 20 22 24)
JUL 6	10	NEST FOUND, 4 EGGS — X(?)
7	9	
8	8	
9	7	X(?)
10	6	|A|—— B ——| (0830)
11	5	|B—|A-| (1830)
12	4	|—— B —|
13	3	
14	2	|—— A ——|
15	1	EGGS PIPPING — |B-|— A —| (1720)
16	0	FIRST EGG HATCHES — |———— B ————|
17		LEAVE NEST — |———— B ————|

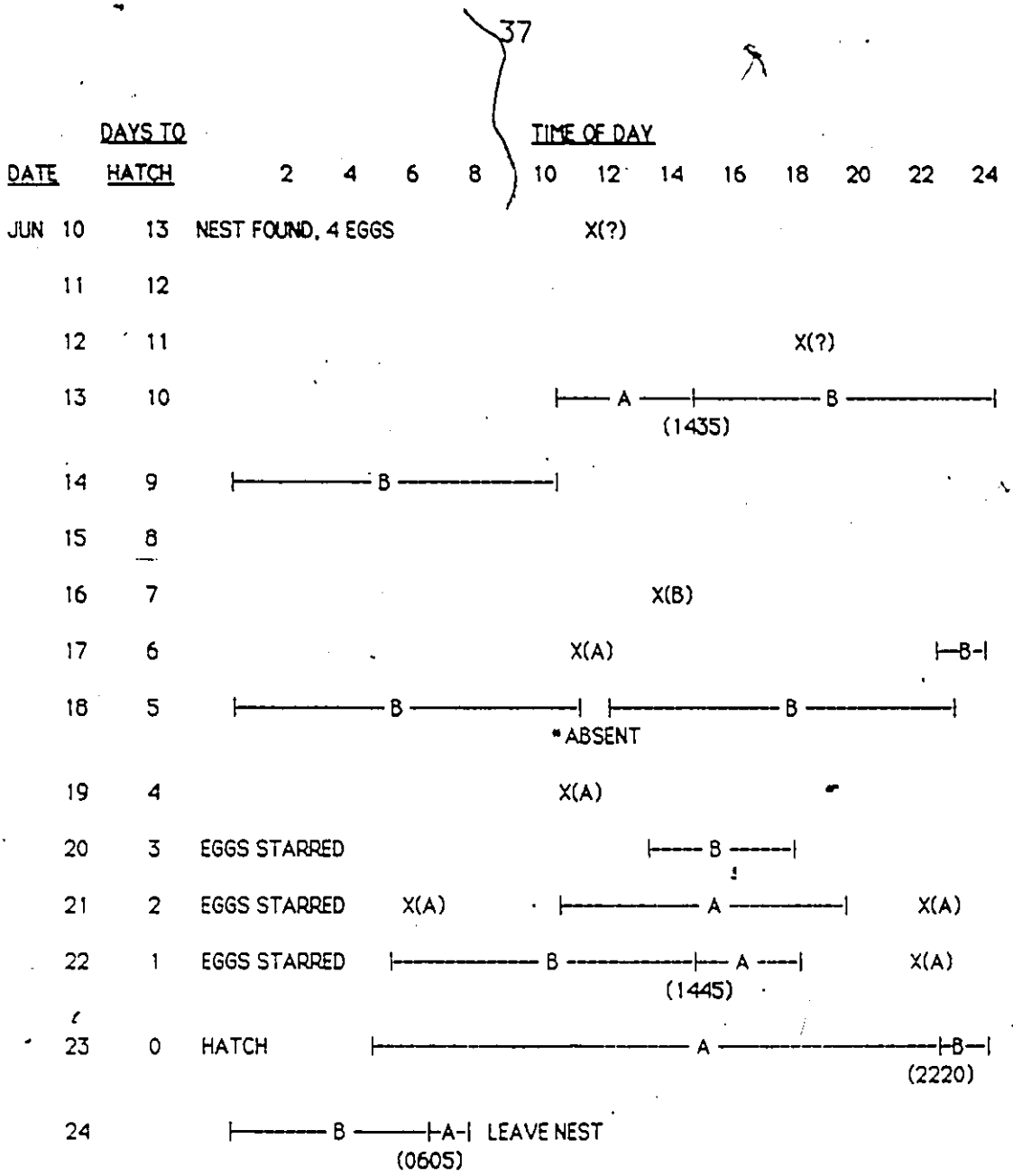
X = visit to nest by observer at which an adult was on the nest.

|---| = prolonged observations of nest from blind.

A, B = indicate which adult was on the nest. ? = adult unknown.

(0830) = indicates the time of the changeover at the nest.

Figure 16: 1980 - Incubation schedule at the Short-billed Dowitcher nest.



* Adult B suddenly flushed from nest at 1136 h, gave broken-wing distraction display, mysteriously disappeared and did not return until 1204 h.

X = visit to nest by observer at which an adult was on the nest.

|---| = prolonged observations of nest from blind.

A, B = indicate which adult was on the nest. ? = adult unknown.

(0830) = indicates the time of the changeover at the nest.

(WF= wing flat, BE= bill exposed, BN= bill nasal, BW= bill width, TR= tarsus. All these measurements, and tail, are in mm.) No measurements were taken of the nest adults at either of the 1978 nests.

Hatching period

The hatching period was observed at two nests -- the 1978 post-storm nest, and the 1980 nest. The hatching period is defined here as the time from first starring of the eggs to departure of the downy young from the nest cup.

At the 1978 nest, the hatching period was from 15 to 17 July. The period of starring and pipping of the eggs prior to the actual hatch lasted approximately 24 hours, from about 1900 h on 15 July to 1845 h on 16 July. Hatch occurred overnight, beginning with the first egg at 1845 h on 16 July to the last egg probably just before 0600 h on 17 July, a period of some 11 hours. All four downy chicks left the nest cup at 1243 h on 17 July. This was about 7 hours after the last chick hatched. They were last located about 21 hours later, at 0925 h on 18 July, about 160 m from the nest.

In 1980, starring of the eggs was first noted at 1830 h on 20 June; they had probably begun to star several hours earlier. Hatch occurred between about 1058 h and 2205 h on 23 June. Starring and pipping lasted over 65 hours at this nest, while the hatch itself was approximately 11 hours. Nine hours later, at 0710 h on 24 June, the chicks departed the nest cup. The last young to hatch was collected. This may have had some influence on the time to departure, probably to shorten it, because the last and weakest young may determine in part when the adult leads the brood from the nest.

The only large difference in the timing of events between these nests is the starring and pipping period. This was about 24 hours at the 1978 nest, while the 1980 nest was a much longer 65 + hours.

At the 1978 post-storm nest, adult 'A' was incubating at 1900 h on 15 July when the eggs were beginning to star. From 16 July on, adult 'B' was the only dowitcher seen at the nest or with the brood (Fig. 15). Adult 'B', agitated and presumably with chicks close by, was last seen some 160 m from the nest at 0925 h on 18 July, the day after they left the nest.

Both adults were observed incubating for many hours during the hatching period at the 1980 nest (Fig. 16). Adult 'A' was incubating when the four eggs hatched on 23 June, and took over from adult 'B' just before the chicks departed the nest cup. Adult 'B' brooded the chicks overnight before they

departed the next morning. When the eggs were still starred, adult 'A' was seen within several meters of the nest while adult 'B' incubated. Adult 'A' incubated approximately 58% of the observed time; 'B' incubated 42% (Fig. 16). During the hatch itself on 23 June, both adults were observed to carry eggshell fragments from the nest and adult 'A' was seen to eat a small piece of shell. No evidence of the brood was seen in the immediate vicinity of the nest only seven hours after they left the nest.

Hatch at both of these nests was 100% successful. A list of chick weights and measurements is provided in Table 6.

Young-attending period

Broods were always located by the conspicuous agitated behaviour of the adults. Rarely were the chicks themselves subsequently found, despite often intensive searches. The adults with broods exhibited a mobbing behaviour. They called excitedly - short, sharp notes - and flew about, often landing in treetops or in a flark or pond. They neither flushed at close quarters and performed a distraction display, as Common Snipe do, nor were they as loud and aggressive (divebombing) as Greater Yellowlegs are.

In most cases only one adult was seen with a brood or behaving as though with a brood. In a few instances in both 1978 and 1980, two and once three adults were seen together behaving so. Adult 'B' from the 1980 nest was seen accompanying another adult in such a manner. The other adult was not banded and was therefore not adult 'A' from the 1980 nest. The unbanded adult was also more excited. As the observer moved towards the spot from which 'B' originally flew to join this other unbanded dowitcher, 'B' became far more agitated as its brood was presumably approached.

In 1980, adults attended broods until about 14 July. Sightings of dowitcher broods, or dowitcher adults behaving as though with broods, were made on five days between 2 July and 14 July 1980. Adult 'A' from the 1980 nest was found on 26 June possibly with a brood, but not behaving typically so (see below). The only chicks actually discovered in 1980 were found on 2 July (two downy young). Measurements of all chicks are provided in Table 6.

Broods and adults behaving as though with broods were seen on 18 and 23 July 1978. The observation on 18 July was of the post-storm nest brood, one day after departing the nest. They were

not seen during the one other visit to this area on 27 July. One downy young was found and banded, and another heard nearby, in the study plot on 23 July.

In 1977, when hatch at the one nest found was sometime between 24 and 28 June, chicks were seen with adults on 28 and 29 June.

Several sightings were made of both adults colour-banded at the 1980 nest. The only post-hatch record of adult 'A' was on 26 June. When encountered, 'A' did not flush and fly away, or mob as described above. Rather it walked slowly away skulking through the undergrowth and flying for short distances, once giving a weak distraction display, until it was some 100 m distant from the point of discovery. Then it flew up and away, not returning to the original spot where a brood may have been, but later being discovered nearby where it last flew up and away. No calls were given.

Adult 'B' was sighted on 7 and 13 July, behaving as though with a brood each time. On these dates, 13 and 19 days respectively after the hatch, it was approximately 1.2 km from the nest site and on the other side of a dirt road.

Two adult Short-billed Dowitchers were collected on 14 July 1980; each behaved as though with a brood and in one case two young were heard calling after the adult was collected. Both specimens were males with shrinking testes (3 x 2 mm, 4 x 2 mm), bare brood patches, and light fat (Table 7). An unsuccessful attempt was made to locate the above two calling young by playing back tapes of the adult-chick vocalizations recorded at the 1980 nest hatch.

A total of three dowitcher broods was found or heard in 1978 and 1980. This includes downy young found or heard with an attendant adult. In all three cases there were two young.

Broods, or adults behaving as though with broods, were always observed in wetland habitats. The only two chicks found after hatch in 1980 were discovered after 1.5 hours of careful searching, crouched motionless on a floating sedge mat in a flark of a patterned fen. Two others heard, on 14 July, were by a pond edge. Those found in 1978 were amongst sedge growth along a pond margin. Agitated adults were also seen in the sedge meadow habitat (Fig. 12).

Departure

In 1980, the last adult dowitchers are believed to have left the study plot sometime in the period 14-17 July. In a large wetland area where there had been, on 14 July, a dozen shorebirds (4-5 Greater

TABLE 6: Weights and measurements of downy young Short-billed Dowitchers at Schefferville, Quebec.

	wt (gm)	WF (mm)	BE (mm)	BN (mm)	TR (mm)
AT HATCH					
1978 nest[1]	12.7	–	--	13.0	28.0
	11.9	–	--	13.5	27.0
	12.3	–	--	13.5	26.5
1980 nest[2]	11.9	18	14.1	12.8	26.8
	12.7	19	14.5	12.9	28.2
	12.9	20	15.0	12.6	28.3
	12.0	20	15.7	12.8	26.7
Means	12.3	19	14.8	13.0	27.4
S.D.	0.36	1.0	0.69	0.35	0.69
POST HATCH[3]					
28 June 1977	11.3	18	17.8	–	24.1
29 June 1977	13.7	18	20.2	16.8	24.8
23 July 1978	21	–	26	22	27.5
2 July 1980	--	20	18.3	15.0	29.5
	--	21	17.5	14.8	28.9

wt= weight, WF= wing flat, BE= bill exposed, BN= bill nasal, TR= tarsus

1. 1978: Weight of dry, downy young still in nest cup. Oldest chick approx. 11 hours old at time of weighing. Weighed with 50 gm Pesola scale. BN measured with small ruler to nearest 0.5 mm. TR measured with calipers to nearest 0.5 mm

2. 1980: Data presented in order of hatching; first young hatched at top. to last hatched at bottom. Weight of all four chicks weighed when down still wet, on triple-beam balance to nearest 0.1 gm. WF measured to nearest mm with ruler. BE, BN, TR measured to nearest 0.1 mm with calipers.

3. Post hatch: These young still had downy plumage, but their exact age is unknown.

TABLE 7: Data on Short-billed Dowitchers collected in the Schefferville area.

	Date	Gonads (mm)	Fat	Wt (gm)	Remarks
ADULT MALES					
NMNS 79752	20 May 1980	7x4	02	89.3	
NMNS 79751	20 May 1980	11x5	02	98.9	
NMNS 79753	21 May 1980	9x5	01	88.3	
NMNS 68503	17 Jun 1978	9x3	01	78.1	brood patches
NMNS 68502	17 Jun 1978	10x4	00	---	no brood patches
NMNS 66038	22 Jun 1977	7	–	95.1	brood patches
NMNS 66039	27 Jun 1977	9	02	95.2	brood patches
NMNS 66042	29 Jun 1977	8	03	111.0	brood patches
NMNS 66045	6 Jul 1977	8	00	87.3	no brood patches
NMNS 66043	6 Jul 1977	8	00	90.1	no brood patches
NMNS 66047	11 Jul 1977	N.E.	01	83.5	brood patches
NMNS 79755	14 Jul 1980	3x2	01	79	brood patches
NMNS 79754	14 Jul 1980	4x2	01	84	brood patches
NMNS 43629	27 Jul 1958	3	–	95.5	small brood patch
ADULT FEMALES					
NMNS 68504	17 Jun 1978	12x12	01	96.2	no brood patches. Lrgst ovum 6x4 mm
ROM 116069	3 Jul 1972	gran.	01	115	no brood patches. Lrgst ovum 3 mm
NMNS 66046	6 Jul 1977	S.E.	02	102.0	brood patches
NMNS 66044	6 Jul 1977	S.E.	04	113.9	brood patches
JUVENILES					
NMNS 43633	28 Jul 1958	–	–	–	Down on head, neck, tail coverts. Base of primaries in sheaths.
NMNS 43634	28 Jul 1958	–	–	–	As above.
NMNS 43630	15 Aug 1958	–	–	–	No down.
NMNS 43631	15 Aug 1958	–	–	–	No down.
NMNS 43632	15 Aug 1958	–	–	–	No down.

NMNS = National Museum of Natural Sciences, National Museums of Canada.
ROM = Royal Ontario Museum.
Gonads: N.E. = not enlarged, S.E. = slightly enlarged, gran. = granular.
Fat: 00 = none, 01 = little, 02 = moderate, 03 = fat, 04 = very, 05 = excessively.

Yellowlegs, 4 Short-billed Dowitchers, 2 Red-necked Phalaropes and 1 Solitary Sandpiper), only one Common Snipe was flushed on 17 July despite a very thorough check. No field work was done in the study plot on 15 and 16 July. Other searches throughout the study plot after 17 July provided no more sightings of dowitchers exhibiting mobbing behaviour as though with a brood. The only sightings were of some flying overhead. Adult 'A' was last seen on 26 June; adult 'B' was last seen on 13 July. Dowitchers were last sighted in 1978 on 23 July when agitated adults with broods were noted.

Juvenile and presumed juvenile dowitchers were recorded on 23 July, 24 July and 3 August 1980. On 23 July one recognizable as a recently fledged juvenile (plumage still with down) flushed at the observer's feet and flew low (about 2 to 3 m high) for some 20 m before descending as though to land. The following day two separate dowitchers were flushed, again at close quarters. One of these appeared recently fledged (still with some down), and flew well but not strongly for approximately 100 m before landing. The other bird was in a 'cleaner' plumage (no down), and flew more strongly. Two dowitchers were again flushed in this same area on 3 August, this time together. They both flew very well and eventually flew out of sight. No juvenile dowitchers were collected.

DISCUSSION

SEXING ADULTS 'A' AND 'B', 1978 AND 1980

Three pairs of dowitchers were observed incubating during the study: (1) at the pre-storm 1978 nest, (2) at the post-storm 1978 nest, and (3) at the one nest found in 1980. None of these was collected. It is not possible to sex the pre-storm 1978 nest adults; they were neither trapped and measured nor were appropriate behavioural observations made. It is possible, however, to sex the post-storm 1978, and 1980 nest adults.

Aside from examining the gonads of collected or trapped birds, it is possible to sex Short-billed Dowitchers (a) by external body measurements and (b) perhaps by parental behaviour: (a) Pitelka (1950: 38) provides the following measurements of male and female Short-billed Dowitchers, nominate race.

adult females: wing= 136-144mm, culmen= 56.4-63.3mm, tarsus= 31.3-37.3mm

adult males: wing= 133-145, culmen= 51.2-60.4, tarsus= 31.5-35.7

These measurements were of dried museum specimens; fresh measurements would have been slightly larger. He also states that females average 10% larger than males. (b) Field studies indicate that adult males provide most of the care of the young. Jehl and Smith (1970) state that, at Churchill, Manitoba, females depart the breeding grounds soon after the chicks hatch whereas adult males remain until the chicks are fledged. Also, most adult female Short-billed Dowitchers arrive ahead of adult males in fall migration at New Jersey (Jehl 1963). At Schefferville, two adults with broods or behaving as though with broods, were collected. Both were males.

Measurements are not available for the 1978 post-storm nest adults. It may be possible to sex them on the basis of parental behaviour, however. At the 1978 post-storm nest, adult 'A' was last seen on 15 July, when the eggs were pipping, although observations continued there to 18 July. Adult 'B', however, was seen to 18 July, the day after hatch, at which time it was very agitated and behaving as though with the brood. On the basis of male care of the brood, adult 'A' was the female and 'B' the male in this pair. This assumes that the roles of the sexes at the 1978 post-storm nest were the same

as those found at Churchill, Manitoba.

Measurements are available for the 1980 nest adults. Culmen and tarsus measures are comparable with Pitelka (1950); his wing measure is wing chord whereas wing flat was taken in 1980. The range of Pitelka's tarsus measurements for females completely include the range for males. It is therefore not possible to separate the sexes on this basis. Pitelka's culmen is comparable with my bill exposed (BE) measurement. The 1980 nest adults measured: adult 'A', BE = 64.3mm; adult 'B', BE = 54.2mm. Because Pitelka's measurements were of dried specimens and the 1980 measurements were fresh, they are not directly comparable. However, the fresh measurements of the 1980 nest adults are well beyond the range of shrinkage. On the basis of a BE> 56.4mm, and greater overall size, adult 'A' at the 1980 nest is a female. On the basis of a BE< 56.4mm, and smaller overall size, 'B' is a male. Adult 'B' also provided most of the care of the brood, the male's role as discussed above, whereas adult 'A' was last seen three days after hatch occurred.

Therefore, in both cases above, adult 'A' was the female and 'B' the male.

SONG AND RELATED BEHAVIOURS

Literature Review

The Schefferville observations of the song and display flight of the Short-billed Dowitcher are the first detailed accounts of these behaviours in this species. Brief and partial descriptions can be found in the literature (Bent 1962; Clement, in Todd 1963; Hurley 1932; Randall, in Bannerman 1961; Rowan 1927; Shortt 1939; Shortt and Waller 1937). The only analyses of the song are available in Greenewalt (1968; oscillogram) and recently in Miller et al. (1983).

The song varies in completeness, loudness, speed and accent but is relatively loud and carries well. It is most stereotyped when given as part of the display flight (Miller et al. 1983) and is probably similar in this respect as a long-distance, stereotyped call, to the songs and flight displays of other shorebird species (see Miller 1983). An undulating display flight is performed by a number of other shorebird species: Whimbrel (*Numenius phaeopus*, Skeel 1978), Lesser Yellowlegs (Rowan 1929), Greater Yellowlegs (pers. obs.), Solitary Sandpiper (pers. obs.), Redshank (*Tringa totanus*, Hale and Ashcroft 1982). Some quantitative but not qualitative variation has been found in the song across the

Short-billed Dowitcher's nesting range (Miller et al. 1983).

The few published descriptions that refer to the display flight of the Short-billed Dowitcher (Hurley 1932; Rowan 1927; Shortt 1939), are too brief for comparison with, or to supplement, the Schefferville observations. The following two references are questionable. Nelson (1887) described a hovering courtship flight he observed in Alaska. Although this reference is referred to in later Short-billed Dowitcher literature (Bent 1962; Clement, in Todd 1963), only one other original description of a flight display mentions a hovering flight (Shortt and Waller 1937, see below). In fact, Clement (in Todd 1963) specifically mentions that he did not see this type of display. Pitelka (1950:75) questions whether Nelson's observations refer to the Short-billed or Long-billed Dowitcher. Shortt and Waller (1937) described a 'nuptial performance': "Its flight was hesitant with frequent hovering and at the same time a vocal whistling was heard" (p.23). The description matches the observations of known agitated adults with broods at Schefferville but not the observations there of presumed 'nuptial' behaviour. It is difficult to comment on what Shortt and Waller mean by "vocal whistling".

Clement (in Todd 1963) mentions hearing the song of the dowitcher at Schefferville on 31 May, 1 June, 22 June, and 3 July. However, he makes no specific reference to the display flight but only to one case of a song given by a bird on the ground. Bent (1962) does mention that he heard Short-billed Dowitchers singing in spring migration, in coastal New Jersey during the last week of May. No comments on song or display flight seasonal frequency are available in the literature.

Hurley (1932) mentions a male in song, while Rowan (1927) observed a female singing. The basis for their identifications of the sex is questionable without the stated collection of the birds. At Schefferville a male was collected after singing. Adult 'B' at the 1978 post-storm nest, and adult 'B' at the 1980 nest sang during incubation changeovers. These are both believed to be males (see "Discussion - Sexing Adults 'A' and 'B', 1978 and 1980" above). Therefore, at present, there is solid evidence only that males sing.

Harlow (in Bent 1962) described apparent ground displays that involved song: "There were at least eight pairs of birds in the vicinity...The males apparently outnumber the females, for at least two females were seen surrounded by little groups of three or four males, frequently singing and displaying. The male frequently strutted like a woodcock and displayed, and several times arose and

gave his flight song..." (p.108). This is the only original such description found in the literature.

Descriptions referring to apparent chases are similar to the Schefferville observations (Bannerman 1961; Bent 1962; Rowan 1927; Clements, in Todd 1963). Rowan (1927) mentions a dowitcher singing when flushed from the nest, in an alarm/disturbance context. This was not observed at Schefferville, although song did occur in other alarm/disturbance contexts.

Functions

The functions of particular displays and other behaviour may be deduced from the contexts in which they occur and the status of the players involved. In behavioural studies, however, there are neither always readily obtainable observations nor simple conclusions. The difficulties in observing complete sequences of Short-billed Dowitcher behaviour at Schefferville, due to the trees and other vegetation frequently concealing the birds, forced tentative interpretations of partial observations. Supplemental observations in the literature are few and anecdotal for the most part. The age and reproductive status of the dowitchers being observed were unknown. Whether they were previously mated pairs, first-time breeders, returning to previously used nesting sites, or any other factors of obvious importance, was unknown. No pre-incubation observations of known (colour-banded) birds were made.

The Schefferville observations indicate that, over the late May to mid July period of occurrence, songs are given in a number of different contexts: aerial displays, localized song and aerial displays, chases, copulation, incubation changeovers, and alarm/disturbance. The primary context and function of singing by Short-billed Dowitchers is interpreted as being sexual, that is, involved in courtship, pairing, and pair maintenance. Singing in association with mounting/copulation is obviously a sexual context, but there is additional evidence.

The song is loud and carries well, especially when given in flight which, in addition, is typically wide-ranging. Song thus can communicate over large areas and be used to contact receptive dowitchers of the opposite sex, presumably males contacting females. Although direct evidence of sexes involved is lacking, aerial displays were observed performed only by birds alone (males?) or by two birds together (male and female?). When localized, songs and aerial displays appear to be performed by one dowitcher (male?), but in association with another dowitcher (female?) on the ground.

I interpret aerial chases as one sex (males?) chasing the other (females?) so as to pair with them, and not as territorial behaviour. Aerial chases are wide-ranging and not restricted to a territory. They often involve more than the two or three birds one would expect in a territorial conflict. The restricted seasonal occurrence of chases, in association with peak frequencies of song and flight displays, in late May and early June coincides with the courtship period.

If song's sole function were to obtain a mate, why are songs heard into mid July? This should be long after any pair formation has finished or is indeed even useful. Dowitcher song at Schefferville was also performed during incubation changeovers and in alarm/disturbance contexts. The function of song during incubation changeovers is unclear, although possibly it is a greeting. Hale and Ashcroft (1982) felt that Redshank song and display flights in alarm/disturbance contexts were performed as displacement activities. The Schefferville observations also suggest this. At Schefferville after early June most singing dowitchers were heard only and not seen, thus the identities of the singers and the contexts are unknown. However, in the few cases where the behaviour was observed, the context was alarm/disturbed. The brief resurgence in song activity in early July was probably associated with the alarmed behaviour of adults with broods. Song was last heard at Schefferville in mid July when adult males apparently departed (see discussion on nesting cycle). Although the few observations do not rule out other possibilities, displaying non- or late nesters for example, they do confirm the alarm/disturbance context for some cases.

Miller et al. (1983: 2193) stated that Short-billed Dowitcher song occurs in sexual-agonistic contexts. "Unpaired male dowitchers utter aerial song in the breeding season to attract females. Both sexes sing during aerial chases, in agonistic encounters on the ground, and often when they are disturbed during the nesting period." The Schefferville data appear to agree with these statements, although conclusions on the sexes involved and the ultimate functions of these behaviours require further confirmation. Song was not interpreted as being involved in agonistic contexts, however.

NESTING CYCLE

Arrival

Little is available in the literature concerning the arrival of Short-billed Dowitchers at

Schefferville or elsewhere in central Quebec-Labrador. Clement (in Todd 1963:336) reports only that he first observed dowitchers on 25 May (1957). It is not known if these were first arrivals or previously arrived birds. Based on the Schefferville observations in 1980, it is likely that dowitchers had been present for a week or more prior to Clement's first record.

In 1980, observations at Schefferville began on 17 May and dowitchers were first observed on 18 May. Because observations began only the day before, the data are insufficient to conclude that 18 May was the date of first arrivals. The data do indicate, however, that dowitchers were present earlier than previously recorded. When observed in May, dowitchers were usually conspicuous by their song and flight activity. All five seen on 18 May, for example, were flying overhead; some gave call notes or brief songs. Late-winter weather (cold and snowstorms) was the only condition under which dowitchers were not readily detectable. Because May 17 was sunny and relatively warm, dowitchers should have been detected if many had been present. Therefore, the data support the conclusions that few if any dowitchers were present prior to 18 May, and that most dowitchers began arriving at Schefferville in the third week of May.

It was difficult to determine the spring arrival pattern of dowitchers at Schefferville. Other than first arrivals, spring migration is not a readily noticeable event there. For example, noticeable movements of large flocks were not observed. Small groups of one or two, and less frequently three birds were most often seen. Group sizes larger than these, although recorded in both 1978 and 1980, were relatively infrequent. Presumably this is because the birds are dispersing as they move northwards and near their nesting areas. The fragmentary nature of the study plot habitats - pockets of wetlands and ponds separated by woods - could also be a factor dispersing birds. The patterns of migration and arrival might be different in more extensive and homogenous wetlands.

It was difficult to separate newly arrived dowitchers from those already present and to tell transients from local nesters because no identified dowitchers were observed. On the basis of an estimated five or six broods censused later in the study plot, however, most observations were of transients.

In this study, presumed characteristics of migratory behaviour (larger flocks; resting, feeding and other non-sexual behaviours) were used to identify migrating or newly arrived dowitchers, versus the smaller group sizes and courtship behaviours of already established local nesters. Using these criteria,

spring dowitcher migration at Schefferville in 1978 continued until 2 June when a flock of five were flushed. No data on first arrivals are available for 1978; dowitchers were already present at my arrival on 26 May. In 1980, the first arrivals were recorded on 18 May, and the last obvious migrants, a flock of 23, were sighted on 23 May, a six day period.

It is probable that some migration occurred after these dates. Group size and behaviour are functions of more than migration. Group size at Schefferville is also a function of habitat availability; dowitchers concentrated along snowfree pond margins in mid May and dispersed as snow melt progressed and more habitat became snowfree. As the season progressed, these changes in habitat availability along with other factors presumably initiated sexual behaviours. Therefore, later in the arrival period, newly arriving birds may immediately exhibit sexual behaviours and would not be concentrated by habitat unavailability. Late arriving dowitchers would therefore be less easy to recognize.

At Churchill, Manitoba, locally nesting dowitchers arrive in the first days of June, but small flocks of migrants can be found until 10 June -- a period of approximately 10 days (Jehl and Smith 1970).

There is no evidence to indicate that Short-billed Dowitchers arrive at Schefferville in two separate waves, as found in some other shorebirds (e.g. Semipalmated Sandpiper *Calidris pusilla*, Ashkenazie and Safriel 1979a). The only evidence suggestive of two arrival periods at Schefferville was a week long increase in song activity in the second week of July. This would appear to be an extremely late time at which to begin nesting. Song in this period is interpreted as displacement behaviour by agitated dowitchers with broods (see discussion of song). There is no evidence for two hatching peaks at Schefferville.

At Schefferville, three dowitchers were collected during the arrival period: two males on 20 May 1980, and one male on 21 May 1980. At Churchill, Manitoba, Jehl and Smith (1970) and Taverner and Sutton (1934) both mention first arrivals of dowitchers in early June. More specifically, Taverner and Sutton state that females were collected on 2 and 5 June, but do not provide data on male arrival. Therefore, males were collected early in the arrival period at Schefferville, and females were collected early in the arrival period at Churchill. The data are few, but indicate that both sexes can arrive early in the arrival period. This suggests that there may be little difference in the first

arrival dates of male and female dowitchers at their nesting areas.

To determine whether Short-billed Dowitchers arrive as mated pairs, therefore pairing en route, requires observations of courtship behaviour during migration rather than merely the recording of known, colour-marked, mated pairs during arrival in the nesting area. The latter observation can be explained simply as the individual homing of each mate, exhibiting site and mate fidelity (Jehl 1968, 1973). Few applicable observations of spring migration are available in the literature. Bent (1962:112) mentions that he and Oberholser frequently heard the flight song during spring migration on the coast of New Jersey (late May). These observations do not indicate clearly whether or not pairing does occur en route and it seems more sensible to accept the homing explanation for now.

At present, only indirect data are available regarding any differential arrival by age. Studies outside the breeding range indicate that first-year birds commonly summer south of the boreal nesting grounds (Loftin 1962). This suggests that Short-billed Dowitchers may not begin breeding until at least their third summer, that is, two years after they were born. If some first-year (second summer) birds do migrate north to the nesting grounds, data from other shorebirds (e.g. Dunlin *Calidris alpina*; Soikkeli 1967) suggest that experienced breeders arrive before first-breeders.

Three dowitcher specimens were collected during the arrival period at Schefferville. All were males with moderate body fat and enlarged testes. None was collected in the study plot, and it was not obvious as to whether these birds were transients or local nesters. The body fat is certainly of survival value as late winter storms and overnight freezing temperatures regularly occur in late May and early June. Early season invertebrate food to restore lost energy stores is by no means abundant either. Such fat stores could be used for further migration, should these birds have been transients, and for early season sexual activities such as display flights and chases.

Courtship, Nest-building and Egg-laying

The courtship and pair formation stage of the nesting cycle, defined as the period of occurrence of chases and copulations, occurred in 1980 from approximately 21 May to 6 June. Few observations are available in the literature: Clement (in Todd 1963:336) reported songs on 31 May and 1 June, and an apparent chase and 'tame pair' behaviour on 1 June.

Considering the relatively short boreal nesting season, one might assume that Short-billed

Dowitchers would begin sexual activities immediately upon arrival. Instead there was a delay of three days following first arrivals (18-20 May 1980) before any chases were observed. Perhaps those dowitchers present in the first three days are transients that will not exhibit sexual behaviours until on their own nesting areas; locally nesting birds do not arrive until several days following first arrivals. None of the colour-banded dowitchers was sighted in this period so as to know when locally nesting birds arrived. If first-arriving birds do include local nesters they could be more experienced pairs that require little courtship prior to nest-building and egg-laying. Later arrivals could be less experienced individuals that must complete more elaborate courtship activities before continuing. No data on age or experience of dowitchers in the study plot are available.

There is evidence of overlap in timing between spring migration and the local commencement of courtship activities. Songs, display flights, and chases were observed on 21 May 1980, before the last obviously migrant flock of 23 birds was seen on 23 May 1980. Similarly there is indirect evidence for overlap occurring at Churchill, Manitoba: a female was collected there on 5 June 1932 with a completely formed and coloured egg in the oviduct (Taverner and Sutton 1934). This is well within the approximate 1-10 June arrival period mentioned by Jehl and Smith (1970). Jehl and Smith also list egg dates beginning on 10 June. These data indicate that local sexual activity begins before local spring migration, whether by arriving local nesters or transients, is complete.

Courtship activities definitely overlap the beginning of incubation by some pairs in the local population. At the 1980 nest, hatch occurred on 23 June. Assuming an incubation period of 21 days (Jehl and Hussell 1966), an estimated four day egg-laying period, and two days for nest-site selection and nest building, the latter stage began on 27 May. There is either asynchrony of egg-laying in the population, or synchrony but with the continuation of displays and chases into the incubation stage.

No nest site selection and nest building observations, and few egg-laying data are available from the Schefferville observations or the literature. The only direct observations during the egg-laying period are of the pre-storm 1978 nest: one egg was in the nest when it was discovered on 30 May, and a full clutch of four eggs was found on 3 June, an egg-laying period of at least four days. Assuming a 21-day incubation period (Jehl and Hussell 1966) and a four day egg-laying period, it is possible to backdate from hatch dates and determine the approximate dates of egg-laying periods. The post-blizzard 1978 nest (hatch 17 July) backdates to a 23-26 June egg-laying period; the 1980 nest

TABLE 8: Short-billed Dowitcher clutch sizes reported in the literature.

LOCALITY	REFERENCE	CLUTCH SIZE (NO. OF NESTS)	REMARKS
Churchill, Manitoba	1	4(8)	complete first clutches
	1	5(1)	complete first clutches
southern coastal Alaska	2	4('most')	
	2	3(2)	1/3 incubated, therefore complete
central Alberta	3	4(2)	
	4	4(7)	
	5	5(1)	one addled egg

References: (1) Jehl and Smith 1970, (2) Hurley 1932, (3) Rowan 1927, (4) Randall 1930, (5) Randall, in Bannerman 1961.

(hatch 23 June) backdates to 30 May-2 June. The last few days of May and first few of June would appear to be the usual egg-laying period for the Short-billed Dowitcher at Schefferville.

At Churchill, Manitoba Jehl and Smith (1970) record egg dates from 10 June to 10 July. While this range undoubtedly includes year-to-year variation, renestings, and population asynchrony, the egg-laying period begins 11 days later (30 May versus 10 June) at Churchill than Schefferville, assuming that 10 June represents first eggs laid.

Clutch size in the Short-billed Dowitcher at Schefferville was four eggs in each of the four nests found. In other localities, full clutch sizes of from three to five eggs have been reported (Table 8). The status of these nests in Table 8, with respect to factors that are known to affect clutch size (e.g. first nesting versus renesting, age of parents, time of season) is unknown. However, considering the relative lack of variability of the clutch size in shorebirds, these data probably represent the range and frequency of clutch sizes in the Short-billed Dowitcher.

Incubation

No data on the length of the incubation period of the Short-billed Dowitcher were obtained during the present study, and only one report is available in the literature. The incubation period at one nest at Churchill, Manitoba was 21 days (maximum error six hours; Jehl and Hussell 1966).

Incubation in the Short-billed Dowitcher at Schefferville is essentially continuous, apparently beginning near or with the laying of the last egg. A synchronous start of incubation for all four eggs leads to a synchronous hatch, which is of obvious advantage in nidifugous species (e.g. Ashkenazie and Safriel 1979a; Jehl 1973). An adult was occasionally observed on the nest during egg-laying at Schefferville, and thus some incubation of the eggs could occur at this stage. Several nest visits were made even in cold and snowy weather, however, at which no adult was present. It is known that eggs can be cold-tolerant, moreso soon after laying (Norton 1972; Zerba and Morton 1983). This adaptation permits some degree of absence during egg-laying and helps ensure higher hatching and fledging success through a synchronous hatch.

Incubation changeovers were timed irregularly throughout the daylight hours and at dusk. No incubation shifts were observed from beginning to end, but shifts ranged to at least 19 hours 12 minutes in length. Long incubation shifts reduce the frequency of nest visits while the irregularity of

changeover times makes these few visits difficult to predict. Nests are therefore hard to locate.

In an area of at least several hundred meters about the nest, there is little or no activity by Short-billed Dowitchers during incubation. Other than a suggestion of foraging activity in the vicinity of the nest during egg-laying in 1978, incubation and changeover were the only activities observed at or near any of the Schefferville nests. Dowitchers proved to be so quiet about the nest, even early in incubation, that their presence was entirely unsuspected. As Hurley (1932:17) states, "This species proved to be a very close sitter, flushing only when nearly stepped on."

Randall (in Bannerman 1961) found four nests within several hundred yards of an area where he had earlier seen five pairs of "red-breasted snipe" feeding. An example of adults feeding near their nests? Bent (1962) reported a male seen singing near a nest and a male and a female feeding together nearby a nest, but there are no comments as to the stage of the cycle, whether it was a changeover or whatever. Similarly Hurley (1932) mentioned a male being near the female-on-the-nest. Again, however, no further details were provided. It is also not stated how the birds were sexed and no method of identifying the sexes by plumage alone is known.

Where do Schefferville dowitchers go to feed, rest and preen if these activities are not conducted in the area of the nest? The incubating adult is too active on the nest to be resting, and preens little. Other observations lend credence to the idea of maintenance activity areas away from nest sites. It is known that other shorebirds will feed many kilometers from their nests (e.g. Semipalmated Sandpiper; Ashkenazie and Safriel 1979a). No colour-banded birds were observed away from the nest during incubation. As the study plot was regularly traversed throughout this period, and the 1980 nest adults were both seen in the study plot following hatch, it suggests that these two adults fed, preened, and rested outside the study plot. Dowitchers were seen foraging, resting and/or preening in one particular wetlands area of the study plot, far moreso than in any other area of the study plot.

Clement, in Todd (1963:337) writes, "...and all fed in a loose, peaceful (non-antagonistic) aggregate in an area about 100 by 200 feet." and, "These birds were thus possibly coming from smaller surrounding bogs and utilizing the large bog as a feeding area. We flushed no dowitchers from any of the small bogs we crossed, however. There were scores of such small bogs within a mile of the larger bog, however.". Randall (in Bannerman1961:162) mentions, "...several pairs feeding at a favourite spot.", while Pitelka (1950:56) states that both species of dowitchers "...feed at pond and lake

margins often at considerable distances from nesting sites.".

Incubation by dowitchers at Schefferville was performed by both sexes. Two different individuals were identified incubating at each of the three nests observed in 1978 and 1980. Where it was possible to sex these individuals (see "Discussion - Sexing Adults 'A' and 'B', 1978 and 1980"), each pair was identified as a male and female. This also agrees with statements in the literature referring to both sexes having incubation patches and both sexes being collected from nests (Hurley 1932; Jehl and Smith 1970; Palmer 1967; Taverner and Sutton 1934).

The majority of boreal shorebird species share incubation duties, with the obvious advantage that the eggs can be covered continuously (Wilkie 1981). This last criterion is not met to the same degree by such one-sex incubators as Dotterel (*Charadrius morinellus* ; Wilkie 1981), Pectoral Sandpiper (*Calidris melanotos*; Norton 1972) and Sanderling (*Calidris alba*; Parmelee 1970), which achieve approximately 80-85% attentiveness. This compares with the 96+% attentiveness of Baird's Sandpipers (*Calidris bairdii*) and Dunlin, both two-sex incubators (Norton 1972).

Although both sexes incubated, there was no consistent timetable for each sex as has been found in some other shorebirds. For example, in both Dunlins (Soikkeli 1967) and Stilt Sandpipers (Jehl 1973), the male incubates by day and the female by night. At the 1978 post-storm nest, the male (adult 'B') incubated for 67% of the observed time and the female (adult 'A') for 33%. At the 1980 nest, the male (adult 'B') incubated for 91% of the observed time and the female (adult 'A') for only 9%. As most of the observations were during the daylight hours, it may be that the daytime incubation is done mostly but not exclusively by the male dowitcher.

Hatching Period

'Hatching period' is defined here as the period from first starring of the eggs to departure of the downy young from the nest cup. Along with the observations of the hatching period at two Schefferville nests, there is one published account relating facts on one hatch at Churchill, Manitoba (Jehl 1979). Hatch itself (chicks coming out of the eggs) at Schefferville occurred both overnight (16 July:1845h to 17 July:0600h) and through the day (23 June:1058-2205h). Although not directly stated, the hatch at Churchill apparently occurred overnight: there was still one wet chick and one well-pipped egg in the nest in the morning. The only major difference in timing of events during the

two Schefferville hatch periods, was in the length of the starring/pipping period (24 hours versus 65+ hours). The much shorter period occurred in the late nest of 1978. Perhaps the lateness of this nest, following the mid June blizzard, was a factor.

Hatching success at Schefferville was 100% at three nests; the fourth nest was deserted during the mid June blizzard. At Churchill, Manitoba hatching success was also 100% (30 of 30 eggs; Jehl 1971).

During the two recorded hatching periods at Schefferville, both sexes were present and shared in the observed incubating/brooding. In 1978 (post-storm nest), the female (adult 'A', see "Discussion - Sexing Adults 'A' and 'B', 1978 and 1980") was recorded incubating during the early starring of the eggs but was not observed afterwards. At the 1980 nest, the male (adult 'B') did 42% of the observed incubating, while the female (adult 'A') did approximately 58%. Both removed some eggshell fragments from the nest cup. At Churchill, Jehl (1979) flushed a male from the nest when one wet chick and a well-pipped egg remained. It was not stated on what basis the adult was sexed as a male (dowitchers cannot be sexed by plumage).

Young-Attending Period

The fledging period for Short-billed Dowitchers is approximately three to four weeks (Jehl and Smith 1970). The estimated point of fledging at Schefferville in 1980, based on presumed-male departure (see following section), was in the 15-17 July period. Recently fledged juveniles were first actually seen on 23 and 24 July. Using a 21-day fledging period, the date of fledging from the late 1978 (hatch 17 July) nest was no earlier than 7 August. Henri Ouellet and Raymond McNeil collected two recently fledged juveniles near Schefferville on 28 July 1958 (Todd 1963). The young had trouble flying and landed after a flight of 25 ft or less. Taverner and Sutton (1934) first saw recently fledged juvenile dowitchers on 20 July (not 20 June as obviously misprinted in their text) at Churchill, Manitoba.

No data are available on growth rates of young Short-billed Dowitchers. At Schefferville young were captured only at hatch and within a few days following hatch.

In the one case of known brood movement recorded at Schefferville, colour-banded adult 'B' from the 1980 nest (the male) was observed behaving as though with a brood approximately 1.2 km from

the nest site. Such seemingly long-distance movements are typical of shorebird broods (e.g. Ashkenazie and Safriel 1979a; Jehl 1973).

No direct predation of chicks was observed at Schefferville, although never more than two young were seen or heard in any brood. Shorebird chick mortality is generally reported to be highest in the first few days following hatch (e.g. Jehl 1973; Soikkeli 1967).

Direct and indirect evidence from both breeding and migration studies indicates that the male Short-billed Dowitcher cares for the brood. The female parent provides assistance only within the first days following hatch. Jehl (1963) discovered that adult female dowitchers comprised the bulk of the first of three waves (females, males, juveniles) of fall migrant dowitchers in New Jersey. Females left the nesting grounds first, soon after hatch. On the breeding grounds at Churchill, Manitoba, Jehl and Smith (1970) summarized that females take little part in caring for chicks; they gather in small flocks shortly after the chicks hatch and depart by mid July.

In most cases at Schefferville only one adult was observed with a brood, or behaving as though with a brood. In two cases these birds were collected and proved to be males. Less frequent cases of two, and once three adults together behaving as though with young did occur at Schefferville and other cases are mentioned in the literature (Bent 1962; Clement, in Todd 1963; Hurley 1932; Taverner and Sutton 1934). These records of more than one adult with a brood suggest that not just the male is with the young. In one case in 1980, the colour-banded male (adult 'B') from the 1980 nest joined an unbanded dowitcher that was therefore not its colour-banded mate, adult 'A'. Both together were very agitated about the observer. Soikkeli (1967) mentions group 'mobbing' of a similar nature in the Dunlin. What at first might appear to be one brood with two or more adults, is in actuality two or more broods with one adult each. Indications are that females do care for the brood briefly following hatch (Jehl and Smith 1970), during which period both sexes could be with the chicks. The female from the 1980 nest (adult 'A') was last observed on 26 June, three days following hatch. These explanations for sightings of more than one adult with a brood do not prove that all such adults were males. However, the collection of the two males with broods at Schefferville, the sighting of the 1980 nest male (adult 'B', sexed by measurements; see "Discussion - Sexing Adults 'A' and 'B', 1978 and 1980") behaving as though with a brood, and the findings of Jehl (1963) and Jehl and Smith (1970) indicate that males do the bulk of chick-rearing.

Semipalmated Sandpipers and Stilt Sandpipers are also male-brood species. In the Semipalmated Sandpiper, the female broods within the first week following hatch but for less than half the time of the male. She devotes most of her time to premigratory feeding (Ashkenazie and Safriel 1979a, b). Jehl (1973:131) states that in the Stilt Sandpiper, "It is extremely unusual to encounter both parents with chicks more than one week old. In late July 1965 I found two adults defending what appeared to be a single brood of well-grown chicks: when collected, however, both proved to be males."

Departure

It has been well-documented, both on the breeding grounds (Jehl and Smith 1970) and along migration routes (Jehl 1963; Pitelka 1950), that there is differential migration by age and sex in the Short-billed Dowitcher. Adult females depart the nesting areas soon after hatch, followed by the adult males some two to three weeks later. The adult males remain on the nesting grounds until the juveniles are fledged or nearly so. Juvenile dowitchers begin migration another two to three weeks after fledging; their migration is more protracted than that of the adults.

Fall departure of Short-billed Dowitchers from Schefferville is an even less noticeable event than spring arrival. Records indicate that adult female dowitchers depart Schefferville in late June and early July. The colour-banded female from the 1980 nest (adult 'A', sexed by measurements; see "Discussion - Sexing Adults 'A' and 'B', 1978 and 1980") was last seen on 26 June, three days following hatch. Adult female dowitchers have been collected at Schefferville as late as 3 and 6 July (Table 7). On 3 July 1972, an adult female was collected from one of several flocks of 10-15 dowitchers sighted that day (J.D. Rising, University of Toronto, pers. comm.). Birds in flocks increased in the 17-26 June 1980 period. Clement (in Todd 1963) reported sighting a flock of 14 dowitchers passing overhead on 22 June. It is postulated that these were flocks of post-breeding, premigratory or already migrating females.

Evidence suggests that most female dowitchers stage, or at least conduct their premigratory feeding away from the Schefferville area. If premigratory feeding is done at Schefferville it is not done in flocks. In 1980, groups of dowitchers were not observed feeding in the study plot during the departure period, but only flying over. The 1977 data are unclear, as are those of J.D. Rising (pers. comm.). Adult female dowitcher specimens had light fat (3 July 1972), moderate fat (6 July 1977),

and heavy fat (6 July 1972) (Table 7).

Adult male dowitchers depart Schefferville in mid to late July. Based on male brood care, adult male dowitchers departed the study plot sometime in the period 15-17 July in 1980. One flock of three dowitchers was seen flying overhead on 18 July 1980. The latest adult male record at Schefferville is one collected on 27 July 1958 (Table 7). These data are consistent with a male departure following care of the young to fledging. It appears that in 1980 the adult males may have left before the chicks were well fledged. Recently fledged juveniles were not seen until 23 July 1980. The apparently simultaneous departure of adult males from the study area in the 15-17 July period suggests synchrony in the timing of the nesting cycle in the local population or that adult males leave regardless of the stage of development of the young, as long as they are near fledging. Adult male dowitchers were not observed in premigratory feeding flocks in the study plot and those collected had little fat. Apparently adult males, as adult females, move elsewhere after nesting duties on the study plot are completed.

Juvenile dowitchers have been recorded at Schefferville as late as 15 August (specimens, Table 7) and elsewhere in interior Quebec-Labrador as late as 23 August (specimens; Todd 1963). Recently fledged juveniles have been recorded from 23 to 28 July. It is difficult to say when those young actually raised in the study plot in 1980 departed. The only obvious movement of dowitchers occurred on 10 August when flocks of four and six, and a daily total of 14 were sighted. The two flocks were both flying overhead, well above treetop level, giving the appearance of migrating flocks. Although none of these birds was collected, the date and the previous departure of adult males and females from the study plot suggest that these must be departing juveniles.

At Churchill, Manitoba Jehl and Smith (1970:43) summarize, "females...gather in small flocks soon after the chicks hatch, and by mid July nearly all have migrated. Males remain until the chicks are able to fly, usually about the third week of July, but all depart before the end of the month. Young birds begin migrating in early August and some are present into early September. The height of fall movement occurs in the second week of August."

The departure periods for adult females, adult males, and juveniles from Schefferville correspond well with fall arrival dates at migration sites on the Magdalen Islands (McNeil and Burton 1973) and in New Jersey (Jehl 1963). At Schefferville, adult females depart in late June and early July; the

latest record is a specimen collected on 6 July. In New Jersey, Jehl (1963: 253) found that adult females arrive in "a tremendous rush, usually about 10 July". Adult males depart Schefferville from mid to late July: in 1980, adult males departed the study plot sometime in the period 15-17 July; the latest adult male record at Schefferville is one collected 27 July. In New Jersey (Jehl 1963), adult males arrive in a second wave of migrating dowitchers, in late July or early August. On the Magdalen Islands in the Gulf of St. Lawrence, where males outnumber females during the whole migration period of adults, southbound dowitchers usually arrive about 14 July. Peak abundance of adults occurs between 20 July and 10 August (McNeil and Burton 1973). When juvenile dowitchers depart Schefferville is unclear. The departure appears to begin in the second week of August: in 1980, the only obvious movement of dowitchers, presumed juveniles, occurred on 10 August. On the Magdalen Islands, peak abundance of juveniles occurs 10-25 August (McNeil and Burton 1973). In New Jersey, juveniles form a third wave of migrant dowitchers, beginning in mid-August (Jehl 1973). Dowitchers arrived in the Magdalen Islands and New Jersey with little body fat.

Mating System

Short-billed Dowitchers appear to have a monogamous mating system. The primary evidence is that there is no emancipation of either sex from nesting duties. Polygamy is more prevalent in species where one sex is freed from parental care duties and thus has the time to acquire additional matings (Emlen and Oring 1977; Oring 1982). The female dowitcher is emancipated following hatch but apparently does not seek additional matings presumably because it is late in the season, food supplies are declining on migration areas (see next section), and few males are available because they are tending broods. Dowitchers are also not strongly sexually dimorphic -- females average 10% larger than males and plumages are alike (Pitelka 1950) -- strong sexual dimorphism often being a characteristic of polygamous species, but they do exhibit aerial chases during the courtship period. Chases are seen in some polygamous shorebirds, such as the Pectoral Sandpiper (Pitelka 1959). Such sexual behaviour would be expected to continue longer than it does at Schefferville, however, as additional matings are sought through the nesting season. Aerial chases, flight displays and localized song and displays occurred principally and most frequently in late May and early June.

TIMING OF THE NESTING SEASON

At Schefferville, the Short-billed Dowitcher nesting cycle, from arrival of adults to southbound departure by juveniles, takes approximately 12-13 weeks: third week May to mid August. Female parents are present for 6-6.5 weeks: third week May to late June/early July. Male parents are present for approximately eight weeks: third week May to mid July. How does the timing of this breeding season correlate with habitat and food availability, weather patterns and other factors?

To define the amount of time available to Short-billed Dowitchers for successful completion of their nesting cycle is difficult. It is perhaps ultimately linked to availability of a habitat that provides food and suitable ground for nesting sites. Dowitchers at Schefferville can withstand short periods of freezing temperatures and snowfall, as witnessed by their mid May arrival when such late winter/early spring weather does occur. Early nest construction and egg-laying can proceed under these conditions also. The nest discovered in 1978 before clutch completion was such an example: egg-laying took place 30 May to 3 June. If one therefore defines a period of suitable availability as the time from the first appearance of snowfree patches (nesting sites) to the first fall frosts, this is a period from early May to late August/early September (D. Barr, pers. comm.), or some 17 to 18 weeks. Year-to-year variations in the timing of spring melt and fall frosts will change the length of this period by a week or two. It is possible that Short-billed Dowitchers could physically manage to stay at Schefferville even longer, perhaps until the first snow cover or frozen ground in mid October (D. Barr, pers. comm.). Common Snipe are known to remain at Moosonee in northern Ontario into October (Tuck 1972:259-260). The point, though, is that potentially suitable conditions do exist at Schefferville for a period at least one month longer than Short-billed Dowitchers do in fact remain. The difference is greater still if one considers when male and moreso female parents depart.

Considering the purely physical restrictions of snow cover and temperature, Short-billed Dowitchers do not function under as brief an available breeding schedule as do arctic species. In some arctic-nesting species, non-breeding seasons occur because physical conditions prevent commencement of nesting until insufficient time remains for successful completion (Bertram et al. 1934; Bird and Bird 1940). The breeding cycle for that year is aborted.

It was found that hatch at the dowitcher nest corresponded in time with the hatch of many insects. In the third week of June 1980, there was the rather sudden appearance of plants in flower

and the emergence of multitudes of flying and surface-active adult insects. Adult insects were in abundance until my departure in mid August, and probably for several weeks longer, but were first in great numbers in late June. Previous to this time, these insects were in larval and pupal stages available only to the probing bills of the adult dowitchers. With the emergence of flying and surface-active adult insects, this food source became available to the downy young dowitchers, who are unable to probe and who, if like most shorebird young, are not fed by the adults. Both Baker and Baker (1973) and Holmes (1972) found that young shorebirds they were studying were dependent upon this food source. Holmes found that once fledged, the young Western Sandpipers *(Calidris mauri)* had a diet very similar to that of the adult shorebirds.

This qualitative assessment agrees with Lack's (1954) ideas that the breeding season of birds is timed so that the young are being raised when their food is most plentiful. The reproductive output of the parents is thus maximized. Although adult insects were in abundance into August, the third week of June was their first major appearance and that time may therefore be the earliest possible date for the young dowitchers to hatch and have sufficient suitable food resources available.

Some other studies of breeding shorebirds have also found that most nests hatched in coincidence with the first major emergence of adult insects (Holmes 1966, 1972; Nettleship 1973, 1974). In northeast Greenland, Green et al. (1977) did not discover a peak of food availability and concluded that sufficient food resources were probably available over a long period. Pitelka (1959) found that the main growth period of young Pectoral Sandpipers in Alaska occurred after the peak of overall food availability.

Several studies have revealed counteracting acting forces at either ends of the nesting cycle that may select against too early or too late an initiation. If dowitchers were to build their nests and begin egg-laying when only the first few snowfree patches were available, they would seemingly be very vulnerable to predators. Byrkjedal's (1980) field experiments resulted in more of his man-made nests being predated in mid May under conditions of small snowfree patches, than later in mid June. Although few avian and fewer mammalian predators were observed at Schefferville, they are undoubtedly present in numbers throughout enough of the dowitcher's range to be a selective factor.

Perrins (1970) presented evidence for several species showing that the time of egg-laying may be determined by the date at which the female is able to find enough food to form eggs. Laying is then

begun as soon as possible after that. One dowitcher nest was discovered during the egg-laying stage at Schefferville, on 30 May 1978. Clutch completion occurred on 3 June (four eggs). No data are available on the reproductive condition of arriving females.

Nest initiation at too early a date may be prevented by physical unavailability of suitable habitat. Green et al. (1977) observed the influence snow conditions and timing of spring thaw had upon the date of breeding of shorebirds in northeast Greenland. The time at which snow cleared and wader breeding commenced varied considerably between valleys. Breeding was delayed in valleys that cleared late. The first snowfree patches appear at Schefferville in the first two weeks of May, often as early as 1 May. These sites are in the wetlands where Short-billed Dowitchers nest. It would appear then that suitable habitat for nesting is available as much as two weeks in advance of the first arriving dowitchers. Other factors such as predation (Byrkjedal 1980) and the unpredictability and severity of early spring weather may make apparently suitable habitat less so. Yet dowitchers at Schefferville do withstand poor late May weather, for example while egg-laying in 1978.

More apparently surplus time is available at the end of the nesting cycle than the beginning. In mid June of 1978, an unusual blizzard caused one dowitcher nest and almost certainly many others to be deserted. A dowitcher nest found after the storm successfully hatched its full clutch of four eggs in mid July. Other broods were also observed in mid July, when young dowitchers normally would have been at or near fledging. Field studies ended before fledging success could be determined. It was noted that adult insects emerged in abundance soon after the end of the blizzard, several weeks before the mid July dowitcher hatch. Therefore, excess time at the end of the cycle permitted later nestings in which the hatch at least was successful.

Pitelka (1959) found that summer insect populations at Barrow, Alaska began to decline after mid July. Just prior to this, adult male Pectoral Sandpipers left the breeding areas. Pitelka hypothesized that this departure of what amounted to half the biomass of Pectoral Sandpiper consumers, at a time when insect food supplies were about to decline, was a strategy that left more food available for the young sandpipers. Declining food supplies on the breeding grounds may therefore select for an earlier departure than bad weather may.

Schneider and Harrington (1981) recently studied the aspect of seasonally declining food supplies for shorebirds at a fall migration stopover, rather than at the breeding site. They found substantial

reductions in prey densities during the fall migration period (July to September), that were due to shorebird predation. If these reductions are sufficient to affect future survival and reproductive success, they may then be a powerful selective force in determining the time of departure from the breeding grounds. Although weather conditions and perhaps even food supplies at the nesting site may themselves permit longer residence on the breeding grounds, dwindling food supplies at a migratory stopover may not.

There is some evidence to indicate that although timing of the nesting season in Short-billed Dowitchers at Schefferville may be ultimately determined by availability of food for the young, that is surface-active insects, additional selective pressures on the adults may finely tune this timing. In 1978, hatch at one dowitcher nest occurred after the mid June blizzard and long after the first emergence of adult, surface-active insects. Young dowitchers were found up to one week after the hatch, indicating that survival to this stage at least was successful. Difficulties in locating young dowitchers after this age, and the fact that 1978 field studies culminated before fledging occurred, meant that data on fledging success were not obtained. However, food resources were sufficient to ensure survival to age one week, despite hatch not being coincident with the first major emergence of adult insects. Perhaps there is enough food for the young dowitchers over a long period of time, as Green et al. (1977) suggested. As long as the hatch occurs with or within several weeks after the first major emergence of adult insects, then there is sufficient food for the young dowitchers.

Adult dowitchers, however, feed primarily on larval and pupal forms (Baker 1977) which they are capable of probing for. They are faced with a declining food supply as adult insects emerge. At this point then, selective pressure is on the adult dowitchers to complete their roles and depart. The departure of one sex (adult females) before the other results in less competition for a declining food resource while still providing care for the young. While Pitelka (1959) contended that early departure from the breeding grounds by one sex leaves more food for the young shorebirds, it may be that it in fact leaves more food for the remaining parent. Diets of young and adult shorebirds apparently are not similar until after fledging (Holmes 1972).

If adult dowitchers fed on emerging insects, or young dowitchers probed for food, this would negate the above argument. Adults would then be competing with young dowitchers for the same surface-active food source and would not be restricted to a declining food supply of larval and pupal

forms. Young dowitchers would be subject to the same selective pressure to depart early that exists for the adults. The data are not available from Schefferville, but other studies indicate that this is not the case. At Churchill, Baker (1977) observed that although adult dowitchers could and did feed on surface-active food, they fed primarily on larval and pupal forms. Also, if young dowitchers are like other young shorebirds which have been studied (Holmes 1972), their diets are not similar to adult diets until after fledging.

To summarize, timing of hatch can fall within a period of several weeks beginning with and following, but not before, the first major emergence of adult insects and be successful. However, selection is forcing the parents to time hatch as early as possible within this period, and to complete their respective duties as soon as possible, as their food supplies on the breeding grounds and at migration stopovers decline.

CONCLUSIONS

My observations of flocking and early season behaviour, in conjunction with regular censusing, lead me to conclude that Short-billed Dowitchers arrive in the Schefferville area from the third week of May into the first several days of June. This coincides in general with the spring thaw and more specifically with the disappearance of snow in wetland habitats. Based on data from two springs, arrival of dowitchers in the Schefferville area coincides with the early availability of suitable nesting habitat, i.e. wetlands. Their arrival is not coincident with the first appearance of snowfree patches in the wetlands, but occurs as much as two weeks later. Most sightings of dowitchers in the arrival period were of single birds or groups of two or three; only infrequently were dowitchers seen in larger flocks. It is postulated that this is because the birds are dispersing as they move northwards and near their nesting areas. My data indicate that Short-billed Dowitchers arrive only in the late May/early June period, although it becomes more difficult to detect newly arriving birds as the season progresses. Some other shorebirds are known to arrive in several separate waves. The data are few but lead me to suggest that both sexes arrive on the nesting grounds at approximately the same time, but it is unclear whether they arrive as mated pairs or not.

Courtship activities were observed in the last ten days of May and the first week of June, indicating overlap in timing with the end of migration and the beginning of local incubation. A delay of three days in commencement of courtship activities following first arrivals is postulated as the first three days of arrivals being either transients or experienced local pairs exhibiting little or no courtship. On the basis of one nest found during egg-laying and the backdating from hatch dates of other nests, most egg-laying in the Schefferville area occurs in the last few days of May and the first few of June. This is approximately 1.5 weeks following first arrivals and agrees with general findings that species nesting in high latitude, relatively short breeding seasons do not delay commencement of nesting activities. Clutch size ranges from three to five eggs but is typically four, as is found in almost all shorebirds.

My data indicate that the primary function of song in Short-billed Dowitchers is related to courtship, pairing, and pair maintenance. Song and related behaviour - display flights and aerial chases

appear not to have a territorial function but are also given in 'greeting' contexts (incubation changeovers) and as displacement activities in alarm/disturbance situations. Song given in conjunction with display flights appears to be used to communicate over large areas to contact receptive dowitchers of the opposite sex, probably males trying to contact females although the data are inconclusive regarding the sexes involved. This is the first detailed description and investigation of the function of the song of the Short-billed Dowitcher. The song appears to function similarly to the songs of other shorebirds with the exception that it was not observed in obviously agonistic contexts.

Observations show that incubation, by both sexes, is essentially continuous, beginning near or with the laying of the last egg. Little if any incubation occurs during the egg-laying period. This is typical of species with precocial nidifugous young that benefit from a synchronous hatch, which the simultaneous commencement of incubation with the laying of the last egg facilitates. My data indicate that incubation shifts are long and changeovers are timed irregularly throughout the daylight hours and at dusk. No consistent timetable was observed for each sex although the data suggest that most daytime incubation is done by the male and most night time incubation by the female, as is found in some other shorebirds. Maintenance activities (feeding, preening, resting) are conducted away from the nest area apparently in communally-used wetland sites; the nest area may be used for feeding during egg-laying but it is not patrolled during incubation. The prolonged incubation shifts, low frequency and irregular timing of changeovers, and restriction of feeding, resting and preening activities to areas away from the nest-site make nests very difficult to find. The high percentage attentiveness at the nest has also been found in other shorebird species where both sexes share incubation duties.

Hatch usually occurs in the third week of June at Schefferville, although it can occur as late as mid July when there is a disruption of the normal schedule due to severe weather. This is approximately 1.5-2 weeks earlier than at Churchill, Manitoba. Hatching success was high, as was also found at Churchill. Both sexes incubate and brood at this stage, as they did throughout incubation.

Observations show that the fledging period lasts about four weeks, from the third week of June to the last half of July. The data indicate that males care for the brood; females may provide some care within the first few days following hatch. Broods move away from the nest area following

hatch, as is common in many shorebirds. Males with broods often join together to mob intruders. These findings are in agreement with observations at Churchill, Manitoba.

At Schefferville, the data indicate that there is differential departure from the nesting grounds by age and sex: adult females leave soon after hatch, in late June and early July; adult males leave about when the young fledge, in mid July; juveniles begin migrating some two to three weeks after adult male departure. This supports findings at Churchill and during migration. Both adult males and females apparently conducted premigratory feeding outside the study plot.

My data indicate that Short-billed Dowitchers have a monogamous mating system: (a) neither sex is emancipated from nesting duties and neither therefore has the time to seek additional matings, at least to a large degree, (b) dowitchers are not strongly sexually dimorphic -- females average 10% larger and plumages are alike, and (c) sexual behaviour occurs over a relatively brief period early in the nesting season and is not continued into later stages. The Short-billed Dowitcher is similar to most species of sandpipers in being monogamous with shared parental care. Differential departure of one sex, in this case the female, is also common.

Other studies of shorebirds have indicated that the advantage of having hatch occur when surface-active prey are available for the young is the ultimate factor determining the timing of the nesting cycle. Additional selective pressure on nesting shorebirds -- declining food resources on the nesting grounds and on migration areas -- force them to time hatch to occur as early as possible in this period of availability of surface-active prey. The sex that departs first is the one most stressed. Although these conclusions cannot be made from my data, the Schefferville observations also suggest these explanations.

The primary significance of this thesis lies in it being the first description of many of the basic aspects of the breeding biology of a poorly known shorebird. The conclusions reached based on my data are consistent with the few data available previously, and do not reveal that the Short-billed Dowitcher is unique with respect to general features of shorebird nesting biology.

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