Seasonal abundance of fish in Delta Marsh

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Introduction

Delta Marsh is a 21,870 ha freshwater marsh located on the south shore of Lake Manitoba. It is a valuable habitat for many species of fish during the ice-free seasons, during which time it is used for spawning, rearing young-of-the-year, and foraging. It is useful to know the seasonal patterns of use of the marsh by various species over time and space if we are to be able to have an understanding of the marsh community as a whole.

This study has attempted to quantify the temporal and spatial patterns of distribution and abundance of several fish species in the marsh during May to August, 1995. We have duplicated in part a study done by Schneider (1983) in order to assess the extent of change in the use of the marsh by fish after more than a decade. Schneider chose the Blind Channel as a representative portion of the marsh for her study, which we also used to keep the study sites consistent.

Methods

Fish distribution within Delta Marsh was monitored by using minnow traps at various sites (Fig. 1), mainly in Blind Channel (BC), which approximated the same sites used by Schneider (1983). Site 1 was located off the Portage Country Club (PCC) dock, site 2 was located at Fisherman's Shack, site 3 was at the north-east end of Blind Channel (i.e., just west of the Assiniboine River Diversion road), site 4 was in Blind Channel north-east of the cut to Forster's Bay, and site 6 was off the winter road in a small pond that must have been connected to the channel in early spring during the highest water levels. The "Pool" was an unenclosed area, into which fish could freely swim, surrounded by ten enclosures that formed the basis of another experiment (Goldsborough and Hann 1996). The enclosures were located approximately 75 m from the west end of the canoe ditch in Blind Channel.

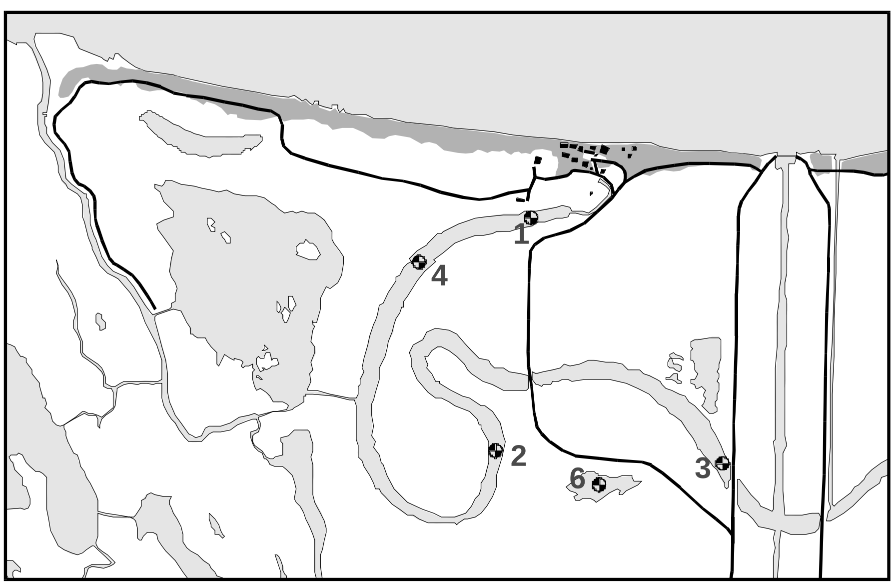

Figure 1. Map of the area surrounding the University Field Station (Delta Marsh) where fish survey stations 1, 2, 3, 4, and 6 were established in 1995.

Transects were established at sites 1,2, and 4. Each transect was composed of three stations: station A at the *Typha*-water interface, station B ten meters offshore, and station C twenty meters offshore (approximately mid-channel). At each station, two minnow traps were attached to a 3 m length of rebar pushed into the substrate. One minnow trap was suspended from a float at approximately 10 cm below the water surface, and the second at approximately sixty cm, which in most cases placed the trap near the sediment-water interface. Site 3 consisted of station A only (top and bottom traps), which was accessible by chest waders. Site 6 also consisted of station A only. Because the water was very shallow at all times at this site, a single minnow trap was located approximately 10 cm below the water surface. The Pool contained two minnow traps, one in the south-east corner and the other in the north-west corner, located 20 cm below the water surface.

These traps were set for 24-hour periods, subdivided into two daytime and two nighttime catches per week, from 29 May 1995 until 14 July 1995. From that time until 25 August 1995, the traps were set for one 24-hour period, separated into one daytime and one nighttime catch, per week. Minnow traps were set for an average of ten hours for a daytime set, and for an average of fourteen hours for a nighttime set throughout the season. Fish were identified to species (Scott 1967; Scott and Crossman 1968) and counted. The mean number of fish caught per trap per site was calculated by adding together the total number caught in each trap at a particular site over the 24-hour period, and dividing by the number of traps at that site.

Water temperature and dissolved oxygen were measured using a YSI (Model 51B) Dissolved Oxygen Meter at each station of sites 1, 2, and 4 each time the traps were set/retrieved. A reading was taken at ten cm below the water surface and another at fifty cm below surface. Once a week, water samples were collected from Station B of Sites 1, 2, and 4, and analyzed for turbidity using a Hach turbidimeter (Model 2100).

Mean water temperatures at sites 1, 2, and 4 in BC were calculated by averaging temperatures at 10 cm and 50 cm, at all three locations along the transects over all three sites. Morning and evening temperature data were averaged separately. Temperature data from 1983 were similarly averaged from sites 1, 2, and 4 for both morning and evening temperature readings.

Variation in fish community composition at each site over the season for both 1983 and 1995 was examined by correspondence analysis using SYNTAX 5.0 (Podani 1994). CA-ordination data are presented as a biplot of species abundances over time.

Results

Table 1 lists the nine species of fish that were caught in the minnow traps over the summer. The total number of fish present at each of the five sites (i.e., 1-4, 6) peaked in mid to late June, and dropped off to relatively low numbers by the third week of July (Fig. 2). Site 6 was the only exception to this generalization, as the number of fish caught remained relatively high until the last week in July. Numbers of fish remained very low through August at all sites, except at site 2, which showed an increase due to large numbers of bullheads.

The fathead minnow, *Pimephales promelas*, was by far the most abundant of all species, caught in very high numbers until late June, but by late July numbers had decreased greatly and remained low throughout August. Yellow perch (*Perca flavescens*) were present all summer, as were five-spined sticklebacks (*Culaea inconstans*). Nine-spined sticklebacks (*Pungitius pungitius*) were present in fairly low numbers in early June, but had completely disappeared from all sites by July. Some spot-tailed shiners (*Notropis hudsonius*) were found until mid June, then they too disappeared. Juvenile white suckers (*Catostomus commersoni*), carp (*Cyprinus carpio*), and bullheads (*Ictalurus* spp.) appeared in August at all sites except 6, bullheads found in the greatest number of the three. Both black bullheads (*Ictalurus nebulasus*) and brown bullheads (*I. melas*) were present in traps but were not differentiated in counts.

Table 1. Fish Species Caught in Delta Marsh, 1995

Species	Sites
Pimephales promelas (FH - fathead minnow)	all
Culaea inconstans (5S - five-spined stickleback)	all
Pungittius pungittius (9S - nine-spined stickleback)	all
Perca flavescens (YP - yellow perch)	all
Notropis hudsonias (SS - spot-tailed shiner)	1, 2, 4
Catostomus commersoni (WS - white sucker)	1, 2, 3, 4, Pool
Cyprinus carpio (carp)	1, 2, 3, 4, Pool
Ictalurus melas, I. nebulasus (BH - brown and black bullheads)	1, 2, 3, 4, Pool
Etheostoma exile (Iowa darter)	2

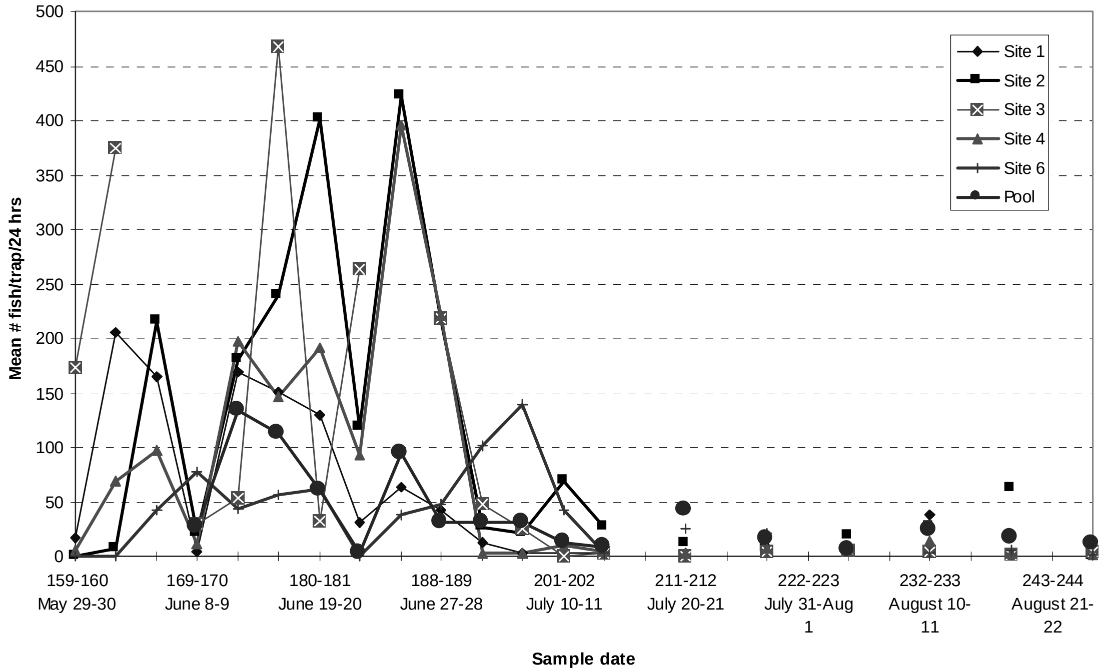

Figure 2. Total fish caught (mean per trap over 24 hour period) at each of the six sites over the sampling period in 1995.

Total nighttime catch for each site almost always exceeded total daytime catch, and the few exceptions to this generally occurred in August, when the total 24-hour catch was typically minimal. Total numbers in the top traps of sites 1, 2, and 4 exceeded the total caught in the bottom traps until early July, when numbers began to drop off. After this point, the reverse was true; the bottom catches were generally greater in number than were the top catches. There was no consistent pattern of fish distribution with distance from the *Typha*-water interface for any site or over time.

Site Specific Results

Site 1. The fathead minnow was the dominant species, present in extremely large numbers throughout June. The peak mean number occurred on 1-2 June, when 201 fish per trap per 24 hours were caught. The five-spined stickleback was the only other species to reach a significant number, with a definite peak mean value of 61 fish per trap per 24 hours on 26-27 June. Other species found at this site included spot-tailed shiners, nine-spined sticklebacks, yellow perch, carp, white suckers, and bullheads (Fig. 3).

Site 2. Fathead minnows were present in extremely large numbers throughout June, with a peak mean number of 420 fatheads per trap per 24 hours occurring on 26-27 June. Bullheads were trapped beginning in the last week of July, and increased into August to 61 bullheads per trap per 24 hours on 17-18 August. Other species present were spot-tailed shiners, nine-spined and five-spined sticklebacks, yellow perch, white suckers, carp, and Iowa darters (Fig. 4).

The number of fish caught at station C (i.e. mid-channel) was typically greater than that caught at A or B throughout June. In August, the greatest number of fish was caught generally at station A.

Site 3. Fathead minnows reached their peak numbers (464 per trap per 24 hours) on 15-16 June, and declined to almost zero by 13-14 July. No other fish were present in large numbers, however, nine-spined and five-spined sticklebacks, yellow perch, white suckers, carp, and bullheads were all trapped at some time during the summer (Fig. 5).

Site 4. Fathead minnows peaked at 373 per trap per 24 hours on 26-27 June, and declined to very low numbers by mid-July. Yellow perch were present throughout the summer, with a peak of 23 per trap per 24 hours on 26-27 June. Other species found at this site were spot-tailed shiners, nine-spined and five-spined sticklebacks, white suckers, carp, and bullheads (Fig. 6).

The total number of all species caught at station A was greater than that of B or C throughout the summer, with a few exceptions.

Site 6. Fathead minnows were present in the highest numbers of all species at this site, reaching a peak of 135 per trap per 24 hours on 6-7 July. Nine-spined sticklebacks reached a peak of 33 per trap per 24 hours on 12-13 June, but none were trapped in July. Five-

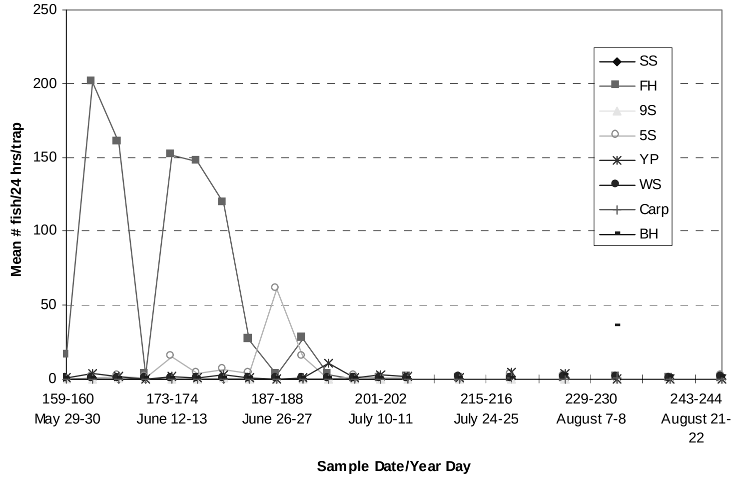

Figure 3. Fish species caught at site 1 over the sampling period in 1995. See Table 1 for species name codes.

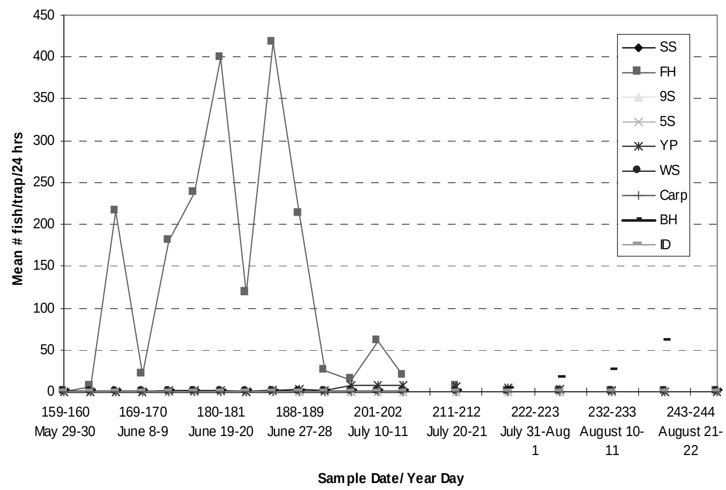

Figure 4. Fish species caught at site 2 over the sampling period in 1995. See Table 1 for species name codes.

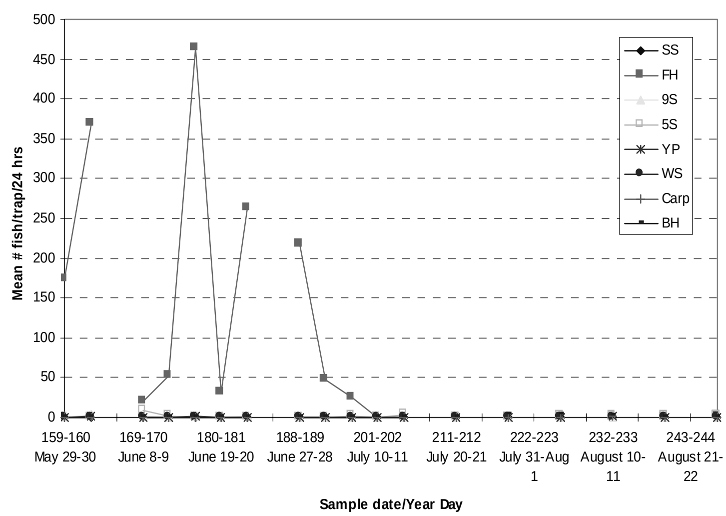

Figure 5. Fish species caught at site 3 over the sampling period in 1995. See Table 1 for species name codes.

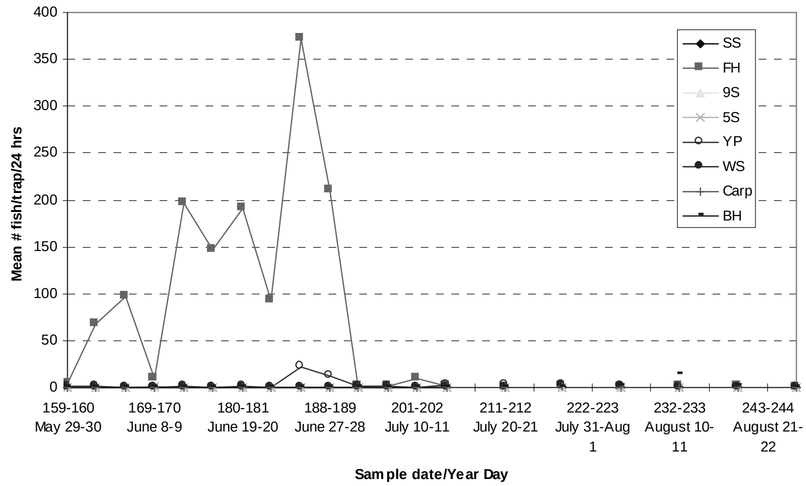

Figure 6. Fish species caught at site 4 over the sampling period in 1995. See Table 1 for species name codes.

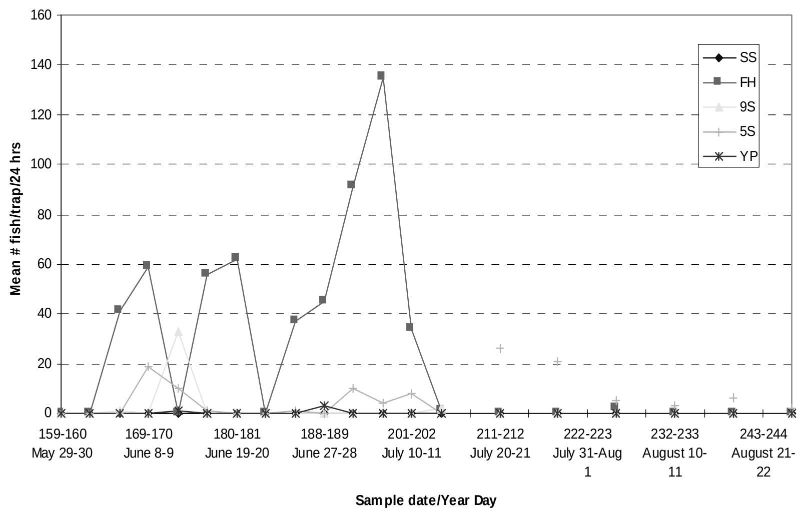

Figure 7. Fish species caught at site 6 over the sampling period in 1995. See Table 1 for species name codes.

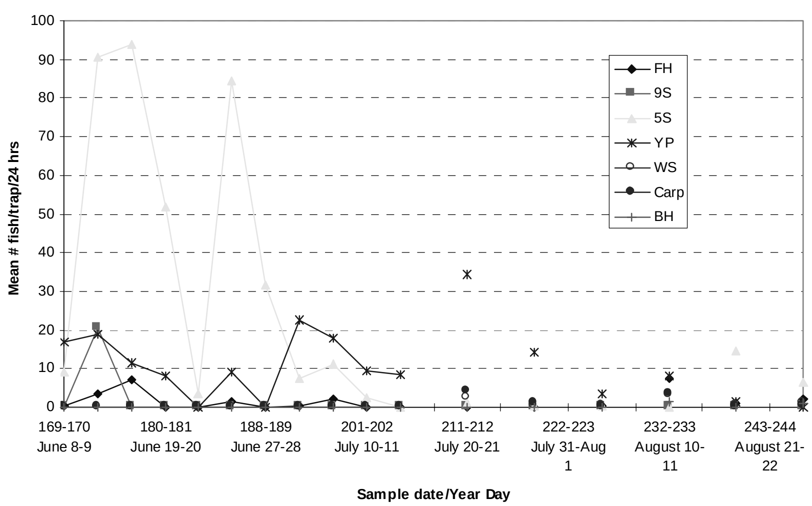

Figure 8. Fish species caught at the Pool over the sampling period in 1995. See Table 1 for species name codes.

spined sticklebacks were present throughout the summer at reasonable numbers, the highest being 26 per trap per 24 hours on 20-21 July. Yellow perch were also found at this site occasionally (Fig. 7).

Pool. The Pool showed a similar pattern of abundace to the other sites (i.e. relatively high numbers of fish caught in June and July, followed by low numbers in August). The dominant species, however, was the five-spined stickleback, which peaked at 94 per trap per 24 hours on 15-16 June. Few fathead minnows were caught over any one 24-hour period. Yellow perch were present throughout the summer, with a peak of 35 per trap per 24 hours on 20-21 July. Nine-spined sticklebacks, white suckers, carp, and bullheads were all caught over the course of the summer (Fig. 8).

Fish Community Composition

In 1995, fish communities at sites 1-4 showed very similar patterns so a summary pattern representing pooled abundances across all sites is shown in Fig. 9. An early summer community consisted of fathead minnows, five- and ninespined sticklebacks, and spottail shiners and was prevalent during June and early July. During the mid-summer period, abundances of all fish species were depressed generally. A late summer fish community comprised of yellow perch, bullheads, carp, and white suckers appeared dominant throughout August.

In 1983, the spring and early summer fish communities were similar except for generally lower abundance in and higher abundance in June and early July. The fish community in August 1983 was reduced to bullheads only (Fig. 10).

Environmental Variables

Turbidity was considerably higher at all sites in BC (1,2, and 4) than in the pool, the control enclosures and in Crescent Pond throughout the season (Fig. 11). The one noticeably elevated turbidity reading in early August in BC1 was mirrored in the pool. These two sites are in close proximity to each other, suggesting a local cause.

Throughout the season, evening water temperatures were consistently higher than morning temperatures (Fig. 12). Seasonal patterns were very similar to those recorded in 1983 (Schneider 1983). In 1983, however, sampling began in early May, and cooler early season water temperatures were recorded.

Discussion

The temporal pattern of fish abundance in the marsh reflects several aspects of the biology of the dominant species, and their use of the marsh as a seasonal habitat. Fathead minnows, nine-spined and five-spined sticklebacks entered the marsh in early spring (May) to spawn. Numbers of nine-spined sticklebacks had declined by June, but fatheads, five-spined sticklebacks and yellow perch abundance persisted at near maximum levels into early July. In Delta Marsh, fatheads represented a substantial proportion of the total fish abundance during this period. The sudden drop in numbers of fish in early July appeared largely due to a decrease in fathead minnows. Price *et al.* (1991) point out that post-spawning mortality in fathead minnows is very high, especially for males. Sex of the fish was not recorded in our study; however, a decline in numbers

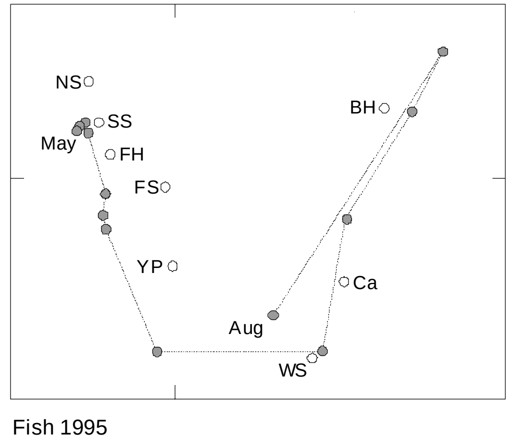

Figure 9. Correspondence analysis of fish abundance data for 1995. Sampling dates are indicated by solid circles linked to show the time series from the beginning of sampling in May to the end in August. Fish species are indicated by open circles and species names are indicated by codes from Table 1.

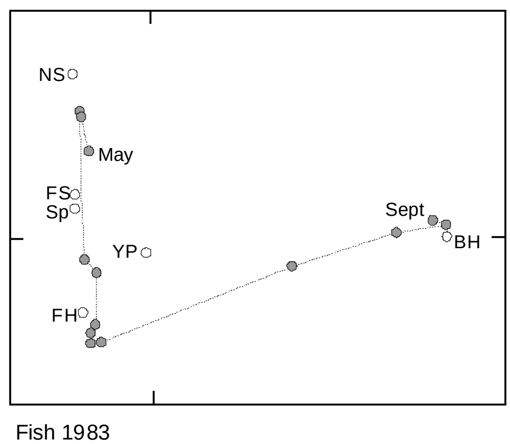

Figure 10. Correspondence analysis of fish abundance data for 1983. Other details are as indicated in Figure 9. Data for 1983 are from Schneider (1983).

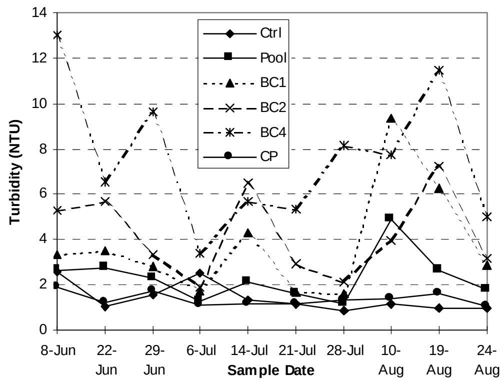

Figure 11. Turbidity data for 1995 at all sampling sites from June to August.

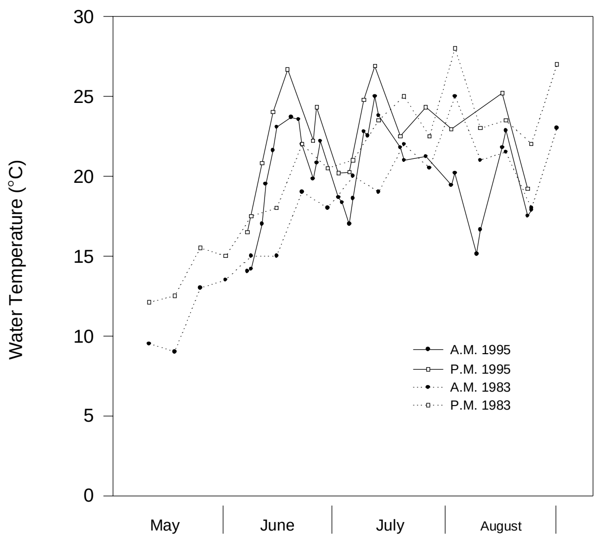

Figure 12. Mean water temperatures (ºC) in morning and evening in 1995 and 1983. Data for 1983 are from Schneider (unpubl.).

of fatheads with prominent tubercles and dark head coloration, defining characteristics of male fatheads, was observed but not quantified.

Fathead minnows, nine-spined sticklebacks, and five-spined stickleback numbers remained low through the rest of the summer. Fry of these species have been reported to emigrate from the marsh (into Lake Manitoba) in August, a possible explanation for the low numbers caught at that time (Schneider 1983). Also, fry of these species were too small to catch with minnow traps during August.

Fathead minnow adults, males and females, have been shown to be more active at night than during the day (Price *et al.* 1991), as have bullhead species (Scott and Crossman 1973). This behaviour partly explains the consistently higher nighttime catches in comparison with daytime catches. Another contributing factor is that the duration of the overnight set was invariably several hours longer than that of the daytime set.

The top traps caught higher mean numbers of fish than the bottom traps during June due to a number of factors. The water levels in June were abnormally high and, combined with the high turbidity levels in the channel, would have resulted in the phytoplankton concentrating in the upper water column where there likely was good light penetration. As a result, the zooplankton which feed on phytoplankton, as well as the fish species that feed on the zooplankton, would primarily be found in the upper water column. Fathead minnows are one such species, and have been shown to feed primarily on cladocerans (Held and Peterka 1974). In contrast, the number of fish caught in the bottom traps of sites 1, 2, and 4 generally exceeded the number caught in the top traps beginning in mid-July. This trend coincides with the appearance of bullhead and carp species, both benthivores which tend to swim and feed near the substratum (Scott and Crossman 1973).

The Pool was dominated by five-spined sticklebacks in June and July. This is peculiar because site 1, which was only 30 m away from the enclosures, was dominated exclusively by fathead minnows in June. This difference is probably because the Pool was surrounded by the plastic curtains of the enclosures, resulting in a habitat with lower and more extensive macrophyte development than in Blind Channel. Five-spined sticklebacks prefer clear water with dense vegetation (Scott and Crossman 1973).

Temporal patterns of species occurrence at the sites studied in 1995 correlated well with the patterns found in 1983. Numbers of fish trapped in both years were generally high during June and early July, with most sites demonstrating very low numbers by late July, then an increase again in August at some sites. This increase was due to the bullhead, carp, and white sucker fry that had reached a size large enough to be trapped. The August increase was observed in both years, especially at site 2, due to bullhead young of the year. In 1983, site 4 also showed this increase of bullheads, but in far greater numbers than site 2. This pattern did not occur at site 4 in 1995, possibly because of different placements of the minnow traps. In 1983, site 4 was probably located just outside the cut to Forster's Bay (used as a route for fish to enter and leave the marsh), as indicated by Schneider (1983), whereas in 1995, "site 4" was 100 m farther along the channel from the cut.

Abundance of fish varied quite substantially between the two years at most sites. At both site 1 and 2, considerably higher mean numbers of fish were caught in 1995 than in 1983, although fathead minnows were the dominant species in both years. Sites 3 and 4 in 1995 showed a similar level of fish abundance to 1983, with fatheads again being the dominant species in both sites in both years. Site 6 shows the most variation in terms of species composition. In 1983 the dominant species was five-spined sticklebacks, and almost no fathead minnows were found at this site. In 1995, however, fatheads were found in the greatest numbers until late July, with five-spined sticklebacks present in minor numbers throughout the season. This could possibly be explained by several reasons. The actual location of site 6 in 1983 could not be accurately determined from Schneider (1983), resulting in an educated guess in 1995 as to the placement of the site. If the sites used in 1983 and 1995 were indeed different, this might explain the discrepancies in species composition. However, if site 6 was in the same location both years, other factors may play a role. Site 6 was in a pond that was probably flooded due to the extremely high water levels throughout the entire marsh in the spring of 1995, probably resulting in an influx of fish at that time. The predominant fish species in Blind Channel at the time the pond flooded were fathead minnows and five-spined sticklebacks.

In summary, Delta Marsh, in particular the Blind Channel, is used by several species of fish (fathead minnows, five-spined sticklebacks, yellow perch) for spawning and nursery grounds, as well as foraging. The studies in both 1995 and 1983 revealed very similar seasonal fish assemblages. There is a late spring-early summer assemblage, a mid-summer period of low fish abundance generally, and a late summer assemblage. The high number of adult fathead minnows and carp present in early summer indicates that the marsh is indeed used for spawning activities, and the moderate number of juvenile carp, bullheads, and white suckers present in late summer confirms the importance of the marsh as a protected area for rearing young-of-the-year fish of several species.

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