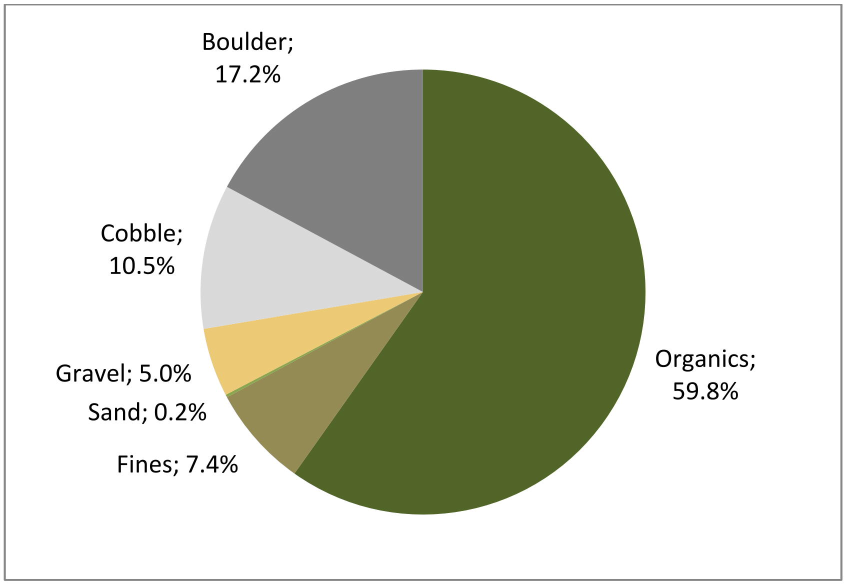

Figure 7-8: Composition of Substrates in Peninsula Ponds

With regard to fish habitat, aquatic vegetation was the most common (42.8%) cover type available in ponds followed by overhanging edge (26.2%) and boulders (20.1%) (Figure 7-9). Aquatic vegetation was common along pond margins and was more prevalent during early summer when water levels were higher because of recent snow and ice melt. Overhanging edge material resulted from eroding tundra vegetation along pond margins. Both aquatic vegetation and overhanging edge served as excellent cover for small forage species such and Ninespine Stickleback. Boulders, while present, did not contribute substantially to available fish habitat. Depth and turbidity (5.2%) and over-hanging vegetation (5.7%) provided only small amounts of cover. These small contributions resulted directly from the shallow nature of the ponds and the lack of vegetation in the area. Where over-hanging vegetation was encountered, it was typically along flooded pond margins in early summer.

Despite being located in the same area, habitat quality for fish varied between ponds; for example, Pond H20 is a large (9.5 ha), relatively deep (maximum depth of 1.6 m) pond with high quality habitat for both forage and seasonal sport fish use. Pond H02, however, is substantially smaller (0.06 ha), shallower (maximum depth of 0.25 m) and contains poor fish habitat.

Good quality habitat was limited and suitable mainly for rearing and spawning by forage species, particularily Ninespine Stickleback. Spawning potential for Arctic Grayling was limited by the lack of suitable coarse substrates. Overwintering by fish in the basin is not possible because the ponds freeze to bottom during winter. Pond H17 is suspected to be the deepest; although a bathymetric survey has not been performed, the maximum depth likely does not exceed 2.0 m. Movement within ponds was unimpeded; however, movement between ponds appeared possible only during periods of increased flow (e.g., spring freshet and/or precipitation events). Given the propensity of the ponds to winterkill, they offer only seasonal habitat (when accessible) and there is no potential to support fish on an annual basis.

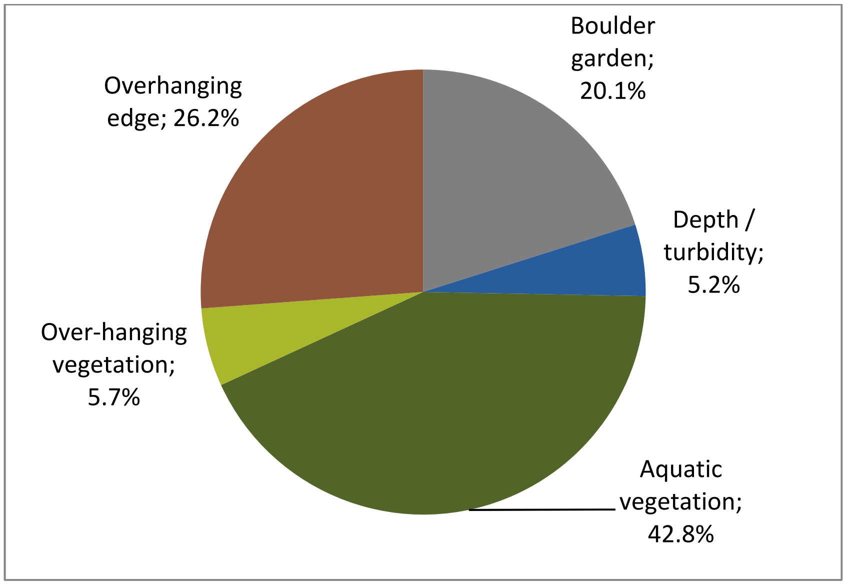

Figure 7-9: Composition of Cover Available for Fish in Peninsula Basin Ponds

7.5 Water Temperature Monitoring

Water temperature was monitored at several streams and lakes during 1997 to 2000 to provide a comparative database of seasonal changes and daily temperature fluctuations within a wide range of waterbodies. Data were collected continuously during the open-water seasons allowing for comparison between waterbodies and description of seasonal trends. Temperature monitoring was also used to assess ice thickness in the narrows between east and central basins of Meliadine Lake, and hence evaluate the connectivity of the 2 basins during winter. Daily mean water temperature data are provided in Appendices D9 to D12. The results are discussed separately for each monitoring year, with a multi-year comparison provided in the concluding section.

1997

Upon inspection of the downloaded data, it was discovered that only one (Stream B1-2) of 13 tempertaure loggers deployed in 1997 functioned properly. The temperature logger in Stream B1-2 provided a continuous water temperature record between 12 July and 1 September 1997. Water flows during this period were low (0.018 m^3/s on 19 July), but the temperature logger remained submerged during the entire period. A summary of mean daily water temperatures is provided in Appendix D9. Water temperatures ranged between 3.5°C (1 September) and 21.4°C (27 July); average water temperature over the monitored period was 12.8°C. The diurnal fluctuations in temperature ranged from 1.8 to 11.8°C, with an average difference of 5.6°C between daily minimum and maximum temperatures. The period of greatest daily fluctuations in temperature occurred between 13 and 16 August, when the magnitude of changes ranged from 10.0 to 11.8°C. This period also corresponded to dramatic changes in air temperature, with values as low as 1.6°C and as high as 22.2°C over the four-day duration.

In terms of weekly or monthly trends, average daily water temperatures in excess of 15°C were recorded during the second half of July. By early to mid-August, the average daily water temperature had decreased by approximately 7°C and the highest daily mean was only 13.6°C. From mid-August until the end of the study period, average daily temperatures exhibited less variation and were largely stabilized between 10 and 14°C.

This slight increase in average temperature also corresponded to a period of increased air temperature during the third week of August.

The results suggested that the large daily fluctuations in water temperature that occurred in Stream B1-2 were likely typical of other small streams in the study area. They also indicated that the water temperature was closely related to the air temperature and sudden changes in air temperature resulted in almost immediate corresponding changes in water temperature. This close relationship between air and water temperature was largely due to the shallow nature of the stream which permitted rapid warming or cooling over a short period of time.

1998

Temperature data recorded by the paired loggers deployed in the narrows between east and central basins of Meliadine Lake (Figure 7-10; Appendix D12) were nearly identical during the early part of winter (until mid-January) and early spring (after mid May). The sudden decrease in temperature recorded on 18 January by the logger pair deployed at the shallower depth indicated that the ice thickness had reached 0.8 m. From that date until 15 May (approximately 4 months) these temperature loggers were frozen in ice. The ice temperature was less than -4.9°C (the lower limit of the temperature loggers' temperature range) between 1 February and 28 April 1998. The temperatures recorded by the pair of temperature loggers set in the deepest area within the narrows (1.5 m deep) remained above 0°C until early April, but then dropped below freezing (minimum of 1.0°C) until mid May. These results suggested that the narrows area was frozen to the bottom for at least one month during late winter and thus created a temporary barrier to water movement between the east basin and the remainder of Meliadine Lake.

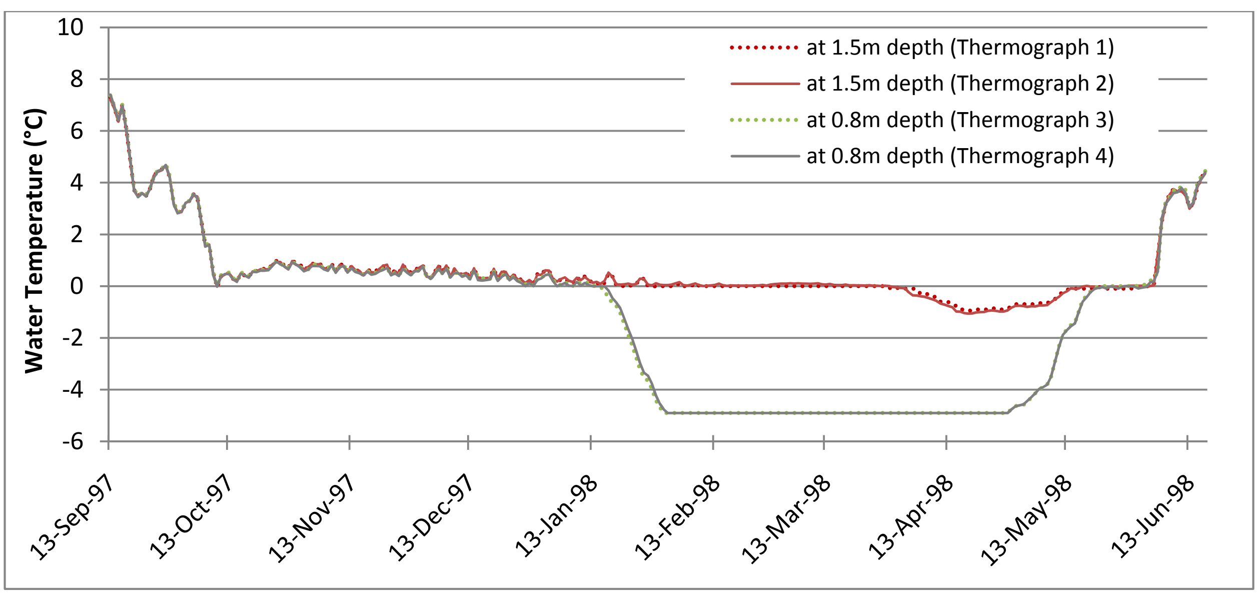

Figure 7-10: Mean Daily Water Temperatures at 1.5 and 0.8 m depth in the Narrows between the East and Central Basins of Meliadine Lake, September 1997 to June 1998

The second objective of the water temperature program in 1998 was to continuously monitor surface water temperatures in selected streams and lakes in the study area (Table 7-6, Appendices D9 and D10). Water temperatures in sampled streams ranged from 0.2 to 21.4°C during the open water period. In general, the smaller systems exhibited higher mean monthly temperatures during the warming period (June and July) and lower mean monthly temperatures during the cooling period (August and September). The difference between the small and large systems usually exceeded 3 Celsius degrees. Smaller streams also experienced a greater range in water temperature during the open water period, which was reflected by higher mean daily fluctuations for each month. This was most apparent in June and July when mean daily fluctuations were as high as 6.4 Celsius degrees in the small streams compared to 5.5 Celsius degrees in the Meliadine River.

Mean daily water temperatures at individual sites in the 3 smaller streams (A0-1, B1-2, and B4-5) exhibited similar seasonal patterns. Each stream warmed rapidly in spring (late June), peaked in late July, and then gradually cooled to the end of September. Distinct fluctuations in temperature were also apparent. Warmest mean daily temperatures (17.7 to 18.3°C) were recorded on 31 July, whereas dramatic decreases in temperature occurred on 15 July and 20 August. Differences were also noted between the small streams. Stream A0-1 warmed much more rapidly in spring than Streams B1-2 and B4-5. A comparison of the mean monthly temperatures for these streams also reflected this pattern. Stream A0-1 achieved a higher mean temperature in June, was slightly warmer in July, and exhibited slightly lower mean monthly temperatures during August and September (Table 7-6).

Stream A0-1 also experienced more extreme daily fluctuations in temperature than did the 2 other watercourses. These results likely reflected the smaller size of Stream A0-1 relative to Streams B1-2 and B4-5, which could make the system more sensitive to shifts in air temperature.

Table 7-6: Mean Monthly Temperatures (°C) and Mean Diurnal Fluctuations in Sampled Streams of the Meliadine Lake Study Area, June to September 1998

Streams		June 1998 [a]			July 1998			August 1998			September 1998		
		Mean	Range	Fluct.[b]	Mean	Range	Fluct.	Mean	Range	Fluct.	Mean	Range	Fluct.
Small	A0-1	11.5	2.2-17.7	6.4	13.7	6.7-21.4	5.1	12.3	5.2-21.0	4.5	6.7	1.6-12.7	1.9
	B1-2	6.7	3.7-13.0	2.5	13.5	8.3-19.7	3.2	12.5	7.3-20.2	3.5	6.9	2.3-12.1	1.6
	B4-5	7.3	3.2-13.8	6.4	13.4	8.3-20.0	4.1	12.4	7.3-20.3	3.7	6.8	2.2-12.4	1.9
Large	ML-PL	4.7	3.5-6.2	1.1	10.5	5.0-14.9	1.2	12.7	9.9-14.9	0.9	8.2	4.4-11.1	0.5
	ML-MR	5.6	4.3-8.1	2.7	10.7	4.9-16.6	2.3	12.6	8.6-17.8	2.1	7.4	3.7-10.6	1.3
	MR-L	9.1	5.0-13.3	5.5	12.7	6.2-19.9	4.8	12.3	5.8-20.0	4.2	7.1	2.0-13.0	2.6

[a] Represents data recorded between 22 and 30 June.

[b] Mean daily temperature fluctuation (maximum - minimum).

Mean daily water temperatures at sites on the 3 larger streams (ML-PL, ML-MR, and MR-L) also exhibited similar seasonal patterns, but changes in temperature were more gradual than those documented for the small streams. There was a slow warming period that peaked in late July or early August and then a gradual cooling to the end of September; however, fluctuations in temperature did occur and a dramatic decrease in temperature was recorded between 10 and 15 July. Differences among the large streams also were recorded. The site on the Meliadine River near its mouth (MR-L) warmed more rapidly in spring than the 2 other sites, and temperatures tended to exhibit a higher degree of daily fluctuation (Table 7-6). The west outflow from Meliadine Lake to Peter Lake (ML-PL) was the most stable of the 3 sites in terms of daily fluctuations and it exhibited a lower rate of change between seasons. It warmed more slowly in spring, remained cooler during summer, and cooled more slowly than the other sites in fall. These results reflected the position of the temperature loggers within the study area. The site on the Meliadine River near its mouth (MR-L) received flowing water that had been subjected to influences of air temperature for approximately 40 km (distance between Meliadine Lake and the mouth). In contrast, both ML-PL and ML-MR received outflow from large bodies of water (west and south basins of Meliadine Lake), which exhibited slower warming and cooling rates.

Surface water temperatures were also monitored in study area lakes (Table 7-7). Monitoring locations included sites on 3 small waterbodies (A8, B2, and B5), as well as sites on 3 larger lake basins: the south basin of Meliadine Lake (ML SE), the east basin of Meliadine Lake (ML-E), and Peter Lake (PL). Water temperatures in sampled lakes ranged from 1.7 to 19.7°C during the open water period. In general, the smaller lakes exhibited higher mean monthly temperatures during the warming period (June and July) and lower mean monthly temperatures during the cooling period (August and September). The smaller lakes also tended to exhibit a greater range in water temperature during the warming period, which was reflected by higher mean daily fluctuations.

Table 7-7: Mean Monthly Surface Water Temperatures (°C) and Mean Diurnal Fluctuations in Sampled Lakes of the Meliadine Study Area, June to September 1998

Lakes		June 1998 [a]			July 1998			August 1998			September 1998		
		Mean	Range	Fluct.[b]	Mean	Range	Fluct.	Mean	Range	Fluct.	Mean	Range	Fluct.
Small	A8	7.9	4.0-13.0	3.5	13.3	8.6-18.1	2.4	12.6	7.8-18.3	1.9	6.9	2.5-10.8	1.1
	B2	7.4	3.7-13.3	2.8	13.6	8.6-19.7	2.7	12.9	8.6-19.1	2.1	7.1	2.6-11.2	1.3
	B5	6.3	2.2-12.3	3.5	13.4	8.9-18.9	2.3	12.8	8.4-18.8	1.9	7.1	2.8-10.9	1.1
Large	ML-SE	9.1	5.3-12.9	3.6	13.4	8.0-18.8	2.8	12.6	6.8-18.8	2.3	6.8	2.2-11.1	1.3
	ML-E	4.7	4.0-6.1	1.2	10.6	3.5-15.2	1.4	13.1	9.6-16.2	1.0	8.0	4.1-10.9	1.2
	PL	4.5	2.2-6.1	1.8	9.0	1.7-14.2	2.0	13.1	9.8-16.3	1.0	8.8	4.7-11.7	0.9

[a] Represents data recorded between 22 and 30 June.
[b] Mean daily temperature fluctuation (maximum - minimum).

Mean daily water temperatures at individual sites in the 3 smaller lakes (A8, B2, and B5) exhibited similar seasonal patterns. The lakes warmed rapidly in spring (late June), peaked in late July or early August, and then gradually cooled to the end of September. Fluctuations in temperature did occur, but were not dramatic. Warmest mean daily temperatures (17.4 to 17.7°C) were recorded between 31 July and 5 August, whereas a dramatic decrease in temperature was noted in all 3 lakes between 8 and 16 July.

Mean daily water temperatures at the 3 larger lake sites (ML-SE, ML-E, and PL) exhibited similar seasonal patterns, but seasonal changes in temperature were more gradual than those documented for the small lakes. Differences among the large lakes also were recorded; the site at the east end of the south basin of Meliadine Lake (ML-SE) warmed more rapidly in spring than the 2 other sites and temperatures exhibited a higher degree of daily fluctuation (Table 7-7); this was likely due to the shallow nature of this area. The east basin of Meliadine Lake (ML-E) was the most stable of the 3 sites in terms of daily fluctuations, but the Peter Lake site (PL) exhibited a lower rate of change between seasons. Being the largest waterbody in the study area, Peter Lake warmed more slowly in spring, remained cooler during summer, and cooled more slowly than the other sites in fall.

A third objective of the water temperature monitoring program was to determine if there were temperature differences between the surface and near-bottom waters of Meliadine Lake. To accomplish this, 2 temperature loggers were deployed in the middle of the east basin of Meliadine Lake. One temperature logger was suspended 1 m beneath the surface and the other was suspended directly below at a depth of 14 m (approximately 1 m above the lake bottom). The results of these deployments showed very little difference between the surface and near-bottom water temperatures during the 28 July to 4 September period (i.e., the mean surface temperatures were only 0.1 Celsius degree higher than the mean near-bottom temperatures), indicating that the lake was well mixed during this period (Appendix D11).

1999

The temperature regime during the open water period in 1999 exhibited several distinct cycles of rapid warming following by fast cooling. Although extended periods of cold weather were recorded during the previous 2 summers (1997 and 1998), the frequency, duration, and magnitude of these "cold spells" were considerably greater during summer 1999. This resulted in cooler water temperatures in 1999 relative to 1997 and 1998. For example, mean daily water temperatures at Site B1-2 exceeded 15°C during only 5 days in 1999 compared to 15 days in 1998 and 12 days in 1997. Similarly, maximum water temperature recorded at this site in 1999 (17.8°C) was much lower than in 1998 (20.2°C) and 1997 (21.4°C). Site-specific daily water temperature data are presented in Appendices D9 and D10; the monthly means, ranges, and mean diurnal fluctuations are summarized in Table 7-8.

Table 7-8: Mean Monthly Temperatures (°C) and Mean Diurnal Fluctuations in Sampled Streams of the Meliadine Study Area, June to September 1999

Waterbody		June 1999 [a]			July 1999			August 1999			September 1999 [b]		
		Mean	Range	Fluct.[c]	Mean	Range	Fluct.	Mean	Range	Fluct.	Mean	Range	Fluct.
Streams	A0-1	7.5	2.8-15.7	3.4	13.0	7.1-19.7	4.3	11.4	5.8-18.1	3.9	5.4	4.9-6.1	0.8
	B1-2	4.9	0.7-11.1	2.3	12.8	8.6-17.8	2.8	11.5	5.9-16.8	2.7	5.4	4.7-6.1	1.0
	ML-MR	3.9	2.3-5.5	1.1	10.6	4.3-15.1	1.6	11.8	7.4-15.9	1.7	7.1	6.8-7.8	0.8
	MR-L	5.7	2.0-10.3	4.5	11.5	4.6-17.5	4.4	11.5	5.3-19.1	3.8	7.7	4.9-11.8	3.5
Lakes	A6	5.4	0.8-12.1	2.6	12.8	8.9-17.8	2.1	11.4	6.1-15.9	1.8	5.4	4.7-6.5	1.0
	B2	4.8	0.4-11.2	2.4	12.9	9.0-17.8	2.2	11.6	5.9-16.2	1.8	5.5	4.9-6.1	1.1
	ML-SE	6.4	1.4-12.1	3.6	12.5	8.6-17.2	2.6	11.5	5.9-16.6	1.9	5.3	4.9-5.9	0.8
	Control	4.4	1.0-9.8	2.1	12.7	7.7-16.8	1.6	11.9	7.1-15.7	1.4	6.6	6.1-7.3	0.9

[a] Represents data recorded between 19 and 30 June (20-30 June for sites ML-MR, MR-L, and Control).
[b] Represents data recorded between 1 and 2 September (1 to12 Sep for site MR-L).
[c] Mean daily temperature fluctuation (maximum - minimum).

Maximum water temperatures in lakes monitored in 1999 ranged from 16.8 to 17.8°C. On monthly bases, mean lake temperatures in July and August (12.5 to 12.9°C and 11.4 to 11.9°C, respectively) did not vary more than 0.5 Celsius degrees between the 4 monitored lake sites (Table 7.8).

2000

The temperature regime during the open water period in 2000 exhibited a delayed warming period during spring. Mean daily water temperatures in small streams (e.g., A0-1 and B1-2) did not surpass 6°C until 4 and 8 July, respectively; the corresponding temperatures in 1998 and 1999 were recorded considerably earlier (16 to 28

June). Following a rapid warming period during the second week of July, water temperatures remained relatively warm (above 13°C) from mid-July until mid-August. This resulted in warmer mid-summer water temperatures in 2000 relative to 1997, 1998, and 1999. For example, mean daily water temperatures at Site B1-2 (the only site monitored over the 4 year period) exceeded 15°C during 21 days in 2000, compared to only 5 days in 1999, 15 days in 1998, and 12 days in 1997. Maximum water temperature recorded in the monitored waterbodies during 2000 ranged between 15.9°C (Site ML-PL) and 23.7°C (Stream A0-1).

Site-specific daily water temperature data are presented in Appendix D9; the monthly means, ranges, and mean diurnal fluctuations are summarized in Table 7-9.

Table 7-9: Mean Monthly Temperatures (°C) and Mean Diurnal Fluctuations in Sampled Streams of the Meliadine Study Area, June to September 2000

Waterbody		June 2000 [a]			July 2000			August 2000			September 2000 [b]		
		Mean	Range	Fluct.[c]	Mean	Range	Fluct.	Mean	Range	Fluct.	Mean	Range	Fluct.
Streams	A0-1	3.7	1.6 - 7.3	2.2	14.0	4.0 - 23.7	5.9	11.5	2.7 - 21.5	4.1	5.2	-0.1 - 11.7	2.8
	B1-2	2.1	1.0 - 4.5	1.6	12.4	2.4 - 21.2	3.1	12.5	3.9 - 21.0	3.2	5.1	-0.1 - 10.1	2.4
	ML-MR	4.0	3.1 - 4.9	1.2	9.3	3.9 - 16.3	2.5	12.9	5.7 - 18.8	2.1	5.8	-0.1 - 9.6	1.9
	ML-PL	3.6	2.2 - 4.1	1.2	8.5	3.5 - 14.7	1.4	12.4	6.5 - 15.9	1.0	6.0	-0.2 - 8.8	1.0
	MR-L	3.8	1.8 - 6.6	2.6	10.9	3.1 - 20.9	5.5	12.3	3.7 - 21.0	3.8	5.4	-0.3 - 12.2	3.0
Lakes	A6	2.4	0.7 – 4.9	1.9	12.1	2.9 – 21.3	2.6	13.0	4.4 – 21.4	1.9	4.8	-0.1 – 9.2	1.4
	B2	1.8	0.6 - 4.6	1.5	12.4	2.4 - 20.8	2.9	13.1	4.6 - 21.1	1.8	5.4	0.0 - 8.7	1.4
	ML-SE	3.0	1.3 - 7.1	2.6	12.4	3.4 - 21.1	3.8	13.1	5.2 - 20.5	2.2	5.6	-0.1 - 9.7	1.6
	Control	4.8	3.8 - 5.9	1.1	11.8	3.7 - 21.1	2.1	13.5	5.1 - 20.3	1.3	5.6	-0.1 - 8.7	1.0

[a] Represents data recorded between 21 and 30 June (22-30 Jun for sites B1-2, ML-MR, B2, and ML-SE; 23-30 Jun for ML-PL; 25-30 Jun for MR-L and Control).

[b] Represents data recorded between 1 and 25 September (1-26 Sep for site ML-PL).

[c] Mean daily temperature fluctuation (daily maximum - daily minimum).

Cold weather during the second half of September resulted in very rapid cooling of all waterbodies. When the temperature loggers were retrieved on 25 September 2000, mean daily water temperatures ranged from 0.0 to 1.0°C and surface ice conditions were recorded at all sites except the large basins of Meliadine Lake. In contrast, when the temperature loggers were retrieved on 30 September 1998, water temperatures ranged between 2.5 and 4.9°C.

In general, the smaller streams (A0-1 and B1-2) exhibited higher water temperatures during the warming period (early July) and lower temperatures during the cooling period (late August) than the outflows from Meliadine Lake (ML-MR and ML-PL) and the lower Meliadine River (MR-L). The small streams and the lower Meliadine River experienced a greater range of diurnal water temperature fluctuations (related to changes in air temperature) than the south and west outflows from Meliadine Lake (i.e., large waterbody less responsive to diurnal temperature changes).

Maximum water temperature in lakes was 21.1°C; this temperature was recorded as a maximum in all 3 lakes monitored in 2000. On monthly bases, mean lake temperatures in July and August (11.8 to 12.4°C and 13.1 to 13.5°C, respectively) did not vary more than 0.6 Celsius degree between the monitored lake sites.

Comparison Between Years

Mean July and August monthly water temperatures during the 1998 to 2000 period were compared at selected stream and lake monitoring sites that provided multi-year records. These 2 months were chosen because they had a continous daily record of temperature during the entire months. As illustrated in Figure 7-11, mean July temperatures at most sites in 1998 were considerably warmer than in 1999 and 2000, Except for one site (Stream A0-1), the mean July water temperatures in 2000 were lower than during the preceding years. In contrast, mean August temperatures were approximately the same in 1998 and 2000, with considerably colder temperatures recorded during August 1999.

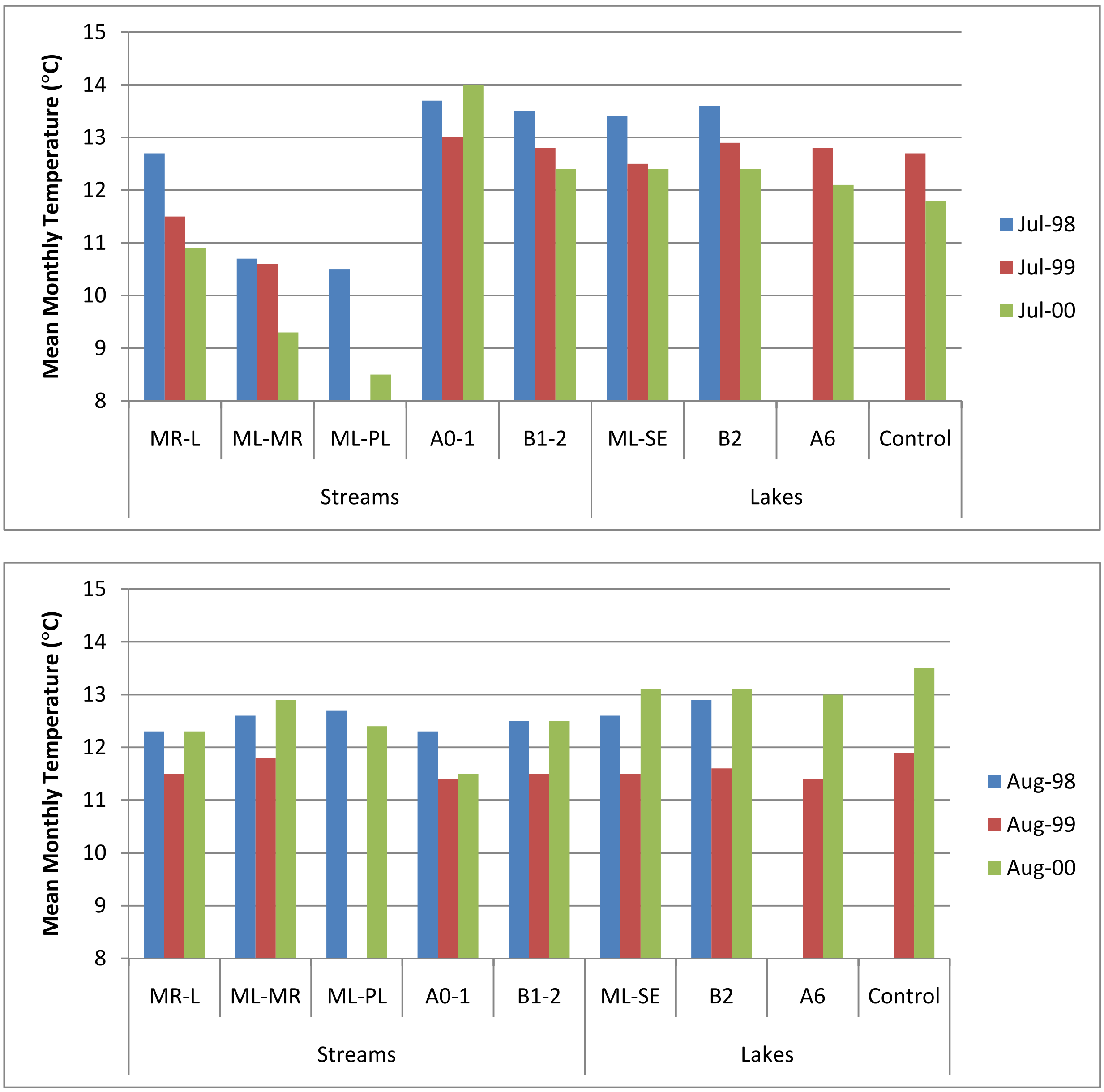

Figure 7-11: Yearly Variation in Mean Monthly Water Temperature in July and August at Selected Streams and Lakes in the Meliadine Study Area, 1998 to 2000

Mean daily water temperatures are presented for Stream B0-1 (the only waterbody with a 4-year record) in Figure 7-12. The results indicate large temperature differences between the same periods in different years. This was particularly evident in mid-summer (20 July to 10 August), when mean daily temperatures ranged between 8.2 and 19.1°C.

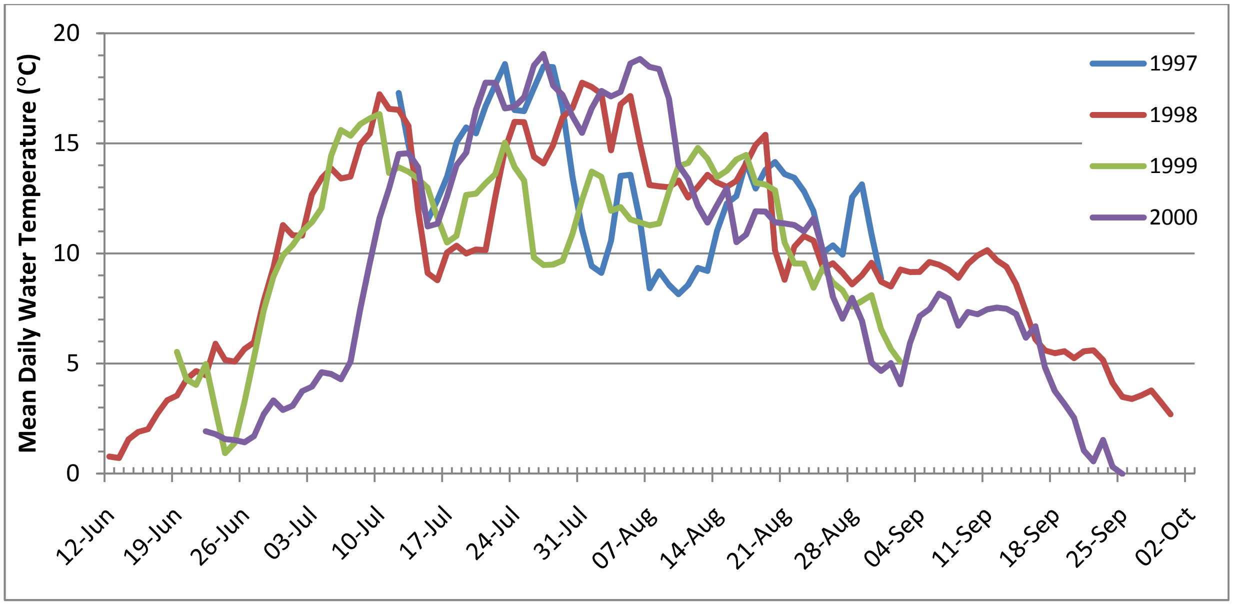

Figure 7-12: Yearly Variation in Mean Daily Water Temperature in Stream B0-1, 1997 to 2000

7.6 In-Situ Water Quality Measurements

Temperature, conductivity, and pH measurements were collected in conjunction with most fisheries investigations in the Meliadine Study Area during 1997 to 2009 period. These data are presented for each fish sampling event in Appendices F1, F2, F4 F6, and F7 to supplement the more detailed water quality data discussed in Section 5 and to provide a better understanding of the aquatic habitat conditions in the studied watercourses.

7.6.1 Streams

7.6.1.1 Meliadine River

Temperature, conductivity, and pH values were measured during investigations on the Meliadine River at ML-MR (*n*=5), LML-MR (*n*=1) and at the fish fence site located in the lower section of the river, approximately 2 km upstream from the mouth. At the outlet from Meliadine Lake (ML-MR), temperature ranged from 5.4°C in July 1998 to 15°C in July 1997 illustrating how variable water temperatures can be even during the same month. The mean temperature for the site was 10.8°C (SD ± 4.0, *n* = 5). On average, conductivity at the site was relatively low (mean = 50 µS/cm, SD ±17.3, *n* = 4) ranging from a low of 30 µS/cm in June 1997 to a high of 66 µS/cm in June 1998 and pH values were neutral (range 7.3 to 8.0, mean=7.6, SD ± 0.4, *n* = 3).

Further downstream at the fish fence site, temperature data were collected between 16 August to 3 September in 1997, 16 August to 2 September in 1998, and 10 August to 12 September in 1999. Temperatures were taken in the morning and evening on several occasions (*n* = 60) during the common time period (16 August to 2 September). On average, daily temperatures varied by 2.5 Celsius degrees (SD ± 1.5).

7.6.1.2 Peninsula Basin Streams

Temperature, conductivity, and pH values were collected during 135 investigations at 44 streams. In general, in-situ water quality values were highly variable owing to the wide range of streams and habitats sampled within the watershed. Temperatures ranged from 1.3°C at Stream B1-2 in June 1998 to 25.1°C at Stream A44-45 in July 2000. The mean temperature for all visits to Peninsula basin streams was 11.6°C (SD ± 5.2). Conductivity values also varied substantially from 10 µS/cm at Stream B4-5 in June 1998 to 480 µS/cm at Stream A39-45 in September 2000; mean conductivity was 86.8 µS/cm (SD ± 55.8). Similarly, pH values varied but were generally neutral (mean = 7.5, SD ± 0.5); the lowest pH value (6.1) was recorded at Stream B6-7 in June 1998 and the highest (8.6) at Stream A7-8 in July 1997. Data from specific sampling sites are located in Appendices F1 to F3.

7.6.2 Lakes and Ponds

7.6.2.1 Meliadine Lake

Temperature data were collected during gill and fyke net operations on Meliadine Lake. Gill nets were set with different amounts of effort at varying times in the basins and hence, temperature data are not directly comparable. When combined, however, it is possible to describe lake temperatures on a seasonal basis. Data were collected in ML-E in July 1997, ML-S in August 1997, August 1998 and July 1998, and in ML-W in September-October 1999 and September 2000. As expected, average temperatures cooled substantially from July (mean = 14.1°C, SD ± 1.9, *n* = 31) through October (mean = 3.0°C, SD ± 0.0, *n* = 3), decreasing most rapidly (change of 8.4 Celsius degrees on average) from August (mean = 12.7°C, SD ± 2.3, *n* = 3) to September (mean = 4.3°C, SD ± 1.1, *n* =25). Temperature data collected at fyke net sites (mean = 14.1°C, SD ± 1.8, *n* = 33) from July 1997, July 1998 and August 1998 (9.1°C, SD ± 0.6, *n* = 5) were consistent with those collected during gill net operations. Data from specific sampling sites are located in Appendices F4 and F6.

7.6.2.2 Peninsula Lakes and Ponds

Temperatures in Peninsula lakes were measured in-situ during gill and fyke net sampling from 1997 to 2000 and in 2008 and 2009. Temperature data are available from July (*n* = 52), August (*n* = 47), and September (*n* = 6). As was observed in Meliadine Lake, average temperatures cooled substantially from July (mean=14.9°C, SD ± 2.7) to September (mean = 7.3°C, SD ± 0.88) with a notable drop of 5.4 Celsius degrees from August (mean = 12.8°C, SD ± 2.9) to September. Data from specific sampling sites are located in Appendices F4 and F6.

The in-situ water quality data collected at Peninsula ponds are summarized in Section 7.4 (Pond Habitat). Data from specific sampling sites are located in Appendix D8.

7.7 Vertical Profiles in Lakes

Vertical profiles of water temperature and dissolved oxygen concentrations were measured on 57 occasions in 16 lakes. Detailed data for each depth interval are presented in Appendix D13. The results are summarized in the following sections.

Temperature Profiles

Temperature profiles measured during the open water period indicated a lack of thermal stratification in all of the surveyed lakes (Table 7-10). Among the 44 temperature profiles measured, 36 profiles registered less than one Celsius degree temperature difference between surface and bottom layers. The largest difference between surface and bottom temperatures (4.1 Celsius degree) was recorded in ML-E in August 1997, when the surface layer (up to 2 m in depth) was considerably warmer than the underlaying waters, likely due to unusually warm and calm conditions on that day. More commonly, wind induced mixing resulted in uniform water temperatures throughout the water column, even in the deepest lake (Peter Lake in July 1998) when the surface layer was 2.4 Celsius degree warmer than the waters at 18 m depth (Appendix D13).

Table 7-10: Temperature (ºC) Range in the Water Column of Lakes in the Meliadine Study Area, 1997 to 1999

Lake	Maximum Depth (m)	Jul-97		Aug-97		Apr-98		Jul-98		Aug/Sep-98		Jul-99	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
ML-E	14.7	13.2	13.9	11.2	15.3	-0.2	2.8	9.9	9.9	9.7	9.7		
ML-S	6.3	14.3	14.6	11.4	13.2	-0.2	1.6	12.6	13.1				
ML-SE	3.1					-0.2	1.2	11.0	11.4			11.2	11.7
ML-W	8.5	13.9	14.3	11.4	13.6	0.1	1.2	12.4	12.9				
LML	14.8					0.0	2.0	12.2	14.0	10.2	10.5		
PL	18.8					0.4	2.7	9.5	11.9				
A1	1.8			14.7	14.9								
A6	4.0	18.2	19.0	15.1	15.7	0.0	2.1	14.3	15.1			9.8	9.9
A8	3.6	16.4	17.7	14.2	14.3	-0.2	1.8	12.3	12.7				
B2	3.0	16.0	17.4	14.8	15.3	-0.2	0.8	9.7	9.8	8.9	8.9	10.9	11.1
B5	2.7	15.1	15.1	15.1	15.1	-0.2	0.0	9.9	10.0	8.9	8.9	10.2	10.5
B7	3.8	14.3	14.3	14.3	15.1	-0.1	1.7	9.7	9.7	9.6	10.3		
D1	2.2			15.7	16.7	-0.2	-0.2						
D7	2.3	13.5	14.0	15.2	15.8	-0.2	0.3						
G2	2.3	17.3	17.4	16.0	16.0								
Control	4.3							14.5	14.7			11.9	12.6

Note: m = metre

Under-ice temperature profiles measured in late April 1998 registered generally higher temperatures near bottom than at ice-water interface. The differences of 2 or more Celsius degrees were recorded in 5 of 13 lakes surveyed, reflecting the absence of wind-induced mixing and the intrinsic property of water, which is most dense at 4ºC. The late winter surveys also demonstrated that the average ice thickness was 1.8 m, ranging from 1.5 m in Little Meliadine Lake and Lake D1 to 2.4 m in Peter Lake (Appendix D13).

Dissolved Oxygen Profiles

The dissolved oxygen profiles measured during the open water period indicated well-oxygenated conditions throughout the water column in all of the surveyed lakes (Table 7-11). The minimum concentration of dissolved oxygen (9.2 mg/L) was recorded in July 1998 in Little Meliadine Lake at depths between 6 and 14 m. Among the 44 profiles measured during the open water period, 40 registered less than 1 mg/L difference in dissolved oxygen concentrations between surface and bottom water layers. The largest difference between surface and bottom concentrations (4.3 mg/L) was recorded in ML-E in July 1998, when the surface layer registered a super-saturated oxygen level of 16.0 mg/L while the near-bottom layer contained 11.7 mg/L of dissolved oxygen (Appendix D13). The general similarity of dissolved oxygen concentrations throughout the water column was likely due to a high degree of mixing induced by wind.

Table 7-11: Range of Dissolved Oxygen Concentrations (mg/L) in the Water Column of Lakes in the Meliadine Study Area, 1997 to 1999

Lake	Depth (m)	Jul-97		Aug-97		Apr-98		Jul-98		Aug-98		Jul-99	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
ML-E	14.7	10.1	10.3	11.3	11.8	7.4	18.0	11.7	16.0	11.1	11.2		
ML-S	6.3	10.2	10.3	11.5	11.9	17.6	19.6	11.6	13.5				
ML-SE	3.1					14.6	16.2	13.4	14.2			11.2	11.3
ML-W	8.5	9.9	10.1	11.2	11.9	16.4	19.6	11.0	11.8				
LML	14.8					9.7	15.3	9.2	9.7	10.6	10.8		
PL	18.8					7.5	18.4	9.5	12.3				
A1	1.8			9.8	10.0								
A6	4.0	10.0	10.6	11.4	11.6	0.7	3.4	12.6	13.1			10.9	11.3
A8	3.6	9.9	10.0	10.8	11.0	2.0	4.5	13.3	13.7				
B2	3.0	9.7	10.2	11.0	11.4	3.5	4.2	13.3	13.8	11.0	11.3	11.7	11.9
B5	2.7	10.4	10.6	10.8	10.9	2.6	3.2	13.8	14.0	10.8	10.8	11.5	11.7
B7	3.8	10.8	11.2	10.6	10.8	2.5	4.1	12.7	13.2	10.3	11.2		
D1	2.2			10.3	10.8	0.2	0.4						
D7	2.3	10.8	11.1	10.7	10.9	1.5	2.3						
G2	2.3	9.9	9.9	10.2	10.4								
Control	4.3							10.1	12.4			11.3	11.4

Note: m = metre

During the ice-covered period in April 1998, dissolved oxygen concentrations were low in the Peninsula lakes (A6, A8, B2, B5, B7, D1 and D7). Near-surface values ranged from 0.4 mg/L in Lake D1 to 4.5 mg/L in Lake A8. These concentrations represented very low oxygen saturation levels and were below the minimum level required for the protection of salmonid fish species (CWQG of 6.5 mg/L). Dissolved oxygen concentrations were much higher (generally greater than 13 mg/L) in the upper strata (0 to 5 m depth) of the larger waterbodies (Meliadine, Little Meliadine, and Peter lakes); however, recorded values were below 8 mg/L in the near-bottom strata of the east basin of Meliadine Lake and Peter Lake.

7.8 Aquatic Habitat Summary and Conclusions

Ground and aerial surveys were conducted at numerous streams within the Peninsula basins to assess habitat suitability for fish use with special reference to fish movements and spawning and/or rearing potential. Habitat for fish was dominated by shallow runs; other habitat types encountered included riffles, pools and riffle/boulder garden combinations. High quality habitats occurred in pools and deeper run habitats that were present mainly in larger streams connecting the primary chains of lakes in each Peninsula basin. Coarse substrates and abundant instream cover in these larger streams provided suitable habitat for Arctic Grayling spawning and rearing.

Numerous ponds were also investigated to assess habitat suitability for fish. Ponds were predominantly shallow with substrates dominated by fines, and contained poor to moderate fish habitat. Where fish were present, Ninespine Stickleback was the dominant species. Some fishless ponds contained moderate to high habitat quality. In contrast, habitat quality was rated low to moderate in many of the ponds where fish presence was confirmed. Regardless of the habitat potential ratings, ponds in close proximity to fish-bearing waterbodies (e.g., Meliadine Lake) had a higher likelihood to support small-bodied fish. This suggested that fish presence was more closely related to connectivity and proximity to fish-bearing waterbodies than to the quality of habitat encountered.

Lake bathymetric surveys were carried out in the east and south basins Meliadine Lake, in 13 Peninsula lakes and ponds and in Chickenhead Lake. The east basin of Meliadine Lake (2212 ha) contributes approximately 21% to the entire area of the lake. It is separated from the rest of the lake by a shallow and narrow constriction that may result in separation of the east basin from the rest of the lake during winter. Owing to the high shoreline development index and the shallow nature of the lake, the littoral zones (i.e., less than 6 m in depth) contribute approximately 66% to the lake's area. The mean depth of the east basin was estimated at 4.5 m. The south basin of Meliadine Lake (1135 ha) contributes 11% to the entire area of the lake and has a maximum depth of 22 m. The littoral zones account for approximately 72% to the lake's area. The mean depth of the south basin was estimated at 4.3 m.

The surveyed Peninsula lakes and ponds ranged from 0.4 ha (Pond B10) to 89.7 ha (Lake A8) in surface area. Only 4 lakes had depths of 4 m or greater; the deepest spot was recorded in Lake B7 (5.1 m). As most of lakes' volume is contributed by the surface 2 m layer of water, which becomes ice in winter, some of the shallower lakes (e.g., B4, J1 and D1) may freeze to the bottom. The deep water zones in lakes B7, B6, A6, A8, B2, and B5 appear to be sufficient to allow fish to overwinter.

8.0 LOWER TROPHIC LEVELS

8.1 Periphyton

Periphyton refers to the community of algae, bacteria, fungi, and their secretions that grow on substrates in freshwater systems (Lock et al. 1984). Periphyton provides food and habitat resources for benthic macroinvertebrates and herbivorous fish, especially in flowing waters (Warren et al. 1964; Hynes 1970; Horner and Welch 1981; Lock et al. 1984; Merritt et al. 1984). Although periphyton within temperate zone lake systems generally account for a small amount of a lake's overall primary productivity (i.e., phytoplankton accounts for the vast majority of primary productivity), it has been documented that Arctic lakes can derive a large proportion (15 to 80%) of their energy inputs from benthic sources (Welch and Kalff 1974; Kalff and Welch 1974; Welch et al. 1988; Welch et al.1989). For these reasons, periphyton communities were sampled in both streams and lakes of the Meliadine Study Area.

In addition to having an important role in aquatic trophic relationships (i.e., invertebrates and fish use periphyton as a source of food and shelter), the periphyton community is well suited for use as a biological indicator of environmental conditions, including those imposed by anthropogenic activities. Summary results of chlorophyll *a* concentration (a biomass estimate of the amount of live algae), ash-free-dry-mass (AFDM) concentration (a biomass estimate of the total organic content of periphyton), and the periphyton algal community are presented in this report.

8.2 Phytoplankton

Phytoplankton are microscopic free-floating algae (Smith 1950). Summary results of phytoplankton biomass (µg/L) and density (number of cells/mL) are both presented in this report; however, biomass is examined in greater detail. Both biomass and density are presented because density alone does not provide an accurate assessment of a taxon's importance. For example, taxa that are extremely numerous may have a low biomass due to the small size of individual organisms. Conversely, taxa that have large biomasses (due to large size of individual organisms) may not be numerically abundant. These large bodied groups can contribute significantly to lake productivity. As such, they can influence the abundance of herbivores that feed on them (generally zooplankton) and can modify nutrient availability for competing plants or algae.

8.3 Zooplankton

Zooplankton communities are composed of microscopic animals that live in the water column (Pennak 1989; Wetzel 1983). Summary results of zooplankton biomass (mg/m^3; dry weight) and density (Number of individuals/m^3) are both presented in this report because, as described previously, density alone does not provide an accurate assessment of a taxon's importance. Zooplankton groups can contribute to lake productivity by influencing the abundance of predators that feed on them (generally other zooplankton and fish) and modifying phytoplankton communities through grazing.

8.4 Benthic Macroinvertebrates

Benthic macroinvertebrates are animals (e.g., insects, crustaceans, molluscs, worms) that exist among bottom substrata of aquatic systems. The benthic macroinvertebrate community has proven to be useful in environmental surveys because invertebrates are typically numerous (i.e., hundreds to thousands per square metre), sedentary (i.e., generally have small home ranges), have long life cycles (a few weeks to a few years, depending on species) and respond to environmental disturbances in a predictable manner. These attributes make them useful as indicators of pollution effects (Alberta Environment 1990; Environment Canada 1993). In addition, their ecological relationships are generally well understood (e.g., Hynes 1970; Resh and Rosenberg 1984; Rosenberg and Resh 1993) and they are the major food source for many fish species. For these reasons, evaluating benthic communities is regarded as a cost-effective means of assessing the aquatic environment.

8.5 Methods

Periphyton and benthic macroinvertebrates were sampled in lakes and streams throughout the Meliadine Gold Project area, only during the summer (i.e., the most biologically productive season; Figure 8-1; Table 8-1). Periphyton lake samples were collected at wadable depths. Phytoplankton and zooplankton samples were collected in lakes only; they were sampled during both summer and fall to account for seasonal differences in community composition (Table 8-1; Figure 8-1). Detailed descriptions of field sampling methods and laboratory procedures are provided in the following subsections.

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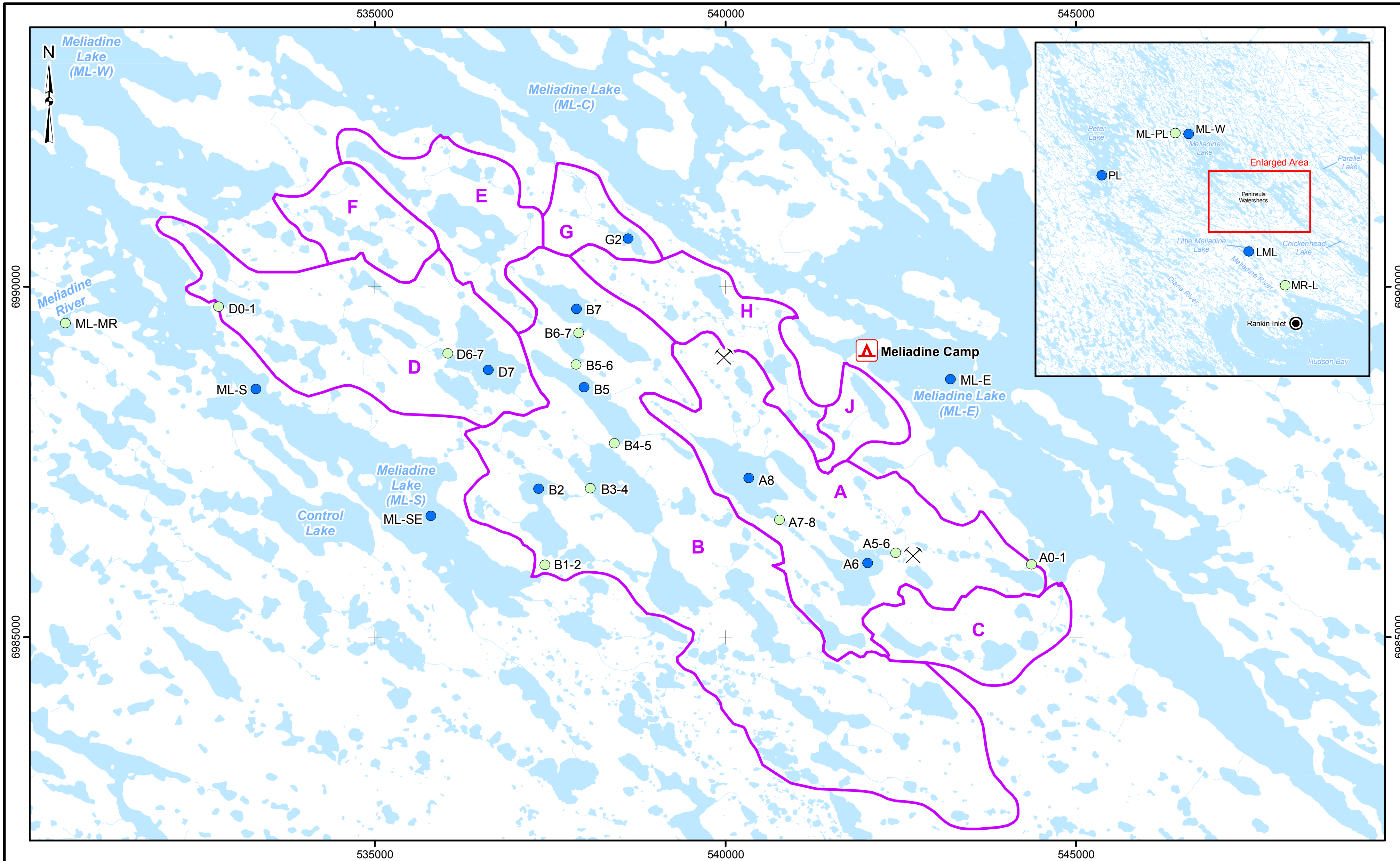


LEGEND

Lower Trophic Level Sampling Location

- Lake Sampling Site
- Stream or River Sampling Site
- Camp
- Proposed Mine Site
- Watercourse
- Waterbody
- Watershed Boundary

1.5 0 1.5

SCALE 1:75,000 KILOMETRES

DRAFT

REFERENCE

Base data obtained from Comaplex Minerals Corporation

Projection: UTM Zone 15 Datum: NAD 83

PROJECT

COMAPLEX MINERALS CORP

COMAPLEX MINERALS CORPORATION
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

LOWER TROPHIC LEVEL SAMPLING LOCATIONS IN THE MELIADINE STUDY AREA

Golder Associates
Edmonton, Alberta

PROJECT No. 09-1373-0010			PHASE No. 1000	
DESIGN	CC	12 Nov. 2009	SCALE AS SHOWN	REV. 0
GIS	CDB	12 Nov. 2009		
CHECK			**FIGURE 8-1**	
REVIEW				

Table 8-1: Number of Lower Trophic Sampling Sites in the Meliadine Study Area, 1997 to 1998

Field Session	Periphyton Lakes	Periphyton Streams	Phytoplankton	Zooplankton	Benthic Macroinvertebrates Lakes	Benthic Macroinvertebrates Streams
17 to 24 Jul 1997	10	10	10	10	10	10
16 to 22 Aug 1997	-	-	10	10	-	-
17 to 29 Jul 1998	11	11	11	11	11	11
22 Aug to 4 Sep 1998	-	-	6	6	-	-

Note: - = no sample collected.

8.5.1 Periphyton

8.5.1.1 Field

Five replicate periphyton samples were collected at each site. Each replicate consisted of scrapings from the surface (4 cm^2) of 3 stones that were randomly selected from the stream or lake bottom (near-shore areas accessed by wading). Samples used for algal identification and enumeration were placed in individually labelled 50-mL opaque containers and preserved with Lugol's solution. Shortly after collection, 2 drops of 100% formalin were added to each of these samples to prevent growth of bacteria and fungi. Samples destined for chlorophyll *a* analysis were filtered onto Whatman™ GF/C filter paper, covered with anhydrous $MgCO_3$, and were frozen. Samples for ash-free dry mass (AFDM) determinations were subsampled (in the laboratory) from the Lugol's preserved samples.

8.5.1.2 Laboratory

Three of 5 replicate periphyton samples collected from each location were initially processed as outlined by Lund et al. (1958). If variability among the 3 replicates from a site was high (i.e., standard error greater than 20% of the mean; Elliott 1977), additional samples were processed, up to the maximum of 5. Samples were first mixed and then subjected to serial dilutions (generally 0 to 1000 fold dilutions depending on the amount of algal and organic debris in the sample). Subsequently, 1 to 10 mL subsamples were dispensed into sedimentation chambers. After a 12-h settling period, the basal area of each chamber was scanned qualitatively with an inverted Leitz™ microscope to identify the best dilution factor for subsequent quantitative analysis and to obtain a comprehensive species list. Taxa within the sample were then identified and enumerated.

Taxonomic keys of Smith (1950), Prescott (1970), and Webber (1971) were used for species identification. Counts were made at a magnification of approximately 450x along horizontal transects across the diameter of the chamber; a minimum of 200 algal units were examined. Species that were encountered, but not enumerated during transect counts, were recorded as "present".

To identify and enumerate diatoms, subsamples were treated with a mixture of concentrated sulphuric acid, potassium dichromate, and hydrogen peroxide, followed by repeated washes in distilled water. The cleaned frustules were then dried on cover glasses and mounted in Storax™.

Chlorophyll *a* analysis was conducted on all 5 replicates using the spectrophotometric-acetone extraction method described by Moss (1967a, 1967b). The AFDM subsamples were filtered onto pre-washed and pre-weighed WhatmanTM GF/C filters, subsequently dried (at 105^{o}C for 24 h) and weighed. The dried samples were then ashed in a muffle furnace (at 550^{o}C for 1 h), cooled in a desiccator, and weighed. The difference between dry mass and ash mass is the AFDM (APHA 1992).

8.5.2 Phytoplankton

8.5.2.1 Field

Phytoplankton samples were collected during the summer (July) and fall (August and early September). A composite sample was collected from the euphotic zone at each lake site. The euphotic zone is equal to the depth of 1% light penetration (approximately 2 times the Secchi depth). Vertical collections were made using a weighted plastic tube. A sample consisted of a composite of 3 discrete vertical collections within this zone. In lakes that were shallower than 2 times the Secchi depth, phytoplankton hauls encompassed the entire water column to 1 m above the lake bottom (to avoid contamination of the sample with sediment). Samples were placed in labelled 1-L polyethylene containers, preserved with 5% Lugol's solution, and stored in the dark. Three drops of 100% formalin were added to each sample to prevent growth of bacteria and fungi during storage. Samples destined for chlorophyll *a* analysis were filtered onto Whatman^{TM} GF/C filter paper, covered with anhydrous $MgCO_3$, and frozen.

8.5.2.2 Laboratory

Prior to taxonomic analysis, the phytoplankton samples were gently inverted, and 10 to 100 mL subsamples were dispensed into sedimentation chambers (Lund et al. 1958). After a 24-h sedimentation period, samples were processed. To obtain a comprehensive species list, the entire basal area of the chamber was scanned qualitatively with an inverted microscope (Wild^{TM} M-40). Taxonomic keys by Prescott (1970), Taft and Taft (1971), and Webber (1971) were used for identification.

Once a comprehensive species list was established, cell density (cells/mL) was assessed by enumerating individual cells within a specified area of the sedimentation chamber. This was accomplished by counting cells along horizontal transects placed across the specified area. The cell density of each species in the entire sample was calculated by extrapolating the number of cells within the specified area to the subsample, and then to the entire sample.

Cell biomass (µg/L) was calculated by first measuring the physical dimensions (length, width, and depth) of 10 to 30 cells of each species present in the sample. Estimates of cell biovolume were then generated by multiplying the mean dimension of cells of a particular species by the number of cells enumerated for that species. Cell biovolume was converted to biomass by assuming a specific gravity of 1. The mean cell biomass estimate for the subsample was then extrapolated to the entire sample. Species that were encountered during the qualitative assessment, but not enumerated (i.e., very low numbers or located outside the enumeration transects) were recorded as present.

For diatom identification and enumeration, a separate subsample was concentrated, dried onto a coverslip, ashed in a muffle furnace to remove organic matter, and mounted in Storax^{TM}.

Chlorophyll *a* analysis was conducted using the spectrophotometric-acetone extraction method described by Moss (1967a, 1967b). The AFDM subsamples were filtered onto pre-washed and pre-weighed Whatman^{TM} GF/C filters and subsequently dried (at 105°C for 24 h) and weighed. The dried samples were then ashed in a muffle furnace (at 550°C for 1 h), cooled in a desiccator and weighed. The difference between dry mass and ash mass is the AFDM (APHA 1992).

8.5.3 Zooplankton

8.5.3.1 Field

Zooplankton samples were collected during summer (July) and fall (August and early September). Each sample consisted of a composite of 2 or 3 vertical hauls at a site. The depth of each haul encompassed the entire water column between the surface and 1 m above the lake bottom (to avoid contamination of the sample with sediment). Zooplankton collections were made with a Wisconsin™ plankton net (net mouth diameter of 13.34 cm) constructed with 0.064 x 0.064 mm Nitex™ mesh, as recommended by Green (1977) to ensure adequate sampling of rotifers. To prevent predation by cyclopoid copepods, each sample was immediately preserved in 5% formalin and stored in labelled 500-mL polyethylene bottles. Equipment was thoroughly rinsed after sampling at each site to prevent cross-contamination.

8.5.3.2 Laboratory

Zooplankton counts were conducted using a dissecting stereo-microscope (Wild™ M-5); identifications were made using a compound microscope equipped with a phase-contrast condenser (Wild™ M-20). Taxonomic keys used for crustacean plankton included those by Brooks, Wilson, and Yeatman (in Edmondson 1959), supplemented by the keys of Brooks (1957), Smirnov (1971), Brandlova et al. (1972), Flössner (1972), and Kiefer (1978). The taxonomic key used for identification of rotifers was the Voigt revision by Koste (1978), supplemented by keys of Ahlstrom (1943) and Ruttner-Kolisko (1974). Chaoboridae were identified using the keys of Cook (1956) and Saether (1970). Specimens were identified to the lowest taxonomic level possible, typically species.

Enumeration of zooplankton involved different techniques, depending on taxonomic group. Cladocerans and copepods (all stages) were enumerated either from three 15-mL subsamples or from the entire sample using a dissecting microscope at 12x to 50x magnification. For cladocerans and copepods, subsampling was performed (using an automatic pipette) on samples that contained large numbers of specimens. All samples were subsampled (using an automatic pipette) for rotifer enumeration; however, each subsample was allowed to settle for 24 h before processing. An inverted microscope (100x or 200x magnification) was used to enumerate rotifers in subsamples by counting either 6 fields if density was extremely high (one field = 0.02625 cm^2) or the entire counting chamber (4.907 cm^2). Additional subsamples were continually removed from the original sample until approximately 200 mature or identifiable rotifer organisms were processed. Once numbers of organisms within each sample were established, these values were converted to densities per cubic metre by dividing the number of organisms in a sample by the total volume filtered (i.e., net mouth area × depth of haul × number of hauls).

The biomass of major taxonomic groups within each sample was also determined. Lengths were recorded for the first 30 individuals observed in a sample. Lengths of larger zooplankton were measured directly with a microscope connected to a calibrated Sigma Scan™ digitizing tablet. Smaller zooplankton, such as rotifers, were measured using an eyepiece graticule and corrected for magnification. These length measurements were used to calculate weights from published length-weight regression equations (Table 8-2). For each sample, a mean individual weight was calculated by averaging the estimated weights generated from the length-weight regression equation. As discussed in Bird and Prairie (1985), it is important to average weights rather than the lengths. Biomass for each taxonomic group was calculated by multiplying the number enumerated for that sample by the mean individual weight.

Table 8-2: Length-Weight Regression Equations used to Calculate Zooplankton Weights

Organism	Equation[a]	Reference
Copepods (N1-Adult)	$\ln W(\mu g) = 1.9526 + 2.399 \cdot \ln L(mm)$	Bottrell et al. (1976)
Daphnia spp.	$\ln W(\mu g) = 1.6 + 2.84 \cdot \ln L(mm)$	Bottrell et al. (1976)
Bosmina and *Eubosmina* spp.	$\ln W(\mu g) = 3.0896 + 3.0395 \cdot \ln L(mm)$	Bottrell et al. (1976)
Chydorus sphaericus	$\ln W(\mu g) = 4.543 + 3.636 \cdot \ln L(mm)$	Downing and Rigler (1984)
Holopedium spp.	$\ln W(\mu g) = 6.4957 + 3.190 \cdot \ln L(mm)$	Downing and Rigler (1984)
Rotifers	$\ln W(\mu g) = -10.3815 + 1.574 \cdot \ln L(\mu m)$	Stemberger and Gilbert (1987)

[a] W = weight of individual organism, µg = microgram, ln = natural logarithm, L = length, mm = millimetre.

8.5.4 Benthic Macroinvertebrates

8.5.4.1 Field Methods in Streams

Benthic macroinvertebrates were collected from stream sites during summer. Five replicate samples were collected at each site using a modified (243 µm mesh) Surber™ sampler (0.093 m^2 bottom area). The substrate within the area enclosed by the sampler was thoroughly stirred with a wooden dowel to a 5 cm depth to dislodge the invertebrates (larger stones were individually cleaned and rinsed by hand). The sample was preserved with 10% buffered formalin and stored in a labelled, polyethylene sample bag. Water velocity, water depth, and substrate type were recorded at each site.

8.5.4.2 Field Methods in Lakes

Benthic macroinvertebrates were sampled from mid-basin locations (2.2 to 19 m depth). Five replicate samples were collected at each site using an Ekman grab (0.023 m^2 bottom area). Individual samples were then sieved through a 0.243 mm mesh to remove excess sediment, placed in labelled polyethylene sample bags, and preserved in 10% buffered formalin. Water depth and substrate type were recorded at each sample location.

8.5.4.3 Laboratory

Laboratory analysis of benthic macroinvertebrates was conducted in the same manner for both stream and lake samples. Three of the 5 replicate samples collected at each location were initially processed. If variability among the 3 replicates from a site was high (i.e., standard error greater than 20% of the mean; Elliott 1977), additional samples were processed, up to the maximum of 5. Samples were first processed to remove all extraneous substrate and inorganic matter. Individual samples were washed to remove the preservative and repeatedly elutriated (i.e., rinsed and decanted repeatedly) to separate silt, sand and gravel from organic material. This procedure was continued until organic material was no longer observed in the elutriated water. The remaining inorganic material was scanned (by eye) in an enamelled tray, and large shelled or cased animals (greater than 0.5 cm) were removed. Inorganic material was subsequently discarded. The organic sample material was then fractionated (using a series of nested sieves) into the following components:

- a large fraction containing filamentous algae and plant material (greater than 4 mm);

- a coarse fraction (1 to 4 mm);
- a medium fraction (0.5 to 1 mm); and
- a fine fraction (0.25 to 0.5 mm).

Invertebrates were removed from the organic material, sorted to major taxonomic groups and identified to the lowest practical taxonomic level (genus or species where possible) under a dissecting microscope (6x to 42x magnification). Keys used for identification included Baumann et al. (1977), Wiederholm (1983), Brinkhurst (1986), Pennak (1989), Clifford (1991), Merritt and Cummins (1996), and Wiggins (1998).

8.6 Results

8.6.1 Periphyton

A total of 10 lakes and 10 streams/rivers were sampled in the Study Area in 1997, and 11 lakes and 11 streams/rivers were sampled in 1998 (Figure 8-1; Table 8-1). Data are presented in Appendices E1 to E3. Periphyton biomass was not determined for these data as periphyton cell size was unavailable.

8.6.1.1 Streams

Meliadine Lake Outflows and Lower Meliadine River

Mean chlorophyll *a* ranged from 0.10 ± 0.02 µg/cm^2 in MR-L to 6.03 ± 1.44 µg/cm^2 (± 1 standard error) in ML-MR (1997 sampling event; Figure 8-2, Appendix E1). AFDM estimates were more variable; means ranged from 2.21 ± 0.26 mg/cm^2 in MR-L to 172.32 ± 34.42 mg/cm^2 in ML-PL (1997 sampling event). Both chlorophyll *a* and AFDM concentrations were lower in 1998.

Periphyton density in these watercourses ranged from 505 835 ± 11 905 cells/cm^2 in ML-PL (1997 sampling event) to 4 451 939 ± 1 469 589 cells/cm^2 in ML-MR (1998 sampling event; Figure 8.2, Table 8.3, Appendix E2). Densities collected during the 1998 sampling events for ML-MR and ML-PL were approximately 6 times greater than densities collected at those sites in 1997.

Cyanophyta (cyanobacteria) had the highest density in both years, comprising over 75% of the total density at each site (Figure 8.2, Appendix E2). Bacillariophyta (diatoms) and Chlorophyta (green algae) were also common at each site, comprising between 3 and 19% of total density. These taxa decreased in density in 1998, while Cyanophyta density increased. Cryptophyta (cryptophytes), Chrysophyta (golden brown algae), Pyrrophyta (dinoflagellates) and Euglenophyta (euglenoids) were present in low density at most sites in both years. Variation in taxonomic composition was low between years.

A total of 337 species of algae were identified in the periphyton samples collected in streams within the Meliadine Study Area. The average number of species collected at each watercourse site ranged from 74 ± 3 in ML-MR (1997 sampling event) to 94 ± 5 in ML-PL (1998 sampling event; Table 8-3).

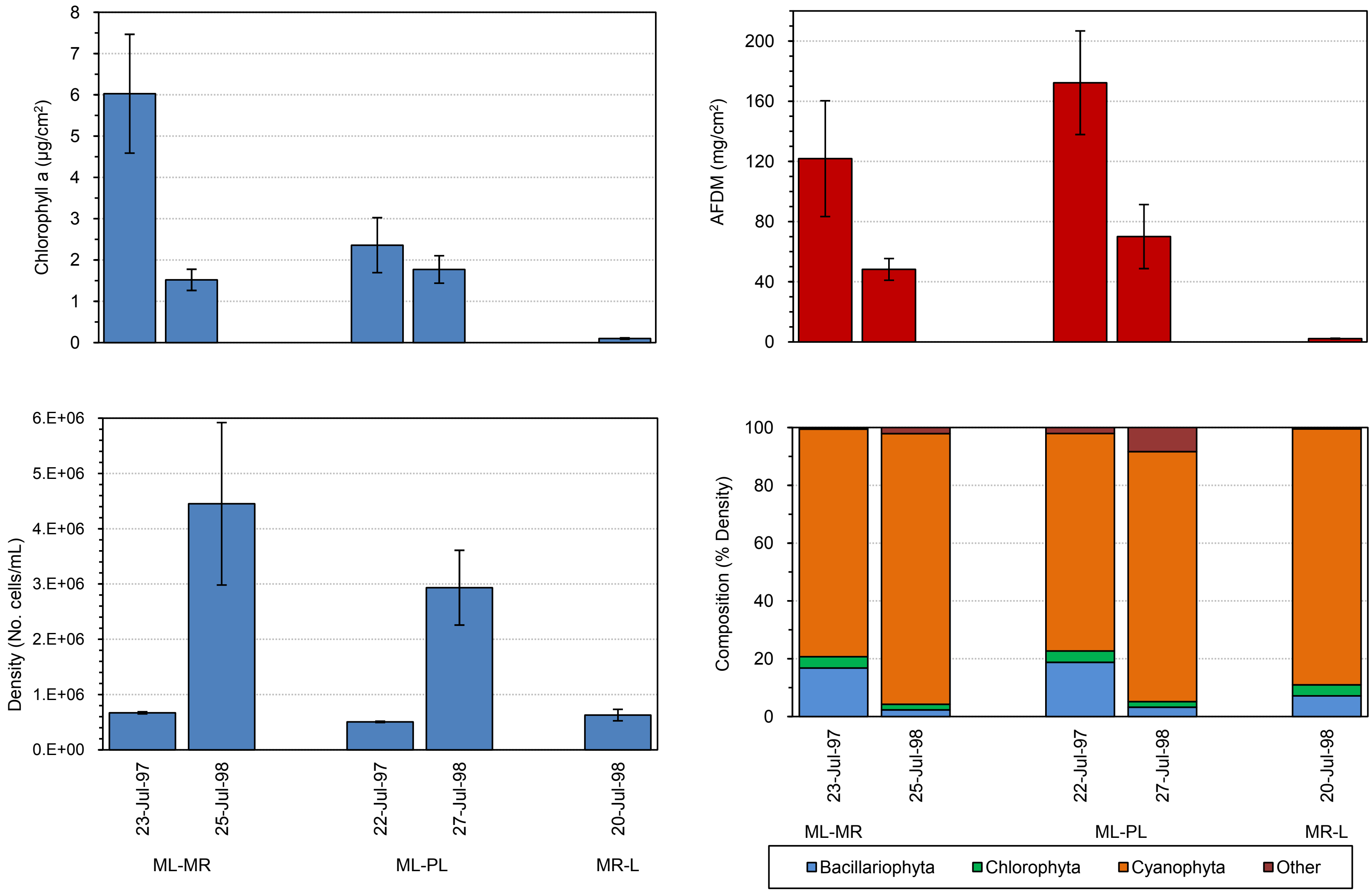


Figure 8-2: Chlorophyll a Concentrations, AFDM Concentrations, Density and Community Composition in the Meliadine Lake Outflows and Lower Meliadine River of the Meliadine Study Area, 1997 to 1998 (error bars represent ±1 standard error)

Table 8-3: Periphyton Density and Taxonomic Richness in the Meliadine Lake Outflows and Lower Meliadine River of the Meliadine Study Area, 1997 to 1998

Site	Date	Density (No. cells/mL ± 1 SE)	Taxonomic Richness (No. taxa/site ± 1 SE)
ML-MR	23 Jul 97	669 842 ± 19 278	74 ± 3
	25 Jul 98	4 451 939 ± 1 469 589	91 ± 6
ML-PL	22 Jul 97	505 835 ± 11 905	81 ± 5
	27 Jul 98	2 934 000 ± 676 449	94 ± 5
MR-L	20 Jul 98	628 843 ± 103 800	83 ± 3

Note: No.= number, mL = millilitre, SE = standard error.

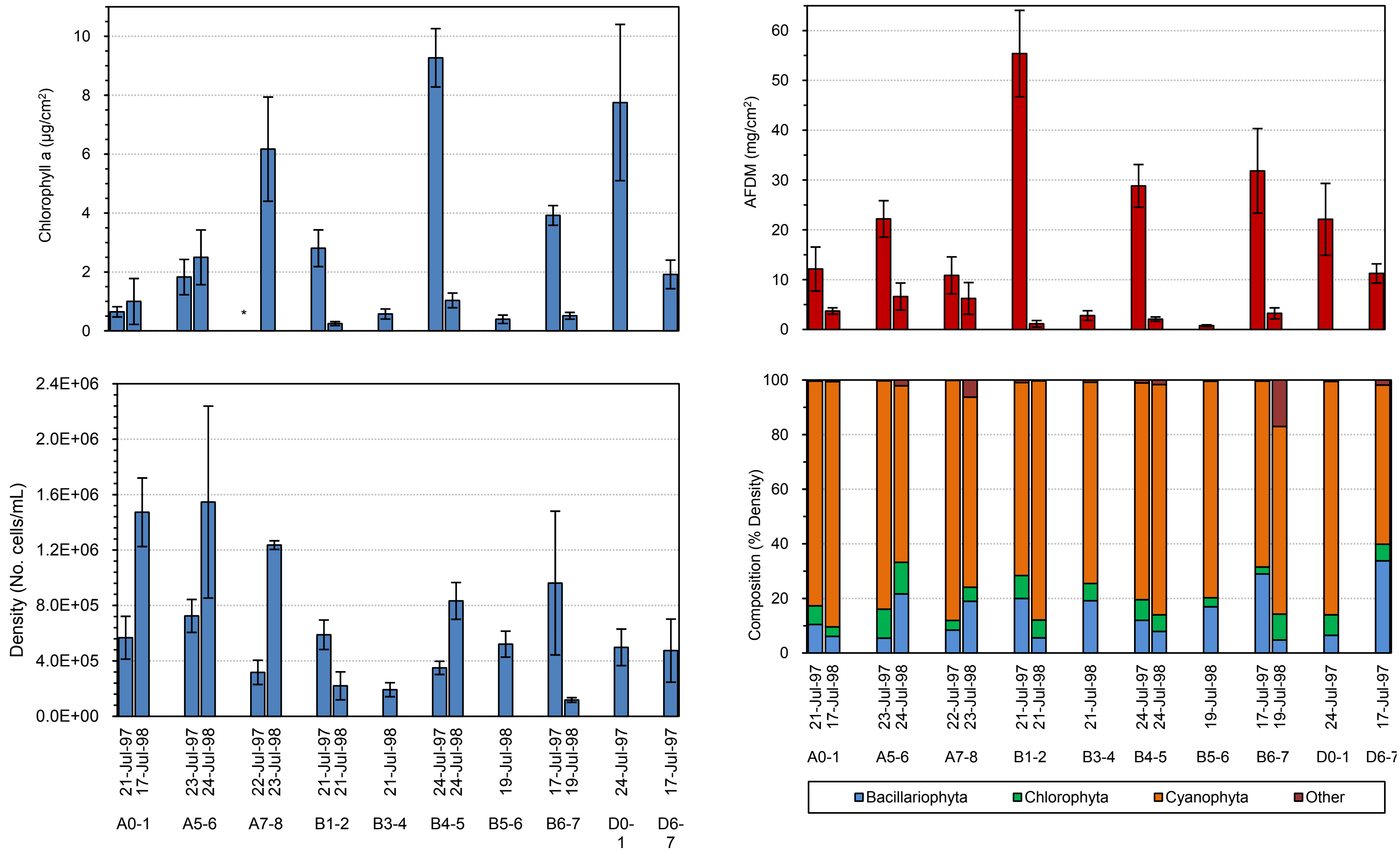
Basins A, B and D Outflows

Mean chlorophyll *a* concentrations ranged from below the detection limit (0.01 µg/cm^2) in A7-8 (1997 sampling event) to 9.27 ± 0.99 µg/cm^2 in B4-5 (1997 sampling event; Figure 8-3, Appendix E1). AFDM estimates were more variable; means ranged from 0.78 ± 0.17 mg/cm^2 in B1-2 (1998 sampling event) to 55.39 ± 8.68 mg/cm^2 in B1-2 (1997 sampling event). In general, both chlorophyll *a* and AFDM concentrations were lower in 1998, and lowest in the Basin A streams.

Periphyton density in the outflows of Basins A, B, D and G ranged from 117 885 ± 17 037 cells/cm^2 in B6-7 (1998 samping event) to 1 546 229 ± 692 480 cells/cm^2 in A5-6 (1998 sampling event; Figure 8-3, Table 8-4, Appendix E2). Most sites had densities between 200 000 and 900 000 cells/cm^2, however, densities at sites sampled in both 1997 and 1998 varied between years. Periphyton densities were generally higher in 1998 than 1997.

Cyanophyta had the highest density at each site in both years, comprising over 50% of the total density (Figure 8-3, Appendix E2). Bacillariophyta and Chlorophyta were also common at each site, comprising between 3 and 34% of total density. Cryptophyta, Chrysophyta, Pyrrophyta and Euglenophyta were present at most sites in both years, but densities were low. Variability in taxonomic composition was low between years.

A total of 337 species of algae were identified in the periphyton samples collected in streams within the Meliadine Study Area. The average number of species collected at each site in Basins A, B, D and G ranged from 70 ± 2 in B5-6 (1998 sampling event) to 110 ± 7 in B4-5 (1998 sampling event; Table 8-4).



Note: * = value below detection limit (0.01 µg/cm²).

Figure 8-3: Chlorophyll a Concentrations, AFDM Concentrations, Density and Community Composition in the Basins A, B, D and G Streams of the Meliadine Study Area, 1997 to 1998 (error bars represent ±1 standard error)

Table 8-4: Periphyton Density and Taxonomic Richness in Basin A, B and D Streams of the Meliadine Study Area, 1997 to 1998

Site	Date	Density (No. cells/mL ± 1 SE)	Taxonomic Richness (No. taxa/site ± 1 SE)
A0-1	21 Jul 97	567 216 ± 154 528	89 ± 3
	17 Jul 98	1 472 705 ± 247 527	93 ± 6
A5-6	23 Jul 97	724 427 ± 118 806	92 ± 2
	24 Jul 98	1 546 229 ± 692 480	85 ± 7
A7-8	22 Jul 97	317 377 ± 87 637	78 ± 8
	23 Jul 98	1 235 735 ± 31 228	80 ± 10
B1-2	21 Jul 97	588 717 ± 106 290	82 ± 1
	21 Jul 98	220 098 ± 101 011	82 ± 11
B3-4	21 Jul 98	192 008 ± 50 527	78 ± 7
B4-5	24 Jul 97	349 794 ± 47 627	88 ± 5
	20 Jul 98	833 008 ± 132 499	110 ± 7
B5-6	19 Jul 98	520 979 ± 93 799	70 ± 2
B6-7	17 Jul 97	961 869 ± 518 590	89 ± 4
	19 Jul 98	117 885 ± 17 037	76 ± 5
D0-1	24 Jul 97	497 724 ± 131 910	83 ± 4
D6-7	17 Jul 97	474 200 ± 227 599	91 ± 3

Note: No.= number, mL = millilitre, SE = standard error.

8.6.1.2 Lakes

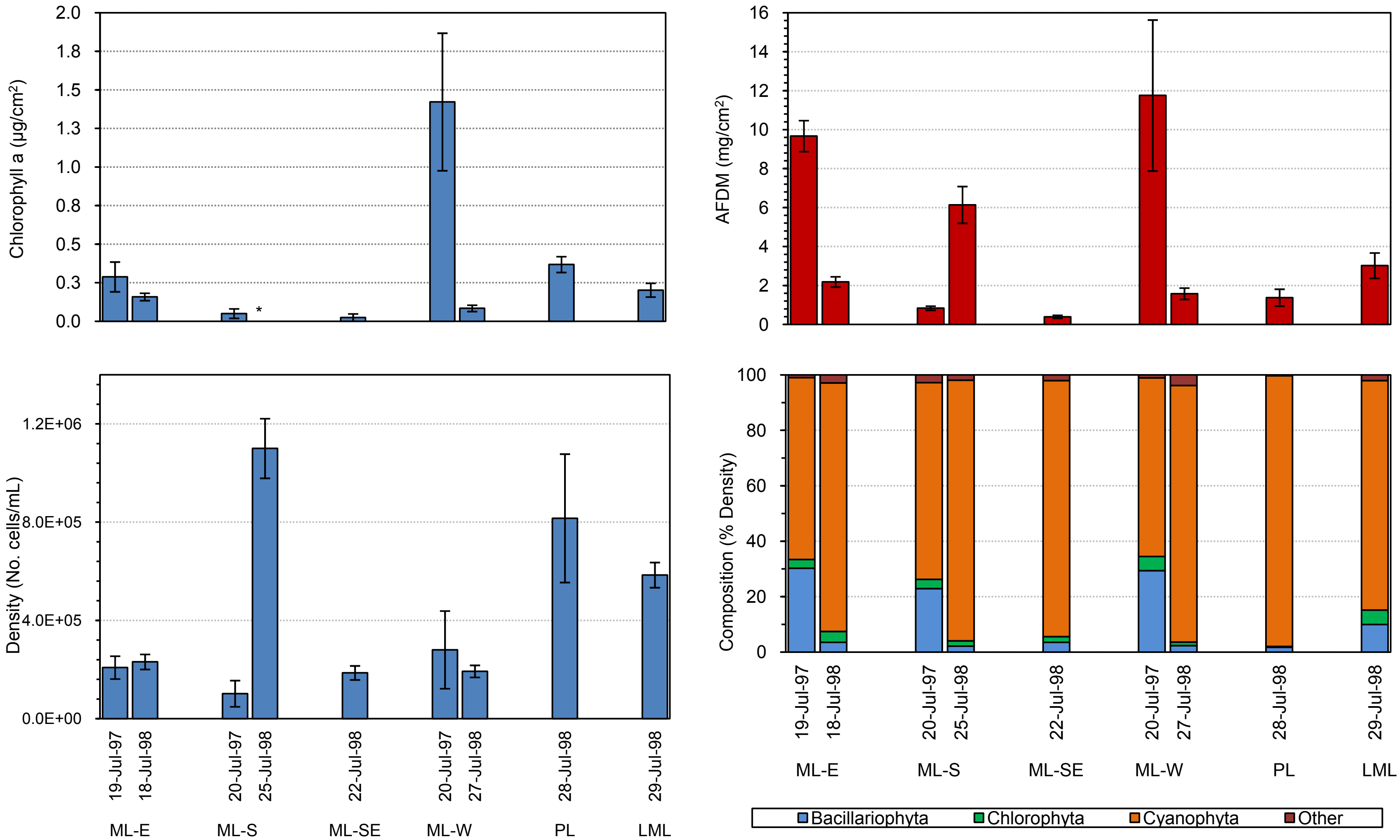
8.6.1.2.1 Large Lakes

Mean chlorophyll *a* in the large lakes (Meliadine, Peter and Little Meliadine) ranged from below the detection limit (0.01 µg/cm²) at ML-S (1998 sampling event) to 1.42 ± 0.45 µg/cm² at ML-W (1997 sampling event; Figure 8.4, Appendix E1). AFDM estimates were also variable, ranging from 0.39 ± 0.08 mg/cm^2 at ML-SE (1998 sampling event) to 11.76 ± 3.87 mg/cm^2 at ML-W (1997 sampling event). The majority of concentrations, however, were below 3 mg/cm^2. Variability between years for both chlorophyll *a* and AFDM was high; overall, 1997 concentrations were higher than 1998.

Periphyton density in the large lakes ranged from 101 950 ± 53 272 cells/cm^2 in ML-S (1997 sampling event) to 1 100 115 ± 121 473 cells/cm^2, also in ML-S (1998 sampling event; Figure 8-4, Table 8-5, Appendix E3). The majority of sites had densities between 100 000 and 800 000 cells/cm^2. Overall, density in 1998 was higher than 1997.

Cyanophyta had the highest density in both years, comprising over 66% of the total density at each site (Figure 8-4, Appendix E3). Bacillariophyta and Chlorophyta were also common at each site, comprising between 2 and 30% of total density. As with the corresponding streams, both taxa were less common in 1998. Cryptophyta, Chrysophyta and Pyrrophyta were present in low density at most sites in both years.

A total of 322 species of algae were identified in the periphyton samples collected in lakes within the Meliadine Study Area. The average number of species collected at each large lake ranged from 47 ± 2 in PL (1998 sampling event) to 107 ± 8 in LML (1998 sampling event; Table 8-5).



Note: * = value below detection limit (0.01 µg/cm²).

Figure 8-4: Chlorophyll a Concentrations, AFDM Concentrations, and Community Composition in the Meliadine, Peter and Little Meliadine lakes of the Meliadine Study Area, 1997 to 1998 (error bars represent ± 1 standard error)

Table 8-5: Periphyton Density and Taxonomic Richness in the Meliadine, Peter and Little Meliadine Lakes of the Meliadine Study Area, 1997 to 1998

Site	Date	Density (No. cells/mL ± 1 SE)	Taxonomic Richness (No. taxa/site ± 1 SE)
ML-E	19 Jul 97	208 187 ± 46 458	68 ± 4
	18 Jul 98	231 319 ± 30 579	66 ± 5
ML-S	20 Jul 97	101 950 ± 53 272	64 ± 10
	25 Jul 98	1 100 115 ± 121 473	98 ± 4
ML-SE	22 Jul 98	186 604 ± 28 432	60 ± 5
ML-W	20 Jul 97	280 374 ± 158 122	71 ± 7
	27 Jul 98	192 809 ± 24 505	64 ± 3
PL	28 Jul 98	815 931 ± 261 271	47 ± 2
LML	29 Jul 98	584 729 ± 51 119	107 ± 8

Note: No.= number, mL = millilitre, SE = standard error.

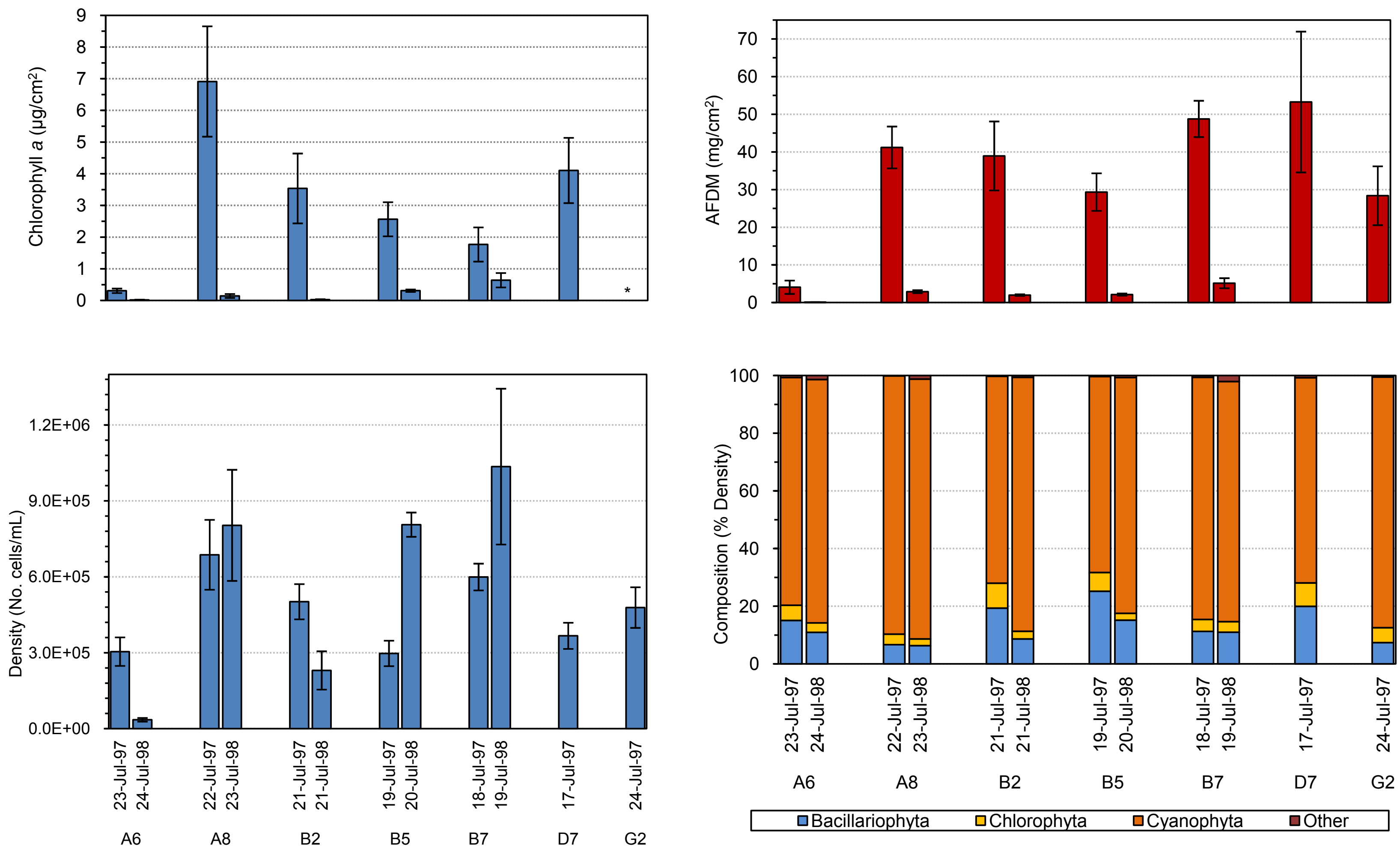
8.6.1.2.2 Peninsula Lakes

Mean chlorophyll *a* in the Peninsula lakes ranged from below the detection limit (0.01 µg/cm²) at G2 (1997 sampling event) to 6.91 ± 1.74 µg/cm² at A8 (1997 sampling event; Figure 8.5, Appendix E1). AFDM estimates were also variable, ranging from 0.11 ± 0.03 mg/cm^2 at A6 (1998 sampling event) to 53.25 ± 18.70 mg/cm^2 at D7 (1997 sampling event). The majority of concentrations were below 6 mg/cm^2. Variability between years for both chlorophyll *a* and AFDM was high, with higher concentrations present in 1997.

Periphyton density in the Peninsula lakes ranged from 35 013 ± 6996 cells/cm^2 in A-6 (1998 sampling event) to 1 035 561 ± 307 895 cells/cm^2 in B7 (1998 sampling event; Figure 8-5, Table 8-6, Appendix E3). Density at most sites varied between 300 000 and 800 000 cells/cm^2, and varied between years. Density was generally highest in 1998.

Cyanophyta had the highest density, comprising over 65% of the total density at each site in both years (Figure 8-5, Appendix E3). Bacillariophyta was also common at each site, comprising between 2 and 25% of total density. Chlorophyta was the next most dominant taxa, comprising between 1 and 5% of total density at most sites. Both taxonomic groups decreased in density in 1998, while Cyanophyta increased. Cryptophyta, Chrysophyta and Pyrrophyta were present at most sites in both years at low densities.

In total, 322 species of algae were identified in the periphyton samples collected in lakes within the Meliadine Study Area. The average number of species collected at each Peninsula Lake ranged from 52 ± 2 in A6 (1998 sampling event) to 106 ± 7 in B7 (1998 sampling event; Table 8-6).



Note: * = value below detection limit (0.01 µg/cm^2).

Figure 8-5: Chlorophyll a Concentrations, AFDM Concentrations, Density and Community Composition in the Peninsula Lakes of the Meliadine Study Area, 1997 to 1998 (error bars represent ±1 standard error)

Table 8-6: Periphyton Density and Taxonomic Richness in the Peninsula Lakes of the Meliadine Study Area, 1997 to 1998

Site	Date	Density (No. cells/mL ± 1 SE)	Taxonomic Richness (No. taxa/site ± 1 SE)
A6	23 Jul 97	304 335 ± 56 245	80 ± 5
	24 Jul 98	35 013 ± 6996	52 ± 2
A8	22 Jul 97	687 043 ± 138 053	92 ± 2
	23 Jul 98	803 448 ± 219 587	87 ± 1
B2	21 Jul 97	501 709 ± 69 601	92 ± 4
	21 Jul 98	230 043 ± 75 610	81 ± 7
B5	19 Jul 97	297 235 ± 50 336	81 ± 4
	20 Jul 98	806 144 ± 47 940	104 ± 3
B7	18 Jul 97	599 161 ± 52 933	87 ± 4
	19 Jul 98	1 035 561 ± 307 895	106 ± 7
D7	17 Jul 97	366 972 ± 51 719	90 ± 3
G2	24 Jul 97	478 546 ± 80 151	88 ± 2

Note: No.= number, mL = millilitre, SE = standard error.

8.6.2 Phytoplankton

To provide baseline information on the phytoplankton community composition, abundance and taxonomic richness, samples were collected from the Meliadine Study Area in summer and fall between 1997 and 1998. A total of 13 sampling sites was established in 10 lakes, including 4 sites in Meliadine Lake (Figure 8-1; Table 8-1). Detailed phytoplankton data are presented in Appendices E4 to E6.

8.6.2.1 Large Lakes

Chlorophyll *a* in the large lakes (Meliadine, Peter and Little Meliadine) ranged from below the detection limit (0.01 mg/m^3) to 2.4 mg/m^3 (Figure 8-6). The majority of the chlorophyll *a* concentrations were between 0.4 and 0.9 mg/m^3. Chlorophyll *a* concentrations were generally similar between summer and fall, with among-year variability low at some locations (i.e., ML-W) and high at others (i.e., ML-S). Chlorophyll *a* concentrations were typically higher in 1998. There was considerable variation of chlorophyll *a* concentrations among the 4 basins of Meliadine Lake.

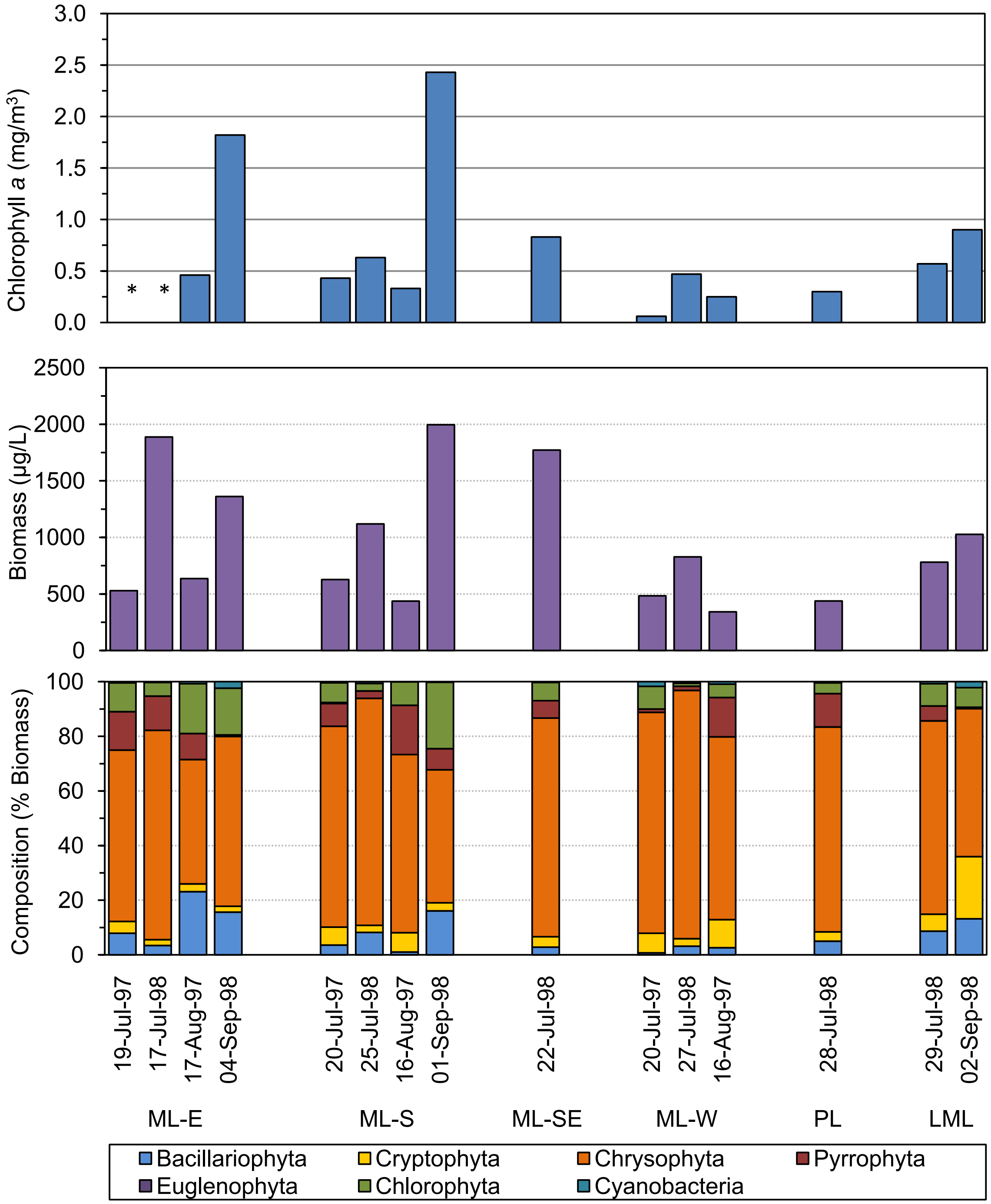
Phytoplankton biomass in the large lakes ranged from 342 to 1 996 µg/L (Figure 8-6). The majority of sites had phytoplankton biomass between 500 and 1 000 µg/L. Phytoplankton biomass displayed similar trends as chlorophyll *a* concentrations: biomass was similar between summer and fall periods with interannual variability low at some locations (i.e. ML-W) and high at others (i.e. ML-E). There was also considerable variation of phytoplankton biomass among the 4 basins of Meliadine Lake. Phytoplankton biomass was consistently higher in 1998.

Chrysophyta (golden brown algae) had the highest biomass at each sampling site and date and often comprised over half of the community biomass (Figure 8-6). Chlorophyta (green algae), Pyrrophyta (dinoflagellates), and

Bacillariophyta (diatoms) were also abundant at most sampling sites and dates. Cryptophyta (cryptophytes), Euglenophyta (euglenoids) and Cyanophyta (cyanobacteria) typically had low abundances at all sites. The phytoplankton community composition showed only small variations among seasons and years. The phytoplankton community was generally similar among each of the 4 basins of Meliadine Lake.

Phytoplankton density was notably different than biomass, and the relationship between the 2 variables was weak (Table 8-7). When considering phytoplankton density, the golden-brown algae and cyanophyta were the most abundant taxonomic groups (Appendix E6). The small size of most cyanophyta results in small contributions to overall biomass, despite being present in high densities.

A total of 242 species of algae were identified in the samples collected in the Meliadine study area, but the number of taxa observed at one site on a single date ranged from 46 to 83 taxa (Table 8-7). Taxonomic richness tended to be higher in the fall and higher in 1998 compared to 1997.



Note: * = value below detection limit (0.01 mg/m^3), na = not sampled

Figure 8-6: Chlorophyll a Concentrations, Phytoplankton Biomass and Community Composition in the Large Lakes of the Meliadine Study Area, 1997 to 1998

Table 8-7: Phytoplankton Density, Biomass and Taxonomic Richness in the Peninsula Lakes of the Meliadine Study Area, 1997 to 1998

Site	Date	Density (No. cells/mL)	Biomass (µg/L)	Taxonomic Richness (No. taxa/site)
ML-E	19 Jul 97	2008	529	56
	17 Aug 97	3844	636	65
	17 Jul 98	2593	1887	75
	4 Sep 98	4933	1362	78
ML-S	20 Jul 97	1863	627	73
	16 Aug 97	1871	437	63
	25 Jul 98	3736	1119	67
	1 Sep 98	5713	1996	80
ML-SE	22 Jul 98	2991	1772	83
ML-W	20 Jul 97	2175	483	46
	16 Aug 97	1135	342	52
	27 Jul 98	3026	828	68
PL	28 Jul 98	1985	438	59
LML	29 Jul 98	3406	780	66
	2 Sep 98	10748	1027	70

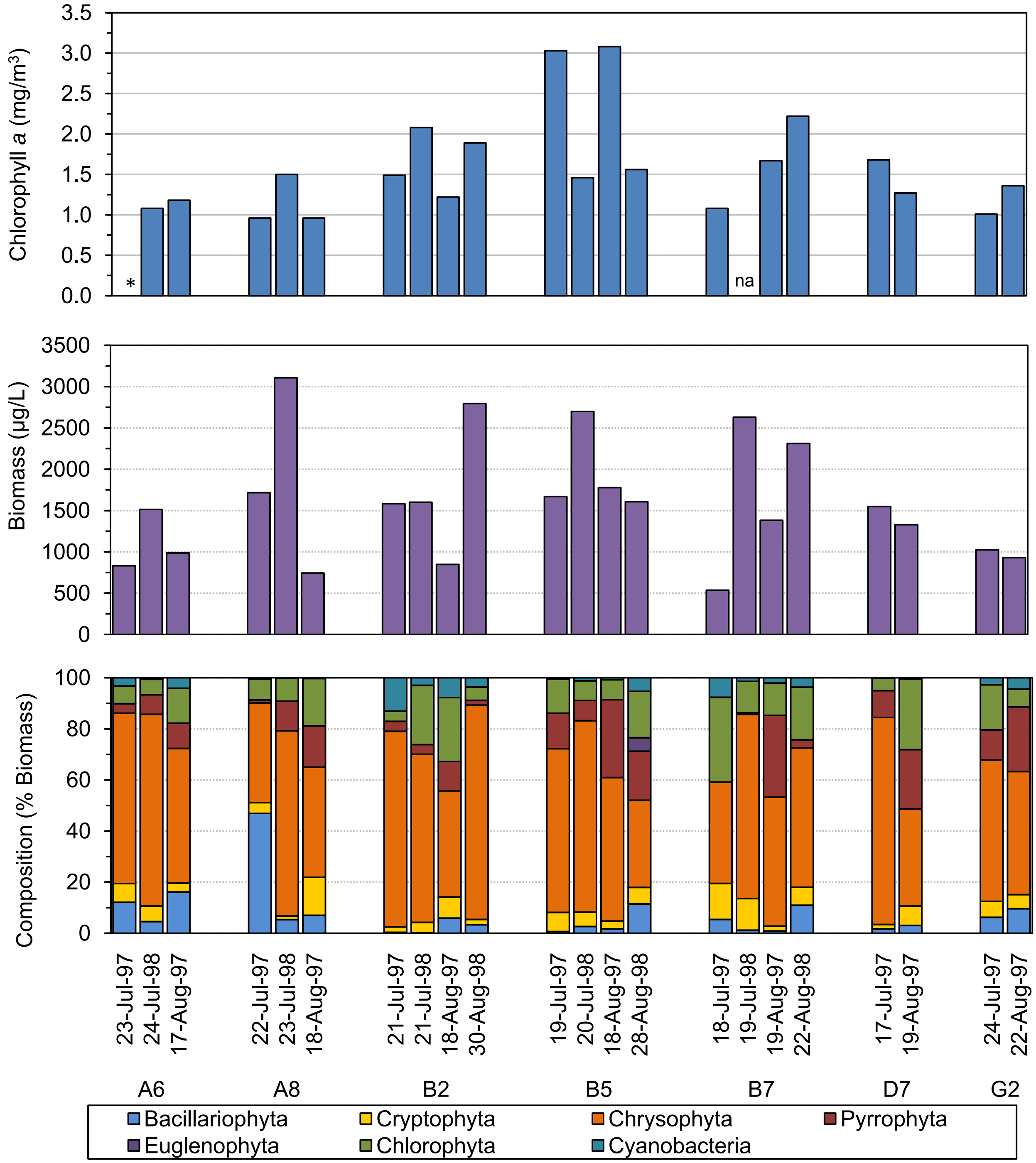
Note: No.= number; mL = millilitre; µg/L = microgram per litre.

8.6.2.2 Peninsula Lakes

Chlorophyll *a* concentrations in the Peninsula lakes ranged from below detection (0.01 mg/m^3) to 3.1 mg/m^3 (Figure 8-7). The majority of the chlorophyll *a* concentrations were between 1.0 and 1.6 mg/m^3. Similar to the large lakes, chlorophyll *a* concentrations in the Peninsula lakes were generally similar between summer and fall conditions, and were highest in 1998. The Peninsula lakes typically had higher chlorophyll *a* concentrations, and greater interannual variability than the larger lakes.

Phytoplankton biomass ranged from 536 to 3107 µg/L (Figure 8-7). The majority of sites had phytoplankton biomass between 800 and 2000 µg/L. Phytoplankton biomasses displayed similar trends as chlorophyll *a* concentrations. Phytoplankton biomass was typically greater in the Peninsula lakes than the large lakes. Phytoplankton biomass was consistently higher in 1998, and similar between summer and fall.

Chrysophyta had the highest biomass at each sampling site and date (with the exception of site A8, 22-July-97), and often comprised over half of the community biomass (Figure 8-7). Chlorophyta, Pyrrophyta, and Bacillariophyta were also abundant at most sampling sites and dates. Cryptophyta, Euglenophyta and Cyanophyta typically had low abundances at all sites. The phytoplankton community composition showed only small variations between seasons and years and was similar in the Peninsula and large lakes.



Note: * = value below detection limit (0.01 mg/m^3), na = not sampled.

Figure 8- 7: Chlorophyll a Concentrations, Phytoplankton Biomass and Community Composition in the Peninsula Lakes of the Meliadine Study Area, 1997 to 1998

Phytoplankton density was notably different than phytoplankton biomass, and the relationship between the two variables was weak (Table 8-8). As in the large lakes, the golden-brown algae and cyanophyta were the most abundant taxonomic groups (Appendix E6). The small size of most cyanophyta, however, results in small contributions to overall biomass despite being present in high densities.

A total of 242 species of algae were identified in the samples collected in the Meliadine study area, but the number of taxa observed at one site on a single date ranged from 46 to 83 taxa (Table 8-8). Taxonomic richness tended to be higher in the fall and higher in 1998 compared to 1997.

Table 8-8: Phytoplankton Density, Biomass and Taxonomic Richness in the Peninsula Lakes of the Meliadine Study Area, 1997 to 1998

Site	Date	Density (No. cells/mL)	Biomass (µg/L)	Taxonomic Richness (No. taxa/site)
A6	23 Jul 97	4689	831	64
	17 Aug 97	8120	986	72
	24 Jul 98	3039	1514	77
A8	22 Jul 97	6099	1716	59
	18 Aug 97	6526	744	79
	23 Jul 98	5225	3107	78
B2	21 Jul 97	15 426	1583	54
	18 Aug 97	12 210	848	56
	21 Jul 98	8501	1600	83
	30 Aug 98	29 192	2795	84
B5	19 Jul 97	10 348	1670	65
	18 Aug 97	6101	1777	71
	20 Jul 98	6221	2699	84
	28 Aug 98	22 518	1607	91
B7	18 Jul 97	7070	536	53
	19 Aug 97	12 551	1382	66
	19 Jul 98	9472	2629	81
	22 Aug 98	18 373	2311	96
D7	17 Jul 97	6627	1549	81
	19 Aug 97	2770	1329	84
G2	24 Jul 97	7126	1026	74
	22 Aug 97	5841	929	66

Note: No. = number: mL = millilitre; µg = microgram.

8.7 Zooplankton

8.7.1 Large Lakes

Zooplankton biomass in the large lakes (Meliadine, Peter and Little Meliadine) ranged from 25 to 503 mg/m^3; with most sites falling within the range of 75 to 300 mg/m^3 (Figure 8-8). Zooplankton biomass was typically higher in 1997, and lower during the fall. Among-year variability of zooplankton biomass was high. Zooplankton biomass also differed dramatically among the 4 basins of Meliadine Lake.

In each of the large lakes, the zooplankton community was variable, but was generally dominated by Cladocera (cladocerans; Figure 8-8). *Holopedium gibberum* was the dominant cladoceran in terms of biomass. Rotifera (rotifers) dominated the zooplankton community at site ML-S in the fall of 1998, which was not observed at other sites or other years. The most abundant rotifers in the large lakes were *Conochilus unicornis* and *Keratella cochlearis*. Calanoida (calanoid copepods) and Cyclopoida (cyclopoid copepods) were abundant in the single sample collected from Peter Lake, but had low biomass at other sites.

Trends of zooplankton density were notably different from zooplankton biomass, and the relationship between the two variables was weak (Table 8-9). When considering zooplankton density, Rotifera dominated the zooplankton community at each site; however, due to their small size, they did not make large contributions to the community biomass (Appendices E7 and E8).

A total of 42 zooplankton taxa were observed in the study area, but the number of taxa observed at one sampling location on a single date ranged from 13 to 22 (Table 8-9).

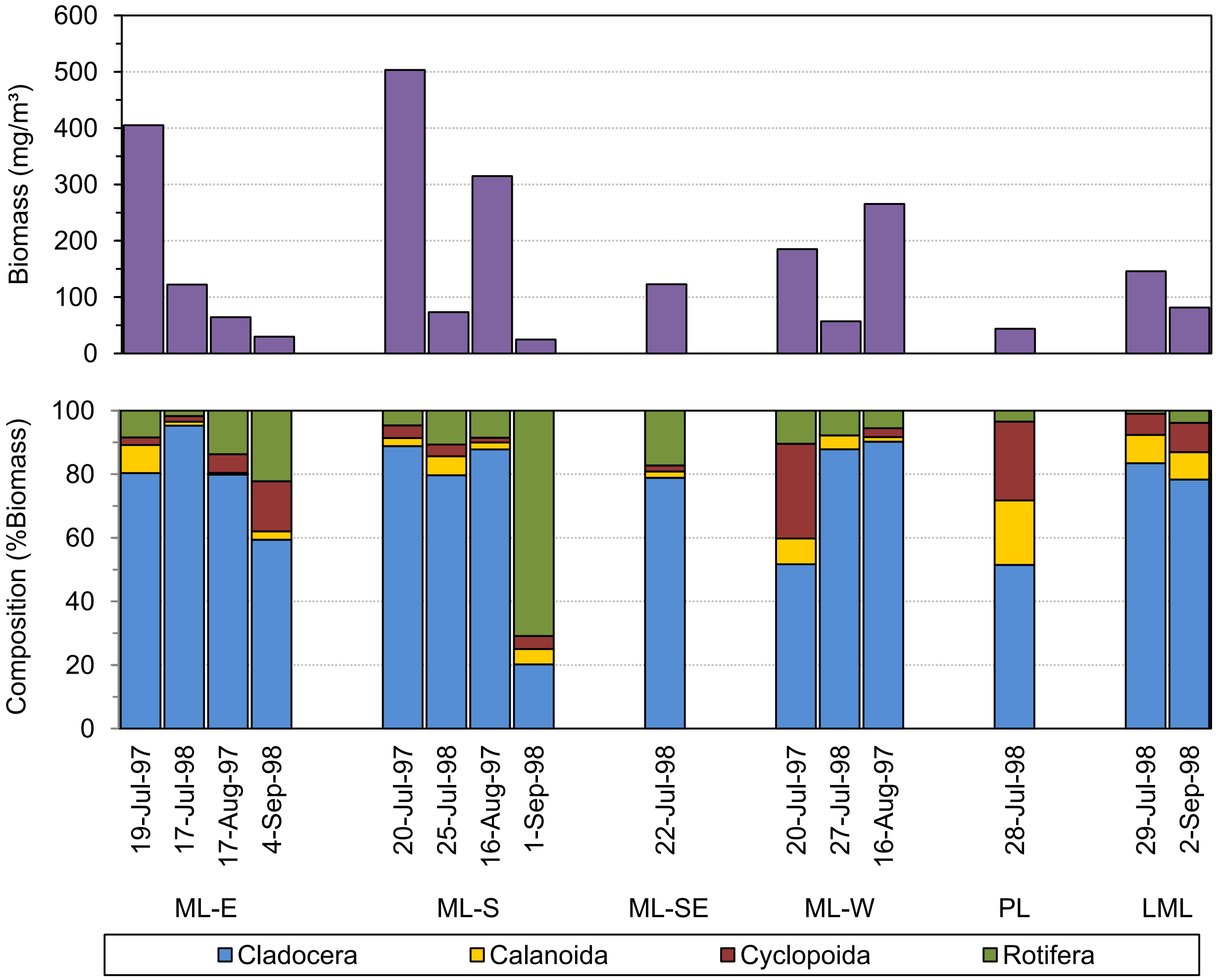


Figure 8-8: Zooplankton Biomass and Community Composition in the Large Lakes of the Meliadine Study Area, 1997 to 1998

Table 8-9: Zooplankton Density, Biomass and Taxonomic Richness in the Large Lakes of the Meliadine Study Area, 1997 to 1998

Site	Date	Density (No. indiv./m^3)	Biomass (mg/m^3)	Taxonomic Richness (No. taxa/site)
ML-E	19 Jul 97	460 071	405	18
	17 Aug 97	123 990	64	13
	17 Jul 98	32 204	122	22
	4 Sep 98	65 989	30	19
ML-S	20 Jul 97	288 137	503	19
	16 Aug 97	355 791	315	18
	25 Jul 98	83 843	73	22
	1 Sep 98	162 868	25	16
ML-W	20 Jul 97	319 785	185	19
	16 Aug 97	241 577	265	18
	27 Jul 98	52 002	57	16
ML-SE	22 Jul 98	244 711	123	20
PL	28 Jul 98	24 640	44	17
LML	29-Jul-98	27 111	146	22
	2 Sep 98	44 229	81	19

Note: No. = number; indiv. = individuals; m^3 = cubed metre; mg = milligram.

8.7.2 Peninsula Lakes

Zooplankton biomass in the Peninsula lakes ranged from 18 to 7287 mg/m^3. The biomass at most sites, however, ranged between 50 and 400 mg/m^3 (Figure 8-9). With the exception of sites B2 and B7, where biomass was exceptionally high during the summer, zooplankton biomass was similar between the Peninsula lakes and large lakes (i.e., Meliadine, Peter and Little Meliadine). Zooplankton biomass was consistently higher in the summer and in 1998.

Unlike the phytoplankton community which was fairly uniform among all sites, seasons and years, the zooplankton community was more variable, and patterns were difficult to detect (Figure 8-9). Sites A6 and A8 had high biomass of Calanoida in the summer, which were replaced by Rotifera and Cladocera, respectively, in the fall. Sites B2 and B7 were both dominated by Cladocera in the summer; however, Cladocera was still abundant in B7 in the fall, but Cyclopoida began to dominate in B2. Site B5 was represented by a diverse assemblage of taxa in the summer, but was dominated by Rotifera in the fall. Sites D7 and G2 were both dominated by Rotifera in both summer and fall. Similar to the large lakes, *Holopedium gibberum* was the most abundant cladoceran. *Asplanchna* spp. and *Keratella cochlearis* were the most abundant rotifers. *Leptodiaptomus minutus* and *Cyclops scutifer* were the largest contributors to Calanoida and Cyclopoida copepod biomass, respectively.

Trends of zooplankton density were notably different from zooplankton biomass, and the relationship between the two variables was weak (Table 8-10). When considering zooplankton density, Rotifera dominated the zooplankton community at each site; however, due to their small size, they did not make large contributions to the community biomass (Appendices E7 and E8).

A total of 42 zooplankton taxa were observed in the study area, but the number of taxa observed at one sampling location on a single date ranged from 7 to 22 (Table 8-10).

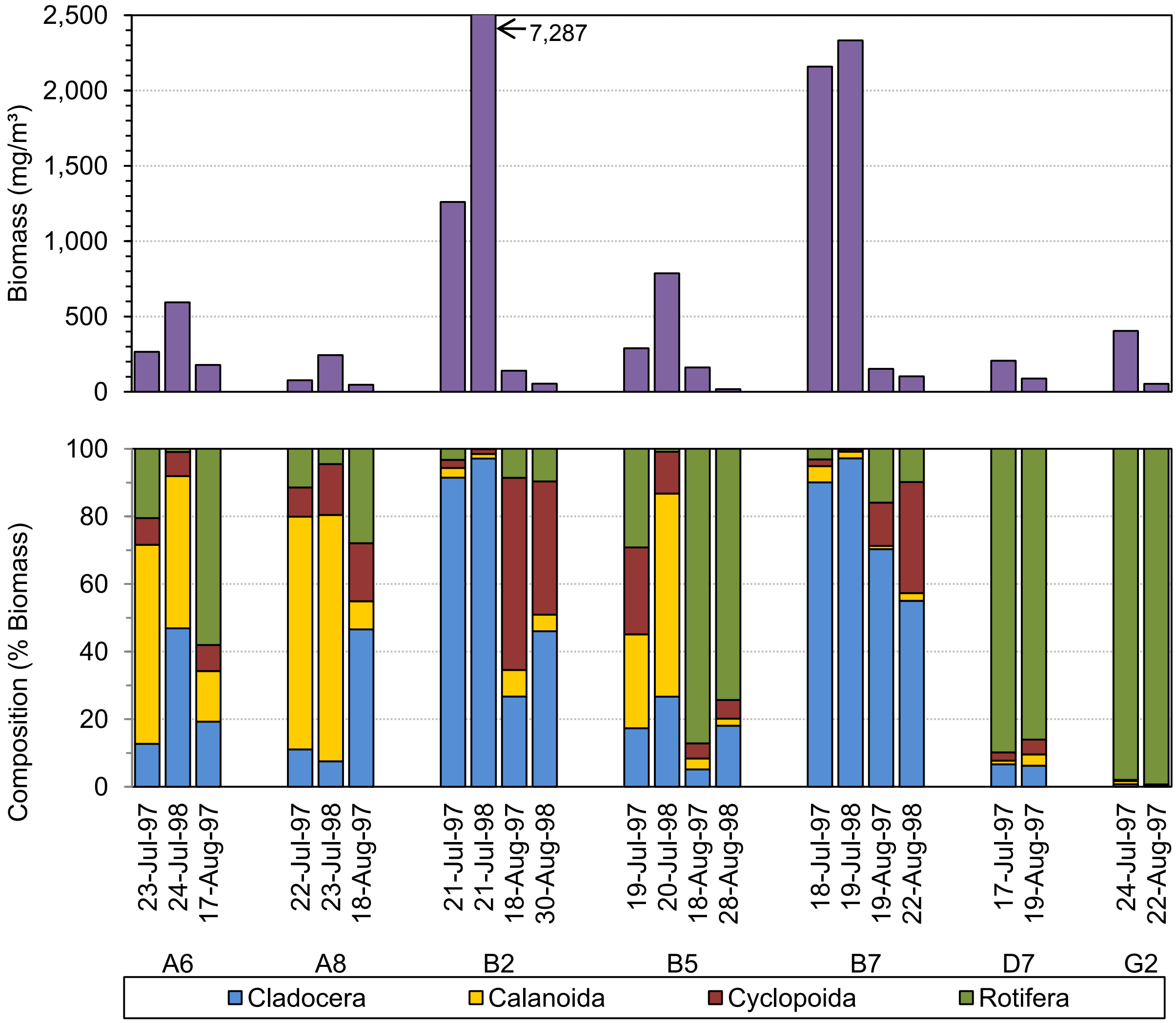


Figure 8-9: Zooplankton Biomass and Community Composition in the Peninsula Lakes of the Meliadine Study Area, 1997 to 1998

Table 8-10: Zooplankton Density, Biomass and Taxonomic Richness in the Peninsula Lakes of the Meliadine Study Area, 1997 to 1998

Site	Date	Density (No. indiv./m^3)	Biomass (mg/m^3)	Taxonomic Richness (No. taxa/site)
A6	23 Jul 97	763 545	265	16
	17 Aug 97	1 139 104	178	18
	24 Jul 98	127 278	594	21
A8	22 Jul 97	153 737	77	17
	18 Aug 97	26 047	47	15
	23 Jul 98	156 284	243	18
B2	21 Jul 97	594 544	1261	21
	18 Aug 97	264 494	140	15
	21 Jul 98	119 581	7287	22
	30 Aug 98	78 889	54	19
B5	19 Jul 97	840 204	289	16
	18 Aug 97	760 282	162	16
	20 Jul 98	210 653	786	19
	28 Aug 98	135 633	17	18
B7	18 Jul 97	637 546	2159	17
	19 Aug 97	353 755	153	14
	19 Jul 98	72 429	2333	19
	22 Aug 98	159 397	103	23
D7	17 Jul 97	1 614 279	207	13
	19 Aug 97	744 163	88	15
G2	24 Jul 97	2 598 011	404	12
	22 Aug 97	737 978	53	7

Note: No. = number; indiv. = individuals; m^3 = cubed metre; mg = milligram.

8.8 Benthic Macroinvertebrates

A total of 10 lakes and 10 streams/rivers were sampled in 1997 in the study area, and 11 lakes and 11 streams/rivers were sampled in 1998 (Figure 8-1; Table 8-1). Benthic invertebrate data are presented in Appendices E9 to E14.

8.8.1 Streams

8.8.1.1 Meliadine Lake Outflows and Lower Meliadine River

Benthic invertebrate density in Meliadine Lake outflows and Lower Meliadine River ranged from 4731 ± 962 individuals/m^2 at MR-L to 39 331 ± 7471 individuals/m^2 at ML-MR (1998 data; Figure 8-10; Table 8-11; Appendix E10). Streams ML-PL and MR-L had densities below 13 000 individuals/m^2 whereas ML-MR had densities greater than 29 000 individuals/m^2. There were too few sampling events to evaluate an annual trend in density.

Chironomidae was a very common taxonomic group in the Meliadine Lake Outflows and the Lower Meliadine River, comprising between 24% and 53% of total density (Figure 8-10). Oligochaeta was the second most common group in ML-MR, comprising 33% in 1997 and 23% in 1998. Coelenterata was common at ML-PL in 1997 (27%), but absent in 1998 when both Nematoda and Ostracoda comprised approximately 10% of invertebrate density. Nematoda was common at MR-L comprising 31% of total density. Differences in community structure among the streams of the Meliadine Study Area may be attributed, in part, to natural variation and differences in the physical habitat that was sampled (i.e., water depth, flow velocity, substrate composition).

Chironomidae communities were dominated by Orthocladiinae at each site, comprising over 90% of total density at ML-MR and between 62% and 79% at the remaining two sites (Figure 8-10; Appendix E11). The remaining Chironomidae taxa included Chironomini, Diamesinae, Tanypodinae or Tanytarsini.

Overall richness (no. taxa present at a site) for streams/rivers in the Meliadine Study Area included 47 taxonomic groups at the lowest level of identification (Table 8-11). Most taxa were identified to the family level, as a large number of individuals were not identified to genus. Richness at these sites (range: 11 ± 0 to 16 ± 1) was slightly lower than that of streams in Basins A, B and D (range: 14 ± 0 to 22 ± 1).

Simpson's Diversity Index (SDI) was also calculated for each site. SDI is based on the proportional distribution of organisms in a community, taking into account the number of taxonomic groups at a site as well as the abundance of each group. Values ranged from 0 to 1; values close to zero indicate low diversity and a small number of taxa can be very dominant. Values close to one indicate high diversity, where there are no strongly dominant taxa. SDI values ranged from 0.4 to 0.75 (Table 8-11). SDI at ML-PL was 0.4, while at the remaining sites SDI values were equal to or greater than 0.6, indicating moderate diversity with very few strongly dominant taxa.

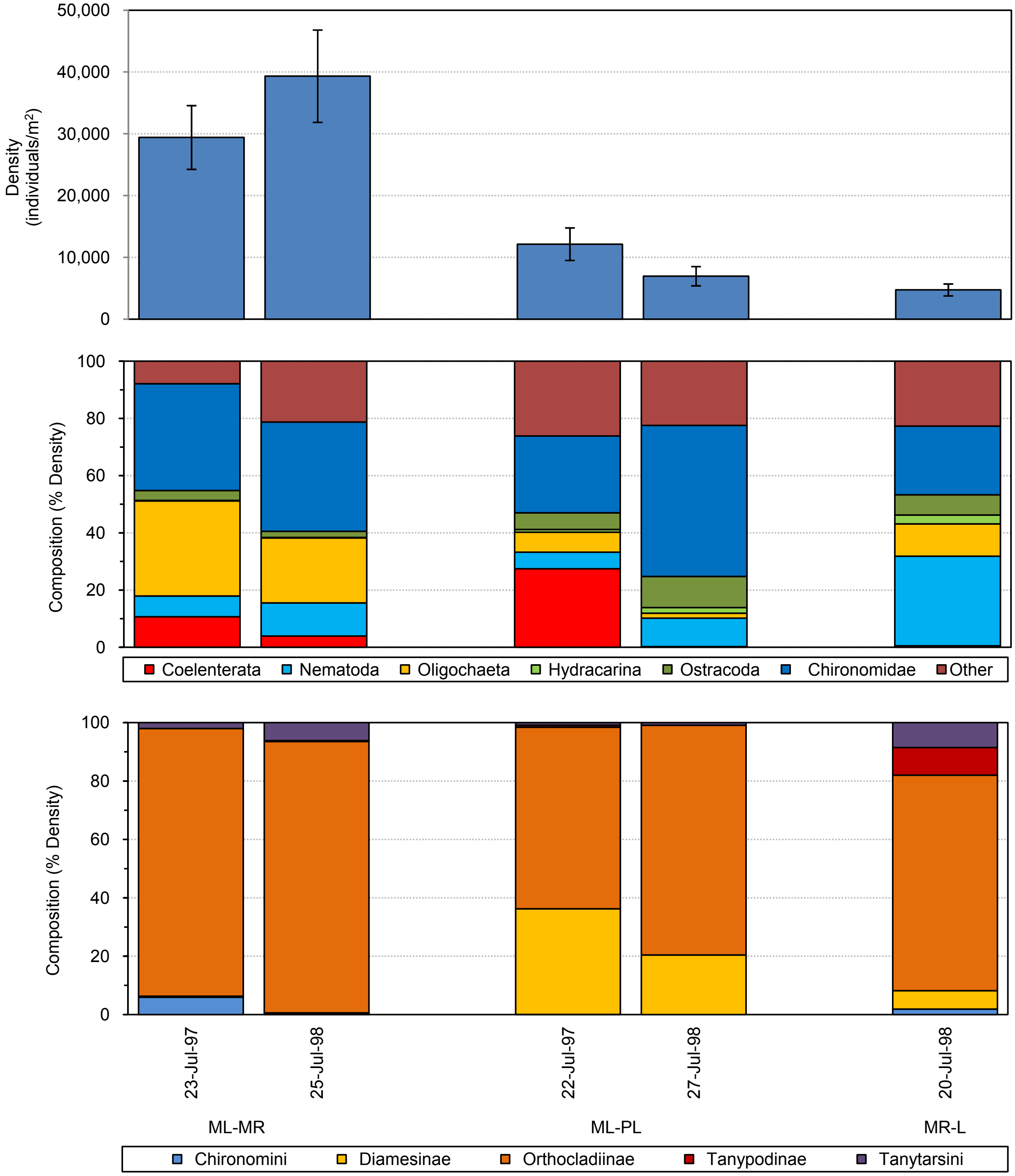


Figure 8-10: Benthic Macroinvertebrate Density, Community Composition, and Chironomidae Composition in the Meliadine Lake Outflows and Lower Meliadine River of the Meliadine Study Area, 1997 to 1998 (error bars represent ±1 standard error)

Table 8-11: Benthic Invertebrate Density, Taxonomic Richness and Simpson's Diversity Index in the Meliadine Lake Outflows and Lower Meliadine River of the Meliadine Study Area, 1997 to1998

Site	Date	Density (No. indiv./m^2 ± 1 SE)	Taxonomic Richness (No. taxa/site ± 1 SE)	Simpson's Diversity Index
ML-MR	23 Jul 97	29 412 ± 5161	11 ± 0	0.60
ML-MR	25 Jul 98	39 331 ± 7471	16 ± 1	0.62
ML-PL	22 Jul 97	12 137 ± 2635	15 ± 1	0.75
ML-PL	27 Jul 98	6 960 ± 1554	12 ± 1	0.40
MR-L	20 Jul 98	4 731 ± 962	16 ± 1	0.75

Note: No. =number; indiv. = individuals; m^2 = square metre, SE = standard error.

8.8.1.2 Basin A, B and D Streams

Benthic invertebrate density in streams located in Basins A, B and D ranged from 8853 ± 1255 individuals/m^2 in D6-7 (1997 sampling event) to 45 043 ± 2119 individuals/m^2 (± 1 standard error) in A5-6 (1998 sampling event) (Figure 8-11; Table 8-12; Appendix B10). For the majority of sites, density was between 15 000 and 30 000 individuals/m^2. These densities are generally considered low in comparison to some lake environments with densities greater than 10^6 individuals/m^2 (Hynes 1970; Resh and Rosenberg 1984; Rosenberg and Resh 1993). In general, density was similar between years.

The benthic invertebrate community varied among sites with no consistently dominant taxon (Figure 8-11). For example, Chironomidae comprised the majority of invertebrate density in Streams A5-6, A7-8 and D6-7, while Streams B5-6 and B6-7 had low Chironomidae densities in 1998. Streams A5-6 and A7-8 were almost completely devoid of Coelenterata (hydroids), yet Streams B1-2 and B6-7 had large numbers of this taxon. Oligochaeta (aquatic earthworms) was very common in Streams B3-4, B4-5 (1998) and B5-6, but contributed far less to overall density in remaining sites. Other common taxa included Nematoda (roundworms), Hydracarina (water mites), and Ostracoda (seed shrimp). The community was generally similar for sites sampled in both years. Differences in the community structure among the streams of the Meliadine Study Area may be attributed, in part, to natural variation and differences in the physical habitat that was sampled (i.e., water depth, flow velocity, substrate composition).

The Chironomidae was dominated by Orthocladiinae at all but one site, B4-5 (1998), where Tanytarsini comprised over 50% of total chironomid density (Figure 8-11; Appendix B11). Tanytarsini was the second most common chironomid taxon at most sites. The remaining Chironomidae taxa included Chironomini, Diamesinae and Tanytarsini.

Overall richness for streams in the Meliadine Study Area is 47 taxa (Table 8-12). The number of taxa present at each site ranged from 16 ± 0 to 22 ± 1.

SDI values ranged from 0.26 to 0.79, with the majority of values equal to or greater than 0.65 (Table 8-12). This indicates that most streams have a moderate level of diversity with very few strongly dominant taxa.

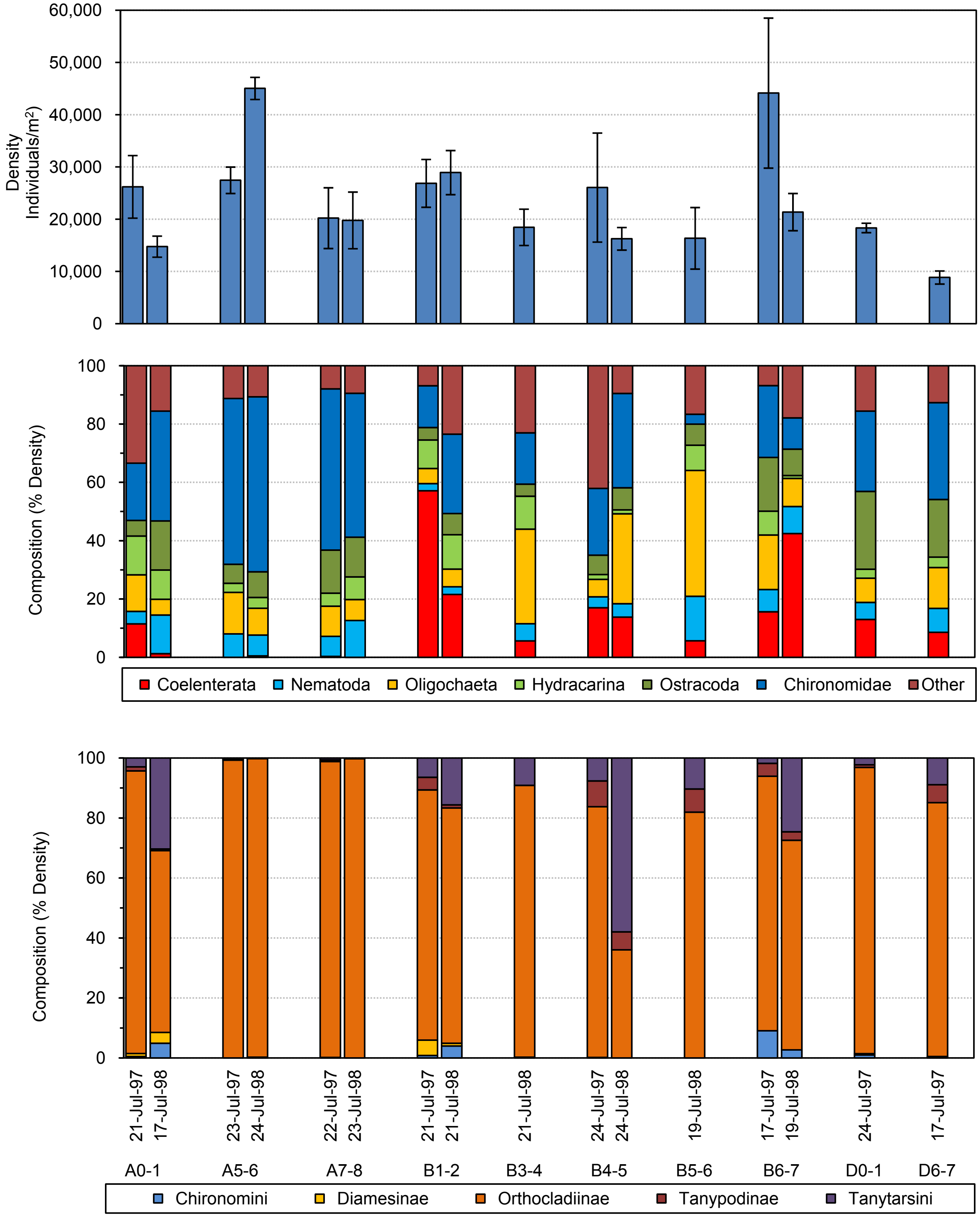


Figure 8-11: Benthic Macroinvertebrate Density, Community Composition, and Chironomidae Composition in the Basin A, B and D Streams of the Meliadine Study Area, 1997 to 1998 (error bars represent ±1 standard error)

Table 8-12: Benthic Invertebrate Density, Taxonomic Richness and Simpson's Diversity Index in the Basin A, B and D Streams of the Meliadine Study Area, 1997 to 1998

Site	Date	Density (No. indiv./m^2 ± 1 SE)	Taxonomic Richness (No. taxa/site ± 1 SE)	Simpson's Diversity Index
A0-1	21 Jul 97	26 202 ± 5992	17 ± 1	0.7
A0-1	17 Jul 98	14 759 ± 2015	19 ± 0	0.65
A5-6	23 Jul 97	27 462 ± 2529	14 ± 0	0.33
A5-6	24 Jul 98	45 043 ± 2119	19 ± 1	0.26
A7-8	22 Jul 97	20 215 ± 5812	16 ± 1	0.36
A7-8	23 Jul 98	19 779 ± 5423	16 ± 0	0.47
B1-2	21 Jul 97	26 871 ± 4576	17 ± 1	0.62
B1-2	21 Jul 98	28 935 ± 4222	16 ± 1	0.75
B3-4	21 Jul 98	18 457 ± 3479	18 ± 1	0.81
B4-5	24 Jul 97	26 071 ± 10 434	18 ± 1	0.71
B4-5	20 Jul 98	16 258 ± 2164	17 ± 1	0.68
B5-6	19 Jul 98	16 355 ± 5890	18 ± 0	0.75
B6-7	17 Jul 97	44 148 ± 14 355	18 ± 1	0.79
B6-7	19 Jul 98	21 371 ± 3560	17 ± 0	0.74
D0-1	24 Jul 97	18 337 ± 902	18 ± 2	0.78
D6-7	17 Jul 97	8 853 ± 1255	22 ± 1	0.72

Note: No. = number; indiv.= individuals; m^2 = metre; SE = standard error.

8.8.2 Lakes

8.8.1.1 Large Lakes

Benthic invertebrate density in the large lakes (Meliadine, Peter and Little Meliadine) ranged from 3171 ± 689 individuals/m^2 at ML-E (1997 sampling event) to 52 400 ± 22 865 individuals/m^2 at ML-SE (1998 sampling event; Figure 8-12; Table 8-13; Appendix B13). The majority of sites had densities between 4000 and 20 000 individuals/m^2. These densities were low considering some lake environments have densities greater than 10^6 individuals/m^2 (Hynes 1970; Resh and Rosenberg 1984; Rosenberg and Resh 1993).

The benthic invertebrate community varied among sites with no consistently dominant taxon (Figure 8-12). For example, Chironomidae was the dominant taxon at ML-E (1998 sampling event) comprising over 70% of total density. Conversely, Chironomidae was far less dominant at LML (1998 sampling event), comprising 18% of total density. Nematoda comprised over 37% of total density at ML-W (1997 sampling event) but was completely absent from ML-E (1998 sampling event). Other common taxa included Ostracoda and Copepoda (Harpacticoida). The differences in the community structure among the streams of the Meliadine Study Area may be attributed, in part, to natural variation and differences in the physical habitat that was sampled (i.e., water depth, flow velocity, substrate composition).

The composition of the Chironomidae showed a consistent pattern in terms of dominant taxa. Tanytarsini comprised over 95% of total density at ML-SE (1998 sampling event), but less than 13% at ML-E (both sampling events; Figure 8-12; Appendix B14). Chironomini comprised close to 50% of total density at ML-S (1998 sampling event) and less 5% at ML-SE (1998 sampling event). Other chironomid taxa included Diamesinae, Prodiamesinae, Orthocladiinae and Tanypodinae.

Overall richness for lakes in the Meliadine Study Area was 28 taxa (Table 8-13). Richness at these sites (range: 6 ± 1 to 10 ± 1) was lower than those in the corresponding streams (range: 11 ± 0 to 16 ± 1).

SDI values ranged from 0.46 to 0.78, indicating a moderate level of diversity (Table 8-13) with few strongly dominant taxa. Three sites, ML-E (1998 sampling event), ML-S (1997 sampling event), and ML-SE (1998 sampling event), had values below 0.60. The remaining sites had values of 0.60 or greater.

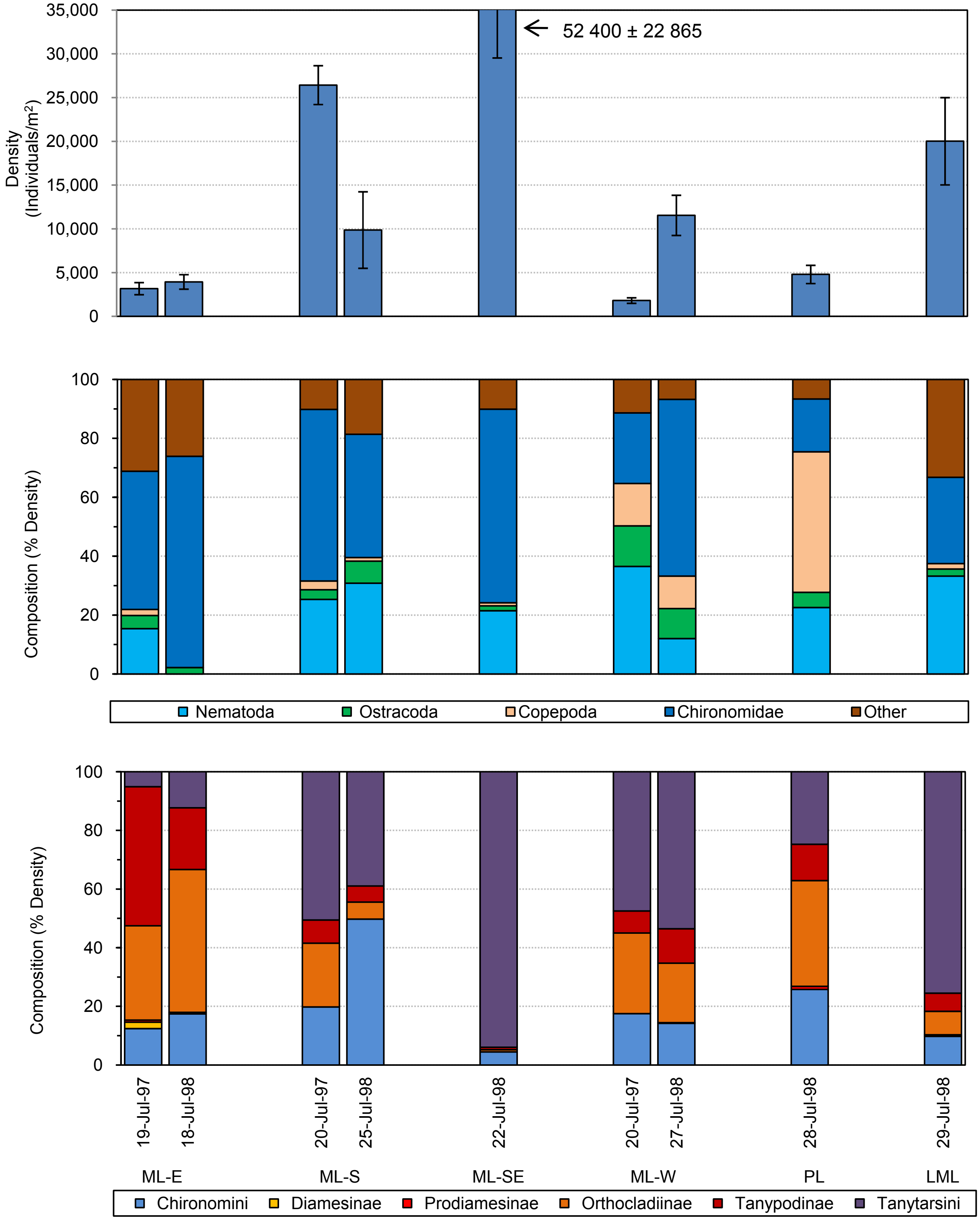


Figure 8-12: Benthic Macroinvertebrate Density, Community Composition, and Chironomidae Composition in the Large Lakes of the Meliadine Study Area, 1997 to 1998 (error bars represent ±1 standard error)

Table 8-13: Benthic Invertebrate Density, Taxonomic Richness and Simson's Diversity Index in the Large Lakes of the Meliadine Study Area, 1997 to 1998

Site	Date	Density (No. indiv./m^2 ± 1 SE)	Taxonomic Richness (No. taxa/site ± 1SE)	Simpson's Diversity Index
ML-E	19 Jul 97	3 174 ± 689	9 ± 1	0.73
	18 Jul 98	3 942 ± 827	6 ± 1	0.46
ML-S	20 Jul 97	26 435 ± 2217	15[a]	0.59
	25 Jul 98	9 870 ± 4371	7 ± 1	0.71
ML-SE	22 Jul 98	52 400 ± 22 865	9 ± 1	0.52
ML-W	20 Jul 97	1 815 ± 315	7 ± 1	0.77
	27 Jul 98	11 551 ± 2293	10 ± 1	0.60
PL	28 Jul 98	4 797 ± 1039	10 ± 0	0.78
LML	29 Jul 98	20 017 ± 4985	8 ± 1	0.69

No.= number, indiv.= individuals, m^2 = square metre, SE = standard error.
[a] Only one sample was collected from this site, therefore, no standard error was calculated.

8.8.1.2 Peninsula Lakes

Benthic invertebrate density in the Peninsula lakes was higher than in the large lakes, ranging from 10 193 ± 1494 individuals/m^2 at A8 (1997 sampling event) to 248 812 ± 47 006 individuals/m^2 at A8 (1998 sampling event; Figure 8-13; Table 8-14; Appendix B13). The majority of sites had densities between 15 000 and 57 000 individuals/m^2, which are low considering some lake environments have densities greater than 10^6 individuals/m^2 (Hynes 1970; Resh and Rosenberg 1984; Rosenberg and Resh 1993).

The benthic invertebrate community varied among sites and there was no consistently dominant taxon (Figure 8-13). For example, Chironomidae comprised over 64% of total density at sites A8 and B7 (1998 sampling events), and less than 5% of total density at sites B7 and D7 (1997 sampling events). Similarly, Ostracoda comprised over 50% of total density at B2 (1998 sampling event) and D7 (1997 sampling event), and less than 3% at A6 (1997 sampling event) and A8 (both sampling events). Other common taxa included Nematoda and Copepoda (Harpacticoida). Differences in the community structure among the streams of the Meliadine Study Area may be attributed, in part, to natural variation and differences in the physical habitat that was sampled (i.e., water depth, flow velocity, substrate composition).

The Chironomidae was dominated by Tanytarsini at all but two sites, comprising over 45% of total density (Figure 8-13; Appendix B14). At A6 (1998 sampling event) and D7 (1997 sampling event), Chironomini was the dominant taxon, comprising over 60% of total density. Other chironomid taxa included Diamesinae, Orthocladiinae and Tanypodinae.

Overall richness for the Peninsula lakes in the Meliadine Study Area was 28 taxa (Table 8-14). As expected, richness at these sites (range: 7 ± 0 to 10 ± 2) was lower than in the corresponding streams (range: 14 ± 0 to 22 ± 1).

SDI values ranged from 0.46 to 0.81, indicating a moderate level of diversity (Table 8-14) with few strongly dominant taxa. All but two sampling events, A8 (1998) and B7 (1998), yielded values higher than 0.60.

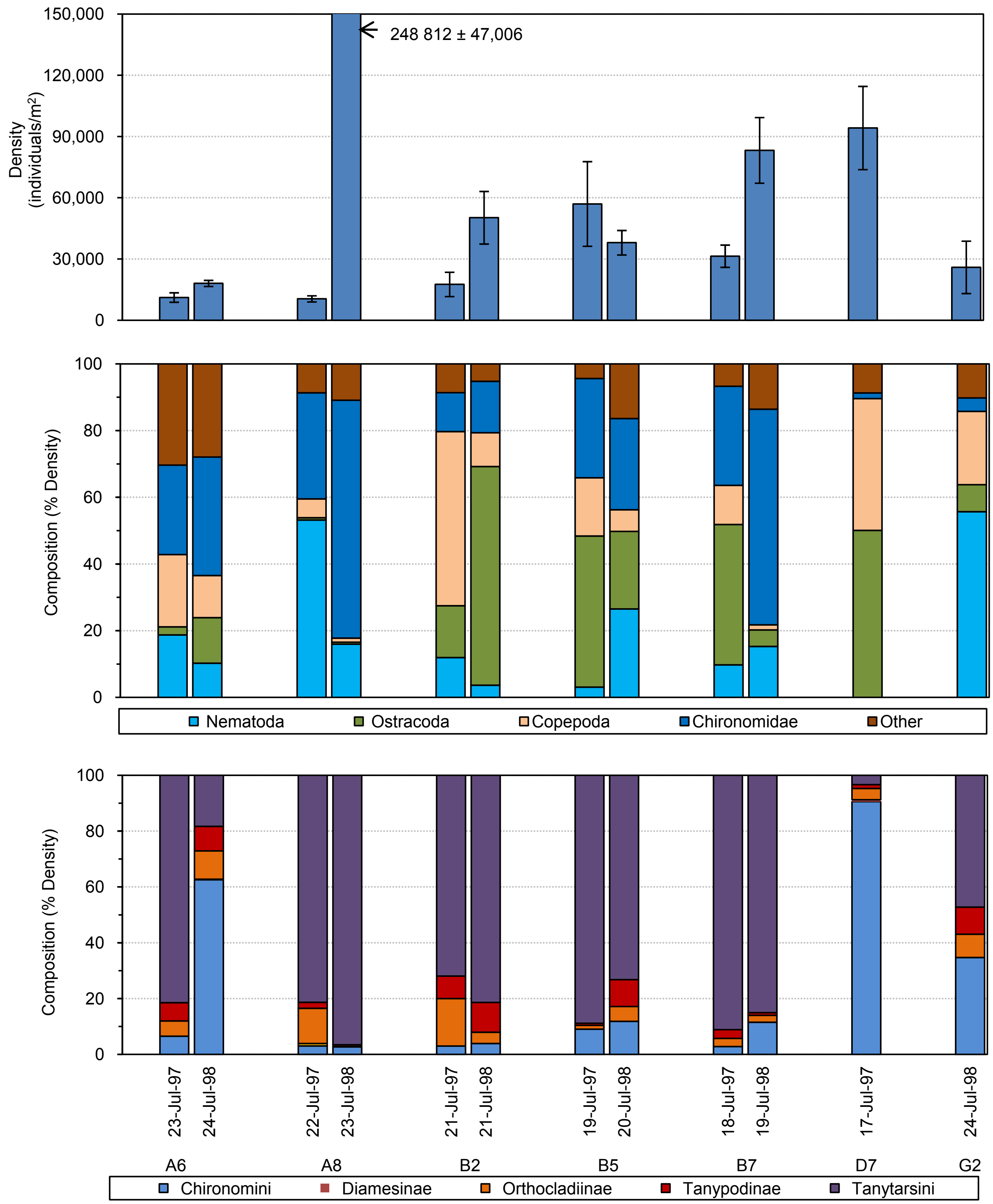


Figure 8-13: Benthic Macroinvertebrate Density, Community Composition, and Chironomidae Composition in the Peninsula Lakes of the Meliadine Study Area, 1997 to 1998 (error bars represent ± 1 standard error)

9.2.2.2 Peninsula Lakes

In total, 20 Peninsula lakes were sampled from 1997 to 2000 and in 2008 and 2009. In total, 2 329 fish were collected from Peninsula Basin lakes comprising 42.5% of fish captured in Peninsula Basins and 11.8% of all fish caught in the Meliadine Study Area. Fish were captured from all Lakes except A2, B4, D2, D4, and D5. The catch was dominated by Ninespine Stickleback (39.6%) followed closely by Arctic Grayling (38%). Proportionally, Cisco (10.3%) were next in abundance followed by Threespine Stickleback (6.8%), Arctic Char (3.5%), and Burbot, Lake Trout, and Round Whitefish at less than 1%. No Slimy Sculpin were captured (Figure 9-11).

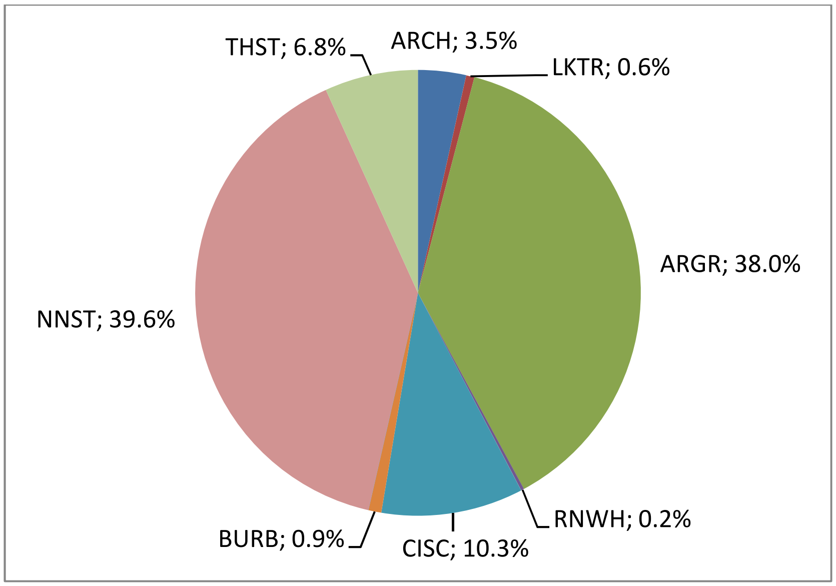


Figure 9-11: Relative Proportion of Species Captured in Peninsula Basin Lakes (all sampling methods and seasons combined)

Sampling techniques included angling (27.3 rod-h), electrofishing (1081 s), fyke (486 h) and gill netting (103.8 net-units), and minnow trapping (1431 h). Techniques were often used in combination (e.g., electrofishing and minnow trapping) depending on the purpose of the investigation. Proportionally, the majority (78.8%) of fish were captured in fyke nets. Gill nets, electrofishing, minnow traps angling, capturing proportionally less fish at 16.1%, 3.4%, 0.9%, and 0.7% respectively.

Gill nets were relied upon most heavily to sample Peninsula Basin lakes. CPUE values varied among species with Arctic Grayling captured most effectively by gill nets, followed by Cisco and Arctic Char. Similar to the electrofishing results from the Peninsula streams, Lake Trout and Arctic Char were captured mainly in the lower parts of each basin and were absent from lakes near the headwaters (Figure 9-12). CPUE values ranged among lakes as well with ranging from 3.1 (D7) to 9.7 fish/net-unit (A6). Of the 3 basins, gill netting was most productive in the A Basin (7.0 fish/net-unit) compared with the B and D Basins that had very similar CPUE values (5.1 and 5.0 fish/net-unit). Reasons for slightly higher CPUE values from the A Basin may include the location of the basin relative to Meliadine Lake, greater habitat potential for fish, or differences in the abundance of fish.

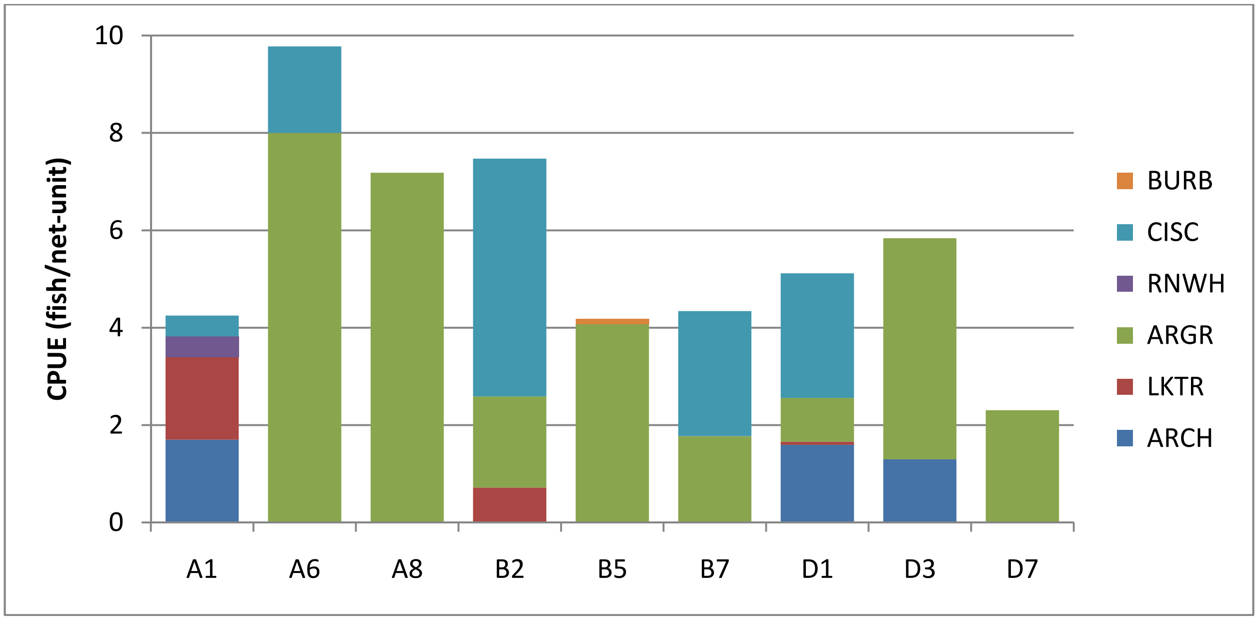


Figure 9-12: Comparison of Gill Net CPUE Values for Peninsula Lakes

Lake A6

Lake A6 was investigated in 1997, 1998, and 2009. In total, 221 fish were captured using minnow traps and fyke and gill nets. Arctic Grayling comprised the majority of the catch (95%) followed to a lesser extent by Ninespine Stickleback (2.3%), Cisco (1.8%), and Threespine Stickleback (0.5%). In 2009, a fyke net, the most productive (89.6% of fish captured) sampling tool used at the lake, was using in combination with gill nets to sample fish from the northeast bay, an area slated to be dammed and drained in preparation for mining operations. Gill nets were also used in 1997 and 1998 to sample fish from deeper areas (>1.5 m) of the lake; gill nets accounted for 9.9% of the catch. Catch per unit effort for gill nets ranged widely from 6 to 21.6 fish/net unit, however catches were relatively small overall (Table 9-9). Minnow traps were only used in 2009 capturing only one Ninespine Stickleback.

Table 9-9: Fish Capture Methods, Effort, and Catch for Lake A6

Method	Effort	Species				Total	CPUE
		ARGR	CISC	NNST	THST		
Fyke net	41.3 trap-h	193		4	1	198	4.8 fish/h
Gill net	2.25 net-units	18	4			22	9.78 fish/net unit
Minnow traps	235.75 trap-h			1		1	0.10 fish/24h
TOTAL		**211**	**4**	**5**	**1**	**221**	

Note: ARGR = Arctic Grayling; CISC = Cisco; NNST = Ninespine Stickleback; THST = Threespine Stickleback

Lake A52

The fish community in Lake A52 was sampled in 2008 using backpack electrofishing, gill and fyke nets, and minnow traps (Table 9-10). Ninespine Stickleback was the only species captured or observed. The fyke net captured over 500 fish of which 20 were randomly selected and measured (Appendix F11). In addition, more than 100 individuals were captured or observed during backpack electrofishing. In contrast, fish were not captured in the minnow traps, despite considerable effort exerted (144 trap-h). Similarly, fish were not captured in the gill net because the mesh size (25 mm) was too large to capture small-bodied fish such as Ninespine Stickleback. The absence of fish in the gill net catch suggested that Lake A52 did not provide suitable habitat for large-bodied fish such as Arctic Grayling or Cisco, even though these species have been previously documented in nearby Lake A6 and Arctic Grayling in connecting watercourses in the area.

Table 9-10: Fish Capture Methods, Effort, and Catch for Lake A52

Method	Effort	Species	Number Captured	Size Range (mm)	CPUE
Gill net	48.5 net-h	-			0 fish/net-h
Backpack electrofishing	381 s	Ninespine Stickleback	>100	-	>26 fish/100s
Minnow traps	144 trap-h	-			0 fish/trap-h
TOTAL			**>600**		

Lake B6

Lake B6 was sampled in both 1997 and 2008. The lake was sampled by angling in July 1997 when 2 Arctic Grayling adults were captured (RL&L 1998). In 2008, fish were sampled using a small fyke net set on the northeast shore of the lake for 43.5 h (Table 9-11). The total catch of 10 fish included one Arctic Grayling, 3 Cisco, and 6 Ninespine Stickleback.

Table 9-11: Fish Capture Methods, Effort, and Catch for Lake B6

Method	Effort	Species	Number Captured	Size Range (mm)	CPUE (fish/trap-h)
Small fyke net	43.5 trap-h	Arctic Grayling	1	134	0.02
		Cisco	3	172 to 178	0.07
		Ninespine Stickleback	6	43 to 61	0.14
TOTAL			**10**		**0.23**

Lake B7

Lake B7, along with several small peripheral ponds, is being considered as a potential location to store tailings. As such the lake was studied extensively with investigations aimed at describing the fish community as well as estimating the size of the Arctic Grayling population. The lake was sampled in 1997, 1998, and in 2008 using angling, and fyke and gill netting. Efforts resulted in a total catch of 358 fish, accounting for 16% of the total catch in Peninsula Basin lakes.

In 1997 and 1998, the lake was sampled by angling (6.8 rod-h) and gill netting (9.8 net-units). The catch included 14 Arctic Grayling and 15 Cisco. In addition one Burbot was found dead near the outlet. Gill netting was more effective in capturing fish in 2008 (15.6 fish/net-unit) as compared to CPUE values ranging from 1.6 to 7.4 fish/net-unit in 1997 and 1998. Sampling periods were comparable among years (July-August) so differences in catch may be a result of net location. In 2008, gill netting (1.5 net-units) was used to catch fish as part of a population estimate for Arctic Grayling. As such, nets were set for short periods of time (e.g., 0.5 h) and were moved frequently throughout the lake as opposed to longer sets and fewer locations in 1997 and 1998.

In 2008, efforts were focused on estimating the size of the Arctic Grayling population. Fish were collected during both a mark and a recapture phase using an Arctic fyke net (138.5 h) set on the southeast shore and numerous short-duration gill nets sets. The total catch of 318 fish included 293 Arctic Grayling, 19 Cisco, 4 Ninespine Stickleback, and 2 Burbot (Figure 9-13).

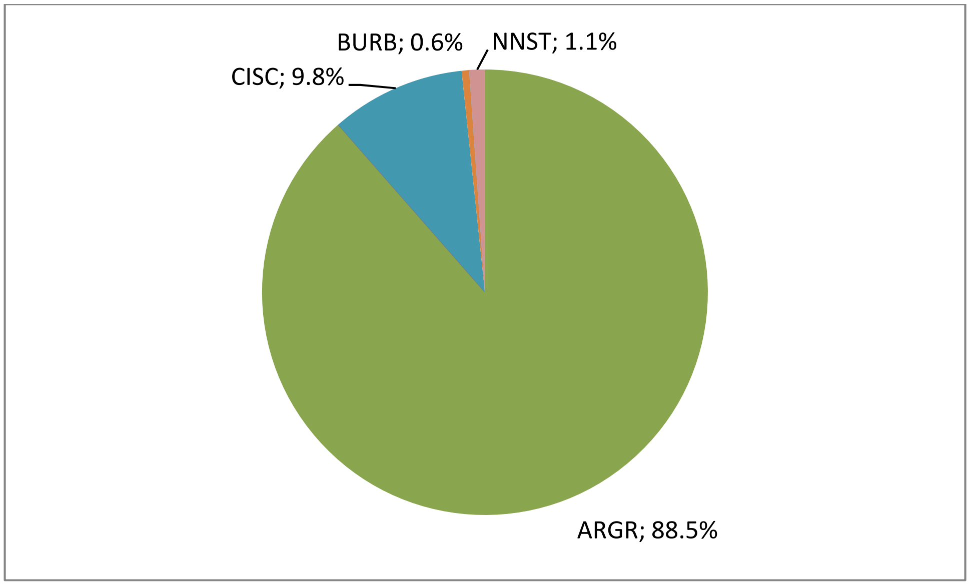


Figure 9-13: Relative Proportion of Species Captured from Lake B7
(all sampling methods and seasons combined)

Although CPUE was relatively low (2.2 fish/h), the fyke net was effective in capturing a wide-range of life-stages representing 4 species during both the mark and recapture phases of the assessment. Arctic Grayling (*n*=283) was the most prominent species captured, comprising 96% of the catch from the fyke net. Burbot, Cisco, and Ninespine Stickleback comprised the remainder of the catch. Gill nets were used to sample a large proportion of deep-water habitat at Lake B7 however fewer fish were captured compared with the fyke net.

Based on the modified Peterson method, the size of the Arctic Grayling population in Lake B7 was estimated at 1345 fish, with 95% confidence intervals ranging from 836 to 2507. The estimate was based on 188 fish marked in the first samples, 92 fish captured in the second sample; and 12 individuals in second sample that were marked. This estimate included both juvenile and adult fish. The variability of the estimate can be attributed to the fact that only 12 marked individuals were recaptured. The small number of recaptures may be a result of Arctic Grayling using the entire lake as a home range thereby reducing the probability of recapture at the same location as the original capture. It is also possible that marked fish became trap-averse resulting from the capture and mark procedures. The most probable explanation is that Arctic Grayling distributed themselves throughout the entire lake. Habitat quality in the lake was relatively homogenous; therefore, Arctic Grayling were no more likely to frequent the areas near the fyke net than the other areas of the lake. Further support for this idea is that only small fish (<220 mm), which typically move less than large fish, were recaptured.

Lake D1

Lake D1 was sampled from 1997 to 2000, and in 2009 using angling (10.3 rod-h), and fyke (127.5h) and gill nets (33.2 net-units). The goal of the investigations was to assess community composition, survey spawning Arctic Char, and to capture mature Arctic Char (current year spawners) for implantation of radio transmitters. Angling was used in 1997 and 2000 but yielded only one Lake Trout (0.1 fish/rod-h).

A fyke net was installed at the same location in 2000 and 2009. While effort was similar (58.5 h in 2000 versus 69 h in 2009), resulting catches differed substantially. In 2000, 611 fish were captured including 21 Arctic Char, 101 Arctic Grayling, 4 Round Whitefish, 78 Cisco, 19 Burbot, 233 Ninespine Stickleback, and 155 Threespine Stickleback (CPUE=10.4 fish/h). In contrast, only 150 fish were captured in 2009 with a CPUE almost 5 times lower than in 2000. The catch was comprised of one Arctic Char, 2 Lake Trout, 133 Arctic Grayling, 12 Ninespine Stickleback, and 2 Threespine Stickleback. The difference in catches is skewed by large numbers of Ninespine Stickleback. If these individuals are removed, CPUE values are more comparable (3.81 fish/h in 2000 versus 1.97 fish/h in 2009). Cisco and Burbot were not captured in 2009, whereas 78 and 19, respectively, were collected in 2000. These differences are likely a result of the timing of the investigations. In 2000, the lake was sampled during September as opposed to a July visit in 2009.

Other Lakes

- Lake A1 was investigated in 1997 using using angling (0.5 rod-h) and gill nets (2.4 net-units) resulting in the capture of 4 Arctic Char, 4 Lake Trout, 1 Round Whitefish and 1 Cisco.
- Lake A2 was investigated in 1997 using only angling (0.5 rod-h); no fish were captured.
- Lake A5 was investigated in 1997 using angling (0.5 rod-h), and in 2009 using electrofishing (596 s) and minnow traps (120 h) resulting in the capture of 7 Ninespine Stickleback.
- Lake A8 was investigated in 1997 and 1998 using only gill nets. Arctic Grayling (n=19) was the only species captured during 2.7 net-units of effort.
- Lake B2 was sampled in 1997 and 1998 using angling (1.5 rod-h) and gill nets (7.0 net-units) resulting in the capture of 5 Lake Trout, 17 Arctic Grayling, and 34 Cisco.
- Lake B4 was investigated in 1997 and 1998 using angling (0.5 rod-h) and gill nets (2.8 net-units). No fish were captured.
- Lake B5 was sampled in 1997 and 1998 using angling (1.5 rod-h) and gill nets (9.3 net-units) resulting in the capture of 39 Arctic Grayling, and 1 Burbot.
- Lake D2 was investigated in 1997 using only angling (0.4 rod-h); no fish were captured.
- Lake D3 was investigated in 1997 using only gill nets (1.5 net-units) resulting in the capture of 2 Arctic Char and 7 Arctic Grayling.

- Lake D4 was investigated in 1997 using angling (0.4 rod-h) and gill netting (5.7 net-units); no fish were captured.
- Lake D5 was investigated in 1997 using gill nets (4.5 net-units); no fish were captured.
- Lake D7 was sampled in 1997 angling (2.6 rod-h) and gill nets (2.6 net-units) resulting in the capture of 9 Arctic Grayling.
- Lake G1 was sampled only in 2009 using electrofishing (485 s), gill netting (3.92 net-units), and minnow trapping (190 trap-h) resulting in the capture of 88 Ninespine Stickleback. All but one of the fish (minnow trap) were collected by electrofishing (9.5 fish/min). No fish were collected using the gill net suggesting that the lake in inhabited only by small-bodied forage species.
- Lake G2 was sampled in 1997 using angling (0.8 rod-h) and gill nets (4.9 net-units); no fish were captured. In 2009, it was discovered that the lake is inhabited by fish when 7 Ninespine Stickleback were captured in a fyke net (89 h, CPUE=0.08 fish/h) and one in a minnow trap (0.04 fish/24h).
- Lake J1 was sampled in 2009 using gill nets (6.5 net-units) and minnow traps (195.3 trap-h) resulting in the capture of 14 Ninespine Stickleback.

9.2.2.3 Peninsula Ponds

In total, 76 ponds were sampled in 1997, 1998, 2008, and 2009. Fish were captured or observed in 33 of the ponds; fish presence, although possible in some ponds was not confirmed in the remaining 43 ponds (Appendix F11). In total, 169 fish were captured, comprising only 3.1% of fish captured in Peninsula Basins and 0.9% of all fish caught in the Meliadine Study Area.

The catch was dominated by Ninespine Stickleback (98.8% of total). Arctic Grayling (1.2%) were also captured; they were represented by 2 young-of-the-year fish from Pond H2, one captured by backpack electrofishing and one in a minnow trap in August 2008. Threespine Stickleback were not captured in any of the ponds. The absence of Threespine Stickleback is consistent with data collected from all waterbodies on the Peninsula Basin with 55.6% of the catch being comprised of Ninespine Stickleback with only 6.5% Threespine Stickleback, mainly in lowermost parts of the basins. In contrast, the catch in Meliadine Lake was dominated by Threespine Stickleback (62.2%) with no Ninespine Stickleback being captured

Sampling techniques included angling, electrofishing, fyke and gill netting, and minnow trapping (Table 9-12). Techniques were often used in combination (e.g., electrofishing and minnow trapping) depending on the morphometry of the pond (i.e., sufficient depth to set minnow traps). Proportionally, most fish (71%) were captured by electrofishing, followed by minnow traps (26.6%) and fyke nets (2.4%); no fish were captured by angling or gill nets.

Table 9-12: Sampling Effort and Fish Catch in Peninsula Ponds, 1998 to 2009

Method	Effort	Fish Captured	Proportion of Catch (%)	CPUE
Angling (rod-h)	2	0	0.0	-
Electrofishing (s)	22 736	120	71.0	0.32 fish/min
Fyke nets (h)	50	4	2.4	0.08 fish/h

Table 9-12: Sampling Effort and Fish Catch in Peninsula Ponds, 1998 to 2009 (continued)

Method	Effort	Fish Captured	Proportion of Catch (%)	CPUE
Gill nets (net-units)	40.9	0	0.0	-
Minnow traps (trap-h)	3450.5	45	26.6	0.01 fish/h
TOTAL	**-**	**169**	**100**	**-**

9.2.3 Little Meliadine Lake

Little Meliadine Lake was sampled on 6 occasions from 1997 to 2000. The purpose of the investigations were to describe the fish community and investigate seasonal use of the area by Arctic Char. Other waters sampled in the basin, sampled in 1998 and 2000, included Horseshoe Lake, HSL-W, the watercourse connecting Horseshoe Lake and Lake W, Lake W, and W-LML, the watercourse connecting Lake W and Little Meliadine Lake. Similar to Lake D1, these waterbodies were explored to assess spawning potential for Arctic Char.

Little Meliadine Lake basin was sampled using angling (15 rod-h), electrofishing (2825 s), and gill netting (42.2 net-units) resulting in the capture of 340 fish, 1.7% of the total catch in the Meliadine Study Area. Round Whitefish comprised the largest portion (26.8%), followed closely by Lake Trout and Arctic Grayling, both at 24.4%. Arctic Char (8.8%), Cisco (7.9%), Ninespine Stickleback (5.3%), Slimy Sculpin (2.1%), and a single Burbot (0.3%) (Figure 9-14).

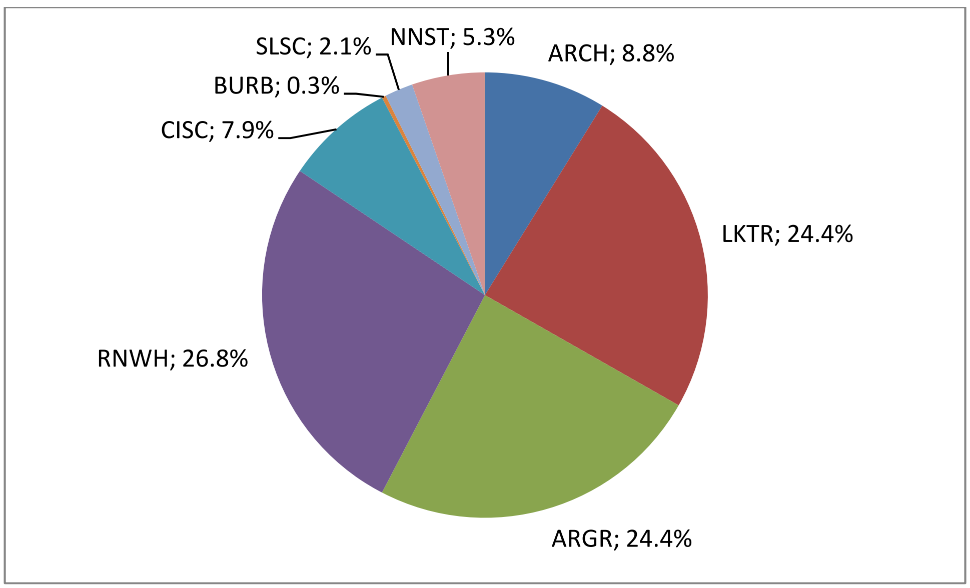


Figure 9-14: Relative Proportion of Species Captured from the Little Meliadine Lake Basin (all sampling methods and seasons combined)

Of the waters sampled in the basin, Little Meliadine Lake received the most focus (36 of 53 sampling events) and as a result, produced the majority of fish (n=208 or 61.2% of total basin catch), resulting from gill netting (34.7 net-units) from 1997 to 2000 and angling (11.0 rod-h) in 2000. Round Whitefish dominated the catch (43.8%), followed by Lake Trout (25.0%). Arctic Char (12.9%), with Cisco (9.6%), and Arctic Grayling (8.7%)

were also common. Also captured were Ninespine Stickleback (5.3%), Slimy Sculpin (2.1%), and a single Burbot (0.3%). Neither Ninespine Stickleback, Slimy Sculpin, nor Burbot were captured. The catch reflects the focus of the investigation in and the techniques used to sample Little Meliadine Lake. CPUE values for angling (1.0 fish/rod-h), and gill netting (5.7 fish/net-unit) were comparable to average values for the basin.

9.2.4 Meliadine River

The Meliadine River was sampled from 1997 to 1999 using angling (18.8 rod-h), electrofishing (3422 s), gill netting (2.5 net-units), and a fish fence (1650.7 h). Sampling efforts captured a total of 3834 fish, 19.4% of the total catch from the Meliadine Study Area. Anglers captured 15 fish (0.79 fish/rod-h), backpack electrofishing captured 55 fish (0.96 fish/min), and gill netting captured 3 fish (1.2 fish/net-unit). However the fish fence was the most productive sampling method producing 98.1% (*n*=3761) of the catch.

The fish fence was operated from 1997 to 1999 in the lower reaches of the Meliadine River (ML-L) to sample fish migrating into the river from Hudson Bay during late summer and early fall. The fish fence was operated during similar periods in 1997 (15 August to 3 September), 1998 (16 August to 2 September), and 1999 (10 August and 12 September 1999). The monitoring period in 1999 (34 d) was considerably longer than in 1997 (18 d) and 1998 (17 d), and was intended to assess early and late migrants that may not have been enumerated in the previous years.

Overall, the fish fence catch (n=3761) was dominated by Arctic Char (86.1%) followed by Arctic Grayling (7.0%), Round Whitefish (6.0%), and Lake Trout and Cisco at <1% (Figure 9-15; Appendix F8). The composition of catches at the fish fence changed through time with the relative proportions of Arctic Char decreasing from 1997 to 1999 in favor of Arctic Grayling and Round Whitefish.

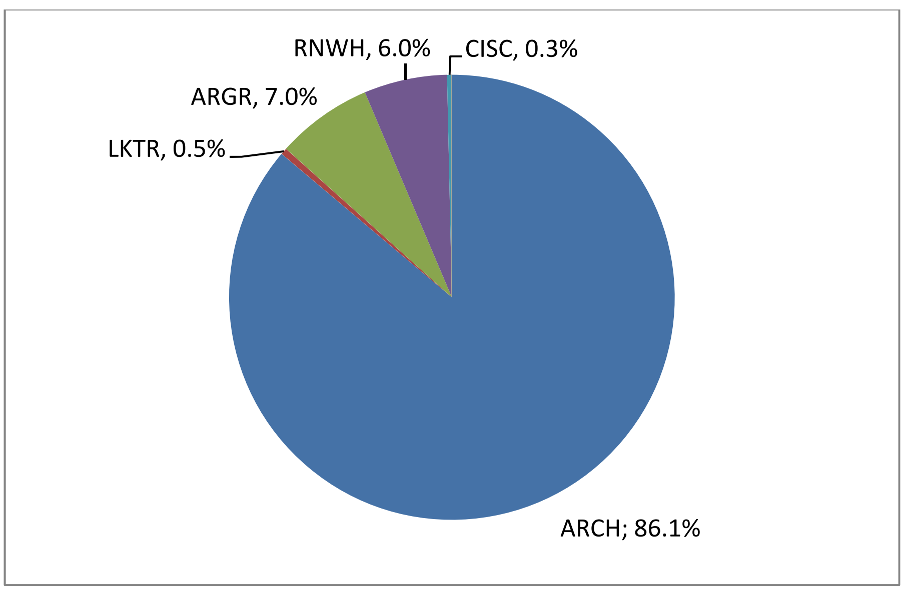


Figure 9-15: Relative Proportion of Species Captured from Meliadine River (all sampling methods and years combined)

In 1997, 1066 fish were captured; the catch consisted entirely of salmonid species, of which Arctic Char (*n*=1022) was predominant (95.9% of the catch). Other captured species included Round Whitefish (*n*=29), Arctic Grayling (*n*=13), and lake Trout (*n*=2). Although the total number of Arctic Char enumerated through the fish fence in 1998 (*n*=926) was slightly lower than in 1997, the numbers of other captured species (Round Whitefish, Arctic Grayling, Lake Trout, and Cisco) nearly doubled relative to the previous year catches (from 44 fish in 1997 to 80 fish in 1998). In 1999, 1689 fish were captured in the fish fence. The catch consisted entirely of salmonid species, of which Arctic Char (*n*=1292) was predominant (76.5% of the catch) (Appendix F8).

The total number of Arctic Char enumerated at the fish fence in 1999 (*n*=1292) was higher than in 1997 (*n*=1022) and 1998 (*n*=926). This increase in catch was mainly because of the longer period of operation; when compared over the period common to the 3 years of fish fence operations (16 August to 3 September). In contrast, the numbers of other captured species (Round Whitefish, Arctic Grayling, Lake Trout, and Cisco) increased considerably relative to the previous years' catches (from 44 fish in 1997 and 80 fish in 1998 to 397 fish in 1999). Most of this increase in 1999 was because of higher catches of Arctic Grayling (*n*=230) and Round Whitefish (*n*=146) relative to previous years (only 13 and 29 fish, respectively, were caught during 1997 fish fence operations).

Of note is the small increase in the numbers of Cisco captured by the fish fence in 1999 (*n*=11) relative to 1997 (*n*=0) and 1998 (*n*=2). The low numbers of Cisco captured during the 1997 to 1999 fish fence operations were in sharp contrast to the much higher catches of Cisco reported at the same location and season in 1990 (*n*=121 during 22 August to 10 September; McGowan 1992). This suggested that Cisco fall migrations into the Meliadine River may have decreased over the decade or may vary greatly from year to year.

The mean CPUE values for all fish combined were consistent between 1997, 1998, and 1999 (2.41, 2.50, and 2.09 fish/h, respectively). Arctic Char dominated the catch in all 3 years. Arctic Char CPUE values were similar in 1997 and 1998 (2.3 fish/h) but declined to 1.6 fish/h in 1999 (Figure 9-16). The lower values in 1999 were likely due to a more extended trap period which monitored movements during the less productive shoulder periods of the run. In contrast, CPUE values for Arctic Grayling increased from 0.03 fish/h in 1997 to 0.29 fish/h in 1999. Round Whitefish CPUE values also increased consistently during this period (from 0.07 fish/h in 1997 to 0.18 fish/h in 1999). CPUE values for Lake Trout and Cisco were low (less than 0.02 fish/h) throughout the fish fence monitoring period

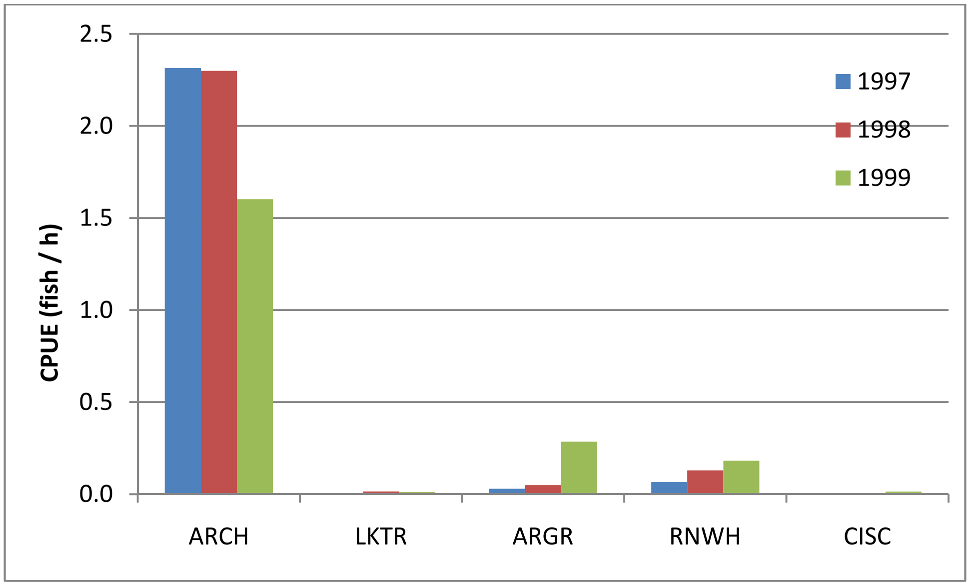


Figure 9-16: CPUE Values for Species Captured in the Meliadine River Fish Fence, 1997 to 1999

Arctic Char CPUE values varied with the sampling period in each of the sampling years (Figure 9-17). In 1997, Arctic Char CPUE values increased gradually during the first 10 days of fish fence operation (from 0.26 fish/h on 16 August to 4.67 fish/h on 25 August); subsequently they declined to 0.77 fish/h on 2 September. The peak of upstream movements by Arctic Char occurred between 18 and 28 August, when 829 fish were enumerated (mean CPUE value of 3.14 fish/h).

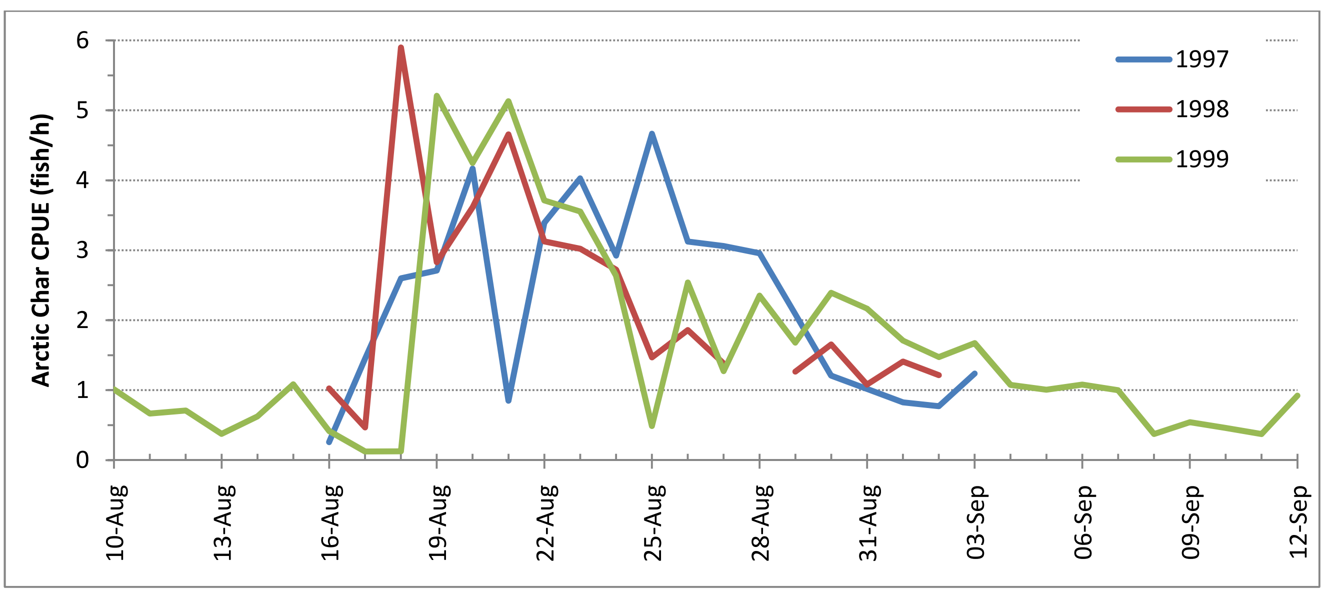


Figure 9-17: Daily Catch Rates for Arctic Char in the Meliadine River Fish Fence, 1997 to 1999

In 1998, Arctic Char CPUE values increased sharply during the third day of fish fence operation (from 0.5 fish/h on 17 August to 5.9 fish/h on 18 August); subsequently they declined to 1.2 fish/h on 2 September, when the fish fence was dismantled. The peak of Arctic Char upstream movements occurred between 18 and 24 August, when 617 fish were enumerated (mean CPUE value of 3.7 fish/h); this period coincided with a sharp drop in the water temperature.

In 1999, CPUE values of Arctic Char varied between 0.12 and 1.08 fish/h during the first 9 days of fish fence operation; CPUE values increased considerably (3.55 to 5.21 fish/h) during the following 5 days (19 to 23 August). Subsequently, CPUE values generally declined to less than 1.1 fish/h after 4 September. Most of the Arctic Char upstream movements in 1999 occurred between 19 and 31 August, when 898 fish were enumerated (mean CPUE value of 2.87 fish/h); the onset of this period coincided with a decrease in water temperature.

None of the Arctic Char captured at the fish fence in 1997 to 1999 were in pre-spawning condition. This suggested that the current year spawners did not migrate to the sea in the spring and spent the entire year in freshwater.

9.2.5 Parallel Lake

Parallel Lake (located approximately 12 km north of Meliadine Lake) was sampled in 1998 to collect fish for monitoring metal concentrations in fish tissues. Variable-mesh experimental gill nets (11.9 net-units) and angling (7 rod-h) were employed to sample deep water habitats. These efforts resulted in a total catch of 49 fish, accounting for 0.2% of the total catch in the Meliadine Study Area. Lake Trout (*n*=31) dominated the catch (63.2%), followed by Round Whitefish (*n* = 12, 24.5%) and Cisco (*n* = 6, 12.2%).

9.2.6 Chickenhead Lake

The fish community in Chickenhead Lake was sampled in August 2008 using a fyke net (42.8 h), gill nets (1.9 net-units), and minnow traps (94 trap-h). These efforts resulted in a total catch of 30 fish, accounting for 0.2% of fish captured from the Meliadine Study Area. Lake Trout were most prevalent (*n* = 17) accounting for 57% of the catch followed closely by Arctic Grayling (*n*=12, 40%). One Burbot was also captured.

9.3 Life History

Length, weight, age and diet statistics for fish captured during 1997 to 2009 are presented in Appendices F12 through F20. Length-frequency summaries, length-weight regressions, relative weight calculations and length-at-age analyses were performed for each basin to facilitate comparisons among watersheds. The results are briefly described, by species, in the following sections.

9.3.1 Arctic Char

9.3.1.1 Size Distribution

The length frequency distribution of the overall Arctic Char catch (*n*=3879) was widespread with fork lengths ranging from 61 to 777 mm. Three distinct modes were noted (Figure 9-18, A; Appendix 12a). The smallest mode was centred on 80 to 100 mm and consisted primarily of fish captured by fyke nets in the east basin of Meliadine Lake and backpack electrofishing in Peninsula streams (Figure 9-18, B and C). The second mode (160 to 240 mm in fork length) was comprised mostly of fish captured by fyke net in the east basin of Meliadine Lake (Figure 9-18, B). The third and largest mode (300 to 670 mm in fork length) consisted of large adults caught in the fish fence at Meliadine River when returning from the sea (Figure 9-18, A). Several adult Arctic

Char (*n*=26) were captured in Little Meliadine Lake (Figure 9-18, A). Both Meliadine Lake (*n*=473; 70 to 780 mm in fork length) and Basin D (*n*=91; 70 to 620 mm in fork length) had the most diverse representation of all size classes in the Meliadine Study Area (Figure 9-18, B and C). The largest Arctic Char in the sample (777 mm in fork length) was captured by a gill net near the west outflow from Meliadine Lake.

The size distribution of Arctic Char in Meliadine Lake is noteworthy (Figure 9-18, B). The majority of Arctic Char captured (*n*=438) in the east and south basins of Meliadine Lake were less than 300 mm. The smaller size class is in contrast to the predominately large fish (mean of 622 mm; SD ± 143; *n*=30) caught by gill net in the west basin of Meliadine Lake. Sampling efforts in 1997 and 1998 consisted primarily of fyke nets in the east and south basins of Meliadine Lake. Targeted sampling to obtain fish for radio transmitter implantation close to the west outflow of Meliadine Lake in 1999 and 2000 resulted in the capture of the large adults in pre-spawning condition.

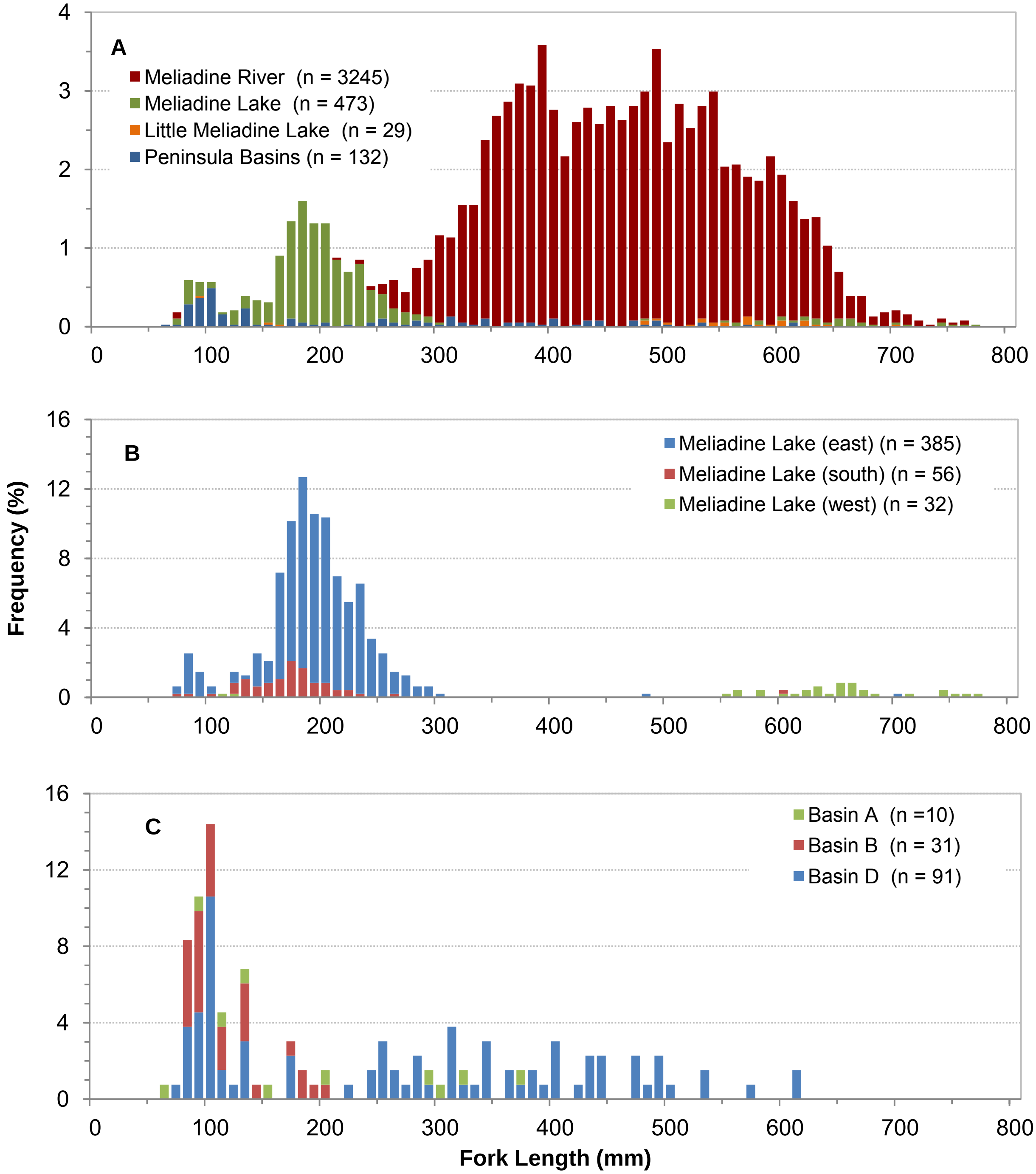


Figure 9-18: Length-frequency Distribution of Arctic Char Captured in the Meliadine Study Area (A), Meliadine Lake (B) and Peninsula Basins (C), 1997-2009

9.3.1.2 Size Distribution of Returning Adults

The size distribution of the Arctic Char run captured by the fish fence in 1997, 1998 and 1999 (n=3240) indicated significant differences between the early, middle, and late stages of the run (F = 523.31, df = 4, 3235, p <0.001) (Figure 9-19). Grouping the catch data from all 3 years, the mean fork length of Arctic Char captured during the first stage of the fish fence (i.e., 10 to 15 August) was 594 mm (SD ± 612 mm; n=109), and gradually decreased to 456 mm (SD ± 812 mm; n=1166) during the week 22 to 27 August, and to 351 mm (SD ± 79 mm; n=153) by 3 to12 September. These results indicated that the larger size-classes return from the sea earlier than the smaller size-classes and the final phases of the run are dominated by the first-year sea migrants. Similar data were reported for Arctic Char upstream migrations into Nauyuk Lake on the Kent Peninsula by Johnson (1980) and Gyselman (1994).

9.3.1.3 Length-Weight Relationships

The length-weight regression equations for individual study basins are presented in Appendix F13; these relationships are also plotted for individual fish in Appendix F14. The length-weight regression equation for Arctic Char using all samples combined was:

Log Weight (g) = -5.6505 + 3.2638 log Fork Length (mm)   where n = 1092 and r^2 = 0.9952.

The slope of the regression line (3.2638) indicated positive allometric growth (i.e., slope greater than 3).

Relative weight was calculated for Arctic Char by basin using a MFL of 120 mm. Relative weights for individual fish within the study area varied from 58 to 157. Arctic Char captured by gill nets in Basin D (mean = 102.0; SD ± 11.0; n = 51) and by the fish fence in Meliadine River (mean = 101.3; SD ± 8; n=513) had the highest relative weight among all basins. Both samples consisted primarily of adult fish (i.e., average age 5 and 6, respectively). Within Meliadine Lake the overall relative weight was low (mean = 81.7; SD ± 8.9; n=436); however, condition differed greatly among sites. The primarily adult fish in the west basin of the lake exhibited a higher relative weight (mean = 93.0; SD ± 6.9; n = 15) than their counterparts in the East and South Basins (mean = 81.1; SD ± 8.1; n=359 and mean = 81.2; SD ± 11.8; n=51, respectively). This is a typical trend as the amount of body fat will increase as fish reach sexual maturity. The mean relative weight for all Arctic Char captured within the Meliadine Study Area was 92.8 (SD ± 13.2; n=1040).

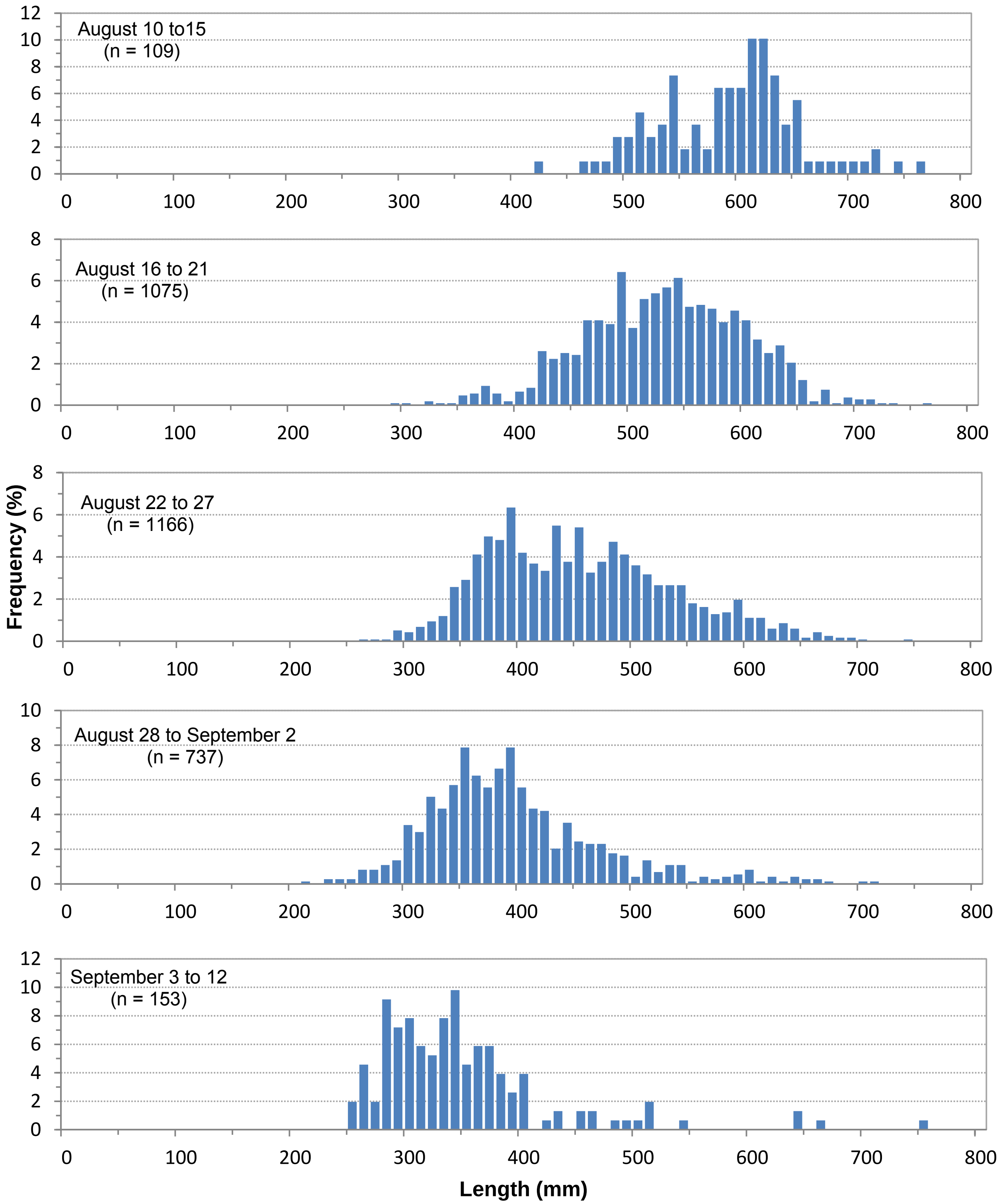


Figure 9- 19: Length-frequency Distribution of Arctic Char Captured at Different Periods of Fish Fence Operations in the Meliadine River, 1997 to 1999

9.3.1.4 Age and Length

The age-length relationship for individual Arctic Char are presented in Figure 9-20 and Appendix F15. Age classes between 1 and 10 were represented in the sample (mean age = 4.4 years; SD ± 2.3; *n*=213). The fastest rate of growth (approximately 117 mm per year) occurred between the sixth and seventh (age 5 and 6) year of life and likely corresponds to the time that smolts make their first migration to sea. This can be directly attributed to better feeding conditions at sea (Johnson 1980; Moshenko et al 1984; Moore and Moore 2006). Growth begins to slow again in year 7 (age 6), dropping below 60 mm per year.

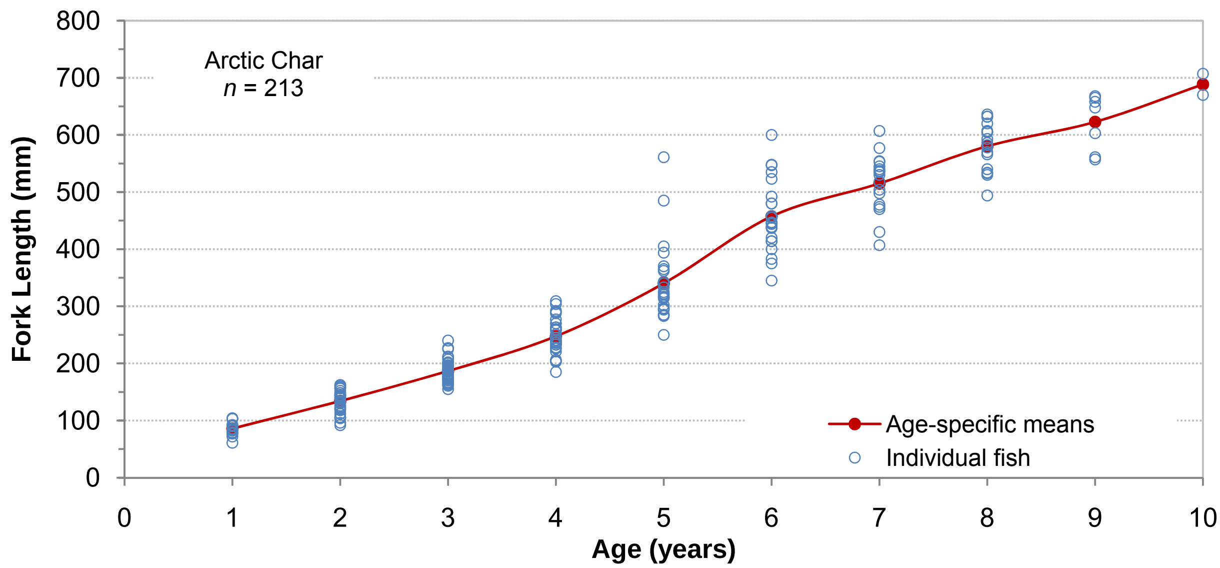


Figure 9-20: Age-length Relationship for Arctic Char captured in the Meliadine Study Area, 1997 to 2000

9.3.1.5 Feeding Habits

The majority (86%) of Arctic Char stomachs examined from 1997 to 2000 (*n* = 62) contained no food items; the mean fullness index was only 5.8% (Appendix F20). Invertebrates, consisting primarily of amphipods (49%), gastropods (4%) and unidentified taxa (29%), collectively accounted for 80% (by volume) of the Arctic Char diet. Fish species, of which only Ninespine Stickleback (10%) could be identified to species, accounted for the remaining 20% of the diet.

The majority (64%) of 32 stomachs examined from Arctic Char in the Meliadine River were empty. Unidentified fish remains were observed in the stomachs of two fish captured in the fish fence during that period. Diet data were also collected for 13 Arctic Char from Meliadine Lake (Appendix F20). The Meliadine Lake stomach data accounted for 21% of all of the stomach data collected for the study area. Diet composition for Meliadine Lake did not differ from the composition of all the basins combined.

9.3.2 Lake Trout

9.3.2.1 Size Distribution

The Lake Trout captured in the Meliadine Study Area from 1997 through 2009 (*n*=706) ranged from 43 to 965 mm in fork length (mean=365 mm, SD ± 209). Two modes were observed (Figure 9-19, A; Appendix F12b). The smaller mode was centred on 90 to 100 mm and consisted primarily of fish captured by fyke net in Meliadine

Lake East (Figure 9-21, A and B). The larger mode was centred on 300 to 450 mm and consisted of fish captured primarily in Meliadine Lake and Meliadine River (Figure 9-19, A and B). Approximately, 63% (*n* = 444) of the total catch measured over 300 mm in fork length. The majority of Lake Trout were captured in Meliadine Lake (*n*=438) and had the most diverse representation of size classes (73 to 965 mm). All life stages were represented throughout the study area. Seventeen Lake Trout were captured in Chickenhead Lake and ranged from 172 to 942 mm in fork length though most measured less than 300 mm.

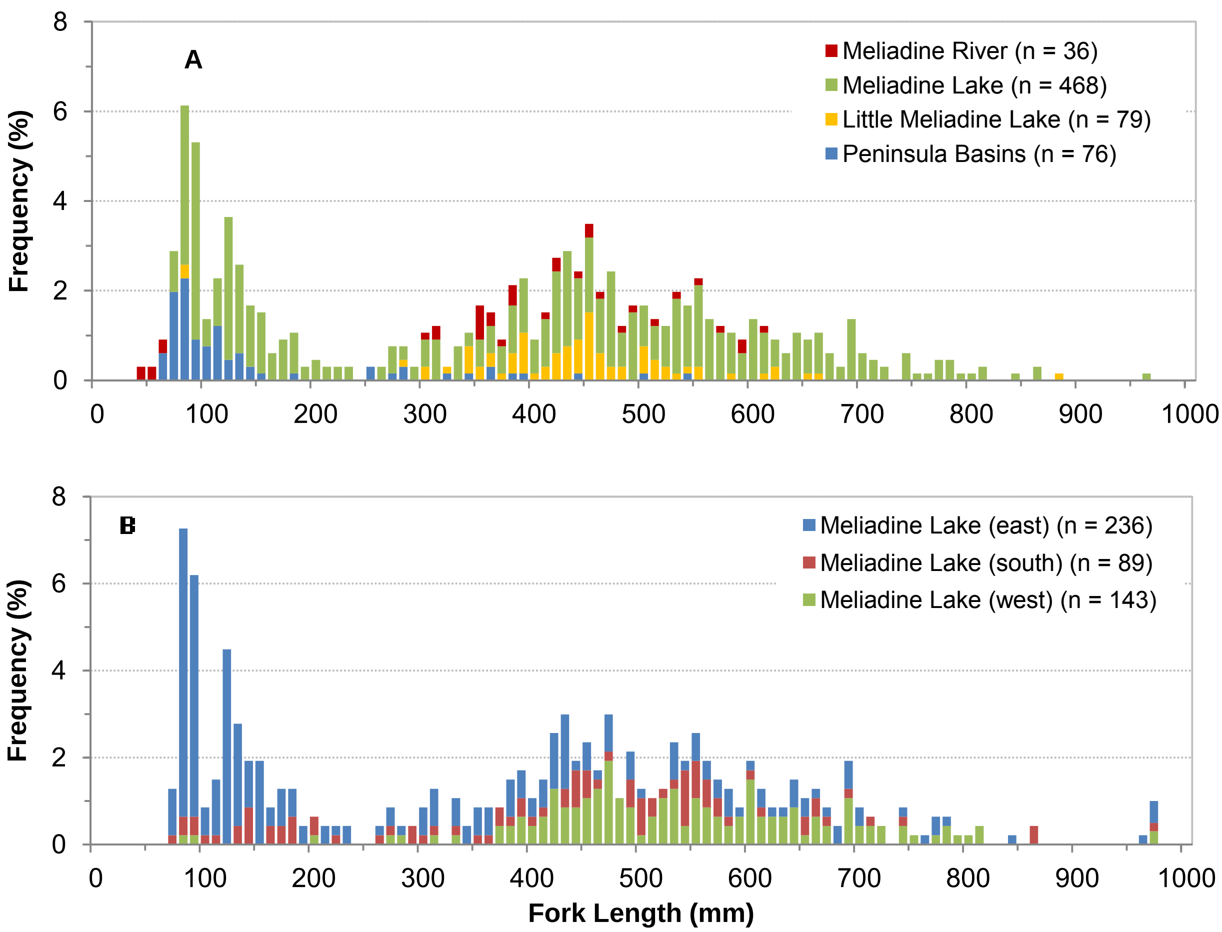


Figure 9-21: Length-frequency Distribution of Lake Trout in the Meliadine Study Area (A) and Meliadine Lake (B), 1997 to 2009

9.3.2.2 Length-Weight Relationships

The length-weight relationship for Lake Trout sampled in each basin are provided in Appendix F13 and plotted for individual fish in Appendix F14. The combined length-weight regression equation for Lake Trout in the entire study area was:

Log Weight (g) = -5.2483 + 3.1063 log Fork Length (mm) where n = 592 and r^2 = 0.9964.

Relative weight was calculated for Lake Trout by basin using a MFL of 120 mm. Relative weights for individual fish within the study area ranged from 62 to 163 (mean = 100.4; SD ± 12.2; *n* = 488). Lake Trout captured by electrofishing and gill netting in the Peninsula Lakes (122 to 540 mm; *n* = 23) had the highest mean relative weight (mean = 110.6; SD ± 22.9) of all of the basins. The primarily larger Lake Trout (356 to 611 mm; *n* = 16) captured in Meliadine River also had a high mean relative weight (103.8; SD ± 9.9). Lake Trout captured in Meliadine Lake had the lowest mean relative weight (99.1; SD ± 11.2), which was still well within the range of a healthy population.

9.3.2.3 Age and Length

The age-length data for individual Lake Trout are presented in Figure 9-22 and Appendix F16. Age classes between 1 and 30 were represented (mean age = 9.1 years; SD ± 7.5; *n* = 184). The oldest fish captured in the Meliadine Study Area was captured in east basin of Meliadine Lake; it was 30 years old and measured 780 mm. Growth increases consistently across year classes; however, specific patterns are difficult to predict due to low sample sizes in each size class. An ANOVA indicated no significant differences in length-at-age among basins for age 1 fish (F = 0.828; df = 4, 48; p = 0.513). Differences among length-at-age for other age classes could not be determined due to small sample sizes.

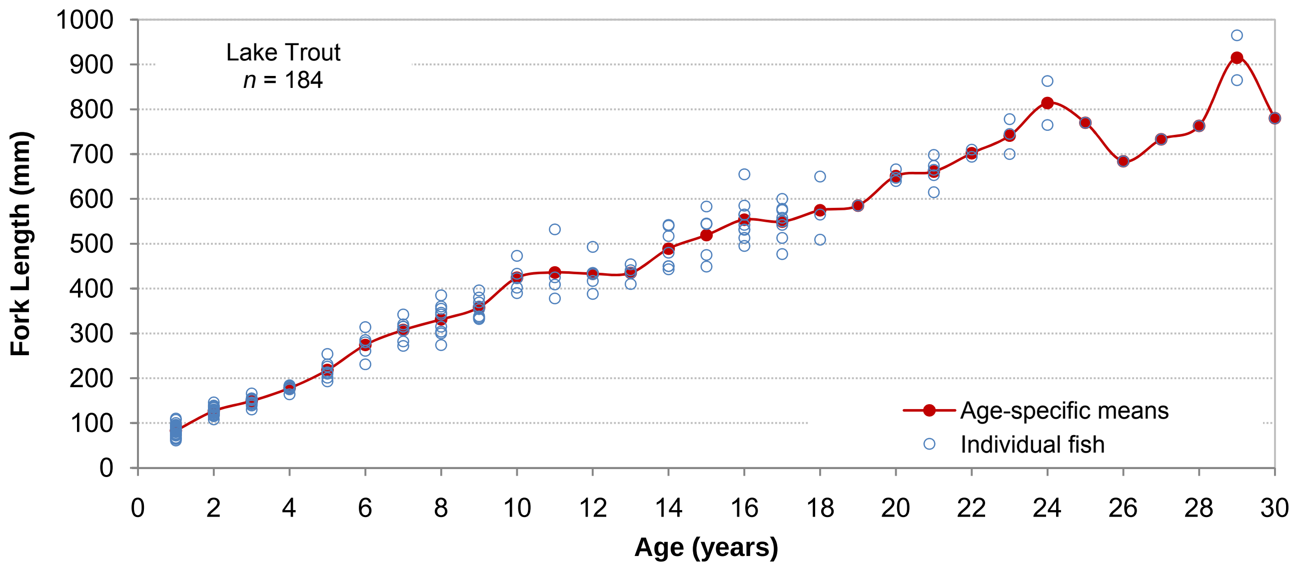


Figure 9-22: Age-length Relationship for Lake Trout captured in the Meliadine Study Area from 1997 to 2009

9.3.2.4 Feeding Habits

Close to 50% of the 143 Lake Trout stomachs examined during 1997 to 2000 contained no food items; the mean fullness index was 22% (Appendix F20). Lake Trout diet consisted primarily of fish (71% of the total food volume). Identifiable species detected in the diet included (in order of abundance): Cisco (15%), Threespine Stickleback (13%), Burbot (6%), Ninespine Stickleback (6%), Lake Trout (4%), and Slimy Sculpin (3%). Unidentified fish remains accounted for 23% of the total diet composition. Invertebrates collectively accounted for the remaining 29% of the Lake Trout diet with identifiable taxa including amphipods, clams, midges, caddis flies, snails, beetles, bees, and moths.

Diet was assessed for Lake Trout (n = 93) collected from Meliadine Lake (Appendix F20). Lake Trout captured in Meliadine Lake accounted for 66% of all Lake Trout captured in the Meliadine Study Area. Diet of Lake Trout captured in Meliadine Lake did not differ from the diet of Lake Trout from all the basins combined.

9.3.3 Arctic Grayling

9.3.3.1 Size Distribution

The overall length range of Arctic Grayling captured in the study area (n=1938) was 20 to 435 mm. The length frequency histogram exhibited numerous modes; patterns emerged for small (i.e., less than 100 mm in fork length), medium (i.e., 100 to 200 mm in fork length) and large size (i.e., 300 to 400 mm in fork length) classes indicating that all age-classes of Arctic Grayling were well represented in the Meliadine Study Area (Figure 9-23, C). The largest Arctic Grayling (435 mm in fork length).was captured in Basin B.

The majority (70%; n = 1362) of Arctic Grayling in the sample were captured in Peninsula Streams primarily through the use of electrofishing. Within the Peninsula Basins the majority of Arctic Grayling were captured in Basin A (31%; n = 421), Basin B (47%; n = 638) and Basin D (22%; n = 295); all age classes were represented in each of the mentioned basins (Figure 9-23, A). Of the lakes sampled in Basin A, Lake A6 had the highest Arctic Grayling catch (50%; n = 211, mean fork length = 196 mm; SD ± 76); many fish were also captured in the outflow Stream A5-6 (16%; n = 69, mean fork length = 151 mm; SD ± 119).

Of the lakes sampled in Basin B, Lake B7 had the highest Grayling catch (50%; n=316, mean fork length = 189.7; SD ± 65.7 mm). Fish captured in the Peninsula Basins accounted for the majority of the juvenile catch, whereas the majority of the adult fish were captured in the other basins (i.e., primarily Meliadine River and Meliadine Lake) (Figure 9-23, B).

Twelve Arctic Grayling were captured in Chickenhead Lake; Arctic Grayling from Chickenhead Lake were represented by larger size classes ranging from 168 to 402 mm in fork length (mean = 315 mm; SD ± 20).

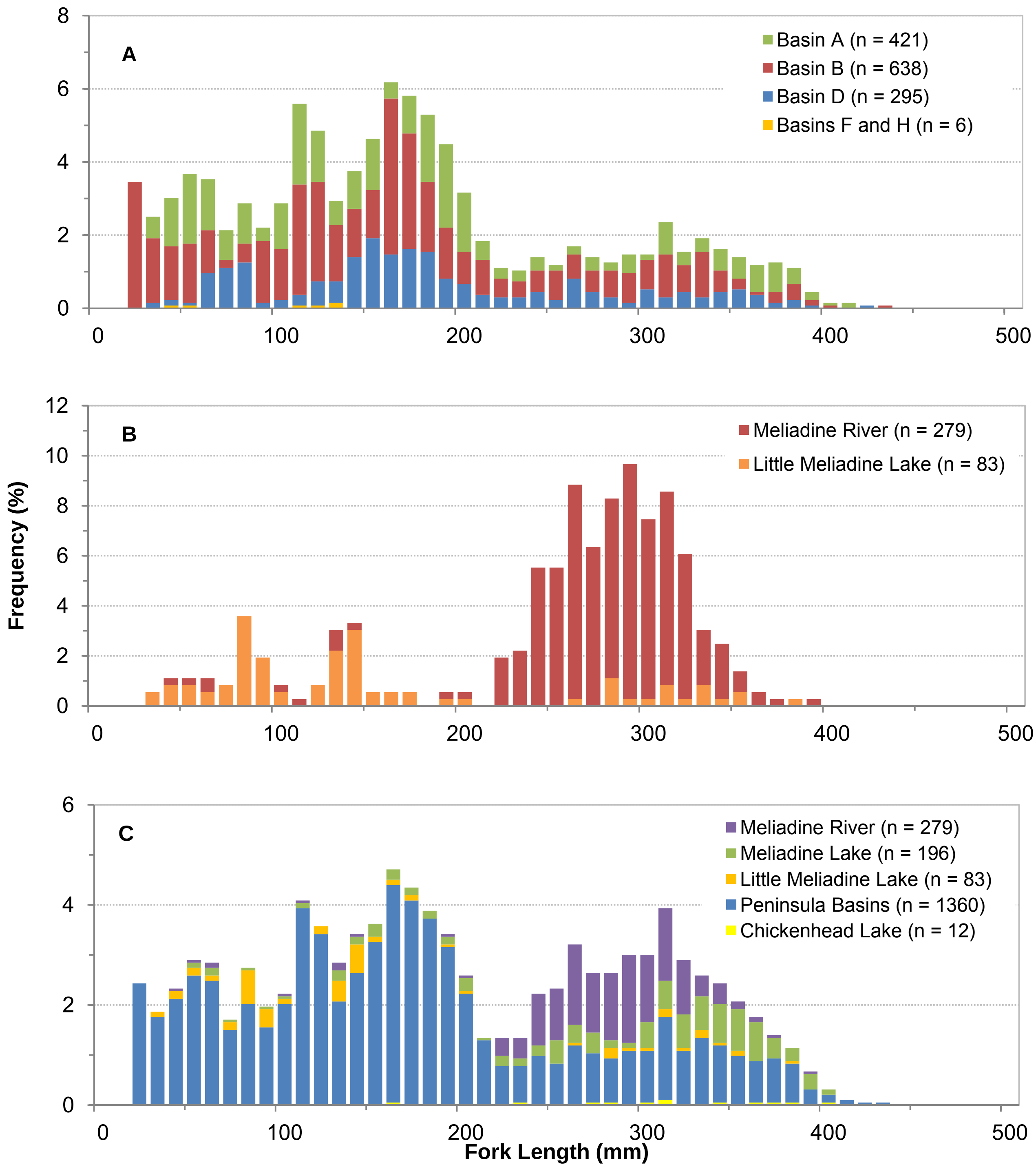


Figure 9-23: Length-frequency distribution of Arctic Grayling in the Peninsula Basins (A), Meliadine Lake and Meliadine River (B), and the Meliadine Study Area (C), 1997-2009

9.3.3.2 Length-Weight Relationships

The length-weight relationships for Arctic Grayling in each sampled basin are provided in Appendix F13 and plotted for individual fish in Appendix F14. The combined length-weight regression equation for all basins was:

Log Weight (g) = -5.3175 + 3.1456 log Fork Length (mm) where n = 1116 and $r^2 = 0.9927$.

Relative weight calculated for Arctic Grayling by basin using a MFL of 120 mm. Relative weights for individual fish within the study area ranged from 57 to 141. Average relative weights calculated for basins within the Meliadine Study Area ranged from 96 (SD $\pm$ 11.9; *n* = 23) in Little Meliadine Lake to 110 (SD $\pm$ 9.3; *n* = 97) in Basin D, all of which are well within the range of a healthy population.

9.3.3.3 Age and Length

Age-length data for Arctic Grayling is provided in Appendix F17 and Figure 9-24. Fish in the aged sample (*n* = 669) ranged between the ages 0 and 11. Growth increments during the first 5 years averaged approximately 50 mm in length per year; the older fish grew considerably slower averaging approximately 20 mm in length per year. Almost no growth was recorded during the last growth period (i.e., between ages 9 and 11).

An ANOVA revealed significant differences in mean fork length-at-age among basins for fish in age classes 0 through 4 (age 0, F = 15.6, df = 4, 199, *p* <0.001; age 1, F = 4.10, df = 4, 63, *p* <0.001; age 2, F = 3.69, df = 4, 69, p <0.001; age 3, F = 4.06, df = 3, 39, p = 0.013, age 4; F = 25.53, df = 5, 65, *p* <0.001). For example, age 4 fish in Basin D (*n*=10; mean length = 296 mm; SD $\pm$ 26) were much larger then fish of the same age in Basin A (*n* = 19, mean length = 200 mm; SD $\pm$ 15) and Basin B (*n* = 29, mean length = 212 mm; SD $\pm$ 28).

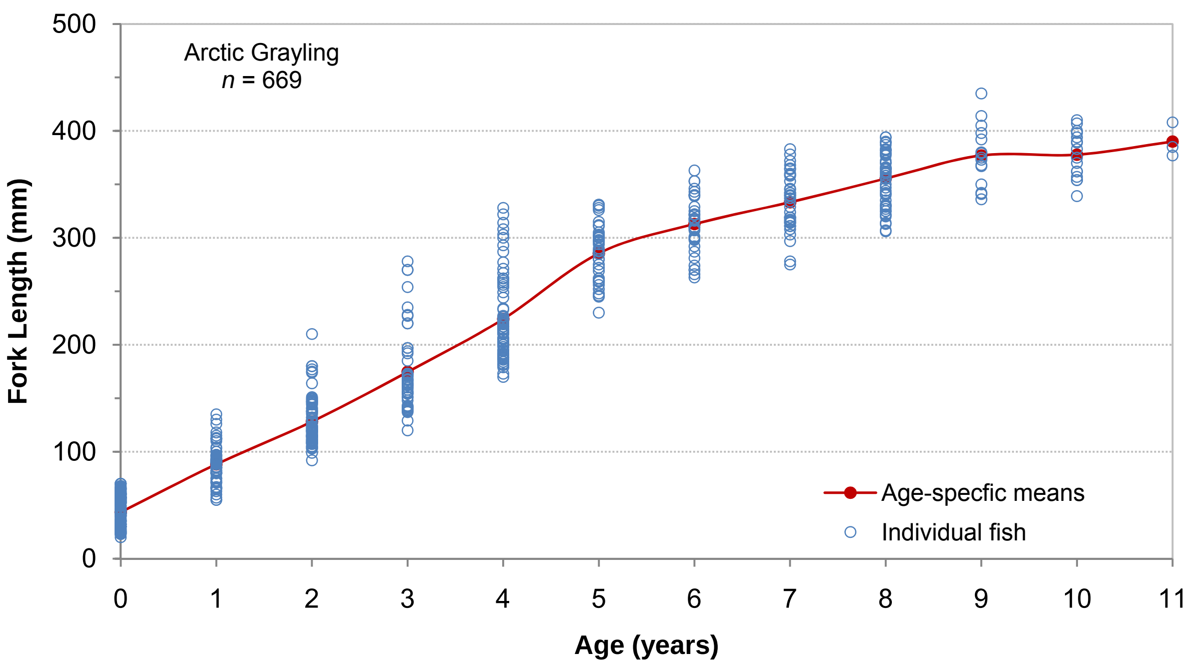


Figure 9-24: Age-length Relationship for Arctic Grayling captured in the Meliadine Study Area from 1997 to 2009

9.3.3.4 Feeding Habits

Arctic Grayling diet was assessed based on data collected from 31 stomachs from 1997 to 2000. In contrast to the other species examined, most (84%) Arctic Grayling had at least one food item in their stomachs; the mean fullness index was 45% (Appendix F20). This is likely because they are opportunistic in their feeding habits and their diet is extremely variable compared to other species (Bishop 1967; de Bruyn and McCart 1974). The diet consisted primarily of invertebrates (87% of the total food volume) with identifiable taxa including (in order of abundance): amphipods, caddis flies, crane flies, beetles, midges, mosquitoes, and stoneflies. In addition, Ninespine Stickleback accounted for 13% of the total food volume.

9.3.4 Round Whitefish

9.3.4.1 Size Distribution

The fork length of Round Whitefish captured in the Study Area (*n*=442) from 1997 through 2000 ranged from 81 to 510 mm (Figure 9-23). Approximately 51% (*n*=227) of all Round Whitefish captured in the study area were collected in the Meliadine River. The majority of the fish captured in Meliadine River were adults ranging from 253 to 464 mm in fork length (mean = 376 mm, SD ± 56). Smaller fish (i.e., less than 250 mm) were captured primarily in Meliadine Lake (*n*=64) and the Peninsula Basins (*n*=7). The largest Round Whitefish (531 mm in fork length) was captured in Little Meliadine Lake.

9.3.4.1 Length-Weight Relationships

The length weight relationships for individual Round Whitefish captured from 1997 to 2000 are provided in Appendix F13 and plotted for individual fish in Appendix F14. The regression equation for all samples combined was:

log Weight (g) = -5.4918 + 3.1934 log Fork Length (mm) where $n = 282$ and $r^2 = 0.9953$.

The slope of the regression line (3.1934) indicated positive allometric growth. Relative weight of individual fish was calculated using a MFL of 100 mm for Round Whitefish. Relative weights for individual fish ranged from 61 (Meliadine Lake) to 136 (Meliadine Lake). Average relative weights calculated for basins within the Meliadine Study Area ranged from 98 (SD ± 11.4; *n* = 79) in Meliadine Lake to 106 (SD ± 9.0; *n* = 11) in Parallel Lake, all of which are well within the range of a healthy population.

An ANOVA indicated that relative weights differed significantly among years (F = 6.15, df = 3, 252, $p < 0.001$) which may be related to a variable food source within the study area. The year with the highest mean relative weight was 1999 (103; SD ± 9.8; *n* = 117) where Round Whitefish were only captured in Meliadine River and Little Meliadine Lake. This is in contrast with 1997 (mean = 96; SD ± 9.5, *n* = 55), when the majority (*n* = 36) were captured in Meliadine Lake. The differences in relative weights noted among years may be more of a reflection of the differences in relative weights among locations within the study area rather than food availability year to year.

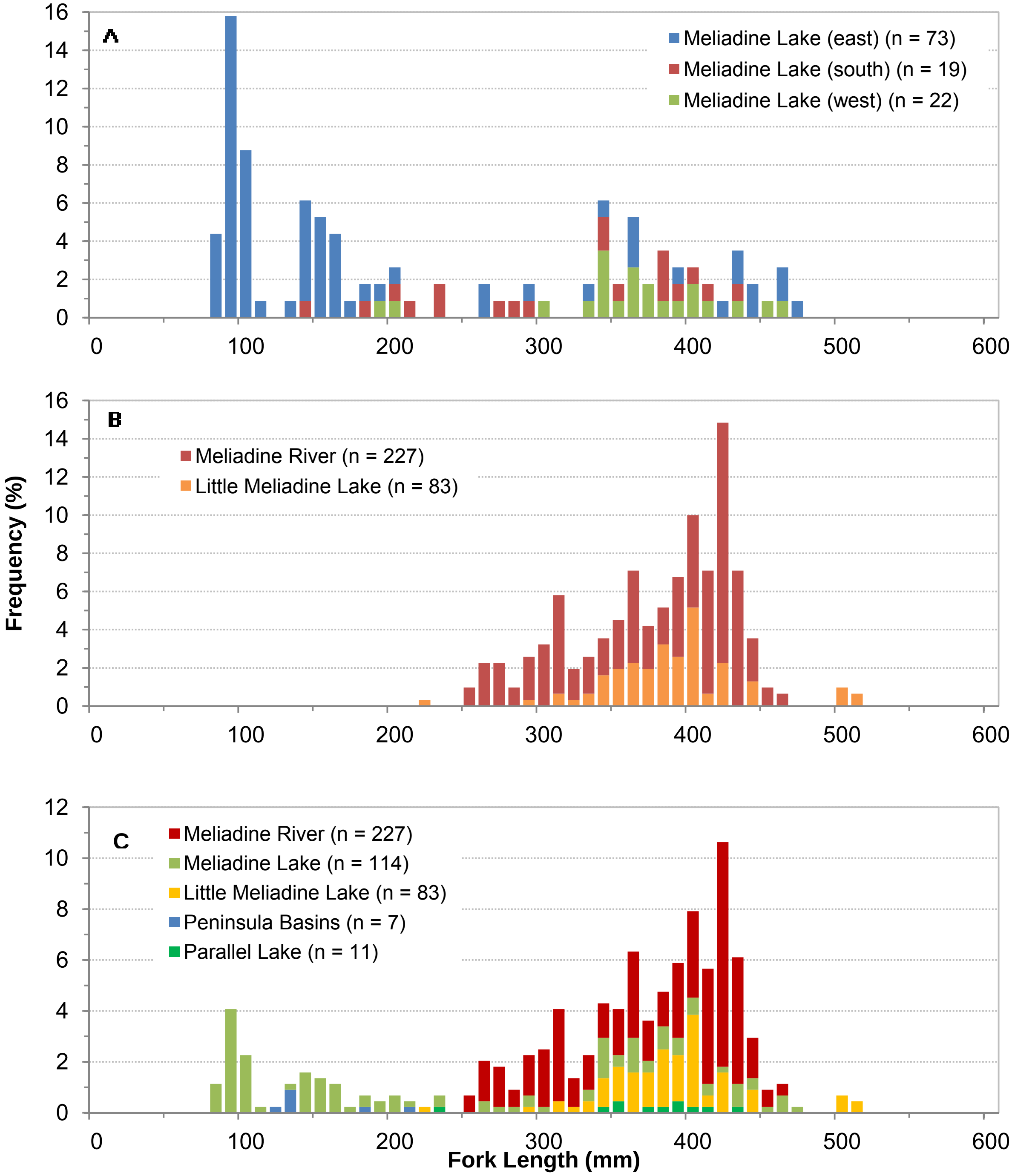


Figure 9-25: Length-frequency Distribution of Round Whitefish in Meliadine Lake (A), Meliadine River (B), and the Meliadine Study Area (C), from 1997 to 2000

9.3.4.2 Age and Length

Age-length data for Round Whitefish are provided in Appendix F18 and Figure 9-26. Fish in the aged sample (*n*= 134) ranged from age 1 through 18. Growth increments in the first 5 years of life averaged approximately

57 mm in length per year. Average growth in later years dropped significantly and averaged approximately 13 mm in length per year from age 5 through 14. Growth increments could not be assessed for ages 15 through 18 due to small sample sizes. The major changes in growth can be attributed to the transition from juvenile to adult life stages or the onset of sexual maturity. Relative weights differed significantly (one tailed $t(77) = -1.78$, $p = 0.039$) between the younger (age 1 - 4) fast growing fish (mean relative weight = 94.8, SD ± 11.2; *n* = 37) and the older slower growing fish (mean relative weight = 99.1, SD ± 11.2, *n* = 56). Differences in condition may be a direct result of growth rates as younger, faster growing fish would be expected to have a lower body condition.

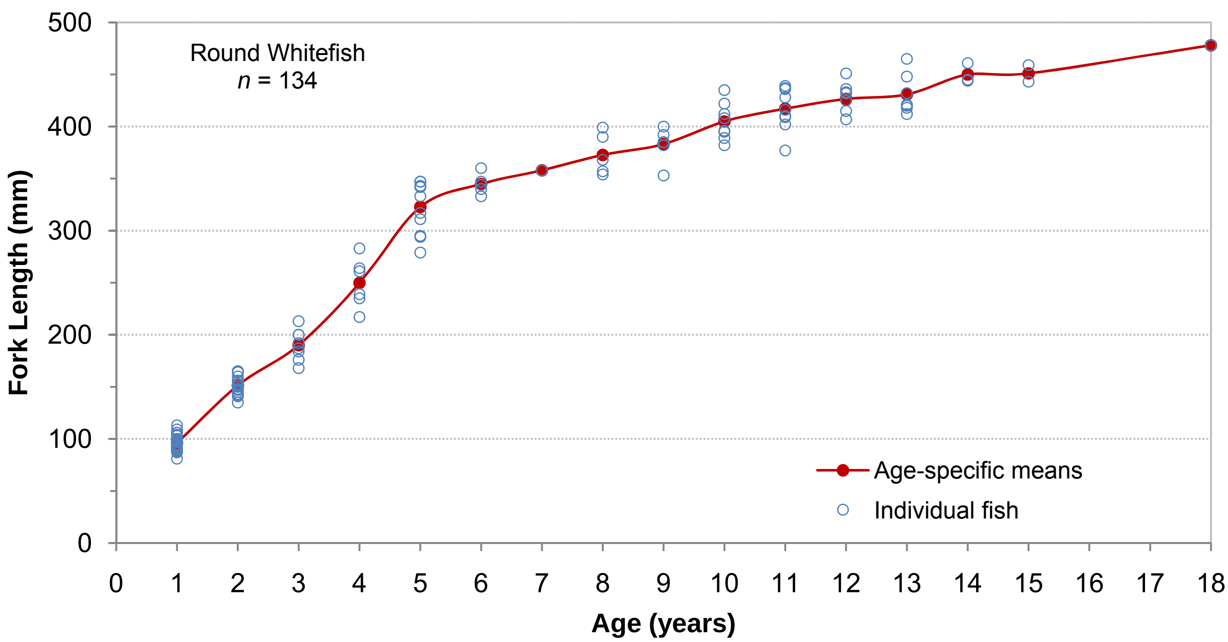


Figure 9-26: Age-length Relationship for Round Whitefish Captured in the Meliadine Study Area from 1997 to 2000

9.3.4.3 Feeding Habits

Almost 50% of the 65 Round Whitefish stomachs examined contained no food items; the mean fullness index was 18% (Appendix F20). The diet consisted entirely of aquatic invertebrates including (in order of abundance): snails, caddis flies, midges, clams, and hydroids. Due to their habits of feeding on the bottom, inorganic material consisting primarily of sand contributed to 6% of the total volume in the examined Round Whitefish stomachs.

9.3.5 Cisco

9.3.5.1 Size Distribution

The fork length range of Cisco captured in the Meliadine Study Area (*n*=1833) was 72 to 456 mm (Figure 9-27). The largest Cisco (456 mm in fork length) was captured in Little Meliadine Lake. The length-frequency histogram shows a prominence of fish in the 70 to 130 mm size class; the majority (67%) of Cisco captured in the study area were less than 200 mm in fork length. Approximately 93% of the fish that were less than 200 mm in fork length were captured in Meliadine Lake. Basin D (108 to 404 mm; *n*=161) and Meliadine Lake (72 to 437 mm; *n*=547) both had a diverse representation of all size classes.

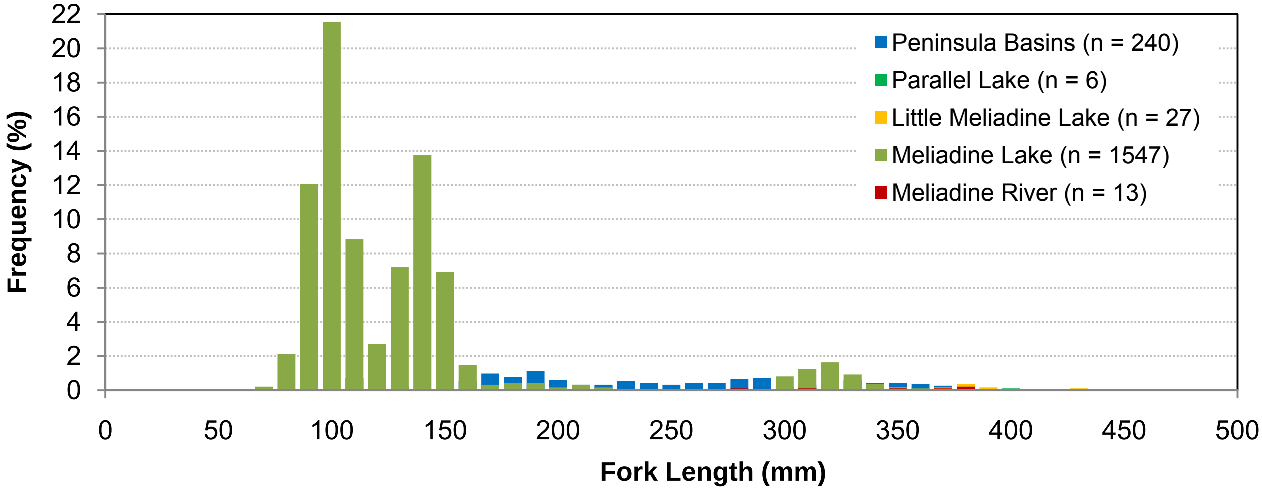


Figure 9-27: Length-frequency Distribution of Cisco in the Meliadine Study Area, 1997 to 2009

9.3.5.2 Length-Weight Relationships

The length-weight relationships for Cisco captured in the Meliadine Study Area are presented in Appendix F13, and plotted for individual fish in Appendix F14. The combined length-weight regression equation for all basins was:

log Weight (g) = -5.4918 + 3.1934 log Fork Length (mm) where n = 282 and r^2 = 0.9953.

A MFL of 100 mm was used to calculate relative weight for Cisco. An ANOVA on relative weight data by basin revealed that relative weight differed significantly among basins (F = 16.77, df = 6, 533, p < 0.001). Mean relative weights calculated for each basin ranged from 97 (SD ± 10.5; *n*=324) in Meliadine Lake to 109 (SD ± 16.7; *n* = 117) in Basin D; the mean value for the entire study area was 101 (SD ± 14.4; *n* = 540).

9.3.5.3 Age and Length

Age-length data for Cisco are provided in Appendix F19 and Figure 9-28. Fish in the aged sample (*n* = 265) ranged from age 1 through 10. Growth increments in the first 6 years averaged approximately 45 mm in length per year. Growth slowed considerably after age 6. Age 10 fish (*n*=6) ranged from 305 to 381 mm in fork length. The largest aged Cisco captured in the Meliadine Study Area measured 417 mm and was 7 years old.