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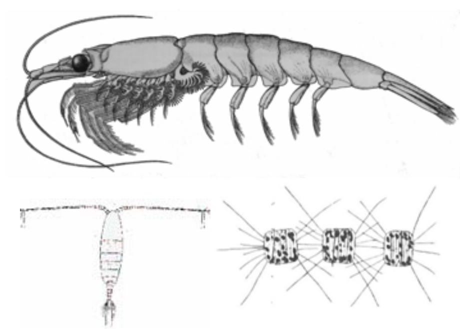
2003 STATE OF THE OCEAN: CHEMICAL AND BIOLOGICAL OCEANOGRAPHIC CONDITIONS IN THE ESTUARY AND GULF OF ST. LAWRENCE



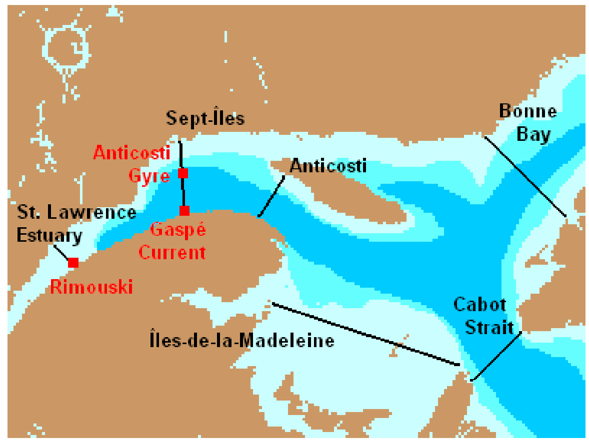


Figure 1. Atlantic Zone Monitoring Program (AZMP) sections (lines) and fixed stations (red squares).

Context

The Atlantic Zonal Monitoring Program (AZMP) was implemented in 1998 with the aim of: (1) increasing DFO's capacity to understand, describe, and forecast the state of the marine ecosystem and (2) quantifying the changes in physical, chemical, and biological oceanic properties and the predator-prey relationships of marine resources. A critical element in the AZMP observation program is an annual assessment of the distribution and variability of nutrients and the plankton they support.

A description of the distribution in time and space of nutrients (nitrate, silicate, phosphate) dissolved in seawater provides important information on water-mass movements and on the locations, timing, and magnitude of biological production cycles. A description of the distribution of phytoplankton and zooplankton provides important information on the organisms forming the base of the marine food-web. An understanding of the production cycles of plankton is an essential part of an ecosystems approach to fisheries management.

The AZMP derives its information on the state of the marine ecosystem from data collected at a network of sampling locations (fixed point stations, cross-shelf sections, groundfish surveys, satellite remote sensing) in each region (Québec, Maritimes, Newfoundland) sampled at a frequency of bi-weekly to once annually.

SUMMARY

- The initiation of the spring phytoplankton bloom in the Lower St. Lawrence Estuary occurred one month earlier than usual. Excluding 2002, this continued a trend that began in 1998.

- The phytoplankton biomass during spring-summer 2003 in the Lower St. Lawrence Estuary was, for a fourthly consecutive year, much lower compared 1999, but nevertheless has shown an increasing trend since 2000.

- Spring-summer phytoplankton production in the Lower St. Lawrence Estuary was also higher in 2003 compared to the previous three years but lower than in 1999.

- On the basis of the nutrient evolution, phytoplankton production in the northwestern Gulf of St. Lawrence could have been higher in 2003 compared to the previous three years.

- Surface nutrient levels in late winter 2003 were higher in the southern and northeastern Gulf of St. Lawrence compared to 2000 and 2001 while levels were not markedly different for the late spring-summer period, suggesting that the spring phytoplankton bloom in this region was again more intense in 2003 compared to the previous two years.

- For a third consecutive year, we noted the presence of the diatom *Neodenticula seminae* in the Gulf of St. Lawrence; this phenomenon is unusual since this species is typically found in North Pacific waters.

- In the Lower Estuary and the northwest Gulf of St. Lawrence, there was a slight increase in the mesozooplankton biomass in 2003 compared to 2002 and no changes in the macrozooplankton biomass.

- The year 2003 was characterized by an increase in the abundance of hyperiid amphipods (*T. libellula*) and mysids and a decrease in the abundance of chaetognaths and gelatinous zooplankton in the Lower Estuary and the northwest Gulf of St. Lawrence.

- The mean integrated zooplankton biomass in 2003 in the Anticosti Gyre was slightly higher than in 1999, 2000, 2001, and 2002 while in the Gaspé Current the overall zooplankton biomass was 1.2 times higher than in 2002 and 1.7 higher than in 2001 and 2000 observations.

- At both stations, the total abundance of zooplankton observed in 2003 was on ca. 1.5 times higher than 2002, 2001, and 2000.

- No larvacea were found in 2003 in the Gaspé Current and the Anticosti gyre whereas these organisms generally accounted for ca. 10% of the zooplankton assemblage in July and August at both stations.

- The total abundance of copepods observed in 2003 was 1.6 and 1.9 times higher than in 2002, 2001, and 2000 in the Gaspé Current and the Anticosti gyre respectively.

- There was an important increase of the abundance of the large copepod *Calanus finmarchicus* in 2003 (30,078 ind. per m^2) which was 3.8 times higher than in 2000 (8,369 ind. per m^2)

- The overall abundance and biomass of zooplankton observed in 2003 along all sections in both spring and fall were comparable to observations made in 2002, 2001, and 2000.

- The mean annual abundances of *C. finmarchicus* observed in 2003 along the Sept-îles and Anticosti sections where 2.5 and 1.5 higher than in 2002 respectively.

INTRODUCTION

Phytoplankton are microscopic plants that form the base of the aquatic food web, occupying a position in the marine environment analogous to terrestrial plants on land. They use light to synthesize organic matter from inorganic carbon and nutrients dissolved in marine waters. Thus, they are responsible for ocean productivity. The rate at which phytoplankton produce new organic matter in the marine environment is determined by nutrient availability (especially nitrogen compounds), light intensity, and temperature. The maximum potential level of primary productivity in a system also depends on additional factors such as the freshwater runoff and the stratification of the water column.

Zooplankton are animals that range in size from smaller than 1 mm (e.g., copepods) to about 4 cm (e.g., krill). Because zooplankton are the principal consumers of phytoplankton, they represent a critical link in the food web between phytoplankton and larger animals. Zooplankton are fed on by all species of fish at some time in the fishes' life cycle.

CONDITIONS IN 2003

Nutrient concentrations and phytoplankton biomass

Lower St. Lawrence Estuary: In most marine waters, phytoplankton undergo spring-summer population explosions called blooms. In the Lower St. Lawrence Estuary, the primary phytoplankton bloom is a well-established seasonal event representing the major net input of carbon into the food web in the estuary. To follow the inter-annual variability in timing, duration, and magnitude of the spring phytoplankton bloom, Station Rimouski (Fig. 1) has been visited on a weekly basis from May to September since 1992.

In 2003, the standing stock of phytoplankton at Station Rimouski, as reflected by the amount of chlorophyll *a* (Figure 2), showed a major pulse in mid May - mid July, with integrated values in the upper 50 m exceeding 400 mg of chlorophyll *a* per m^2 (Figure 3). Outside of this period, chlorophyll levels remained relatively low except in early October, when a small bloom of short duration was observed (Figures 2 and 3). The phytoplankton species responsible for the late May – mid July bloom were the diatoms *Thalassiosira nordenskioeldii*, *Skeletonema costatum*, *Chaetoceros furcellatus,* and *C. debilis*. These species were gradually replaced by several species of dinoflagellates and flagellates.

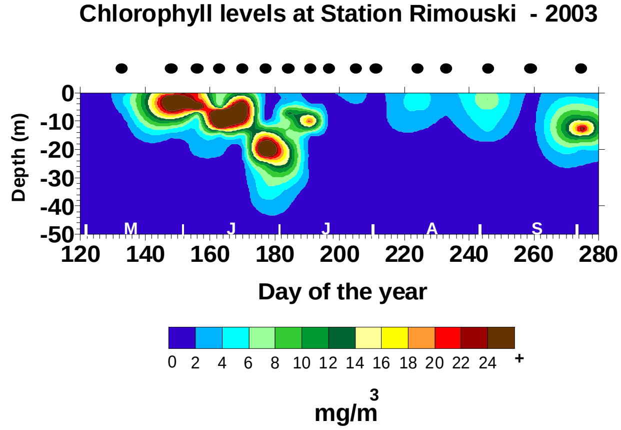


Figure 2. Chlorophyll a *concentrations in the upper 50 m of the water column at Station Rimouski during spring-summer 2003. Dots : sampling periods.*

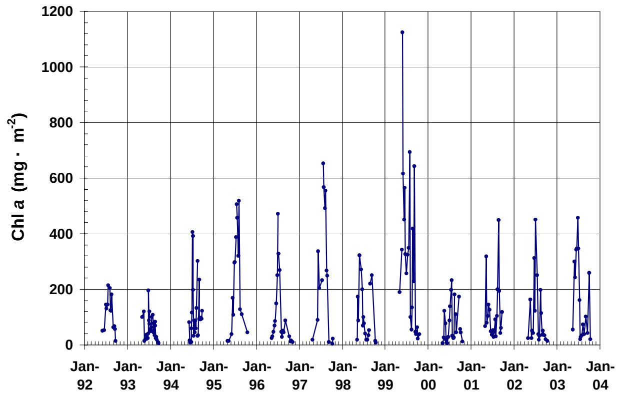


Figure 3. Chlorophyll a concentrations integrated over the upper 50 m at Station Rimouski during spring-summer 1992-2003.

Compared to our previous observations, the onset of the spring phytoplankton bloom at Station Rimouski in 2003 (late May) occurred somewhat later compared to the 1998-2001 period (early May), but 4 weeks earlier compared to 1992-1997 (late-June, Figure 4). A comparison of these results with the historical data on the phytoplankton biomass in the Lower St. Lawrence Estuary confirms that the development of the primary bloom in May as observed in 2003 is unusual for this region.

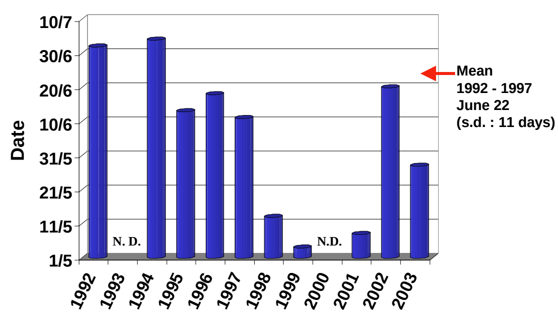


Figure 4. Date of onset of the primary bloom defined by the first incidence of chlorophyll concentrations greater than 100 mg of chlorophyll a *per m^2 at Station Rimouski, 1992-2003. N.D. = no distinct bloom.*

Typically, the spring bloom in the lower St. Lawrence Estuary starts just after the spring-summer runoff peak. The below-normal spring freshwater runoff generally observed since 1998 in the St. Lawrence basin (except for 2002) could thus be responsible for the recent shift seen in the timing of phytoplankton cycle.

Overall, the average phytoplankton biomass during spring-summer 2003 at Station Rimouski was close to the historical mean, being higher compared to 1992-1994, 1996, 1998, and 2000-2002 but lower compared to 1995, 1997, and, more especially, to 1999 (Figure 5). Spring-summer phytoplankton production measured at Station Rimouski was also higher in 2003 compared to the previous three years but lower than in 1999 (Figure 6).

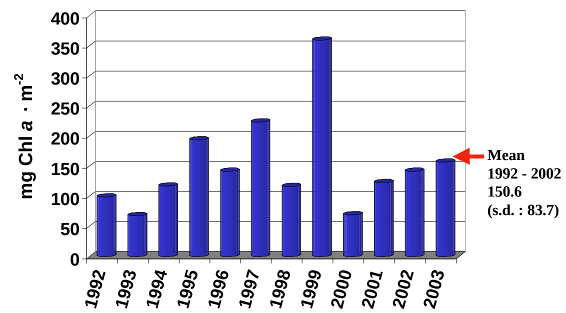


Figure 5. Mean integrated (surface to 50 m depth) chlorophyll a levels at Station Rimouski from May to August, 1992-2003.

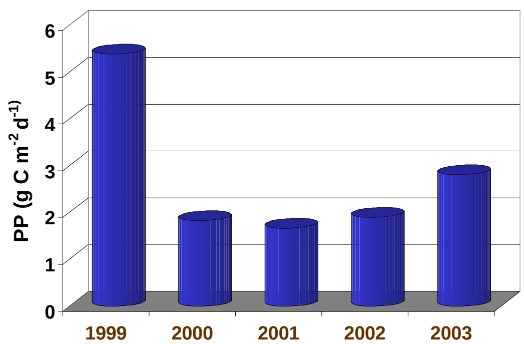


Figure 6. Mean phytoplankton production (g C per m^2 per day) at Station Rimouski from May to August 1999-2003.

Northwest Gulf of St. Lawrence: The northwestern Gulf of St. Lawrence is characterized by a quasi-permanent cyclonic gyre, the Anticosti Gyre. The Anticosti Gyre is separated from the Gaspé Current by a frontal system; the Gaspé Current is a coastal jet resulting from the seaward advection of the low salinity waters of the St. Lawrence Estuary along the Gaspé Peninsula. These two systems represent two identifiable pelagic ecosystems. The biological and chemical properties of the Gaspé Current primarily reflect the conditions developing in the Lower Estuary whereas those found in the Anticosti Gyre are more typical of the conditions prevailing over the rest of the Gulf of St. Lawrence. Within the AZMP, these two systems are monitored at a frequency of 9 to 16 times per year.

In 2003, nutrient concentrations in the surface layer (top 50 m) followed a similar seasonal pattern at both stations in the northwestern Gulf of St. Lawrence: nitrate and silicate concentrations were high in late fall-winter and low in spring-summer due to biological consumption by phytoplankton (Fig. 6). Typically, nutrient concentrations were somewhat higher in the Gaspé Current than in the Anticosti Gyre and more variable due to the dynamics of this coastal jet. At both stations, the spring decrease of nitrate and silicate occurred principally between late April and June.

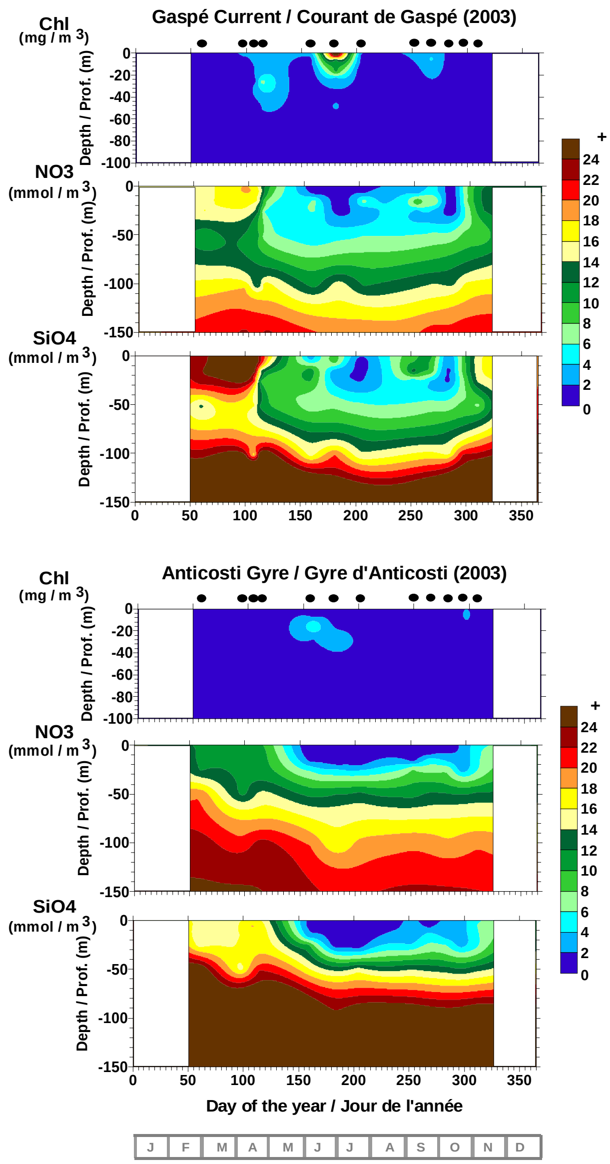


Figure 7. Chlorophyll a (mg per m^3), nitrate (mmol per m^3) and silicate (mmol per m^3) concentrations in upper 100-150 m of water column in the Gaspé Current and Anticosti Gyre during 2003. Dots : sampling periods.

The major increase in the chlorophyll concentration in the Gaspé Current's low salinity surface waters was observed in June and coincided with the major pulse of phytoplankton at Station Rimouski (Figures 2 and 7). Outside of this period, chlorophyll levels remained relatively low except in late April and late September, when small phytoplankton peaks of short duration were observed (Figure 7) that were similar to the one observed in the St. Lawrence Estuary. In the Anticosti Gyre, near-surface chlorophyll concentrations remained low throughout the sampling period except in June, when a subsurface phytoplankton peak was observed (Figure 7).

Compared to our previous observations, the chlorophyll a levels at the Gaspé Current station were generally lower in 2003 than in 1999 but relatively comparable to 2000-2002 (Figure 8). In contrast, chlorophyll concentrations at the Gaspé Current were somewhat lower compared to recent years (Figure 9). On the other hand, the late winter nutrient concentrations in the top 50 m were higher at both stations compared to the previous three years while the summer levels were comparable (i.e., Anticosti Gyre) or lower (i.e., Gaspé Current). Consequently, the amount of nutrients potentially used by phytoplankton in the surface layer during spring-summer in both stations was much more pronounced in 2003 compared to the 2000-2002 period. Thus based on this evolution of nutrients, phytoplankton production in the northwestern Gulf of St. Lawrence could have been higher in 2003 compared to the previous three years. This is consistent with data from Station Rimouski in the Lower St. Lawrence Estuary.

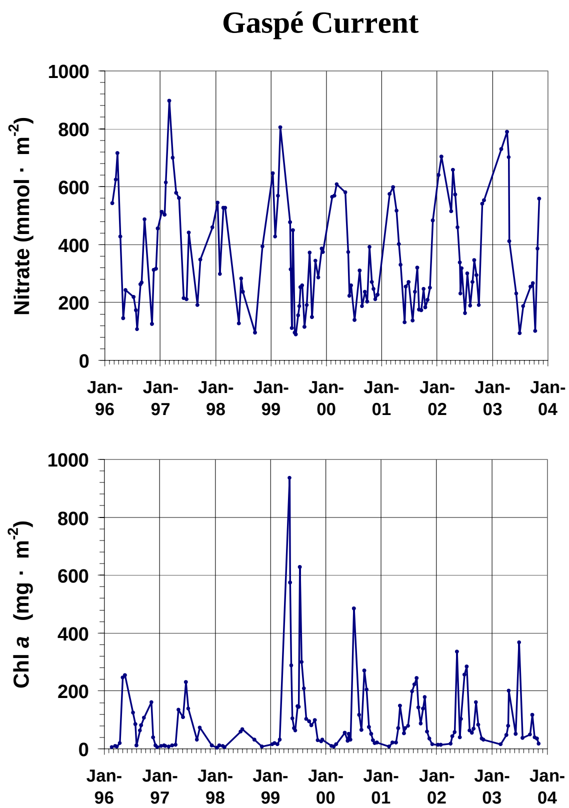


Figure 8. Nitrate (mmol per m²) and chlorophyll a (mg per m²) concentrations in the Gaspé Current, 1996-2003. Values are integrated over the upper 50 m of the water column.

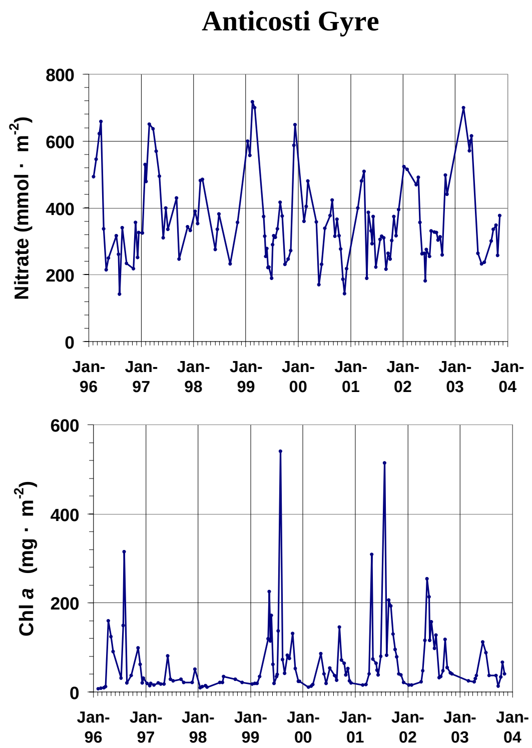


Figure 9. Nitrate (mmol per m^2) and chlorophyll a *(mg per m^2) concentrations in the Anticosti Gyre, 1996-2003. Values are integrated over the upper 50 m of the water column.*

AZMP Sections and winter helicopter Survey: Biological and chemical data were collected at stations along six sections crossing the Estuary and the Gulf of St. Lawrence (Fig. 1) to obtain quasi-synoptic information over a broader spatial scale. Sections were occupied during early spring (April), late spring (June), and mid-fall (November) 2003. In addition, nutrient concentrations at the surface (2 m) were collected at 64 stations covering the Gulf of St. Lawrence in late winter (March) 2003. Winter nutrient concentrations are key elements that determine the intensity of the spring phytoplankton bloom.

Late winter nutrient concentrations in 2003 were extremely high for most regions of the Gulf of St. Lawrence (Figure 10). The highest nutrient concentrations were observed in the St. Lawrence Estuary, which is typical. In early spring, surface nutrient concentrations were similar to those observed during the winter survey, except for the southern Gulf of St. Lawrence (Magdalen Island and Cabot Strait sections) (Figure 11), where the spring phytoplankton bloom had clearly already begun (Figure 12).

In contrast, surface nitrate concentrations during the late spring survey were usually low for most regions of the Gulf of St. Lawrence due to utilisation of phytoplankton (Figure 11). The depletion of nutrients in the surface layers was more pronounced in the eastern and southern part of the Gulf of St. Lawrence compared to the Estuary and northwestern part of the Gulf, which is typical. During the 2003 fall survey, surface nitrate levels were comparable or somewhat lower than those measured during the late spring survey for most areas of the Gulf of St. Lawrence (Figure 11). This indicates that the autumnal turnover had not yet occurred.

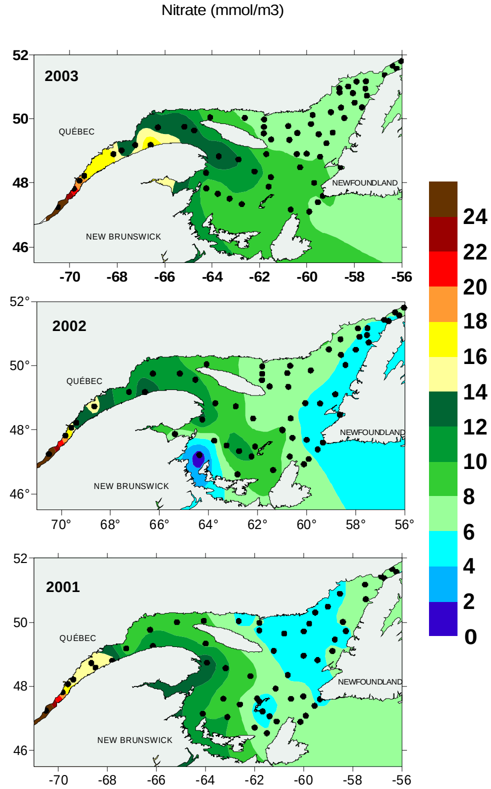


Figure 10. Late winter (March) nitrate concentrations (mmol per m³) in the Estuary and Gulf of St. Lawrence, 2001-2003. Dots indicate the location of sampling stations. Depth = 2 m.

Below the surface, nitrate concentrations did not vary with time but varied spatially (Figure 11). Deep concentrations of nitrate (> 200 m) increased from Cabot Strait toward the head of the Laurentian Channel in the Lower St. Lawrence Estuary, a gradient that probably results from the circulation and mineralization of organic matter that sinks into the deep layer. Compared to previous years, nitrate concentrations in the deep layer in spring and fall 2003 were comparable to those in 2001 and 2002.

Overall, chlorophyll levels in 2003 were higher in early to late spring than during the fall survey, which is typical (Figure 12). During the early spring survey of 2003, higher chlorophyll levels were observed in the southern parts of the Gulf of St. Lawrence including Cabot Strait. Conversely, the late spring and fall chlorophyll levels were extremely low for most areas of the Gulf of St. Lawrence, except for the St. Lawrence Estuary. Compared to our previous observations, the chlorophyll levels in late spring and fall of 2003 were not markedly different for most areas of the Gulf of St. Lawrence compared to recent years (not shown here).

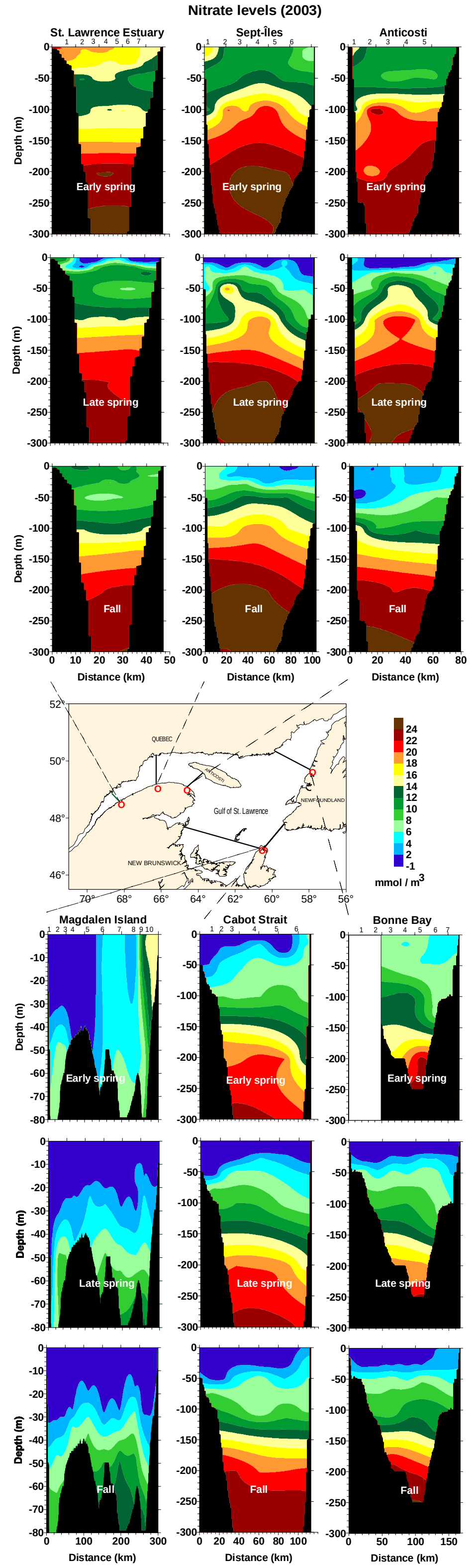


Figure 11. Concentrations of nitrate (mmol per m^3) with depth along the six sections sampled in early spring (April), late spring (June), and fall (November) 2003 in the Estuary and Gulf of St. Lawrence. The numbers over graphs indicate the location of sampling stations. Red circle on the map : station 1 of the sections.

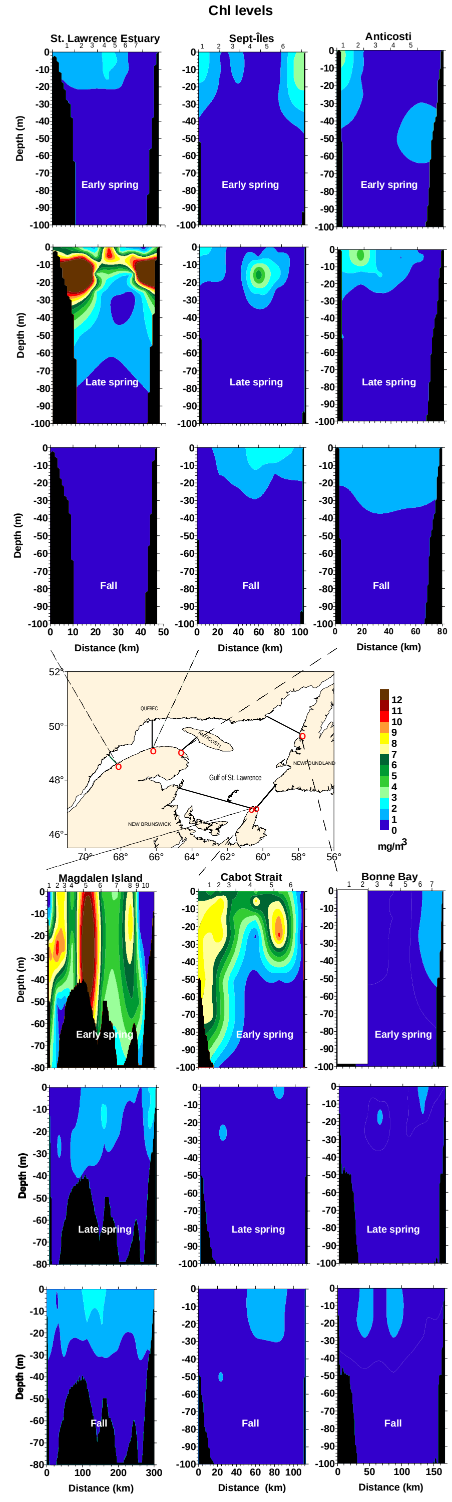


Figure 12. Concentrations of chlorophyll a *(mg per m^3) with depth along the six sections sampled in early spring (April), late spring (June), and fall (November) 2003 in the Estuary and Gulf of St. Lawrence. The numbers over graphs indicate the locations of sampling stations. Red circle on the map: station 1 of the sections.*

Satellite derived estimates of surface chlorophyll: Phytoplankton biomass was also assessed from ocean color data collected by the Sea-viewing Wide Field-of-View Sensor (SeaWiFS) satellite launched by NASA in late summer 1997. While satellite data do not give information for the water column, they provide high-resolution (1.5 km) data on the geographical distribution of phytoplankton in surface waters over a large scale. Satellite data showed a greater spatial variability in the timing of the spring bloom in the Gulf of St. Lawrence in 2003, which is potentially due to sub-regional differences in the timing of sea-ice melting. The spring phytoplankton bloom occurred between April and June depending on the region and started earlier in the southern part of the Gulf (early April), which is typical. During summer, chlorophyll levels remained low for most areas of the Gulf except for the estuarine portion. Another smaller phytoplankton peak was observed in fall 2003 for most areas of the Gulf, which is usual. This is consistent with observations from the fixed stations and sections crossing the Gulf.

Coastal stations: Within the Toxic Algae Monitoring Program, phytoplankton samples were collected from May to September at eleven coastal stations covering the Estuary and Gulf of St. Lawrence (Fig. 13) to determine the presence of harmful algae and toxic or invasive species. This sampling program has been in place at the Maurice Lamontagne Institute since 1989.

In 2003, no major toxic event was observed in the Estuary and Gulf of St. Lawrence. Nevertheless, the analysis of phytoplankton samples revealed for a third consecutive year the presence of the diatom *Neodenticula seminae* in many areas of the Gulf of St. Lawrence with concentrations up to 197 x 10^2 cells per litre (Figure 13). This phenomenon is unusual since this species is usually only found in North Pacific waters. In the Atlantic Ocean, this species has only been recorded in high-latitude Quaternary sediments dating from between 0.84 and 1.26 million years ago. Since the presence of *N. seminae* was also detected in the Labrador waters during spring-summer 2001, we suppose that this Pacific species was introduced naturally into the Gulf (across the Arctic, down the Labrador Current, and through Strait of Belle-Isle) rather than via ballast waters. The return of *N. seminae* to the Atlantic coast is consistent with recent observations indicating a greater influx of Pacific waters into the Atlantic. Impacts of this invasive species on the productivity of the Gulf of St. Lawrence have not yet been determined.

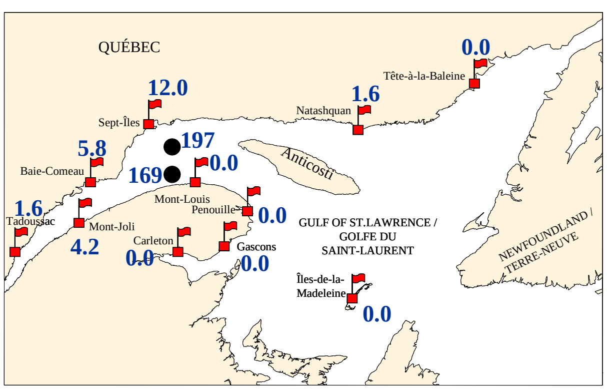


Figure 13. Maximum abundance of the diatom Neodenticula seminae (x 10^2 cells per litre) in 2003 at fixed stations of the Toxic Algae Monitoring Program (red flags) and of the Atlantic Zone Monitoring Program (black dots). Depth = 0-15 m.

Zooplankton biomass and abundance

Lower Estuary and northwest Gulf of St. Lawrence: The total mesozooplankton biomass observed in September 2003 in the Lower St. Lawrence Estuary and in the northwest GSL is higher than the September 1995, 1996, 1998, 2000, and 2001 observations, comparable to the September 1997, 1999, and 2002 measurements, and 1.4 times lower than in September 1994 (Fig. 14). Likewise, the total macrozooplankton biomass observed in September 2003 is comparable to the 1996 1998, 1999, 2000, 2001, and 2002 measurements, slightly lower than the September 1997, observations, and 4.4 and 3.3 times lower than in September 1994 and 1995 respectively.

On the other hand, the relative abundance of the three most important macrozooplankton groups in terms of biomass (euphausiids, mysids, hyperiid amphipods) varied significantly as a function of the year (Fig. 14). The relative abundance of the euphausiids decreased steadily from 87% to 55% between 1994 and 1995 and stays stable to ca. 50% of the macrozooplankton assemblage between 1995 and 2002 and slightly decreased to 40% in 2003. The relative abundance of the mysid *Boreomysis artica* increased from 3% in 1994 to 29% in 2000 and decreased again to ca.16% in 2001, 2002 and 2003 (Figure 14). Finally, the relative abundance of the hyperiid amphipods increased from 8% in 1994 to 40% in 1995, stayed around 20% from 1996 to 1998, significantly decreased from 23% to 1% between 1998 and 2000, and significantly increased again from 1% to 26% in 2001, 33% in 2002, and 44% in 2003 (Figure 14).

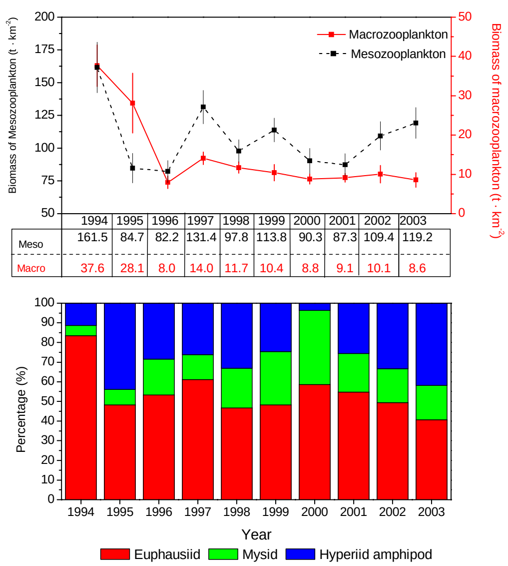


Figure 14. Mean biomass of mesozooplankton and macrozooplankton in the Lower St. Lawrence Estuary and the Northwest Gulf of St. Lawrence from 1994 to 2002 (upper panel) and relative abundance the three most important macrozooplankton groups in terms of biomass (lower panel).

The most notable feature of the mean annual abundance of the various macrozooplankton species in 2003 was an increase in the abundance of hyperiid amphipods (*T. libellula)* and mysids and a decrease in the abundance of chaetognaths and gelatinous zooplankton (Fig. 15). The mean abundance of *T. libellula* increased from 10 ind. per m^2 in 2002 to 14 ind. per m^2 in 2003 and the mysids from 20 ind. per m^2 in

2002 to 40 ind. per m^2 in 2003. The abundance of both the gelatinous zooplankton and chaetognaths decreased from 35 ind. per m^2 in 2002 to 23 and 10 ind. per m^2 in 2003 respectively.

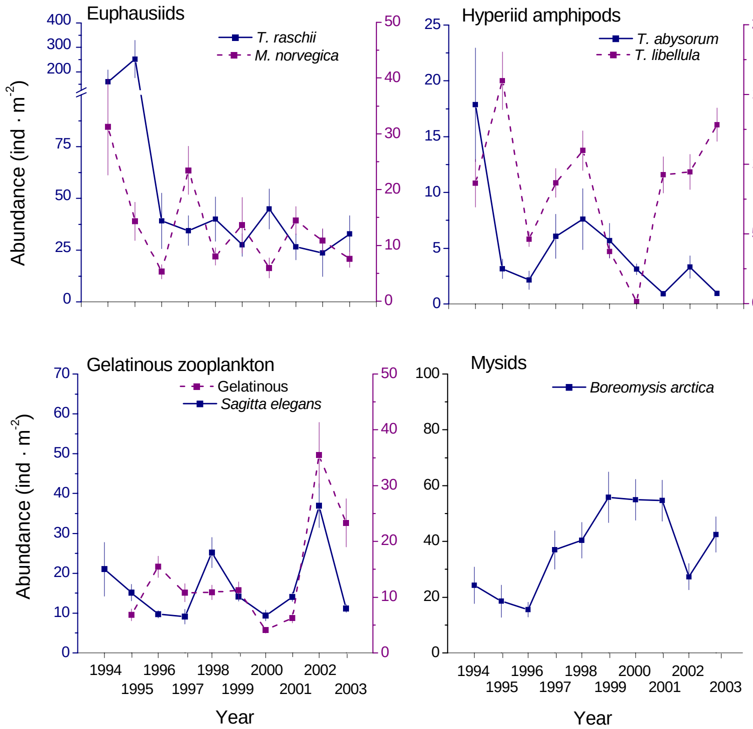


Figure 15. Mean abundance of the most important species of macrozooplankton in the Lower St. Lawrence Estuary and the northwest Gulf of St. Lawrence from 1994 to 2002.

<u>Fixed stations</u>: In 2003, the monthly variations in zooplankton biomass observed in both the Anticosti Gyre was slightly higher than in 1999, 2000, 2001, and 2002 while in the Gaspé Current the overall zooplankton biomass was 1.2 times higher than in 2002 and 1.7 higher than in 2001 and 2000 observations (Fig. 16). The minimum and the maximum biomasses occurred in May and October respectively at the Anticosti Gyre (AG) station while the minimum and the maximum biomasses were observed in November and April respectively in the Gaspé Current (CG). The annual minimum (AG) and maximum (CG) zooplankton biomasses occurring in spring seem to be typical since the same situation was observed in 1999, 2000, 2001, and 2002 (Fig. 16).

At both stations, the total abundance of zooplankton observed in 2003 was on ca. 1.5 times higher than 2002, 2001, and 2000. Copepod eggs, juveniles, and adults were clearly dominant, accounting for more than 80% of the zooplankton community for all sampling dates at the Anticosti Gyre and the Gaspé Current. In the Anticosti Gyre, the ostracoda were present at all sampling dates and accounted for ca. 10% of the zooplankton assemblage from April to July. On the other hand, contrary to the situation observed during the previous years (1999-2002), where the larvacea accounted for ca. 10% of the zooplankton assemblage in July and August in both the Gaspé current and the Anticosti gyre, there was no larvacea found in 2003 at both stations (not shown).

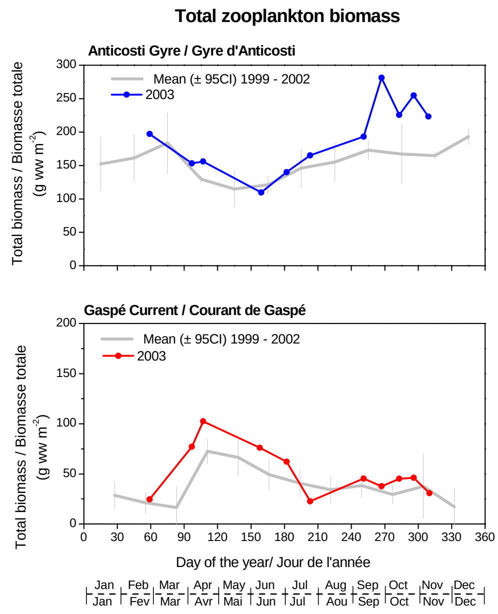


Figure 16. Monthly variations of the zooplankton biomass in the Anticosti Gyre and the Gaspé Current in 2003.

Likewise, the total abundance of copepods observed in 2003 was 1.6 and 1.9 times higher than in 2002, 2001, and 2000 in the Gaspé Current and the Anticosti gyre respectively. In both the Gaspé Current and the Anticosti gyre, the minimum and the maximum copepod abundances occurred in June and late October respectively and were synchronized with the minimum and the maximum values observed in 1999, 2000, 2001, and 2002 (Fig. 17). Close examination of the monthly variations of the copepod community structure reveals that Copepod nauplii accounted for an average of 16% of the copepod community in 2003 in the Gaspé Current as oppose to 9% in 2002, 18% in 2001, and 15% in 2000. In the Anticosti gyre, this difference in the proportion of copepod nauplii was more important than in the Gaspé Current with values of 21% in 2003 vs. 11, 13, and 9% in 2002, 2001, and 2000 (Fig. 17). Finally, the large copepod species (*Calanus finmarchicus* and *C. hyperboreus*) were dominant for all sampling dates in the Anticosti Gyre (Fig. 17) whereas in the Gaspé Current, the small copepod *Oithona similis* was dominant for all sampling dates in the except in July, when larger species such as *C. finmarchicus* and *C. hyperboreus* were more abundant (Fig. 17). The same situation was observed in 2002, 2001, 2000, and 1999 at both stations.

Figure 18 shows the mean integrated annual abundance of the copepodites stages CIV and CV for the period of August to December that represented the portion of the population that will enter in diapauses during winter and produce the next generation during the next summer. According to the results presented on this figure, in the Gaspé current, the abundance of CIV and CV in autumn increased constantly between 2000 and 2003 and was 3.8 times higher in 2003 (30,078 ind. per m^2) than in 2000 (8,369 ind. per m^2) (Fig. 18). On the other hand, in the Anticosti Gyre, the mean integrated annual abundance of the CIV and CV for the period of August to December was stable at 28,720 ind. per m^2 between 1999 and 2002 and increased to 62,240 ind. per m^2 in 2003 (Figure 18).

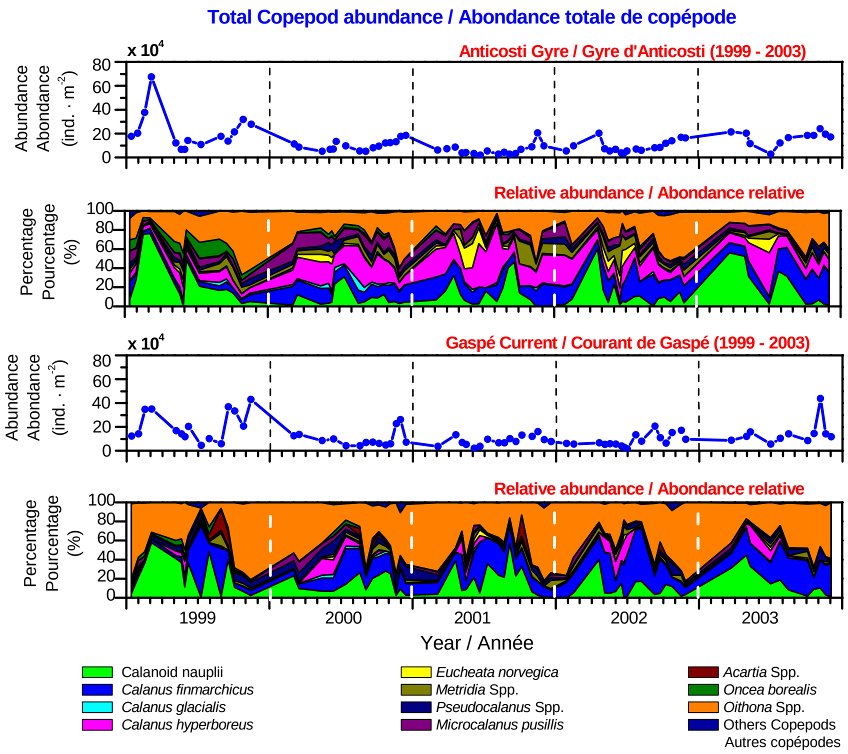


Figure 17. Monthly variations in the integrated copepod abundance and community structure for the Anticosti Gyre and the Gaspé Current fixed stations in 1999, 2000, 2001, 2002 and 2003.

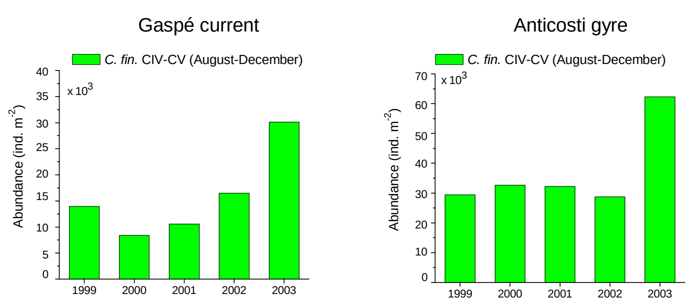


Figure 18. Mean integrated annual abundance of Calanus finmarchicus *copepodite stages CIV and CV for the period of August to December in the Gaspé Current and the Anticosti gyre.*

Figure 19 shows the mean integrated annual abundance of *C. finmarchicus* and *Metridia longa* during the summer-autumn period (April-October) in the Lower Estuary in 1979 and 1980, at station Rimouski from 1992 to 1998, and in the Gaspé Curent from 1999 to 2003. This results showed that the relative abundance of these two species in the Gaspé Curent from 1999 to 2003 is comparable with the situation previously observed in 1799 and 1980 in the Lower estuary but very different to the situation observed at station Rimouski from 1992 to 1998 by Plourde et al. (2002). According to Plourde et al (2002), the increase in abundance of midwater copepod species (mainly *Metridia longa*) and, subsequent decline in the relative abundance of *C. finmarchicus* in the 1990s appears to be related to a change in environmental conditions associated with a decadal climate variation in the GSL-LSLE region.

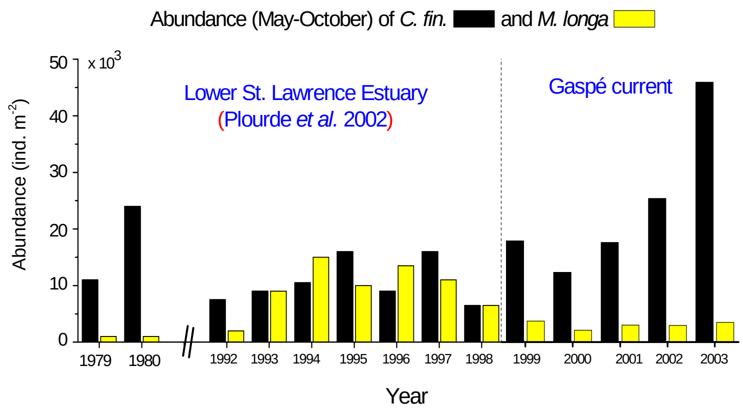


Figure 19. Mean integrated annual abundance of C. finmarchicus *and* Metridia longa *during the summer-autumn period (April-October) in the Lower Estuary in 1979 and 1980, at station Rimouski from 1992 to 1998 and in the Gaspé Current from 1999 to 2003.*

AZMP Sections: The zooplankton biomasses observed in 2003 along all sections in late spring and fall was comparable with observations made in 2002, 2001, and 2000 (not shown). The overall abundance of zooplankton integrated over the water column varied between 7,000 and 380,000 ind. per m^2 along all sections in April, June and November (Figure 20). The total abundances of zooplankton were higher in early spring (April) and fall (November) than in late spring (June) along all sections except for the Iles-de-la-Madeleine and the Cabot Strait sections where the abundance was higher in fall than in early and late spring (Fig. 20). There was no apparent variations on the mean annual abundance of zooplankton along the sampled sections in late spring and fall 2000, 2001, 2002, and 2003 except in fall 2001 long the Cabot Strait, Bonne bay, and the Anticosti sections where the mean zooplankton abundance was almost two times lower than in fall 2000, 2002, and 2003 (not shown). Finally, the mean annual abundances of *C. finmarchicus* observed in 2003 along all sections were comparable with observations made in late spring and fall 2002, 2001, and 2000 except in fall along the Sept-îles and Anticosti transect where the abundance of *C. finmarchicus* was respectively 2.5 and 1.5 higher than in 2002 (Fig. 21).

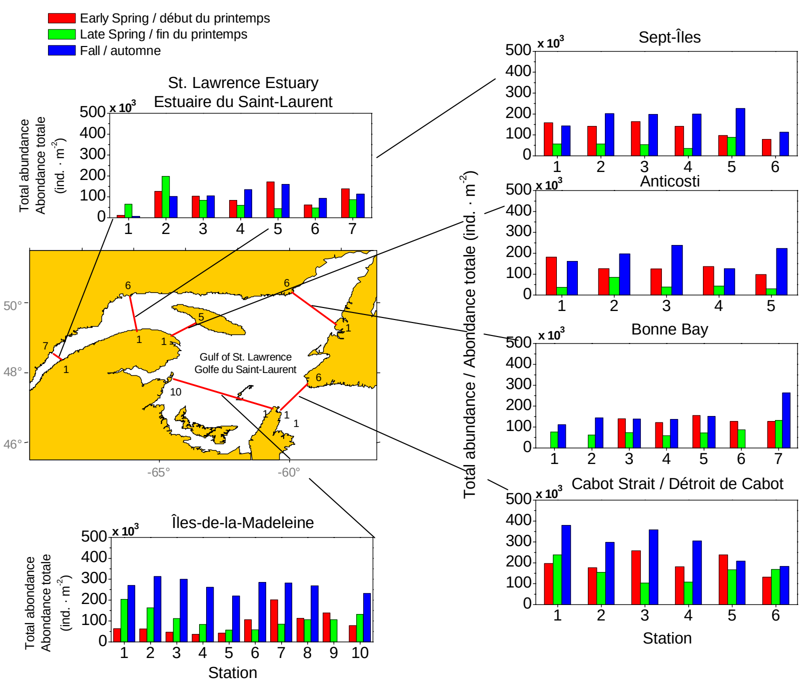


Figure 20. Integrated zooplankton abundance along the six sections sampled in April, June and November 2003 in the Lower Estuary and the Gulf of St. Lawrence.

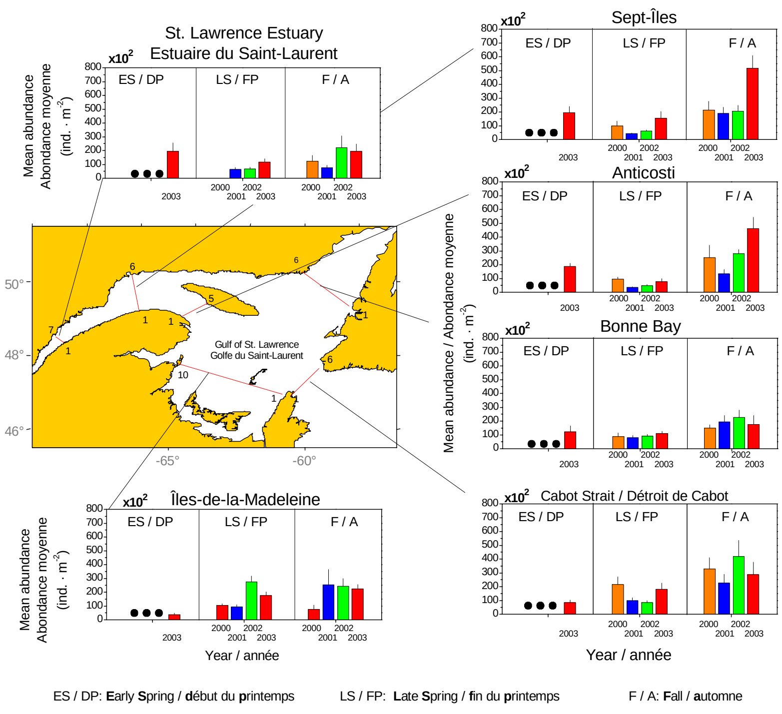


Figure 21. Mean abundance of Calanus finmarchicus *along the six sections sampled in late spring and fall 2000, 2001, 2002, and in early spring, late spring, and fall 2003 in the Lower Estuary and the Gulf of St. Lawrence.*

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