

2010

NYSDEC Lake Ontario Annual Report 2010

New York State Department of Environmental Conservation

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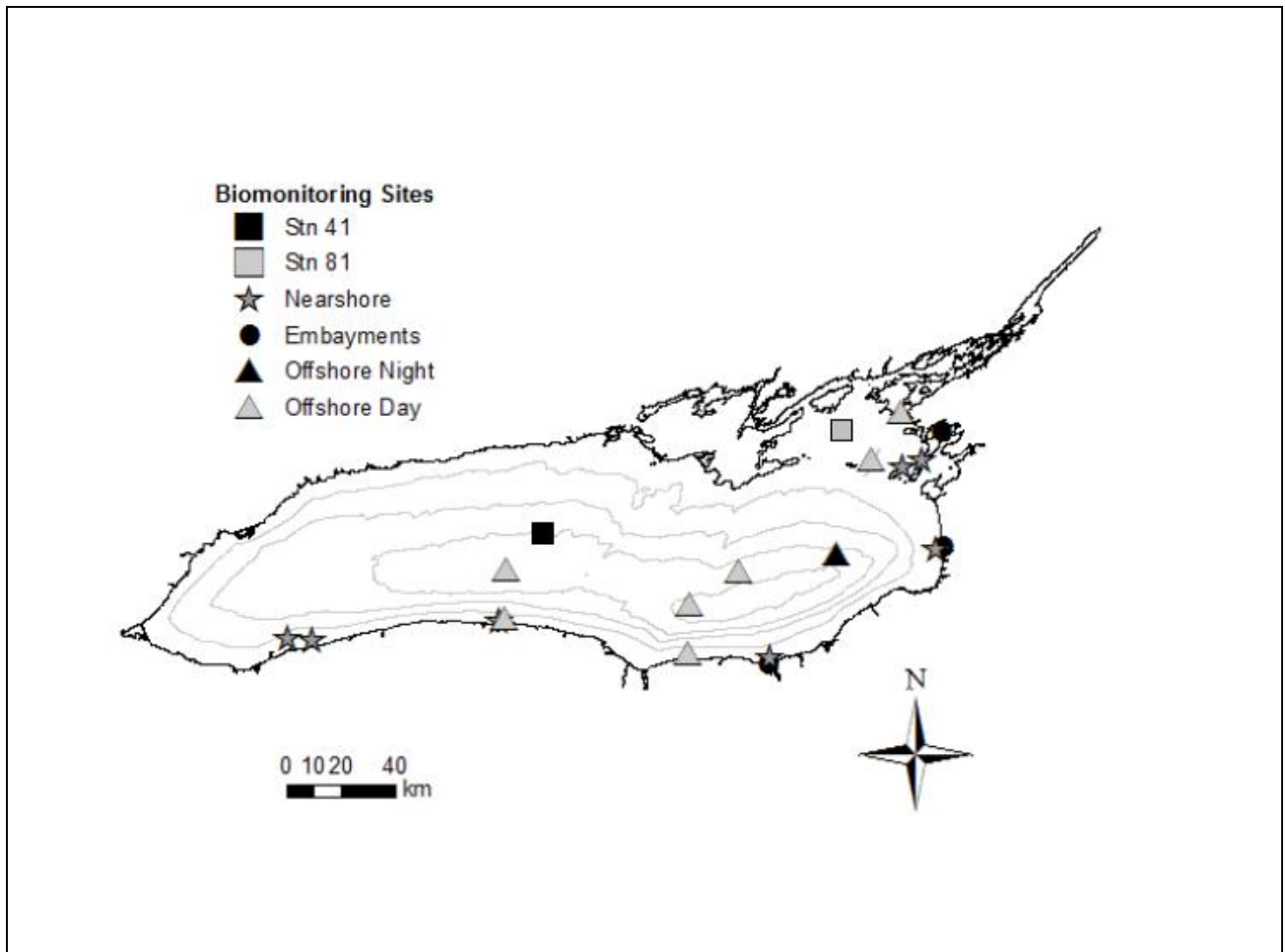


Figure 1. Map of biomonitoring program sites, 2010.

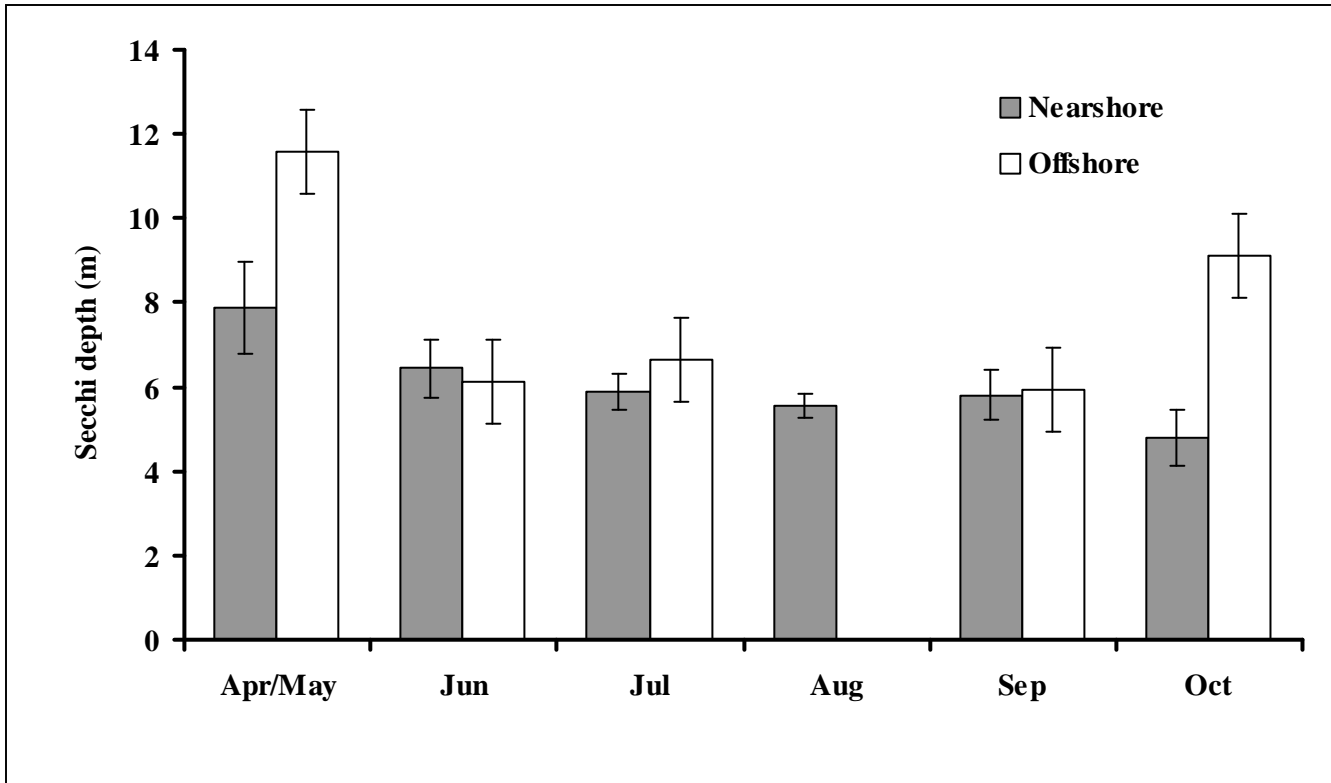


Figure 2a. Mean monthly Secchi depth (meters) for nearshore and offshore habitats in Lake Ontario, Apr/May - October, 2010.

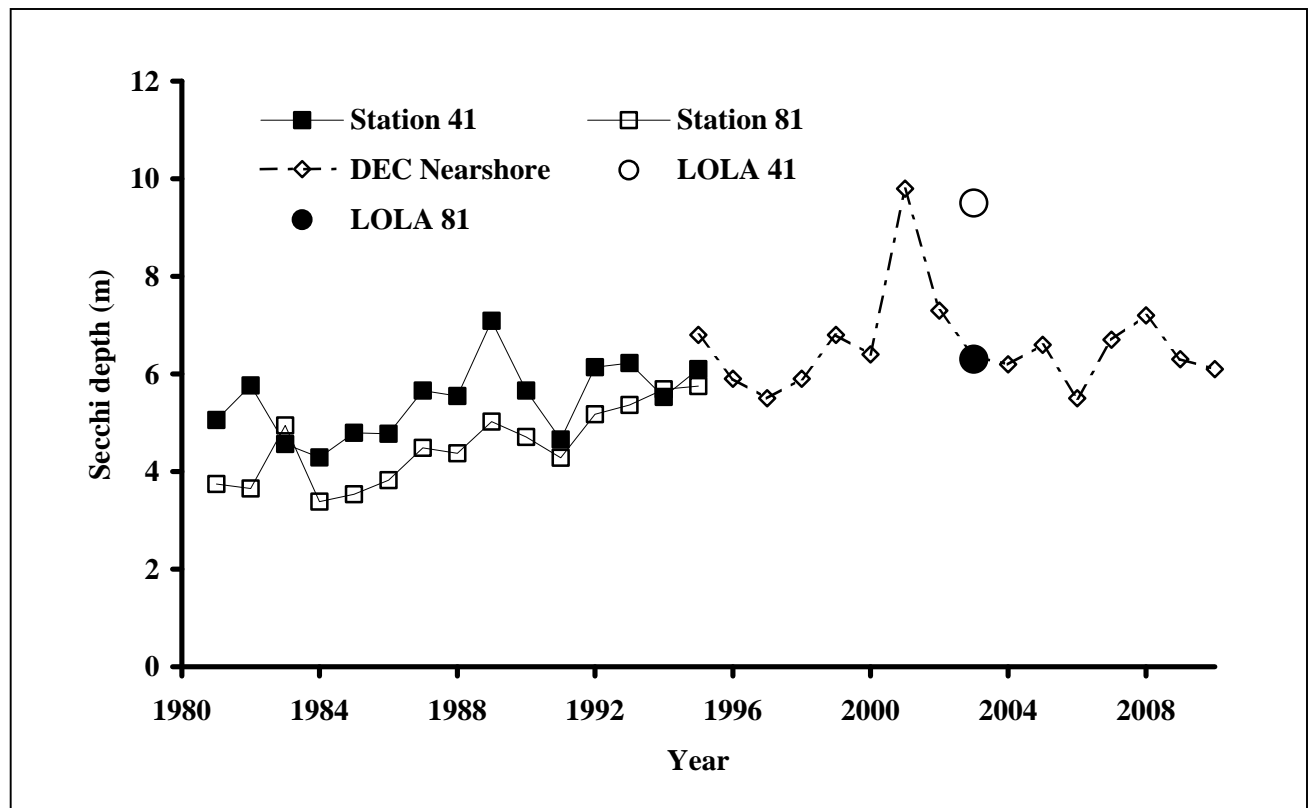


Figure 2b. Long-term mean May - Oct Secchi depth (meters) in Lake Ontario, 1981 - 2010. Data from 1981 - 1995 are from the Department of Fisheries and Oceans Canada's Bioindex Program. Data from 1995 - 2010 are from the NYSDEC Biomonitoring Program.

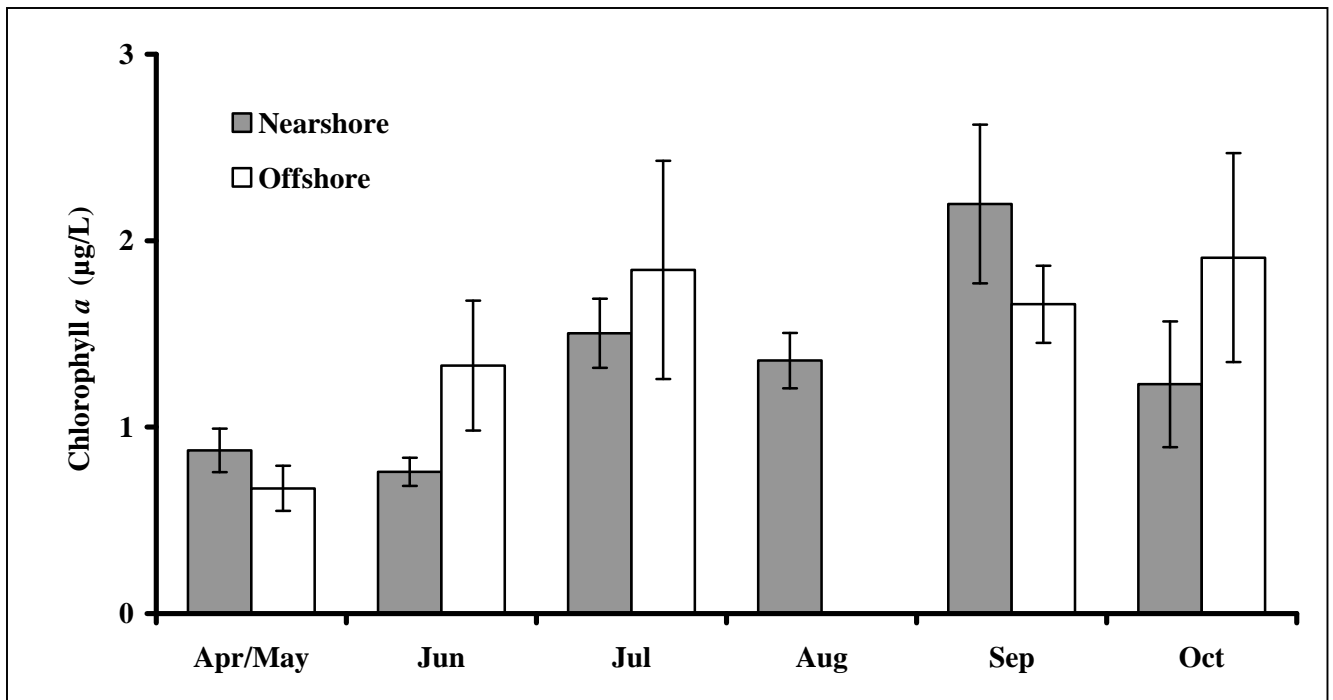


Figure 3a. Mean monthly chlorophyll *a* concentrations for nearshore and offshore habitats in Lake Ontario, Apr/ May - October, 2010.

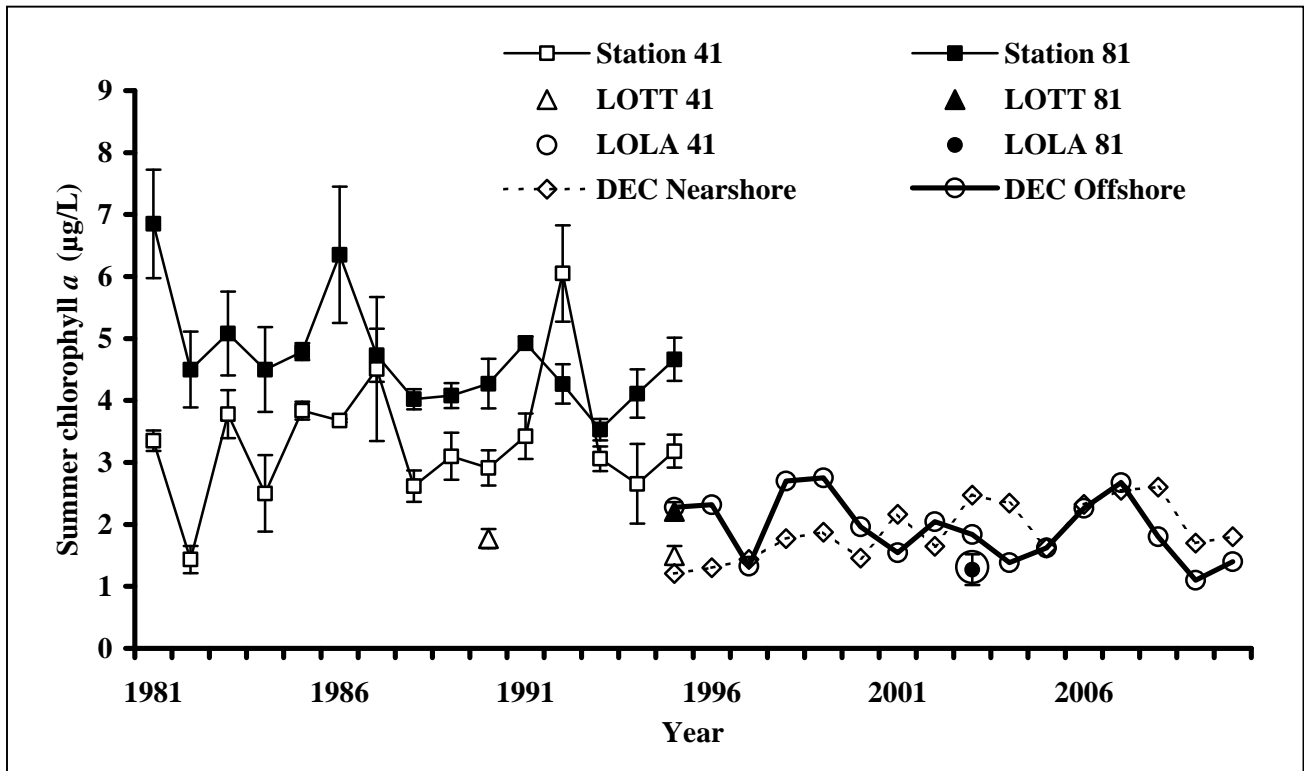


Figure 3b. Long-term summer (Jul – Aug) chlorophyll *a* concentrations in Lake Ontario, 1981 - 2010. Station 41 and Station 81 are from the Department of Fisheries and Oceans Canada's Bioindex Program. LOTT 41 and LOTT 81 are from the Lake Ontario Trophic Transfer Project. LOLA 41 and LOLA 81 are from the Lake Ontario Lower Food Web Assessment. Data from 1995 – 2010 are from the NYSDEC Biomonitoring Program.

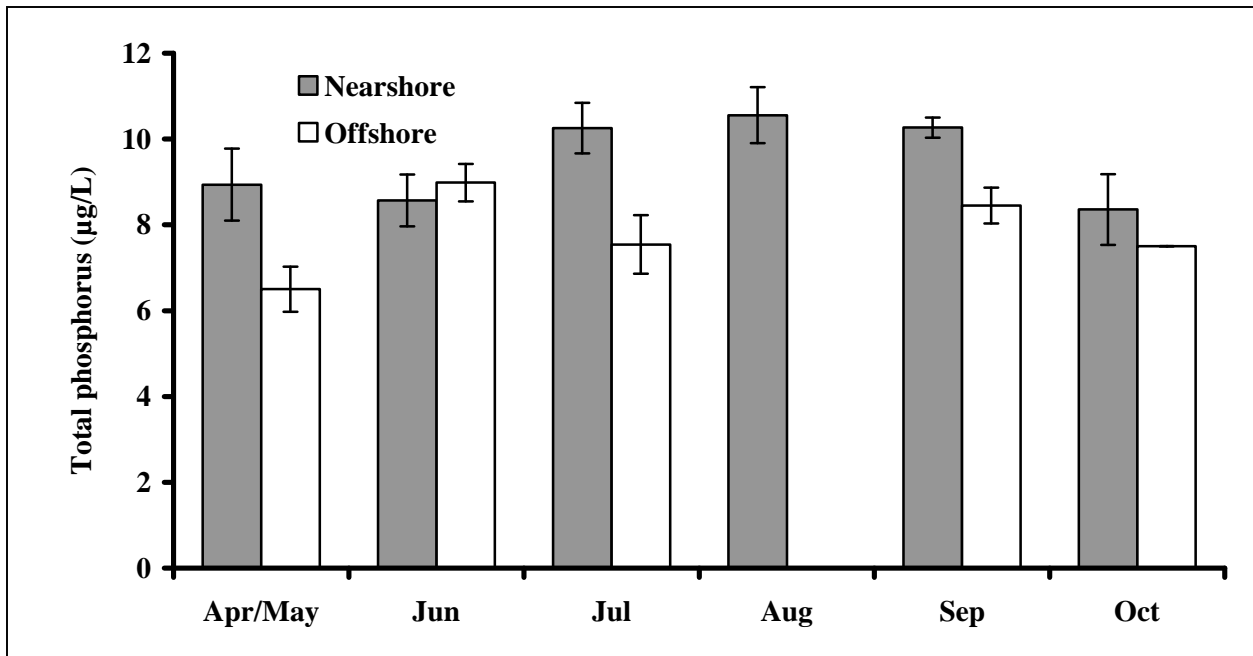


Figure 4a. Mean monthly total phosphorus concentrations for nearshore and offshore habitats in Lake Ontario, Apr/May - October, 2010.



Figure 4b. Long-term spring (Apr – May) total phosphorus concentrations in Lake Ontario, 1970 - 2010. Data from 1970 – 2001 are from Environment Canada’s Surveillance Program. Station 41 and 81 are from the Department of Fisheries and Oceans Canada’s Bioindex Program. LOTT data is from the Lake Ontario Trophic Transfer Project. LOLA data is from the Lake Ontario Lower Food Web Assessment. Data from 1995 – 2010 are from the NYSDEC Biomonitoring Program.

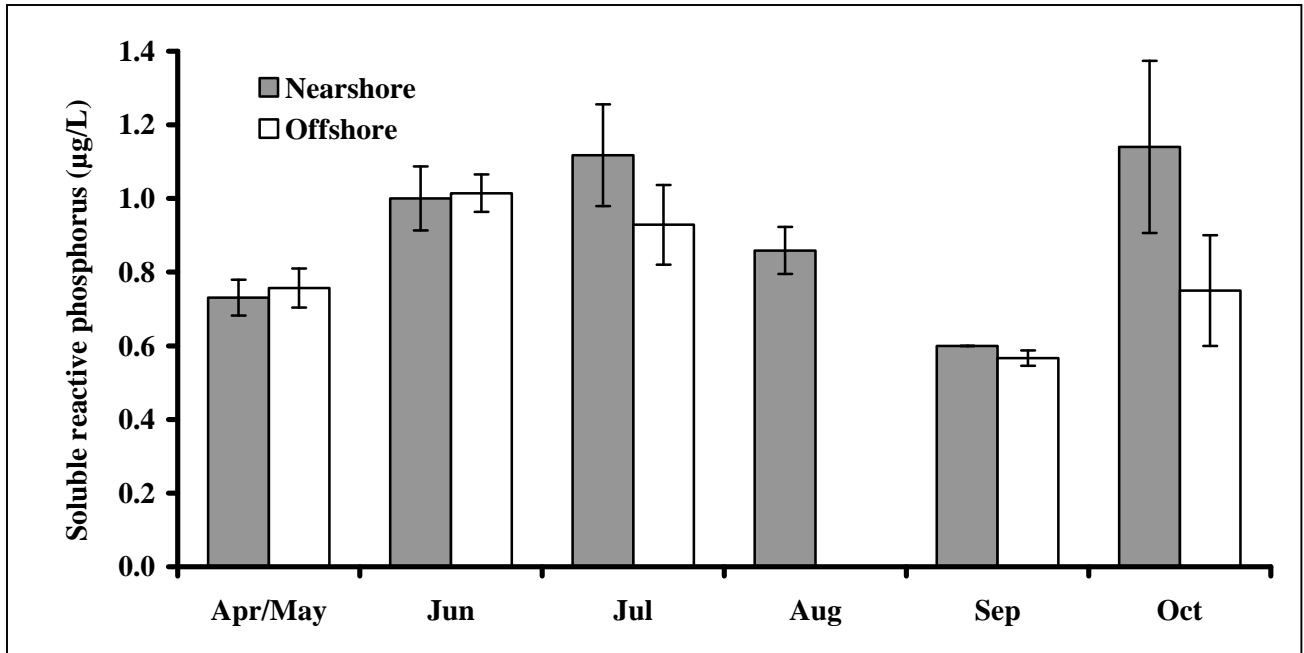


Figure 5. Mean monthly soluble reactive phosphorus concentrations for nearshore and offshore habitats in Lake Ontario, Apr/May - October, 2010.

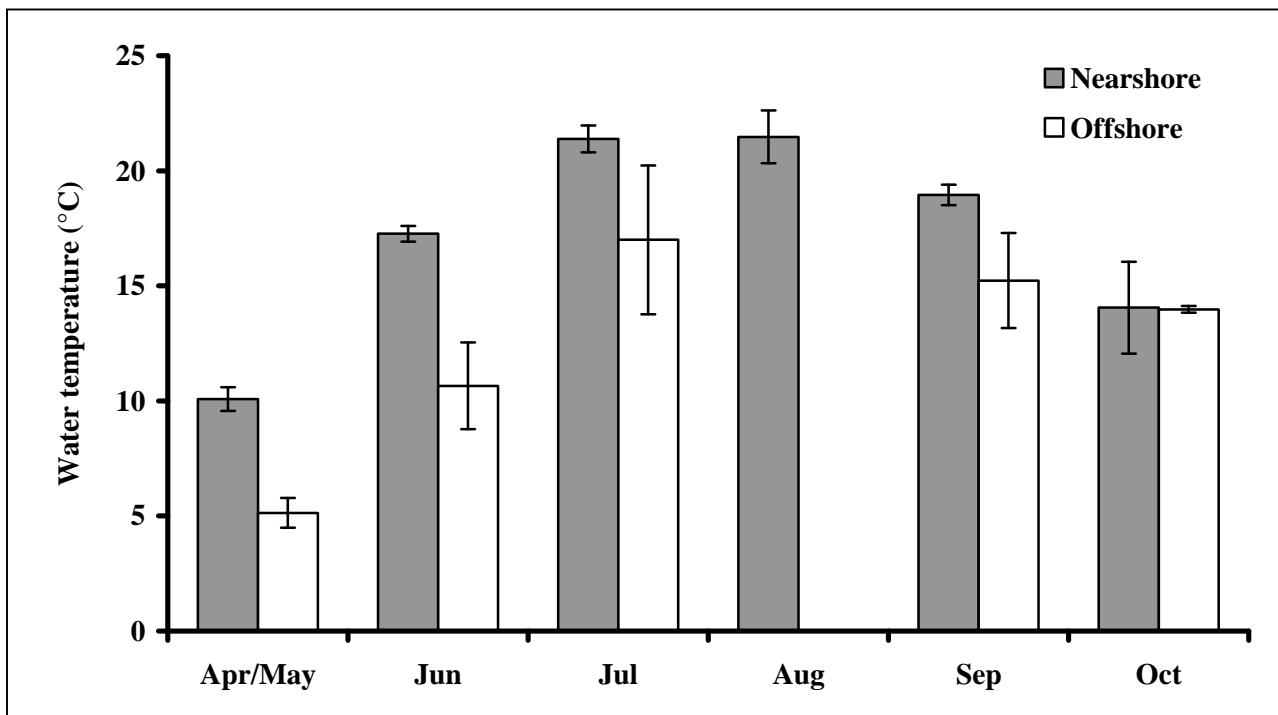


Figure 6. Mean monthly water temperatures in nearshore and offshore habitats in Lake Ontario, Apr/May - October, 2010.

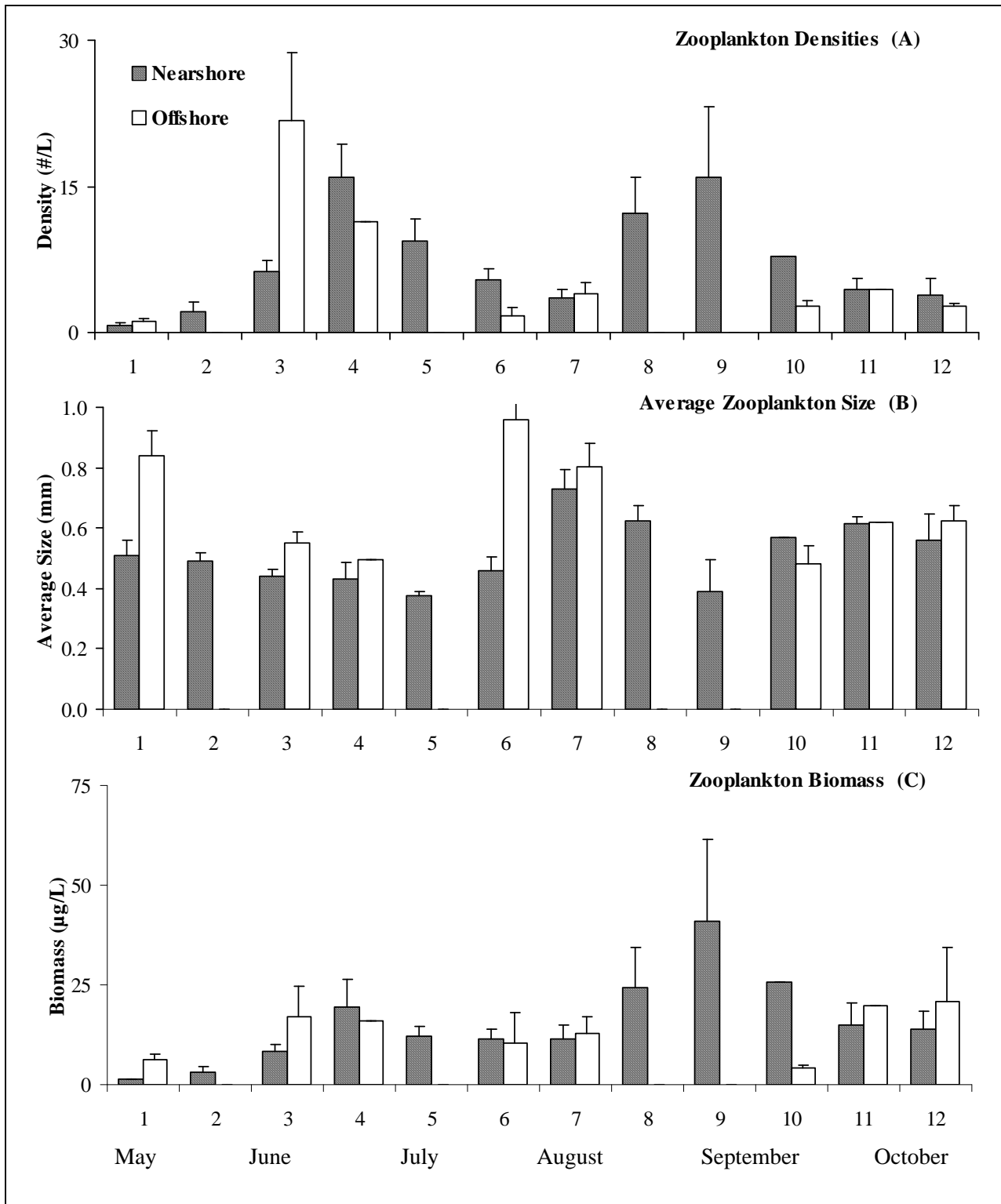


Figure 7. Biweekly means (+ 1SE) of zooplankton densities, sizes, and biomass for May through October 2010 nearshore, and offshore sites on Lake Ontario. On the x-axis, weeks sampled are designated by numbers 1-12.

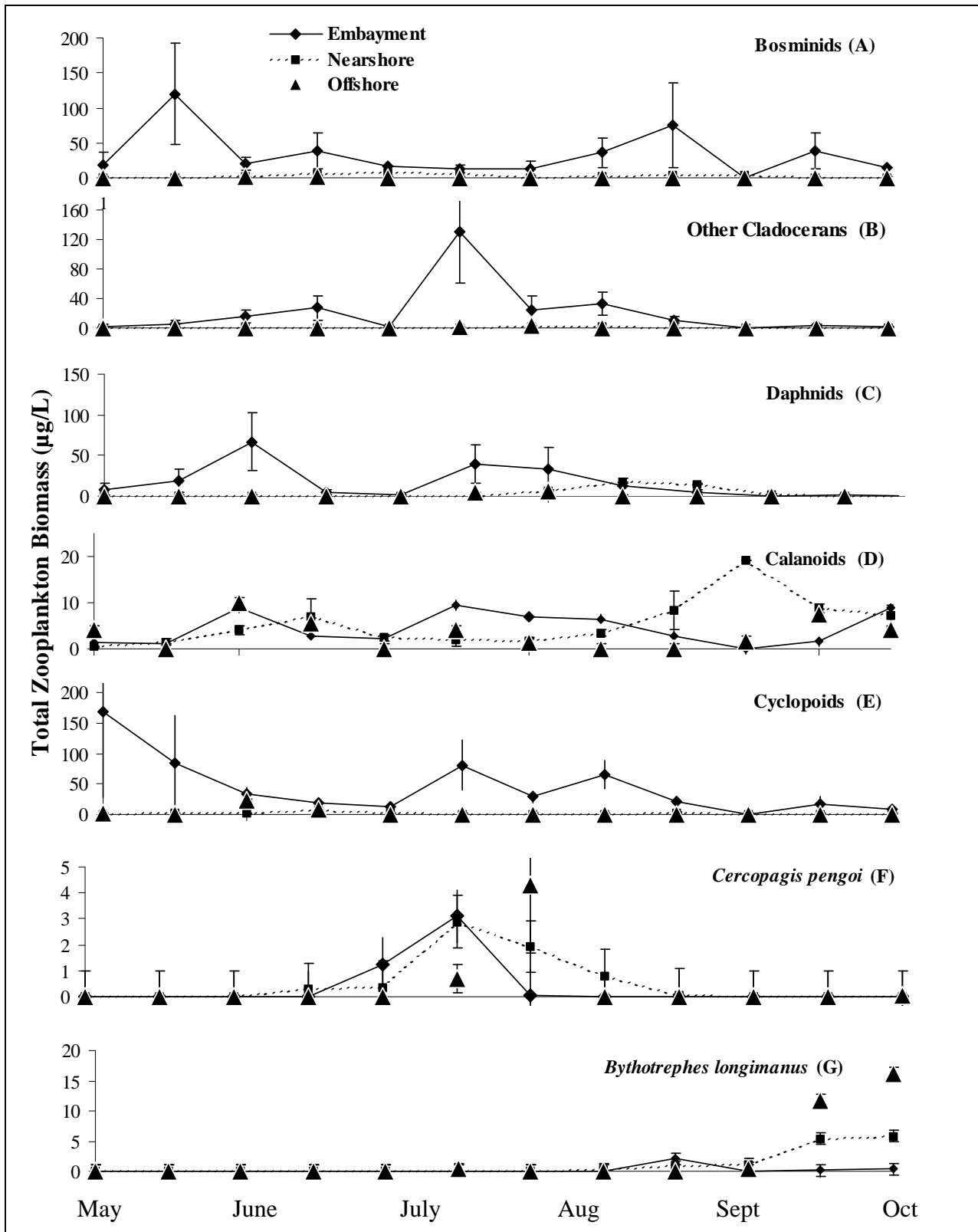


Figure 8. Total biomass of zooplankton community for embayments, nearshore and offshore areas of Lake Ontario, May - October 2010 (weeks 1-12). Zooplankton are grouped as Bosminids (A), Other Cladocerans (B), Daphnids (C), Calanoids (D), Cyclopoids (E), *Cercopagis pengoi* (F) and *Bythotrephes longimanus* (G). Bars represent + 1SE.

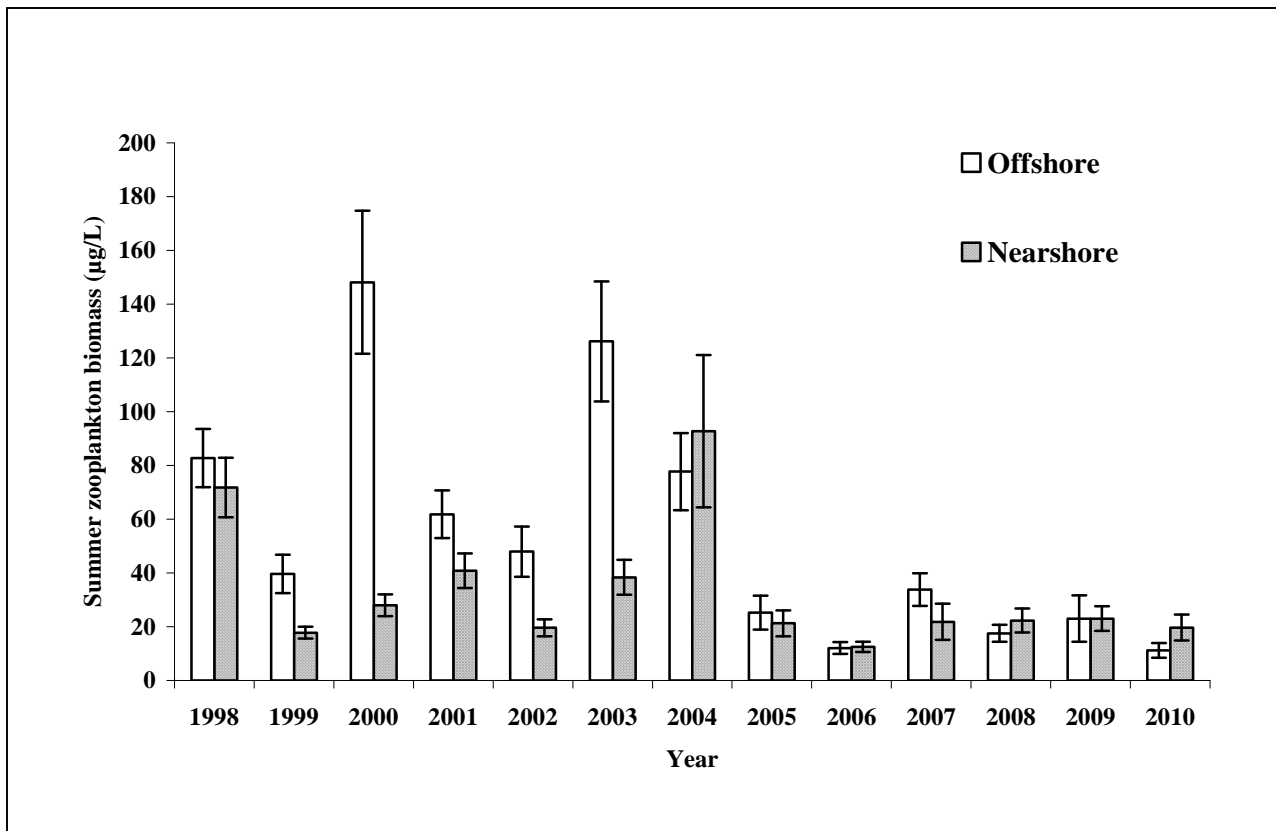


Figure 9. Mean summer (Jul – Aug) total zooplankton biomass in nearshore and offshore habitats in Lake Ontario, 1998 - 2010.

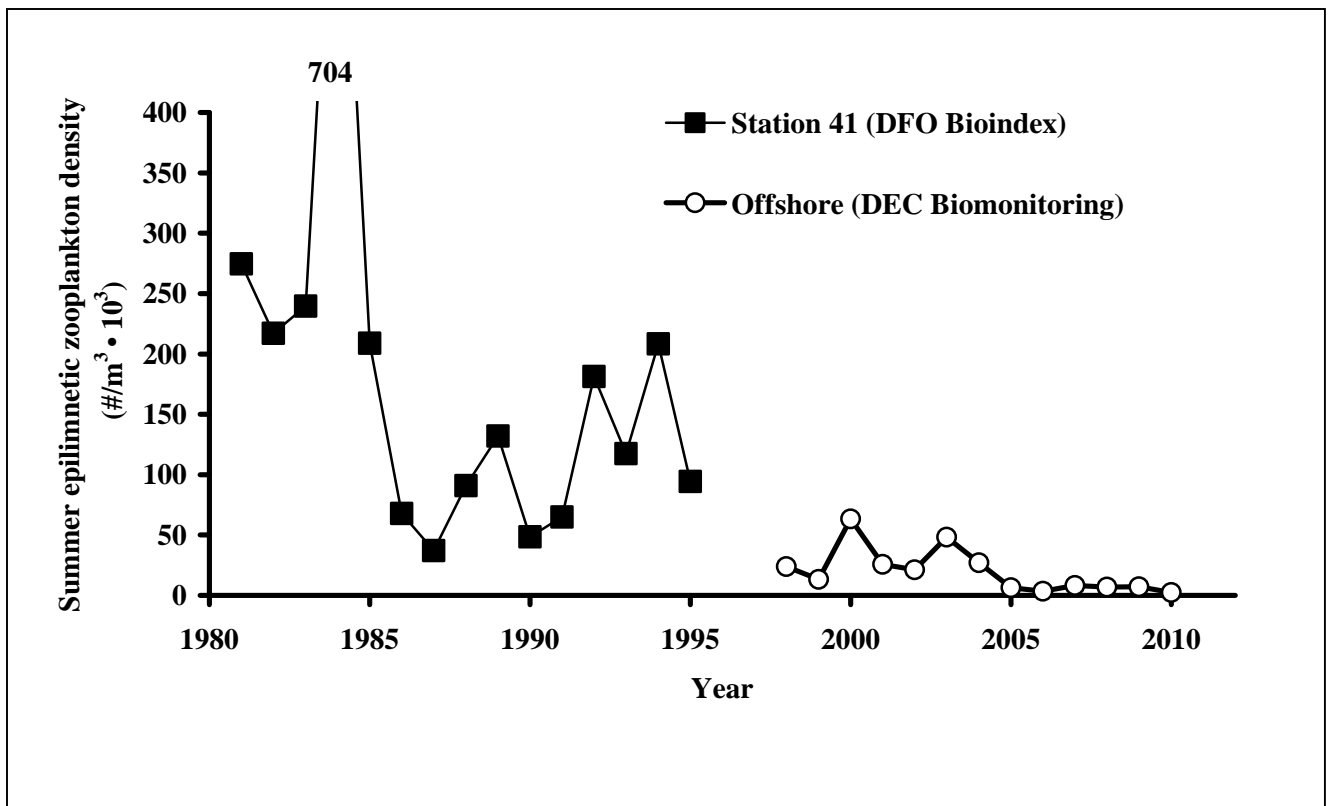


Figure 10. Mean summer epilimnetic zooplankton density in Lake Ontario's offshore, 1981 – 2010.

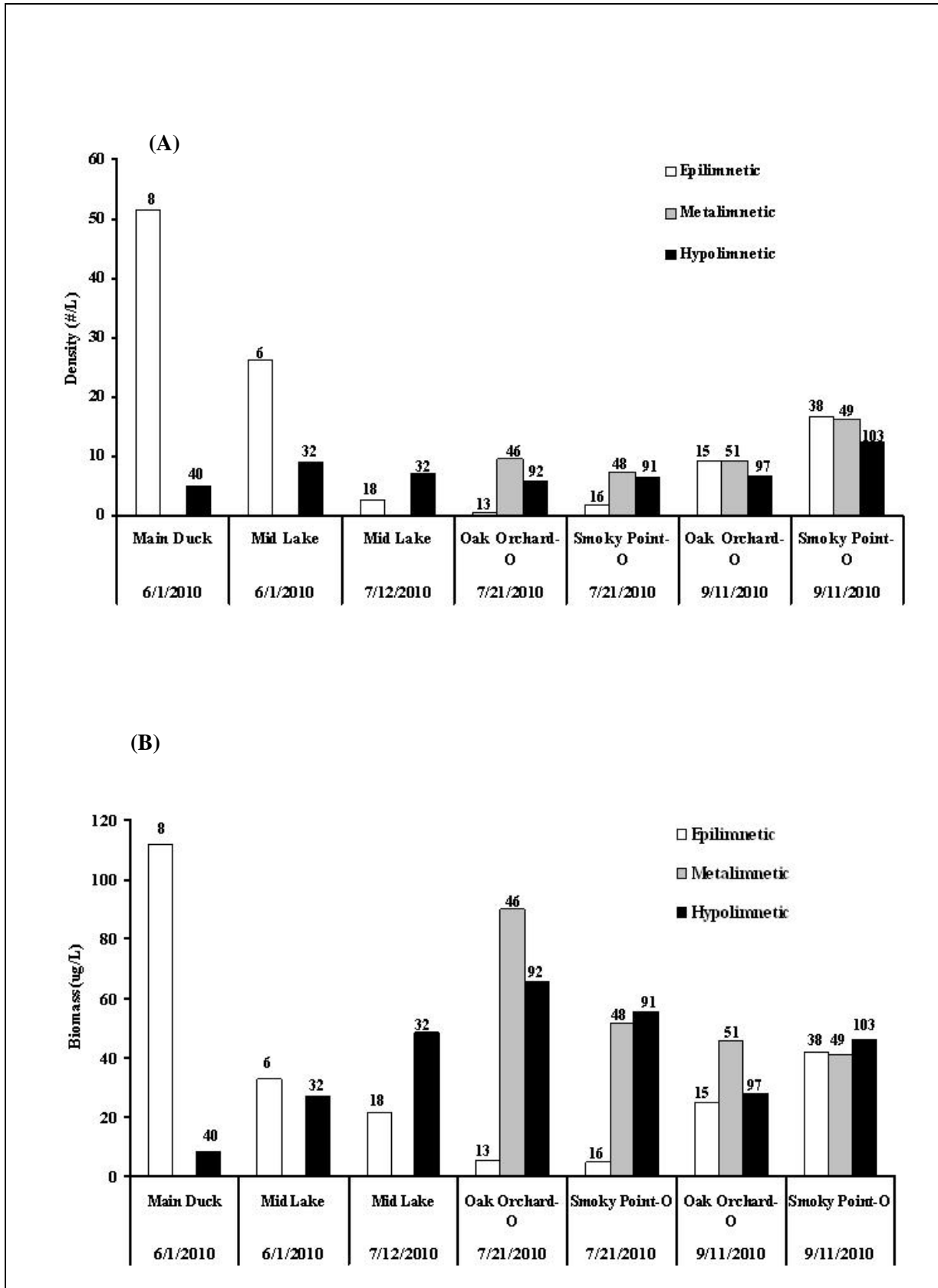


Figure 11. Epilimnetic, metalimnetic, and hypolimnetic zooplankton abundance (A) and biomass (B) in Lake Ontario's offshore, 2010. Tow depths (m) are listed above each bar.

Table 1. Mean chl *a*, TP, SRP and water temperature (\pm SE) for embayment, nearshore, and offshore sites Apr/May - October 2010.

Sites	Mean \pm SE				
	Chlorophyll <i>a</i>	Total phosphorus	Soluble reactive phosphorus	Secchi depth	Water temperature
Embayment					
Chaumont Bay (CBB)	2.8 \pm 0.6 (n=11)	12.4 \pm 1.3 (n=10)	0.7 \pm 0.04 (n=11)	4.4 \pm 0.5 (n=11)	21.0 \pm 1.2 (n=9)
Sodus Bay (SOB)	4.9 \pm 1.5 (n=8)	21.4 \pm 2.5 (n=8)	1.2 \pm 0.2 (n=8)	3.1 \pm 0.4 (n=8)	19.3 \pm 1.6 (n=8)
Sandy Pond Bay (SPB)	18.3 \pm 7.7 (n=7)	34.2 \pm 5.6 (n=7)	1.6 \pm 0.3 (n=7)	1.7 \pm 0.4 (n=7)	22.0 \pm 1.5 (n=7)
Nearshore					
Chaumont Lake (CBL)	1.4 \pm 0.2 (n=11)	8.3 \pm 0.5 (n=11)	0.8 \pm 0.1 (n=11)	6.6 \pm 0.4 (n=11)	18.8 \pm 1.3 (n=10)
Galloo Island (GIL)	1.1 \pm 0.2 (n=11)	8.2 \pm 0.6 (n=11)	0.8 \pm 0.1 (n=11)	7.3 \pm 0.6 (n=11)	18.8 \pm 1.7 (n=10)
Oak Orchard (OOL)	0.8 \pm 0.1 (n=10)	9.2 \pm 0.7 (n=9)	0.9 \pm 0.1 (n=9)	7.3 \pm 1.5 (n=9)	18.4 \pm 1.9 (n=10)
Sodus Lake (SOL)	0.9 \pm 0.2 (n=8)	7.9 \pm 0.5 (n=8)	0.7 \pm 0.1 (n=8)	8.0 \pm 0.8 (n=8)	16.1 \pm 2.3 (n=8)
Sandy Pond Lake (SPL)	1.8 \pm 0.4 (n=7)	10.2 \pm 1.0 (n=7)	0.7 \pm 0.1 (n=7)	6.2 \pm 0.6 (n=7)	19.6 \pm 1.96 (n=7)
Niagara East Lake (NEL)	1.4 \pm 0.3 (n=10)	11.9 \pm 0.9 (n=10)	1.2 \pm 0.2 (n=10)	3.9 \pm 0.4 (n=10)	18.9 \pm 1.3 (n=9)
Niagara West Lake (NWL)	1.0 \pm 0.1 (n=10)	11.3 \pm 0.6 (n=10)	1.3 \pm 0.2 (n=10)	4.8 \pm 0.5 (n=10)	17.2 \pm 1.3 (n=9)
Offshore					
Kaho					
Oak Orchard-N	1.4 \pm 0.2 (n=5)	7.6 \pm 0.4 (n=5)	0.8 \pm 0.09 (n=5)	7.0 \pm 1.2 (n=5)	11.4 \pm 2.0 (n=5)
Oak Orchard-O	1.1 \pm 0.4 (n=4)	6.7 \pm 1.0 (n=4)	0.8 \pm 0.1 (n=4)	10.4 \pm 2.8 (n=4)	4.8 \pm 1.4 (n=4)
Smoky Point-N	1.5 \pm 0.3 (n=5)	8.6 \pm 0.4 (n=5)	0.7 \pm 0.07 (n=5)	6.1 \pm 0.3 (n=5)	13.3 \pm 3.5 (n=5)
Smoky Point-O	2.4 \pm 1.0 (n=4)	8.2 \pm 1.0 (n=4)	0.9 \pm 0.1 (n=4)	7.5 \pm 2.5 (n=4)	10.2 \pm 6.8 (n=4)
Seth Green					
Main Duck	1.1 \pm 0.2 (n=4)	7.6 \pm 0.7 (n=4)	1.0 \pm 0.2 (n=4)	8.6 \pm 2.2 (n=4)	12.0 \pm 3.1 (n=4)
Mid Lake	1.0 \pm 0.2 (n=3)	7.1 \pm 0.8 (n=3)	0.8 \pm 0.1 (n=3)	6.8 \pm 0.7 (n=3)	8.3 \pm 2.5 (n=3)
Tibbetts Point	1.4 \pm 0.4 (n=4)	8.6 \pm 1.2 (n=4)	0.8 \pm 0.1 (n=4)	8.9 \pm 2.3 (n=3)	15.4 \pm 3.7 (n=4)

Table 2. Comparisons of embayment and nearshore sites Apr/May-October, 2010 using paired t-tests on biweekly, log-transformed average values of zooplankton density and biomass, untransformed data for all other parameters, and the proportions of total biomass of zooplankton taxa (i.e. bosminids, other cladocerans, daphnids, calanoid copepods, cyclopoid copepods, *Cercopagis pengoi*, *Bythotrephes longimanus*, and nauplii).

Parameter	Mean		p-value
	Embayment	Nearshore	
Total phosphorus (ug/L)	21.0	9.6	0.0021
Soluble reactive phosphorus (ug/L)	1.0	0.9	0.5682
Chlorophyll <i>a</i> (ug/L)	7.0	1.3	0.0151
Secchi depth (m)	3.3	6.1	<0.0001
Temperature (C)	19.7	17.7	0.0027
Total zooplankton:			
Density (#/L)	111.0	7.6	<0.0001
Average Size (mm)	0.43	0.54	0.0119
Biomass (ug/L)	127.1	16.0	<0.0001
Proportion of total biomass:			
Bosminids	0.33	0.19	0.13
Other Cladocera	0.11	0.04	0.05
Daphnids	0.10	0.10	0.98
Calanoid copepods	0.08	0.42	<0.0001
Cyclopoid copepods	0.36	0.13	0.0007
<i>Cercopagis pengoi</i>	0.01	0.04	0.17
<i>Bythotrephes longimanus</i>	0.01	0.06	0.12
Nauplii	0.01	0.02	0.05

Table 3. Comparisons of offshore (OS), nearshore (NS), and embayment (EM) habitats during July-August 2010 using ANOVA on log transformed mean values of zooplankton density and biomass, and untransformed average size data. Mean values were blocked by site for each habitat. Significant results were determined after using Tukey’s HSD test to identify differences between habitat pairs and are reported as p-values in the ANOVA columns.

Parameter	Mean			ANOVA		
	OS	NS	EM	OS-NS	OS-EM	NS-EM
Total zooplankton:						
Density (#/L)	2.7	9.3	148.0	0.055	<0.0001	0.0003
Average Size (mm)	0.88	0.55	0.43	0.0149	0.0101	0.63
Biomass (ug/L)	11.2	19.7	157.2	0.79	0.0005	0.0014
Zooplankton biomass (ug/L):						
Bosminids	0.4	2.8	31.0	0.004	<0.0001	<0.0001
Other Cladocera	1.5	2.6	38.8	0.58	0.0001	0.0004
Daphnids	4.3	8.0	22.9	0.90	0.17	0.29
Calanoid copepods	2.3	3.7	7.8	0.44	0.23	0.74
Cyclopoid copepods	0.2	0.9	54.3	0.28	<0.0001	<0.0001
<i>Cercopagis pengoi</i>	2.1	1.5	0.7	0.99	0.74	0.68
<i>Bythotrephes longimanus</i>	0.5	0.2	0.3	0.53	0.79	0.98
Nauplii	0.03	0.1	1.5	0.77	0.0004	0.0011

Table 4. Results of regression and change point analyses performed on data from two time stanzas in Lake Ontario, 1995/1998 - 2010 and 1981 - 2010. All data were log-transformed prior to analysis. Trends are indicated by (+) or (-). Significant p-values and change points are indicated in bold.

Offshore	Regression				Change Point Analysis	
	1998 - 2010 ^a	% change	1981 - 2010	% change	1998 - 2010 ^a	1981 - 2010
Spring TP (ug/L)	(-) p=0.37		(-) p<0.0001	3	no breaks	(-) 1996
Summer chlorophyll <i>a</i> (ug/L)	(-) p=0.21		not tested		no breaks	na
Summer epilimnetic zooplankton density (#/L)	(-) p=<0.0035	19	(-) p<0.0001	14	(-) 2005	(-) 1986, (-) 1998, (-)2005
Summer epilimnetic zooplankton biomass (ug/L)	(-) p=.0031	16	not tested		(-) 2005	na
Summer epilimnetic zooplankton group biomass						
Bosminids	(-) p=0.0082	20	not tested		(-) 2005	na
<i>Bythotrephes longimanus</i>	(+) p=0.14		not tested			na
Calanoid copepods	(-) p=0.90		not tested			na
<i>Cercopagis pengoi</i>	(+) p=0.90		not tested			na
Cyclopoid copepods	(-) p=0.001	38	not tested		(-) 2005	na
Daphnids	(-) p=0.18		not tested			na
Other Cladocera	(+) p=0.08		not tested			na
Nearshore	Regression				Change Point Analysis	
	1998 - 2010 ^a	% change			1998 - 2010 ^a	
Spring TP (ug/L)	(-) p=0.32				no breaks	
Summer chlorophyll <i>a</i> (ug/L)	(+) p=0.0482	3			(+) 2001	
Summer epilimnetic zooplankton density (#/L)	(-) p=0.04	10			(-) 2005	
Summer epilimnetic zooplankton biomass (ug/L)	(-) p=0.16				no breaks	
Summer epilimnetic zooplankton group biomass						
Bosminids	(-) p=0.38				(-) 2005	
<i>Bythotrephes longimanus</i>	(+) p=0.27					
Calanoid copepods	(+) p=0.02	18			(+) 2007	
<i>Cercopagis pengoi</i>	(-) p=0.08				(-) 2007	
Cyclopoid copepods	(-) p=0.24				(-) 2005	
Daphnids	(-) p=0.86					
Other Cladocera	(+) p=0.30					

^a1995 – 2010 for spring TP and summer chl *a*

<i>Cercopagis pengoi</i>		Mean		
Parameter	Year	OS	NS	EM
Density (#/L)	1998	0.47	0.40	0.05
	1999	0.44	0.42	0.12
	2000	0.16	0.37	0.24
	2001	0.21	0.69	0.08
	2002	0.36	0.30	trace*
	2003	0.05	0.47	0.44
	2004	0.44	0.51	0.10
	2005	0.26	0.20	0.18
	2006	1.03	0.64	0.06
	2007	0.74	0.34	0.08
	2008	0.26	0.33	0.06
2009	0.39	0.29	0.29	
2010	0.19	0.39	0.23	
Average Size (mm)	1998	1.27	1.12	1.06
	1999	1.30	1.15	1.19
	2000	1.15	1.02	1.13
	2001	1.29	1.16	1.39
	2002	1.07	1.04	-
	2003	1.06	0.97	1.08
	2004	1.27	1.12	1.14
	2005	1.29	1.26	1.07
	2006	1.09	1.17	1.10
	2007	1.29	1.10	1.14
	2008	1.27	1.22	1.24
2009	1.26	0.97	0.93	
2010	1.37	1.04	1.09	
Biomass (µg/L)	1998	3.97	2.72	0.34
	1999	5.28	3.65	1.32
	2000	0.99	2.38	1.87
	2001	1.83	6.12	1.15
	2002	1.75	2.03	trace*
	2003	0.37	2.70	3.14
	2004	3.80	3.97	0.77
	2005	2.45	2.06	1.29
	2006	6.00	5.54	0.45
	2007	6.82	2.53	0.62
	2008	2.15	3.16	0.56
2009	3.20	1.64	1.52	
2010	2.05	2.43	1.52	

Table 5. *Cercopagis pengoi* density, average size, and biomass in offshore (OS), nearshore (NS), and embayment (EM) habitats during July – August, 1998 – 2010. Sampling dates differed each year: late August 1998, August 1999, July 2000, August 2001, August 2002, July 2003, late July - early August 2004, July 2005, July 2006, July 2007, mid-July to early August 2008, July 2009, and July 2010.

* trace indicates 0 < value < 0.001

<i>Bythotrephes longimanus</i>		Mean		
Parameter	Year	OS	NS	EM
Density (#/L)	1998	no data	trace*	trace*
	1999	trace*	0.03	trace*
	2000	no data	0.01	trace*
	2001	trace*	0.01	trace*
	2002	trace*	trace*	trace*
	2003	trace*	trace*	trace*
	2004	trace*	trace*	trace*
	2005	0.02	0.01	0.01
	2006	0.02	0.01	trace*
	2007	0.01	0.02	0.01
	2008	0.03	0.01	trace*
	2009	0.01	0.01	0.01
2010	0.04	0.04	0.004	
Average Size (mm)	1998	no data	2.06	2.14
	1999	1.60	1.11	1.16
	2000	no data	1.20	1.08
	2001	-	1.03	-
	2002	-	-	-
	2003	-	-	-
	2004	2.75	2.47	-
	2005	2.23	2.27	2.28
	2006	2.56	2.60	2.12
	2007	2.59	2.61	2.51
	2008	2.51	2.50	2.24
	2009	2.46	2.42	2.49
2010	2.35	2.50	1.78	
Biomass (µg/L)	1998	no data	0.11	0.13
	1999	trace*	0.53	0.01
	2000	no data	0.26	0.07
	2001	trace*	0.11	trace*
	2002	trace*	trace*	trace*
	2003	trace*	trace*	trace*
	2004	0.57	0.36	trace*
	2005	2.67	1.08	0.70
	2006	2.82	1.93	0.41
	2007	2.22	3.49	0.93
	2008	4.81	2.02	0.34
	2009	1.19	1.79	1.23
2010	6.26	5.15	0.19	

Table 6. *Bythotrephes longimanus* density, average size, and biomass in offshore (OS), nearshore (NS), and embayment (EM) habitats for September-October 1998-2010.