Section 8 – Nitrogen Modeling and Budget

To quantify the inputs of nitrogen into Martins Pond, a mass balance analysis similar to that discussed in the previous phosphorus loading section (Section 5) was conducted. The watershed results of that analysis are presented in Table 34.

Table 34. A monthly comparison of total nitrogen loading in different subwatersheds in the Martins Pond Watershed.

	Subwatershed(s)								
	J	**G**	**WW-NB**	**C**	**D**	**F**	**G, F, H**	**Entire Skug River at Route 28**	**Martins Pond Outlet**
	Reference	Wetland	Wetland	Sub-Shed	Sub-Shed	Sub-Shed	Sub-Sheds	Sub-Sheds	
Month	**Total N in kg**								
03/05	641.33	314.26	187.02	864.92	4540.18	4678.79	2955.11	7634.17	8503.62
04/05	969.89	563.19	53.13	317.97	2908.33	2113.24	4475.95	5224.06	16448.91
05/05	1247.90	393.74	331.13	541.58	7350.87	3490.57	585.94	2398.62	10559.02
06/05	249.40	228.95	475.52	242.47	824.93	1681.65	1485.20	3598.51	644.23
07/05	62.90	88.38	109.40	57.60	702.88	416.33	649.05	1259.62	771.33
08/05	42.24	39.06	15.52	1.61	403.48	418.61	3302.09	1181.26	3553.18
09/05	165.09	44.19	3.22	0.81	861.39	101.53	361.15	537.98	379.56
10/05	74.83	491.54	96.21	340.28	491.36	3381.38	2136.25	1756.68	7487.77
11/05	236.09	52.94	40.39	283.20	1426.50	1043.32	704.58	7606.23	2451.09
12/05	28.64	186.58	121.33	225.08	989.68	1278.04	3774.32	4732.53	6874.59
1/06	249.49	204.96	114.01	174.75	413.54	1351.22	2320.36	5185.73	4464.61
2/06	215.81	88.49	414.10	211.96	788.61	808.46	2674.14	890.73	9916.71
Kg N/ year	**4183.6**	**2696.3**	**1961.0**	**3262.3**	**21701.8**	**20763.2**	**25424.1**	**42006.2**	**72054.6**
ha	188.6	191.1	52.1	303.4	189.1	193.7	690.3	1709.7	1993.9
kg N /ha	22.18	14.11	37.64	10.75	114.76	107.19	36.83	24.57	36.14

The results shown in Table 34 indicate great variability in N loadings across the different subwatersheds analyzed in this study. The reference watershed (J) exhibited a relatively low loading on a per hectare basis (22.18 kg N/ha), as did wetland site G (14.11 kg N/ha) and subwatershed C (10.75 kg N/ha). The two highest loadings were from watershed D and F, two basins with relatively high levels of residential development. The high N loadings from subwatershed D were in stark contrast to the very low P loadings calculated (Table 33).

An analysis of N loading into Martins Pond was also conducted. The results are shown in Table 35. Unlike the P loading results, some 41.7% more N exited Martins Pond than entered it (42006 kg N versus 72055 kg N). There was also a more pronounced seasonal pattern in N loadings than observed with P loadings. The months of July, August, September and October ranked lowest in seasonal loadings of total N accounting for a total of 11.3% of the total inflow to Martins Pond. In contrast, the months of March (18.2%) and November (18.1%) accounted for over 1/3rd of all the N inflows. Table 35 includes a column that denotes the change in % of inlet loading relative to the N outflow from Martins Pond. Positive (+) values denote outflow > inflow loadings and negative (-) values denote inflow > outflow. In March, April, May, August, October, December and February, there was more N exiting the pond than entering it. The mean percent exported for those seven months was some 60.2% more than entered. This result points to significant sources of in-pond N other than watershed sources. A similar result (outflow N > inflow N) was observed during the summer season in the IEP Study (1977).

Table 35. A comparison of nitrogen loading into and out of Martins Pond. Total N loading at the inlet (Skug River at Route 28 [WW-6]) is compared to total N exiting Martins Pond at its outlet (Burroughs Road [MP-3]). Positive (+) values [green] denote outflow > inflow loadings and negative (-) values denote inflow > outflow. Great monthly variation in the total N exiting Martins Pond and/or assimilated is clearly evident. Monthly inflows and outlflows are not shown but can be referenced from Table 30.

Month	Inlet	Outlet	Outlet minus Inlet kg	% of Inlet Loading Relative to the N Outflow
	Total N Loading - kg			
03/05	7634.17	8503.62	869.45	**10.2**
04/05	5224.06	16448.91	11224.85	**68.2**
05/05	2398.62	10559.02	8160.4	**77.3**
06/05	3598.51	644.23	(-2954.28)	**- 458.6**
07/05	1259.62	771.33	(-488.29)	**- 63.3**
08/05	1181.26	3553.18	2371.92	**66.8**
09/05	537.98	379.56	(-158.42)	**- 41.7**
10/05	1756.68	7487.77	5731.09	**76.5**
11/05	7606.23	2451.09	(-5155.14)	**- 210.3**
12/05	4732.53	6874.59	2142.06	**31.2**
1/06	5185.73	4464.61	(-721.12)	**- 16.2**
2/06	890.73	9916.71	9025.98	**91.0**
Yearly Sum	**42006.2**	**72054.6**	**30048.4**	**41.7**

To ascertain potential non-watershed sources of nitrogen, a simple N budget was constructed and is shown in Table 36.

Table 36. A total nitrogen budget for Martins Pond.

N Sources / Inputs	kg / year	percent
Watershed Inflow	42,006	58.3
[a]Septic Tank Inflow	1,200	1.7
[b]In-Pond Processes	28,645	39.8
[c]Atmospheric	204	0.3
Outflow	72,055	

[a] Based on Williams et al. (2004)

[b] Due to in-pond processes and/or shoreline runoff

[c] Based on N deposition data from NADP site MA13

Watershed inflow accounts for only 58.3% of the total N budget for Martins Pond. The source of the other N inputs remains unknown, but it is likely a combination of septic tank inflows, atmospheric deposition, shoreline property run-off (including fertilizers), stormwater conveyance, wetland inputs, nitrogen fixation in the water and sediments, decomposition occurring at lake and pond bottom sediments and inputs from groundwater. Thus, as noted in Table 35, N loadings are both dynamic seasonally and, based on the N budget in Table 36, are influenced heavily by in-pond and/or near-pond processes.

It was difficult in the current study to get a handle on all the sinks, sources and transformations of nitrogen compounds, including dissolved molecular N_2, ammonia (NH_4^+), nitrate (NO_3^-), nitrite (NO_2^-) and dissolved organic N (DON). Nitrogen can be transformed into nitrogen gas N_2 under anaerobic conditions through the process of denitrification and ammonia can be transformed by microbes to nitrate via the process of nitrification. Neither ammonia nor nitrate bind well to pond sediments, thus in some lakes and ponds undergoing eutrophication, nitrogen may or may not accumulate in the sediment (Scheffer 1998). Overall, it was not possible in this study to identify specific in-pond sources of N, although there clearly are internal loadings evident.