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No. 1409

TITLE

Sublittoral macro-infauna of Saint John Harbour, New Brunswick in 1959, 1961, and 1973

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D. J. Wildish

Establishment

Department of the Environment
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Dated November 1976

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ABSTRACT

Taxonomic data for 12 stations worked in Saint John Harbour in 1973 are presented. A partial synonomy list for earlier data obtained by Maclellan and Sprague is also given.

In the main part of the Harbour the sediments are of silt (median particle diameter range of 18-50 μm) that is relatively well sorted (QDØ 0.785-1.380). Only at station 10 is sand present (median particle diameter of 290 μm).

Between 1959 and 1961, at three stations closest to an oil refinery effluent, there is a change in the relationship between species and individuals suggestive of disruptive change in environmental conditions.

INTRODUCTION

Hydrographic observations in Saint John Harbour were made by Hachey (1935a, 1935b, and 1939), M'Gonigle (1937), and Trites (1960). Some hydrographic and chemical observations were made by Sprague (1964), mainly in the estuary above the Reversing Falls. Freshwater runoff data are available (Anon. 1975; Hachey 1935) and are notable for a very large but annually variable spring freshet. A feature of salinity control in Saint John Harbour, recognized by Stommel and Farmer (1953), is the phenomenon of "overmixing". The depth of the surface dilute sea water is limited by the narrowness of the estuary mouth through its effect on the Froude number. The limitation on the depth of the interface allows the bottom layer to deliver salt water into the Harbour even under freshet conditions. The net flow averaged over one tidal cycle is downstream in the upper layer and upstream in the lower layer. This phenomenon has important implications for siting point source effluents in the Harbour. Climatic data, wind direction, wind speed precipitation and ground temperatures, are available from Saint John Airport in Monthly Records of the Meteorological Office.

Previous biological observations in the Harbour have been made by M'Gonigle who investigated the marine borer (*Teredo* and *Limnoria*) problem of the wooden pier piling, and Maclellan and Sprague (1966) who presented sublittoral macro-infaunal data for 1959 and 1961 at 11 stations within Saint John Harbour.

This report presents sediment and biological data obtained in 1973 at the same stations occupied by Maclellan and Sprague. Because these authors left a type series at St. Andrews, it has been possible to check their specimens, thus ensuring a common taxonomic nomenclature. These collections are now located at the Identification Centre, Biological Station, St. Andrews. A temporal comparison of the 1959, 1961, and 1973 data, based on the species/number matrix, is attempted.

MATERIALS AND METHODS

Salient differences in the method, number of replicates obtained and dates are shown in Table 1. A full description of the 1973 sampling and handling procedures is given elsewhere (Wildish, in preparation). A sediment sub-sample from one of the grab samples was taken to a depth of 10 cm, placed in a plastic bag and stored at -20°C on return to the laboratory. Sediment sorting characteristics and organic carbon content were determined on these samples as previously described (Akagi and Wildish 1975).

Table 1. Comparison of sampling methods between 1959, 1961, and 1973 data.

Sampling methods and date	Maclellan and Sprague (1966)	Present work
Sampling dates	30.9-4.12, 1959 24-26.9, 1961	6-7.3 1973
No. stations	11[a]	12[b]
No. replicates/station	3	5
Grab type Surface area sampled	Van Veen 0.1 m^2	Smith-McIntyre 0.1 m^2
Final mesh screen opening size	0.87 mm^2	1.0 mm^2
Vessel	*MALLOTUS*	*MALLOTUS*

[a]Four stations above the Reversing Falls excluded.
[b]Additional station at Black Point.

RESULTS

Taxonomy

A complete species list for the 1973 sampling is given in Table 2. Species(S)/number(N) and species/biomass (B, wet weight of 70% alcohol preserved samples correct to 0.01 g) data are shown in Table 3.

Some of Maclellan and Sprague's specimens were checked by the Canadian Oceanographic Identification Centre, Ottawa, and the synonomies of the earlier and later work are shown in Table 4. It was not possible to check all the earlier specimens because some were missing or had dried out in their bottles and become damaged.

Sediments

Saint John Harbour is extensively dredged. An annual maintenance dredging is necessary at the west side slips.

This involves an average amount of 100,000 cubic yards, scow measure (cysm) of silt carried out during the summer months. The main Saint John Harbour channel (see Canadian Hydrographic Service Chart No. 4344, 1972 ed.) is maintained to a depth of 9.2 m below ELWS requiring an annual removal of a further 100,000 cysm of sediment.

Table 2. Species list for 1973 sampling and corresponding name and number of Maclellan and Sprague (1966).

Name and number - 1976		Name and number of Maclellan & Sprague (1966)	
001	*Tonicella marmorea*		
002	*Ishnochiton albus*		
027	*Oenopota (turricula)*		
033	*Urosalpinx cinerea*		
104	*Mytilus edulis*	*Mytilus edulis*	60
111	*Astarte undata*	*Astarte* sp.	64
121	*Periploma leanum*		
201	*Nereis virens*	*N. diversicolor* (part) and *N. succinea*	7 and 8
202	*Nephtys caeca*	*N. bucera* (part)	9
203	*Nephtys incisa*	*N. bucera* (part)	9
204	*Nephtys ciliata*		
214	*Nereis zonata*		
221	*Sthenelais limicola*	*Sthenelais limicola*	29
222	*Nereis diversicolor*	*N. diversicolor* (part)	7
-	*Nereis* sp.	*Nereis* sp.	46
262	*Eteone longa*	*Eteone longa*	6
-	*Eteone* sp.		
267	*Spio filicornis*		
269	*Goniada maculata*	*Goniada maculata*	26
270	*Scolelepis* sp.		
276	*Clymenella torquata*	*Clymenella torquata*	20
278	*Scalibregma inflatum*	*Scalibregma inflatum*	19
281	*Ninoe nigripes*	*Ninoe nigripes*	12
346	*Terebellides stroemi*	*Terebellides stroemi*	31
357	*Sternaspis scutata*	*Sternaspis* sp.	17
401	*Edotea montosa*		
421	*Calanus finmarchicus*		
430	*Balanus crenatus*		
431	*Balanus improvisus*	*Balanus* sp.	55
-	*Balanus* sp.		
451	*Crangon septemspinosa*	*Crangon* sp.	39
504	*Gammarus oceanicus*	*Gammarus oceanicus*	40
831	*Boltenia ovifera*		
872	*Cerebratulus* sp.	Unidentified Nemertea	1

Table 3. S x N and S x B (in brackets) matrix for sampling in Saint John Harbour on 6.3. 1973.

Sample station	Species no.	Replicate 1	2	3	4	5
1	104		4(2.80)	3(2.33)	1(1.16)	
	121		2(0.30)			
	431			4(0.26)		
	504	5(0.33)	267(18.31)	12(0.76)	35(1.64)	
2	222		2(0.29)	1(0.16)		1(0.32)
	262		1(0.04)			
	504			147(0.31)	2(0.19)	2(0.11)
3	104	46(17.51)	293(15.61)	24(32.93)		
	421	1(0.01)				
	430	14(-)	21(-)	6(0.01)		
	504	139(7.86)	9(0.44)	54(3.64)		
4	204	1(0.32)	Nothing found			
	267	1(0.01)				
5	203		8(0.46)	5(0.61)		
	204	7(0.29)				
	269	1(0.03)	1(0.03)	3(0.10)		
	281	1(0.03)	1(0.03)			
	357	2(0.75)	2(0.16)	5(0.08)		
	401		1(0.01)			
	831		2(0.08)			
	872			1(0.51)		
6	001		2(0.12)			
	027	1(0.03)				
	111	1(1.53)				
	203			1(0.08)		
	214	1(0.01)				
	265		1(0.01)			
	276	1(0.01)				
	278	1(0.01)				
	346	1(0.01)				
7	203	3(0.17)	3(0.13)	1(0.03)	6(0.24)	
	269	2(0.10)	3(0.16)	3(0.16)	3(0.13)	
	270			1(0.07)		
	281				4(0.25)	
9	2		1(0.45)			

Table 3 (cont'd)

Sample station	Species no.	Replicate 1	2	3	4	5
10	201		1(0.03)			
	202	1(0.02)				
	203		1(0.01)			
	204		1(0.03)			
	222	2(0.36)				
	223	1(0.02)				
	270	2(0.05)				
	401	3(0.03)	1(0.01)	1(0.01)	1(0.01)	
	451		2(4.43)	1(0.03)		
11	204					1(0.01)
	221					1(0.12)
12	033	1(0.68)				
	203			1(0.06)		
	451		1(0.23)	1(0.27)		

Table 4. Species list for 1959, 1961 sampling of Maclellan and Sprague (1966) and synonomies with 1976 nomenclature. Asterisks indicate specimens checked by COIC.

	Maclellan & Sprague (1966)	Presently used name and no.	
1	Unidentified Nemeretea	**Cerebratulus* sp.	-
2	*Priapulus caudatus*	Specimen lost	810
3	Unidentified Oligochaeta and Nemathelminthes	" "	
4	Unidentified Polychaeta	**Crystallophrisson* sp. (=*Chaetoderma nitidulum ?*)	
4a	*Aphrodita* sp.		
4b	*Nereis* sp.	**Nereis* sp.	-
4c	*Arenicola marina*	Specimens lost	
4d	*Maldane sarsi*	" "	287
4e	*Amphitrite cirrata*	" "	
5	*Phyllodoce arenae*	" "	
6	*Eteone longa*	" "	262
7	*Nereis diversicolor*	**Nereis* sp. (possibly young *virens*)	201
8	*Nereis succinea*	**Nereis* sp. (possibly young *virens*)	201
9	*Nepthys bucera*	**Nepthys caeca* (Fabricus 1780) and *Nepthys incisa* Malmgren 1865	202 203
10	*Nepthys* sp.	*Unidentifiable Nephtyidae	-
11	*Lumbrineneis* sp.	**Lumbrinereis (fragilis* (O.F. Muller 1776))	282
12	*Ninoe nigripes*	**Ninoe nigripes* Verrill 1873	281
13	*Microphthalmus sczelkowii*	**Aricidea jeffreysii* (McIntosh 1874)	295
14	*Paraonis gracilis*	**Paraonis gracilis* (Tauber 1879)	299
15	*Aricidae sciecica*	**Scoloplos* sp.	284
16	*Scoloplos acutus*	Specimen lost	
17	*Sternaspis* sp.	**Sternaspis scutata* (Renier 1807)	357
18	*Pherusa* sp.		
19	*Scalibregma inflatum*	Specimen lost	278
20	*Clymenella torquata*		276
21	*Maldanopsis* sp.	Specimen lost	-
22	*Ophelia* sp.	*Unidentifiable sabellid posterior	-
23	*Ammotoypane aulogaster*		113
24	*Trochochaeta* sp.	**Disoma watsoni* Fauvel 1916	
25	Unidentified Capitellidae	**Tharyx acutus* Webster & Benedict	298
26	*Goniada maculata*		269
27	*Harmothoe imbricata*		207
28	*Antinoella sarsi*		217
29	*Sthenelais limicola*	**Sthenelais limicola* (Ehlers 1864)	221

Table 4 (cont'd)

	Maclellan & Sprague (1966)	Presently used name and no.	
30	*Pista maculata*		347
31	*Terebellides stroemi*		346
32	*Cossura* sp.	**Cossura longocirrata* Webster & Benedict 1887	296
33	*Cirratulus* sp.	**Tharyx* or *Chaetozone* sp.	-
34	*Prionospio malmgreni*	Specimen lost	
35	*Scolelepides viridis*	**Scolecolepides viridis* Verrill 1873	
36	*Streblospio benedicti*		279
37	*Polydora* sp.		280
38	*Glycera dibranchiata*	**Glycera dibranchiata* Ehlers 1868	
39	*Cragon* sps.	Specimen lost	451
40	*Gammarus oceanicus*	*Gammarus oceanicus* Sergestrale 1947	504
41	Ampeliscidae species 1	) **Byblis gaimardi* (Kroyer 1846)	501
42	Ampeliscidae species 2	)	
43	*Leptocheirus* sp.	Specimen lost	
44	*Unciola* sp.	**Unciola irrorata* Say 1818	503
45	*Phoxocephalidae* sps.	**Phoxocephalus holboloi* Kroyer 1842	
46	*Hippomedon* sp.	**Hippomedon propinguus* G.O. Sars 1890	
47	*Caprellidae* sps.	**Aegina longicornis* (Kroyer 1842-43)	440
48	*Cyathura polita (?)*	**Idotea phosphorea* Harger 1873	402
49	*Edotea triloba*	**Edotea triloba* (Say 1818)	
50	*Chiridotea* sp.	**Chiridotea tuftsi* (Stimpson)	
51	*Jaera marina*	Specimen lost	
52	*Diastylis bispinosus*	" "	
53	*Eudorella hispida*	" "	586
54	*Michtheimysis stenolepis*	" "	
55	*Balanus* sp.	**Balanus improvisus* Darwin 1854	431
56	*Terebratulina* sp.	Specimen lost	
57	Unidentified gastropod	**Nassarius trivittatus* (Say)	032
58	Unidentified Bullidae	**Retusa* sp.	
59	Unidentified pelecypod	Specimen lost	
60	*Mytilus edulis*	" "	104
61	*Mya arenaria*		118
62	*Macoma balthica*		117
63	*Nucula proxima*		100
64	*Astarte* sp.	Specimen lost	-
65	Unidentified ascidean	Specimen lost	

The Courtenay Bay Channel and Turning Basin (Chart No. 4344) are dredged annually in the winter months requiring removal of 400,000 cysm. The dredge spoil from all this activity is shipped by barge to Black Point for dumping. Station 12, added to the 1959, 1961 stations, is at Black Point (Fig. 1). There have been no recent changes in dredging practice except in 1961 ladder dredges were replaced with suction hopper or clam-shell types.

The percent silt/clay, sand and fraction >2 mm are shown in Table 5. Swift currents below the Reversing Falls

Table 5. Sediment characteristics of Saint John Harbour.

	Percent		
Station	2 mm	Sand	Silt and clay
1	93.2	6.3	0.5
2	59.8	39.5	0.8
3	HARD	0	0
4	6.0	39.0	1.0
5	0	6.8	93.2
6	0	19.8	80.2
7	0	13.6	86.4
8	0	20.0	80.0
9	0	3.6	96.4
10	0	65.3	34.7
11	0	16.3	83.7
12	0	13.1	86.9

keep fine sediments from settling here. At station 1 grab samples consisted almost entirely of wood chips and fibres of various sizes. Quantitative grabs could not be taken because the grab jaws would not close over long pieces of fibrous bark. At station 2 grab samples consisted of wood chips and a coarse sand. The only material in the grab at station 3 was large numbers of mussels scraped from the hard bottom. Station 4 contained hard lumps of clay >2 mm diameter with some sand. At all other stations quantitative samples were taken and the sediment was of a type which could be analyzed by sieving and pipet techniques (Table 6). The phi quartile deviation values (QDØ) show that all the sediments are relatively well sorted (compare, for instance, with L'Etang data in Akagi and Wildish 1975), and the phi quartile skewness (SKqØ) values are positive indicating that the mean of the quartiles lies to the right of the phi median value (MdØ). The high organic carbon value of station 9 was associated with a black sediment, smelling of H_2S gas, indicating anoxic conditions just beneath the sediment surface.

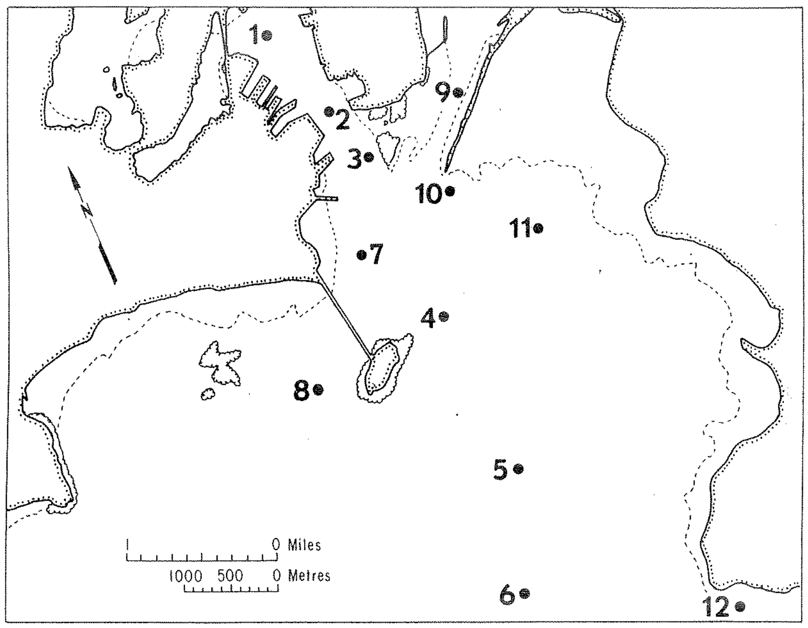

Fig. 1. Map of Saint John Harbour showing the stations occupied in 1959, 1961, and 1973.

Table 6. Sediment sorting characteristics and organic carbon content for Saint John Harbour.

Station	Organic carbon (% dry wt. basis)	MdØ	QDØ	SKqØ
5	1.1269	6.94	1.155	+0.215
6	0.7912	6.10	1.380	+0.950
7	0.4984	5.39	0.625	+0.005
8	0.7378	6.26	1.175	+0.225
9	2.1628	6.04	0.785	+0.065
10	0.6119	1.17	1.605	+1.775
11	1.2104	6.43	1.030	+0.320
12	1.0905	6.20	0.995	+0.065

Temporal comparison of biological data

The species (S) x individuals (N) data (Table 3) is insufficient to calculate the equilibrium species number for each station. Instead the semi-log plot is used for this comparison where:

x = S arithmetic, for accumulated new species found in successive replicates, taken chronologically, at the same station.

y = N logarithmic for numbers of individuals accumulated in successive replicates at the same station.

The data for this comparison are shown in Table 7. Initially, plots were made on semi-log paper and on the basis of inflections in this trend (Fig. 2), stations 4, 9 and 10 selected. Other stations lacked the inflection.

The inflection was sharpest at station 9, least for station 4. Three possibilities might explain this:

- repeat sampling at the same spot;

- sampling station near a sharp discontinuity in benthic community type and slight differences in position of sampling at different times;

- a temporal change in the relationship between species and individuals, unconnected with seasonal effects, due to disruptive change in environmental conditions.

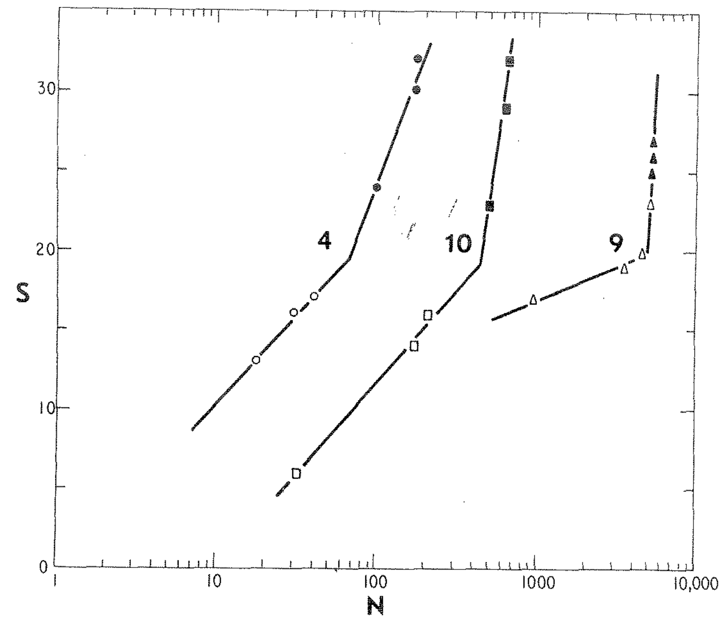

Fig. 2. Semi-log plot of species (S) versus individuals (N) at three stations. Solid symbols represent 1961 and open ones 1959 data.

Table 7. Cumulative new S and accumulated N for Saint John Harbour stations.

Station	Year	Replicate	S	N	Cumulative new S	Cumulative N
		A	7	336	7	336
1	1959	B	4	12	8	348
		C	3	48	9	396
		A	3	279	9	675
1	1961	B	2	1162	9	1837
		C	2	1571	9	3408
		1.	1	5	9	3413
1	1973	2.	3	273	10	3686
		3.	3	19	10	3705
		4.	2	36	10	3741
		A	5	103	5	103
2	1959	B	10	298	11	401
		C	5	233	12	694
		A	4	25	12	719
2	1961	B	4	19	13	738
		C	7	1895	16	2633
		1.	0	0	16	2633
		2.	2	3	16	2636
2	1973	3.	2	148	16	2684
		4.	1	2	16	2686
		5.	2	3	16	2689
		A	6	22	6	22
3	1959	B	5	27	10	49
		C	4	11	12	60
		A	12	843	20	843
3	1961	B	11	1259	23	2102
		C	7	660	24	2762
		1.	3	61	26	2823
3	1973	2.	3	317	26	3140
		3.	2	30	26	3170

Table 7 (cont'd)

Station	Year	Replicate	S	N	Cumulative new S	Cumulative N
4	1959	A	13	18	13	18
		B	4	12	16	30
		C	2	10	17	40
4	1961	A	11	56	24	96
		B	12	75	30	171
		C	-	-	-	-
4	1973	1.	2	2	32	173
		2.	Nothing		32	173
5	1959	A	20	175	20	175
		B	9	14	23	189
		C	20	189	30	378
5	1961	A	7	22	32	400
		B	8	41	34	441
		C	12	70	34	511
5	1973	1.	4	11	35	522
		2.	6	15	37	537
		3.	4	14	38	551
6	1959	A	20	351	20	351
		B	17	228	25	579
		C	21	80	27	659
6	1961	A	15	48	33	707
		B	25	137	38	844
		C	21	93	38	937
6	1973	1.	6	6	42	943
		2.	2	3	43	946
		3.	1	1	43	947
7	1959	A	19	291	19	291
		B	20	328	27	619
		C	23	370	32	989
7	1961	A	12	152	35	1141
		B	16	135	36	1276
		C	9	116	36	1392

Table 7 (cont'd)

Station	Year	Replicate	S	N	Cumulative new S	Cumulative N
7	1973	1.	2	5	36	1397
		2.	2	6	36	1403
		3.	3	5	37	1408
		4.	3	13	37	1421
8	1959	A	17	310	17	310
		B	15	159	21	469
		C	15	219	25	688
8	1961	A	-	-	25	688
		B	12	279	29	967
		C	13	232	31	1199
9	1959	A	17	947	17	947
		B	14	2689	19	3636
		C	13	991	20	4627
9	1961	A	8	395	23	5022
		B	9	212	25	5234
		C	4	51	26	5285
9	1973	1.	-	-	26	5285
		2.	1	1	27	5286
10	1959	A	6	32	6	32
		B	12	142	14	174
		C	9	33	16	207
10	1961	A	9	293	23	500
		B	17	125	29	625
		C	4	7	29	632
10	1973	1.	5	9	32	641
		2.	5	6	32	647
		3.	2	2	32	649
		4.	1	1	32	650
11	1959	A	4	10	4	10
		B	5	9	7	19
		C	11	25	15	44

Table 7 (cont'd)

Station	Year	Replicate	S	N	Cumulative new S	Cumulative N
11	1961	A	-	-	15	44
		B	-	-	15	44
		C	4	35	17	79
11	1973	1.	-	-	17	79
		2.	-	-	17	79
		3.	-	-	17	79
		4.	-	-	17	79
		5.	2	2	18	81
12	1973	1.	1	1	1	1
		2.	1	1	2	2
		3.	2	2	3	4

The species list for these three stations suggests that the change between 1959 and 1961 does not involve species number or composition but rather a reduction in the number of individuals per species.

The 1973 data, despite greater effort, yielded fewer species and individuals than the 1959 and 1961 surveys. This is interpreted as a seasonal effect. The samples were taken in March at the end of the winter before summer reproduction had repopulated sediments. In temperate climates, winter reductions in benthic numbers have previously been recognized (Beukema 1974).

DISCUSSION

Maclellan and Sprague (1966) originally investigated Saint John Harbour to detect changes in sublittoral macro-infauna caused by an oil refinery effluent which started discharging in 1960. This analysis of the earlier data does provide some evidence to suggest a mild reduction in numbers at the three stations nearest the effluent outlet at the tip of Courtenay Bay breakwater. Because of the poor return for effort, the 1973 data cannot be compared with the 1959 and 1961 data using an analytical technique free of seasonal bias.

Temporal comparisons of sublittoral macro-infauna communities are based upon the stability/time concept. The present work points up some technical difficulties in its use for pollution indication purposes:

- possibility of repeat sampling at the same point causing a reduction in N;

- sharp discontinuities in community type over a small area (defined by the tidal swing of the anchored boat during sampling) causing anomalous changes in S versus N plots;

- seasonal effects on N caused by an annual cycle of recruitment and loss in temperate climates;

- the approach to a low equilibrium species number with less than 3 grab samples resulting in anomalies in the S versus N plot;

- imprecision of replicating stations exactly over time; This may be important in areas where a sharp discontinuity in community over a small area is present.

ACKNOWLEDGMENTS

I wish to thank Mr. D. I. Higgins of the Department of Public Works for information on dredging projects in the Harbour. I also thank the staff of COIC who identified all 1973 samples and checked the Maclellan and Sprague material, and Dr. McLeese who read the manuscript and explained that cysm = cubic yard, scow measure.

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