Methods of Hester-Dendy Multiplate Sampler Deployment

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Introduction

Artificial substrate samplers have been employed by stream ecologists since the late 1920s, with the suggestion by Shelford and Eddy (1929) that masonry blocks or rock be placed into the stream as potential substrates for the study of colonization and succession rates of macroinvertebrates (Flannagan and Rosenberg 1982 and Rosenberg and Resh 1982).

Artificial substrates have taken many different forms depending on the study design and information sought. Two major categories of artificial substrates have been developed, each designed to answer different basic questions regarding stream communities. The first, Representative Artificial Substrates (RAS) are designed to reflect actual conditions in the waterbody. They include devices such as trays filled with gravel and rocks (riffle area), and nylon mesh bags filled with leaf litter (leaf packs). RAS are primarily used in studies that require a quantitative approach such as colonization rates of native substrates, secondary production, disturbance ecology, and toxicology (Way et al. 1995 and Schmude et al. 1998).

The second type of artificial substrates, the Standard Artificial Substrates (SAS) are not reflective of stream conditions, but are designed to limit the effects of microhabitat on the study results by removing substrate as a variable. SAS suit the needs of environmental monitoring because they allow more flexibility in locating sampling sites, which are chosen based on several competing factors and not only substrate characteristics. Commonly used examples of SAS samplers are Hester-Dendy multiplate samplers, basket samplers filled with porcelain balls, and strips of plastic artificial turf.

Advantages and disadvantages of artificial substrates have been discussed by many authors and have been reviewed by Rosenberg and Resh, 1982 and CCMET, 1997

Advantages:	
	1) Ability to sample locations which can not be sampled otherwise. Such places include those that are very turbid, or are too deep to wade, or have sediments that are too soft (mud, silt), unstable (shifting sand), or too hard (rock outcrops)
	2) Reduce variability by standardizing samples. Artifical substrates must be used in similar microhabitats to be comparable
Disadvantages:	
	1) Colonization is seasonal
	2) Relatively long exposure times
	3) Selective for organisms that colonize them
	4) Loss of samples

The fauna colonizing artificial substrates has been shown to be influenced by several environmental factors including substrate texture, amount of organism drift from

upstream, water depth, current speed, proximity to aquatic plants, and the stream margin (Beckett and Miller 1982, Roby et al. 1978, De Pauw et. al. 1986, and Stewart et al. 1998). The colonization process has been shown to be dependent on the complex interactions between the sampler and the stream environment. The resulting taxonomic composition can have components derived from a number of sources including oviposition, aerial colonization, benthic movements, and drift. Aerial colonization and small scale benthic movements appear to be minor contributors to colonization, while, oviposition and drift appear to be the major contributors to the community that develops on any particular substrate. Oviposition can take two forms, direct deposition of eggs onto the substrate or by the accumulation of egg masses floating down stream after being released by upstream females. The drifting of macroinvertebrates is a common and well recognized phenomenon resulting in a substrate community largely selected by the chance drifting or swimming organisms (Townsend and Hildrew 1976, William and Hynes, 1976, Wise and Molles 1979, Kramer 1982, Winterbourn, 1982, Benson and Pearson, 1987).

Several workers have noted that the community that develops on an artificial substrate is influenced by the position and orientation of the device (Mason, et al. 1973, Boothroyd and Dickie, 1989). Samplers that are lying on the bottom, suspended in the water column or floating beneath the surface will develop communities that are influenced by the abundance and taxonomic composition of drifting organisms that reach the sampler.

Drift composition has been shown to be dependent on the faunal composition of the stream reach, resulting in common taxa being present more often than taxa that are uncommon. Therefore, artificial substrates are less likely to be colonized by rare taxa. Substrates suspended just below the water surface are more likely to be colonized by organisms originating in the surface layer than those originating in the benthos, while substrates lying on the stream bed are more likely to be colonized by benthic taxa (Mason et al. 1972, Rosenberg and Resh 1982, Boothroyd, and Dickie, 1989)

Beckett, and Miller (1982) investigated the effects of current on community development in the Ohio River and determined that there were distinct slow flow and fast flow communities that developed. They found that fast flow areas produced communities dominated by net spinning hydropsychid caddisflies while slow flow communities were dominated by gammarid amphipods.

Mason et al. 1972 investigated the effect of depth on the colonization of both basket and multiplate samplers. In their study, basket and Hester-Dendy multiplate samplers were suspended in the Ohio River to depths of 0.3 meters to 4 meters. The results indicated that species composition varied significantly with season, depth and length of exposure. They also demonstrated that regardless of substrate type, the maximum number of individuals and taxa were collected by shallow water substrates.

Background

Florida Department of Environmental Protection Standard Operating Procedures (DEP-SOP-001/01), specifically FDEP SOP FS7430, states modified Hester-Dendy multiplate samplers (HDs) to be deployed in fresh waters may be deployed using a concrete filled masonry block with coupling nuts, or by custom floating platforms, or by tying weighted HDs to an overhanging object. For the HD block method, attach at least three HD samplers to the HD block, and place the block at a depth of one meter (or the deepest spot available if shallower than one meter). Take care to place control and test site blocks in areas of similar flow, depth and habitat type. The block has space for four HDs for use in studies requiring additional replication. Knowledge of the system's hydrologic regime is important to make sure samplers will not go dry during the 28-day incubation period. If the depth of the water body is greater than one meter, and/or there is a chance the HD samplers placed on the bottom will be smothered by sand or silt, a floating platform with attachment points for up to four HDs should be used. For the HD floating platform method, attach three or four HDs to each floating platform and then attach the platform to a buoy using one meter of stainless steel cable (or less than one meter in shallow streams). Attach the buoy/platform configuration to an anchor (typically a concrete filled masonry block), using a length of stainless steel cable appropriate for the depth of the stream or river. Alternatively, HDs may be suspended one meter (or less in shallow streams) below the water level by attaching them to an overhanging object with string or monofilament, and weighting them by tying approximately 250g of weight to the bottom. A minimum of three samplers must be incubated at a site for 28 days to evaluate the Biological Integrity Criterion (62-302.530(11) F. A. C.).

Many sites have neither stable substrates suitable for block deployment or overhanging branches suitable for suspending substrates in the water column. In the present study we tested a method for deploying modified Hester-Dendy multiplate samplers attached to a frame constructed of 3//4 in. PVC pipe and supported by 5 inch x 1 inch sponge foam trap floats (Figure 1). The system was then anchored to a concrete filled masonry block with 1/8 inch stainless steel cable.

The frame was constructed utilizing ¾ inch schedule 40 PVC pipe and stainless steel hardware. Construction details are provided in Figure 1.

List of Materials	
1 – ¾ inch x 14 inch pvc pipe	4 – ¼ inch coupling nuts
2 - ¾ inch x 5 inch pvc pipe	6 – ¼ inch hex nuts
2- ¾ inch x 4 inch pvc pipe	4 – ¼ inch x 1 1/4 inch fender washers
2 – ¾ inch x 1 inch pvc pipe	4 - 1 inch x 5 inch sponge foam floats
2 – ¾ inch 45° pvc couplers	4 – ¼ inch x 5 inch threaded rod
2- -3/4 inch 90° pvc couplers	4 – ¼ inch lock nut
1 – ¼ inch x 5 inch eyebolt	

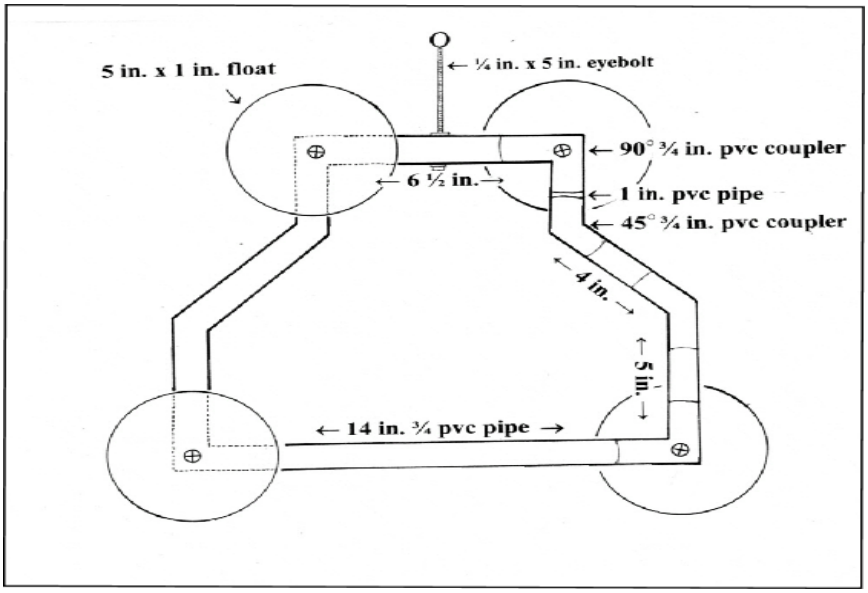


Figure 1. Construction details of the floating Hester-Dendy platform

Study Plan

The study was developed in an attempt to answer two questions about the effectiveness of the Hester-Dendy multiplate sampler deployment methods. "Do the different deployment methods (floating or block) have the same sampler recovery rate?" and "Does the macroinvertebrate assemblage that develops differ between the deployment methods?" Density of individuals, Shannon-Weaver diversity, and multivariate measurements of community structure were compared to answer these questions.

Materials and Methods

Two to four sets of HD samplers were deployed in each of the four study stream locations. Table 1 provides the sampling date, depth, flow, and substrate for each of the study sites. Each set consisted of one floating rack with four samplers attached and one masonry block with four attached samplers cabled together (Figure 1). Blocks and racks were deployed in Sutton Creek (upstream and downstream of the Blountstown WWTP), in Ten Mile Creek (a reference site), in Mosquito Creek (upstream and downstream of the Chattahoochee WWTP), and North Mosquito Creek (upstream and downstream of the Florida State Hospital WWTP). Ten Mile Creek was clear and <1m deep. Mosquito Creek was dark and depth ranged between 0.75 to 1.5 m. Sutton Creek was <0.5m deep; color was dark above the outfall, but was lighter downstream of the outfall after the stream was diluted by effluent from the wastewater treatment plant.

Table 1 Stream sites utilized for the deployment and recovery of Hester-Dendy samplers

Location	Date	Depth (m)	Current (m/sec)	Substrate
Sutton Cr.	6 Jan. 03	0.28-1.1	0.1-0.2	Sand
Ten Mile Cr.	11 Feb. 03	<1.0		Sand
Mosquito Cr.	28 Apr. 03	1.0-1.5	0.15-0.25	Sand
N. Mosquito Cr.	30 Aug. 04	0.3-0.5	0.25-0.33	Sand

Data analysis included a combination of univariate and multivariate parametric or non-parametric techniques, as appropriate. Loss of HD samplers and the small sample sizes that resulted prevented balanced statistical analyses in most cases.

Results

1. Sampler Recovery Rates

A total of 160 samplers were deployed, 80 floating and 80 block mounted samplers. Table 2 summarizes the number of HD samplers deployed and retrieved at each site. The floating samplers were recovered at a rate of 79% (range 45-100%). While the block mounted samplers were recovered at a rate of 60% (range 21-100%).

Table 2. Deployment and recovery of Hester-Dendy samplers						
	Floating			Block Mounted		
Stream	Deployed	Recovered	**%**	Deployed	Recovered	**%**
Sutton Cr.	24	21	88	24	24	100
Ten Mile Cr.	8	8	100	8	7	88
Mosquito Cr.	24	11	45	24	5	21
N. Mosquito Cr	24	23	96	24	12	50
Total	**80**	**63**	**79**	**80**	**48**	**60**

The loss of floating samplers was primarily due to the loosening of the nuts that secured the sampler to the frame. This problem arose in high flow conditions where the current, eventually, spun the sampler completely off. This problem was mostly corrected, but further tests in fast flowing streams would be necessary to state that definitively. Regardless, it is a technical problem that could easily be solved with lock-washers and/or lock-nuts. Losses of block mounted samplers were primarily due to sand smothering and in high flow conditions, the shifting or turning over of the block.

2. Macroinvertebrate Colonization of Hester-Dendy Multiplate Samplers

Multivariate community comparisons

Non-parametric analysis of similarities (ANOSIM) and non-metric multidimensional scaling (nMDS) were used to examine macroinvertebrate assemblages from floating rack and masonry block mounted HD samplers. ANOSIM, an ANOVA analogue, tests for differences in the assemblage as a whole across sample groups. nMDS is a visual representation of the pattern of similarities among complex samples. Together, these methods display and test for overall differences for all taxa in the HD sampler data. All multivariate analyses were performed with Primer^{TM} 5.28.

Table 3 summarizes the data for number of individuals, the number of taxa and the percent differences of floating and block mounted Hester-Dendy Samplers by stream. Total number of individuals and Shannon-Weaver diversity for each group of four samples by location and depth within each stream. These data indicate that colonization of HD samplers is impacted by several factors, including flow, substrate type, and depth. Both Mosquito Creek sites had the block mounted sampler results impacted by shifting sand substrates under high flow conditions.

Table 3. Number of individuals and, mean number of taxa per sampler for floating and block-mounted Hester-Dendy samplers

Location	Floating		Block Mounted		% Difference	
	# Indiv.	# Taxa	# Indiv.	# Taxa	Indiv.	Taxa
Sutton Cr.	53	13	31	10	41.5	23.1
Ten Mile Cr.	23	12	26	14	-13.0	-16.7
Mosquito Cr.	157	23	18	7	88.5	69.6
N. Mosquito Cr	434	28	312	29	28.1	-3.60

Figure 2 shows nMDS results for all streams, with HD samplers combined by location regardless of depth. Streams had different assemblages, as indicated by the separation of sample groups (symbols differ by stream). Distances between samples in nMDS plots are proportional to the similarity of samples being compared, with more similar samples closer together than those that are less similar to each other. ANOSIM results showed stream assemblages were all statistically different from each other (Global R = 0.858, p =0.001, streams differ, pair-wise R =0.667-0.903, $p \leq 0.029$, all pairs of streams differed from each other). R values ranged from 0 to 1.0, with larger values indicating stronger differences between sites. Of the four streams study, Ten Mile Creek and North Mosquito Creek samples were homogenous while Sutton and Mosquito Creek samples were more scattered. Mosquito Creek results are particularly impacted by the loss of samplers (Table 2).

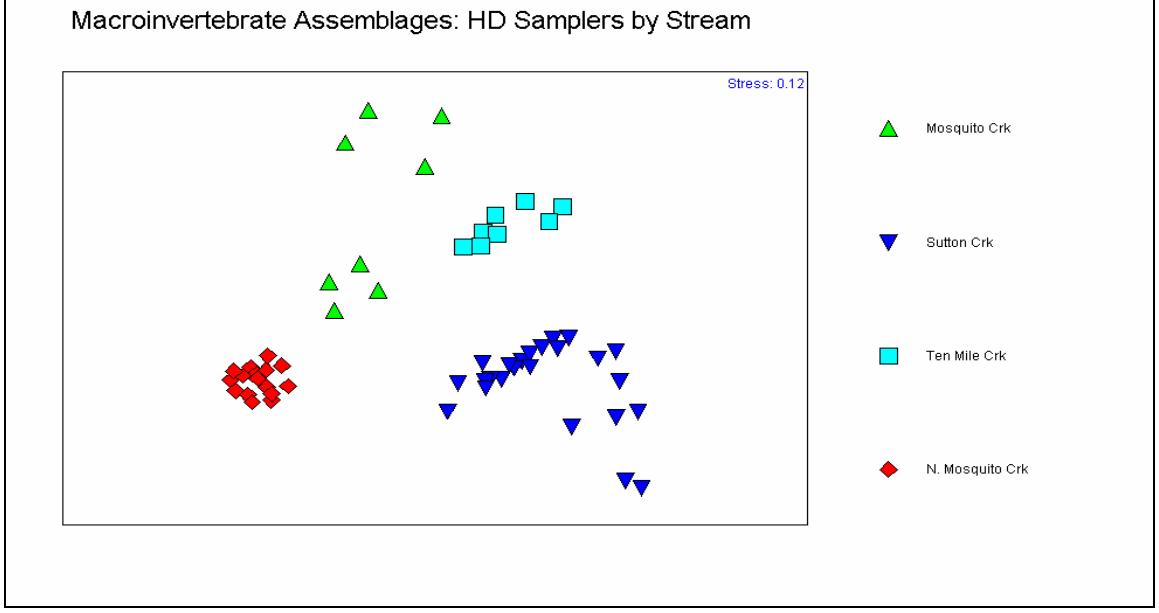


Figure 2. nMDS plot for all streams. Each point represents all HD samplers recovered from a group of four deployed on either a floating rack or a masonry block. Green triangles are data from Mosquito Creek, turquoise squares are data from Ten Mile Creek, inverted blue triangles are from Sutton Creek, and red diamonds are from North Mosquito Creek.

Table 4 summarizes the data for number of individuals, number of taxa and percent differences of individuals and Shannon-Weaver diversity for each group of four samplers by location and depth within each stream. These data indicate that, in general, samplers attached to the floating racks were colonized of more macroinvertebrate at all of the sampling sites. They also demonstrate the effects of depth and flow conditions.

Table 4. Mean Shannon-Weaver diversity (H'), and number of individuals for floating and block-mounted Hester-Dendy samplers

	Floating			Block Mounted			
	H'	# Indiv/ Sampler	# Total Indiv/ Site	H'	# Indiv/ Sampler	# Total Indiv/ Site	% Diff H'
Sutton Cr.							
Upstream 1	3.62	32	64	3.33	7	26	8.7
Upstream 4	3.97	24	96	3.78	17	67	5.0
Upstream 5	3.63	18	71	3.89	13	53	-6.7
Downstream 2	3.94	54	214	3.68	64	255	7.1
Downstream 3	4.04	84	334	3.79	48	191	6.6
Downstream 6	3.89	109	328	3.63	29	117	7.2
Ten Mile Cr.							
Site 2	3.55	17	66	4.27	23	70	-16.9
Site 6	4.20	31	124	4.20	30	120	0.0

Mosquito Cr.							
Upstream	3.41	100	299	3.25	7	20	17.8
Downstream	3.79	197	394	3.2	35	70	18.4
N. Mosquito Cr							
Upstream 1	3.68	386	1544	3.59	268	1072	2.38
Upstream 4	371	438	1751	-	-	-	-
Upstream 6	-	-	-	-	-	-	-
Downstream 2	3.69	435	1738	3.67	382	1528	0.54
Downstream 3	3.49	330	1318	4.05	283	1132	-15.99
Downstream 5	3.84	382	1145	-	-	-	-

Only Sutton Creek had sufficient samples to test for effects of location (up or downstream of an outfall) and depth (floating or masonry-block mounted HD samplers). Data were checked for homogeneity of variances and square root transformed to meet the assumptions of ANOVA (Levene's Test, $p>0.05$). The square root of number of individuals per HD sampler was then analyzed with a nested analysis of variance (depth nested within location, sample group (i.e. set of 4 samplers on the same sampling apparatus) nested within depth and location). All analyses were performed with Statistica 6.0. A nested ANOSIM, with depth nested within location, showed significant effects of both location. The test for differences between up and downstream of the outfall was weak, because nested ANOSIM averages across depth groups, leaving only four samples for comparison (Table 5 and Figure 3). The Global R was 0.75, indicating strong differences, but the probability level was >0.05. The test was repeated as a one-way ANOSIM, comparing up and downstream of the outfall. The up and downstream groups of HD samplers differed significantly, with a Global R of 0.426 ($p=0.002$). Figure 3 gives nMDS results for these data. Macroinvertebrate assemblages varied significantly, but weakly, with depth of HD sampler ($R = 0.352$, $p=0.03$). Back-transformed means and 95% confidence intervals were 57.8 individuals/HD sampler (41.7-76.6) downstream of the facility and 16.9 (12.6-21.8) individuals/HD upstream of the facility (n=16 each group). The Blountstown Wastewater Treatment Plant (WWTP) has elevated nutrient levels in its effluent, which may have been related to the increased density of macroinvertebrates downstream of the outfall. Also, it should be noted that the low overall numbers collected in Sutton Creek may have been the result of the small population size of the upstream.

Table 5. Nested analysis of variance for square-root transformed number of individuals/sampler in Sutton Creek.

	Degrees of freedom	Sum of Squares	Mean square	F	Probability
Location (upstream or downstream of facility)	1	97.561	97.561	33.5112	<0.0001
Depth (floating or block) within location	2	5.096	2.548	0.8752	0.430
Group (set of 4 samplers) within location and depth	4	10.216	2.548	0.8773	0.439
Error	24	69.871	2.911		
Total	**31**	**182.743**			

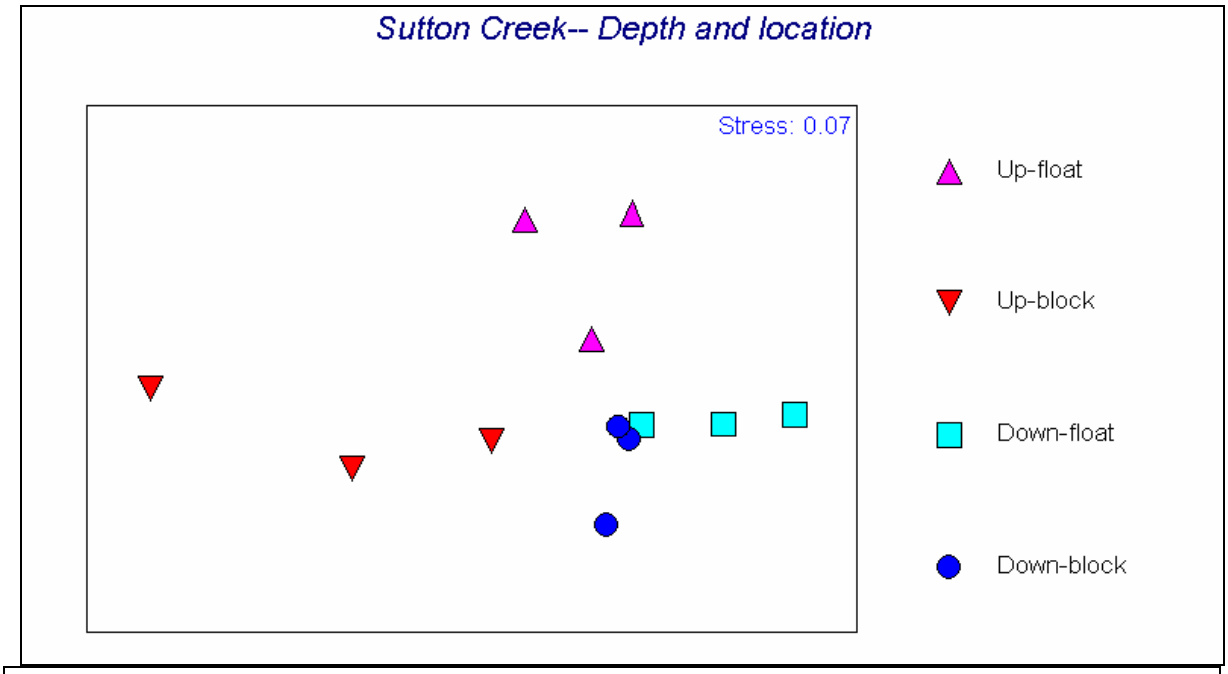


Figure 3. nMDS plot of Sutton Creek HD samplers. Symbols code for depth and location in the stream. Separation of sampler groups indicates differences among treatments. See text for further explanation

For Ten Mile Creek, there was no significant effect of depth (floating or block deployment) on number of individuals that settled per HD sampler (Mann-Whitney U test, $p>0.05$, $n=7, 8$). Median number collected per HD sampler was 22.5 (range 3-46, $n=8$) on floating HD samplers as compared with 25 (range (13-46, $n=7$) on block-mounted HD samplers.

In contrast, Mosquito Creek, which had the greatest difference in depth between floating and blocks, had significantly more macroinvertebrates on floating HD samplers than on those deployed on blocks (Mann-Whitney U test, $p=0.01$, $n=5, 5$) when all HD samplers were combined (both upstream and downstream of the outfall considered together). This agrees with the findings of Mason et al. 1972 that regardless of substrate type, the maximum number of individuals and taxa are collected by shallow water substrates. The median number of individuals collected per sampler was 122 (range 82-240) on floating HD samplers as compared with 13 (range 3-48) on block-mounted samplers ($n=5$ each group). Too few HD samplers were retrieved at Mosquito Creek to test for increased settlement of macroinvertebrates with respect to the facility's effluent.

3. Community comparisons

Shannon-Weaver Diversity

This index is specified in the Florida Administrative Code 62-302 as a measure of biological integrity. Low diversity scores are undesirable. Where diversity is low, only a few taxa are abundant as compared to an area where many taxa are present in equitable abundance among taxa. A difference of ≥25% in Shannon-Weaver diversity between results from Hester-Dendy multiplate samplers incubated for 28 days at test and control sites constitutes a violation of 62-302.530(11) F.A.C..

Thirteen pairs of values were available for analysis, comparing floating and block deployment methods (Table 4). For nine (69%) of thirteen comparisons, diversity was higher on the floating racks of HD samplers than those HD samplers mounted on masonry blocks. We note that 31% of the diversity values were calculated on <100 individuals total, while only 46% of the values were calculated from collections of 300 individuals or greater. These results must thus be interpreted cautiously, because diversity values usually are considered to stabilize for a sample when approximately 300 individuals are included in the calculation (Magurran 1988). However, in no case did differences between deployment methods result in a difference in H' >25% for paired floating and masonry block-mounted HD samplers (Table 4).

HD samplers in Sutton, Mosquito and N. Mosquito Creeks were located upstream and downstream of WWTP outfalls. Results of recent fifth year inspections did not detect a 25% difference in Shannon-Weaver diversity between upstream and downstream samples. In this deployment study, we compared the highest upstream H' result with the lowest downstream H' result. In all cases, upstream and downstream values were within 25% of each other (Table 4), and results using either floating or masonry-block mounted HD samplers would have given the same result.

Similarity Indexes

Three additional measures of community similarity which are commonly utilized in bioassessment studies were also calculated for sites which had paired floating and bottom deployed HDs (Table 6). Figure 5 provides a comparison of the theoretical outcomes of the different similarity indexes when 1%, 25%, 50%, 85% and 96% of the taxa are in both sample A and B.

Table 6. Procedures used in the calculation of selected metrics used in this report

	Metric	
1	Community Loss Index	CL = d-a/e Where: a = number of taxa common to both samples. d = total number of taxa present in sample A. e = total number of taxa present in sample B.
2	Jaccard Coefficient of Similarity	JCS = a/a+b+c Where: a = number of taxa common to both samples. b = number of taxa present in sample B but not A. c = number of taxa present in sample A but not B
3	Sörensen Coefficient	CS = 2a/(d+e) Where: a = number of taxa common to both samples. d = the number of taxa present in sample A. e = the

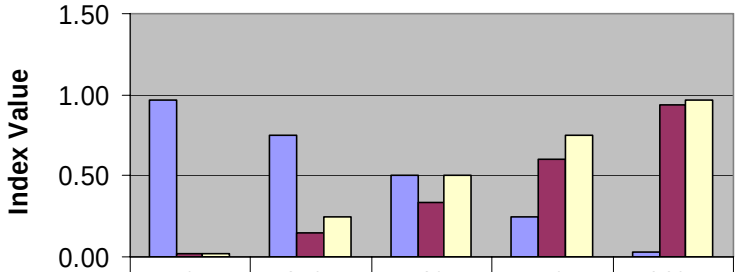
		number of taxa present in sample B.

1) The Community loss index - Measures the loss of taxa between a reference or control station and a study site. It is an index of dissimilarity, with values increasing as the degree of dissimilarity from the reference station increases (Courtemanch, and Davies, 1987; Plafkin el al. 1989). It should be noted that the community loss index is sensitive to the number of taxa in a sample and may be adversely impacted when the taxa richness increases downstream (Table 6 and Figure 5).

2) Jaccard coefficient of community similarity - Measures the degree of similarity in taxonomic composition between two stations in terms of taxon presence or absence. Values range from 0 to 1.0, increasing as the degree of similarity increases (Jaccard, 1912; Plafkin el al. 1989).

3) Sörensen coefficient - Measures the degree of similarity in taxonomic composition between two stations in terms of taxon presence or absence. Values range from 0 to 1.0, increasing as the degree of similarity increases (Breitenmoser-Würsten and Satori, 1995). When one-half of the total taxa in both samples are shared the resulting value is 0.50

Figure 4: CL, JCS, and Sorensen Index Values when 1%, 25%, 50%, 75%, and 96% of the Taxa are in Both Sample A and B



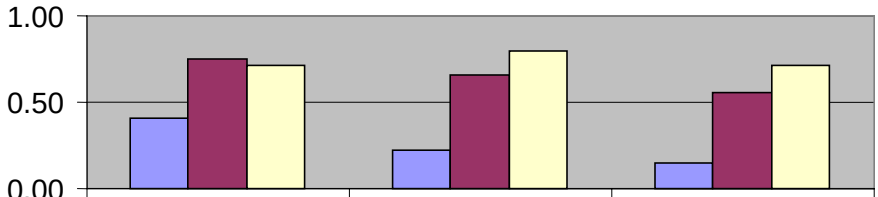
	1%	25%	50%	75%	96%
CL33=d-a/e	0.97	0.75	0.50	0.25	0.03
JCS33=a/a+b+c	0.02	0.14	0.33	0.60	0.94
Sorensen=2a/(d+e)	0.02	0.25	0.50	0.75	0.97

% Taxa in Both Samples

The results of the various community similarity indexes agree with the result of the analysis of the Shannon-Weaver Index, in that differences between streams, as well as between different locations within a stream can be determined. In comparing pairs of floating and bottom deployed HDs using commonly used similarity indexes (Figure 5-7),

the results generally indicate that floating or bottom deployment has little effect on community similarity in shallow (<1.0m) streams.

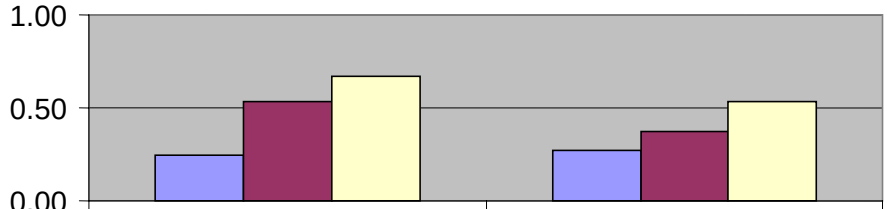
Figure 5: CL, JCS, and Sorensen Index values for N. Mosquito Creek HDs Floating vs Bottom deployment (n=3)



	Sta. 1	Sta. 2	Sta. 3
CL=d-a/e	0.41	0.22	0.15
JCS=a/a+b+c	0.75	0.66	0.56
Sorensen=2a/(d+e)	0.71	0.8	0.72

Location

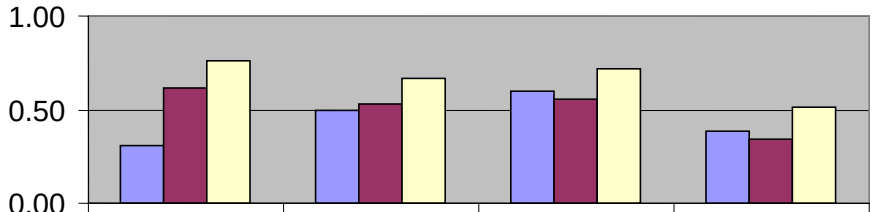
Figure 6: CL, JCS, and Sorensen Index values for Ten Mile Creek HDs Floating vs Bottom deployment (n=2)



	Sta. 1	Sta. 2
CL=d-a/e	0.24	0.27
JCS=a/a+b+c	0.54	0.37
Sorensen=2a/(d+e)	0.67	0.53

Location

Figure 7: CL, JCS, and Sorensen's Index Values for Sutton Creek HDs Floating vs Bottom depolyment (n=4)



	Sta. 1	Sta. 2	Sta. 3	Sta. 4
CL=d-a/e	0.31	0.50	0.60	0.38
JCS=a/a+b+c	0.62	0.53	0.56	0.34
Sorensen=2a/(d+e)	0.76	0.67	0.71	0.51

Location

Recommendations

There have been many studies of the colonization of all types of artificial substrates dating back to the early 1960s. These studies have shown that with certain precautions artificial substrates can be successfully used in pollution studies (Rosenberg and Resh, 1982). They have been shown to reduce variability between samples only when they are placed in ecologically similar locations (Cairns and Dickson 1971). Therefore, it is very important that due consideration be given to water velocity, depth, and substrate types before deployment. Failure to not adequately consider these variables can lead to erroneous conclusions when comparing up and downstream sites or when comparing different water bodies.

In the monitoring programs normally supported by the Florida Department of Environmental Protection, depth, water velocity, and substrate are usually of secondary importance to proximity to a particular discharge point, and therefore the choice of deployment method must offset site differences when possible. In general, differences of over 1 meter should be avoided (Mason et al. 1972).

When studying larger and deeper systems, the depth at which samplers are placed should be dependent on the particular organisms being studied. If bottom dwelling organisms are the target, then samplers should be placed near the bottom, if littoral or shallow water groups are the target, then substrates should be suspended or attached to a float (Boothroyd, and Dickie, 1989). FDEP accounted for this and by providing three deployment methodologies (FDEP SOP FS7430 and Ross 1990) for Hester-Dendy samplers. The present study compares the effectiveness of floating and bottom deployed HDs. The proposed method of attaching four samplers to a single floating structure has the advantage over suspension because of its ease of use in streams that experience rapid

changes in water level, as well as statistically, because all of the samplers are connected to the same platform and undergo the same conditions.

The floating platform is superior to block-mounted deployment in streams which have shifting sand substrates. Block-mounted samplers are commonly buried before they are retrieved.

Settlement density data, in combination with field observations of biologists with the Bureau of Laboratories and published results by earlier workers such as Mason et al. 1972, suggest that depth affects the density of settlement and species composition only when HD samplers are placed in water that is greater than 1m deep. Mason et al. 1972 also demonstrated that regardless of substrate type, the maximum number of individuals and taxa were collected by shallow water substrates. Taxa richness and other measures of community structure are usually related to number of individuals collected for macroinvertebrate assemblages. Given that depth of deployment may affect density of settlement, matching depth of deployment for sites that are being compared using HD samplers is highly recommended.

Shannon-Weaver diversity tended to be slightly higher for HD samplers deployed on floating racks as compared with blocks. In the two comparisons of NPDES sources possible in the current study, method of deployment would not have changed results for evaluation of the Biological Integrity criterion. Multivariate analyses were more sensitive to assemblage characteristics than Shannon-Weaver diversity measurements, but differences detected in depth of deployment in Sutton Creek were weak. Results suggest that either floating or block mounted HD samplers can be used, depending upon conditions at the study sites.

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