Illinois Environmental Protection Agency

Bureau of Water

Document Control Number 169

Standard Operating Procedure for Methods to Collect Aquatic Macroinvertebrates with Multi-plate Artificial Substrate Samplers

Surface Water Section

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1.0 Scope and Application

The Standard Operating Procedure (SOP) describes how to collect aquatic macroinvertebrates with multi-plate, artificial substrate samplers. Use these samples to evaluate aquatic life designated use attainment as well as NPDES permit compliance. The methods outlined in this SOP, generally applies to flowing waters that are non-wadeable.

Aquatic macroinvertebrates are invertebrates that are visible to the unaided eye, retained in a U.S. Standard No. 30 sieve (595-micron mesh size) and live at least a portion of their lives in the water. Refer to Appendix A for the list of SOP-applicable aquatic macroinvertebrates.

2.0 Summary of Method

- Use multi-plate artificial substrate samplers when rivers and streams are non-wadeable.
- Collect macroinvertebrates during June 1st through October 15th.
- Sample in a manner that places three multi-plate artificial substrate samplers per monitoring site.
- Set the samplers in locations that have at least 0.3 feet per second current velocity.
- Place one sampler on the Right Descending Side,
- Place one sampler on the Left Descending Side
- Place one sampler in the Center of Flow.
- The ideal situation for sampler placement by may not always be possible. To ensure colonization of an adequate representation of the macroinvertebrate community, a minimum of three circular multi-plate samplers are installed by IEPA biological staff at each sampling location and left for a period of four to six weeks (Weber, 1976). Samplers should be hung together to be considered as replicates. In larger river systems, such as the Illinois, Mississippi, Ohio, and Wabash, it is recommended that three replicates (one set) be installed near each bank.
- In all cases, suspend samplers well up in the photic zone.
- Retrieve the samplers after 4-6 weeks.
- At a given monitoring site, composite the macroinvertebrates obtained from the three samplers.
- Randomly subsample the composited macroinvertebrates to a fixed count of 300 ± 20 percent individuals.

3.0 Interferences and Corrective Action

Factors affecting colonization of artificial substrates by macroinvertebrates have been discussed in studies by Mason et al. (1973) and Roby (1976) and summarized in methods manuals prepared by the U.S. Geological Survey (Slack et al, 1973) and the U.S. Environmental Protection Agency (Weber, 1973). Variables affecting artificial substrate performance are minimized when possible and consistent between sampling stations. Factors affecting macroinvertebrate colonization which are considered when planning and conducting aquatic investigations are listed below:

- Depth of sample placement
- Light intensity – shading
- Stream velocity
- Season
- Duration of sample placement
- Fluctuating water levels

- Organism selectivity
- Sedimentation of sampler surfaces
- Predation
- Detritus accumulation
- Organism drift
- Vandalism

Advantages and Limitations (Modified from Weber, 1973)

While some of the factors affecting artificial substrate performance are considered as drawbacks to this sampling approach, there are definite advantages to be considered in utilizing artificial substrates. Some of the more important advantages and limitations of artificial substrates are listed below:

Advantages

- The confounding effects of substrate differences are reduced.
- A higher level of precision is obtained as compared to other sampling devices.
- Quantitatively comparable data are obtained from environments which are virtually impossible to sample with other devices.
- Samples usually contain negligible amounts of extraneous material, permitting quick laboratory processing.
- Artificial substrates may be used as a bioassay tool (Burks and Wilhm, 1977).
- Statistical inferences may be made when replicate samples are taken.
- Substrate standardization allows comparison of data from different investigators.
- In addition to the above, use of uniform artificial substrates allows:
  - biomass and/or productivity estimates
  - calculation of diversity indices
  - detection of subtle differences in certain macroinvertebrate communities not readily apparent from qualitative studies

Limitations

- The need for a long exposure period (4-6 weeks) makes the samplers unsuited for short-term studies.
- Samplers and floats are sometimes difficult to anchor in place and may present a navigation hazard.
- Samplers are vulnerable to vandalism and are often lost.
- Samplers provide no measure of the condition of the natural substrate at a station or of the effect of pollution on that substrate, including settled solids.
- Samplers only record the community that develops during the sampling period, thus reducing the value of the collected fauna as indicators of prior conditions.
- Samplers are selective for drift organisms.

4.0 Safety

Follow the general field-safety guidelines in the Illinois EPA, Bureau of Water Surface Water Section, Field Safety Manual (Document Control Number 151) (Illinois EPA, 1994).

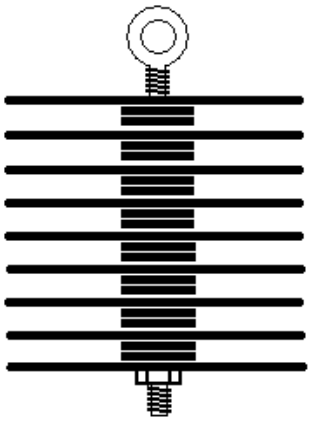
5.0 Equipment and Supplies

-Circular hardboard multi-plate artificial substrate samplers (see schematic)
-2x8x16-inch concrete blocks (1-per sampler)
-An assortment of assorted length threaded rod plus a sufficient number of threaded couplers to join the rods to the cinder blocks and the multi-plate artificial substrate samplers to the rods.
-Sieve bucket with a 600-micron stainless mesh bottom
-Forceps
-Sample bottles
-95% ethanol

6.0 General Instructions

A wide variety of artificial substrates has been developed for the evaluation of benthic macroinvertebrate communities. The first samplers of this type consisted of trays of rocks placed in lakes (Moon, 1935). Other investigators have used barbecue baskets filled with limestone rocks (Mason. et al, 1973) or round spheres (Jacobi, 1971). The hardboard multi-plate type sampler was first used by Hester and Dendy (1962) and numerous variations of this artificial substrate design have subsequently evolved (Arthur and Horning, 1969; Fullner, 1971; Parsons and Tatum, 1974; and McDaniel, 1974). Fullner (1971), concluded in a study comparing the effectiveness of basket and multi-plate samplers that the multi-plate sampler collected a wide variety of invertebrates and its performance compared favorably to that of the basket sampler. Mason et al. (1973) similarly found that multi-plate samplers yield samples comparable to the basket samplers and concluded that acceptable collecting efficiency is attained with three replicates.

Weber (1973) recommended using circular multi-plate samplers consisting of 14 hardboard plates, each 7.5 cm in diameter. A modification of this design was developed for use by Illinois EPA staff biologists in 1974 (see Figure 1).



Sampler design consists of nine circular hardboard plates 0.35 mm thick and 7.25 cm in diameter each separated by two circular hardboard spacers 0.35 mm thick and 2.1 cm in diameter. Plates and spacers are strung on a 3/16" eye bolt and secured with a 3/16" nut. Each sampler has 717.4 cm (0.072 m) available for macroinvertebrate colonization. Note that the above diagram is not to scale.

Figure 1. Circular multi-plate hardboard artificial substrate sampler

Applicable Sampler Use

Use multi-plate artificial substrate samplers for sample reaches that are non-wadeable. In general, the multi-plate sampler approach is applicable if less than 50% of the stream is accessible by wading.

Sampler Placement

Install multi-plate samplers in areas which are representative of overall water quality of the stream in question. Use one cinder block to anchor each sampler. Affix a threaded rod to a 2x8x16-inch cinder block, or equivalent, and attach a multi-plate sampler to the free end of the rod. Use threaded couplers to connect the threaded rod(s), multi-plate samplers and cinder blocks. Use various length rods to account for the various water depths encountered among monitoring sites and to suspend samplers well up in the photic zone. Care is taken when placing samplers in water with fluctuating levels.

- Always install multi-plate samplers in flow with a velocity ≥ 0.3 feet per second (Ohio EPA, 1988).
- Place multi-plate sampler at three locations within a given monitoring site.
- Place one sampler on the Right Descending Side,
- Place one sampler on the Left Descending Side
- Place one sampler in the Center of Flow.
- The ideal situation for sampler placement by may not always be possible. To ensure colonization of an adequate representation of the macroinvertebrate community, a minimum of three circular

multi-plate samplers are installed by IEPA biological staff at each sampling location and left for a period of four to six weeks (Weber, 1976). Samplers should be hung together to be considered as replicates. In larger river systems, such as the Illinois, Mississippi, Ohio, and Wabash, it is recommended that three replicates (one set) be installed near each bank.

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- In all cases, suspend the samplers well up in the photic zone.

In deeper waters, suspend the samplers by other methods (e.g., floats, docks etc.,). In all cases, suspend the samplers well up in the photic zone.

Sampler Retrieval

Artificial substrate samplers collected after the colonization period of 4-6 weeks and are retrieved individually with the aid of a container with a No. 30 mesh screen bottom. Samplers, once located, are raised very slowly until the collection container can be placed under the sampler and the wire cut. Each sampler along with all organisms attached are then placed in a container of 95% ethanol. If time permits, each circular multi-plate sampler is placed in a bucket of screened water and dismantled. The organisms and debris are then removed from the substrate material. This is accomplished by shaking the material in the bucket of water and by scraping or brushing actions. Care is taken to ensure removal of all the specimens. The water in the bucket is then poured through a U.S. Standard No. 30 sieve to remove the fine particles. All organisms detached in the retrieval process are then placed in sample containers containing 95% ethanol.

Sample processing

- At a given monitoring site, composite the macroinvertebrates obtained from the three samplers.
- Randomly subsample the composited macroinvertebrates to a fixed count of 300 ± 20 percent individuals.

Table 1. Nine plate circular artificial substrate conversions, organisms per sampler to estimated number organisms per square meter.

#/Sampler	#/m2	#/Sampler	#/m2	#Sampler	#/m2	#/Sampler	#/m2
1	14	26	364	51	714	76	1064
2	28	27	378	52	728	77	1078
3	42	28	392	53	742	78	1092
4	56	29	406	54	756	79	1106
5	21	30	1290	55	2365	80	3440
6	258	31	1333	56	2408	81	3483
7	301	32	1376	57	2451	82	3526
8	344	33	1419	58	2494	83	3569
9	387	34	1462	59	2537	84	3612
10	430	35	1505	60	2580	85	3655
11	473	36	1548	61	2623	86	3698
12	516	37	1591	62	2666	87	3741
13	559	38	1634	63	2709	88	3784
14	602	39	1677	64	2752	89	3827
15	645	40	1720	65	2795	90	3870
16	688	41	1763	66	2838	91	3913
17	731	42	1806	67	2881	92	395
18	774	43	1849	68	2924	93	3999
19	817	44	1892	69	2967	94	4042
20	860	45	1935	70	3010	95	4085
21	903	46	1978	71	3053	96	4128
22	946	47	2021	72	3096	97	417
23	989	48	2064	73	3139	98	4214
24	1032	49	2107	74	3182	99	4257
25	1075	50	2150	75	3225	100	4300

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2	28	27	378	52	728	77	1078
3	42	28	392	53	742	78	1092
4	56	29	406	54	756	79	1106
5	70	30	420	55	770	80	1120
6	84	31	434	56	784	81	1134
7	98	32	48	57	798	83	1148
8	112	33	462	58	812	83	1162
9	126	34	476	59	826	84	1176
10	140	35	490	60	840	85	1190
11	154	36	504	61	854	86	1204
12	168	37	518	62	868	87	1218
13	182	38	532	63	882	88	1232
14	196	39	546	64	896	89	1246
15	210	40	560	65	910	90	1260
16	224	41	574	66	924	91	1274
17	238	42	588	67	938	92	1288
18	252	43	602	68	952	93	1302
19	266	44	616	69	966	94	1316
20	280	45	630	70	980	95	133
21	294	46	644	71	994	96	134
22	308	47	658	72	1008	97	1358
23	322	48	672	73	1022	98	1372
24	336	49	686	74	1036	99	1386
25	350	50	700	75	1050	100	1400

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