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Standard Guide for Selecting Grab Sampling Devices for Collecting Benthic Macroinvertebrates¹

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1. Scope

1.1 This guide covers selecting grab sampling devices for collecting benthic macroinvertebrates. (See Table 1)

1.2 The grab sampler when used correctly is a quantitative collecting device. It is designed to penetrate and grab or scoop a variety of substrates or sediment types from which macroinvertebrates are collected in freshwater, estuarine, and marine habitats.

2. Referenced Documents

2.1 ASTM Standards:

- D 1129 Terminology Relating to Water²
- D 4342 Practice for Collecting Benthic Macroinvertebrates with Ponar Grab Sampler³
- D 4343 Practice for Collecting Benthic Macroinvertebrates with Ekman Grab Sampler³
- D 4344 Practice for Collecting Benthic Macroinvertebrates with Smith-McIntyre Grab Sampler³
- D 4345 Practice for Collecting Benthic Macroinvertebrates with Van Veen Grab Sampler³
- D 4346 Practice for Collecting Benthic Macroinvertebrates with Okean 50 Grab Sampler³
- D 4347 Practice for Collecting Benthic Macroinvertebrates with Shipek (Scoop) Grab Sampler³
- D 4348 Practice for Collecting Benthic Macroinvertebrates with Holme (Scoop) Grab Sampler³
- D 4401 Practice for Collecting Benthic Macroinvertebrates with Petersen Grab Sampler³
- D 4407 Practice for Collecting Benthic Macroinvertebrates with Orange Peel Grab Sampler³

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology D 1129.

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² *Annual Book of ASTM Standards*, Vol 11.01.

³ *Annual Book of ASTM Standards*, Vol 11.05.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *benthos*—the community of organisms living in or on the bottom or other substrate in an aquatic environment.

3.2.2 *grab*—any device designed to “bite” or “scoop” into the bottom sediment of a lake, stream, estuary, ocean, and similar habitats to sample the benthos. Grabs are samplers with jaws that are forced shut by weights, lever arms, springs, or cables. Scoops are grab samplers that scoop sediment with a rotating container.

3.2.3 *habitat*—the place where an organism lives, that is, mud, rock, shoreline, etc.

3.2.4 *macroinvertebrates*—benthic or substrate dwelling organisms visible to the unaided eye and retained on a U.S. Standard No. 30 (0.595-mm mesh openings) sieve. The standard sieve opening for marine benthic fauna is 1.0 mm, U.S. Standard No. 18 sieve. Examples of macroinvertebrates are aquatic insects, macrocrustaceans, mollusks, annelids, roundworms, flatworms, and echinoderms.

4. Significance and Use

4.1 Qualitative and quantitative samples of macroinvertebrates inhabiting sediments or substrates are usually taken by a grab sampler. Grab samplers, if used correctly, are devices that sample a unit area or volume of the habitat. They are used to obtain a quantitative estimate of the number of individuals and number of taxa of aquatic macroinvertebrates. In view of the advantages and limitations regarding the penetration of the sediment by many grab samplers and their closing mechanisms, it is not possible to recommend any single instrument as suitable for general use. However, the Petersen grab is considered the least effective bottom grab sampler and, therefore, has limited application. The type and size of the grab sampler or device selected for use will depend on such factors as the size of boat, hoisting gear available, the type of substrate or sediment to be sampled, depth of water, current velocity, and whether sampling is in sheltered areas or in open waters of large rivers, reservoirs, lakes, and oceans. A great variety of instruments have been described and choice of a grab sampler will depend largely on what is available, what is suitable for the sampling area, and what can be obtained without difficulty.

TABLE 1 Standard Classification of Grab Sampling Devices for Collecting Benthic Macroinvertebrates

| Grab Sampling Device | Habitat Sampled | Substrate Type Sampled | Effectiveness of Sampling Device; Taxa Sampled | Advantages | Limitations | Preference or Recommendation | Selected Literature |
|----------------------|--|---|---|---|---|---|--|
| Ponar Grab Standard | Freshwater lakes, rivers, and estuaries, reservoirs | Hard sediments, except hard clay; somewhat less efficient in softer sediments | Sample area 523 cm ² ; efficient and versatile; not entirely adequate for deep burrowing organisms in soft sediments; quantitative and qualitative sampling obtained; sediment inhabiting macroinvertebrates | Better penetration than other grabs; side plates and screens prevent washout and shock wave that accompany other grabs | Requires boat, winch, and cable; jaws can be blocked and part of sample lost | Better for quantitative sampling than Petersen grab | Brinkhurst (1) ^A (2) Elliot and Drake (3) Elliott and Tullett (4) Flannagan (5) Howmiller (6) Hudson (7) Lewis, Mason, Weber (8) Powers and Robertson (9) Weber (10) Klemm et al(11) |
| Petite | Freshwater lakes, rivers, and estuaries, reservoirs | Hard sediments, except hard clay; somewhat less efficient in softer sediments | Sample area 232 cm ² ; efficient and versatile; not entirely adequate for deep burrowing organisms in soft sediments; sediment inhabiting macroinvertebrates | Better penetration than other grabs; side plates and screens prevent washout and shock wave that accompany other grabs; can be operated by hand | Jaws can be blocked and part of sample lost; insufficient in swiftly moving water ½ to 1 m/s velocity | | Klemm et al (11) Merritt et al (12) Gerritsen et al (13) |
| Ekman Grab Standard | Freshwater lakes, reservoirs, where there is little current; usually small bodies of water | Soft sediments only | Sample area 232 cm ² ; efficient in soft sediments; extra weights can be used for deeper penetration; quantitative and qualitative obtainable; sediment inhabiting macroinvertebrates | Can be operated by hand; can be operated in shallow, sand or mud bottom streams; comes in a range of sizes | Jaws can fail to penetrate; only partial cylinder cut from substrate, small surface area coverage jaws can be blocked and part of sample lost; inefficient in deep water or moderate to strong currents | | Beatties (14) Burton and Flannagan (15) Ekman (16) (17) Elliott and Drake (4) Elliott and Tullett (4) Flannagan (5) Howmiller (6) Hudson (7) Lanz, (18) Lewis, Mason, Weber (8) Lind (19) Milbrink and Wiederholm (20) Rowe and Clifford (21) Lewis et al (22) Klemm et al (11) Merritt et al (12) Gerritsen et al (13) Paterson and Fernando (23) Schwoerbel (24) |
| Standard Tall | Same as above | Same as above | Sample area 232 cm ² Same as above | Same as above | Same as above | | |
| Large | Same as above | Same as above | Sample area 523 cm ² Same as above | Same as above | Same as above | | Rawson (25) Welch (26) Weber (10) |
| Extra Large | Same as above | Same as above | Sample area 929 cm ² | Same as above | Same as above | | |

5. Descriptions of Grab Samplers

5.1 *Ponar Grab Sampler* (see Fig. 1) is designed to obtain quantitative samples of macroinvertebrates from sediments in

lakes, rivers, estuaries, oceans, and similar habitats. This device is most useful for collecting benthic macroinvertebrates from coarse and hard substrates, such as coarse sand, gravel,

TABLE 1 *Continued*

| Grab Sampling Device | Habitat Sampled | Substrate Type Sampled | Effectiveness of Sampling Device; Taxa Sampled | Advantages | Limitations | Preference or Recommendation | Selected Literature |
|----------------------|--|---|--|--|---|--|---|
| Petersen Grab | Freshwater lakes, reservoirs; adaptable to rivers, estuaries, and oceans | Sand, gravel, mud, clay | Sample penetration limited sample area from 0.06 to 0.099 m ² ; sediment inhabiting macroinvertebrates | Gives reasonable quantitative samples when used carefully; comes in a range of sizes | Fairly heavy; need boat and power winch; jaws maybe blocked by sand, etc.; inadequate for deep burrowing organisms; questionable value for strictly quantitative samples; hard to use in adverse weather conditions | Least preferred grab sampler | Barnes (27) Birkett (28) Brinkhurst, (29) Davis (30) Edmondson and Winberg (29) Davis (30) Elliott and Tullett (4) Holme and McIntyre (31) Hudson (7) Howmiller (6) Lewis, Mason, Weber (8) Lind (20) Petersen (32) Thorson (33) Welch (27) Weber, 1973 (10) Petersen and Boysen Jensen (34) Klemm et al (11) Carey and Heyamoto (35) |
| Smith-McIntyre Grab | Marine and estuaries; adaptable to large rivers, lakes | Sand, gravel, mud, clay, and similar substrates | Sample area limited to 0.1 m ² with approximately 4 cm deep in hard sand; reasonably quantitative; sediment inhabiting macroinvertebrates | Reasonable quantitative samples; the trigger plates provide added leverage essential to its penetration of substrate | Heavy; need boat and power winch; spring-loaded jaws, hazardous; jaws can be blocked; inadequate for deep burrowing organisms | Widely acceptable sampling device for use in marine and estuary habitats | Carey and Paul (36) Elliott and Tullett (4) Holme (37) (38) Hopkins (39) Hunter and Simpson (40) McIntyre (41) Smith and McIntyre (42) Tyler and Shackley (43) Wigley (44) Word (45) Klemm et al (11) |
| Van Veen Grab | Marine and estuaries, adaptable to freshwater areas | Sand, gravel, mud, clay, and similar substrates | Sample area 0.1 m ² and 0.2 m ² ; reasonable penetration; to depth of approximately 5–7 cm; sediment inhabiting macroinvertebrates | Jaws close tighter than Petersen grab; samples most sediment types; comes in a range of sizes | Need large boat, power winch and cable line; blockage of jaws may cause sample loss; not useful for deep burrowing organisms | Limited application | Barnes (27) Beukema (46) Birkett (28) Elliott and Drake (3) Elliott and Tullett (4) Holme (37) (38) Lassig (47) Longhurst (48) McIntyre (41) (49) Nichols and Ellison (50) Schwoerbel(24) Ursin (51) Wigley (44), Word (52) (53) Word (45) Klemm et al (11) |

and similar substrates, rather than soft sediments, such as mud, fine sand, or sludge. The sampler can be used in swift currents and deeper waters. The sampler is available in a range of sizes from 23 cm to 15 cm. For operating procedures, see Practice D 4342.

5.2 *Ekman Grab Sampler* (see Fig. 2) is designed to obtain quantitative samples of macroinvertebrates from soft sediments in lakes, estuaries, oceans, and similar habitats where there is little current. This device is most useful for collecting macroinvertebrates from soft sediments, such as very fine sand, mud, and sludge. The sampler is available in sizes of 15 cm, 23 cm, and 30 cm. For operating procedures, see Practice D 4343.

5.3 *Petersen Grab Sampler* is designed to obtain quantitative samples of macroinvertebrates from sediments in lakes,

reservoirs, and similar habitats and is adaptable to rivers, estuaries, and oceans. This device (see Fig. 3) is useful for sampling sand, gravel, marl, and clay in swift currents and deep waters. This sampler is available in a range of sizes that will sample an area from 0.06 to 0.099 m². A consensus of aquatic biologists consider the use of this device the least preferable grab sampler and would use it only in limited applications. For operating procedures, see Practice D 4401.

5.4 *Smith-McIntyre Grab Sampler* (see Fig. 4) is designed to obtain quantitative samples of macroinvertebrates from sediments in rough weather in hard sand bottoms in lakes, streams, estuaries, and oceans. This device is useful for sampling macroinvertebrates from sand, gravel, mud, clay, and