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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 macro-invertebrates	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 Tullet (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 macro-invertebrates	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 may be 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 macro-invertebrates	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

TABLE 1 *Continued*

Grab Sampling Device	Habitat Sampled	Substrate Type Sampled	Effectiveness of Sampling Device; Taxa Sampled	Advantages	Limitations	Preference or Recommendation	Selected Literature
Orange-Peel Grab	Marine waters, deep lakes	Sandy substrates, cobble, rubble stone	Sample area 0.025 m ² ; penetration depth about 18 cm; qualitative sampler, not a satisfactory quantitative sampler; should not be used in critical quantitative work that is to be compared with results from other sampling areas; sediment inhabiting macro-invertebrates	Comes in a range of sizes	Need large boat, powered which and cable line; blocking of jaws may cause sample loss	Limited application; reconnaissance sampling only	Briba and Reys (54) Elliott and Tullett (4) Hartman (55) Hopkins (39) Merna (56) Packard (57) Reish (58) Thorson (33) Word (52) Klemm et al (11)
Okean 50 Grab	Marine, estuarine, also large rivers	Sand, gravel, mud, clay, similar substrates	Sample area 0.25 m ² ; must be lowered slowly for quantitative work; moderately deep penetration in hard sand; better for quantitative sampling than Petersen grab; sediment inhabiting macroinvertebrates	Moderately deep penetration in hard sand; gauze covered window at top of each bucket to allow water to escape while grab is closing; offer some resistance to swift currents; lowering of grab desirable for deep sea sampling; may also have hinged doors instead of screened windows; rapid rates of lowering are possible; comes in a range of sizes	Heavy; requires large boat, powered winch and cable line; jaws may be blocked and sample lost; not entirely adequate for deep burrowing organisms; must be lowered slowly for quantitative sampling		Elliott and Tullett (4) Holme (37) (38) Holme and McIntyre (31) Lisitsin and Udintsen (59) Zhadin (60)
Shipek Grab	Estuarine areas, also large freshwater lakes	Sand, gravel, mud, clay, and similar substrates	Sample area 20 cm ² , approximately 10 cm deep at center; sediment inhabiting macroinvertebrates	Scoop type sampler	Heavy; requires boat, powered winch and line; must be lowered on a near vertical line; inadequate for deep burrowing organisms; sampled area may be rather small for quantitative work	Limited application	Barnes (31) Elliott and Tullett (4) Flannagan (5) Holme (42) (43) Holme and McIntyre (35)

similar substrates. This device samples a surface area of 0.1 m². For operating procedures, see Practice D 4344.

5.5 *Van Veen Grab Sampler* (see Fig. 5) is designed to give quantitative samples of macroinvertebrates from sediments in

estuaries, oceans, and similar habitats, and is adaptable to freshwater areas. This device is useful for sampling sand, gravel, mud, clay and similar substrates. This sampler is



TABLE 1 *Continued*

Grab Sampling Device	Habitat Sampled	Substrate Type Sampled	Effectiveness of Sampling Device; Taxa Sampled	Advantages	Limitations	Preference or Recommendation	Selected Literature
Holme Grab	Marine, estuarine areas, deep lakes	Sand, gravel, mud, clay, and similar substrates	Sample area 0.05 m ² , approximately 15 cm. in hard sand, etc., sediment inhabiting macroinvertebrates	Scoop type sampler; comes with a single scoop or double scoop	Heavy; requires boat, powered winch and line; springs of scoop may be difficult to reset; inadequate for deep burrowing organisms	Limited application	Barnes (31) Elliott and Tullett (4) Holme (56) (57) (43) Holme and McIntyre (35) Thorson (54)

^aThe boldface numbers in parentheses refer to the list of references at the end of this guide.
Table 1 continued

available in two sizes, 0.1 m² and 0.2 m². For operating procedures, see Practice D 4345.

5.6 *Orange-Peel Grab Sampler* (see Fig. 6) is designed to obtain quantitative samples of macroinvertebrates from sediments in marine waters and deep lakes. This device is useful for sampling sandy and similar substrates. The sampler is available in a range of sizes but the 1600 cm³ is generally used although larger sizes are available. For operating procedures, see Practice D 4407.

5.7 *Okean 50 Grab Sampler* (See Holme, 1971 for illustration **(38)**) is designed to obtain quantitative samples of sediment and macroinvertebrates primarily in marine, estuarine, and large rivers. This device is useful for collecting macroinvertebrates from sand, gravel, mud, clay, and similar substrates. The sampler is available in various sizes, generally a sampling area of 0.25 m². For operating procedures, see Practice D 4346.

5.8 *Shipek (Scoop) Grab Sampler* (see Fig. 7) is designed to obtain quantitative samples of macroinvertebrates from

sediments in marine waters and large inland bodies of water. This device is useful for sampling macroinvertebrates from sand, gravel, mud, clay, and similar substrates. It is designed to take a sediment sample with a surface area of 20 cm² to approximately 10 cm deep at the center. For operating procedures, see Practice D 4347.

5.9 *Holme (Scoop) Grab Sampler* (see Fig. 8) is designed to obtain quantitative samples of sediment and macroinvertebrates primarily in marine and estuarine waters and large deep freshwater lakes. This device is useful for sampling macroinvertebrates from sand, gravel, mud, clay, and similar substrates. This sampler is designed to take a sediment sample with a surface area of 0.05 m² and approximately 15 cm deep at the center. The device comes with a single scoop or double scoops. For operating procedures, see Practice D 4348.

5.10 All samplers take discrete grabs or scoops of a defined area.