

A SEDIMENT NEWSLETTER FROM INTEGRAL CONSULTING INC.

# The Benthic Zone

*February 2026*

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# Table of Contents

## Understanding Vibracoring: Technical Considerations for Collecting High-Integrity Sediment Cores

By **Tim Fleming**, *Senior Consultant*

## Unlocking the Future of Environmental Monitoring: Environmental DNA as a Tool for Biological Characterization and Site Management (Part Two of a Two-Part Series)

By **Jennifer Wollenberg, Ph.D.**, *Principal*;

**Maryann Welsch**, *Senior Consultant*;

**Sadie McGarvey**, *Senior Consultant*

## Previous Newsletter Articles:

## Technical Impracticability Waivers: An Underutilized Tool for Managing Sediment Sites

By **Andrew Halmstad, P.E.**, *Senior Consultant*;

**Chris Sinton, Ph.D., R.G.**, *Consultant*; **Nicole Ott**, *Principal*

## Unlocking the Future of Environmental Monitoring: Environmental DNA as a Tool for Biological Characterization and Site Management (Part One of a Two-Part Series)

By **Jennifer Wollenberg, Ph.D.**, *Principal*; **Daniel Doolittle**, *Principal*; **Sadie McGarvey**, *Senior Consultant*

# Understanding Vibracoring: Technical Considerations for Collecting High-Integrity Sediment Cores

By **Tim Fleming**, *Senior Consultant*

Vibracoring is a widely applied technique in marine, estuarine, and freshwater investigations for acquiring continuous sediment cores while preserving *in situ* stratigraphy. These sediment profiles record both natural depositional processes and anthropogenic disturbances, such as dredging, disposal activities, and infrastructure development. Recovering intact, depth-resolved profiles is essential for geochemical characterization, geotechnical assessment, and contaminant delineation.

## Principles of Vibracore Operation

Vibracoring employs high-frequency vertical oscillations generated by counter-rotating electric motors mounted on the core head assembly. The vibration reduces shear resistance along the sediment–barrel interface, facilitating downward penetration while minimizing internal distortion. Because the method is non-rotational, sedimentary laminations remain largely intact.

Standard environmental programs commonly use 4-in. aluminum barrels capable of achieving penetration depths exceeding 10 m (30–40 ft), depending on sediment strength, porewater content, and energy transfer. The technique is most effective in fine-grained, water-saturated sediments, such as estuarine muds, deltaic deposits, and reservoir silts, with efficiency decreasing in coarse or consolidated materials.

## Stratigraphic Integrity and Sampling Limitations

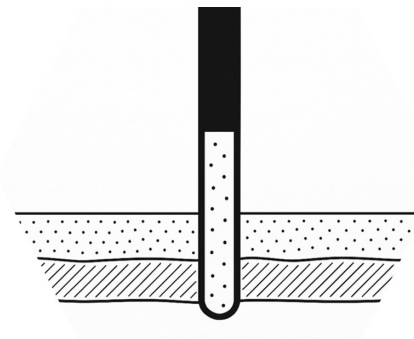
Although vibracoring is designed to preserve sediment structure, several mechanical processes can compromise depth accuracy.

**Rodding** (under-recovery) occurs when sediment compacts inside the barrel and stops ascending while the barrel continues to penetrate. This creates a discrepancy between penetration depth and recovered length:

- Penetration (P): total depth the barrel tip advances into the sediment
- Recovery (R): length of sediment that rises inside the barrel.

**Pumping** (over-recovery) is associated with suction from the check valve during sampling. In low-strength sediments, excess suction or expansion of soft material entering the tube can cause the recovered length to exceed the actual penetration depth (Figure 1). These effects complicate depth normalization and can distort contaminant concentration profiles.

Additional factors such as elastic rebound, barrel wall friction, and pressure changes can influence internal deformation and must be considered when interpreting stratigraphy.



**Figure 1:** Conceptual illustration of pumping (over-recovery) by which the upper interval is over-represented in the core barrel and the lower interval is absent. Excess suction or expansion of soft material entering the tube can cause the recovered length to exceed the actual penetration depth.

## Real-Time Monitoring to Improve Data Quality

To address uncertainty associated with rodding, pumping, and expansion, a dual-sonar monitoring system known as the Vibracore Recovery Monitoring System (VRMS) has been developed. The system integrates sonar in two ways:

- Internal sonar, which records the height of sediment entering the barrel
- External sonar, which records penetration depth into the sediment bed.

The relationship between penetration and recovery is expressed as follows:

$$\Delta(t) = P(t) - R(t)$$

Interpretation of  $\Delta(t)$ :

- $\Delta \approx 0 \rightarrow$  representative recovery
- $\Delta > 0 \rightarrow$  rodding or compaction (under-recovery)
- $\Delta < 0 \rightarrow$  pumping or expansion (over-recovery)

Significant divergence between  $P(t)$  and  $R(t)$  indicates mechanical issues affecting core integrity. Although VRMS does not allow real-time changes to the ongoing coring process, it provides a post-event diagnostic record showing where sediment actually entered the barrel (Figure 2). This enables the sampling team to confirm whether material corresponds to the intended depth interval and to refine technique, barrel placement, or vibration time on subsequent attempts.

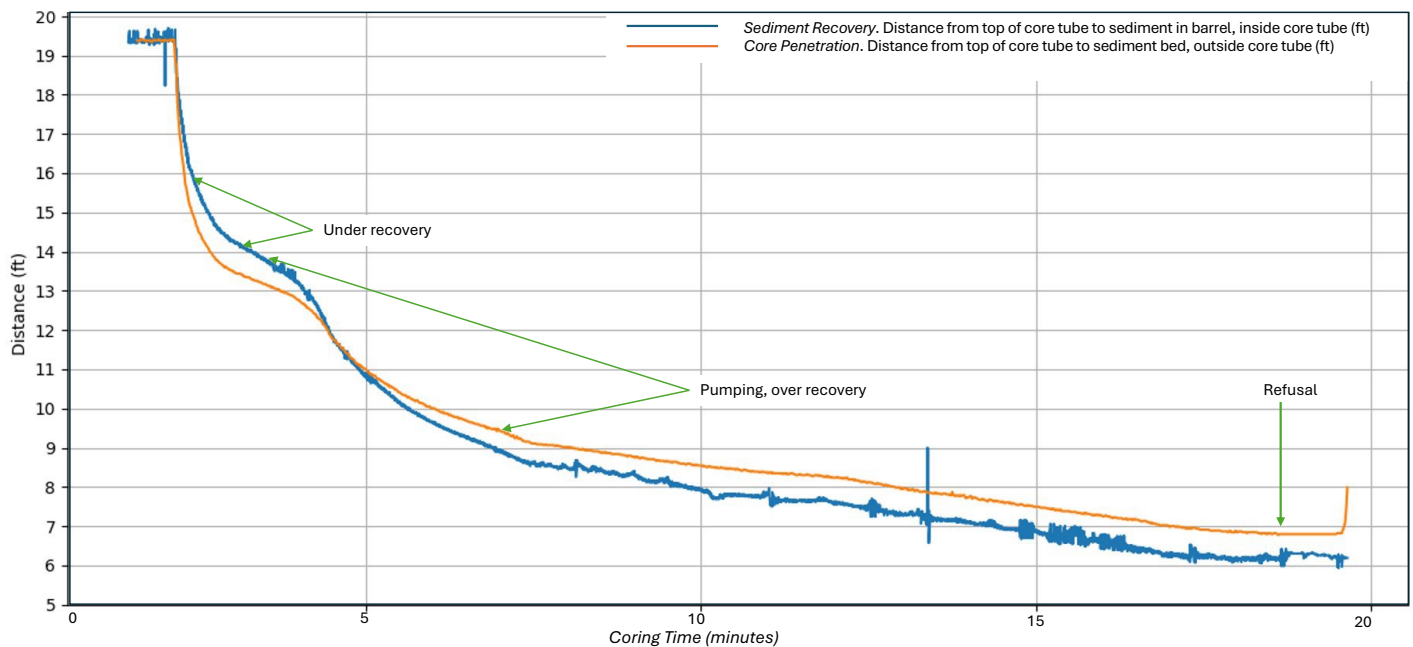


Figure 2: Comparisons of readings from the internal sonar to those from the external sonar provide real time information about sediment recovery.

## Clarification on System Capabilities

VRMS is most valuable in understanding how the core behaved during collection and in reconstructing the true depth origin of recovered material. This capability is especially important for the following activities:

- Contaminant delineation, where accurate depth boundaries govern remedial design
- Stratigraphic interpretation, where mixing or distortion may obscure depositional contacts
- Repeat attempts, where operators adjust technique to improve sample integrity.

VRMS therefore improves depth attribution accuracy, strengthens data defensibility, and reduces uncertainty inherent in traditional vibracoring where recovery and penetration must be inferred after retrieval.

## Benefits for Remediation Projects

In contaminated sediment investigations, vertical accuracy is critical. Misidentifying the depth of contamination can alter:

- Estimated removal volumes
- Dredge cut design
- Risk characterization
- Engineering controls

By pairing penetration and recovery data, VRMS helps ensure that recovered sediment corresponds to the correct depth interval, improving stratigraphic interpretation and contaminant profiling. This depth-resolved information directly supports remedial boundary decisions and regulatory compliance.

## Field Deployment Platforms and Positioning Systems

Vibracoring requires stable platforms capable of supporting vertical loads associated with long core barrels. Common platforms include shallow-draft pontoon vessels, barge-mounted A-frames, and Bristol Bay–style vessels (Figure 3). Platform selection depends on bathymetry, hydrodynamic conditions, site access, and logistical constraints.

Accurate vertical alignment and station holding are maintained using dynamic-positioning motors, three-point



**Figure 3:** Integral's Bristol Bay vessel DW Hood is stationed in Long Beach, CA.

anchoring systems, or spuds. Limiting lateral movement prevents off-axis penetration, which can introduce shear, affect core geometry, and/or bias recovery.

## Applications and Data Interpretation

High-quality vibracores provide continuous records of lithology, contaminant stratification, accumulation history, and geotechnical properties, such as undrained shear strength and bulk density. These data support a variety of environmental and engineering activities:

- Dredging and sediment management
- Delineation of contamination depth intervals
- Evaluation of sediment suitability for restoration projects
- Geotechnical assessments for waterfront structures.

Interpretation integrates VRMS data, lithologic logging, laboratory analyses (grain size, metals, organics, total organic carbon), and precise geospatial positioning to reconstruct depth-corrected environmental profiles.

## Conclusion

Vibracoring remains a foundational technique for obtaining continuous, minimally disturbed sediment cores in aquatic environments. Although mechanical limitations can introduce uncertainty, the use of monitoring systems such as VRMS improves depth fidelity and enhances scientific defensibility. Combined with appropriate field platforms, controlled penetration geometry, and rigorous analytical procedures, vibracoring provides a robust data set for environmental and geotechnical decision-making.

# Unlocking the Future of Environmental Monitoring: Environmental DNA as a Tool for Biological Characterization and Site Management (Part Two of a Two-Part Series)

**By Jennifer Wollenberg, Ph.D.,** *Principal*  
**Maryann Welsch,** *Senior Consultant*  
**Sadie McGarvey,** *Senior Consultant*

In this second installment of our environmental DNA (eDNA) series, we discuss practical applications of this technology. Understanding the biological community present at a site can help focus the scope of remedial investigations and ecological risk characterizations. Integral applies this novel approach to characterize the presence and abundance of certain freshwater fish, birds, bats, amphibians, and marine biota in both contaminated sediment and greenfield applications.

## Case Study: Former Landfill Feasibility Study

A former landfill in New Jersey, dormant since the late 1960s, is surrounded by wetlands and presently supports a diverse range of wetland, meadow, and forested habitats like those at an adjacent wildlife refuge and conservation area. Ten years ago, Integral evaluated potential ecological risks of landfill-related chemicals in the soil and sediment of those habitats to the flora and fauna of the site. More recently, Integral has been revisiting the characterization of those habitats in support of a feasibility study, including documenting the biota present using eDNA surveys of the aquatic and terrestrial habitats.

Large stands of Phragmites-dominated marshes and dense scrub/shrub wetlands make navigating the approximately 200-acre site challenging, so traditional

biological surveys would be time- and labor-intensive. Therefore, the primary objective of the eDNA survey is to document current biodiversity in the array of habitats present. The eDNA survey includes collection of water and soil samples in key areas, with eDNA data compared to the reference conditions at the neighboring conservation area. This information can also be used to define baseline conditions that can later be compared to results from post-remedy eDNA surveys.

Through eDNA, Integral will quickly gain a comprehensive understanding of the current biological communities present and how the proposed cleanup may impact those communities. The eDNA data collected post cleanup will aid in documenting the recruitment of the flora and fauna, and, in the long term, register the success of restoration and resiliency of those communities.

## Beyond Contaminated Sites: Broader Applications of eDNA

Potential uses of eDNA analysis extend to greenfield-related applications of environmental monitoring and compliance.

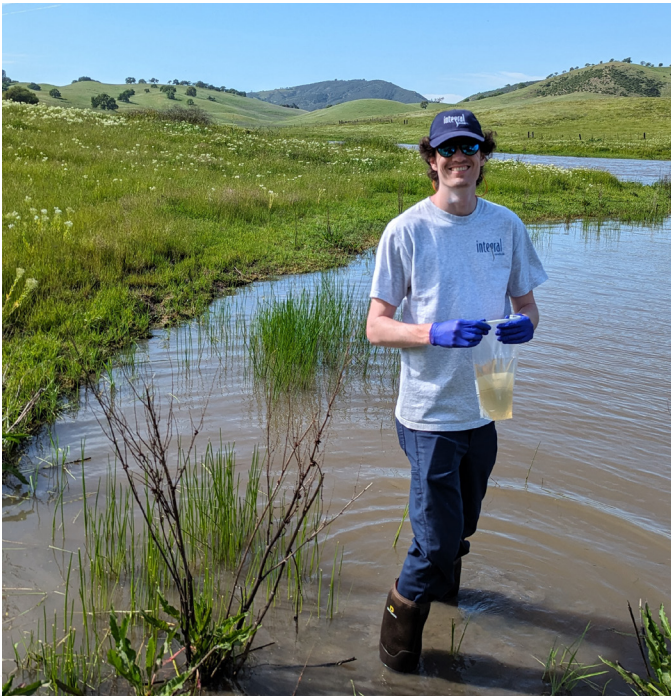
## Threatened and Endangered Species Monitoring

eDNA is particularly valuable for monitoring rare or protected species at sediment sites and in other habitats.

Integral is collaborating with an eDNA laboratory and academic partners to use eDNA collected from northern

California seasonal ponds to differentiate between native and hybrid populations of the California tiger salamander, a state- and federally listed species. Traditional methods require finding and catching salamanders during specific seasons, followed by invasive tail clipping for testing to distinguish the species and determine the level of hybridity. Conversely, collection of water and sediment samples from the target ponded habitats and eDNA analysis of those samples could offer a noninvasive, cost-effective alternative to identification of hybrid populations.

Similarly, a recently published investigation into the feasibility of using airborne eDNA to detect aquatic organisms<sup>1</sup> demonstrated that fully passive airborne eDNA sampling accurately assessed spawning Coho salmon (*Oncorhynchus kisutch*) presence in Issaquah Creek near Seattle, Washington. Aerosolized genetic material (resulting from evaporation, bubble-bursts and splashing at riffles, and spawning activity) enables this novel approach to detect sensitive aquatic species while allowing scientists to track site use without invasive or laborious surveys.



Collection of a pond water sample for eDNA analysis.

## Conservation and Restoration

eDNA is being used to monitor biodiversity in restoration projects, track invasive species, and assess the success of habitat interventions. Its ability to detect species presence without requiring detailed community or

habitat surveys makes it ideal for identifying cryptic, rare, or invasive species, and for tracking community changes spatially, seasonally, or over broader time spans. The efficiency of eDNA in detecting focal species and assessing biodiversity also allows landowners to understand species assemblages on their land and manage accordingly; enables park and open space agencies to prioritize areas that support vulnerable species; and permits conservation groups to assess the ecological value of sites targeted for protection efforts. Some companies are also using eDNA to monitor biodiversity as part of their sustainability initiatives and reporting.

## Renewable Energy and Extractive Industries

Site assessments for wind farms, solar installations, and mining operations increasingly incorporate eDNA to characterize ecological communities and evaluate potential impacts before, during, and after development. Integral is incorporating eDNA data into an essential fish habitat assessment for offshore wind projects. Some offshore wind farms in the United States have added eDNA to their required fisheries and benthic monitoring programs.

## Environmental Permitting

Permits for wastewater discharge often require biological monitoring to ensure compliance with water quality standards. Although the biotic indices typically specified in permit conditions necessitate traditional biological surveys, supplemental eDNA analysis can provide an additional line of evidence to evaluate community health and clarify potential impacts to benthic invertebrates and other organisms.

## Water Management

The use of eDNA is revolutionizing water management at local, regional, and state levels. For example, in 2024, the California Department of Water Resources (DWR) released its eDNA Strategy,<sup>2</sup> outlining its approach to integrating eDNA technology to detect rare, invasive, and nuisance species; assess and track biodiversity; and monitor pathogens. Using eDNA, DWR can more effectively monitor large and remote ecosystems, improve science-based management decisions and environmental stewardship, and enhance collaboration both within the agency and with external partners. DWR's eDNA efforts are in support of key operational goals, including compliance with environmental regulations,



informing habitat restoration, anticipating harmful biological events such as toxic algal blooms or disease outbreaks, and creating opportunities for meaningful community engagement.

## Conclusion

eDNA has the potential to revolutionize how we understand and manage ecosystems. From contaminated urban waterways to remote conservation areas, eDNA offers a powerful, efficient, and noninvasive means of assessing biodiversity. Including eDNA as a line of evidence in the early phases of project planning can allow project proponents the opportunity to design around sensitive resources to maximize development, remediation, and habitat restoration opportunities on a site while minimizing impacts to species or habitats of concern.

Although challenges remain, the momentum is clear: eDNA is not just a research tool—it is a practical tool for the complex environmental challenges of today and tomorrow. As adoption grows, eDNA will play a critical role in advancing sustainable development, protecting endangered species, and promoting ecosystem health.

Field processing of a water sample for transport to an analytical laboratory.

<sup>1</sup> Ip, Y.C.A., G. Guri, E.A. Allan, and R.P. Kelly. 2025. Passive air sampling detects environmental DNA transfer from water into air. *Sci. Rep.* 15:42245. <https://doi.org/10.1038/s41598-025-26293-6>.

<sup>2</sup> California Department of Water Resources. 2024. Department of Water Resources Environmental DNA (eDNA) Strategy. Sacramento, CA. 38 pp. Available at: [https://water.ca.gov/-/media/DWR-Website/Web-Pages/What-We-Do/Science/Files/eDNA\\_Strategy.pdf](https://water.ca.gov/-/media/DWR-Website/Web-Pages/What-We-Do/Science/Files/eDNA_Strategy.pdf)

# Authors

## TIM FLEMING, *Senior Consultant*

Mr. Timothy Fleming is a senior consultant with 22 years of environmental monitoring experience specializing in sediment sampling, water quality monitoring, and stormwater management. Mr. Fleming has overseen complex environmental projects across California, focusing on coastal and marine ecosystems. His extensive expertise includes developing and implementing sampling and analysis plans (SAPs), conducting vibracore sampling for beach replenishment and dredging projects, and leading water quality and stormwater compliance programs for public agencies and private entities...

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## JENNIFER L. WOLLENBERG, PH.D., *Principal*

Dr. Jennifer L. Wollenberg is a multidisciplinary expert in the environmental sciences, who leverages her skills to help clients understand and manage business risks and opportunities in relation to natural resources. Dr. Wollenberg has spent more than 20 years characterizing the physical, chemical, and biological conditions at commercial and industrial sites to help clients better understand the environmental footprint of their operations, including potential impacts to natural resources. She works with corporate decision-makers to develop environmental management strategies that integrate with other aspects of their compliance programming and environmental, social, and corporate governance (ESG) reporting.

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## MARYANN WELSCH, *Senior Consultant*

Ms. Maryann Welsch is an environmental scientist with more than 20 years of experience working with industrial clients of regulated community and government entities to assess and reduce environmental risks and damage. She has provided strategic support and technical analyses on a variety of chemicals, including per- and polyfluoroalkyl substances (PFAS), petroleum compounds, dioxins, PCBs, PAHs, and metals to help clients and regulators understand the significance of ecological exposures and the potential for risks. As a project manager, Ms. Welsch collaborates with multidisciplinary project teams to deliver results in support of remedial investigations, feasibility studies, ecological risk assessments, natural resource damage assessments (NRDAs), ecosystem restoration, sediment management, and expert reporting.

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## SADIE MCGARVEY, *Senior Consultant*

Ms. Sadie McGarvey has 12 years of professional experience as a field biologist and regulatory specialist, working in a variety of habitats and municipalities. She has a wide range of experience in biological fieldwork, regulatory compliance, and environmental permitting. Her professional experience includes California Environmental Quality Act (CEQA) level site assessments and reporting, due diligence reporting, regulatory compliance support for various development, reclamation, repair, transportation, and utilities projects throughout Northern California, construction compliance monitoring, vegetation and hydrology monitoring, vegetation mapping, wetland delineations and habitat assessments, and special-status species surveys and research. Ms. McGarvey assists clients with navigating environmental regulations and obtaining regulatory authorizations from the U.S. Army Corps of Engineers (USACE), state and regional Water Quality Control Boards, California Department of Fish and Wildlife (CDFW), and U.S. Fish and Wildlife Service (USFWS). She ensures projects meet permitting and construction milestones while staying in compliance with regulatory authorizations and applicable laws.

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