

Focus on: Sediment Quality Monitoring in the Bainbridge Basin



Bainbridge Basin from the air

Bainbridge Basin sediments surveyed

We sampled surface sediments at 30 monitoring stations in the Bainbridge Basin during June 2023 as part of the Puget Sound Sediment Monitoring Program's Urban Bays Surveys. The results are presented in an interactive story map that summarizes key findings, including analyses of physical, biogeochemical, and chemical contaminant parameters, as well as the composition of sediment-dwelling invertebrate communities. The 2023 data are also compared with results from previous surveys, providing a long-term perspective on sediment conditions in the Bainbridge Basin. To learn more, visit <https://ecology.wa.gov/marinesediments>.

Summary of findings

Habitat

The Bainbridge Basin study area encompasses a geographically diverse region west of Bainbridge Island, characterized by shallow terminal inlets, deeper tidal passages, and a mix of urban and rural shorelines. Sampling depths ranged from 3 to 48 meters, with nearly half of the stations falling between 7 and 14 meters; shallower sites occurred in terminal inlets, while deeper stations were located in passages and near Port Madison. Grain size patterns reflected local energy conditions, with finer silt and clay accumulating in sheltered inner areas, and coarser sand and gravel dominating more exposed, higher energy passages. These grain size distributions were consistent with results from earlier surveys.

Biogeochemistry

Biogeochemical patterns in the Bainbridge Basin showed a clear spatial gradient from shallow, low-energy terminal inlets to deeper, higher-energy passages. Total organic carbon (TOC) dominated sediment carbon pools, accounting for 93% of total carbon (TC), with the highest TC, TOC, and total inorganic carbon concentrations occurring in the terminal inlets of Sinclair Inlet, Dyes Inlet, and Liberty Bay. TOC levels measured in 2023 were consistent with those observed in previous survey years.

Total nitrogen showed a similar distribution but was undetected at roughly half the stations, limiting carbon-to-nitrogen ratio (C:N) calculations. Elevated C:N (>10) in parts of Sinclair Inlet and north Port Orchard indicated older, lower-quality organic matter. Stable carbon and nitrogen isotopes pointed to predominantly algal-derived matter (from marine sources). Nitrogen isotope values in Bainbridge Basin were amongst the highest in Puget Sound, likely due to extensive algal blooms. Sulfides in the basin were highest in Sinclair Inlet

and Liberty Bay. Analysis of environmental variables revealed two dominant gradients associated with sediment type and depth, highlighting a transition from nutrient-rich depositional inlets to sandier, low-deposition outer areas.

Chemical contamination

Chemical contamination in the Bainbridge Basin showed a mix of long-term improvement and persistent hotspots. Mercury exceeded Sediment Quality Standards (SQS) at seven stations, mostly in Sinclair Inlet, where legacy contamination from historical industrial activity remains elevated. Despite this, the Sediment Chemistry Index (SCI) indicated that most stations had only *minimum exposure* to chemical contaminants, with no sites classified as *moderate* or *high exposure*. Both SCI and Mean SQS quotient (mSQSq) values showed improving trends from 1998 to 2023, reflecting decreasing chemical exposure over time. Metals and PAHs were the most frequently detected contaminants, with the highest concentrations in Sinclair and Dyes Inlets, though most Priority Pollutants remained stable or declined, including significant decreases in benzo(a)pyrene and pyrene.

Benthos

Benthic communities in the Bainbridge Basin showed mixed conditions in 2023, with most stations (61%) classified as *unaffected*, but long-term data reveal a steady decline in benthic condition, as *adversely affected* areas increased from 9% in 1998 to 39% in 2023. Median Multivariate AZTI Marine Biotic Index (M-AMBI) scores by survey year reflected this trend, shifting from *moderate* conditions in earlier surveys to *poor* in 2023, with the poorest conditions concentrated in terminal inlets. Communities were dominated by annelids and mollusks, and while most benthic metrics showed no significant long-term trends, echinoderm abundance declined consistently. Spatial patterns were pronounced: terminal inlets supported low-abundance, opportunistic assemblages, whereas offshore areas supported more abundant and diverse communities. Although community structure shifted over time, especially between 1998 and later years, core taxa such as *Aphelochaeta spp.* and *Paraprionospio alata* remained persistent contributors across surveys.

Putting it all together

Modeling results show that carbon, sediment grain size, total nitrogen, and metals are the strongest predictors of benthic community structure in the Bainbridge Basin, together explaining roughly half of the observed variation, while the remaining variability reflects unmeasured or interacting stressors. Despite relatively stable habitat conditions and improving chemical contaminant levels over time, benthic communities have continued to decline, suggesting that additional pressures such as habitat alteration, nutrient enrichment, changes in organic matter quality, or broader climate-related influences may be driving long-term shifts. Although new biogeochemical and geochemical measurements have improved our ability to detect patterns, much of the benthic variability remains unexplained, underscoring the need for continued research and collaboration to better understand the complex factors shaping benthic health in the Bainbridge Basin.



Julianne Ruffner
julianne.ruffner@ecy.wa.gov
360-280-4518



To request an ADA accommodation, email EAPpubs@ecy.wa.gov, call (564)-669-3028, or dial 711 to call through the Washington Telecommunications Relay for services like text telephone (TTY). Visit ecology.wa.gov/ADA for more accessibility information.