

Aquatic Insight
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Integrated Aquatic Vegetation Management Plan for Black Lake Draft

Black Lake, Thurston County, Washington

November, 2026

Prepared for: Black Lake Management District

Whatcom County Health and Community Services

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Abbreviations

APAM	Aquatic Plant Algae Management
AU	Assessment Unit
BMP	Best Management Practice
Chla	Chlorophyll *a*
DO	Dissolved Oxygen
DOE	Department of Ecology
DOH	Department of Health
EIM	Environmental Information Management
FTW	Floating Treatment Wetland
HAB	Harmful Algae Blooms
HCB	Harmful Cyanobacteria Blooms
IAVMP	Integrated Aquatic Vegetation Management Plan
LA	Lake Association
LCMP	Lake Cyanobacteria Management Plan
LMD	Lake Management District
NRCS	National Resource Conservation Service
Ortho-P	Ortho Phosphorous
OSS	On Site Septic
PC	Phycocyanin
PHS	Priority Habitat Species
QAPP	Quality Assurance Project Plan
SD	Secchi depth
T	Temperature
TN	Total Nitrogen
TSI	Trophic State Index
TP	Total Phosphorus
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area

Definitions

Adaptive Management - a structured management approach in which monitoring results and new information are used to evaluate effectiveness and adjust management strategies over time.

Anoxic - the absence of dissolved oxygen in a lake or water body

Aquatic macrophytes - aquatic plants large enough to be seen without magnification, including submerged, floating-leaved, free-floating, and emergent plants.

Aquatic Plant Management Permit - a regulatory authorization issued by the Dept. of Ecology governing certain aquatic plant management activities, including specified aquatic herbicide applications.

Bathymetry - the measurement and mapping of underwater depths and lake-bottom topography.

Benthic Bottom Barrier - a material placed over lake sediments to suppress aquatic plant growth by blocking sunlight and physically restricting plant emergence.

Best Management Practices - practices or measures designed to prevent, reduce, or control pollution and other environmental impacts.

Biolocial Control - the use of living organisms, such as herbivorous fish, insects, or pathogens, to suppress target plant populations.

Clean Water Act Section 303(d) List - a list of waterbodies assessed as impaired under the federal Clean Water Act because applicable water quality standards are not being met.

Contact Herbicide - an herbicide that primarily affects plant tissues directly exposed to the chemical, with limited movement throughout the plant.

Diver-assisted Suction Harvesting (DASH) - a method of aquatic plant removal in which divers manually dislodge plants, including roots when possible, and use a suction hose to transport the collected vegetation to the surface.

Early Detection Rapid Response (EDRR) - a management approach emphasizing the early identification, reporting, verification, and prompt control of newly introduced or emerging invasive species before they become widely established.

Emergent vegetation - aquatic plants rooted in saturated soils or shallow water with stems, leaves, and reproductive structures extending above the water surface.

Epliminion - the uppermost layer of water in a lake that is warmest and most mixed.

Eutrophic – having rich levels of nutrients and supporting a dense plant population, the decomposition of which kills some aquatic life due to a lack of dissolved oxygen.

Floating-leaved vegetation - aquatic plants rooted in lake sediments with leaves that float on the water surface, such as waterlilies.

Frequency of Occurrence - the percentage of surveyed sampling locations at which a particular species is observed.

Herbicide Resistance - the inherited ability of a plant population to survive an herbicide treatment that would normally control that species.

Hydroacoustic Survey - a method of collecting underwater information using sound waves to measure water depth and characterize submerged aquatic vegetation, including its distribution and height.

Hypolimnion - the lowest layer of water in a stratified lake that is cooler than the water above and relatively stagnant.

Integrated Pest Management - a decision making approach that combines prevention, monitoring, and multiple control techniques to manage undesirable organisms effectively while minimizing environmental and other risks.

Littoral Zone - the shallow, nearshore area of a lake where sufficient sunlight reaches the lake bottom to support the growth of rooted aquatic plants. The depth of the littoral zone varies depending on water clarity and other environmental conditions.

Maximum Colonization Depth - the greatest water depth at which submerged aquatic vegetation is observed growing, based on the survey method and criteria used.

Mechanical Harvesting - the cutting and collection of aquatic vegetation using specialized equipment, typically without removing underground roots or rhizomes.

Metalimnion - the middle layer of a thermally stratified lake, separating the epilimnion and the hypolimnion, in which the water temperature decreases rapidly with depth.

Mesotrophic - having moderate levels of nutrients in a lake or waterbody.

Nonpoint Source Pollution - pollution originating from diffuse sources rather than a single identifiable discharge point, commonly transported by precipitation, surface runoff, or groundwater.

Nuisance Aquatic Vegetation - aquatic vegetation that interferes with designated beneficial uses, such as boating, swimming, or fishing, or adversely affects ecological conditions.

Oligotrophic - having relatively low levels (or deficiency) of nutrients and plants and containing abundant dissolved oxygen in the deeper parts of a lake.

Percent Cover - the percentage of a defined area occupied by vegetation or a particular plant species, typically based on the horizontal area covered.

Point-Intercept Survey - a systematic aquatic vegetation sampling method in which plant presence and abundance are recorded at predetermined geographic locations.

Rake Sampling - a method of collecting submerged aquatic vegetation using a rake to identify plant species and estimate relative abundance at sampling locations.

Rhizome - a horizontal, typically underground or underwater plant stem that stores nutrients and produces new roots and shoots, allowing vegetative reproduction and regrowth.

Secchi Depth - a measurement of water transparency determined by lowering a standardized black-and-white disk into the water and recording the depth at which it disappears from view.

Selective Control - management intended to target specific plant species or populations while minimizing impacts to desirable native vegetation and other nontarget organisms.

Shoreline Management Program (SMP) - a locally adopted and state-approved regulatory program that establishes policies and regulations for managing shorelines under Washington's Shoreline Management Act.

Soluble Reactive Phosphorus (SRP) - a measure of dissolved phosphorus that reacts with standard colorimetric reagents, consisting primarily of orthophosphate and often used as an indicator of readily available phosphorus.

Species Richness - the number of different species present within a defined area or biological community.

Stratification – the process by which a lake separates into distinct layers with different temperatures. Sometimes the accompanied by difference concentrations of dissolved oxygen as well.

Submerged Vegetation - aquatic plants that grow primarily beneath the water surface, including species rooted in lake sediments and some free-floating species.

Systemic Herbicide - an herbicide that is absorbed and transported within a plant, potentially affecting roots, rhizomes, and other tissues beyond the initial point of contact.

Thalweg - a line connecting the lowest points of a series of successive cross-sections along the course of a river or stream. In a lake created from an impounded stream or river the historic river bed, or thalweg, remains visible at the lake bottom.

Thermocline – the zone between the epilimnion above and the hypolimnion below where the water temperature starts a steep decline.

Total Phosphorus (TP) - a measurement of all forms of phosphorus in a water sample, including dissolved and particulate phosphorus.

Trophic State - a classification of a lake based on its nutrient enrichment and biological productivity, commonly described as oligotrophic, mesotrophic, or eutrophic.

Turion - a specialized vegetative reproductive structure produced by certain aquatic plants, including curlyleaf pondweed, that can remain dormant and subsequently develop into a new plant.

Vegetative Reproduction - plant reproduction through structures such as rhizomes, fragments, tubers, or turions rather than seeds.

Watershed - the geographic area of land that drains precipitation and surface water toward a common receiving waterbody, such as a lake, river, or stream.

Executive Summary

Key findings from the study include:

The 2026 aquatic vegetation and bathymetric surveys provide an updated assessment of Black Lake's physical characteristics, aquatic plant community, and invasive species distribution.

- Lake characteristics and vegetation distribution: Black Lake encompasses approximately 572 acres, with a mean depth of 18.4 feet and a maximum depth of 30.1 feet. Hydroacoustic mapping documented submerged vegetation throughout much of the littoral zone and identified areas where dense or tall vegetation may interfere with recreational activities.
- Native aquatic plant community: The submerged plant community remains predominantly native, with slender naiad (*Najas flexilis*) the most frequently encountered species, occurring at 78% of sampling locations. Although species richness was relatively low at individual sampling sites, native aquatic vegetation continues to provide important habitat and ecological functions that should be considered in management decisions.
- Invasive aquatic plants: Three Class C noxious weeds were documented: fragrant waterlily (*Nymphaea odorata*), curlyleaf pondweed (*Potamogeton crispus*), and yellow flag iris (*Iris pseudacorus*). Floating-leaved vegetation, consisting primarily of fragrant waterlily, covered approximately 17.4 acres (13.3% of the littoral zone). Yellow flag iris was widespread along the shoreline, particularly in the northern basin, while curlyleaf pondweed was detected at only three sampling locations. Its limited distribution presents an opportunity for early intervention, with eradication as the primary management objective.
- Eurasian watermilfoil: Eurasian watermilfoil (*Myriophyllum spicatum*), previously documented and managed in Black Lake, was not detected during the 2026 survey. Continued surveillance is recommended to identify potential reestablishment.
- Sensitive habitats and species: Freshwater wetlands and other sensitive shoreline habitats contribute to the lake's ecological value. No threatened, endangered, or rare aquatic plant species were identified during the 2026 surveys.

Overall, the findings support an integrated management approach that prioritizes eradication of curlyleaf pondweed, targeted reduction of fragrant waterlily and yellow flag iris, prevention of new invasive species introductions, and protection of beneficial native aquatic vegetation. Management should focus on locations where invasive plants impair recreational uses, threaten native habitats, and present opportunities for preventing further spread.

Recommended management activities:

The recommended management strategy for Black Lake emphasizes targeted control of invasive aquatic plants, prevention of further spread, and protection of beneficial native vegetation and aquatic habitat. Management priorities and control methods were developed based on the 2026 vegetation survey findings, species specific characteristics, recreational impacts, and feasibility of long-term control. The principal recommendations include:

Priority 1 – Curlyleaf pondweed: Eradication should be the highest management priority given the species' limited distribution. Early-season treatment using dipotassium endothall or diver-assisted suction harvesting (DASH) is recommended at the three documented locations in the northern and southern basins, followed by monitoring and additional treatments as needed to prevent reestablishment.

Priority 2 – Fragrant waterlily: Targeted treatment of established infestations using systemic aquatic herbicides, particularly imazapyr or imazamox, is recommended to reduce nuisance growth and prevent further spread. Priority locations include the northern basin, isolated shoreline populations, and areas affecting recreational access. Surveillance and prevention efforts should also focus on the WDFW public boat launch, while treatment in the more natural southern basin should minimize disturbance to native wetland and aquatic plant communities.

Priority 3 – Yellow flag iris: Initial treatment should focus on established infestations along the northern basin shoreline, with additional attention to isolated populations elsewhere around the lake. Targeted applications of imazapyr or glyphosate, supplemented by manual removal where feasible, are recommended to reduce established populations and prevent further seed dispersal.

Prevention and long-term management: An intensive initial treatment phase should be followed by annual monitoring, targeted follow-up treatments, and a long-term maintenance program emphasizing early detection and rapid response. Public education, shoreline property owner participation, and watercraft decontamination outreach will be important for preventing new introductions and reinfestation. Treatment strategies should be adjusted through adaptive management based on monitoring results, treatment effectiveness, environmental conditions, and community input.

Overall, the recommended approach seeks to achieve sustained reductions in invasive plant populations while maintaining recreational opportunities, protecting native aquatic vegetation and sensitive shoreline habitats, and minimizing unnecessary ecological disturbance.

A. Introduction

A.1 Project Description

The IAVMP evaluates current conditions in Black Lake through a comprehensive assessment of aquatic and emergent plant communities, including mapping the distribution and density of invasive and native species, characterizing sediment and nutrient conditions, and identifying factors driving plant proliferation.

Using this information, the project team developed an integrated management framework that combines multiple control strategies tailored to species and site conditions. The plan emphasizes adaptive management, allowing strategies to evolve based on monitoring results and treatment effectiveness.

A key component of the IAVMP is the evaluation of ecological tradeoffs between vegetation management and habitat value. Aquatic plants provide important functions for fish and wildlife, including refuge, foraging habitat, and water quality benefits. The plan recommends management approaches that balance habitat protection with recreational and water quality goals.

Stakeholder engagement is central to the planning process. The project involves coordination with local residents, the Black Lake Special District (Figure 1), Thurston County, and state agencies including the Washington Department of Fish and Wildlife and the Washington State Department of Ecology. Public input is incorporated through meetings and outreach efforts to ensure that the plan reflects community priorities and supports long-term stewardship.

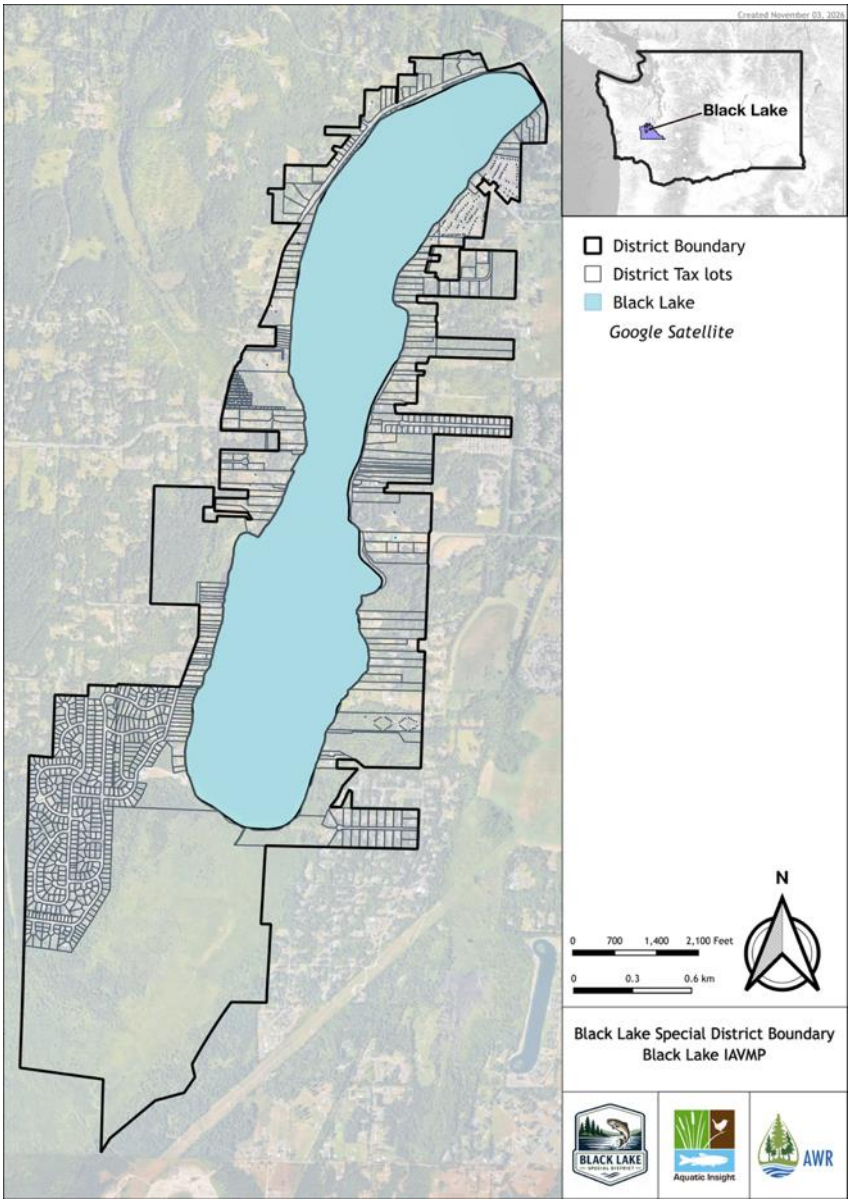


Figure 1. Black Lake Special District Boundary and Taxlots

The final deliverable is a comprehensive IAVMP that includes: (1) existing conditions assessment, (2) prioritized management goals, (3) recommended treatment strategies and implementation schedule, (4) permitting pathway, (5) monitoring plan with performance metrics, and (6) cost estimates and funding options for the recommended treatment strategies. The plan is designed to support future grant applications and regulatory approvals, providing a clear roadmap for improving Black Lake's ecological health and recreation.

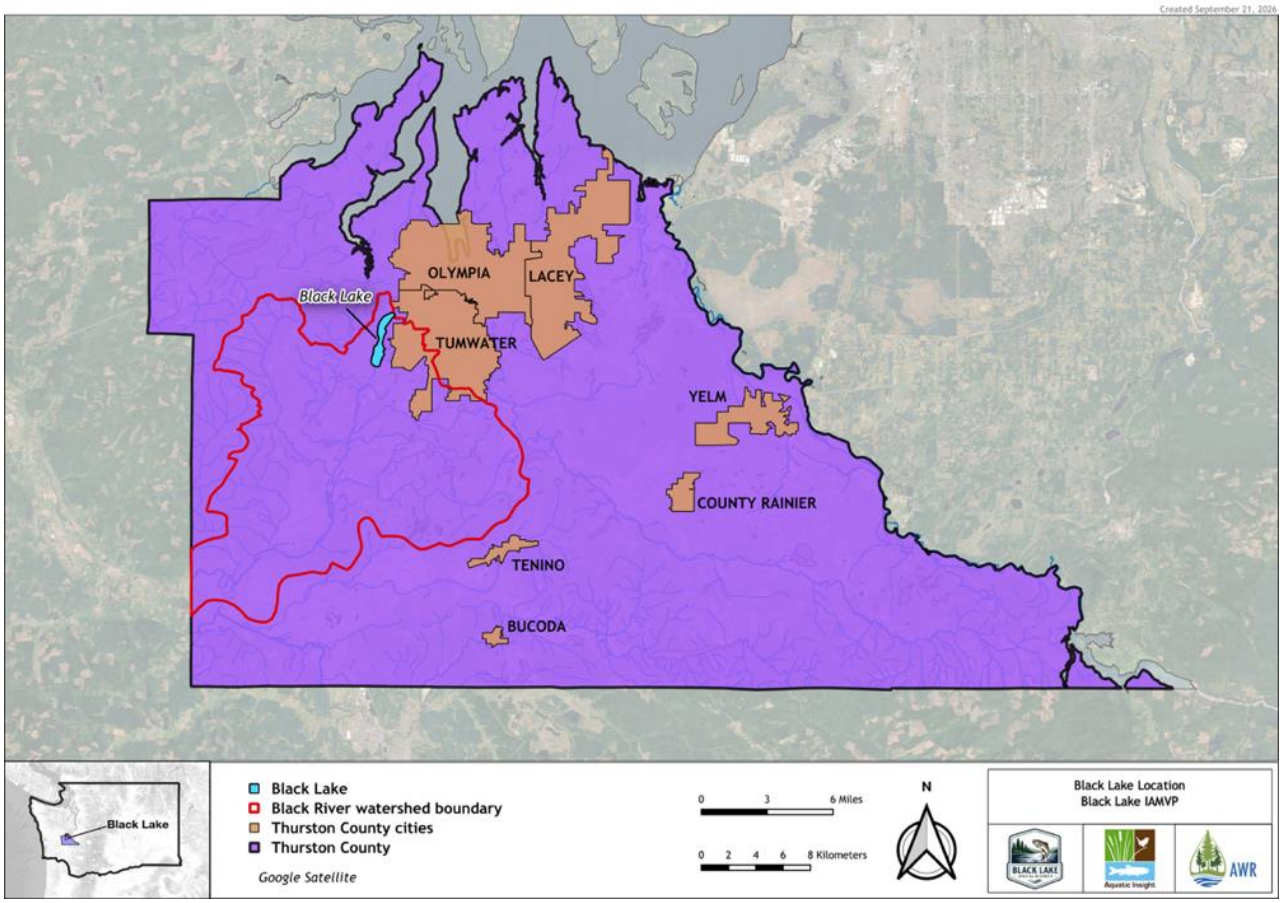


Figure 2. Thurston County cities and Watershed boundary

A.1.1 Problem Statement

Black Lake, located in northern Thurston County, west of Tumwater, WA (Figure 2). It has a surface area of approximately 573.7 acres (2,321,829 m²), a mean depth of 18.3 feet (5.58 m), a maximum depth of 30.1 feet (9.16 m), and an estimated volume of 10,502 acre-feet (12,954,000 m³). The lake continues to experience challenges associated with invasive aquatic plants, excessive growth of some native vegetation, and declining water quality. These conditions can impair recreation and lake access, alter fish and wildlife habitat, and contribute to conditions that support harmful cyanobacteria blooms.

This project updates the 2012 Integrated Aquatic Vegetation Management Plan to provide a science-based, long-term framework for managing invasive and excessive aquatic vegetation while protecting beneficial native plant communities, ecological functions, recreational uses, and water quality.



Figure 3. Fragrant waterlily covering the south end of Black Lake on June 27th, 2026 - photo by Cher Prazak

A.2 Species, location and extent

The 2026 aquatic vegetation survey documented 16 aquatic plant taxa in Black Lake, with the plant community composed predominantly of native species. Slender naiad (*Najas flexilis*) was by far the most widespread submerged species, occurring at 78% of the 200 survey locations and across nearly the entire vegetated depth range of the lake. Other relatively common native species included *Nitella* spp. (24%), common elodea (*Elodea canadensis*; 21%), ribbonleaf pondweed (*Potamogeton epihydrus*; 20%), and largeleaf pondweed (*P. amplifolius*; 13.5%).

Floating-leaved vegetation was also a prominent component of the littoral plant community. Approximately 17.4 acres of floating-leaved vegetation were delineated from aerial imagery, representing 13.3% of the littoral zone and 3% of the total lake area. These beds consisted primarily of fragrant water lily (*Nymphaea odorata*) (Figure 3), with smaller areas of native yellow pond lily (*Nuphar polysepala*), and were concentrated primarily in protected nearshore areas.

Two Class C noxious weeds were documented: fragrant water lily and curly-leaf pondweed (*Potamogeton crispus*). Fragrant water lily was relatively widespread, occurring at 19% of rake-survey locations in addition to the extensive beds identified from aerial imagery. In contrast, curly-leaf pondweed was uncommon, occurring at only three of the 200 survey locations (1.5%). Eurasian watermilfoil (*Myriophyllum spicatum*), which has historically been a management concern in Black Lake, was not detected during the 2026 survey.

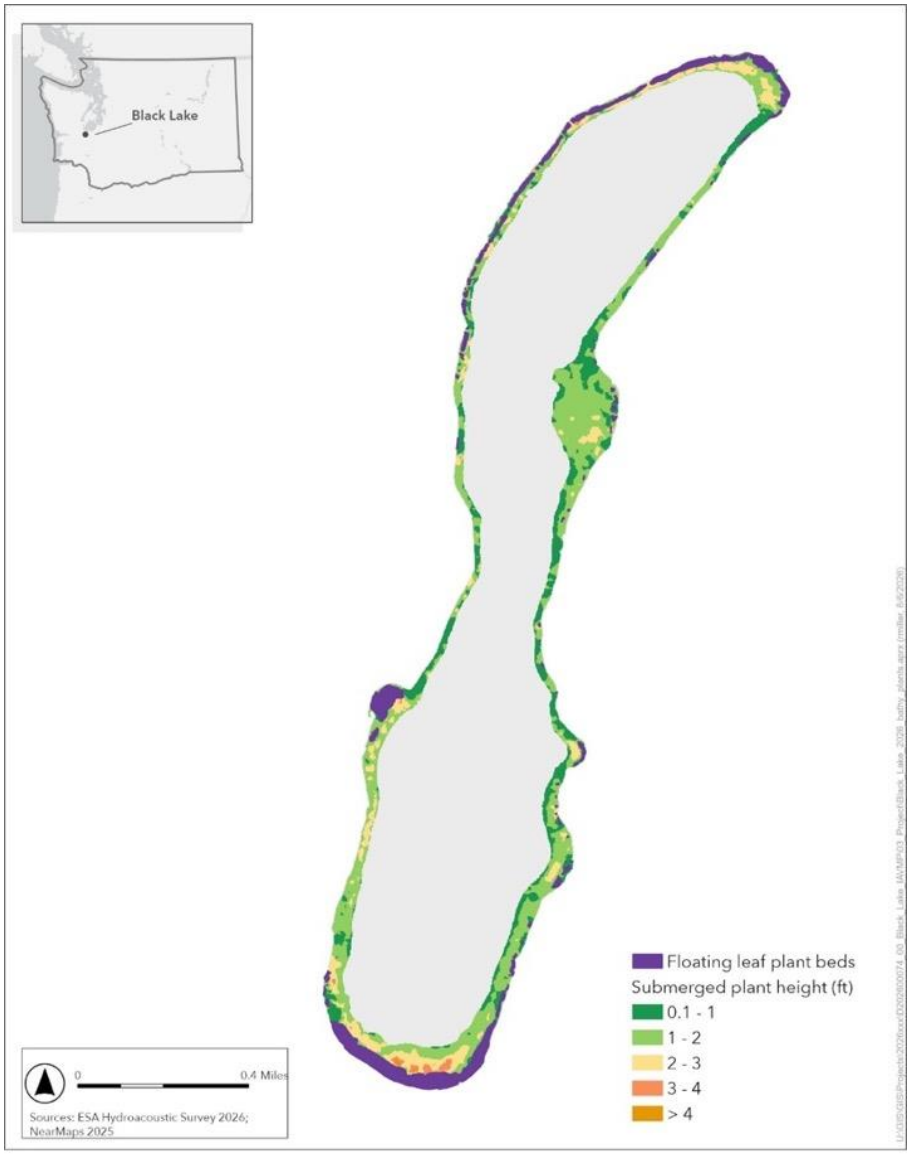


Figure 4. Black Lake aquatic plant canopy height above the sediment. (ft) and floating leaf aquatic plant beds Map created from the 2026 hydroacoustic survey and August 22nd, 2025 NearMaps aerial imagery.

A.3 Community Involvement

The Save Black Lake Coalition (SBLC) was established in 2010–2011 as a nonprofit 501(c)(3) organization in response to growing community concerns about declining water quality and increasing invasive aquatic plant growth in Black Lake. Building on these efforts, the Black Lake Special District—officially classified as a Special Use District and functioning similarly to a Lake Management District (LMD)—was formed in 2011–2012 to support the long-term protection and improvement of Black Lake's water quality for residents, recreational users, and wildlife.

In recent years, excessive aquatic vegetation growth has continued to expand, increasingly affecting recreation, lake access, and overall lake health. In response to these ongoing challenges, this update to

the 2012 Integrated Aquatic Vegetation Management Plan (IAVMP) and long-term management strategy was developed to guide aquatic vegetation control, water quality protection, and lake management decisions over the next five to ten years.

A dedicated IAVMP project webpage (https://blacklakespecialdistrict.org/iavmp/) was developed to help keep community members informed throughout the planning process and to provide accessible information on project goals, progress, and opportunities for participation. Outreach materials, including informational flyers (https://blacklakespecialdistrict.org/iavmp/), were also created and distributed to residents and stakeholders to explain the IAVMP process and encourage community involvement.

To support public engagement, three community workshops were incorporated into the IAVMP development process. Workshop #1, "Understanding Black Lake," was held on June 13, 2026, at the Black Lake Bible Camp & Retreat Center. This initial workshop provided an overview of historic and current lake conditions, introduced the IAVMP process, and gathered community input regarding management priorities and goals.

Workshop #2, "Mapping Results and Management Options," was held on September 9, 2026 and presented the results of the lake-wide aquatic vegetation survey and provided an overview of potential management strategies, including associated costs and implementation considerations. Workshop #3 focused on review of the Draft IAVMP, providing community members an opportunity to comment on the proposed plan before final revisions and submission to the Washington State Department of Ecology for review and approval.



Figure 5. Community Workshop #1 on June 13th, 2026 at Black Lake Bible Camp

A.4 Project schedule

Table 1. Project schedule for IAVMP development

PHASE	TASK	TIMELINE	KEY ACTIVITES	DELIVERABLES
Project Initiation	Coordination	March, 2026	Kickoff meeting, scope, schedule, roles, etc.	Work plan and communication plan
Existing Data Review	Compile and review past data	March – April 2026	Review prior studies, water quality data, plant surveys, lake management	Data summary and graphs
Stakeholder Engagement	Public and Agency input	May – Dec, 2026	Public meeting(s); coordination with agencies; incorporate feedback	Meeting summaries
Field Assessment	Water quality & Sediment assessment	June – Sept, 2026	Collect data on nutrients, clarity, sediments, drivers & limiting factors driving plant growth	Water quality and sediment summary
Management Alternatives	Develop Control Strategies	June – Sept, 2026	Evaluate options: mechanical, DASH, herbicide; benthic barriers, watershed actions	Alternative matrix
Draft Plan Development	Prepare Draft IAVMP	April – Nov, 2026	Integrate data, goals & management strategies; develop monitoring & adaptive management framework	Draft IAVMP
Agency and Public Review	Review by residents and Dept of Ecology	Nov, 2026	Circulate draft; address comments; refine recommendations	Comment response matrix
Final Plan	Final IAVMP produced & submitted to DOE for approval	Nov, 2026	Finalize plan including implementation schedule, permitting pathway and cost estimates	Final IAVMP document – approved by DOE
Funding Options for Plan Implementation	List of funding options for approved management options	Nov – Dec 2026	Assist with applying for funding opportunities	Grant applications provided and submitted

B. Management Goals

B.1 Past Management Efforts

Aquatic vegetation management and water quality improvements in Black Lake has occurred over multiple decades in response to invasive aquatic plant introductions, nuisance native vegetation, cyanobacteria concerns, and declining recreational usability. Washington State Department of Ecology (Ecology) surveys first documented invasive fragrant waterlily (*Nymphaea odorata*) and reed canarygrass (*Phalaris arundinacea*) in 1994. Yellow flag iris (*Iris pseudacorus*), was added to the list of documented invasive species in 2001, followed by creeping Jenny (*Lysimachia nummularia*) in 2003, Japanese knotweed (*Reynoutria japonica*) in 2007, and curlyleaf pondweed (*Potamogeton crispus*) by 2012. These findings demonstrate a progressive pattern of invasive species establishment and the need for continued surveillance and adaptive management.

Eurasian watermilfoil (*Myriophyllum spicatum*), discovered in Black Lake in 2004, became an early and significant management priority. Since 2006 to 2011, Thurston County Noxious Weed Control has conducted annual comprehensive aquatic plant surveys, typically assessing the lake from 0 to 10 feet in depth to map and identify invasive species presence (Figure 6). Eurasian watermilfoil infestations have been aggressively managed through diver hand removal and bottom barrier placement, substantially reducing lake-wide infestations to a point were it was not detected in the 2026 vegetation survey.



Figure 6. Vegetation survey and removal history and milfoil diver harvesting. Aerial map from the Thurston County Noxious Weeds Unit 2010 Year End Report; Photos from the Aquatic Weed Management Fund Final Report, 2009. *Photos by Rick Johnson*

The 2012 Black Lake Integrated Aquatic Vegetation Management Plan (IAVMP) identified nearly 40 aquatic plant species and emphasized management of Eurasian watermilfoil, fragrant waterlily yellow flag iris and nuisance native species including water nymph (*Najas flexilis*), pondweeds (*Potamogeton* spp.), and spatterdock (*Nuphar polysepala*). At that time, Black Lake supported approximately 3 acres of fragrant waterlily along shorelines and nearly 28 acres of mixed plant beds dominated by fragrant waterlily, in addition to approximately 0.21 acres of yellow flag iris. The 2012 IAVMP proposed a multi-year integrated management strategy that combined selective herbicide applications over consecutive years with manual controls and longer-term maintenance.

Management strategies implemented over time have included a combination of manual, mechanical, chemical, and lake-wide water quality treatments:

B.1.1 Manual and Mechanical Controls

- Diver hand-pulling and bottom barriers for Eurasian watermilfoil
- Mechanical harvesting for fragrant waterlily
- Ongoing annual lake-wide invasive species surveys and mapping

B.1.2 Herbicide and Chemical Treatments (2007–2023)

- Glyphosate (2007, 2008, 2009, 2013, 2018, 2020) for fragrant waterlily and yellow flag iris
- Imazamox (2013, 2021, 2022, 2023) for fragrant waterlily
- Fluridone (2007, 2009, 2010, 2011, 2013) for nuisance native submersed vegetation including water nymph and pondweeds
- Diquat dibromide (2016, 2018, 2020, 2021, 2022, 2023) for control of naiad spp., *Elodea canadensis, Potamogeton* spp., and *Ceratophyllum demersum*
- Endothall (2018, 2020, 2021, 2022, 2023) for *Potamogeton* spp., *Elodea canadensis*, *Najas flexilis*, and *Ceratophyllum demersum*
- Adjuvants used in conjunction with floating-leaved plant treatments, particularly fragrant waterlily

B.1.3 Algae and Water Quality Treatments

- Aluminum sulfate (alum) treatments in 2016 and 2021 to address cyanobacteria/algae and broader water quality concerns



Figure 7. Cyanobacteria film on surface of Black Lake during summer of 2011.

Recent treatment records (2016–2026) demonstrate a shift toward increasingly targeted aquatic plant management, with repeated annual or near-annual applications focused on controlling persistent nuisance vegetation communities including pondweeds, elodea, naiad, coontail, and fragrant waterlily. These records indicate that management priorities have expanded beyond the original Eurasian watermilfoil focus to address broader lake-wide vegetation assemblages affecting navigation, recreation, and ecological balance.

Overall, Black Lake's management history reflects substantial long-term investment by Thurston County, the Black Lake Special District, and agency partners in preserving beneficial uses of the lake. Significant progress has been made in suppressing Eurasian watermilfoil, but fragrant waterlily, yellow flag iris, curlyleaf pondweed, native nuisance vegetation, and recurring algae issues remain ongoing challenges. This history underscores the importance of an updated IAVMP as a long-term, adaptive framework that builds on prior successes while addressing persistent and emerging aquatic vegetation and water quality issues through integrated pest management principles.

B.2 Management Goals

Recognizing the need for a coordinated, science-based, and community-supported long-term strategy, the Black Lake IAVMP builds on past management efforts to guide integrated control of invasive and nuisance aquatic vegetation while protecting water quality, ecological function, and beneficial uses. The plan is designed to prevent reinfestation of Eurasian watermilfoil while continuing management of fragrant waterlily, yellow flag iris, curlyleaf pondweed, and nuisance native vegetation through adaptive, integrated management.

B.2.1 Short-Term Goals

- Build strong community awareness, support, and ownership of lake management goals
- Implement aggressive early management actions where needed, with strategic follow-up treatments
- Conduct diligent monitoring, mapping, and rapid response to new or satellite infestations
- Protect recreational access, navigation, and beneficial lake uses during peak use periods
- Promote homeowner and landowner education on nutrient reduction, shoreline stewardship, and best management practices

B.2.2 Long-Term Goals

- Maintain a sustainable, community-led aquatic vegetation management program in coordination with Thurston County and partner agencies
- Use adaptive management with regular program review to refine strategies based on monitoring results and emerging conditions
- Apply best available science and evolving management tools to support effective, ecologically responsible control
- Protect and restore broader watershed functions, including water quality, hydrology, groundwater recharge, and shoreline health
- Preserve fish and wildlife habitat, open space, and long-term recreational opportunities while supporting overall lake stewardship.

C. Water Body and Watershed Characteristics

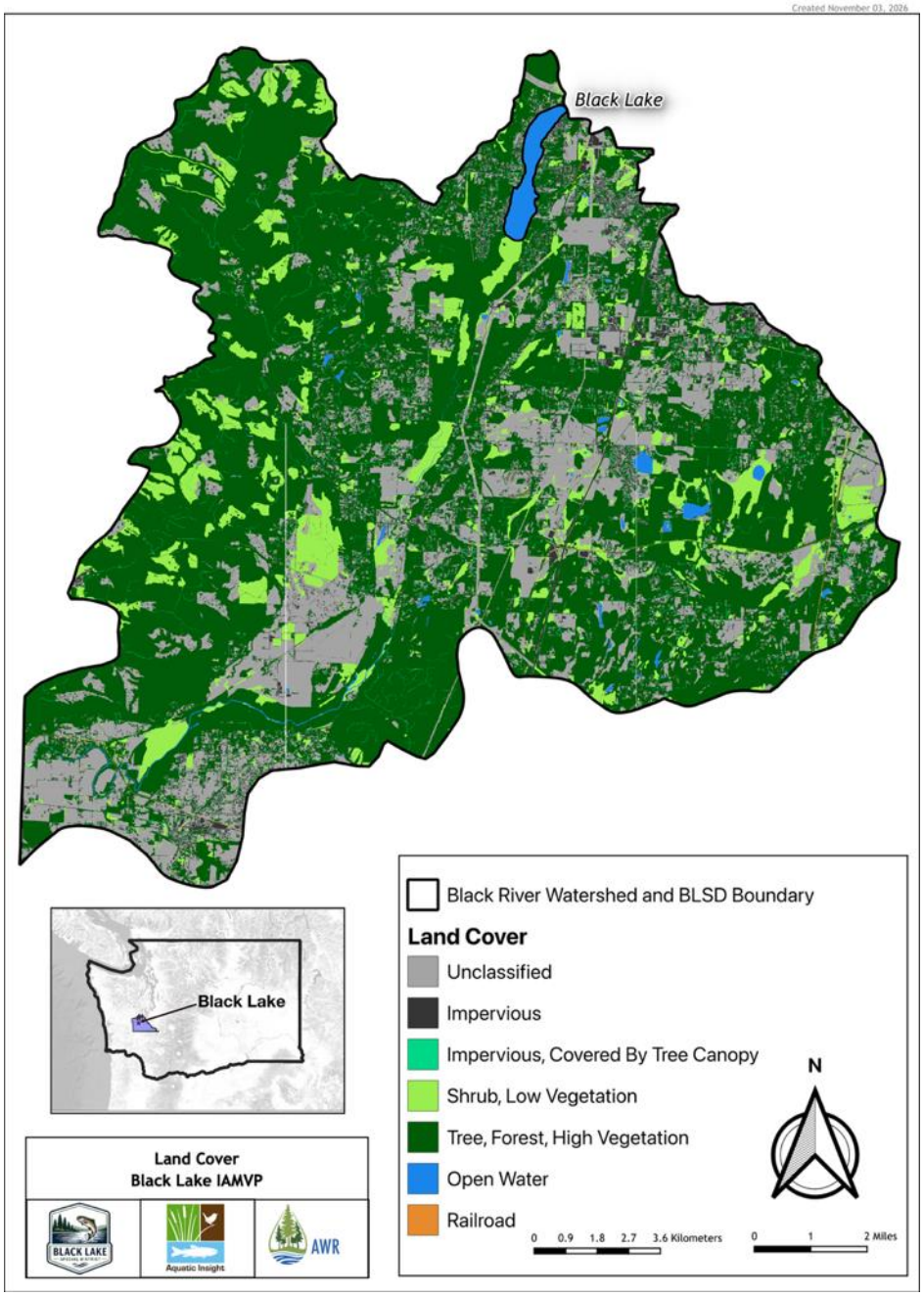


Figure 8. BLSD and Black River Watershed Land Cover Characteristics

C.1 Water quality (current and historical)

Water quality in the south basin of Black Lake has been monitored by Thurston County monthly during the growing season since 1992, providing a long-term record of lake conditions, including nutrient concentrations, water clarity, algal productivity, and trophic status. Historical monitoring has

consistently identified elevated phosphorus concentrations, reduced water clarity, and recurring cyanobacterial blooms, resulting in Black Lake's classification as a eutrophic lake.

In response to these persistent water quality concerns, the Black Lake Special District commissioned several investigations to evaluate nutrient sources and identify management alternatives, including the 2015 Phosphorus and Algae Control Plan prepared by Herrera Environmental Consultants. The study identified phosphorus release from lake sediments under seasonally anoxic conditions as a major contributor to summer phosphorus loading and cyanobacterial productivity. Subsequent whole-lake aluminum sulfate (alum) treatments were conducted in 2016 (Black Lake 2016 Alum Treatment Report, March 2017 and Water Quality Data Report Black Lake Watershed Pollutant Monitoring: Phase 1, September 2019) and in April of 2021 to reduce internal phosphorus loading and improve water quality (Water Quality Data Report, Black Lake Watershed Pollutant Monitoring: Phase 2, May 2021).

The April 2021 alum treatment was intended to further reduce internal phosphorus loading and improve water quality following the 2016 treatment. However, cyanobacterial blooms continued to occur after treatment, including an October 2021 event when microcystin concentrations reached 33.1 µg/L, exceeding Washington State's recreational guideline. Subsequent samples submitted to the Washington State Toxic Algae Program provide additional evidence of continued bloom activity.

Following the 2021 alum treatment, water quality monitoring conducted by Herrera documented substantial short term reductions in total phosphorus (TP) concentrations. Two weeks after treatment, surface water TP concentrations decreased from 50.2 to 9.7 µg/L in the north basin and from 16.5 to 10.5 µg/L in the south basin, with smaller reductions observed near the lake bottom. All four post-treatment measurements were below the established TP objective of 24 µg/L.

However, subsequent monitoring conducted by Thurston County and trained citizen scientists during 2021–2025 recorded surface water TP concentrations ranging from 8 to 40 µg/L, indicating that elevated phosphorus concentrations continued to occur. Chlorophyll-*a* concentrations measured in 2025 ranged from 8 to 24 µg/L, exceeding the treatment objective of 7.2 µg/L in all four samples. Although the 2021 alum treatment produced an immediate reduction in water column phosphorus concentrations, the available longer term monitoring data do not demonstrate sustained achievement of the established water quality objectives, suggesting that eutrophic conditions persist in Black Lake.

Additional watershed investigations and pollutant source tracking studies have evaluated external nutrient inputs, including contributions from tributaries, stormwater runoff, and failing onsite septic systems (Final Monitoring Report, Black Lake PIC Project, July 2022 - June, 2026). Additional information on the PIC (Pollution Identification and Correction) Project results can be found below in Section C.2.4.3. Collectively, these monitoring and management efforts provide an extensive historical record of Black Lake's water quality conditions and demonstrate the ongoing need for both internal and external nutrient management.

Climate change may further exacerbate existing water quality concerns in Black Lake through increasing air and water temperatures, longer growing seasons, and changes in precipitation patterns. Warmer water temperatures and extended periods of favorable growing conditions may promote increased aquatic plant and algal productivity, including the growth and persistence of cyanobacteria. Longer periods of warm, calm weather may also strengthen or prolong thermal stratification, potentially increasing the duration of low dissolved oxygen conditions in bottom waters and promoting the release of phosphorus from lake sediments. Given Black Lake's historically elevated phosphorus concentrations and documented internal phosphorus loading, these changes could increase the frequency, duration, or

intensity of nuisance algal and cyanobacterial blooms. Changes in precipitation patterns, including more intense storm events and extended summer dry periods, may further influence external nutrient loading, water levels, and aquatic vegetation distribution. These potential effects underscore the importance of continued nutrient management, water quality monitoring, and adaptive management strategies to maintain beneficial uses and ecological conditions in Black Lake.

C.1.1 Contaminants of Concern

Black Lake has elevated phosphorus, which contributes to excessive phytoplankton and vegetation growth, both of which inhibit recreational activity during summer. Details on the two sources of concern are included below.

C.1.1.1 Cyanotoxins – Microcystin, Anatoxin-a and Saxitoxin

Washington Ecology has an active cyanotoxin monitoring program that samples lakes several times a year to determine if they are producing toxins that exceed State recreational use guidance values (Table 2). Cyanotoxin monitoring data for Black Lake are available from the Washington State Department of Ecology Freshwater Algae Control Program for 2010 through 2025. Unlike a routine monitoring program in which samples are collected at predetermined intervals, samples were generally submitted for toxin analysis when a visible cyanobacterial bloom or surface accumulation was observed and reported. Black Lake has an active lake management community, and residents have historically reported suspected blooms to local health officials for sampling. Therefore, years with few or no samples likely represent periods with relatively little conspicuous bloom activity; however, the absence of a submitted sample cannot be interpreted as confirmation that cyanobacteria or cyanotoxins were absent.

Table 2. Washington State recreational use values for cyanotoxins

	Microcystins	Anatoxin-a	Saxitoxin	Cylindrospermopsin
Recreational Use Guidance Values	≥ 8 µg/L	≥ 1 µg/L	≥ 75 µg/L	≥ 15 µg/L

Microcystin has been the primary cyanotoxin of concern in Black Lake. The highest concentrations occurred during the earlier portion of the monitoring record, including a maximum microcystin concentration of 669 µg/L in September 2010. Additional substantial concentrations included 167 and 112 µg/L in 2010, 162 µg/L in 2014, and 87.6 µg/L in 2015. Following the 2016 alum treatment, submitted bloom samples generally contained substantially lower microcystin concentrations and no recreational-guideline exceedances were recorded from 2016 through 2020. A recurrence occurred in October 2021, when microcystin reached 33.1 µg/L and exceeded the recreational guideline. Subsequent submitted samples contained substantially lower concentrations, including 1.23 µg/L in 2022 and 0.64 µg/L in 2023, while all four toxins analyzed in the July 2025 sample were below their respective method detection limits. Anatoxin-a, cylindrospermopsin, and saxitoxin have occasionally been detected in Black Lake but have not exceeded their respective recreational guidelines during the monitoring period.

Before the April 2016 alum treatment, Black Lake experienced repeated and sometimes very high microcystin concentrations, including major exceedances in 2010, 2014, and 2015. Following treatment, microcystin concentrations declined substantially, and no recreational-guideline exceedances were recorded from 2016 through 2020 despite continued bloom-related sampling. A notable exceedance of

33.1 µg/L occurred in October 2021, after the second alum treatment, but subsequent results do not indicate a sustained return to the high toxin concentrations observed before 2016.

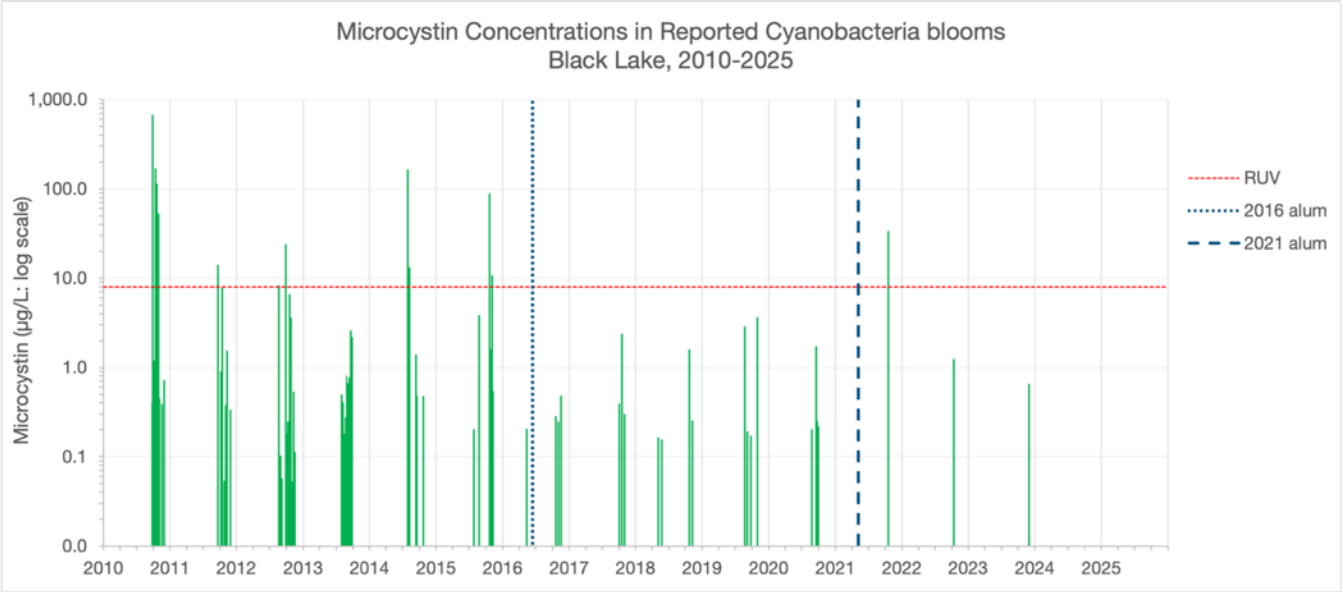


Figure 9. Bloom-response samples of Microcystin concentrations from Black Lake 2010-2025. Dashed vertical lines indicate whole-lake alum treatments conducted in 2016 and 2021. Samples were collected in response to observed cyanobacterial blooms rather than according to a fixed monitoring schedule; results below the method detection limit are not plotted.

C.1.1.2 PHYTOPLANKTON

Phytoplankton identification was conducted for a subset of bloom samples collected between 2010 and 2022 by the King County Environmental Lab (KCEL). The cyanobacteria assemblages included: *Aphanizomenon, Anabaena (Dolichospermum), Woronichinia, Microcystis, Oscillatoria, Lyngbya, Phormidium, Planktothrix and Gloeotrichia (*Table 3*).*

Table 3. Phytoplankton sampes from Black Lake from King County Environmental Lab

Date	Dominant	Subdominant	Interpretation
9/23/2010	*Woronichinia*	*Aphanizomenon*	Mixed colonial + N-fixing cyanobacteria
9/27/2010	*Aphanizomenon*	*Woronichinia*	N-fixing cyanobacterium dominant
10/25/2011	*Dinobryon*	*Anabaena*	Non-cyanobacterial dominant, but N-fixer present
11/2/2011	*Aphanizomenon*	*Anabaena*	Nitrogen fixing species
8/28/2012	*Anabaena*	*Fragilaria*	N-fixing cyanobacterium dominant
7/29/2013	*Oscillatoria*	*Anabaena*	Filamentous cyanobacteria
8/6/2013	*Oscillatoria*	*Anabaena*	Filamentous cyanobacteria
8/19/2013	*Lyngbya*	*Woronichinia*	Filamentous + colonial cyanobacteria
7/29/2014	*Woronichinia*	*Phormidium*	Colonial + filamentous cyanobacteria
10/11/2022	*Aphanizomenon*	*Dolichospermum*	*Microcystis* and *Woronichinia* present

Cyanobacteria were dominant or subdominant in most samples for which relative dominance was recorded. Particularly notable was the repeated dominance of the nitrogen fixing genera *Aphanizomenon* and *Anabaena* (*Dolichospermum*)(Paerl and Otten, 2013) These taxa are capable of obtaining nitrogen through atmospheric N_2 fixation and may have a competitive advantage when dissolved inorganic nitrogen becomes limited while phosphorus remains available (Paerl, 2008). Their repeated occurrence is therefore consistent with the phosphorus-enriched conditions documented in Black Lake and suggests that relative nitrogen availability may periodically influence cyanobacterial community composition. However, phytoplankton composition alone cannot establish nutrient limitation, and concurrent nutrient data would be required to determine the relative importance of nitrogen and phosphorus during individual bloom events (Paerl and Otten, 2013).

Several cyanobacterial genera observed in Black Lake are capable of producing cyanotoxins, particularly microcystins; however, toxin production is strain-specific and the organism responsible for individual toxin detections cannot be determined from microscopic identification alone (Hisbergues et al., 2003; Paerl and Otten, 2013). For example, the severe microcystin events observed in 2010 and 2014 occurred in mixed cyanobacterial assemblages containing multiple potentially toxigenic genera. The phytoplankton and toxin data therefore demonstrate that Black Lake supports a diverse community of bloom-forming and potentially toxigenic cyanobacteria, while reinforcing the importance of direct cyanotoxin analysis rather than relying on taxonomic composition alone to determine recreational health risk.

Beyond nutrients, the cyanobacteria found in Black Lake are characteristic of conditions commonly associated with eutrophic lakes (Beaver et al., 2018). Temperature, phosphorus availability, nitrogen availability, light, and water-column stability interact to determine which cyanobacteria become dominant. *Microcystis* biomass in eutrophic lakes is strongly influenced by temperature and phosphorus, whereas N_2 fixing *Aphanizomenon* and *Dolichospermum* occupy somewhat different nutrient niches (Rigosi et al., 2014; Beaver et al., 2018). Stable water columns can further favor buoyancy-regulating cyanobacteria and formation of surface accumulations, although the relationship differs by genus and lake (Paerl and Otten, 2013).

Planktothrix is a microcystin producer and can perform particularly well at relatively low underwater light levels, an advantage in turbid, productive waters. Studies have shown that *Planktothrix* is adapted to lower optimum light than *Microcystis* (Chaffin et al., 2018).

With Black Lakes' documented internal phosphorus loading, the occurrence of *Gloeotrichia* in several samples is interesting as some *Gloeotrichia* species recruit from sediments and can transport sediment acquired phosphorus into the water column (Carey et al., 2008, 2009).

C.1.1.3 303 D LIST STATUS

C.1.1.3.1 Harmful Algal Blooom (HAB) Assessment

Under Section 303(d) of the federal Clean Water Act, a Category 5 listing means that available data show that a waterbody does not meet one or more state water quality standards and is therefore considered "impaired" for the identified pollutant or condition. The listing does not necessarily mean that the entire lake is unsafe for all uses at all times; rather, it identifies a specific water quality problem that may interfere with uses such as recreation, aquatic life, or drinking water supply. Category 5 waters require development of a water quality improvement plan, typically a Total Maximum Daily Load (TMDL) or another EPA approved cleanup approach, to identify pollution sources and determine the reductions needed to meet water quality standards.

Ecology's dedicated freshwater HAB assessment methodology was formally incorporated into the March 2023 revision of Policy 1-11 after public review in 2022. Policy 1-11 is Ecology's Water Quality Assessment policy that establishes the methods and data requirements used to determine whether Washington waterbodies meet state water quality standards and how they are classified for the federal Clean Water Act 303(d)/305(b) assessment. Ecology lists freshwater harmful algal blooms (HABs) when recurring toxic cyanobacterial blooms demonstrate that a waterbody is not fully supporting its designated use for water contact recreation. HAB determinations are based on Washington's narrative water quality standards and incorporate cyanotoxin results reported through the Washington State Toxic Algae database, public health advisory information and Washington State Department of Health (DOH) recreational guidance. Under Ecology's assessment methodology, a waterbody may be placed in Category 5 when two cyanotoxin sampling events meet DOH WARNING or DANGER advisory thresholds in each of two or more years; the sampling events must be at least one week apart, but the years do not need to be consecutive. Category 5 may also be supported by qualifying multi-week public health advisories in two or more years or by documented human or animal illness or death associated with a HAB exposure.

Black Lake is included in Category 5 of Washington's Water Quality Assessment for harmful algal blooms (HABs), indicating impairment of the lake's designated water contact recreational uses. For the 2022 assessment cycle, Ecology determined that Black Lake met the Category 5 criteria because at least two cyanotoxin sampling events during both 2014 and 2015 reached concentrations warranting a Washington Department of Health Warning or Danger public health advisory (Figure 10). The listing is based on recurring cyanotoxin risks documented in multiple years rather than the presence of cyanobacteria or a single isolated bloom.

Listing ID: 104634

Main Listing Information

Listing ID: 104634
Waterbody Name: BLACK LAKE
Medium: Water
Parameter: Harmful Algae Blooms
WQI Project: None
Designated Use: Recreation - Primary Contact
Current Category: 5
View Category History

Assessment Unit

Assessment Unit ID: 17100103000937_001_001
Size: 2.322 Square kilometers
Associated Components: Reach: 17100103000937, Type: Lakes
County: Thurston
WRIA: Upper Chehalis

Basis Table

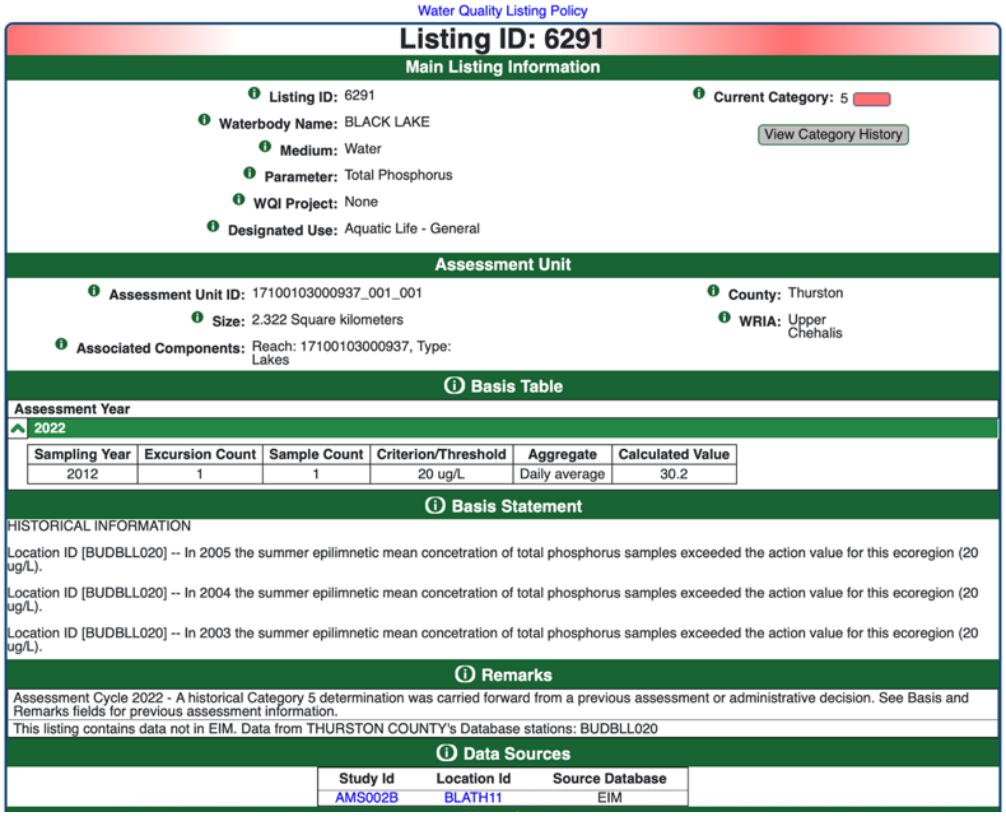
Assessment Year: 2022

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value	Anatoxin-a (ug/L)	Anatoxin-a Threshold (ug/L)	Cylindrospermopsin (ug/L)	Cylindrospermopsi Threshold (ug/L)
2021	1	3	8 (Microcystins) ug/L	Highest daily value	33.1	0.01	1		15
2020	0	6	8 (Microcystins) ug/L	Highest daily value	1.7	0.01	1	0.025	15
2019	0	5	8 (Microcystins) ug/L	Highest daily value	3.6	0.01	1	0.025	15
2018	0	8	8 (Microcystins) ug/L	Highest daily value	1.57	0.018	1	0.025	15
2017	0	4	8 (Microcystins) ug/L	Highest daily value	2.35	0.011	1	0.1	15
2016	0	5	8 (Microcystins) ug/L	Highest daily value	0.477	0.01	1		15
2015	**2**	**8**	**8 (Microcystins) ug/L**	**Highest daily value**	**87.6**	**0.01**	**1**		**15**
2014	**2**	**6**	**8 (Microcystins) ug/L**	**Highest daily value**	**162**	**0.042**	**1**		**15**
2013	0	9	8 (Microcystins) ug/L	Highest daily value	2.57	0.049	1	0.1	15
2012	2	11	8 (Microcystins) ug/L	Highest daily value	23.6	0.15	1	1.12	15

Figure 10. 303(d) listing category for Black Lake. Source: Dept of Ecology, Water Quality Assessment and 303 (d) List. 2026

C.1.1.3.2 Total Phosphorus Assessment

Black Lake is also listed in Category 5 for total phosphorus (TP), indicating impairment of its recreational and aquatic-life uses (Figure 11). Because no lake-specific phosphorus criterion has been established for Black Lake, Ecology evaluates the lake using the 20 µg/L summer TP action value applicable to lakes in the Puget Lowlands ecoregion under WAC 173-201A-230. Ecology calculates the arithmetic mean of at least four daily TP measurements collected from the lake's epilimnion during the June 1 through September 30 assessment period. A lake qualifies for Category 5 when the mean TP concentration for a single assessment season exceeds the applicable criterion or action value. Elevated phosphorus promotes excessive algal and cyanobacterial growth, reduces water clarity, and can contribute to associated changes in dissolved oxygen and aquatic habitat. Black Lake's Category 5 TP listing therefore reflects documented summer phosphorus concentrations above the applicable action value and is separate from, although ecologically related to, its Category 5 HAB listing.



Water Quality Listing Policy

Listing ID: 6291

Main Listing Information

Listing ID: 6291
Waterbody Name: BLACK LAKE
Medium: Water
Parameter: Total Phosphorus
WQI Project: None
Designated Use: Aquatic Life - General
Current Category: 5
View Category History

Assessment Unit

Assessment Unit ID: 17100103000937_001_001
Size: 2.322 Square kilometers
Associated Components: Reach: 17100103000937, Type: Lakes
County: Thurston
WRIA: Upper Chehalis

Basis Table

Assessment Year: 2022

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2012	1	1	20 ug/L	Daily average	30.2

Basis Statement

HISTORICAL INFORMATION

Location ID [BUDBLL020] -- In 2005 the summer epilimnetic mean concetration of total phosphorus samples exceeded the action value for this ecoregion (20 ug/L).

Location ID [BUDBLL020] -- In 2004 the summer epilimnetic mean concetration of total phosphorus samples exceeded the action value for this ecoregion (20 ug/L).

Location ID [BUDBLL020] -- In 2003 the summer epilimnetic mean concetration of total phosphorus samples exceeded the action value for this ecoregion (20 ug/L).

Remarks

Assessment Cycle 2022 - A historical Category 5 determination was carried forward from a previous assessment or administrative decision. See Basis and Remarks fields for previous assessment information.

This listing contains data not in EIM. Data from THURSTON COUNTY's Database stations: BUDBLL020

Data Sources

Study Id	Location Id	Source Database
AMS002B	BLATH11	EIM

Figure 11. 303(d) listing for phosphrous in Black Lake. Source: Dept of Ecology, Water Quality Assessment and 303 (d) List. 2026

C.1.2 Hydrology

Historically, Black Lake formed the headwaters of the Black River system, which drains southwest to the Chehalis River and ultimately Grays Harbor. Excavation of the Black Lake Ditch in 1922 altered this drainage pattern by creating a northern outlet from the lake to Percival Creek. Black Lake now drains north through Black Lake Ditch and Percival Creek to Capitol Lake and Budd Inlet and is therefore included in the Deschutes River Water Resource Inventory Area (WRIA 13). The lake's historic southern outlet toward the Black River remains hydrologically connected to the extensive wetland complex at the southern end of the lake but is largely obstructed by vegetation and beaver dams. Water levels typically fluctuate seasonally between approximately 127.5 feet NAVD 88 during summer and 129.0 feet during winter. Beaver activity in Black Lake Ditch can restrict discharge, raise lake levels, and contribute to flooding of shoreline properties and docks (Thurston County 2015; Herrera 2016).

Black Lake receives water from several tributaries, direct watershed runoff, shallow groundwater, and precipitation on the lake surface. Fish Pond Creek, which enters the lake near Kenneydell Park, is the largest named tributary. Other inflows include an unnamed tributary on the eastern shoreline, a western tributary entering near Guerin Park, several intermittent streams, and seasonal flow from Dempsey Creek conveyed through the southern Black River wetland complex. Groundwater movement also crosses the surface-water basin boundaries: groundwater from portions of the Salmon Creek basin contributes inflow to Black Lake, while some lake water is lost toward the McLane Creek basin. Extensive wetlands at the northern and southern ends of the lake and shallow groundwater throughout much of the basin provide water storage and influence both the timing and quality of water delivered to the lake (Thurston County 2015; NHC 2015).

A modeled water budget developed for the Black Lake Phosphorus and Algae Control Plan using conditions from 2010 through 2012 estimated that surface-water inflows supplied approximately 77 percent of annual inflow, shallow groundwater supplied approximately 14 percent, and direct precipitation supplied the remaining approximately 9 percent. The southern wetland complex was modeled as the largest individual surface-water source, contributing approximately 42 percent of total inflow. Approximately 84 percent of water leaving the lake was discharged through Black Lake Ditch, while groundwater loss toward the McLane Creek basin and evaporation accounted for approximately 12 and 4 percent, respectively. These estimates should be considered planning-level values because flow through the southern wetland complex was not continuously monitored. The model assumed that approximately 40 percent of Dempsey Creek flow was routed toward Black Lake and 60 percent toward the Black River, although the actual split likely varies seasonally with lake stage, wetland vegetation, and hydrologic conditions (NHC 2015; Herrera 2016).

C.1.3 Efforts to improve water quality

2015 Black Lake Phosphorus Control Plan (Herrera Environmental Consultants)

Herrera Environmental Consultants developed a phosphorus control plan for Black Lake based on water quality monitoring conducted between 2010 and 2012. Water and phosphorus budgets indicated that surface inflows were the primary source of water entering the lake, while shallow groundwater provided a smaller contribution. During the summer growing season (May–October), approximately 60 percent of the total phosphorus load originated from internal loading from lake sediments, with surface inflows contributing about 35 percent and shallow groundwater approximately 5 percent. Because internal

phosphorus loading was identified as the dominant source of phosphorus supporting cyanobacteria blooms, the report recommended a whole-lake alum treatment to inactivate mobile sediment phosphorus. The preferred management alternative was a full-lake alum application proposed for spring 2016, which was expected to substantially reduce internal phosphorus loading and improve water quality by limiting phosphorus availability during the summer bloom period.

2016 Black Lake Alum Treatment Report (Herrera Environmental Consultants)

Building on the recommendations of the 2015 Phosphorus Control Plan, a whole-lake alum treatment was conducted in April 2016 by Herrera Environmental Consultants, to reduce internal phosphorus loading from lake sediments. Prior to treatment, the recommended alum dose was revised based on advancements in treatment technology and experience from other Washington lakes, resulting in an application rate approximately 40 percent of what was originally proposed. Post-treatment monitoring indicated that the alum application reduced phosphorus release from bottom sediments, demonstrating a reduction in internal phosphorus loading. However, the treatment did not produce the anticipated improvements in surface water phosphorus concentrations, water clarity, or trophic status, and Black Lake remained eutrophic. Herrera concluded that the lower alum dose was insufficient to achieve the desired water quality improvements and that unusually high watershed phosphorus inputs associated with above-average rainfall may also have reduced treatment effectiveness. The report recommended a follow-up alum treatment using a higher application rate and noted that more frequent alum applications may be necessary where external phosphorus loading remains elevated.

2019 Black Lake Watershed Pollutant Monitoring – Phase 1 (Herrera Environmental Consultants)

In 2019, Herrera Environmental Consultants initiated a watershed pollutant monitoring program to identify external sources of phosphorus and bacterial contamination entering Black Lake following the 2016 alum treatment. The study evaluated stormflow and baseflow conditions to distinguish between runoff- and groundwater-related pollutant sources and to identify potential contaminant "hot spots" within the watershed. Results indicated that stormwater runoff was the primary source of phosphorus and *E. coli* entering the lake, while optical brightener analyses suggested that septic systems were not a major contributor at most sampling locations. Elevated phosphorus concentrations at several sites were attributed to runoff from phosphorus-containing fertilizers or other nonpoint sources, whereas high *E. coli* concentrations were most consistent with animal waste. The report recommended continued public education on septic system maintenance, phosphorus-free fertilizer use, animal waste management, and stormwater best management practices, while identifying areas for additional investigation to better characterize watershed pollutant sources.

2021 Black Lake Watershed Pollutant Monitoring – Phase 2 (Herrera Environmental Consultants)

Building on the Phase 1 watershed monitoring study, Herrera Environmental Consultants conducted a second phase of monitoring in 2021 to evaluate whether onsite sewage systems were contributing phosphorus and bacterial contamination to Black Lake. The investigation targeted drainage basins previously identified as potential hotspots and incorporated human-specific microbial source tracking (HF183) to distinguish septic system inputs from other contamination sources. The study identified low to moderate levels of septic system effluent in three drainage basins, with one basin showing evidence of multiple septic systems that were overdue for inspection and maintenance. The report recommended that Thurston County Environmental Health prioritize inspection and maintenance of these systems to reduce

contaminant inputs to the lake. Consistent with the Phase 1 findings, the report also emphasized continued public education on proper septic system maintenance, phosphorus-free fertilizer use, animal waste management, and stormwater best management practices to reduce external phosphorus loading and improve the long-term effectiveness of alum treatments.

2021 Black Lake Alum Treatment Report (Herrera Environmental Consultants)

Following five years of post-treatment monitoring, Herrera Environmental Consultants concluded that the 2016 alum treatment had successfully reduced toxic cyanobacteria blooms but had not achieved the desired improvement in overall trophic status or water quality. Concurrent watershed investigations also identified external phosphorus inputs from several drainage basins, including contributions from failing septic systems, highlighting the need for both in-lake and watershed management.

To further reduce phosphorus availability, the Black Lake Special District conducted a second whole-lake alum treatment between March and April 2021. The treatment applied a substantially higher aluminum dose than the 2016 application, reflecting the conclusion that the earlier treatment had been insufficient to meet long-term water quality objectives.

The second whole-lake alum treatment was conducted from March 23 through April 8, 2021, using 234,213 gallons of liquid aluminum sulfate and 117,098 gallons of sodium aluminate buffer. Treatment-area dosing complied with the approved treatment plan and permit. All measured pH values remained within the required range of 6.0–8.5 so the treatment did not have to be suspended, and no fish or wildlife impacts were observed during application. Water-quality measurements demonstrated substantial immediate reductions in phosphorus and algal biomass: mean total phosphorus declined from 33 µg/L at the surface and 19 µg/L near the bottom before treatment to approximately 10 µg/L at both depths two days and two weeks afterward. Mean chlorophyll-*a* declined from approximately 10–11 µg/L to 2–3 µg/L, while dissolved organic carbon decreased from approximately 3.3–3.4 mg/L to 1.7–2.1 mg/L. Herrera attributed these reductions to adsorption and settling with the alum floc and noted that the response was more pronounced than after the substantially smaller 2016 treatment. However, total aluminum concentrations exceeded applicable acute and/or chronic aquatic-life criteria in samples collected two days and two weeks after treatment, indicating that sensitive aquatic organisms may have been affected even though no visible impacts were observed. Herrera anticipated that aluminum concentrations would subsequently return to pretreatment levels but did not present monitoring data confirming that assumption. The report recommended evaluating Thurston County's May–October 2021 monitoring results to determine treatment effectiveness and continuing efforts to reduce external phosphorus loading identified through the watershed pollutant investigation.

C.2 Black Lake Watershed

C.2.1 Land Use

The Black Lake drainage basin encompasses just under 5,000 acres (7.8 square miles) in southwestern Thurston County. The watershed is characterized by a mixture of forested uplands, wetlands, rural residential development, agricultural lands, and more intensively developed urban areas. Historical watershed assessments identified approximately 53% of the basin within the urban growth area and 47% within rural areas, with forest cover accounting for approximately 44% of the basin and unmodified wetlands occupying approximately 21%. Extensive wetlands occur near the northern and southern ends of the lake. The watershed contains approximately 9.2 miles of streams and drainage channels that contribute surface water to the lake. Historically, Black Lake drained southward into the Black River;

however, construction of Black Lake Ditch in 1922 redirected its primary outflow northward through Percival Creek toward Budd Inlet.

Land-use mapping indicates that rural character residential development occupies much of the central and eastern portions of the mapped watershed, while relatively contiguous forest lands dominate the western portion. Urban character residential, industrial, and intensive urban land uses are concentrated primarily near the northern end of Black Lake and along major transportation corridors. Agricultural lands, recreational open space, and conservation areas are distributed throughout the watershed. Historical estimates indicate that impervious surfaces increased from approximately 5.1% in 1991 to 8.0% in 2006, reflecting increasing development within the basin. Residential development, agricultural activities, and urban stormwater runoff represent potential sources of nutrients, sediment, and other pollutants, while forested lands and wetlands provide important functions associated with runoff attenuation, sediment retention, and nutrient cycling.

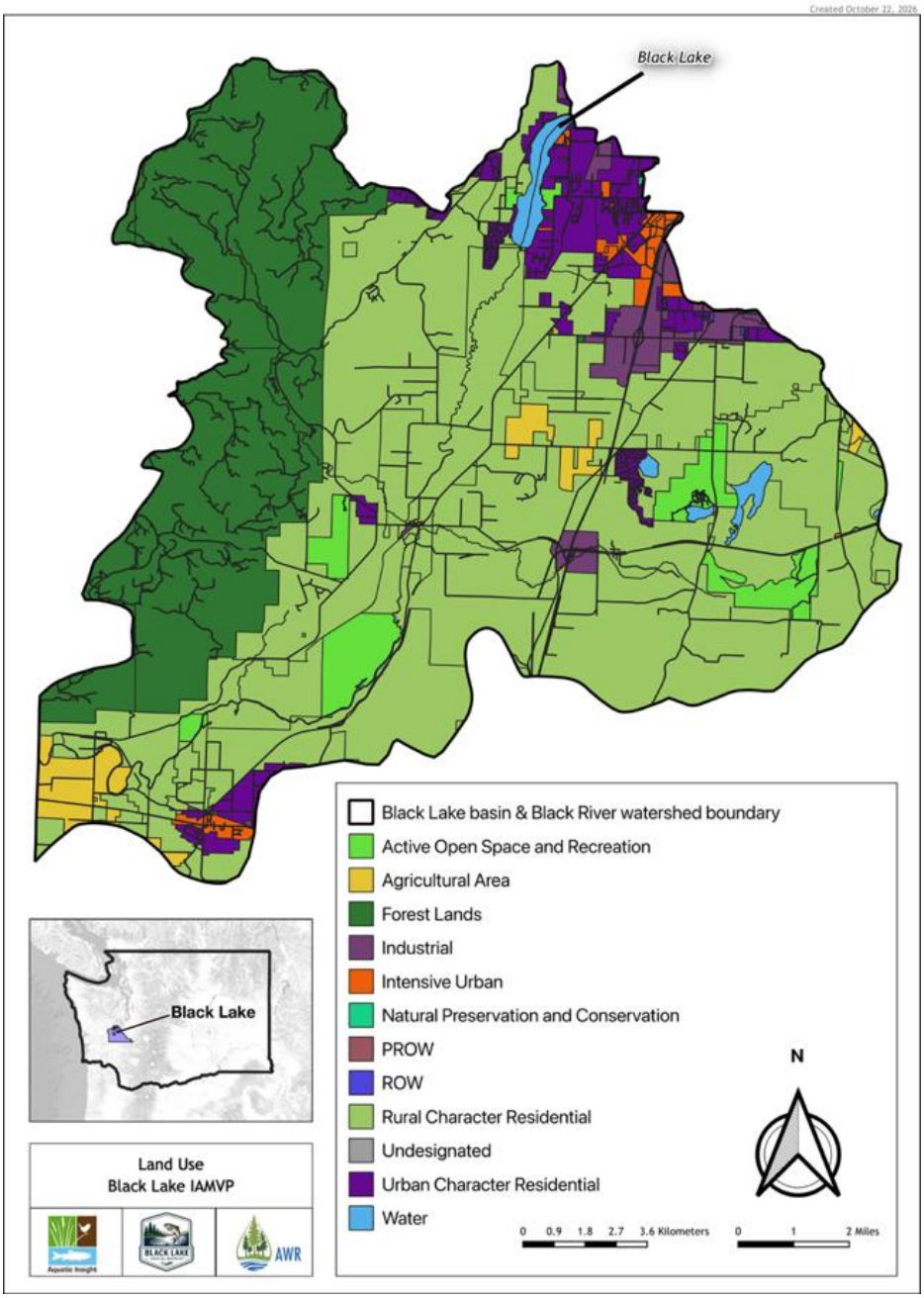


Figure 12. Black River Watershed Land Use from WA state

C.2.2 Streams and Wetlands

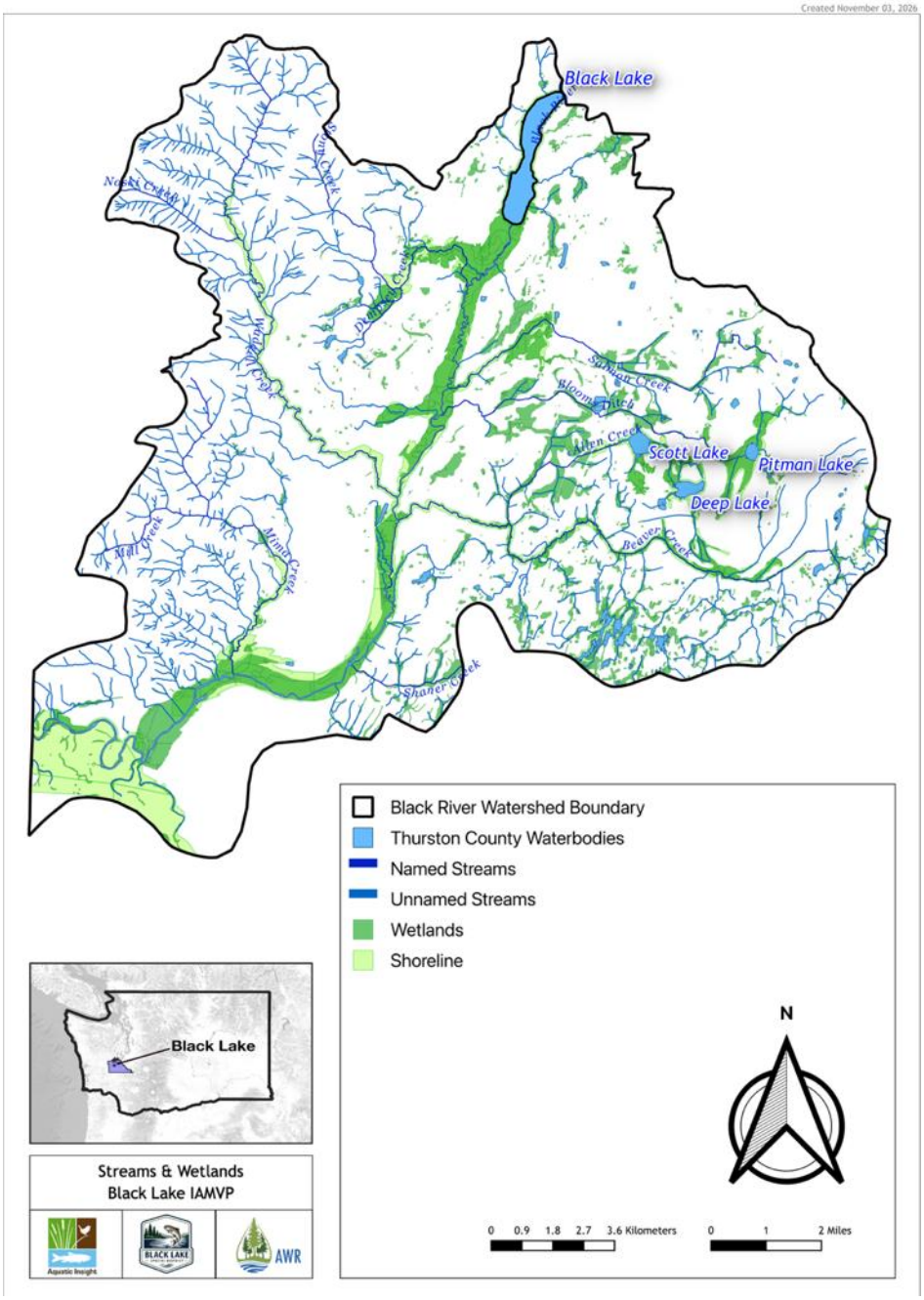


Figure 13. BLSD district and Black River Watershed streams and wetlands

C.2.3 Sediment Characteristics

This basin has highly impermeable rock and glacial till underlying the surface layers. In addition, the topography is steep, and this basin receives approximately 25 percent higher precipitation than the Olympia airport only five miles to the east. Finally, beavers regularly block the outlet of the lake, and those dams are regularly removed, resulting in sudden jumps and falls in water levels. As a result of this

combination of factors – geology, topography, intensified precipitation, and beaver activity - the lake rises and falls more like a river than a lake. (Summary Report and Analysi for Water Year 2019, 2020)

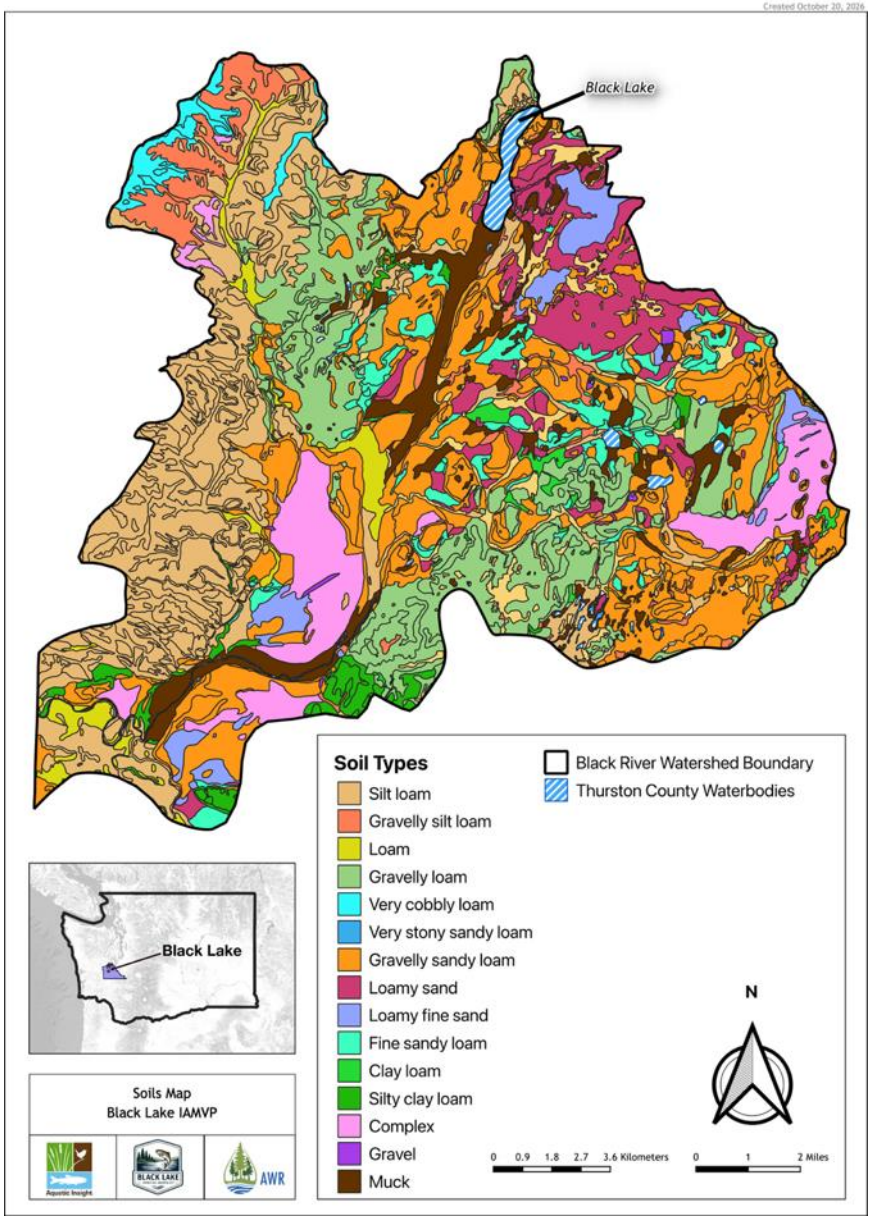


Figure 14. Soil Types in the Black River Watershed and BLSD District

C.2.4 Non-point source inputs of concern

C.2.4.1 Stormwater contaminants

The available Herrera and Thurston County drainage studies did not analyze metals, PAHs, petroleum hydrocarbons, pesticides, PFAS, 6PPD-quinone, or other emerging contaminants. Their absence from

these reports therefore reflects a lack of testing rather than evidence that these contaminants are absent from the lake or watershed.

Tributary and shoreline drainage studies document nutrient and fecal contamination, including septic-system influence, but they did not analyze the broader stormwater contaminant suite.

Therefore, there is a significant data gap regarding metals, petroleum compounds, PAHs, pesticides, PFAS, 6PPD-Q, and other emerging contaminants in Black Lake surface water, tributaries, stormwater discharges, shallow groundwater, and sediments.

C.2.4.2 Groundwater Contaminants

There is a documented contaminant issue near Black Lake. Petroleum contaminated groundwater was detected within the Black Lake Grocery property on the northwest shore. Petroleum contamination from leaking underground storage tanks was discovered there in 1989. The tanks and accessible contaminated soil were removed in 1995, and a permeable treatment wall filled with sphagnum peat was installed near the shoreline in 2004 to treat groundwater flowing toward Black Lake.

Ecology monitors site wells for:

- Total petroleum hydrocarbons as gasoline (TPH-G)
- Benzene
- Toluene
- Ethylbenzene
- Total xylenes, collectively reported with the other compounds as BTEX

Ecology's newest report, published in June 2026 using samples collected in April 2023, found that the shallow aquifer remained contaminated and that concentrations exceeded established cleanup levels in four monitoring wells. Concentrations were lower downgradient of the treatment wall, indicating that it successfully reduces contamination. Importantly, Ecology concluded that the downgradient results also suggest **petroleum contamination is migrating from the site into Black Lake**. It does not establish concentrations within lake water because the study sampled groundwater monitoring wells, not Black Lake itself (Mohr, 2026).

In contrast, the nearby Black Lake Estates public water system's 130-foot-deep well met applicable drinking water standards and had no reported PFAS or regulated organic-contaminant detections, although these results do not characterize shallow groundwater or private shoreline wells.

C.2.4.3 Bacteria and Nutrient Contaminants

From July 2022 through June 2026, the Thurston County Environmental Health Pollution Identification and Correction (PIC) Program conducted routine monitoring and follow-up source investigations in tributaries to Black Lake. Routine monitoring included 303 *E. coli* samples and 164 total phosphorus (TP) samples collected at nine designated stations. An additional 438 *E. coli* and 228 TP samples were collected during investigative sampling to identify potential pollution sources. Based on the component totals reported, the project analyzed 1,133 water-quality samples and conducted 953 site visits. The monitoring and associated investigations identified 76 failing septic systems within the watershed, demonstrating that malfunctioning onsite sewage systems represent an important source of contamination to tributaries entering Black Lake (Thurston County 2026) (Figure 15).

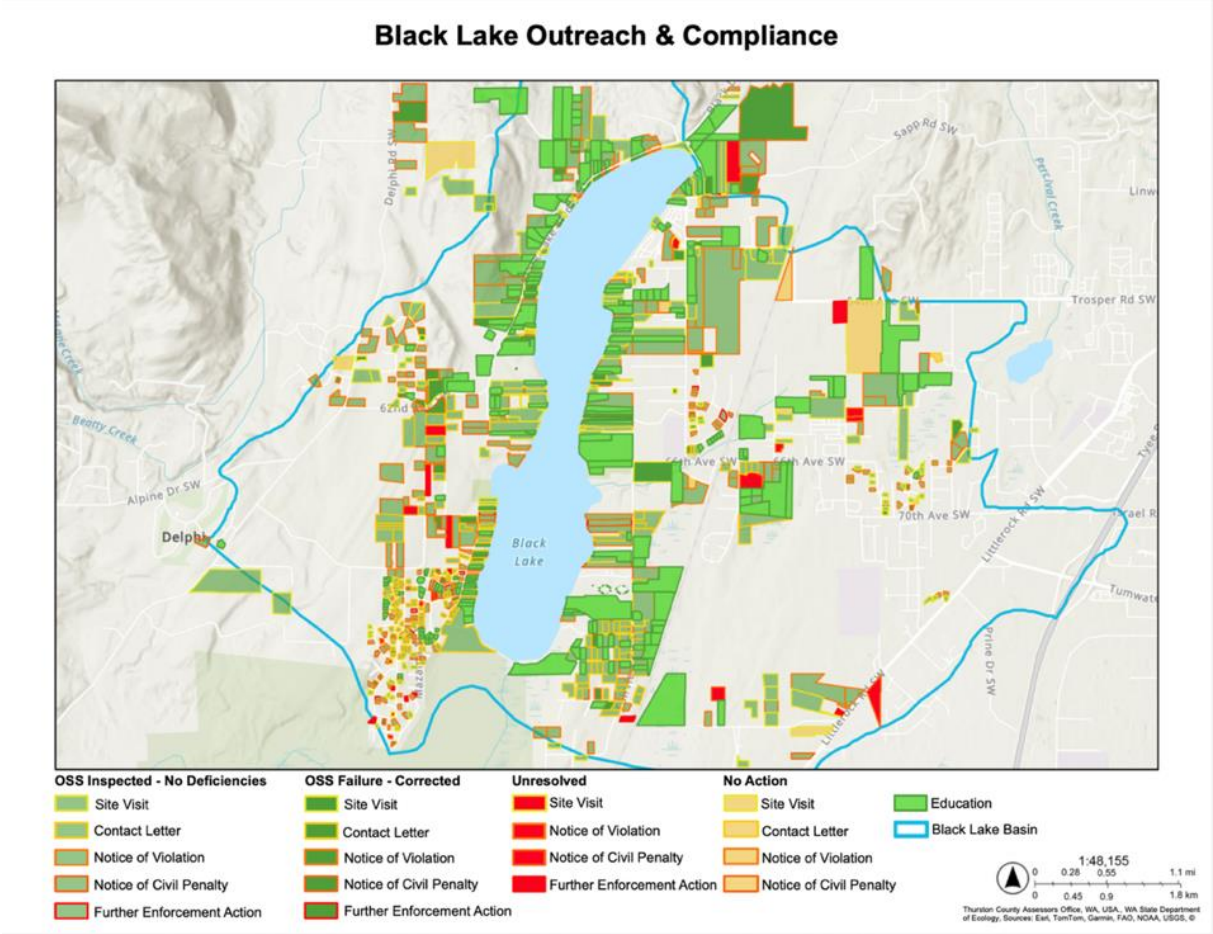


Figure 15. *Black Lake Onsite Septic Outreach & Compliance. Source: Thurston County Public Health & Social Services Department | Environmental Health*

Routine monitoring found elevated *E. coli* concentrations in every monitored tributary during at least part of the study. During the dry season, applicable bacteria criteria were exceeded at stations BLA001, BLA002, BLA003, BLA004, BLA006, and BLA007 (Figure 16); stations BLA003, BLA006, and BLA007 also exceeded the criteria during the wet season (Figure 17**Error! Reference source not found.**). Average and geometric-mean *E. coli* concentrations were generally lower during the wet season. This seasonal pattern is consistent with dilution during periods of greater flow and indicates that dry-weather or continuously present sources—including failing or inadequately functioning septic systems—are important contributors. Animal waste and runoff may provide additional bacterial inputs, although *E. coli* measurements alone cannot distinguish human from animal sources.

TP concentrations were also elevated throughout the watershed. All routine stations except BLA008 exceeded the Puget Lowlands ecoregion action level of 20 µg/L during at least part of the study, and five tributaries exceeded the action level during all seasons. Only stations BLA004, BLA005, and BLA009 remained below 20 µg/L during the wet seasons. Unlike *E. coli*, TP showed a less pronounced seasonal decrease, indicating that phosphorus is supplied by multiple persistent sources and transport pathways. Potential contributors include septic effluent, human and animal waste, fertilizer use, erosion and runoff

from developed or disturbed land, loss of riparian vegetation, and phosphorus accumulated in watershed soils.

Collectively, the results indicate that human activity and development contribute bacteria and nutrients to Black Lake through tributary inflow, surface runoff, and shallow subsurface flow. The study supports continued septic-system inspection and correction, source tracing, riparian protection and restoration, erosion control, and long-term tributary monitoring.

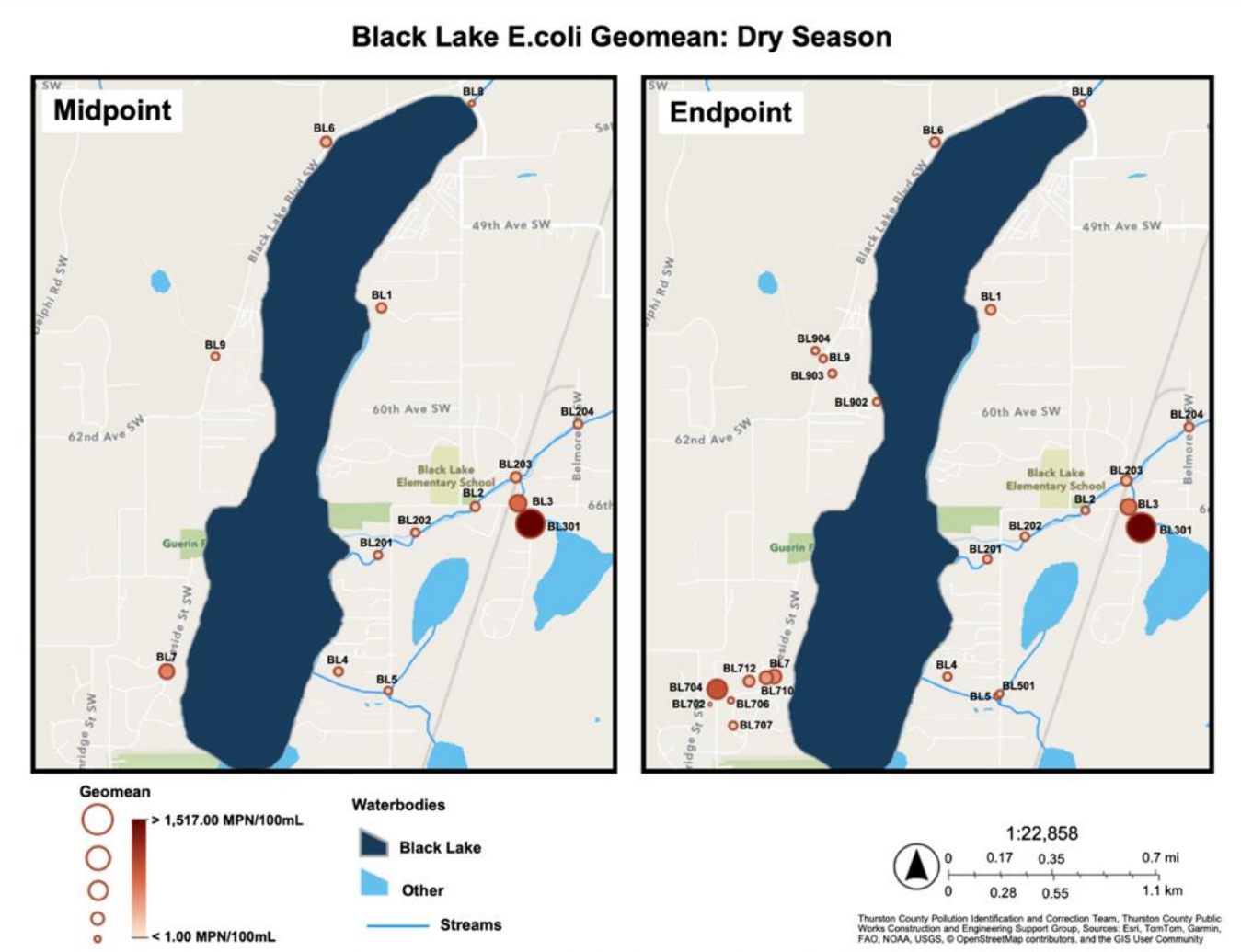


Figure 16. Geometric-mean E. coli *concentrations at routine and investigative monitoring stations during the dry season at the midpoint and endpoint of the Black Lake PIC project. Increasing symbol size represents increasing concentration. Source: Thurston County Environmental Health, supplemental project figures.*

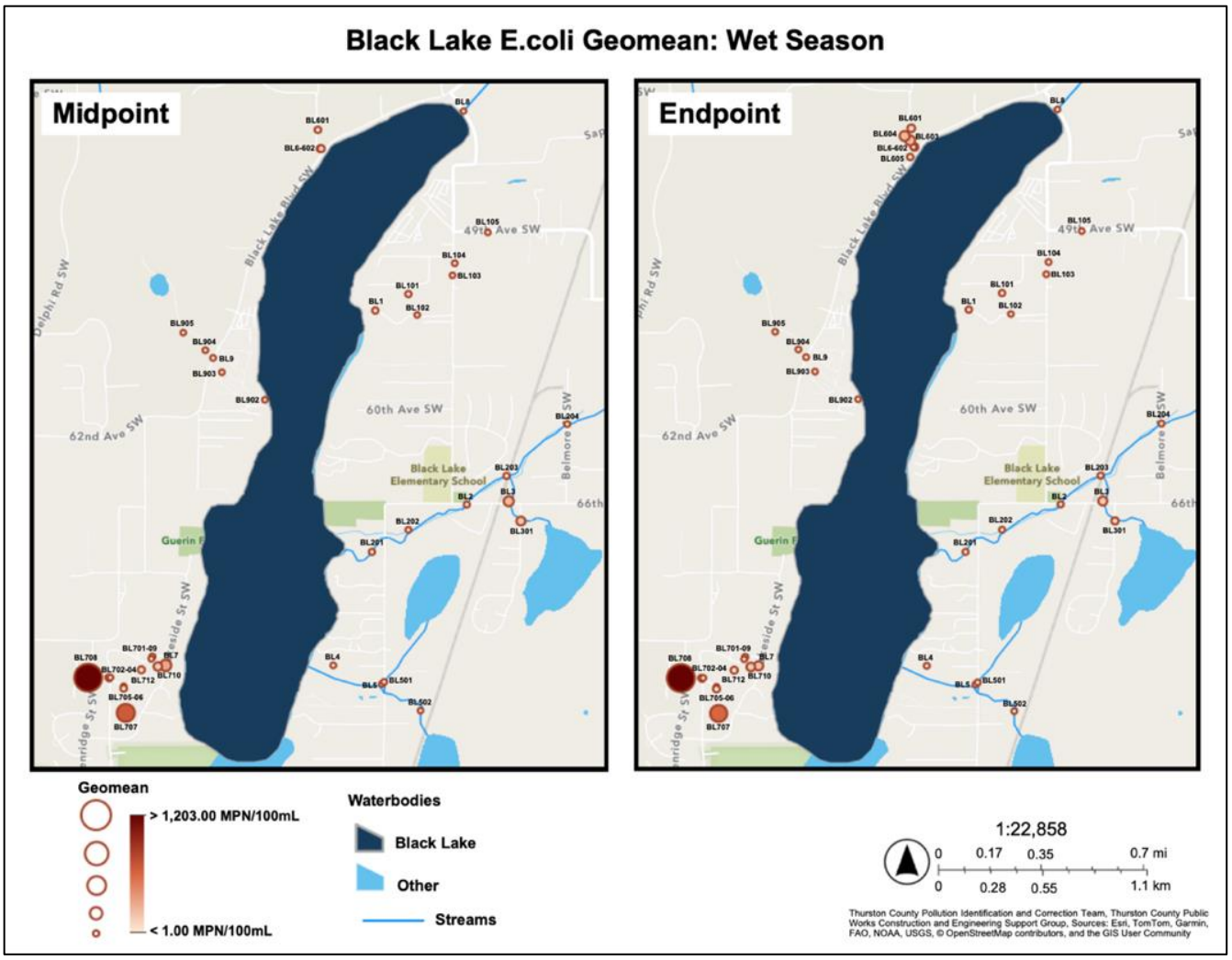


Figure 17. Geometric-mean E. coli *concentrations at routine and investigative monitoring stations during the wet season at the midpoint and endpoint of the Black Lake PIC project. Increasing symbol size represents increasing concentration. Source: Thurston County Environmental Health, supplemental project figures.*

Spatial patterns in the PIC monitoring data show that elevated *E. coli* was not confined to a single tributary or portion of the watershed. During the dry season, the most prominent hotspot occurred in the drainage entering the southeastern side of Black Lake near stations BL3 and BL301. Additional elevated concentrations occurred in tributaries along the western shoreline and at several northern and southern locations. By the project endpoint, investigative sampling had expanded upstream from the routine stations into multiple branches of the contributing drainage networks, allowing the County to more closely isolate potential contaminant sources.

During the wet season, the largest mapped geometric-mean *E. coli* concentrations occurred in the tributary network southwest of the lake near BL7, with elevated results extending into several upstream investigative stations. The southeastern BL3/BL301 drainage remained a concern but was less dominant than during the dry season. Together, the maps demonstrate that bacterial contamination varied spatially and seasonally and that different tributaries represented the principal hotspots under different hydrologic

conditions. This pattern supports the presence of multiple localized pollution sources rather than a single watershed-wide source.

The persistence of localized hotspots during both seasons is consistent with inputs from septic systems or other continuously present waste sources, while the changing magnitude and distribution of concentrations likely reflect seasonal differences in dilution, groundwater and surface-water contributions, and contaminant transport.

D. Beneficial Uses

D.1.1 Recreational

Black Lake supports a variety of recreational uses that are recognized as protected beneficial uses, including swimming, boating, fishing, and wildlife viewing. The lake is widely used for waterskiing, wakeboarding, jet skiing, paddling, and other water-based recreation throughout the year.

Fishing is a popular recreational activity, supported by both stocked and naturally reproducing fish populations. The lake is stocked with rainbow trout during the spring and fall and supports naturally reproducing coastal cutthroat trout. Additional sport fish species include largemouth bass, smallmouth bass, yellow perch, black crappie, and brown bullhead.

Public access is available through the Washington Department of Fish and Wildlife (WDFW) boat launch and Kenneydell County Park (Figure 18). The WDFW access site includes a boat launch, shoreline fishing opportunities, and restroom facilities. Additional lake access is provided by two private resorts offering boat launches, fishing docks, and shoreline access, as well as a church camp and several private community access points. Together, these facilities support the wide range of recreational uses that contribute to Black Lake's social, economic, and ecological value.

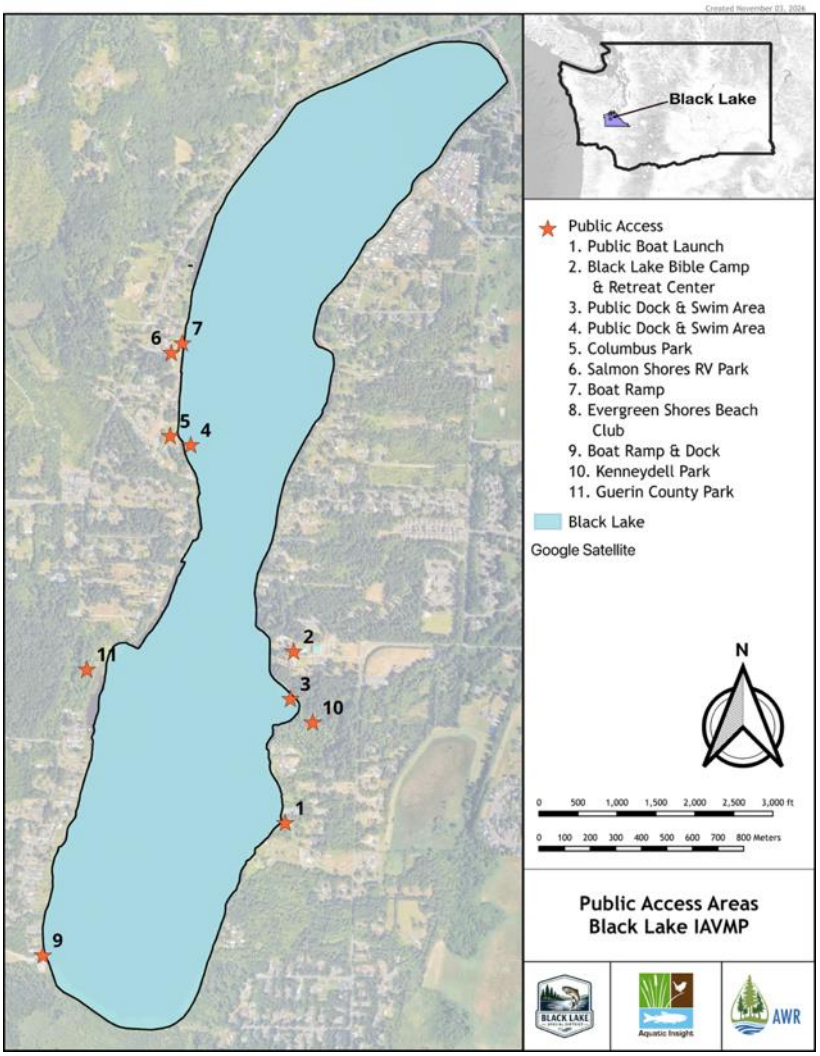


Figure 18. Black Lake public access areas



Figure 19. Black Lake East Public Boat Launch Information Sign

D.1.1.1 Stocked Fish

Black Lake supports an active recreational fishery that is supplemented through regular stocking by the Washington Department of Fish and Wildlife (WDFW). Between 2021 and 2025, WDFW stocked approximately 178,000 fish into the lake, averaging more than 35,000 fish annually. Annual stocking levels ranged from approximately 30,000 to 42,000 fish per year, demonstrating the lake's importance as a regional recreational fishing destination and supporting continued angling opportunities for residents and visitors.

Table 4.WDFW Fish Stocking Reports for Black Lake 2025-2026

Date	Species	Number released	Number per pound
April 15, 2026	Rainbow trout	100	1.25
March 23, 2026	Rainbow trout	14,635	2.37
March 17, 2026	Rainbow trout	7,015	2.5
Nov 24, 2025	Rainbow trout	3,000	1.37
April 15, 2025	Rainbow trout	145	1.0
March 26, 2025	Rainbow trout	9,460	2.2
March 25, 2025	Rainbow trout	12,363	2.28
March 24, 2025	Rainbow trout	5,192	2.41

D.1.1.2 Known Fish Species

Species present in Black Lake were documented through WDFW surveys, stocking records, and current WDFW fishery information. Absence of a species from an individual fish survey does not necessarily indicate absence from the lake because detection varies with sampling method, season, habitat use, and species abundance. The lake is dominated by non-native warm water species, with native species limited to rainbow trout, coastal cutthroat trout, and Chinook salmon (Table 5).

Table 5. WDFW 2025 survey & supplemented by WDFW 1999 survey (historical records) and Herrera 2021

Scientific Name	Common Name	Origin	Population/Stocking Status
Pomoxis nigromaculatus	Black crappie	Non-native	Naturally reproducing
Ameiurus nebulosus	Brown bullhead catfish	Non-native	Naturally reproducing
Cyprinus carpio	Common carp	Non-native	Naturally reproducing/documented
Micropterus salmoides	Largemouth bass	Non-native	Naturally reproducing
Micropterus dolomieu	Smallmouth bass	Non-natie	Naturally reproducing
Oncorhynchus mykiss	Rainbow trout	**Native**	**Stocked**
Ambloplites rupestris	Rock bass	Non-native	Naturally reproducing
Perca flavescens	Yellow perch	Non-native	Naturally reproducing
Lepomis gibbosus	Pumpkinseed	Non-native	Naturally reproducing
Lepomis macrochirus	Bluegill	Non-native	Naturally reproducing
Oncorhynchus clarkii clarkii	Coastal cutthroat trout	**Native**	**Naturally reproducing**
Oncorhynchus tshawytscha	Chinook salmon	**Native**	Historical documented occurence

D.1.2 Wildlife

THREATENED, ENDANGERED AND RARE WILDLIFE SPECIES WITHIN THE WATERSHED

Table 6.Threatened, endangered, and rare wildlife species

Scientific Name	Common Name	Status	Listing Status
Thomomys mazama	Western pocket gopher	Threatened	Occurence
Aix sponsa	Wood duck	N/A	Occurrence
Phanogomphus kurilis	Pacific clubtail	Candidate	Occurrence
Eptesicus fuscus	Big brown bat	Sensitive	Occurrence - basin
Myotis lucifugus	Little brown bat	Sensitive	Occurrence
Myotis yumanensis	Yuma myotis	Sensitive	Occurrence
Corynorhinus townsendii	Townsend big-eared bat	Sensitive	Occurrence
Rana pretiosa	Oregon spotted frog	Sensitive	Occurrence
Haliaeetus leucocephalus	Bald eagle	N/A	Occurrence
Novumbra hubbsi	Olympic mudminnow	Sensitive /endemic	Occurrence - Black River
Chrysemys picta	Painted turtle	Sensitive	Occurrence

D.1.3 Resources

Black Lake and its surrounding basin are associated with several water-resource uses, primarily groundwater withdrawals for domestic and public water supply (Figure 20). Ecology's Thurston County future public water supply reservation identifies a Black Lake source area with reserved groundwater quantities of 2,000 gpm and 1,888 acre-feet per year. Several community water systems and wellhead protection areas occur within or overlap the Black Lake basin, including Black Lake Estates, Lakeland Manor, Black Lake Bible Camp and Conference Center, Evergreen Shores, and other residential systems. These systems indicate that groundwater in the Black Lake basin is an important drinking water resource. The 2015 Black Lake Basin Water Resource Protection Study also describes shallow groundwater, extensive wetlands, tributary inflows, and likely groundwater inputs to Black Lake.

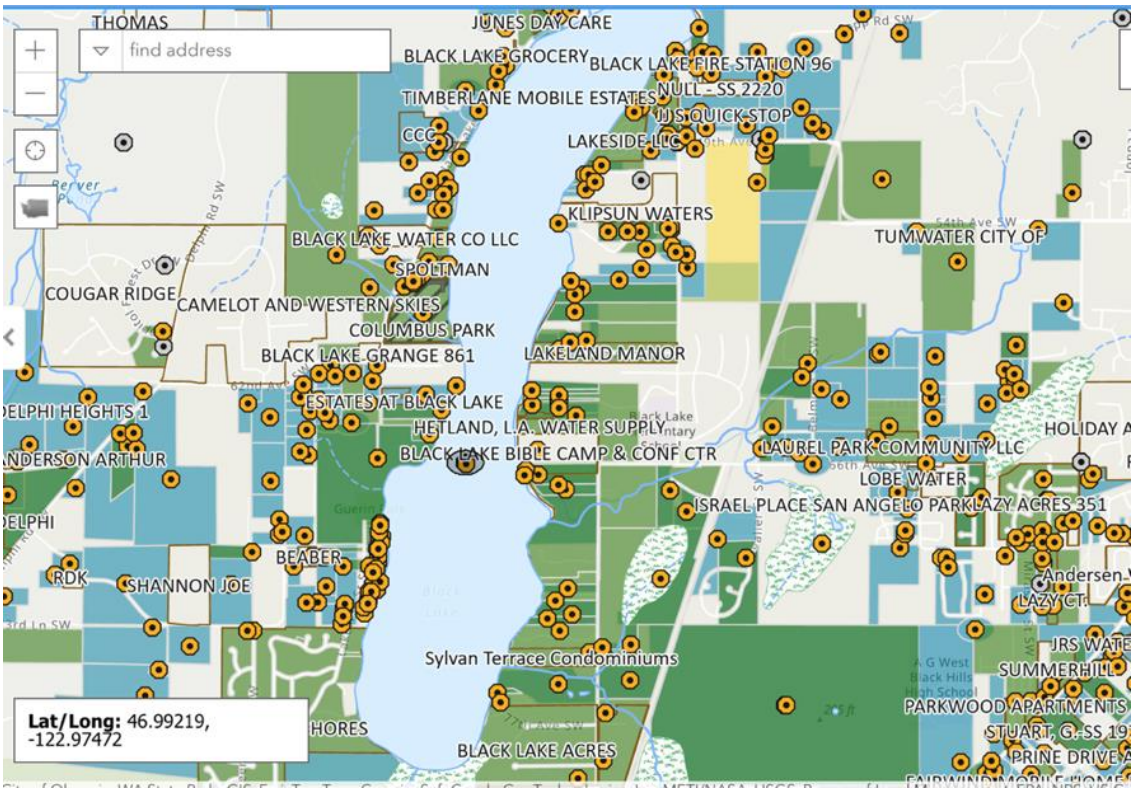


Figure 20. Ground water wells within the Black Lake basin. Source: Dept of Ecology Water Resources

D.1.3.1 HISTORICAL DOMESTIC-WATER AUTHORIZATIONS

Ecology's Water Right Tracking System identifies 44 active surface-water records associated with Black Lake, including 39 certificates and five water right claims (Figure 21). Most authorize irrigation, while 13 authorize a domestic purpose: ten for Domestic Single use and three for Domestic General use. The dated certificate records extend from 1939 through 1981, indicating that the listed rights largely originated several decades ago. Domestic Single use authorizes water for one dwelling and may include potable and other household uses. Thus, Black Lake historically served, or was authorized to serve, as a domestic water source for certain shoreline properties. However, the database does not establish whether these rights are currently exercised or whether lake water is presently used for drinking. Current use would require confirmation through individual water right documents, property records, or contact with the water right holders.

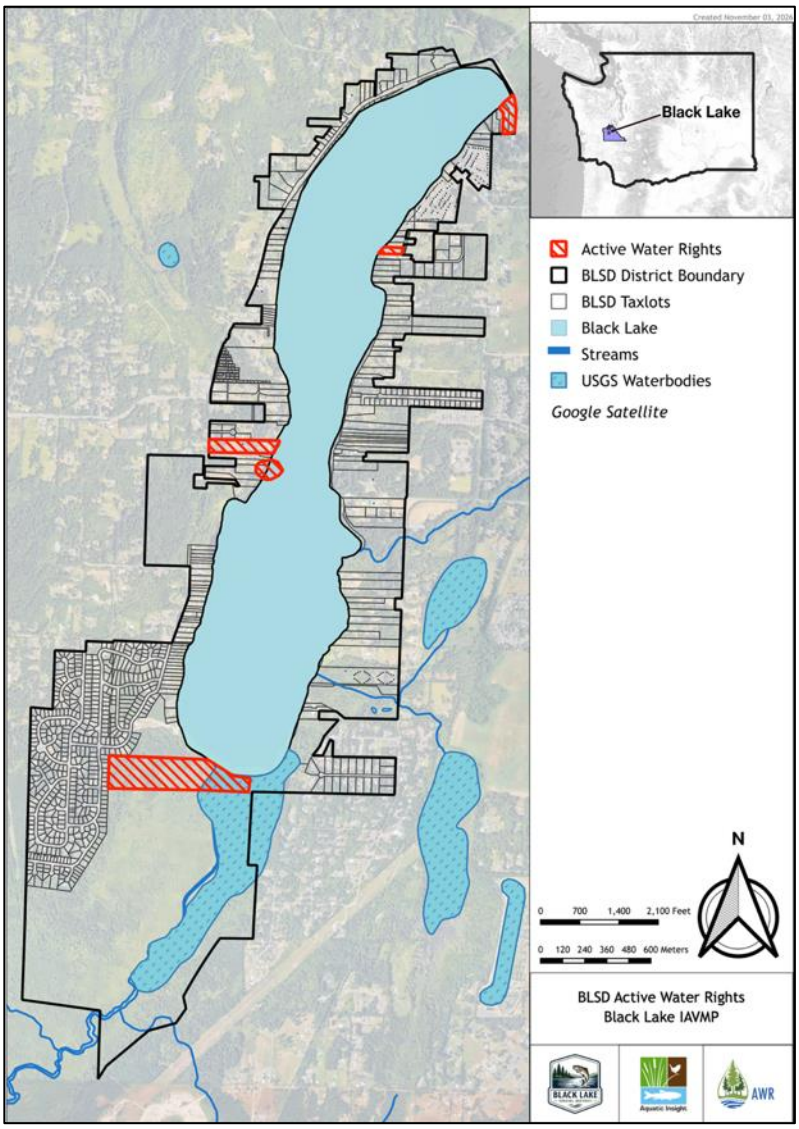


Figure 21. Surface Water Rights, 2026. Source: Dept. of Ecology - Water Resources

E. Aquatic Plant Survey and Description

E.1 Monitoring Methods

E.1.1 Equipment List

Hydroacoustic Survey

- BioSonics DTX Scientific Echosounder
- Single-beam 430 kHz transducer
- EOS Arrow 100 GPS receiver
- BioSonics Visual Aquatic Post-Processing and Data Visualization Software

Grab Sample Survey

- Double-sided thatch rake attached to a graduated pole
- ArcGIS Field Maps

E.1.2 Hydroacoustic Survey – Bathymetry

Hydroacoustic data were collected from June 16–19, 2026 using a BioSonics DTX Scientific Echosounder equipped with a single-beam 430 kHz transducer with a 6.7° beamwidth. Data were collected at a rate of 7 pings per second, with a -80 dB detection threshold and a transmit pulse duration of 0.1 milliseconds. These settings resulted in approximately 4.2 samples per pulse and a vertical sample spacing of approximately 1.8 centimeters. Surveys were conducted at vessel speeds below 5 miles per hour.

Position data were collected using an EOS Arrow 100 GPS receiver with sub-meter accuracy. Survey tracks followed the shoreline as closely as feasible and included parallel transects across the interior of the lake. Transect spacing was approximately 125 feet in nearshore areas, where bottom slopes were steeper and aquatic vegetation was present, and approximately 250 feet in the central portion of the lake, where bottom slopes were gentler and sediments were generally unvegetated.

The transducer was mounted with the acoustic face positioned 0.25 meters below the water surface. Acoustic data collection began 0.10 meters below the transducer face, resulting in an effective measurement range beginning approximately 0.35 meters below the water surface and extending to a maximum depth of 10 meters.

Hydroacoustic data were supplemented with shoreline elevation data derived from LiDAR, including LiDAR points located within one vertical foot above the shoreline. The LiDAR data were collected between June 4 and July 2, 2011, and were assumed to represent typical summer water-level conditions. These supplemental elevation data were incorporated to improve modeling of nearshore bathymetry and the shoreline transition zone.

For additional information on methodology specifics, data processing and analysis, bathycetric surface development, please refer to Appendix B.

E.1.3 Hydroacoustic Survey – Vegetation Analysis

Hydroacoustic survey data were processed to characterize the distribution, height, and canopy structure of submerged aquatic vegetation throughout Black Lake. For each sonar observation, acoustic returns were used to estimate vegetation presence or absence, plant height, and depth to the top of the vegetation canopy.

The maximum colonization depth (MCD), which represents the approximate outer boundary of the littoral zone where submerged aquatic plants are capable of growth, was calculated from the hydroacoustic vegetation data. MCD was defined as the 95th percentile of water depths where vegetation exceeded 0.1 meters, or 0.33 feet, in height. This depth was then used to define the littoral zone for vegetation mapping and analysis.

Plant height within the littoral zone was modeled using the same Integrated Nested Laplace Approximation with Stochastic Partial Differential Equations (INLA-SPDE) framework used for bathymetric modeling. The model incorporated observed plant heights, broad-scale spatial trends, and spatial autocorrelation to predict vegetation height continuously across the lake. Predicted plant heights were then combined with the bathymetric surface to estimate canopy top depth, defined as the vertical distance from the water surface to the top of the aquatic plant canopy.

Model performance was evaluated using 10-fold spatial block cross-validation. This approach accounts for spatial dependence among neighboring sonar observations and provides a more realistic assessment of predictive accuracy than conventional random cross-validation.

Canopy top depths were classified according to their potential effect on recreational use of the lake. Areas where the canopy occurred less than 1 foot below the water surface were classified as high impact; 1 to 3 feet below the surface as moderate impact; 3 to 6 feet as low impact; and greater than 6 feet as minimal impact. These classifications provide a practical framework for identifying areas where submerged aquatic vegetation may interfere with boating, swimming, fishing, and other recreational activities.

Floating-leaf aquatic plant beds were mapped separately from the hydroacoustic analysis because dense surface vegetation can limit boat access and hydroacoustic coverage. These beds were delineated in ArcGIS Pro using 1-foot resolution Nearmap aerial imagery acquired on August 22, 2025.

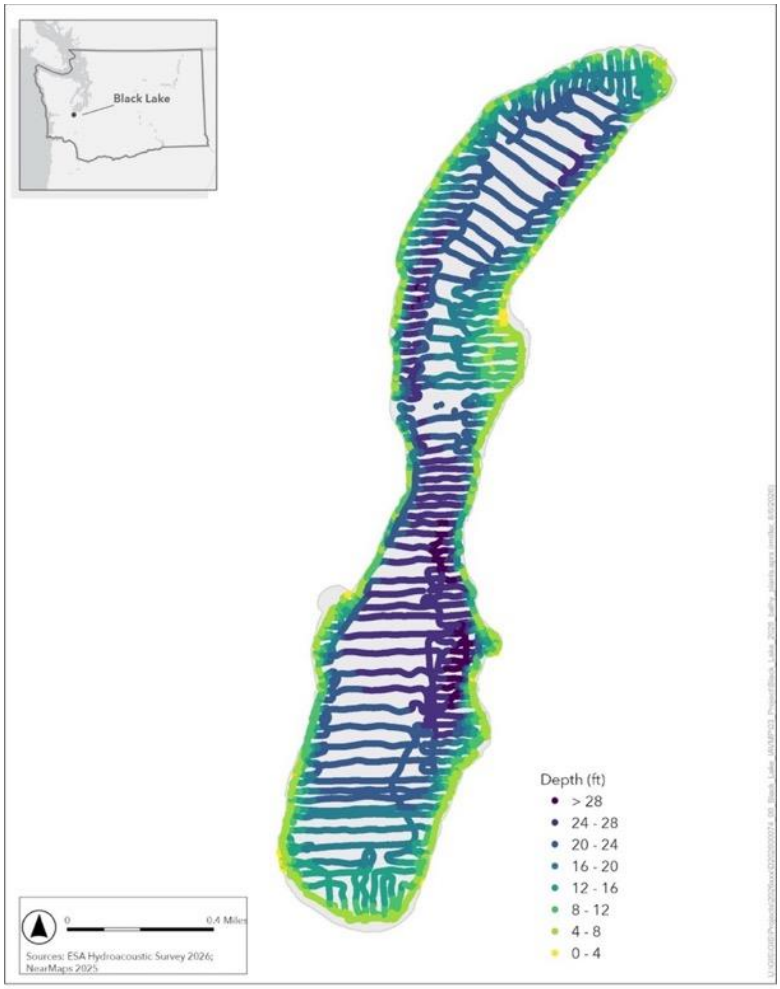


Figure 22.Hydroacoustic survey tracks and measured water depths. Black Lake 2026

E.1.4 Surface Vegetation Inventory

An aquatic plant survey was conducted in June 2026 using a systematic grid-based sampling design. A total of 200 survey points were established at approximately 150-foot intervals throughout the littoral zone.

Aquatic vegetation was sampled at each point using a double-sided thatch rake attached to a graduated pole. At each sampling location, the rake was lowered to the lake bottom, twisted 360 degrees, and retrieved through the water column. All plant material collected on the rake was identified to the lowest practical taxonomic level.

For each species collected, abundance was recorded using a semi-quantitative rake-rating system based on the volume of plant material present on the rake. Ratings were recorded as sparse (1), moderate (2), or dense (3), with dense representing near-complete coverage of the rake tines. Water depth was recorded at each sampling location using the graduated pole.

Sampling locations, species identifications, abundance ratings, and depth measurements were recorded electronically using ArcGIS Field Maps.

Frequency of occurrence (FOO) was calculated for each species as the percentage of survey points where the species was detected. Exact binomial 95% confidence intervals were calculated for each frequency estimate. Site-level plant diversity metrics, including species richness, Shannon diversity, Simpson diversity, and evenness, were also calculated to describe aquatic plant community composition across the littoral zone.

E.2 Monitoring Results

E.2.1 Hydroacoustic Survey – Bathymetry

Bathymetric summary metrics (Table X), area-depth relationships (Table X, Figure X), and storage-depth relationships (Table X, Figure X) were calculated from the final bathymetric surface.

Table 7. Black Lake Morphometric Statistics Derived From Hydroacoustic Survey Data. June 16-19, 2026

Metric	Value at 128.7 ft WSEL
Surface area	572 ac (232 ha)
Volume	10,500 ac-ft (12.95 MCM)
Mean depth	18.4 ft (5.61 m)
Maximum depth	30.1 ft (9.17 m)
WSEL = Water surface elevation	

Area-depth relationships and storage-depth relationships were calculated from the final bathymetric surface. These data can be found in **Appendix B** within Table 2, Figure 3 and Table 2, Figure 4 respectively.

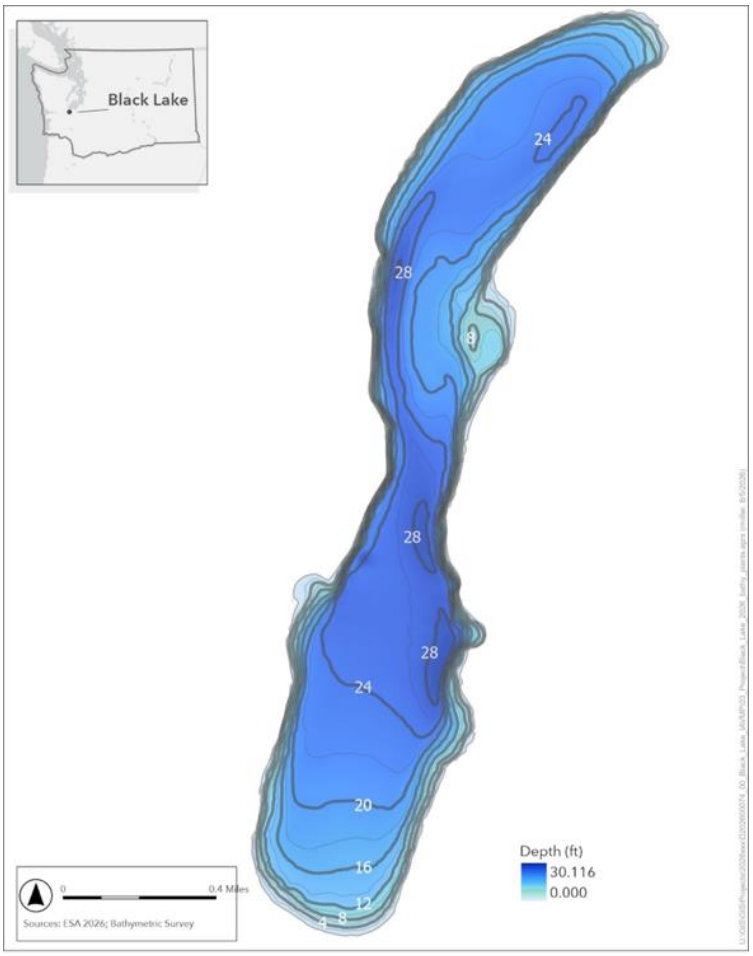


Figure 23. Blake Lake two-foot bathymetric contours and bathymetric raster surface.

E.2.2 Hydroacoustic Survey - Vegetation Analysis

The maximum colonization depth was estimated at 13.7 feet. Based on this depth, the littoral zone was estimated to cover 130.5 acres, representing approximately 22.5% of the total lake area.

The plant-height model had a root mean square error (RMSE) of 0.73 feet, a mean absolute error (MAE) of 0.56 feet, and negligible bias (-0.02 feet), indicating that model predictions were generally accurate and unbiased. The cross-validated coefficient of determination ($R^2 = 0.22$) indicates that the model captured broad lake-wide patterns in vegetation height, although substantial fine-scale variability remained unexplained. Therefore, the model is appropriate for mapping general vegetation patterns and identifying areas of dense growth, while predictions at specific locations should be interpreted with moderate uncertainty.

Predicted plant heights were mapped throughout the littoral zone. These results were combined with the bathymetric model to estimate the proximity of submerged aquatic vegetation to the water surface. The resulting canopy top depth map identifies areas where submerged vegetation is most likely to affect recreational use.

Floating-leaf aquatic plant beds consisted primarily of fragrant water lily (*Nymphaea odorata*), with smaller areas of yellow pond lily (*Nuphar polysepala*). A total of 17.4 acres of floating-leaf vegetation

were delineated, representing approximately 13.3% of the littoral zone and 3% of the total lake area. These delineations also identified areas where hydroacoustic coverage was limited because dense surface vegetation restricted boat navigation.

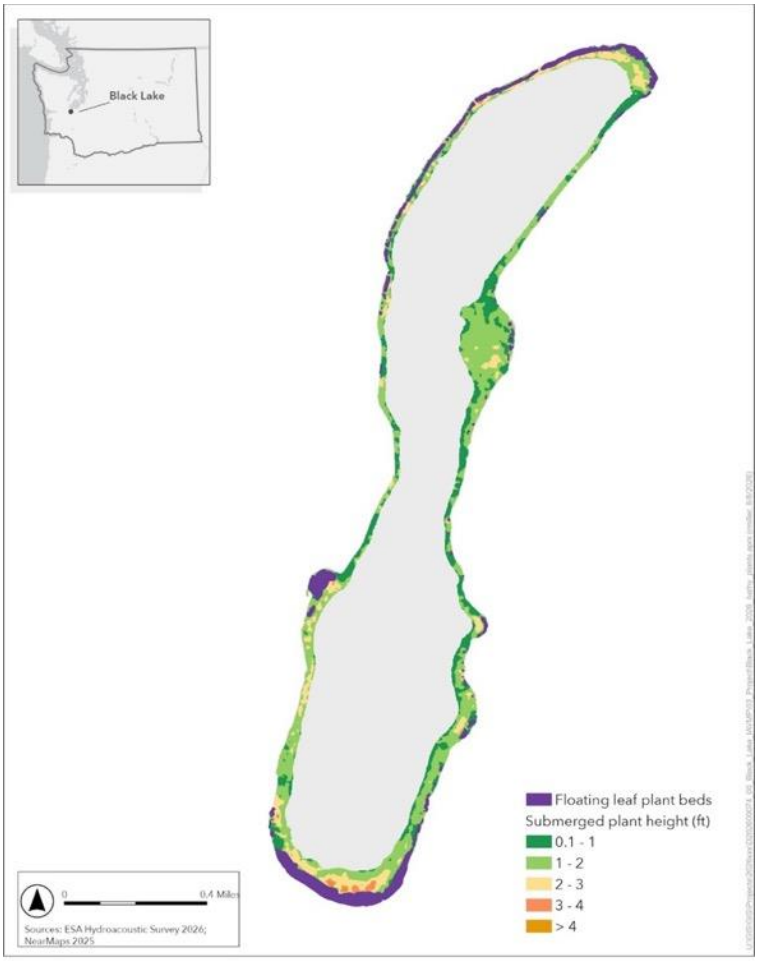


Figure 24. Black Lake aquatic plant canopy height above the sediment (ft) and floating leaf aquatic plant beds. From 2026 hydroacoustic survey and August 22, 2025, NearMaps aerial imagery.

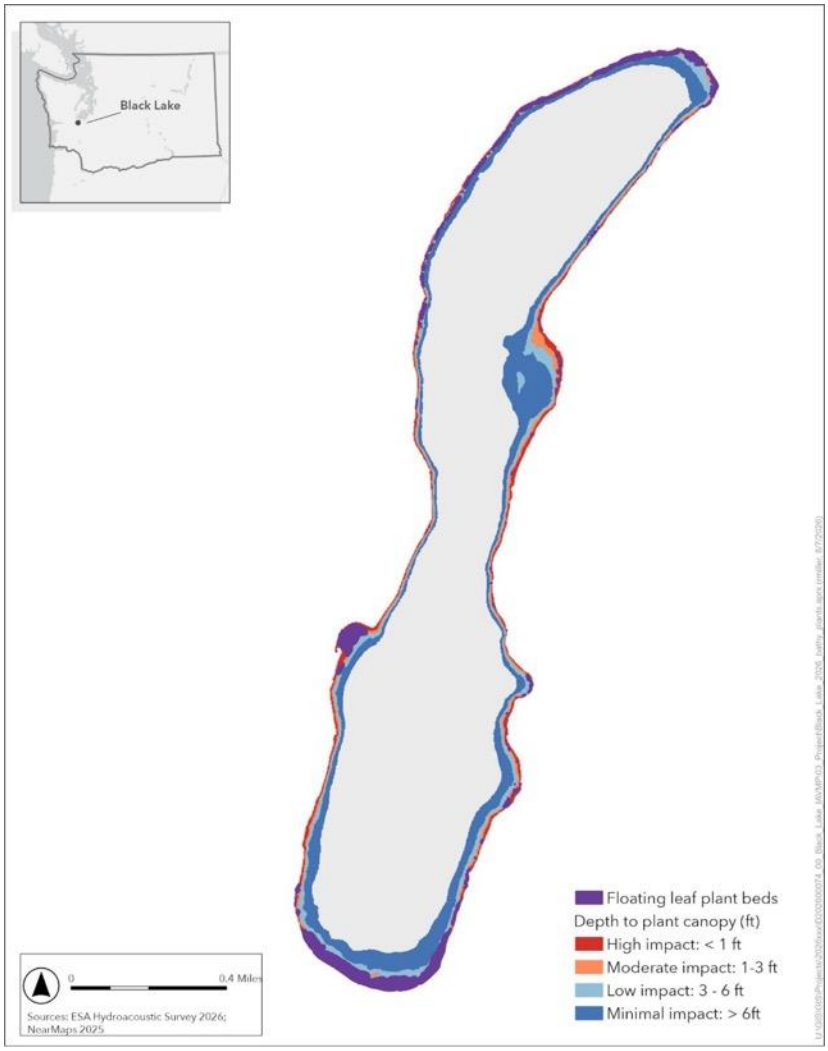


Figure 25. Black Lake distance from the water surface to the aquatic plant canopy height in the littoral zone along with the floating leaf aquatic plant beds. From 2026 hydroacoustic survey and August 22, 2025, NearMaps aerial imagery.

E.2.3 Grab Sample Survey

Seventeen aquatic plant taxa were encountered during the June 2026 grab sample survey. Three of these species are listed as Class C noxious weeds in Washington: **fragrant waterlily** (*Nymphaea odorata*), **curlyleaf pondweed** (*Potamogeton crispus*) and **yellow flag iris** (*Iris pseudacorus*). Fragrant waterlily was present at 19% of survey points (Figure 26), while curlyleaf pondweed was uncommon and detected at 1.5% of survey points (Figure 27) only three survey locations. No Eurasian watermilfoil (*Myriophyllum spicatum*) was detected during the survey.

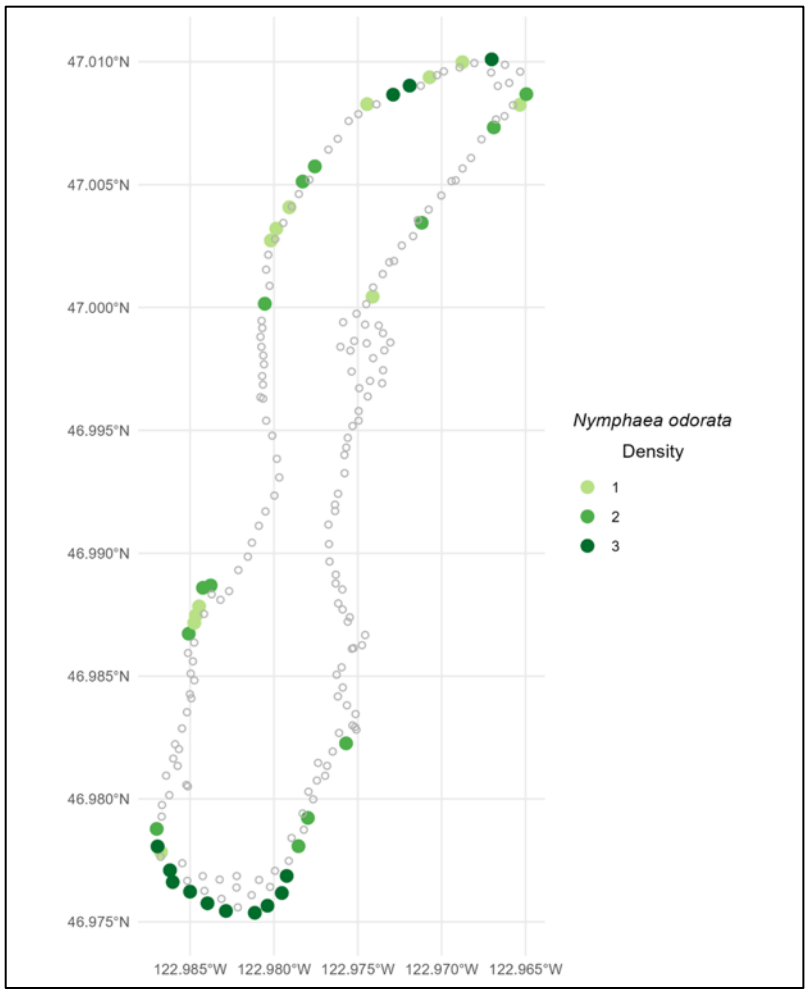


Figure 26. Spatial distribution and relative density of Nymphaea odorata recorded in Black Lake, Washington. Marker color indicates density class (1 = sparse, 2 = moderate, 3 = dense) and open circles are other surveyed sample sites.

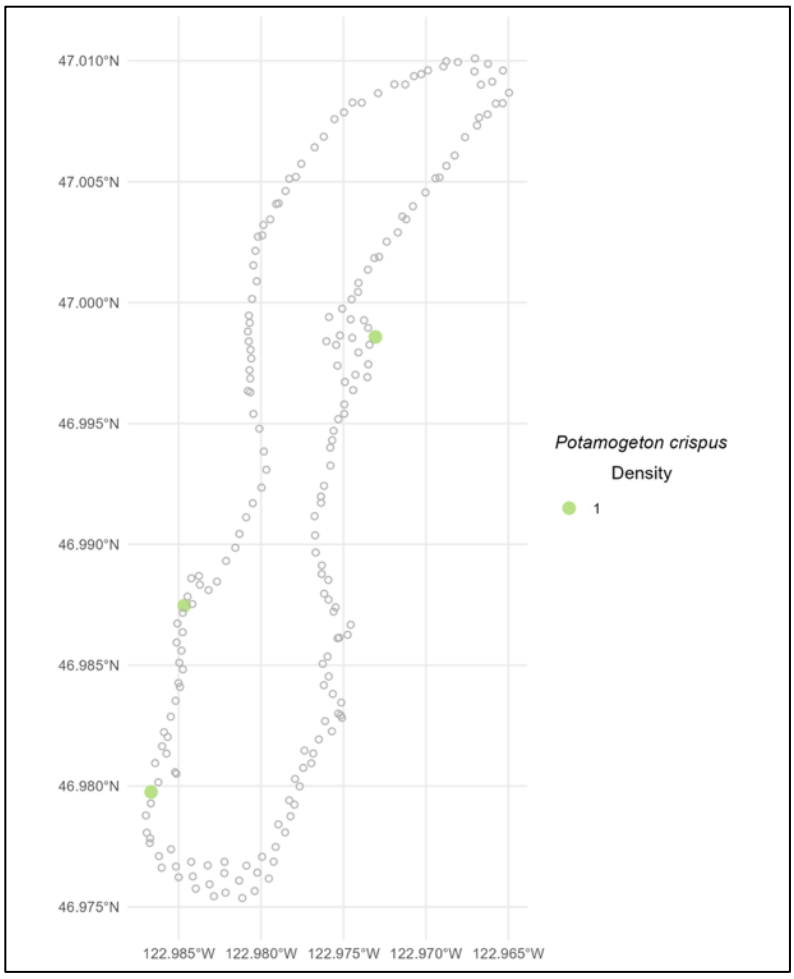


Figure 27. Spatial distribution and relative density of Potamogeton crispus recorded in Black Lake, Washington. Marker color indicates density class (1 = sparse, 2 = moderate, 3 = dense) and open circles are other surveyed sample sites.

Slender naiad (*Najas flexilis*), a native species, was the most frequently encountered submerged aquatic plant in Black Lake. It was detected at 78% of littoral survey points and occurred across nearly the entire vegetated depth range of the lake, from shallow nearshore habitats to depths approaching the maximum colonization depth identified in the hydroacoustic survey. Its broad depth distribution and high frequency of occurrence indicate that slender naiad is the dominant submerged macrophyte in Black Lake.

Aquatic plant diversity at the site level was relatively low. Across the 200 survey points, mean species richness was 2.11 species per site, with a standard deviation of 1.57, indicating that most sampling locations supported only one to three species. Mean Shannon diversity was 0.57, with a standard deviation of 0.57, and mean Simpson diversity was 0.44, with a standard deviation of 0.35. These relatively low diversity values reflect the widespread occurrence of a few common taxa, particularly slender naiad, and the less frequent occurrence of many other species.

Although species richness was generally low, mean evenness was high at 0.93, with a standard deviation of 0.06. This suggests that when multiple species were present at a sampling location, their relative abundances tended to be fairly balanced rather than strongly dominated by a single taxon.

Overall plant density patterns are shown in Figure 28, and species-specific distributions are shown in Figures 26, 27, 29, 30 and Appendix B. Species distributions were not uniform across the littoral zone. Several submerged species, including *Nitella* spp., Canadian waterweed (*Elodea canadensis*), ribbonleaf pondweed (*Potamogeton epihydrus*), and largeleaf pondweed (*Potamogeton amplifolius*), were most common in intermediate-depth habitats and occurred in localized patches. Floating-leaved species, especially fragrant waterlily, were concentrated in protected nearshore areas.

Collectively, the grab sample results indicate that the Black Lake littoral plant community is characterized by widespread slender naiad, large nearshore areas of floating-leaved vegetation, and a diverse assemblage of less common submerged species distributed throughout the lake. The absence of Eurasian watermilfoil during the 2026 survey is notable, particularly given its previous management history in Black Lake.

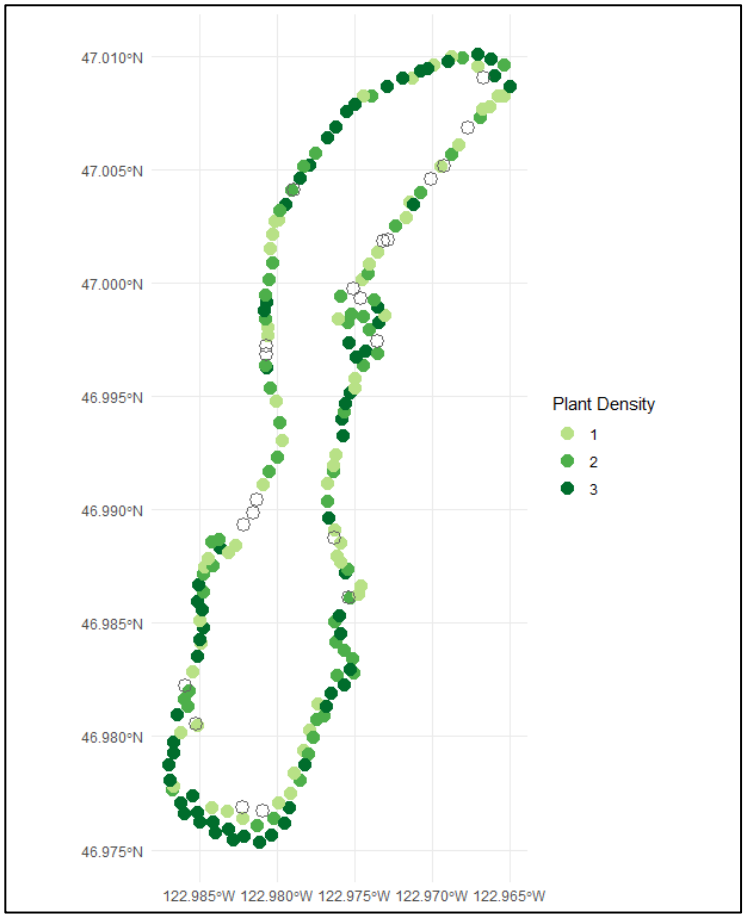


Figure 28. Spatial distribution & relative density of aquatic plants recorded in Black Lake. Marker color indicates density class (1 = sparse, 2 = moderate, 3 = dense) and open circles are surveyed sample sites without plants.

As noted above, slender naiad (*Najas flexilis*) was the most frequently encountered aquatic plant species, occurring at 78% of sampling points (95% CI: 72–84%). Its frequency of occurrence was more than three times that of the next most frequently encountered taxon, *Nitella* sp., which occurred at 24% of sampling points (95% CI: 18–31%).

The widespread occurrence of slender naiad may reflect its annual life history, reliance on seed production, ability to obtain nutrients from lake sediments, and capacity to grow across a range of water depths (Wingfield et al., 2004; Bishop et al., 2018). However, frequency of occurrence alone does not establish the environmental factors responsible for its distribution or indicate degraded ecological condition. Macrophyte distribution and community composition are influenced by interacting factors that include water depth, light availability and water clarity, nutrient conditions, substrate characteristics, exposure, and plant growth form (Hudon et al., 2000; Wingfield et al., 2004).

Several traits could help explain its distribution in Black Lake:

- *Najas flexilis* is an annual plant that does not reproduce vegetatively, relying on seed production for annual regeneration and dispersal. Studies have found *N. flexilis* seeds widely distributed in lake sediments, including in areas where living plants were not detected, indicating that seedlings may emerge in different portions of a lake from year to year (Baldridge and Lodge, 2014; Bishop et al., 2018).
- As a rooted submerged plant, it can obtain phosphorus from lake sediments. Experimental research specifically involving *N. flexilis* found sedimentary phosphorus to be important to the plant and its associated epiphytes. Black Lake's phosphorus-rich sediments could therefore help support its growth even when phosphorus concentrations in the overlying water fluctuate (Moeller et al.,1988).
- The Black Lake survey found *N. flexilis* across nearly the entire vegetated depth range. This broad realized depth distribution provides considerably more potential habitat than is available to species restricted to shallow margins. Elsewhere, *N. flexilis* has been documented across a wide range of depths, although its depth distribution is strongly affected by light availability, water clarity, exposure, and sediment characteristics (Wingfield et al., 2004).
- Its slender, highly branched growth form can make *N. flexilis* relatively inconspicuous compared with larger species. Its small and fragile form may also cause it to be underestimated by rake based surveys (Capers, 2000; Wingfield et al., 2004).

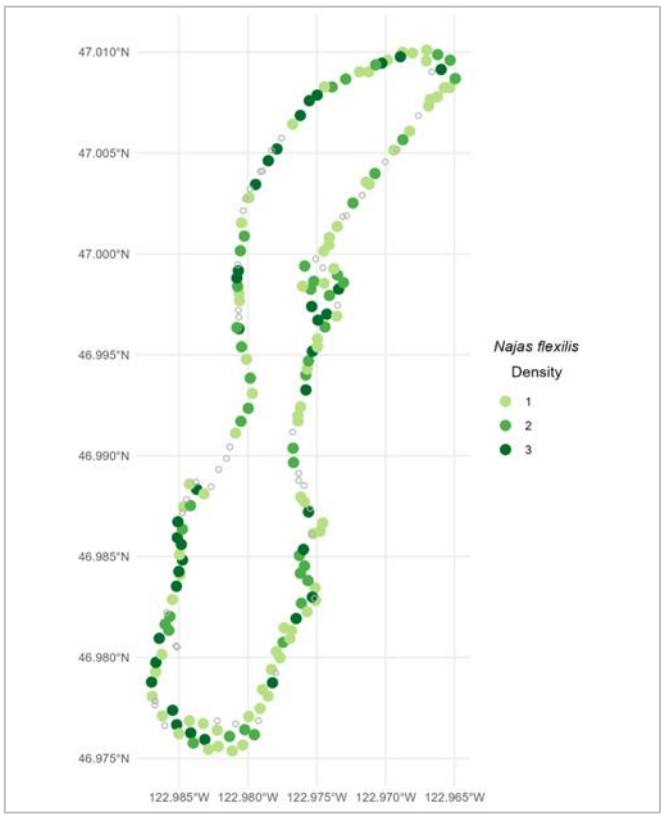


Figure 29. Spatial distribution and relative density of Najas flexilis recorded in Black Lake, Washington. Marker color indicates density class (1 = sparse, 2 = moderate, 3 = dense) and open circles are other surveyed sample sites.

Density maps for remaining native species found in Black Lake can be found in Appendix B. These include: *Nitella spp., Elodea canadensis, Potamogeton epihydrus, Potamogeton amplifolius, Potamogeton zosteriformis, Schoenoplectus acutus, Ceratophyllum demersum, Chara spp., Nuphar polysepala, Potamogeton richardsonii, Potamogeton spp., Typha latifolia, Utricularia vulgaris*.

E.2.4 Shoreline Survey

Yellow flag iris (*Iris pseudacorus*) was commonly encountered during the 2026 shoreline vegetation survey. The shoreline mapping dataset contained 362 records coded as IRIPSE, representing approximately 12.5% of the 2,894 vegetation records included in the dataset. Yellow flag iris was recorded at locations distributed around much of the lake shoreline, with the greatest concentration of records along the northern and northeastern shoreline and additional occurrences along the southern and southwestern shoreline. Because the dataset consists of GPS points used to delineate or document shoreline vegetation rather than a fixed set of independent sampling stations, this percentage represents the relative frequency of mapped records and should not be interpreted as the percentage of shoreline occupied by yellow flag iris or as a conventional frequency-of-occurrence estimate. Yellow flag iris (Class C Noxious Weed) was the fourth most frequently recorded vegetation category following fragrant waterlily.

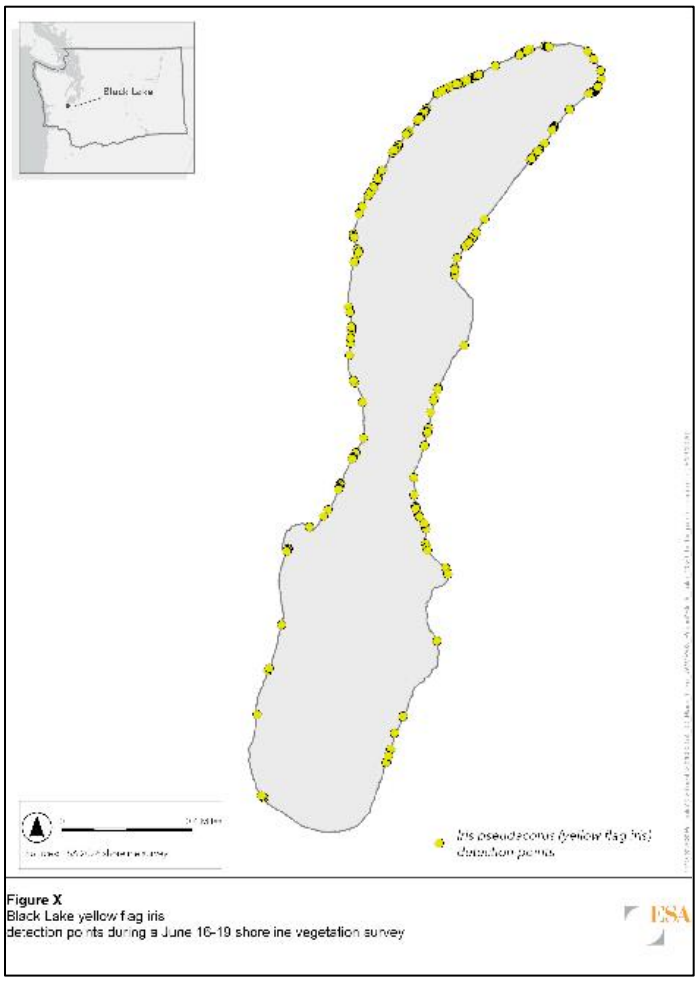


Figure 30. Yellow flag iris locations on the shoreline of Black Lake

E.2.5 Species Identification

E.2.5.1 Submersed Plants



Potamogeton amplifolius



Potamogeton richardsonii



Ceratophyllum demersum



Fontinalis antipyretica



Utricularia vulgaris



Najas flexilis



Potamogeton epihydrus



Potamogeton epihydrus (mature fruit)



Potamogeton foliosus



Pectinetella magnifica (on N. flexilis)



Nitella sp.



Potamogeton zosteriformis



Elodea canadensis

E.2.5.2 Emergent Plants



Schoenoplectus acutus



Typha latifolia

E.2.5.3 Shoreline / Emergent Plants



Iris psuedacorus

E.2.5.4 Floating Plants



Nymphaea odorata



Nuphar polysepala

E.2.6 Littoral Zone Species List (Native and Non-Native)

Table 8. Frequency of occurrence of aquatic plant species collected from Black Lake littoral zone, June 2026

Scientific Name	Common Name	Status	Frequency of occurrence (95% CI [c])
Najas flexilis	slender naiad	Native	78 (72-84)
Nitella sp.	nitella	Native	24 (18 - 31)
Elodea canadensis	Canadian waterweed	Native	21 (16 - 27)
Potamogeton epihydrus	ribbonleaf pondweed	Native	20 (15 - 26)
Nymphaea odorata	fragrant waterlily	Class C noxious weed[a,b]	19 (14 - 25)
Potamogeton amplifolius	large-leaf pondweed	Native	13.5 (9 - 19)
Potamogeton zosteriformis	flat-stem pondweed	Native	9.5 (6 - 14)
Schoenoplectus acutus	bulrush	Native[b]	8 (5 - 13)
Ceratophyllum demersum	hornwort	Native	4.5 (2 - 8)
Nuphar polysepala	yellow pondlily	Native[b]	4 (2 - 8)
Chara sp.	muskgrass	Native	3 (1 - 6)
Potamogeton richardsonii	clasping-leaf pondweed	Native	2 (1 - 5)
Potamogeton crispus	curly-leaf pondweed	Class C noxious weed[a]	1.5 (0 - 4)
Utricularia vulgaris	common bladderwort	Native	1.5 (0 - 4)
Potamogeton foliosus	leafy pondweed	Native	1 (0 - 4)
Typha latifolia	common cattal	Native[b]	0.5 (0 - 3)
Bare sediment			11 (7 - 16)

Notes:

a. Control is encouraged but generally not required because it is widespread in Washington.
b. Frequency of occurrence of emergent and floating leaved plant species is not representative of true coverage using the point sampling method.
c. CI = Confidence Interval

Source: Grab sample survey, June 2026, ESA. – 200 point samples

Table 9. Diversity indices for the aquatic plant community in Black Lake's littoral zone, June 2026.

Index *	Mean ± standard deviation
Richness	2.11 ± 1.57
Shannon diversity (H')	0.57 ± 0.57
Simpson diversity (1-D)	0.44 ± 0.35
Pielou's evenness (J')	0.93 ± 0.06

* Richness represents the number of species per site. Shannon and Simpson indices are measures of species diversity, with larger values indicating greater diversity. Evenness (Pielou's J') describes how equally species are represented within a site, with values approaching 1 indicating a more even distribution of abundances

E.2.7 Survey Limitations

Aerial Imagery

Floating-leaf plant beds were delineated using 1-ft-resolution Nearmap aerial imagery acquired on August 22, 2025, whereas the field surveys were conducted in June 2026. The August imagery likely provides a better representation of floating-leaf vegetation near its peak seasonal development than would imagery collected during the June field survey. However, the mapped distribution represents conditions visible in 2025 and may not fully reflect changes in plant extent, density, or composition between years. The aerial delineations and June field observations should therefore be viewed as complementary datasets representing different years and stages of seasonal plant development.

Species identification from aerial imagery was based on visible growth patterns and was not confirmed at every location in the field. Delineated beds were interpreted as consisting primarily of fragrant waterlily (*Nymphaea odorata*), with smaller areas of yellow pond lily (*Nuphar polysepala*); however, individual species may be difficult to distinguish where beds are mixed or image characteristics are similar. Image resolution, shadows, water-surface glare, turbidity, overhanging shoreline vegetation, and submerged plants not visible at the surface may also affect delineation accuracy. Consequently, the mapped acreage should be interpreted as an estimate of the extent of visibly established floating-leaf beds rather than an exact inventory of individual plants or species.

Dense floating-leaf beds also restricted boat access and limited hydroacoustic coverage in portions of the nearshore zone. Vegetation conditions beneath these beds were therefore represented primarily through aerial interpretation and spatial modeling rather than direct hydroacoustic measurements.

Grab Sampling

The survey represents conditions during a single sampling period in June 2026. Survey timing was selected to improve detection of early-season species, particularly curlyleaf pondweed, and to provide the Special District with survey results in time to plan and implement herbicide treatment during the 2026 treatment season. This timing may, however, have underrepresented species that emerge, become more abundant, or are more readily identifiable later in the growing season. Floating-leaf species also may not have reached their maximum seasonal extent by the time of the June survey. Consequently, the survey provides an early-season characterization of the plant community rather than a complete representation of peak-season vegetation conditions. Frequency-of-occurrence estimates describe the

proportion of sampled locations where each species was detected and should not be interpreted as the percentage of the littoral zone covered by that species.

Rake sampling provides a semi-quantitative measure of plant abundance based on the amount of vegetation retrieved. The amount collected can be influenced by plant growth form, stem strength, patchiness, water depth, substrate, rake placement, and the degree to which plants remain attached during retrieval. The sparse, moderate, and dense ratings therefore represent relative abundance at individual sampling points rather than precise measurements of percent cover, biomass, or lake-wide density.

The survey also represents conditions during a single sampling period in June 2026. Species that emerge, mature, senesce, or become more readily identifiable later in the growing season may have been underrepresented. This is particularly relevant for curlyleaf pondweed, which has an early-season growth cycle, and for floating-leaf species that may not have reached their maximum seasonal extent at the time of field sampling. Frequency-of-occurrence estimates describe the proportion of sampled locations where each species was detected and should not be interpreted as the percentage of the littoral zone covered by that species.

ASSUMPTIONS

Bathymetric depths and elevations were calculated using a water-surface elevation of 124.8 ft during the June 2026 survey. This value was based on measuring the water level from a monument near the Belmore Road bridge on the north side of the lake.

The bathymetric model assumes that the 2011 LiDAR elevations, the 2026 hydroacoustic measurements, and the shoreline points assigned a depth of zero can be combined to represent a consistent lake surface and shoreline transition. It also assumes that no substantial changes in shoreline form or nearshore bathymetry occurred between the LiDAR acquisition and the 2026 survey. Although model validation indicated strong lake-wide bathymetric accuracy, predictions remain less certain in areas with limited direct observations, including very shallow water, dense floating-leaf vegetation, and the west-central shoreline area where the deeper contours required manual adjustment.

Vegetation modeling assumes that hydroacoustic returns accurately distinguish the lake bottom from the top of the submerged plant canopy. Dense vegetation, very short plants, irregular substrates, and overlapping acoustic returns may reduce detection accuracy. The modeled plant-height surface is intended to represent broad lake-wide patterns; its relatively low cross-validated R^2 indicates that fine-scale variation at individual locations remains uncertain.

The maximum colonization depth of 13.7 ft was defined operationally as the 95th percentile of depths where detected vegetation exceeded 0.1 m in height. It represents conditions during the June 2026 survey rather than a fixed biological boundary and may vary with water clarity, lake level, species composition, and seasonal growth. Similarly, the canopy-depth impact categories were developed as a practical framework for evaluating potential recreational interference. Actual effects on boating, swimming, and fishing will vary with plant density, growth form, water level, type of activity, and individual user experience.

E.3 Rare, Sensitive and Endangered Species

E.3.1 DNR Natural Heritage Program Records

THREATENED, ENDANGERED AND RARE PLANT SPECIES WITHIN THE WATERSHED

Table 10. Threatened, endangered, and rare plant species within the Black Lake watershed

Scientific Name	Common Name	Status	Listing Status
Agoseris x elata	tall agoseris, tall goat-chicory	Sensitive (possibly extirpated)	Occurence

RARE AND LISTED HABITAT FEATURES

Table 11. Rare and listed habitat features near Black Lake

Occurence	Site Name / Location	Element Type	State Listing Status
Cornus sericea – Salix spp. – Spirea douglasii Wet Shrubland	Black River Swamp Preserve - to river mile 19.75	Threatened / Rare wetland or riparian ecological community High Quality Ecosystem	Threatened / Imperiled

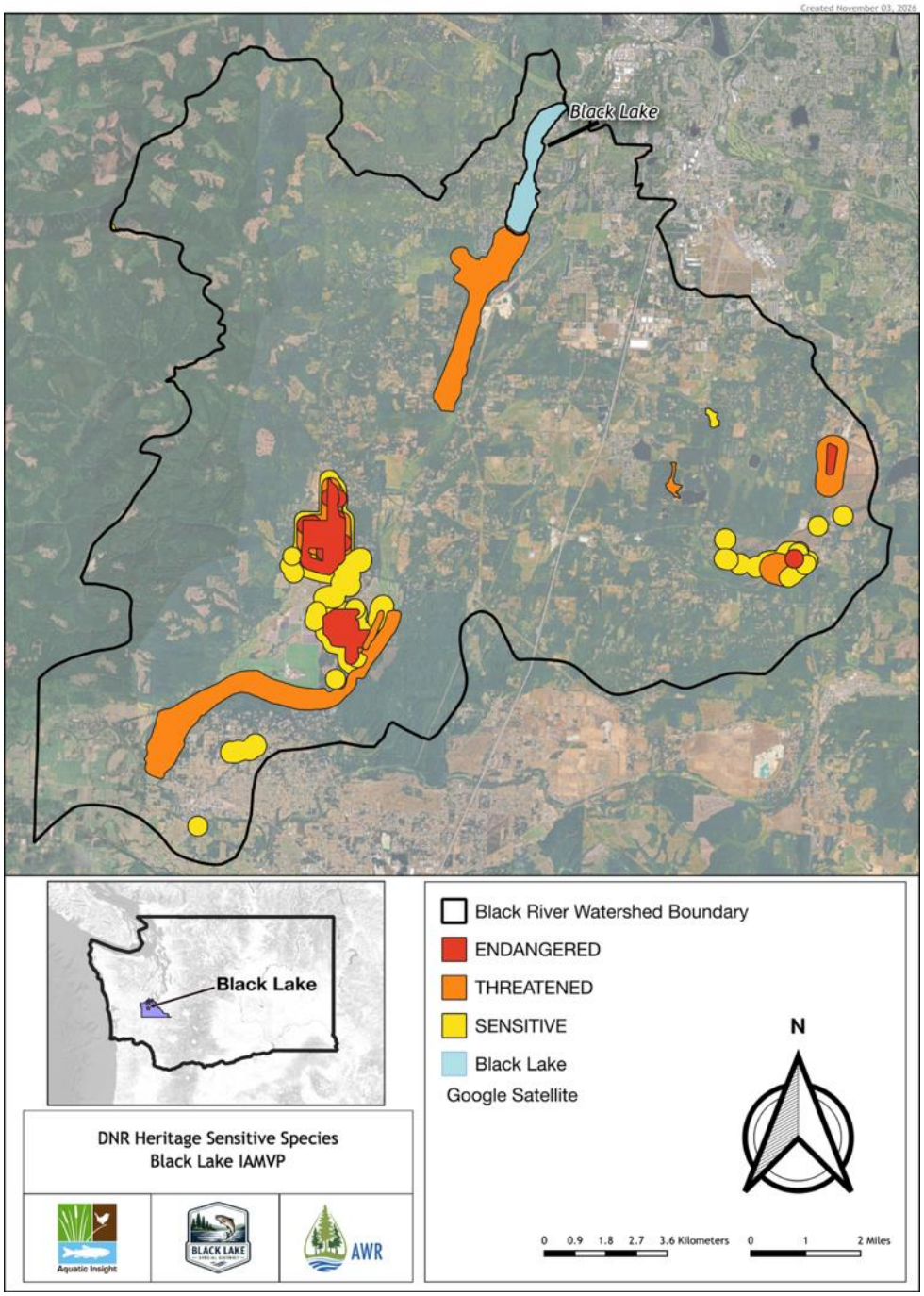


Figure 31. Department of Natural Resources Sensitive Species Map

E.3.2 Other Observed Species



Asian clam (Corbicula fluminea)
photo credit: Vernon



Native Physid snail (Physidae family)
photo credit: Cher Prazak

The nonnative Asian clam (*Corbicula fluminea*) has been confirmed in Black Lake. This invasive freshwater bivalve is established in portions of western Washington and can spread through the movement of boats, equipment, sediment, and water containing juveniles.

Photographs of a separate mollusk observed during the 2026 survey were reviewed by the Washington Department of Fish and Wildlife (WDFW), which identified the organism as a physid snail (family Physidae). Physid snails include native species commonly found in western Washington; however, identification to the family level does not establish the species or its native status. No control measures are recommended for the physid snail, while prevention of further Asian clam spread should be emphasized through aquatic invasive species education and proper cleaning, draining, and drying of boats and equipment.

E.4 Discussion

The 2026 surveys provide a lake-wide characterization of Black Lake's bathymetry and aquatic plant community and identify several findings relevant to future management:

- Black Lake encompasses approximately 572 acres, has a mean depth of 18.4 feet and a maximum depth of 30.1 feet. The hydroacoustic plant-height model reliably characterized broad lake-wide vegetation patterns and areas of dense growth, although estimated plant heights at individual locations should be interpreted with moderate uncertainty.
- Submerged aquatic vegetation occurs throughout much of the littoral zone. Mapping of the distance between the plant canopy and water surface identifies areas where dense or tall

vegetation is most likely to interfere with boating, swimming, fishing, and other recreational uses.

- Floating-leaf vegetation covered approximately 17.4 acres, equivalent to 13.3% of the littoral zone and 3% of the entire lake. These beds consisted primarily of the nonnative fragrant waterlily, with smaller areas of native yellow pond lily. Dense floating-leaf beds also limited boat access and hydroacoustic coverage in portions of the shoreline.
- Seventeen aquatic plant taxa were documented during the June 2026 grab survey. The submerged plant community was strongly characterized by native slender naiad, which occurred at 78% of littoral sampling points and across nearly the entire vegetated depth range. Its frequency was more than three times that of the next most frequently encountered taxon, *Nitella* sp., at 24%.
- Species richness and diversity at individual sampling locations were relatively low, with most sites supporting only one to three species. However, evenness was high where multiple species occurred, indicating that their relative abundances were generally balanced within those locations. Thus, although slender naiad was widespread across the lake, it did not necessarily dominate the plant assemblage at every individual site.
- Three Class C noxious weeds were documented: fragrant waterlily, curlyleaf pondweed, and yellow flag iris. Fragrant waterlily was present at 19% of grab-sampling points and formed extensive nearshore beds. Curlyleaf pondweed was uncommon, occurring at only three sampling points, but its limited distribution makes early and targeted management particularly important.
- Yellow flag iris was broadly distributed around the shoreline, with the greatest concentration of mapped records along the northern and northeastern shores. It represented approximately 12.5% of shoreline vegetation records and was the fourth most frequently recorded vegetation category. Because these records were collected as shoreline mapping points rather than at fixed sampling stations, this value describes its relative representation in the mapping dataset and not the percentage of shoreline occupied.
- No Eurasian watermilfoil was detected. This is an important finding given the species' previous occurrence and management history in Black Lake. However, nondetection during one survey does not confirm its complete absence; continued early-detection monitoring is warranted.

Overall, the surveys indicate that Black Lake retains a predominantly native submerged plant community, but extensive fragrant waterlily beds and the widespread shoreline distribution of yellow flag iris create clear management concerns. Curlyleaf pondweed currently appears localized and may be amenable to containment or eradication. Management should therefore prioritize established nuisance beds, rapid response to localized noxious weeds, continued surveillance for Eurasian watermilfoil, and protection of native vegetation that does not substantially interfere with beneficial uses.

Rare habitat features documented in the Black Lake area include freshwater forested and shrub wetlands, other palustrine wetlands, and snag-rich areas. No threatened, endangered, or rare plant species were identified during the 2026 aquatic plant and shoreline surveys. Common bladderwort (*Utricularia vulgaris*, generally treated in Washington as *U. vulgaris* subsp. *macrorhiza*) was documented but is a native, widely distributed aquatic species classified by the University of Washington Herbarium as "Not of concern." Accordingly, its occurrence does not represent a rare or sensitive plant record, although it contributes to the diversity and ecological value of Black Lake's native aquatic plant community.

F. Control Alternatives

F.1 Methods

F.1.1 Prevention and Early Detection

F.1.1.1 Education and Outreach

Public education and outreach represent one of the most cost-effective strategies for preventing the introduction and spread of invasive aquatic plants. Many aquatic invasive species are unintentionally transported on boats, trailers, fishing gear, waders, and other recreational equipment, increasing public awareness and promoting responsible recreation practices can substantially reduce the risk of new infestations.

Educational efforts should emphasize the Washington Invasive Species Council's "Clean, Drain, Dry" campaign (https://invasivespecies.wa.gov/campaigns/clean-drain-dry/) and encourage compliance with watercraft inspection requirements, and provide information on invasive species identification, reporting procedures, and best management practices. Outreach materials may include interpretive signage at public access sites, social media, community workshops, volunteer programs, and partnerships with local agencies, all of which help foster long-term stewardship of the lake and support EDRR efforts.

F.1.1.2 Boat Inspections/Decontamination

Watercraft inspections and decontamination programs are among the most effective measures for preventing the introduction and spread of aquatic invasive species between waterbodies. Boats (especially wake boats) trailers, anchors, fishing equipment, live wells, ballast tanks, bilges, and other recreational equipment can transport aquatic plants, animals, and pathogens that may establish new infestations if introduced into uninvaded waters. Inspection programs provide an opportunity to intercept contaminated watercraft before launch, educate boaters on invasive species prevention, and perform decontamination when necessary. Inspection protocols typically include a visual examination of the vessel and trailer, verification that all compartments are clean and drained, and an assessment of recent boating history to identify high-risk watercraft. Vessels determined to present an elevated risk may require decontamination using high-pressure, high-temperature water.

The Lake Whatcom and Samish Aquatic Invasive Species Program provides an effective example of a comprehensive prevention program. Since 2012, the program has required inspections and permits for all watercraft entering Lake Whatcom and Lake Samish, complemented by mandatory decontamination of high-risk vessels, public education, enforcement, and ongoing monitoring. More information can be found at https://whatcomboatinspections.com/decontaminations.

Wake boats present a greater risk for transporting aquatic invasive species (AIS) between waterbodies than most other motorized recreational boats because they rely on large ballast systems that intentionally take on water to generate larger wakes. While ballast tanks can be emptied after use, they are generally unable to completely drain, leaving residual water within the system. Depending on the vessel design, internal ballast systems may hold several hundred to more than 2,700 liters (approximately 730 gallons) of water, with many operators also using supplemental ballast bags that further increase water storage capacity.

Studies have shown that even after draining, ballast systems can retain measurable volumes of water capable of harboring plankton, plant fragments, invertebrates, and other aquatic organisms. The amount

of residual water varies among vessel designs and operating conditions, but research has documented average residual volumes of several dozen liters, with some boats retaining substantially more. Investigators have also identified a variety of planktonic organisms within retained ballast water, demonstrating the potential for these systems to transport living aquatic species from one lake to another.

Research has consistently found a positive relationship between the amount of water retained within a watercraft and the number of aquatic organisms that may be transported. Consequently, wake boats are generally considered to present a higher risk of spreading aquatic invasive species than motorized watercraft that do not utilize ballast systems. This increased risk is particularly important for lakes that are currently free of high-priority invasive species or are actively working to prevent new introductions.

Thorough decontamination of internal ballast systems presents an additional challenge because residual water often remains trapped within plumbing lines, pumps, and ballast tanks after draining. This residual water is typically protected from conventional inspection and may be difficult to remove or adequately disinfect without specialized equipment or high-temperature decontamination procedures (Ortiz, et.al, 2026).

Because of these challenges, many states, including Washington, prohibit the transport or introduction of regulated aquatic invasive species and require boaters to take reasonable measures to prevent their spread.

Failure to properly drain, clean, or decontaminate ballast systems may increase the risk of transporting invasive species between waterbodies and may result in violations of state aquatic invasive species regulations.

F.1.1.3 Early Detection Rapid Response (EDRR)

An Early Detection and Rapid Response (EDRR) program is one of the most effective and cost-efficient strategies for preventing the establishment and spread of aquatic invasive species. The likelihood of successful eradication or containment is greatest when a new invasive species is detected shortly after introduction, before it has had an opportunity to reproduce and spread throughout the lake. Once an invasive species becomes well established, management options become more limited, costs increase substantially, and complete eradication is often no longer feasible.

Lake residents, recreational users, and shoreline property owners are in a unique position to serve as the first line of defense against new aquatic invasive species. Providing educational materials that help users recognize Washington's highest-priority invasive plants and animals, understand how they spread, and know what signs to look for can greatly improve the likelihood of early detection. Residents should be encouraged to document any suspected invasive species with photographs whenever possible and report their observations rather than attempting to remove or disturb the organism.

Any suspected aquatic invasive species should be reported promptly to the Washington Invasive Species Council (WISC), which coordinates statewide invasive species reporting and response efforts. Suspected invasive aquatic plants should also be reported to the Thurston County Noxious Weed Control Board (tcweeds@co.thurston.wa.us) and to the Washington Department of Ecology's Aquatic Invasive Plant Management Program (*https://ecology.wa.gov/regulations-permits/guidance-technical-assistance/aquatic-invasive-plant-technical-assistance*) for identification, verification, and guidance on appropriate response actions. Prompt reporting allows resource specialists to evaluate the observation, confirm species identification, and determine whether rapid response measures are warranted.

Incorporating an EDRR program into Black Lake's long-term management strategy will increase the likelihood of detecting new infestations while they remain localized, reducing future management costs and helping protect the lake's ecological integrity, recreational value, and native aquatic communities.

F.1.2 Mechanical Control

F.1.2.1 Hand Removal

Hand removal is a selective management technique most appropriate for small infestations, newly established invasive plant populations, or isolated plants that can be removed before they become established. Plants are removed by hand, typically including the entire root system, to minimize the potential for regrowth. In shallow water, hand removal generally requires minimal equipment, although hand tools such as trowels or long knives may be needed where sediments are compacted or where root systems are well established. All plant material must be collected and removed from the water to prevent fragments from drifting and establishing new populations. Follow-up monitoring is essential to detect and remove any plants that re-establish from missed roots or fragments.

Hand removal is labor-intensive and is generally impractical for large infestations but can be highly effective as part of an Early Detection and Rapid Response (EDRR) program or for controlling small satellite populations before they expand. In Washington, an HPA Pamphlet Permit is typically required for hand removal activities conducted below the ordinary high water mark.

Cutting aquatic vegetation can provide temporary relief for navigation or recreation, however, it is generally not recommended for invasive species that readily reproduce through fragmentation. Cutting leaves the root system intact and may generate numerous plant fragments capable of forming new colonies if they are not completely recovered from the water.

F.1.2.2 Diver Assisted Suction Harvesting (DASH)

Diver removal is a highly selective management technique used to remove invasive aquatic plants growing in deeper water or in locations that cannot be effectively managed from the surface. Divers manually remove entire plants, including the root system whenever possible, and collect all plant material before it can drift away and establish new infestations. This method is particularly effective for small, recently established populations, scattered plants, or follow-up treatments after larger management efforts. Because the work is labor-intensive, diver removal is generally best suited for early detection and rapid response (EDRR) efforts or for maintaining previously treated areas.

Diver-Assisted Suction Harvesting (DASH) expands upon traditional diver removal by using an underwater suction system that transports plants, roots, and dislodged fragments through a hose to a collection container at the surface. The suction system greatly reduces the number of fragments remaining in the water and improves the ability to remove entire root crowns, making DASH one of the most effective non-chemical techniques for controlling small to moderate infestations of invasive aquatic plants. Although DASH requires specialized equipment and trained personnel, it can substantially reduce the likelihood of re-establishment compared to hand removal alone.

Both diver removal and DASH minimize impacts to native aquatic vegetation because management is targeted to individual plants or discrete infestations rather than broad treatment areas. These methods are most effective when infestations are detected early and are integrated with long-term monitoring to identify and remove any remaining plants before they become established. As with all aquatic plant management activities, permits are required. For either of these methods, an HPA (Hydraulic Project Approval) permit is needed from the WA State Dept. of Fish and Wildlife (WDFW).

F.1.2.3 Mechanical Harvesting

Mechanical harvesting uses specialized aquatic equipment to cut, collect, and remove aquatic vegetation from the water. Harvesters typically cut vegetation several feet below the water surface while simultaneously conveying the cut material onto the vessel for transport to shore, where it is transferred for disposal or composting. Mechanical harvesting can quickly improve navigation, recreational access, and water flow, making it an effective option for managing large areas of nuisance vegetation or dense surface canopies.

Because harvesting removes only the above-ground portions of most aquatic plants, regrowth from roots or rhizomes is common, and repeated treatments are often necessary throughout the growing season. In addition, harvesting may generate plant fragments that can spread species capable of reproducing vegetatively. For this reason, mechanical harvesting is generally not recommended for small infestations of highly fragmenting invasive species where eradication is the objective. However, it can be an effective management tool for well established infestations or for species that do not readily spread through fragmentation, particularly when the primary goal is to improve recreational access or reduce excessive plant biomass. Mechanical harvesting also requires a HPA from the WDFW.

F.1.2.4 Bottom Barriers

Bottom barriers, also referred to as benthic barriers or benthic mats, are sheets of biodegradable or synthetic material placed directly on the lake bottom to suppress aquatic vegetation by blocking sunlight and compressing existing plants. The barriers are secured with sandbags, rocks, or other anchors and are most effective for controlling rooted aquatic plants in small, localized areas such as around docks, swimming beaches, boat launches, or other high-use recreational areas. Biodegradable materials, such as burlap, are commonly used because they gradually decompose over time and may not require removal.

Bottom barriers provide effective, non-chemical control in targeted locations but are generally not practical or cost-effective for treating large infestations. Installation is easiest during the fall, winter, or early spring when aquatic vegetation is dormant or has died back. Existing plant biomass should be removed before installation to improve barrier contact with the lake bottom and reduce the potential for plants to grow around or through the edges. Periodic inspection and maintenance are necessary to ensure the barriers remain secure and to remove any vegetation that becomes established on top of or around the barrier.

This method also requires a HPA from WDFW. Depending on the material used and the extent of coverage, additional permit conditions or removal requirements may apply.

F.1.3 Biological Control

F.1.3.1 Grass Carp (*Ctenopharyngodon Idella*)

Triploid (sterile) grass carp have been used in some Washington lakes as a biological control method for managing submersed aquatic vegetation. Grass carp consume a wide variety of aquatic plants and, when stocked at appropriate densities, can substantially reduce plant biomass over several years. However, they are non-selective herbivores and typically consume both invasive and native submerged vegetation. Elimination of native plant communities can reduce important fish and wildlife habitat, increase shoreline erosion and sediment resuspension, and diminish the ecological functions provided by aquatic vegetation.

The loss of submerged vegetation may also reduce nutrient uptake by aquatic plants, leaving more nutrients available to support phytoplankton and cyanobacteria growth. In nutrient-enriched lakes, this shift can contribute to increased algal blooms, reduced water clarity, and degradation of overall lake health. Because grass carp provide limited control of emergent and floating-leaved invasive species such as yellow flag iris and fragrant waterlily, while posing significant risks to beneficial native vegetation and ecosystem function, their use is generally not recommended for Black Lake. Management strategies that selectively target invasive and excessive vegetation while preserving native plant communities are more consistent with the long-term ecological and recreational goals of this IAVMP.

F.1.3.2 Approved Insects

Biological control options for aquatic invasive plants are currently very limited in Washington. Although several biological control agents have been investigated, no insect biological control agents are approved for routine management of aquatic invasive plants. None of the three non-native invasive plant species currently found in Black Lake; fragrant waterlily (*Nymphaea odorata*), curlyleaf pondweed (*Potamogeton crispus*), and yellow flag iris (*Iris pseudacorus*) have approved biological control agents.

The native milfoil weevil (*Euhrychiopsis lecontei*) has been evaluated as a potential biological control agent for Eurasian watermilfoil (*Myriophyllum spicatum*); however, results have been inconsistent, and the species is not considered a reliable stand-alone management tool. In addition, the weevil may also feed on the native northern watermilfoil (*Myriophyllum sibiricum*). Consequently, biological control currently plays only a limited role in integrated aquatic vegetation management in Washington.

F.1.4 Chemical Control

Chemical control methods have been used on Black Lake for many years. In 2026 a total of 18 acres were treated to control nuisance vegetation and non-native fragrant waterlily using diquat, aquathol, flumigard, and imazapyr.

F.1.4.1 Herbicide Selection By Target Species

Herbicides approved for use in Washington to control aquatic vegetation are listed in *Table 12*. Herbicide selection, concentration, timing, treatment area, and adjuvant must be determined by a licensed aquatic applicator under the current Ecology APAM permit and product label. The new Washington permit took effect March 20, 2026, and endothall is among the ingredients subject to WDFW treatment-timing requirements.

Table 12. Approved aquatic herbicides for use in Washington

Active Ingredient	Common Trade Name(s)	Primary Use
2,4-D (amine & ester formulations)	Aqua-Kleen®, Navigate®	Eurasian watermilfoil, broadleaf aquatics
Aminopyralid	Milestone®	Emergent and riparian species (limited aquatic app)
Bispyribac-sodium	Tradewind®	Selected submerged species
Carfentrazone-ethyl	Stingray®	Floating-leaved plants

Active Ingredient	Common Trade Name(s)	Primary Use
Diquat dibromide	Reward®, Tribune®	Broad-spectrum contact herbicide - submerged vegetation
Endothall (dipotassium salt)	Aquathol K®, Aquathol Super K®	Curlyleaf pondweed, milfoils, hydrilla
Endothall (monopotassium salt)	Hydrothol 191®	Broad-spectrum aquatic vegetation
Florpyrauxifen-benzyl	ProcellaCOR® EC	Selective systemic for Eurasian watermilfoil
Flumioxazin	Clipper®	Floating and emergent plants
Fluridone	Sonar®, Avast!®	Whole-lake systemic treatment for submered sp.
Glyphosate	Rodeo®, AquaNeat®, AquaMaster®, AquaPro®	Emergent and shoreline vegetation, some floating
Imazamox	Clearcast®	Emergent vegetation, watermilfoi
Imazapyr	Habitat®	Emergent and shoreline - reed canarygrass
Penoxsulam	Galleon® SC	Eurasian watermilfoil, submerged species
Topramezone	Oasis®	Selected submerged invasive plants
Triclopyr (TEA)	Renovate® 3, Renovate® OTF	Eurasian watermilfoil; broadleaf aquatics

Herbicide selection, concentration, timing, treatment area, and adjuvant must be determined by a licensed aquatic applicator under the current Ecology APAM permit and product label. The new Washington permit took effect March 20, 2026, and endothall is among the ingredients subject to WDFW treatment-timing requirements.

Herbicide selection, application rate, treatment timing, adjuvant, and treatment area must be determined by a licensed aquatic pesticide applicator in accordance with the current product label, Washington Department of Ecology Aquatic Plant and Algae Management General Permit, and applicable WDFW treatment timing windows. Treatment timing may be adjusted based on water temperature, plant development, native vegetation, fish and wildlife restrictions, weather, and site-specific conditions.

Table 13.Management Options

Management Option	Advantages	Limitations	Best Application	Environmental Considerations	Longevity	Permits Required
Education	Low cost; builds community support; promotes prevention and early reporting; encourages proper plant id and BMPs	Effectiveness depends on participation and continued outreach; does not directly control established infestations	Lake wide prevention educating lake residents & users on invasive species, id, reporting, etc	No direct effects; can reduce spread and unnecessary removal of native vegetation	Long term with continued outreach	None
Boat Inspection	Prevents introduction and spread; addresses vectors before establishment	Requires staffing/participation and inspection location, does not directly control established infestations	Prevention of new introductions, particularly EWM and other species spread by fragmentation	Strong environmental benefit by preventing new invasions; proper disposal method of vegetation removed required	Ongoing, preventive	None
EDRR	Can eliminate new infestations before become widespread; reducing long term control costs	Regular surveillance trained lake residents/ users, a known reporting location; rapid reporting & response resources	Newly introduced species or small satellite populations	Minimizes need for larger scale future treatments; control method for response determines impact	Long term; individual responses may provide eradication	Monitoring – none; response method, possibly
Hand Removal	Highly selective; inexpensive for small infestations; removes plant biomass, minimal equipment needed	Labor intensive; impractical for large/dense infestatons; incomplete root/ rhizome removal can result in regrowth; fragmentation possible	Small, isolate infestations and follow up removal of satellite plants	Minimal when carefully conducted; localized sediment disturbance; fragments must be collected and disposed of properly	Short term; repeated inspection and removal often necessary	May require WDFW HPA depending on activity and extent
DASH	Selective; removes entire plants and root material; removes plant biomass from lake; effective in areas too deep for hand removal	Expensive and labor intensive; limited treatment area per day; requires trained divers & equipment; potential sediment disturbance	Small to moderate discrete infestations where eradication is desired	Localized sediment disturbance / turbidity; benthic organisms may be disturbed; plant fragments must be captured and disposed of properly	1 to several years depends on species & removal of all plant parts; follow up needed	WDFW HPA needed; local permits may be necessary
Mechanical Harvest	Rapidly opens large areas; removes plant biomass & associated nutrients; immediate recreational benefit	Does not remove roots; regrowth likely; expensive equipment; limited by depth & access; can spread plant fragments	Large, dense nuisance beds where navigation or recreational access is the primary objective	May fragment plants; require careful collection and removal of plant material to prevent further spread. Bycatch of fish and/or	Weeks to one growing season; often need to repeat annually	WDFW HPA permit and possible local shoreline

				invertebrates possible; temporary turbidity; harvested biomas requires proper disposal		
Bottom Barriers	Highly effective in small areas; controls most species	Expensive/ labor intensive for large areas; requires maintenance; plants may colonize barrier edges and accumulated sediment on top of barrier	Small high use areas such as docks; swimming areas or localized infestations	Smoters benthic organisms and native plants beneath; inappropriate for extensive lake wide use	Several years with maintenance	WDFW HPA permit and possible local shoreline
Grass Carp	Can provide multi-year suppression; potentially effective for extensive vegetation	Nonselective feeding; difficult to control degree or location of grazing; will consume desirable vegetation; stocking density difficult to optimize	Lakes where broad reduction of submerged vegetation is desired and protection of native vegetation is not an objective. **Strongly discourage adding carp**	Substantially reduces native vegetation and fish habitat; alters nutrient cycling, turbidity & food webs. Will increase algal blooms due to reducing competition for nutrients by native veg & nuitrient addition from feces	Several years (5 to 10+)	WDFW Grass carp stocking permit required; SEPA & containment requirements apply
Biological Control/ Insects	Can be species specific & provide long-term control; limits ongoing treatment effort	Effective agents exist for few aquatic species; control is suppression not eradication; results variable and slow;	Species for which an approved, effective biological control agent exists; no biological control approved for WA	Low nontarget impact when host specific agents are used; introduction/release carefully evaluated	Potentially multi-year/ self-sustaining	State and federal authorization required; none approved for WA state
Herbicide	For treating small or large populations; selective products/ application; often cost effective; systemic products can control roots/rhizomes	Repeated treatments may be necessary; efficacy depends on species, timing, concentration/exposure time and flow; public concern/use restrictions possible	Established invasive populations where mechanical/manual methods are impractical; using species-appropriate products	Potential nontarget plant impacts; decomposition may temporarily reduce DO; treatment timing restrictions protect fish/wildlife; product-specific water-use restrictions	One growing season to several years, depending on species/product; follow-up often needed	Ecology's 2026-2031 APAM general permit; WDFW treatment timing window
Nutrient Reduction	Address eutrophication; can help reduce algal/ cyanobacterial blooms	Does not directly eradicate invasive aquatic plants; response may be slow; internal	Lakes where nutrient enrichment contributes to	Generally beneficial; specific techniques (alum or phosphorus sequestration) have	Long-term, particularly when external and internal	Depends - technique; chemical P treatments

	& excessive plant growth; broader water-quality benefits	loading can delay recovery; watershed sources may be difficult to control	nuisance algae and excessive plant production	environmental considerations	sources are addressed	require APAM permit
Shoreline/ Plant Restoration	Improves habitat; stabilizes shoreline; may reduce erosion/ nutrient inputs; increases native plant competition and resilience	Does not rapidly control established invasive aquatic plants; establishment takes time; vulnerable to disturbance/herbivory	Degraded shoreline areas and sites following emergent invasive plant control;	Beneficial; species should be native and appropriate to site; avoid disturbance of existing high quality habitat	Long-term with successful establishment	Possibly local shoreline permits

Permit requirements vary by treatment method, project scale, location, and site-specific conditions. Potential requirements include Ecology aquatic pesticide permit coverage, Washington Department of Fish and Wildlife Hydraulic Project Approval (HPA), local shoreline authorization, and other state or federal approvals. Current requirements should be confirmed with the appropriate regulatory agencies before implementation.

Table 14. Control options for invasive species in Black Lake

Category Method	Specific Method	For Black Lake	Effective on fragrant waterlily	Timing	Effective on yellow flag iris	Timing	Effective on curly leaf pondweed	Timing	Estimated Cost
Prevention & Early Detection	Outreach & Education	Yes	Yes – request residents to not plant ornamentals near or in lake	Year round – emphasis on summer recreation seasson	Yes – request residents to not plant any ornamental plants near lake	Year round – emphasis on spring/summer identification & flowering period	Yes –boaters to make sure they do not spread fragments or turions	Year round – emphasis on spring-early summer – identify and report for control	$1,000 - $5,000 annually
	Boat Inspections & Decontamination	Possibly	Yes - request lake users to remove all plant parts	Throughout boating season – before & after recreating in lake	No – reproduces by seed only, seeds float but do not stick to boats	N/A	Yes – request all boaters to decontaminate craft before entering and leaving the lake	Primarily late spring-early summer before plant senescence	Variable – staffing dependent
	Early Detection Rapid Response	Yes	Yes – when species is eradicated, request residents to survey & report new sightings	Spring –summer Survey when flowering, control before seed prodcuction	Yes - when species is eradicated, request residents to survey & report new sightings	Spring – early summer; easiest to detect during flowering, control before seed production	Yes - when species is eradicated, request residents to survey & report new sightings	Spring – early summer – survey during active growth & before summer senescence/turion dispersal	$2,000 - $5,000 annually
Mechanical Control	Hand Removal	Yes	Yes – small populations; dig out rhizomes completely. Repeated cutting - WA guidance recommends removing surface biomass 4–6 x' per season/as soon as they surface, for 2–3 years	Spring – summer; remove during active growth, repeat as new growth occurs	Yes – small/new populations; Plants have to be dug out due to rhizomes. Seed pods bagged; all rhizome fragments removed	When flowering begins - late April to May	Limited – small, shallow inestations only – remove entire plant & collect all fragments	Spring – early summer; beore turion formation and summer senescence	$10,000 - $15,000 per acre treated
	Diver Assisted Suction Harvesting (DASH)	Yes	Yes -	Spring – summer during active growth; repeat as new growth occurs	N/A	N/A	Yes – small/discrete infestations – effective for populations in deeper water – remove entire	Spring – early summer; before turion formation; repeat as needed for several years	$5,000 - $7,000 per acre

							plant; collect all fragments		
	Mechanical Harvesting	Yes	Yes -	Late spring-summer, repeat during growing season as needed	N/A	N/A	Limited – for established / widespread beds; but high risk of fragment spread	Spring – early summer; before turion formation; avoid late season harvesting the may disperse fragments/turions	$3,000 - $5,000 per acre
	Bottom Barriers	Limited	Limited – small/discrete areas – robust rhizomes, soft sediment & gas release makes this methiod difficult	Spring/early growing season; install before emergence, maintain through growing season	Yes – a barrier method – covering with a pond liner for 4-6 months – monitor regrowth	Early spring on actively growing plants before fowering or seed production; must keep covered for 4-6 months – extend cover at least a foot beyond patch	Limited – small/discrete populations, suppress all benthic organisms under barrier	Early spring; install before substantial growth/turion formation; maintain through growing season	$1.15 - $1.75 per square foot
Biological Control	Grass Carp	No	No – significant impact on water quality & ecosystem	N/A	N/A	N/A	No – significant impact on water quality & ecosystem	N/A	N/A
	Approved Insects	No	No - approved biological control agents are available in WA	N/A	No - approved biological control agents are available in WA	N/A	No - approved biological control agents are available in WA	N/A	N/A
Chemical Control	Imazapyr (systemic)	Yes	Yes – preferred method	During active growth when floating leaves are fully developed and available for foliar treatment; inspect and retreat surviving plants or new growth as necessary	Yes – preferred method	During active growth, generally after leaves are well developed but before seed capsules mature; follow-up treatment may be needed; fall most effective	No – not recommended	N/A	* $500 - $1,500 per treated acre (depending on herbicide, rate, depth, treatment area – continuous vs. spot)
	Glyphosate (systemic)	Yes	Yes – preferred method	During active growth when floating leaves are fully developed and available for foliar treatment; inspect and retreat surviving	Yes – preferred method	During active growth, generally after leaves are well developed but before seed capsules mature; follow-up treatment	No – not appropriate	N/A	* $500 - $1,500 per treated acre (depending on herbicide, rate, depth, treatment area

				plants or new growth as necessary		may be needed; fall most effective			– continuous vs. spot)
	Endothall / Dipotassium salt (contact)	Yes	No – not appropriate	N/A	No – not appropriate	N/A	Yes – preferred contact option	Early spring, after active growth begins but before turion formation and before most native aquatic plants become established	* $500 - $1,500 per treated acre (depending on herbicide, rate, depth, treatment area – continuous vs. spot)
	Penoxsulam (systemic)	Yes	No - Not preferred option	N/A	No - not preferred option	N/A	Yes – preferred systemic option	Early spring, after active growth begins but before turion formation and before most native aquatic plants become established	* $500 - $1,500 per treated acre (depending on herbicide, rate, depth, treatment area – continuous vs. spot)
	Imazamox (systemic)	Yes	Yes	During active growth when floating leaves are fully developed and available for foliar treatment; inspect and retreat surviving plants or new growth as necessary	No – not preferred option	N/A	Yes – systemic alternative	Early spring, after active growth begins but before turion formation and before most native aquatic plants become established	* $500 - $1,500 per treated acre (depending on herbicide, rate, depth, treatment area – continuous vs. spot)
	**Costs are planning level estimates and are generally expressed per treated acre. Actual costs will vary with treatment acreage, water depth, plant density, herbicide and application rate, mobilization, permitting and notification requirements and contractor availability. Costs should be refined through contractor bids prior to implementation.*								

F.1.4.2 Timing

Timing of control activities varies by target species, control method, plant phenology, and applicable regulatory requirements. Recommended treatment periods for individual control methods and target species are summarized above in Table 14. In general, prevention and outreach activities should occur year-round, with increased emphasis during the recreational boating season. Early detection and mechanical control should be timed to maximize plant identification and removal while minimizing reproduction and spread. For curlyleaf pondweed, early-season control is particularly important because treatment before turion formation can reduce production of new propagules. Herbicide applications should target actively growing plants during periods when the selected herbicide is most effective and should comply with product label requirements, permit conditions, and applicable treatment timing windows. Follow-up monitoring should be conducted after treatment to evaluate effectiveness and identify regrowth or new infestations.

F.1.4.3 Selectivity

Prevention and early detection are inherently selective because they are intended to prevent introduction or target newly detected invasive species without affecting established native vegetation. Hand removal and DASH can also provide a high degree of selectivity when target plants can be reliably identified and removed individually. Mechanical harvesting and bottom barriers are less selective because they may remove or suppress native vegetation occurring within the treatment area.

Herbicide selectivity depends on the active ingredient, application method and rate, exposure time, treatment timing, and susceptibility of target and non-target species. Systemic herbicides applied directly to emergent or floating-leaved target plants can provide relatively selective control when applied as spot treatments, even when the herbicide itself is broad-spectrum. For submerged vegetation, selectivity may also be achieved through herbicide choice, concentration and exposure time, and seasonal timing. Early season treatment of curlyleaf pondweed can provide additional operational selectivity because the species begins growth earlier than many native aquatic plants. Treatment methods should be selected and implemented to minimize effects on desirable native vegetation to the extent practicable.

F.1.4.4 Use Restrictions

Control activities must comply with applicable federal, state, and local requirements. Aquatic herbicides may only be applied in accordance with the pesticide label and applicable Washington Department of Ecology aquatic pesticide permit requirements. Restrictions vary among herbicides and may include requirements related to treatment timing, application rates, water depth, irrigation or other water uses, notification and posting, treatment setbacks, and protection of fish and other aquatic resources. Applicable Washington Department of Fish and Wildlife timing restrictions and other requirements should be reviewed prior to treatment.

Mechanical control activities may also require authorization depending on the method, scale, location, and degree of sediment or aquatic habitat disturbance. Current permit and regulatory requirements should therefore be confirmed during annual treatment planning rather than relying solely on requirements in effect when this IAVMP was prepared.

F.1.4.5 Resistance Considerations

Repeated use of herbicides with the same mode of action can select for herbicide resistant plant populations and may also shift the aquatic plant community toward species that are naturally less susceptible to the treatment. Resistance risk can be reduced through integrated management, including use of nonchemical control methods where practical, treatment only when warranted, and rotation among effective herbicides with different modes of action when repeated chemical treatment is necessary. Long-term monitoring should be used to identify declining treatment effectiveness or changes in plant community composition. Herbicide selection and rotation should be based on target species susceptibility and site conditions rather than rotating products solely for the purpose of rotation.

F.1.4.6 Evaluation of Contol Alternatives

Control alternatives were evaluated based on their effectiveness against the three target invasive aquatic plant species, feasibility of implementation in Black Lake, potential impacts to native aquatic vegetation and other ecological resources, treatment timing, cost, regulatory requirements, and anticipated long-term effectiveness. Additional consideration was given to the extent and distribution of infestations, potential for plant fragmentation or propagule dispersal, and the need for repeated treatments or follow-up maintenance.

No single control method is appropriate for all three target species or infestation conditions. Prevention, early detection, and rapid response are important components of an integrated management program, while mechanical and chemical control methods may be appropriate depending on the species, infestation size, location, and management objectives. The evaluation of control alternatives provides the basis for selecting the recommended species-specific management strategies presented in Section G.

Table 15. Permitting requirements for aquatic and emergent invasive plant activities

Permit	Description	Control Method	Agency	Processing Time
Aquatic Plant & Algae Management General Permit (APAM)	- Chemical compounds used to kill or control submersed, floating, or emergent plants. - Compounds used to suppress algal growth. - Products used to lock up phosphorus. - Non-toxic dyes used to block sunlight and reduce plant growth.	Aquatic Herbicides Algaecides Nutrient Inactivators Water Dyes	WA State Dept. of Ecology (DOE)	Coverage begins 31st day after receipt of completed application or close of 30 day public comment period
Hydraulic Project Approval (HPA)	Required for in-water work below the ordinatry high water mark. Physical, mechanical or construction work that diverts, obstructs or changes flow or bed of waters in the state	Mechanical harvesting Dredging / sediment removal Bottom barriers/mats Physical removal of plants with machinery	WA Fish and Wildlife (WDFW)	45 day max Typically 23 days
State Shoreline Management Act – Shoreline Master	Within lakes / reservoirs over 20 acres – Within 200 foot shoreline jurisdiction Associated wetlands & 100 year floodplains	General prohibition on removing native shoreline vegetation; Bulkheading & shoreline stabilization. Dredging / drilling. Installing septic tanks,	Thurston County & Ecology	45 days to 3 to 6 months

Program (SMP)		draing fields, etc. Aquaculture		
Natural Heritage Program Letter	APAM is required for any chemical control; DOE will consult with DNR for rare, threatened or endangered plants within control area. Large scale projects may trigger EIS & Critical Areas Ordinance which may need rare plant survey.	Herbicide projects Large scale projects of any type	WA State Dept. of Natural Resources (DNR)	60 – 90 days
State Environmental Policy Act (SEPA)	5+ acre project – submit the APAM Discharge Management Plan (DMP) and SEPA Addendum. <5 acre project – Does not need a DMP, submit a standard SEPA Environmental Checklist with the APAM application. Ecology has already conducted a comprehensive Statewide EIS. Applicator must use only the pre-approved aquatic herbicides permitted under the APAM	Herbicde in-water projects	WA State Dept. of Ecology (DOE)	Coverage begins 31st day after receipt of completed application or close of 30 day public comment period
Local Permits	In water or within 200 foot shoreline zone - Various activities may need a city or county permit in addition to the SMP approval. These may include: Growth Management Act and/or Sensitive Area Ordinance	Vegetation clearing; soil disturbance; new hard surfaces; wetland crossings or encroachment; bulkheads & bank stabilization	City or county	60 to 90+ days

G. Recommended Integrated Treatment Plan

G.1 Management Objectives

The primary objective of the Black Lake IAVMP is to reduce the abundance and spread of invasive aquatic and emergent plants while maintaining beneficial native vegetation, protecting fish and wildlife habitat, and preserving recreational uses and lake access. Management efforts will focus on reducing established fragrant waterlily infestations, controlling yellow flag iris along shorelines, preventing the expansion of curlyleaf pondweed through treatment with the goal of eventual eradication of the three invasive species currently in Black Lake.

Additional objectives, with outreach and education, EDRR (Early Detection Rapid Response) and targeted treatment, preventing the introduction of new invasive species and reintroduction and further spread of historically documented and currently estabished invasive species.

Given its limited distribution documented during the 2026 survey, eradication of curlyleaf pondweed should be an immediate management priority, with early-season treatment and follow-up monitoring to prevent turion production, further establishment, and spread. Additional priorities include minimizing disturbance to native aquatic plant communities and addressing excessive vegetation growth where it interferes with recreational activities or ecological functions. The management program will emphasize an integrated, adaptive approach that incorporates community participation, ongoing monitoring, and

periodic evaluation of treatment effectiveness to guide future management decisions and support long-term stewardship of Black Lake.

G.2 Recommended Control Methods and Treatment Intensity

The recommended integrated aquatic plant management strategy for Black Lake combines targeted chemical and mechanical control methods with prevention, early detection, rapid response, and continued monitoring. Management recommendations focus on the three invasive aquatic plant species identified in the lake: fragrant waterlily (*Nymphaea odorata*), yellow flag iris (*Iris pseudacorus*), and curlyleaf pondweed (*Potamogeton crispus*). Control methods were selected based on species-specific effectiveness, infestation characteristics, potential impacts to native aquatic vegetation, treatment feasibility, and anticipated long-term maintenance requirements. The overall approach emphasizes reducing established invasive plant populations while preventing their expansion and minimizing impacts to desirable native vegetation and other aquatic resources.

G.2.1 Recommended Control Methods for *Nymphaea odorata* (fragrant waterlily)

Targeted herbicide treatment is recommended as the primary control method for established fragrant waterlily beds. Systemic aquatic herbicides, including imazapyr and imazamox, are preferred options, with aquatic glyphosate providing an additional established alternative. These treatments are intended to control the extensive rhizome systems responsible for continued growth and expansion. Herbicide selection and application methods should minimize impacts to desirable native floating-leaved vegetation, particularly spatterdock and watershield. Mechanical removal, including hand removal of rhizomes, may be appropriate for isolated plants, small infestations, and follow-up control of surviving or newly established plants. Mechanical harvesting may provide temporary relief from dense surface vegetation where recreational access is impaired, but it does not provide long-term control of established rhizomes and should not substitute for more effective control methods.

G.2.2 Recommended Control Methods for *Iris pseudacorus* (yellow flag iris)

Targeted treatment with aquatic formulations of imazapyr or glyphosate is recommended for established yellow flag iris populations, particularly where extensive rhizome systems make physical removal difficult. Herbicide application should be directed at individual plants or discrete patches to minimize impacts to adjacent native shoreline and wetland vegetation. Both herbicides are nonselective. Hand digging is recommended for isolated plants, seedlings, and small infestations where complete removal of rhizomes is feasible. Covering small patches with opaque pond liner may also be considered where site conditions permit. All removed plant material, including rhizomes and seed capsules, should be collected and properly disposed of to prevent reestablishment or dispersal.

G.2.3 Recommended Control Methods for *Potamogeton crispus* (curly leaf pondweed)

Early-season treatment with dipotassium endothall is recommended as the primary chemical control option for established curlyleaf pondweed infestations, with penoxsulam providing a systemic alternative where appropriate. Treatment should occur during active growth but before substantial turion production, preferably when many native aquatic plant species have not yet reached peak growth. This timing may improve treatment selectivity and reduce the production of propagules that contribute to future infestations.

Diver-assisted suction harvesting (DASH) may be appropriate for small, discrete populations, particularly in deeper water where conventional hand removal is impractical. The advantage of DASH is

the potential to remove turions along with the plant material. This removes the seed bank and limits potential future population growth. Hand removal may be considered for isolated plants in shallow areas. Mechanical harvesting is generally less desirable because plant fragmentation and turion dispersal may contribute to further spread.

G.2.4 Prevention, Early Detection and Rapid Response

Prevention and early detection should remain integral components of the management program. Public education, outreach to shoreline residents and recreational users, and promotion of watercraft cleaning and decontamination practices can reduce the likelihood of new introductions and further spread. Routine surveillance should focus on identifying newly established populations, particularly following initial treatment efforts. Rapid response to isolated plants and satellite infestations will be important for preventing recolonization of treated areas and reducing future management costs.

Biological control methods, including grass carp, are not recommended for Black Lake because of their potential ecological impacts, limited species-specific effectiveness, and the absence of approved insect biological control agents for the target species in Washington. Additional species to include in an EDRR program are included in Table 16.

Table 16. Invasive Aquatic/Emergent Plant Sepecies to Monitor for at Black Lake

Scientific Name	Common Name	Noxious Weed Listing
Arundo donax	Giant reed	Quarantine list
Butomus umbellatus	Flowering rush	Class A
Cabomba carolinaiana	Fanwort	Class B
Cyperus eragrostis	Tall flatsedge	Monitor list
Egeria densa	Brazilian elodea	Class B
Eichhornia crassipes	Water hyacinth	Monitor list
Glyceria maxima	Reed sweetgrass	Class A
Hydrilla verticillata	Hydrilla	Class A
Hydrocharis morsus-ranae	European frogbit	Quarantine list
Ludwigia hexapetala	Water primrose	Class B
Lysimachia vulgaris	Garden loosestrife	Class B
Lythrum salicaria	Purple loosestrife	Class B
Lythrum virgatum	Wand loosestrife	Class B
Ludwigia peploides	Floating primrose-willow	Class A
Myriophyllum heterophyllum	Variable-leaf milfoil	Class A
Myriophyllum aquaticum	parrotfeather	Class B
Najas minor	Brittle naiad	Quarantine list

Nymphoides peltata	Yellow floating heart	Class B
Phragmites australis	Common reed	Class B
Potentilla argentea	Silver cinquefoil	Class B
Sagittaria graminea	Grass-leaved arrowhead	Class B
Sagittaria platyphylla	Delta arrowhead	Class A
Typha angustifolia	Narrowleaf cattail	Class C
Utricularia inflata	Swollen bladderwort	Quarantine list

Table 17. Preferred herbicide treatment.

Invasive Species	Preferred herbicide	Key application considerations
Yellow flag iris (*Iris pseudacorus*)	**Imazapyr or glyphosate**	Apply an aquatic-labeled formulation as a targeted foliar or cut-stem treatment. Imazapyr generally provides strong systemic control of the rhizomes, but it can injure nearby desirable vegetation through foliar contact or root uptake. Glyphosate is also effective and may be preferable for highly targeted spot or stem-injection treatments near sensitive plants. Repeat treatment is commonly necessary.
Curlyleaf pondweed (*Potamogeton crispus*)	**Dipotassium endothall**, with **penoxsulam** as a systemic alternative	Endothall—particularly Aquathol K—is the most established choice for early-season control. Treatment should occur while curlyleaf pondweed is actively growing but before turion production, ideally before most native plants become active. Penoxsulam may be useful where longer systemic control and adequate exposure time can be achieved.
Fragrant waterlily (*Nymphaea odorata*)	**Imazapyr or imazamox**; aquatic glyphosate is another established option	Apply to actively growing floating leaves with an aquatic-approved surfactant. Imazapyr is a strong systemic option for established beds; imazamox is also being used successfully for waterlily control in Washington lakes. Glyphosate can provide good control but frequently requires follow-up treatment of surviving plants or seedlings. Avoid overspray onto native spatterdock and watershield.

G.2.5 Treatment Intensity

Treatment intensity should reflect the extent, density, and distribution of each invasive species, the potential for further expansion, and the management objectives established for Black Lake. An intensive initial control effort is recommended to substantially reduce established invasive plant populations,

particularly dense fragrant waterlily beds and other infestations that interfere with recreational uses, displace native vegetation, or contribute to degraded aquatic habitat. Initial treatments should be followed by systematic monitoring and targeted follow-up control to address surviving plants, regrowth, and newly established populations.

Treatment intensity will vary among the three target species. Fragrant waterlily management will likely require treatment of established beds followed by repeated inspections and targeted control of surviving rhizomes and new growth. Yellow flag iris control should emphasize treatment of established shoreline populations while prioritizing removal of isolated plants and satellite infestations before seed production. Curlyleaf pondweed management should focus on early-season control to reduce plant abundance and turion production, with subsequent monitoring used to determine the need for additional treatment.

As invasive plant populations decline, management should transition from intensive control to a long-term maintenance program emphasizing early detection, rapid response, and selective treatment of remaining infestations. Treatment areas and methods should be adjusted annually based on monitoring results, treatment effectiveness, environmental conditions, available funding, and the need to protect native aquatic vegetation. This phased approach is intended to achieve sustained reductions in invasive plant abundance while minimizing unnecessary treatment and associated ecological disturbance.

G.2.6 Treatment Location Priorities

Treatment locations should be prioritized based on the extent and density of invasive plant infestations, impacts to recreational uses and aquatic habitat, potential for further spread, and feasibility of achieving long-term control.

High-priority areas should include:

a) curlyleaf pondweed infestations with the potential to expand into currently uninfested areas. Isolated plants of curly leaf pondweed, and satellite populations should also receive high priority because early removal can prevent establishment and reduce future treatment costs;

b) dense fragrant waterlily beds that restrict boating, waterskiing, fishing, or shoreline access;

c) established yellow flag iris populations that threaten native shoreline and wetland vegetation.

Priority location(s) and species #1 - The highest treatment priority should be assigned to the three locations where **curlyleaf pondweed** (*Potamogeton crispus*) was documented during the 2026 aquatic vegetation survey, **Priority 1A** (northern basin) and **Priority 1B** (southern basin). One occurrence was identified along the eastern shoreline of the northern basin, and two were documented along the western shoreline of the southern basin (Figure X). Given the limited distribution and low observed density of this invasive species, eradication should be the primary management objective, with early-season treatment implemented as soon as practicable. As noted above, DASH or chemical treatment with Dipotassium endothall should be used for this species. Targeted surveys should be conducted around each documented occurrence to delineate the extent of the infestations, followed by treatment before turion production and subsequent monitoring to evaluate effectiveness and detect any remaining or newly emerging plants.

Priority location(s) and species #2 - The second treatment priority should focus on **fragrant waterlily,** (*Nymphaea odorata*) with an emphasis on reducing its spread within Black Lake and preventing its transport to other waterbodies. Based on the 2026 vegetation survey, **priority treatment areas should**

include established infestations in the northern basin, isolated shoreline populations, and locations where dense growth interferes with boating, fishing, or shoreline access. Particular attention should be given to the **WDFW public boat launch along the eastern shoreline of the southern basin**, as boats and equipment moving between waterbodies represent a potential pathway for transporting invasive plant fragments. As noted above, systemic aquatic herbicides, including imazapyr and imazamox, are preferred options for this species.

The boat launch and adjacent shoreline should be prioritized for surveillance, targeted removal of any confirmed infestations, and aquatic invasive species prevention outreach. Although the southern end of Black Lake contains some of the most extensive and dense floating-leaved vegetation, much of this area is associated with relatively undisturbed shoreline and native wetland habitat. Consequently, treatment in this area should focus on locations with recreational activity, potential for plant fragmentation and transport, or encroachment into desirable native plant communities, rather than widespread removal of all floating-leaved vegetation. Treatment boundaries should be refined through field verification to distinguish invasive fragrant waterlily from native yellow pond lily (*Nuphar polysepala*) and minimize impacts to beneficial aquatic vegetation. Outreach and education should address fragrant waterlily and other ornamental aquatic plants that may be intentionally introduced into Black Lake.

Priority location(s) and species #3 - The third treatment priority should focus on **yellow flag iris,** (*Iris pseudacorus*) with initial control efforts concentrated along the shoreline of the northern basin, where the vegetation survey documented widespread occurrences. Treatment should prioritize established infestations that threaten native shoreline and wetland vegetation, as well as isolated populations elsewhere around the lake that can be removed before further expansion. As noted above, imazapyr or glyphosate is receommended for this species and because yellow flag iris spreads through floating seeds and vegetative growth from rhizomes, treatment should be conducted before seed maturation, with follow-up monitoring and removal of regrowth. Public education and shoreline property owner outreach should be integral components of the management strategy, emphasizing the ecological impacts of yellow flag iris, discouraging its intentional planting, and encouraging replacement with appropriate native shoreline species. Treatment should be coordinated with shoreline property owners and implemented in a manner that minimizes disturbance to native wetland vegetation and shoreline habitat.

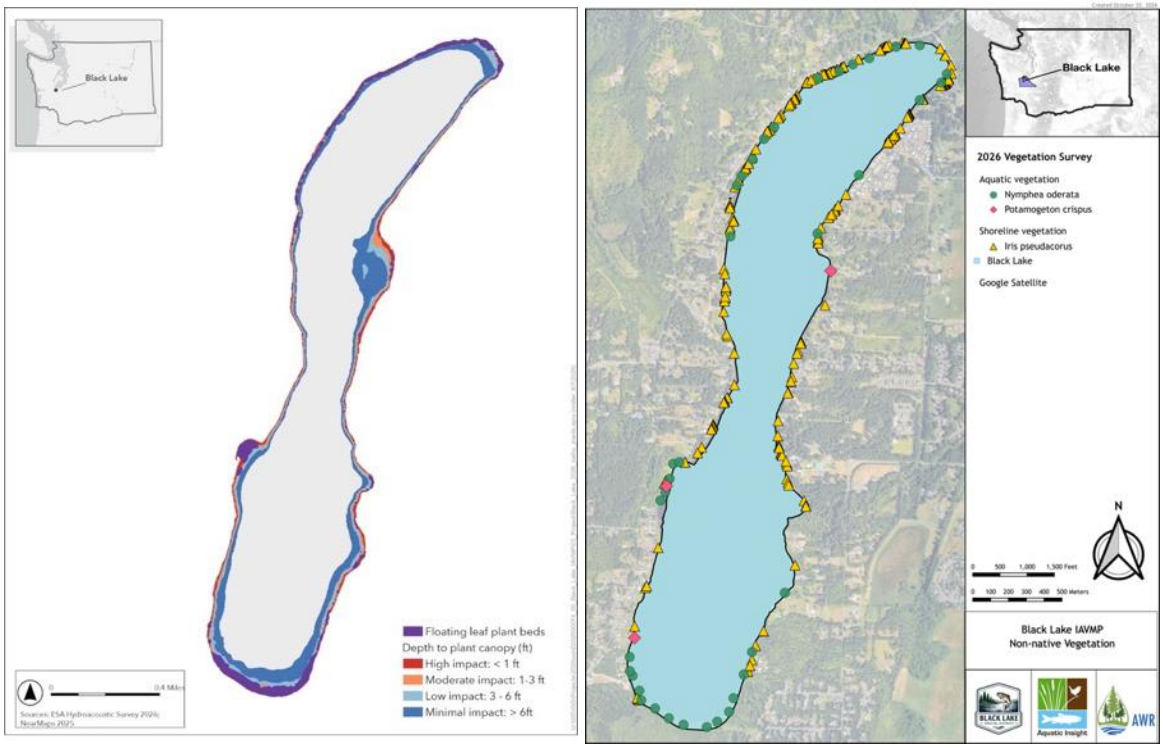


Figure 32. Priority aquatic vegetation treatment areas in Black Lake.

G.3 Monitoring and Evaluation of Success

Monitoring should be conducted annually to evaluate treatment effectiveness, document changes in invasive plant distribution and abundance, and guide future management decisions. The 2026 aquatic vegetation surveys will serve as the baseline for assessing progress, with follow-up surveys using comparable methods where practicable. Particular emphasis will be placed on confirming eradication of curlyleaf pondweed through repeated early-season surveys, evaluating reductions in fragrant waterlily and yellow flag iris coverage and density, and detecting new or expanding infestations. Monitoring should also assess potential impacts to native aquatic vegetation and improvements in recreational access. Treatment success will be determined via the results of the followup monitoring. The monitoring results will be used to evaluate progress toward eradication of curlyleaf pondweed, reduction of fragrant waterlily and yellow flag iris infestations, prevention of further invasive species spread, and protection of native aquatic vegetation and recreational uses, with treatment strategies adjusted as needed to achieve these long-term management objectives.

G.4 Adaptive Management and Monitoring Triggers

The Black Lake IAVMP will employ an adaptive management approach in which treatment strategies and priorities are periodically evaluated and adjusted based on monitoring results, treatment effectiveness, environmental conditions, and community input.

Triggers for modifying management actions may include the detection of new invasive species or previously undocumented infestations; expansion of existing populations; failure to achieve anticipated

reductions in plant abundance or distribution; increased seed, turion, or rhizome production that could contribute to further spread; or unintended impacts to native vegetation and aquatic habitat.

Additional considerations include changes in recreational access, herbicide performance, regulatory requirements, and significant community concerns regarding proposed treatment methods. Where treatments are ineffective or invasive populations continue to expand, the District should reassess treatment timing, application methods, frequency, or alternative control strategies. Particular emphasis should be placed on rapid response to any new curlyleaf pondweed occurrences, given the objective of eradication, and preventing the reestablishment of Eurasian watermilfoil.

If any of these conditions arise, the LMD should consult with a qualified aquatic plant management professional (such as Aquatic Insight) to evaluate monitoring results, identify potential causes of treatment failure, and recommend appropriate modifications to treatment methods, timing, or priorities. Management priorities and treatment approaches should be reviewed annually and modified as necessary to support the long-term ecological and recreational objectives established for Black Lake.

G.5 Long Term Action Plan and Maintenance

Long-term management of aquatic vegetation in Black Lake will require a sustained, coordinated effort involving follow-up treatments, routine monitoring, prevention, and community participation. The initial management phase (Years 1–2) should emphasize eradication of curlyleaf pondweed, reduction of priority fragrant waterlily and yellow flag iris infestations, and establishment of a consistent monitoring program. Subsequent years should focus on maintaining treatment gains, preventing reinfestation, and responding promptly to newly detected invasive species. The following implementation framework outlines anticipated management activities over a 5–10-year period, with priorities and schedules adjusted as needed based on monitoring results, available funding, and treatment effectiveness (Table 18).

Table 18. Management Options and Priorities

Management Activity	Years 1 – 2 Initial Management	Years 3 – 5 Maintenance	Years 6 – 10 Long term Stewardship
Curly leaf pondweed	Target all known infestations for eradication; conduct early-season targeted surveys and follow-up treatments	Continue early-season surveillance and rapid response to any detections	Maintain periodic surveillance and rapid response
Fragrant waterlily	Treat priority infestations near recreational access, the northern basin, and isolated shoreline populations	Follow-up treatment of regrowth; treat any expanding populations; move to other identified populations	Maintain treatment to allow recreational access through targeted treatment; moving toward eventual eradiction
Yellow flag iris	Target northern basin infestations and isolated shoreline populations;	Treat regrowth and seedlings; expand control as larger populations are removed	Continue targeted treatment; prevent reinfestation; move toward eventual eradication
Vegetation monitoring	Annual targeted surveys of treatment areas and priority invasive species; document treatment effectiveness	Annual targeted surveys and periodic broader vegetation assessments	Continue annual surveillance and control measures until eradication is achieved
Prevention / EDRR	Establish outreach and reporting procedures; emphasize boat launch	Continue education, inspections or prevention activities & rapid response	Maintain ongoing prevention and early detection efforts
Community involvement	Engage residents in treatment planning, prevention, and reporting invasive species	Provide annual updates and encourage participation	Maintain communication and community stewardship
Plan review and updates	Evaluate results annually and adjust treatment priorities	Conduct formal review at Year 5	Update the IAVMP as needed

H. Water Quality Assessment and Improvement

H.1 Lake water quality profile monitoring – Field measurements

H1.1 Water Quality Monitoring Parameters

The following field parameters are recommended for routine monitoring of Black Lake. Together, these measurements provide information about thermal stratification, oxygen availability, biological productivity, dissolved constituents and water clarity.

Dissolved Oxygen

Concentrations are influenced by temperature, photosynthesis, respiration, and decomposition of organic matter. Low DO concentrations near the lake bottom can develop during summer stratification when oxygen consumption exceeds replenishment. Under anoxic conditions, phosphorus bound to iron or alum in lake sediments may be released into the overlying water, contributing to internal phosphorus loading. DO should be measured in milligrams per liter (mg/L) and, when available, percent saturation throughout the water column to identify oxygen gradients and areas of anoxia.

Temperature

Water temperature influences biological activity, dissolved oxygen availability, and seasonal thermal stratification. Temperature measurements collected throughout the water column can identify the development of distinct thermal layers, including the warmer surface waters (epilimnion), the thermocline (metalimnion), and the cooler bottom waters (hypolimnion). Understanding the timing, strength, and duration of thermal stratification is important for evaluating oxygen depletion, nutrient cycling, and seasonal mixing processes. Temperature should be recorded in degrees Celsius (°C).

pH

pH measures the acidity or alkalinity of lake water and is influenced by biological and chemical processes. Photosynthesis removes dissolved carbon dioxide and can increase pH, particularly during periods of elevated algal productivity. Conversely, respiration and decomposition release carbon dioxide, potentially lowering pH. Monitoring pH throughout the water column can help identify changes associated with algal blooms, biological activity, and seasonal water chemistry. pH should be measured using a calibrated sonde (more information on equipment below).

Conductivity

Specific conductivity provides an indirect indication of dissolved ion concentrations. Changes in conductivity may reflect runoff from the surrounding watershed, groundwater inputs, or the accumulation of dissolved constituents in deeper waters during stratification. Conductivity measurements can help identify spatial and seasonal differences in water chemistry but do not independently identify specific pollutants. Specific conductivity should be recorded in microsiemens per centimeter (µS/cm) standardized to 25°C.

Secchi Disk Transparency

Secchi disk transparency provides a simple, inexpensive measurement of water clarity and is commonly used to evaluate changes in lake transparency over time. A Secchi disk, typically 20 centimeters in diameter with alternating black and white quadrants is slowly lowered into the water until it is no longer

visible. The disk is then raised until it becomes visible again, and the average of the disappearance and reappearance depths is recorded as the Secchi depth, generally in meters. Measurements should be collected from the shaded side of the boat under consistent lighting conditions. Reduced water clarity may indicate increased phytoplankton abundance, suspended sediments or dissolved organic matter. Although Secchi depth does not directly measure algal biomass, long term measurements can provide valuable information about changes in lake productivity and transparency.

H.2 Citizen Science Monitoring

Trained residents and citizen scientists can provide valuable long term water quality information through routine monitoring of Black Lake. Volunteer monitoring offers a relatively low cost approach for documenting seasonal conditions, identifying changes in water quality and establishing a consistent historical dataset. Monitoring should occur at established locations, including a deep water station and, where feasible, additional stations representing areas of concern, such as major tributary inflows or locations experiencing recurring algal blooms.

A portable multiparameter water quality sonde is recommended for collecting the measurements noted above (DO, temperature, pH and conductivity). These instruments contain multiple sensors within a single probe, allowing users to measure all four parameters simultaneously at selected depths throughout the water column. The sonde is typically connected to a handheld display or data logger that provides real time readings and store measurements for subsequent analysis. The probe can be lowered from a boat using a marked cable to collect vertical water quality profiles at consistent depth intervals. Instruments should be calibrated and maintained according to manufacturer specifications and volunteers should receive training in proper calibration, sensor care, data collection and documentation. The USGS developed a field manual for collection of water quality data. The document can be found here.

At the deep water monitoring station, measurements should be collected at approximately 0.5 meter intervals, beginning 0.5 meters below the surface and continuing to approximately 0.5 meters above the lake bottom. Secchi disk transparency should also be measured at each designated monitoring station. Monitoring should occur at least monthly (preferably every two weeks) from April through October, with additional measurements during periods of elevated algal activity or unusual lake conditions.

Volunteers should document sampling dates, times, weather conditions, monitoring locations, water depths, and any unusual observations, including algal blooms, odors, or changes in water color. Consistent sampling locations, methods, and recordkeeping are essential for developing reliable long term datasets. Monitoring results should be maintained in a centralized database accessible to the LMD and made available to future consultants and agency staff.

The U.S. Environmental Agency (EPA) developed the Volunteer Lake Monitoring: A Methods Manual to provide guidance for organizing and implementing volunteer lake water quality monitoring programs. The manual identifies appropriate water quality parameters, outlines standardized sampling and measurement procedures, and emphasizes quality assurance and quality control (QA/QC) practices to ensure that data collected by volunteers are reliable and useful to state agencies and other organizations responsible for lake management.

H.3 Professional Water Qualtiy Monitoring & LCMP Planning

If funding is available, the LMD should consider contracting with a qualified environmental consulting team to conduct a more comprehensive water quality monitoring and assessment program. Professional monitoring should build upon the citizen science program by incorporating additional sampling locations, increased monitoring frequency, laboratory analyses, and more rigorous quality assurance and quality control procedures.

A professional monitoring program should include vertical profiles of DO, temperature, pH, and specific conductivity, along with Secchi disk transparency measurements. Water quality profiles should be collected at established monitoring stations using a calibrated multiparameter sonde, with additional measurements near the thermocline and sediment/water interface as needed. Monitoring should occur throughout the growing season, with increased frequency during periods of summer stratification and cyanobacterial bloom development.

In addition to field measurements, professional monitoring should include laboratory analyses of total phosphorus, soluble reactive phosphorus (orthophosphate), total nitrogen, nitrate/nitrite, ammonia, and chlorophyll-a. Samples should be collected from appropriate depths to evaluate differences between surface and bottom waters (hypolimnion) particularly during thermal stratification. Additional monitoring may include cyanobacterial identification and enumeration, cyanotoxin analyses, and measurements of other parameters relevant to nutrient cycling and lake productivity.

Professional investigations should also evaluate potential external and internal nutrient sources. External loading assessments may include monitoring tributary inflows, stormwater discharges, and other potential nutrient inputs within the watershed as discussed in this section. Flow measurements should accompany nutrient sampling to estimate nutrient loads. Internal loading investigations may include sediment phosphorus analyses, sediment phosphorus release studies, and evaluation of nutrient accumulation in bottom waters during periods of oxygen depletion. These investigations would help determine the relative importance of watershed derived nutrient inputs (external loading) and internal phosphorus recycling in contributing to Black Lake's water quality impairment.

H.2 Watershed and Shoreline Management

H.2.1 Nutrient Reduction

H.2.1.1 Septic Systems

Onsite sewage systems (OSS) represent a potential source of phosphorus, nitrogen, and fecal bacteria to Black Lake and its tributaries, particularly where systems are aging, inadequately maintained, or failing. Thurston County Environmental Health conducted a comprehensive Pollution Identification and Correction (PIC) study between 2022 and 2026 to identify sources of nutrient and bacterial contamination within the Black Lake watershed. The investigation included 1,135 water quality samples collected through routine and investigative monitoring, with elevated total phosphorus concentrations documented in tributaries entering the lake. The investigation also identified 76 septic system failures, highlighting the importance of addressing wastewater contributions as part of the lake's long-term water quality improvement strategy (Thurston County Environmental Health 2026).

Reducing nutrient inputs from septic systems should be a priority for Black Lake, particularly given its history of elevated phosphorus concentrations, recurring cyanobacterial blooms, and substantial investments in alum treatments to reduce internal phosphorus loading. The Black Lake Special District

should work with Thurston County Environmental Health to prioritize the repair or replacement of failing septic systems, particularly those near the shoreline and tributaries. A long term strategy should also be developed to encourage the gradual replacement of older conventional septic systems with advanced onsite wastewater treatment technologies that provide improved treatment and minimize nutrient discharges.

The Dept. of Ecology, in collaboration with the Spokane Conservation District, supported pilot testing of advanced OSS technologies at Honeymoon Bay on Newman Lake. The project evaluated two membrane bioreactor (MBR) systems: the BioMicrobics BioBarrier system (in-ground) and the BUSSE GT 500 system (above-ground). These systems combine biological wastewater treatment with membrane filtration to produce high-quality treated effluent while requiring substantially less space than conventional septic systems and drainfields. The Phase I Summary Report (2022) identified previously demonstrated treatment capabilities of up to 98.1% phosphorus removal, 97.9% nitrogen removal, and 99.99% fecal coliform removal for these types of technologies. Monitoring of the two pilot installations demonstrated that both systems could produce effluent meeting Class B reclaimed water constituent requirements. However, phosphorus treatment performance differed between the systems, highlighting the importance of incorporating appropriate phosphorus removal components when nutrient reduction is a primary objective.

Both technologies were approved by the Washington State Department of Health (DOH) for onsite wastewater pretreatment at the time of the study. Ecology has also explored alternative regulatory approaches that would allow advanced treatment systems to operate without relying on conventional soil treatment components, particularly where limited property size, high groundwater, or unsuitable soils prevent installation of traditional drainfields. Given the potential for substantial nutrient removal, the Black Lake Special District should consider promoting advanced MBR technologies as alternatives for replacing failing or poorly performing septic systems, particularly on shoreline properties where wastewater derived phosphorus may contribute directly to lake nutrient loading. The District should work with Ecology, DOH, and Thurston County Public Health to evaluate appropriate treatment configurations, phosphorus removal performance, long term maintenance requirements, costs, and permitting options. Financial assistance or incentive programs could also be explored to encourage homeowners to upgrade existing systems and reduce external phosphorus loading to Black Lake.

A phased septic improvement program is recommended for the Black Lake watershed, beginning with documented failing systems, followed by high risk systems near the lake and its tributaries, and ultimately encouraging upgrades of older systems throughout the watershed. Ecology's Water Quality Combined Funding Program provides grants and loans to eligible local agencies, conservation districts, and Tribes for septic system repair and replacement programs, sanitary surveys, maintenance assistance, and related water quality improvements. Ecology staff have identified grant funding opportunities of up to $500,000 for eligible OSS projects, with additional loan funding potentially available. Individual homeowners may also qualify for financing through Craft3, a nonprofit lender that partners with Ecology to support septic system repair and replacement.

H.2.1.2. Stormwater Runoff

Stormwater runoff can transport pollutants from roads, parking lots, lawns, and other developed areas into lakes and streams. These pollutants may include nutrients such as phosphorus and nitrogen from fertilizers, pet waste, and decaying organic matter, as well as sediment, metals, petroleum products, and other contaminants. Excess phosphorus entering Black Lake through stormwater runoff can contribute

to nutrient enrichment and promote the growth of nuisance algae and cyanobacteria, potentially increasing the frequency and severity of harmful algal blooms.

Thurston County provided stormwater infrastructure maps identifying stormwater conveyance systems, outfalls, and stormwater management facilities surrounding Black Lake. The maps indicate that numerous stormwater outfalls discharge into the northern portion of the lake, including several privately owned outfalls along the eastern shoreline (Figure 33). The associated infrastructure includes stormwater pipes, catch basins, culverts, drainage ditches, swales, vegetated filter strips, and dry ponds. Although some of these facilities may provide stormwater treatment, the maps do not indicate their effectiveness in removing nutrients, sediment, or other pollutants prior to discharge into the lake.

In contrast, the County's map of the southern portion of Black Lake identifies no direct stormwater outfalls, despite showing an extensive network of stormwater collection and conveyance infrastructure in surrounding developed areas (Figure 34). The absence of mapped outfalls does not preclude stormwater contributions through overland runoff, groundwater, or other drainage pathways.

The County's infrastructure maps do not provide stormwater discharge volumes, pollutant concentrations, or nutrient loading estimates. Consequently, the contribution of stormwater runoff to Black Lake's phosphorus concentrations and overall nutrient budget cannot be determined from these maps alone. Targeted stormwater monitoring, particularly at major northern basin outfalls during storm events, would help quantify external phosphorus loading and identify opportunities for improved stormwater treatment and source control. Assessment and quantification of stormwater inputs to the lake is included in Ecology’s LCMP study.



Figure 33. Private stormwater outfalls on the north end of Black Lake



Figure 34. Stormwater system on the south end of Black Lake.

H.2.1.3 Fertilizer Management

Residential lawn fertilizers, compost, and other soil amendments can contribute nutrients to lakes through surface runoff and leaching, potentially increasing nutrient concentrations and promoting excessive aquatic plant growth and cyanobacterial blooms. Although the extent of fertilizer and compost use by residents surrounding Black Lake is unknown, properties with maintained lawns and landscaped areas extending to the shoreline present potential pathways for nutrients to enter the lake.

Washington State restricts the application of fertilizers containing phosphorus to established lawns, with limited exceptions, and has also prohibited phosphorus in laundry and automatic dishwasher detergents. Despite these restrictions, phosphorus and nitrogen from other fertilizers, compost, and organic soil amendments remain potential sources of nutrient loading.

To minimize nutrient inputs to Black Lake, residents are encouraged to eliminate fertilizer applications on lawns and landscaped areas adjacent to the shoreline and avoid applying compost, manure, or other nutrient rich soil amendments where runoff could reach the lake. Throughout the watershed, fertilizer use should be minimized and limited to demonstrated plant nutrient needs based on soil testing. Residents should also avoid applying fertilizers before rainfall, prevent fertilizer and compost from entering drainage systems, and properly manage grass clippings and other organic yard waste. Education and outreach regarding responsible lawn and garden management should be incorporated into ongoing lake stewardship efforts to reduce external nutrient loading and support long term water quality improvements.

H.2.1.4 Fish stocking

Fish stocking can contribute to nutrient loading and nutrient cycling in freshwater lakes through the introduction of fish biomass, excretion of dissolved nutrients, production of fecal material, and decomposition following mortality. Hatchery raised fish introduce nitrogen and phosphorus accumulated in their tissues during rearing, as the feed in hatcheries tend to be high in nutrients, representing an external nutrient input to the receiving waterbody. Following stocking, these nutrients may become available through excretion, mortality, and decomposition, while consumption of aquatic organisms can further redistribute and recycle nutrients already present in the lake. Research has demonstrated that fish stocking can influence nutrient availability and lake productivity. Lyons et al. (2016) examined phosphorus loading in nine lakes in California's Sierra Nevada Mountains and found substantially higher modeled phosphorus loading rates in stocked lakes compared to unstocked lakes. The study also identified a positive correlation between stocking frequency and phosphorus loading rates suggesting that repeated fish introductions may contribute to nutrient enrichment. However, the magnitude of these effects varies with stocking biomass, fish survival, nutrient retention, and lake characteristics.

Historical fish stocking records provided by the Washington Department of Fish and Wildlife (WDFW) indicate that approximately 2.21 million fish were released into Black Lake between 1995 and 2026. Of these, approximately 1.24 million (56%) were stocked as fry, primarily rainbow trout, with smaller numbers of cutthroat trout and black crappie (a non-native fish). Stocking intensity was particularly high during the 1990s and early 2000s, with annual releases exceeding 100,000 fish in several years. The greatest number was recorded in 1998, when 271,888 fish were stocked, equivalent to approximately 475 fish per acre. Rainbow trout fry stocking was discontinued after 2008, according to the available records, although stocking of legal sized rainbow trout has continued annually.

The historical stocking of large numbers of juvenile fish is relevant to the potential influence of fish predation on zooplankton communities and phytoplankton abundance. Rainbow trout fry (approximately 2 inches in length) consume zooplankton, including cladocerans and copepods. Predation on cladocerans, particularly *Daphnia* species, can reduce grazing pressure on phytoplankton and potentially contribute to increased algal biomass through trophic cascade effects. The magnitude of these effects depends on fish survival, stocking density, zooplankton community composition, and other lake specific conditions. Although the influence of historical fish stocking on Black Lake's cyanobacterial blooms has not been directly evaluated, the substantial number of fry historically released suggests that fish stocking may have contributed to changes in the lake's food web structure.

WDFW continues to regularly stock Black Lake with rainbow trout (*Oncorhynchus mykiss*) to support recreational fishing. Stocking records indicate that 30,160 rainbow trout were released during five stocking events in 2025, followed by an additional 21,750 trout during three stocking events between March and April 2026. Collectively, these releases introduced 51,910 hatchery raised trout into Black Lake over only 13 months. Although the nutrient contribution associated with these introductions has not been quantified, the addition of fish biomass represents a potential external source of phosphorus and nitrogen. Research has also demonstrated that stocked trout can temporarily increase nutrient availability through excretion and nutrient recycling (Alexiades et al., 2017). Given Black Lake's history of elevated phosphorus concentrations and recurring cyanobacterial blooms, the potential contribution of fish stocking to nutrient loading and internal nutrient cycling warrants further evaluation. Estimating stocking biomass, phosphorus content, post-stocking survival, and angler harvest would help determine whether fish stocking represents a meaningful component of Black Lake's overall phosphorus budget.

In addition to contributing to nutrient cycling, fish stocking of catchable size fish can **also** influence lake water quality through trophic cascades as with stocking fry, in which changes in fish populations alter zooplankton communities and subsequently affect phytoplankton abundance. Planktivorous fish, including rainbow trout (*Oncorhynchus mykiss*), can selectively consume large bodied zooplankton, particularly cladocerans such as *Daphnia*, which are important grazers of phytoplankton and certain cyanobacteria. Increased predation pressure can reduce the abundance and average body size of zooplankton, decreasing grazing pressure on phytoplankton and potentially contributing to increased algal biomass, reduced water clarity, and greater susceptibility to cyanobacterial blooms (Brett and Goldman 1996; Ekvall et al. 2014). A particularly relevant study of Square Lake, Minnesota, demonstrated that a three-year moratorium on rainbow trout stocking resulted in increased abundance of the large bodied *Daphnia pulicaria* and improved water quality (Hembre, 2019). These findings demonstrate that recreational fish stocking can influence lake water quality even when phosphorus concentrations remain relatively stable. Given the substantial annual stocking of rainbow trout in Black Lake, combined with existing populations of other zooplanktivorous fish, fish mediated trophic cascades may contribute to the lake's recurring algal blooms and poor water clarity. Although these relationships have not been evaluated specifically in Black Lake, assessing zooplankton community composition, fish abundance, and stocking practices could provide valuable information for developing a more comprehensive water quality improvement strategy.

Additionally, but separate from fish stocking, several fish species documented in Black Lake have the potential to contribute to sediment disturbance (bioturbation) through benthic feeding and spawning activities. Common carp (*Cyprinus carpio*) and brown bullhead (*Ameiurus nebulosus*) are of particular concern because their bottom-feeding behavior can resuspend sediments and potentially increase the release of sediment associated phosphorus into the water column. Other species, including pumpkinseed (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*), and rock bass (*Ambloplites rupestris*), may

contribute to localized sediment disturbance through benthic foraging and nest construction. Although these activities generally cause less extensive sediment disturbance than common carp feeding, their cumulative effects may be relevant where fish densities are high. The extent to which fish bioturbation contributes to internal phosphorus loading in Black Lake has not been quantified. Again, fish abundance and biomass surveys, including surveys for common carp and brown bullhead, would help determine whether bioturbation is a significant factor in Black Lake's nutrient dynamics.

H.2.1.5 WATERFOWL MANAGEMENT

Waterfowl, particularly Canada geese (*Branta canadensis*) and native duck species such as mallard (*Anas platyrhynchos*), can contribute phosphorus, nitrogen, and fecal bacteria to lakes through the deposition of fecal material. Nutrient inputs can be particularly significant where large populations of resident or migratory waterfowl congregate, especially when birds feed in surrounding upland areas and subsequently deposit nutrients into the lake (Manny et al. 1994). These inputs may contribute to eutrophication, excessive aquatic plant growth, and cyanobacterial blooms. Waterfowl can also increase fecal indicator bacteria concentrations, potentially affecting recreational water quality.

The extent to which waterfowl contribute to nutrient loading in Black Lake has not been quantified. However, residential lawns, parks, and other maintained grassy areas adjacent to the shoreline provide attractive feeding and resting habitat, particularly for Canada geese. Concentrations of waterfowl in these areas may increase localized nutrient and bacterial inputs to the lake.

Waterfowl management should focus on discouraging unnaturally large concentrations of birds while maintaining suitable habitat for native wildlife. Residents and visitors should avoid feeding ducks, geese, and other waterfowl, as supplemental feeding can attract and concentrate birds and increase fecal deposition. Educational signage at public access areas and outreach to shoreline residents are recommended.

Shoreline property owners should also be encouraged to reduce expanses of closely mowed turf, allow grass to grow taller, and establish dense native vegetation along shorelines. WDFW recommends maintaining grass at approximately 6 inches in height and using native shrubs and emergent vegetation to create physical and visual barriers between the lake and adjacent lawns. Residents should also be discouraged from installing artificial shoreline armoring, such as bulkheads and retaining walls, where natural shoreline stabilization methods are feasible, as hardened shorelines can degrade nearshore habitat and may facilitate waterfowl access to maintained lawns. Replacing turfgrass with native vegetation can discourage geese while providing wildlife habitat, stabilizing shorelines, and intercepting nutrients before they enter the lake. The King County Native Plant Guide provides guidance on selecting appropriate native plants based on site conditions. Low fencing or temporary barriers may also be used where appropriate to discourage geese from accessing maintained grassy areas.

Where persistent concentrations of waterfowl create water quality or nuisance concerns, additional nonlethal deterrents may be considered, including visual scare devices, reflective streamers, commercially available repellents, and other methods recommended by WDFW. Solar-powered flashing amber-light deterrents, such as the *Away With Geese* system, provide another option for discouraging Canada geese from roosting in targeted areas. These devices operate from dusk to dawn and are available in shoreline, dock-mounted, and floating configurations (Away With Geese). This approach has shown promising results in a recent Aquatic Insight project and could be considered for areas of Black Lake where geese regularly congregate overnight. Because geese may become accustomed to

deterrents, WDFW recommends varying techniques and combining multiple approaches to maintain effectiveness (Table 19).

The Black Lake Special District should encourage shoreline residents to implement appropriate waterfowl management practices, in coordination with WDFW where necessary, and evaluate their effectiveness as part of ongoing lake management efforts. Although waterfowl are a natural component of lake ecosystems, reducing artificially elevated concentrations of birds and their associated nutrient inputs represents an additional opportunity to support long term water quality improvements in Black Lake.

Table 19. Waterfowl management strategies

Management Strategy	Description	Advantages and Disadvantages
Discourage feeding of all wildlife	Resident and public education, signage	Removes the encouragement that feeding waterfowl provides.
Shoreline vegetation restoration	Remove grass lawns and restore with tall, dense shrubs and grasses, restore emergent species along lake shore	Discourages waterfowl from using parcels along the lakeshore. Vegetation can compete with cyanobacteria for nutrients. Reduces shoreline erosion.
Predators for chasing	Trained dogs are hired to chase the geese from the site.	Discourages waterfowl from remaining on site and nesting. Can be expensive and intrusive on private property
Predator decoys and other	Realistic decoys - coyotes or owls Reflective streamers and/or flags Fences along the shoreline Motion activated sprinklers Chemical repellants	Relatively inexpensive One method may not work for long, multiple methods tend to work better
Lethal control	Capturing and culling the geese population Addling eggs of geese via shaking vigorously, pierce eggshell, apply thin coating of corn oil	USFWS permits are required WDFW permits are required Adult geese are very protective and addling eggs may cause them to charge

H.2.1.6 Wake Boats

Recreational boating, particularly the operation of wake boats designed to generate large waves for wakesurfing and wakeboarding, can contribute to sediment resuspension, shoreline erosion, and reduced water quality. Wake boats produce larger, more energetic waves and greater water column turbulence than conventional recreational boats under typical operating conditions (Marr et al. 2022). Propeller turbulence and wave action can disturb lake bottom sediments, increasing suspended sediment

concentrations and turbidity, reducing water clarity, and potentially releasing sediment associated nutrients into the water column (Ortiz et al. 2024, 2026).

Of particular concern is the potential mobilization of phosphorus stored in lake sediments. Sediment resuspension can increase concentrations of particulate phosphorus and, under certain conditions, release bioavailable phosphorus into the water column, where it may contribute to phytoplankton growth and cyanobacterial blooms. Recent research has documented water-column mixing depths of approximately 5 to more than 10 meters (16–33feet) during wake boat operation, as well as evidence of sediment disturbance and increased nutrient concentrations following boat passage (Ortiz et al. 2026). In stratified lakes, deeper mixing may also transport phosphorus rich bottom water into surface waters, potentially increasing nutrient availability.



Wake Boat Activity during the vegetation survey. Photo taken by: Cher Prazak

These potential impacts are particularly relevant to Black Lake, which has a mean depth of approximately 18.4 feet (5.6 meters), a maximum depth of approximately 30 feet (9.2 meters), and a history of elevated phosphorus concentrations and recurring cyanobacterial blooms. Black Lake also received alum treatments in 2016 and 2021 to reduce internal phosphorus loading. Sediment disturbance associated with wake boat activity could potentially resuspend phosphorus containing sediments, including sediments previously treated with alum, although the extent to which this affects phosphorus availability or alum treatment effectiveness has not been evaluated specifically for Black Lake.

To minimize potential impacts on water quality, wake boat operators should avoid generating large wakes in shallow areas and near shorelines, where wave action and propeller turbulence are more likely to disturb bottom sediments. Education and outreach should emphasize the potential effects of wake boat operation on sediment resuspension, nutrient cycling, shoreline erosion, and aquatic habitat.



Significant shoreline erosion due to high wave activity. Photo taken by Cher Prazak

Given Black Lake's history of elevated phosphorus concentrations, recurring cyanobacterial blooms, and substantial investments in alum treatments to reduce internal phosphorus loading, minimizing activities that disturb lake bottom sediments is an important water quality management consideration. The Black Lake Special District is considering restrictions on wake boat operations, including a potential prohibition, to reduce sediment resuspension, shoreline erosion, and the potential mobilization of sediment associated phosphorus. Although the extent to which wake boat activity may affect the longevity or effectiveness of Black Lake's alum treatments has not been evaluated, the documented ability of wake boats to generate substantial water column turbulence and disturb bottom sediments provides a scientific basis for considering precautionary management measures (Marr et al. 2022; Ortiz et al. 2024, 2026). Any proposed restrictions should consider lake bathymetry, sediment characteristics, the location of alum treated areas, and the potential for wake boat activity to compromise ongoing water quality restoration efforts.

H.3 Shoreline modification

H.3.1 Shoreline Master Program

Black Lake is regulated under Washington's Shoreline Management Act (RCW 90.58) and the Thurston County Shoreline Master Program (SMP), which establishes standards for shoreline development, vegetation conservation, shoreline stabilization, and protection of aquatic habitat. Shoreline jurisdiction generally includes the lake and adjacent upland areas extending 200 feet landward from the ordinary high water mark (OHWM), as well as associated wetlands and other qualifying areas. Thurston County adopted an updated SMP draft in December 2023; however, the update remains subject to the Dept. of Ecology approval, and the County's previously adopted SMP remains in effect until the update is formally approved and adopted, which is expected by the end of 2026.

The proposed 2023 SMP emphasizes the protection and restoration of native shoreline vegetation, maintenance of vegetated buffers, and minimization of alterations that adversely affect shoreline ecological functions (2023 Preliminary Shoreline Environment Designation Map for Black Lake below). Proposed regulations restrict extensive vegetation clearing, removal of native trees and shrubs, shoreline grading, and construction of new hard shoreline stabilization structures. Bulkheads, retaining walls, and riprap are generally discouraged where nonstructural or soft shoreline stabilization methods, including native vegetation and bioengineering techniques, can adequately protect existing structures. Replacement of existing shoreline stabilization structures is also subject to restrictions intended to prevent additional encroachment into the lake and avoid further degradation of nearshore habitat.

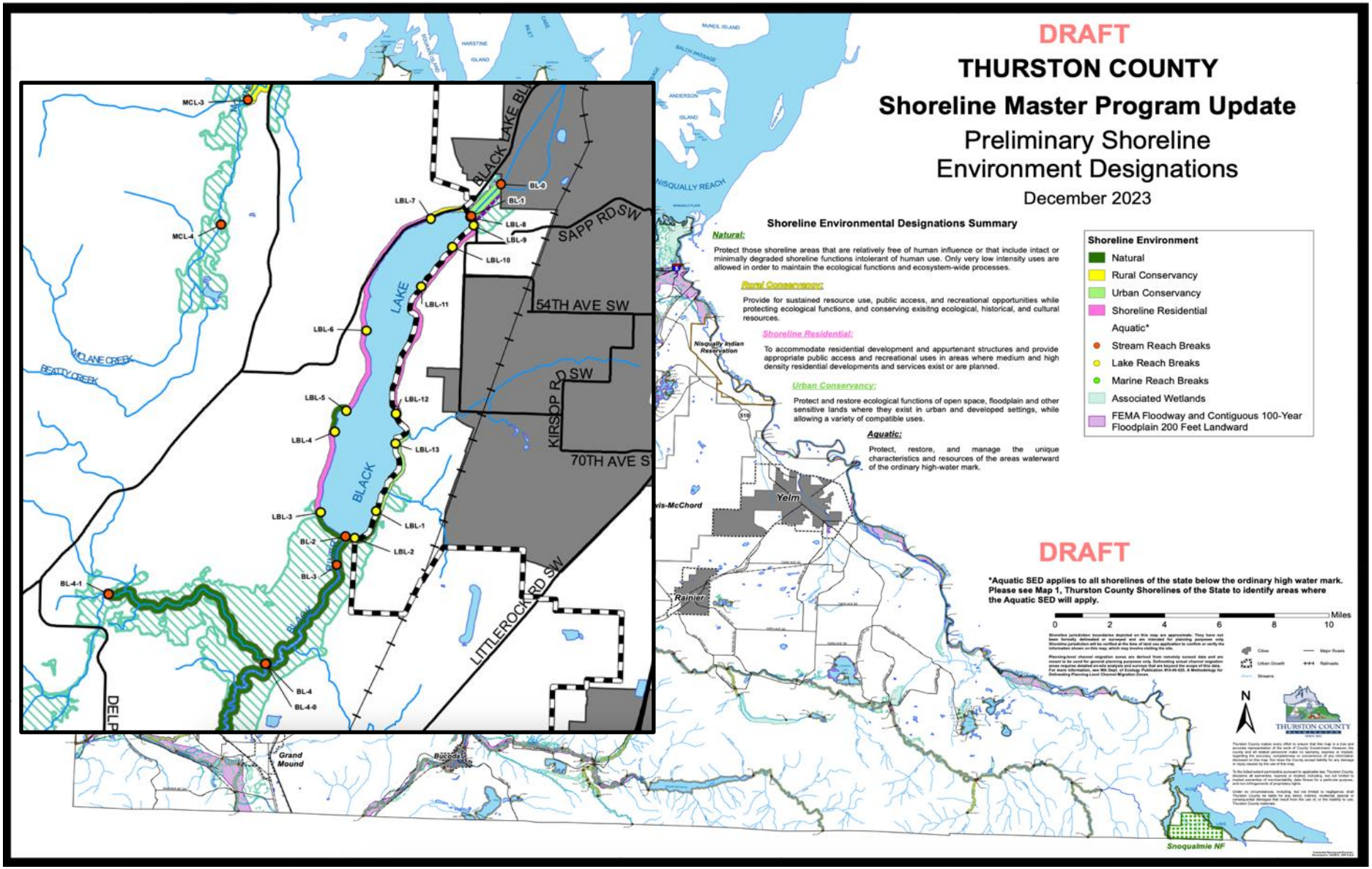
Shoreline property owners should retain native trees, shrubs, and other vegetation wherever feasible and avoid converting naturally vegetated shoreline areas to lawns, impervious surfaces, or hardened shorelines. Native shoreline vegetation helps stabilize banks, intercept sediment and nutrients carried by surface runoff, provide shade and habitat for aquatic organisms, and maintain ecological connectivity between terrestrial and aquatic environments. Maintaining and restoring these functions is particularly important for Black Lake, where nutrient enrichment and recurring cyanobacterial blooms are ongoing water quality concerns.

Before constructing or replacing bulkheads, installing riprap, removing shoreline trees or shrubs, grading shoreline areas, constructing docks, or undertaking other shoreline modifications, property owners should consult Thurston County Community Planning and Economic Development to determine applicable shoreline designations, vegetation buffer requirements, and necessary permits. Property owners should also consult WDFW and other regulatory agencies, as appropriate, before conducting work within or adjacent to the lake. Activities exempt from a Shoreline Substantial Development Permit may still be subject to other shoreline regulations and permit requirements (Table 20).

Table 20. Agencies regulating shoreline modification activities.

Agency	Possible Regulated Activity
Thurston County	Shoreline development, vegetation clearing, grading, bulkheads, docks, construction, critical area impacts
WDFW	Bulkheads, bank stabilization, docks, dredging, aquatic vegetation removal – HPA approval
Ecology	Aquatic herbicide application, water quality protection, potentially Section 401 water quality certification
DNR	Activities affecting state owned aquatic lands
Army Corps of Engineers	Certain dredging, filling and structures or other work n jurisdictional waters

H.3.1 2023 Shoreline Master Plan



H.3.2 Shoreline restoration

Restoring and maintaining natural shoreline vegetation is an important component of protecting and improving water quality, aquatic habitat, and the overall ecological health of Black Lake. Residential development and shoreline modifications, including the removal of native vegetation, conversion of shorelines to maintained lawns, and installation of bulkheads and other hardened structures, can reduce the ecological functions of natural shoreline areas. Native trees, shrubs, grasses, and other vegetation help stabilize shoreline soils, reduce erosion, slow surface runoff, and intercept sediment, nutrients, and other pollutants before they enter the lake. These functions are particularly important for Black Lake, where elevated phosphorus concentrations and recurring cyanobacterial blooms remain ongoing water quality concerns.

Restoring native shoreline vegetation also provides important habitat benefits by increasing shoreline complexity, providing shade, and creating habitat for birds, amphibians, insects, and other wildlife. Vegetated shorelines can also discourage Canada geese from congregating on maintained lawns, potentially reducing localized nutrient and bacterial inputs from waterfowl. Shoreline restoration does not necessarily require eliminating recreational access or lake views. Property owners can incorporate designated access paths, maintain appropriate viewing corridors, and establish native vegetation along portions of their shoreline while preserving access to docks and swimming areas. Encouraging voluntary shoreline restoration, particularly where extensive lawns extend to the water's edge, represents a practical opportunity to improve shoreline habitat and reduce external nutrient inputs to Black Lake.

H.3.2.1. Native Shoreline Revegetation

Native shoreline revegetation involves replacing maintained turfgrass, invasive plants, or sparsely vegetated shoreline areas with native trees, shrubs, grasses, and other plants adapted to local soil moisture, sunlight, and seasonal water level conditions. Restoration should begin with an assessment of existing vegetation, shoreline slope, drainage patterns, soil conditions, and areas used for recreation. Plant selection should reflect the moisture conditions of different shoreline zones, recognizing that areas closest to the water may experience seasonal flooding while slightly elevated areas may remain comparatively dry. A combination of native plant species with different growth forms and root structures is recommended to improve soil stability, provide diverse habitat, and increase the likelihood of successful establishment.

Suitable native shoreline plants may include red-osier dogwood (*Cornus sericea*), Pacific ninebark (*Physocarpus capitatus*), salmonberry (Rubus spectabilis), hardhack (*Spiraea douglasii*), and native willow species (*Salix spp*.) in moist shoreline areas. Taller trees, such as western redcedar (*Thuja plicata*) and Sitka spruce (*Picea sitchensis*), may be appropriate in selected locations where adequate space and suitable growing conditions exist. Lower-growing native grasses, sedges, and herbaceous plants can be incorporated where maintaining lake views is a priority. Plantings should be arranged to create a relatively continuous vegetated buffer while accommodating designated shoreline access areas. The King County Native Plant Guide provides recommendations for shoreline planting, including species selection, planting arrangements, and landscaping plans for different site conditions.

Revegetation projects should generally begin with the removal or control of invasive terrestrial plants, followed by preparation of planting areas and installation of appropriate native species. Planting during fall or early spring is recommended to take advantage of cooler temperatures and seasonal rainfall. Newly installed plants should be mulched, watered during dry periods, and protected from competing vegetation and wildlife damage until established. Regular maintenance, including invasive plant control,

replacement of unsuccessful plantings, and supplemental watering during the first several growing seasons, will improve long-term restoration success. Residents should consult Thurston County before undertaking shoreline vegetation removal, grading, bank modifications, or other activities that may be regulated under the Shoreline Master Program or critical areas regulations. Small-scale native planting projects that do not involve substantial ground disturbance may have fewer permitting requirements, but applicable regulations should be verified before beginning work.

Additional resources for shoreline restoration and revegetation projects include: 1) King County Plant a Beautiful Shoreline and 2) Steps for a Successful Restoration Project

H.4 Conclusions and Management Actions

Black Lake continues to experience water quality challenges associated with elevated phosphorus concentrations, recurring cyanobacterial blooms, and nutrient inputs from both watershed and potentially internal sources. Although previous alum treatments have been implemented to reduce phosphorus release from lake sediments, the relative contributions of external nutrient loading, internal phosphorus recycling, and biological processes to the lake's ongoing water quality impairment remain uncertain. Improving water quality will require a coordinated, long term management strategy that combines nutrient source reduction, routine monitoring, shoreline protection, and further investigation of the factors contributing to cyanobacterial blooms.

The following management actions are recommended for the Black Lake Special District, in coordination with residents, Thurston County, the Dept. of Ecology and other appropriate agencies.

- **Establish a long-term water quality monitoring program.** Develop a citizen science monitoring program using trained residents to collect routine vertical profiles of dissolved oxygen, temperature, pH, and specific conductivity, along with Secchi disk transparency measurements. Monitoring should occur at established locations and follow standardized procedures to ensure consistent, reliable data collection. When funding permits, supplement volunteer monitoring with professional sampling and laboratory analyses of nutrients, chlorophyll-a, and other parameters needed to evaluate lake conditions and seasonal trends.
- **Pursue funding for a comprehensive Lake Cyanobacteria Management Plan (LCMP).** Apply for funding through Ecology's Freshwater Algae Control Program to conduct a more comprehensive assessment of Black Lake's water quality and the underlying causes of recurring cyanobacterial blooms. The LCMP should evaluate external and internal nutrient loading, thermal stratification, dissolved oxygen depletion, seasonal nutrient cycling, and biological processes that influence phytoplankton abundance. The resulting information should be used to develop scientifically supported nutrient reduction strategies, establish measurable water quality objectives, and prioritize future management investments.
- **Evaluate the effectiveness and longevity of previous alum treatments.** As part of the future LCMP, assess the effectiveness of the alum treatments conducted in 2016 and 2021, including their continued capacity to bind phosphorus in lake sediments. Investigations should include current sediment phosphorus release rates, sediment phosphorus characteristics, and phosphorus accumulation in bottom waters during stratification. Comparing these results with available historical monitoring data would help determine whether internal phosphorus loading remains a significant contributor to cyanobacterial blooms despite previous treatment efforts and whether additional in-lake phosphorus management is warranted.

- **Prioritize septic system improvements.** Coordinate with Thurston County Environmental Health to address the 76 failing septic systems identified during the 2022–2026 PIC study. Establish a phased improvement strategy that prioritizes documented failures, high-risk shoreline properties, and systems near tributaries. Encourage the replacement of older conventional systems with advanced wastewater treatment technologies capable of reducing phosphorus and nitrogen discharges as discussed above. Explore funding programs (see Funding Strategy Table below) and homeowner financing opportunities to support septic system repairs and upgrades.
- **Evaluate stormwater phosphorus loading and treatment opportunities.** Conduct targeted monitoring of major stormwater outfalls, particularly those discharging into the northern portion of Black Lake. Storm event sampling should include total phosphorus, dissolved phosphorus, and total suspended solids, together with discharge measurements to estimate pollutant loads. Results should be used to identify significant nutrient sources, evaluate the effectiveness of existing stormwater treatment facilities, and prioritize improvements where additional treatment or source control is warranted.
- **Promote fertilizer reduction and responsible landscaping practices.** Encourage residents to eliminate fertilizer applications on shoreline lawns and landscaped areas and minimize fertilizer use throughout the watershed. Educational outreach should emphasize avoiding nutrient-rich soil amendments near drainage pathways, preventing grass clippings and yard waste from entering the lake, and using soil testing to determine fertilizer needs.
- **Evaluate fish stocking practices and food web interactions.** Coordinate with the WDFW to assess whether continued rainbow trout stocking contributes meaningfully to nutrient loading, nutrient recycling, or changes in zooplankton communities. A future LCMP should consider evaluating fish abundance and biomass, zooplankton community composition, and the potential effects of fish predation on large-bodied grazers such as *Daphnia*. The potential contribution of bottom-feeding fish, particularly common carp and brown bullhead, to sediment disturbance and phosphorus mobilization should also be investigated. These assessments would help determine whether modifications to fish stocking or other fisheries management practices could contribute to improved water quality.
- **Implement waterfowl management practices.** Encourage residents and visitors to avoid feeding waterfowl and reduce shoreline conditions that attract unnaturally large concentrations of geese and ducks. Promote taller shoreline vegetation, native planting buffers, and appropriate nonlethal deterrents in areas where waterfowl congregate. Educational signage and coordination with WDFW should support these efforts to reduce localized nutrient and bacterial inputs.
- **Minimize sediment disturbance associated with wake boat activity.** Consider restrictions on wake boat operations to reduce sediment resuspension, shoreline erosion, and the potential mobilization of sediment-associated phosphorus. Management decisions should consider Black Lake's relatively shallow depths, history of alum treatments, and the potential for propeller turbulence and large wakes to disturb lake sediments. Education and outreach should also encourage boating practices that minimize impacts on shoreline habitats and water quality.
- **Protect and restore native shoreline vegetation.** Encourage property owners to retain existing native shoreline vegetation, replace maintained turfgrass with native trees, shrubs, grasses, and sedges, and establish vegetated buffers wherever feasible. Prioritize restoration of shoreline areas with extensive lawns, exposed soils, erosion, or invasive vegetation. Native revegetation can reduce nutrient and sediment runoff, improve shoreline stability, discourage waterfowl congregation, and enhance nearshore habitat while accommodating appropriate recreational access.

- **Discourage additional shoreline hardening and promote compliance with shoreline regulations.** Encourage the use of natural shoreline stabilization and restoration techniques rather than bulkheads, retaining walls, and riprap where feasible. Shoreline modifications should be consistent with the Thurston County Shoreline Master Program and applicable state and federal requirements. The LMD should provide residents with information on permitting requirements, shoreline restoration resources, and appropriate native plant selection.

Long-Term Management Priorities

The LMD should prioritize actions that can reduce existing nutrient inputs while pursuing funding for the more comprehensive investigations needed to understand Black Lake's water quality impairment. **Septic system improvements**, responsible shoreline management, fertilizer reduction, waterfowl deterrence, and routine water quality monitoring **can begin or continue without waiting for completion of an LCMP.**

However, major future investments in lake wide nutrient management should be informed by a comprehensive assessment of phosphorus sources, internal loading processes, and biological factors influencing cyanobacterial blooms. An Ecology funded LCMP would provide the scientific foundation needed to distinguish the underlying causes of water quality impairment from its symptoms, evaluate the effectiveness of previous management actions, and identify the most appropriate and cost effective long term strategies for improving Black Lake's water quality.

I. Funding Strategy

Table 21. Potential funding sources to support IAVMP control actvities and future waer quality improvements

Grant Agency	Grant Program	Restoration Method	Entities Eligible
Environmental Protection Agency	Pollution Prevention Grant	Creek restoration Wetland restoration	State agency, Educational Institutions, Tribes
Environmental Protection Agency and National Fish and Wildlife Foundation	Five Star and Urban Waters Restoration Grants Program	Shoreline restoration Creek restoration Wetland restoration	Non-profit organizations, State agencies, Local governments, municipal governments, Tribes, Educational institutions
Environmental Protection Agency	Wetland Program Development Grants	Shoreline restoration Creek restoration Wetland restoration	Tribes, Local governments, State agencies, Interstate entities
Department of Ecology and Puget Sound Partnership	National Estuary Program - Habitat SIL	Shoreline restoration Creek restoration Wetland restoration	Federal and State agencies, Local governments, Non-profit organizations, Tribes, Educational institutions
Department of Ecology	Freshwater Algae Control Program	Lake Cyanobacteria Management Plan (LCMP)	State agencies, Local governments, Special Purpose Districts, Tribes
Department of Ecology	Aquatic Invasive Plant Program	**Aquatic and emergent invasive plant control**	State agencies, Local governments, Special Purpose Districts, Tribes
Department of Ecology	Water Quality Combined Funding Program	All non-point activities - Shoreline restoration Riparian /wetland restoration OSS replacement	Tribes, State and Local governments, Non-profit organizations, Special purpose districts, Conservation districts
Department of Ecology	Floodplain by Design	Shoreline restoration Creek restoration Wetland restoration	Conservation Districts, Local governments, Tribes, Ports, Non-profit organizations
Department of Ecology	Puget Sound Riparian Systems Lead	Targets river and stream systems in Puget Sound watersheds	Special Purpose Districts, Local governments, Tribes, Nonprofits and Universities
Department of Ecology	Terry Husseman Account	Environmental restoration near lakes and other state waters.	Special Purpose Districts, Local governments, Tribes, State agencies, Fisheries Enhancement Groups
WA Conservation Commission	Riparian Grant Program	Native riparian plantings, restoration planning, implementation & maintenance	Conservation Districts only
Recreation and Conservation Office	Estuary and Salmon Restoration Program	Shoreline restoration Creek restoration Wetland restoration	Federal and State agencies, Local governments, Non-profit organizations, Tribes, Educational institutions, Private institutions

J. Roles and Responsibilities

For projects to succeed, it is crucial that all participants clearly understand their roles and responsibilities. Clearly defining these roles offers several benefits, including enhanced clarity, greater accountability, improved efficiency, faster achievement of project goals, better collaboration, and a reduction in misunderstandings, conflicts, and duplication of efforts. It also leads to more effective resource allocation and strengthens communication and shared ownership of both project successes and challenges.

The key entities responsible for coordinating and implementing the recommended management options for Black Lake are detailed in Table 22 below.

Table 22. Roles and Responsibilities

Entity	Roles	Responsibilities
Black Lake Management District and Lake Association	Lead	Assist the county with grant and funding procurement Review and select Management Plan recommendations Procure funding mechanisms for chosen management plan Manage contracts for implementing IAVMP recommendations Educate the public, residents & LMD participants on BMPs Lead for water quality monitoring
Thurston County	Support LMD Continue water quality monitoring Community engagement	Educate lake residents and lake users on identification and impacts of invasive species and EDRR Lead for supporting BMPs
Dept. Of Ecology Wes Glisson – Aquatic Plant Specialist Joey Teresi – Grant & Project Manager	Monitoring support IAVMP Reviewers	Review IAVMP for scientific integrity Provide funding for invasive plant control Provide funding for OSS replacement, wetland and shoreline vegetation restoration

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