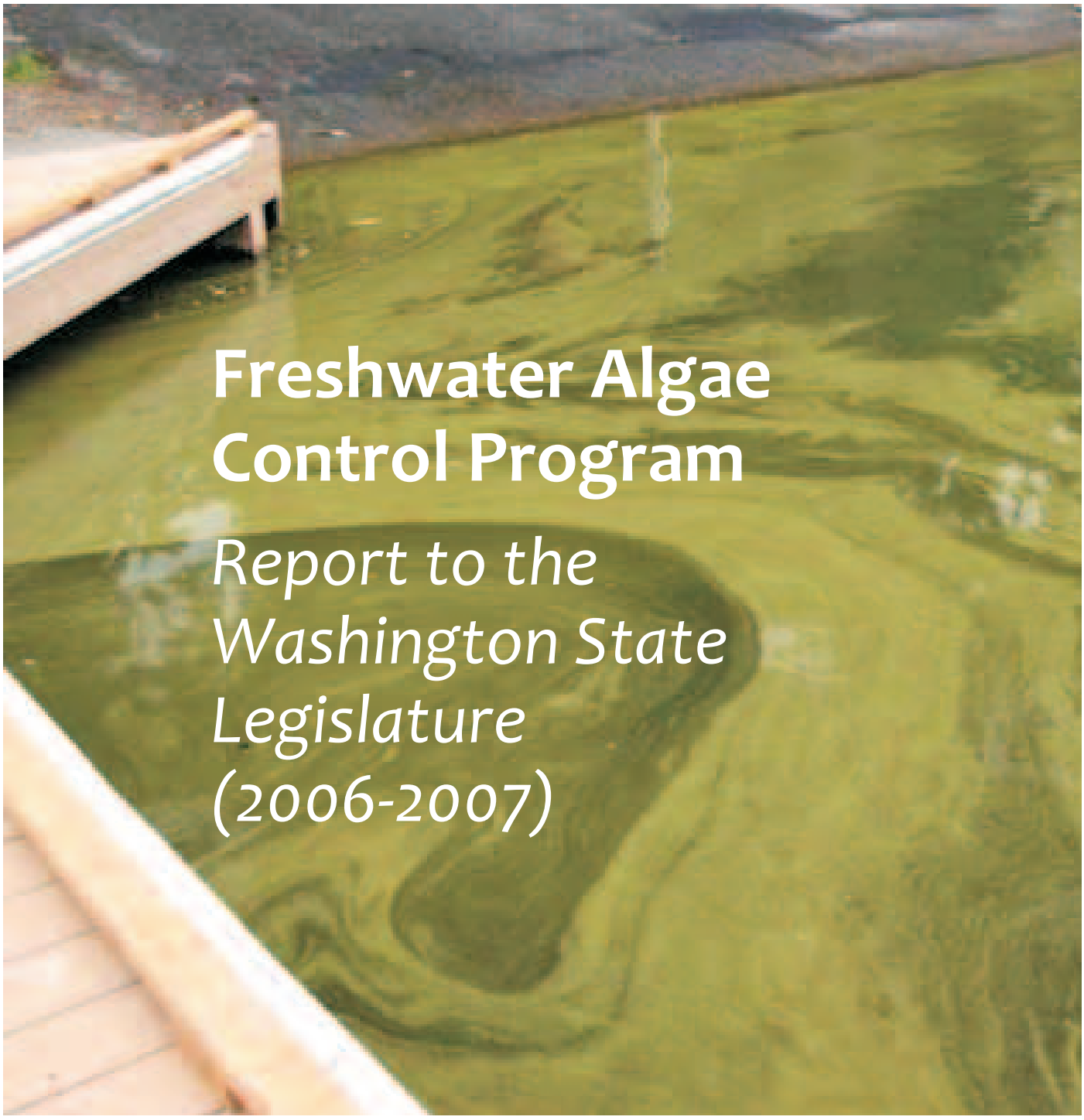

photo by Don Russell

Freshwater Algae Control Program

Report to the Washington State Legislature (2006-2007)

Toxic blue-green algae bloom on Spanaway Lake

WASHINGTON STATE DEPARTMENT OF ECOLOGY

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Program overview

By establishing the Freshwater Algae Control Program, Washington leads the nation in recognizing blue-green algae and their toxins as a serious problem.

Blue-green algae blooms are becoming more common in Washington water bodies. Blooms are dense populations of algae that can sometimes look like a green paint spill in a water body. Blue-green blooms are of particular concern, because some types of blue-green algae produce potent toxins that can kill pets and have the potential to affect humans.

In most cases, blue-green blooms form because of plant nutrients such as nitrogen and phosphorus in the water. These nutrients enter the water body through the land practices of local and watershed residents, storm-water inputs, agricultural runoff, waterfowl, and other external sources.

Sediments may also release nutrients into the water when nutrient-enriched sediments become low in oxygen (called internal nutrient loading). Other factors such as light, temperature, and zooplankton grazing can influence bloom formation. Reducing nutrient input to these water bodies is the best long-term solution to preventing blue-green algae blooms.

In 2005, the Washington State Legislature (Legislature) recognized the problems caused by algae when it established funding for a Freshwater Algae Control Program (*RCW 43.21A.667*) and tasked the Washington Department of Ecology (Ecology) with program development. The Freshwater Algae Control Program focuses on providing local governments with the tools they need to manage algae problems once they occur. This report covers activities conducted during 2006 and 2007.

Jim Lott / Seattle Times

Berni Kenworthy, left, of the University of Washington and Jean Jacoby of Seattle University take concentrated samples from Green Lake. Biologists aren't sure exactly what caused the algae bloom that prompted officials to shut down the lake.

Elements of Ecology's Freshwater Algae Control Program include:

- Toxicity testing for blue-green algae blooms.
- A mail-in service for identification of algae blooms in Washington waters.
- A web-based database to post algae identification and toxicity testing results.
- Algae alerts when a local health jurisdiction decides to close a lake to recreation.
- A partnership with Washington Department of Health (DOH) for the development of statewide guidelines for toxic algae blooms. This includes guidance to local health jurisdictions about how to react to toxic algae blooms.
- Ecology and DOH websites with information about freshwater algae, management methods, and human and pet health risks of toxic blue-green algae.
- A small grants program to fund freshwater algae control projects.

Nutrients are the primary cause of algae blooms. Although costly, nutrient reduction planning and implementation are the only long-term solutions to reducing them. Determining the source of nutrients and developing a nutrient-reduction plan may cost several hundred thousand dollars.

Implementing meaningful nutrient-reduction activities can cost millions of dollars for each affected water body. Because of financial limitations, the Freshwater Algae Control Program cannot fund whole-lake or watershed-wide nutrient reduction activities to preserve the long-term health of Washington lakes.

Control measures are temporary. This summer, *Microcystis*, a toxic blue-

green algae, started blooming in Lake Steilacoom. The lake residents funded an extensive treatment with an algaecide which killed the bloom, but it returned a few weeks later. Treating with an algaecide did not result in a long-term solution of preventing toxic algae blooms in Lake Steilacoom.

Focus on blue-green algae (cyanobacteria)

The Freshwater Algae Control Program focuses on blue-green algae (also known as cyanobacteria) because:

- Blue-green algae pose a health risk to humans, pets, livestock, fish, waterfowl, and wildlife.
- Blue-green blooms affect lake recreational activities and create economic losses.
- The Legislature directed Ecology to target financial assistance to improving conditions in lakes experiencing harmful algae blooms.

Although many blue-green blooms are not toxic, some blue-green algae toxins target the nervous system or the liver. They may also cause skin irritation or gastric symptoms. A single species of algae can have toxic and non-toxic strains. A bloom that is not toxic one day may become toxic the next. Toxicity of a bloom is difficult to predict. Laboratory tests provide the only reliable way to predict whether a bloom is toxic.

People may become ill after playing, wading, swimming, or water skiing in lakes experiencing toxic blue-green algae blooms. Some residents drink lake water and these people may ingest algae toxins. Because resident fish caught in lakes with toxic blooms may concentrate toxins in internal organs, DOH advises people to immediately clean them and discard all internal organs.

Human health effects from algae toxins may include stomach pains, vomiting, diarrhea, skin rashes, sore throat, ear and eye irritation, fevers, blistered mouth, and nerve and liver damage. Algae toxins may also have long-term health effects including promoting liver cancer and possibly neurological diseases in people.

Toxic blue-green blooms may affect species other than humans. Dogs and cats, wildlife, waterfowl, and fish have died after exposure to toxic blue-green algae in Washington lakes.

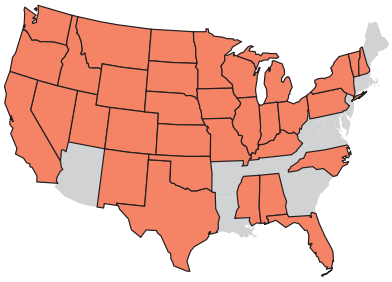
Several years ago, thousands of young trout died in net pens in Lawrence Lake in Thurston County during a blue-green bloom. The Washington Department of Fish and Wildlife staff attributed this fish kill to a lack of oxygen due to algae decomposition or possibly algae toxins.

In 2007, veterinarians reported that two dogs died in separate incidents after swimming in Potholes Lake in Grant County. Toxicity tests conducted through Ecology's Freshwater Algae Control Program showed that the bloom in Potholes Reservoir was toxic.

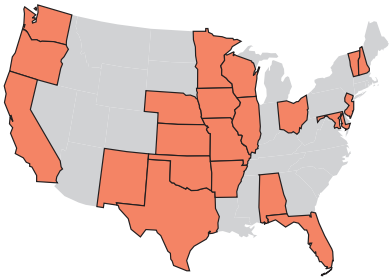
In 2006, dogs died after swimming in Anderson Lake in Jefferson County. Algae toxin levels in the lake were high at the time that the dogs died. In earlier years, other pets have died after exposure to toxic blooms in Lake Steilacoom and other water bodies.

Toxic blue-green algae blooms are emerging as a national and international issue. Recent headlines in the New York Times (*10/14/2007*) describe a toxic bloom in a lake in China that affected drinking water for more than two million people. By establishing the Freshwater Algae Control Program, Washington leads the nation in recognizing blue-green algae and their toxins as a serious problem.

Blue-green algae can kill livestock, like cattle.



At least 33 States have anecdotal reports of human or animal poisonings associated with algae toxins
(Source: United States Geological Service)



Blue-green algae made the news in at least 21 States during 2006
(Source: United States Geological Service)

Accomplishments of the Freshwater Algae Control Program

People and health agencies need information about whether toxic blue-green algae blooms are occurring in their lakes, rivers, or ponds.

Algae identification and toxicity testing

In 2007, Ecology established an algae identification and toxicity-testing program for Washington lake residents, local health districts, and local lake managers using funds from the Freshwater Algae Control Program. People and health agencies need information about whether blue-green algae blooms are occurring in their lakes, rivers, or ponds. They also need to know if these blooms produce toxins and at what concentrations.

The Freshwater Algae Control Program provides information about:

- Washington water bodies experiencing blue-green algae blooms.
- Time of year that blooms occur.
- Type of algae (species/genera) in a water body.
- Toxin levels of the blooms.
- Duration of the bloom.

Algae bloom data will allow Ecology to focus technical and financial assistance on the most impaired water bodies. Sampling algae blooms statewide will also help Ecology detect early infestations of invasive freshwater algae such as *Cylindrospermopsis*. *Cylindrospermopsis*, a toxin-producing blue-green algae generally considered to be sub-tropical, was recently found in Idaho and Oregon.

To initiate the program, Ecology developed an interagency agreement with King County Environmental Laboratories (KCEL) for algae identification and toxicity testing. KCEL tests for two toxins–microcystins (liver toxins) and anatoxin-a (nerve toxins). These toxins are generally of greatest concern for human health. They are also the toxins associated with pet and livestock deaths. In 2007, KCEL tested for microcystins, the most common algae toxins. In 2008, KCEL will have the capability to test for anatoxin-a.

Here is how the algae identification and toxicity testing service works:

- Lake residents or local governments contact Ecology for instructions on how to collect and mail algae samples to KCEL.
- Ecology sends lake residents a sampling kit with sampling instructions. The sampling kit includes an amber glass bottle, an ice pack, mailing labels, and a Styrofoam shipping container (see photograph below).
- Because blue-green bloom distribution can be patchy, Ecology and DOH prefer that samplers collect algae scums when possible.
- Samplers keep the bloom sample on ice, then ship it overnight to KCEL.

(Photo courtesy of Jacob Kann, Ph.D., Aquatic Ecosystem Sciences LLC)

Blue-green algae sample

Algae sampling kit.

◆ When the sample arrives at the laboratory, KCEL identifies the algae to genus level (Example: *Anabaena* spp.).

◆ If a sample contains toxin-producing blue-green algae, laboratory staff freeze it (to release the toxins), and analyze for microcystins. In 2008, KCEL will also begin testing for anatoxin-a.

◆ If a bloom is toxic or if potentially toxin-producing blue-greens are present, Ecology asks the sampler to collect additional samples for toxicity testing.

◆ Ecology also asks samplers to continue to sample lakes with toxic blooms for two weeks after the bloom subsides. As blooms die and decay, they may release their toxins into the water. These toxins may persist, even though algae are no longer visible.

◆ KCEL saves the shipping containers and ice packs for reuse by Ecology.

Ecology announced the algae identification and toxicity-testing program by issuing a press release, writing articles for the Washington Lake Protection Association newsletter, and sending out email information to lake residents, lake managers, city and county staff, and local health jurisdictions. Ecology and DOH staff also met with the public health directors to discuss the Freshwater Algae Control Program.

What happens if the blue-greens in a lake are toxic?

If a lake has a toxic algae bloom, Ecology immediately notifies the appropriate local health jurisdiction and DOH. Once notified, the local health jurisdiction (not the state) determines what actions, if any, it takes to protect human health.

DOH has developed statewide guidance to help local health jurisdictions select appropriate actions based on algae toxin levels. Actions range from no action, recreational advisories, recreational closures, to closure of the water body to all activities.

DOH is also preparing signs that local health jurisdictions may use for posting or closing water bodies to recreational activities. The photographs (right) show signs that Jefferson County posted on Anderson Lake during a toxic algae bloom (dogs died after swimming in the lake).

In collaboration with Ecology's and DOH's Beach Environmental Assessment, Communication and Health (BEACH) program, DOH developed a website to notify interested parties if a local health jurisdiction posts an algae toxin advisory or closes a water body for recreation. When a local health jurisdiction notifies Ecology about an action taken because of an algae toxin, Ecology will post this information on the BEACH website.

Examples of notifications used with toxic algae blooms.

Pet owners need to be careful. Don't allow your dog to swim in blue-green algae infested waters.

Local health jurisdictions and other stakeholders requested direction from the state on what actions to take when dealing with toxic blooms.

Interpreting the toxicity results

The World Health Organization (WHO) has established provisional risk categories for adverse health effects due to microcystins in recreational waters (Table 1).

Table 1: WHO Risk Categories

Microcystin Concentration	Risk Level
< 10 µg/L	Low
10 - 20 µg/L	Moderate
20 - 2,000 µg/L	High
>2,000 µg/L	Very High

No federal agency has established recreational risk levels for microcystins. The United States Environmental Protection Agency (EPA) has released a draft review of toxicity studies for microcystins, anatoxin-a, and cylindrospermosin. EPA's draft report is under review by an expert scientific panel. Values from this report may help EPA develop national recreational guidelines for the above toxins.

In the first year of the Freshwater Algae Control Program, Ecology negotiated an interagency agreement with DOH to develop statewide recreational guidelines for blue-green toxins. Local health jurisdictions and other stakeholders requested direction from the state on what actions to take when dealing with toxic blooms. The recreational guidelines establish action levels for local heath jurisdictions.

DOH reviewed relevant scientific literature and coordinated with other states that are dealing with the same problems before developing recreational guidelines for microcystin. Vermont and Oregon have recently established recreational guidance values (6µg/L and 8µg/L, respectively) for the cyanobacterial toxin microcystin. DOH decided to set a provisional action level at 6 µg/L microcystin using the WHO tolerable daily intake value of 0.04 µg/kg/day in its calculation.

DOH has reviewed scientific literature on anatoxin-a and is developing a recreational guidance value for this toxin.

Waughop Lake

photo by Don Russell

Toxicity testing results - *Washington lakes have toxic algae!*

From spring 2007 to the end of October 2007, local health jurisdictions and state and county lake staff collected 57 algae samples from 24 lakes in 11 counties (three in eastern Washington and eight in western Washington). Because blue-greens continue to bloom even late into the year, the total number of samples for 2007 will be greater than 57.

Lakes in both Eastern and Western Washington produced significant toxic blooms. The map below shows lakes sampled (many more than once). Toxin levels are indicated by color.

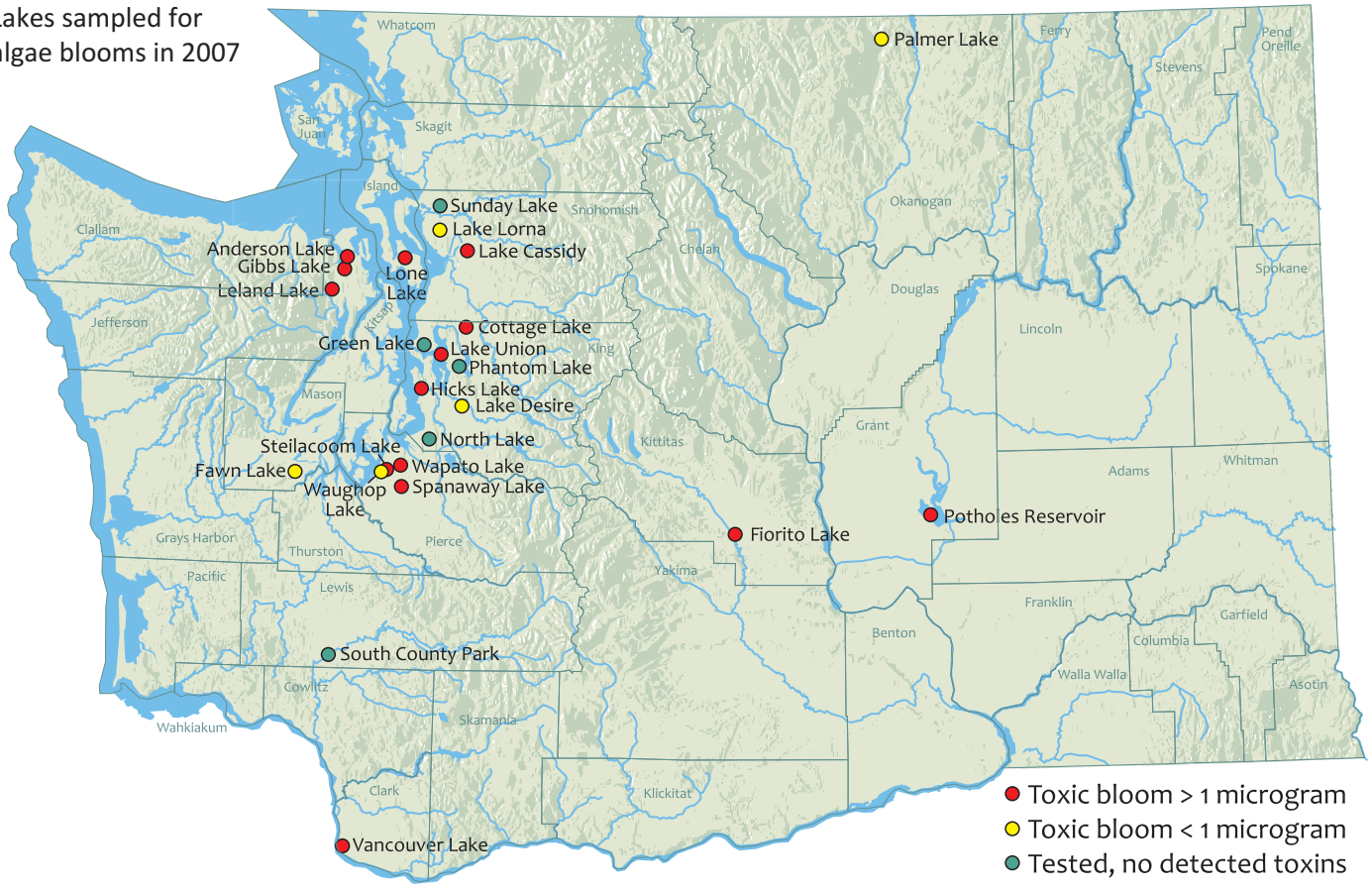
Table 2 – Lakes with Highest Microcystin Concentrations

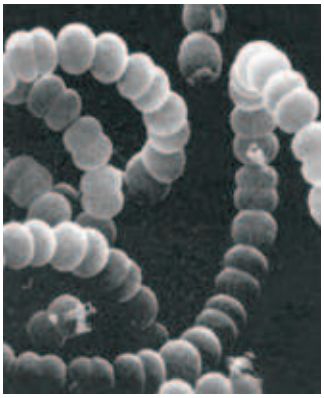
Lake Name and County	Microcystin Concentration
Wapato Lake, *Pierce County*	4,810 µg/L
Lake Steilacoom, *Pierce County*	221 µg/L
Spanaway Lake, *Pierce County*	121 µg/L
Cassidy Lake, *Snohomish County*	>100 µg/L
Lone Lake, *Island County*	92 µg/L
Fiorito Lake, *Kittitas County*	55 µg/L
Potholes Reservoir, *Grant County**	>15 µg/L

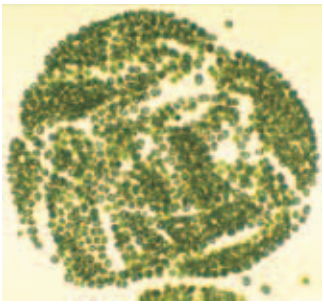
* *Two dogs died after swimming in Potholes Reservoir in 2007*

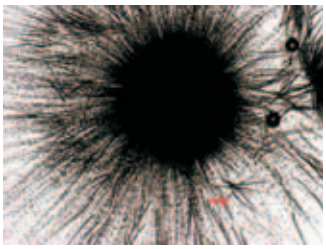
Lakes in both Eastern and Western Washington produced significant toxic blooms in 2007.

Lakes sampled for algae blooms in 2007









The blue-green algae pictured above are some of the species found in Washington with the potential to produce toxins

Toxic blooms can persist. Table 3 shows microcystin concentrations from samples taken in late September through October from Wapato Lake. The variability of the toxin levels is likely due to the patchy distribution of algae within this lake.

Table 3 - Wapato Lake Toxin Levels Through Time - 2007

Date	Toxin Levels
September 27	4,810 µg/L
October 3	11.7 µ g/L
October 11	525 µg/L
October 23	53.7 µg/L

Toxic algae may also impact downstream water bodies and streams. Table 4 shows algae toxicity results from water bodies downstream of Spanaway Lake during a period when the lake was experiencing a toxic algae bloom. Water flows from Spanaway Lake to Morey Creek, through Bresemann Pond, and finally to Tule Lake.

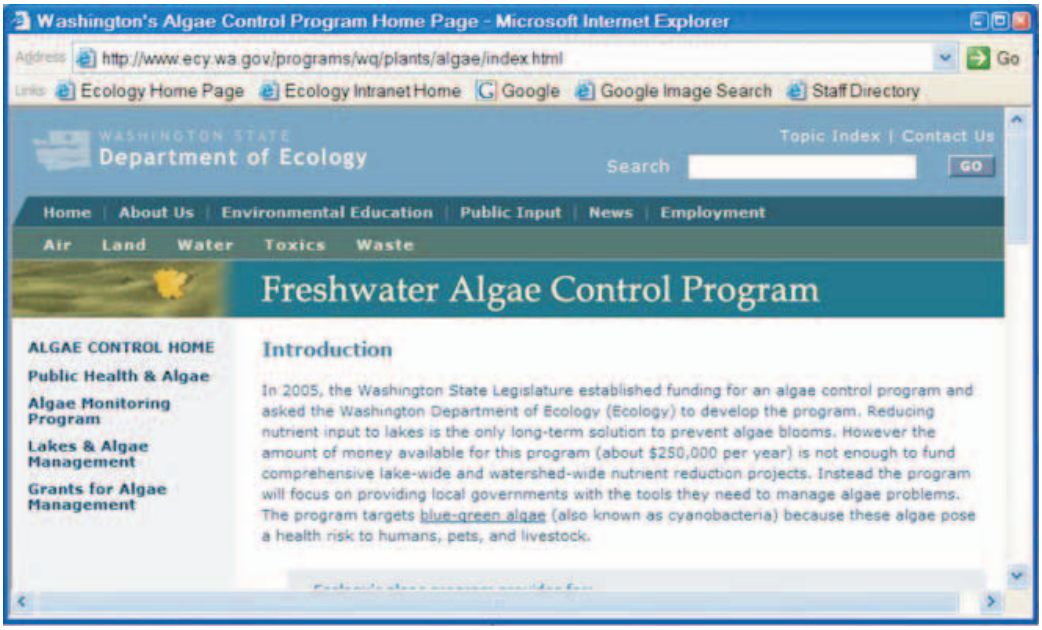
Table 4 - Downstream Impacts from a Toxic Bloom in Spanaway Lake in 2007

Water Bodies Sampled	Toxin Levels
Spanaway Lake *(10/23)*	80.6 µg/L
Morey Creek *(10/26)* (flowing water)	2.33 µg/L
Bresemann Pond *(10/26)* (still pond)	60.5 µg/L
Tule Lake *(10/26)* (marsh)	7.53 µg/L

Because KCEL did not analyze for anatoxin-a in 2007, blooms that tested negative for microcystin may have actually been toxic. This year, the bloom in Anderson Lake in Jefferson County tested negative for microcystin. The same bloom, tested by a private laboratory for anatoxin-a, was highly toxic.

Although Potholes Reservoir had high levels of microcystin, Ecology suspects that it was anatoxin-a that killed hunting dogs at Potholes Reservoir this year.

Algae identification and toxicity testing results will soon be available in a searchable on-line database on Ecology's website. You may search the database by county, water body, toxins, or algae type.



Getting the word out/Grant Program

Ecology and DOH have coordinated freshwater algae websites. **Ecology's algae website** (*http://www.ecy.wa.gov/programs/wq/plants/algae/index.html*) provides information about why blooms occur, what a bloom looks like, how to collect and mail a bloom sample, algae control methods, and availability and information about algae grants.

DOH's website (*http://www.doh.wa.gov/ehp/algae.htm*) discusses algae toxicity and human, pet, and livestock health effects of toxic algae. DOH also has a question and answer page about algae blooms and toxicity.

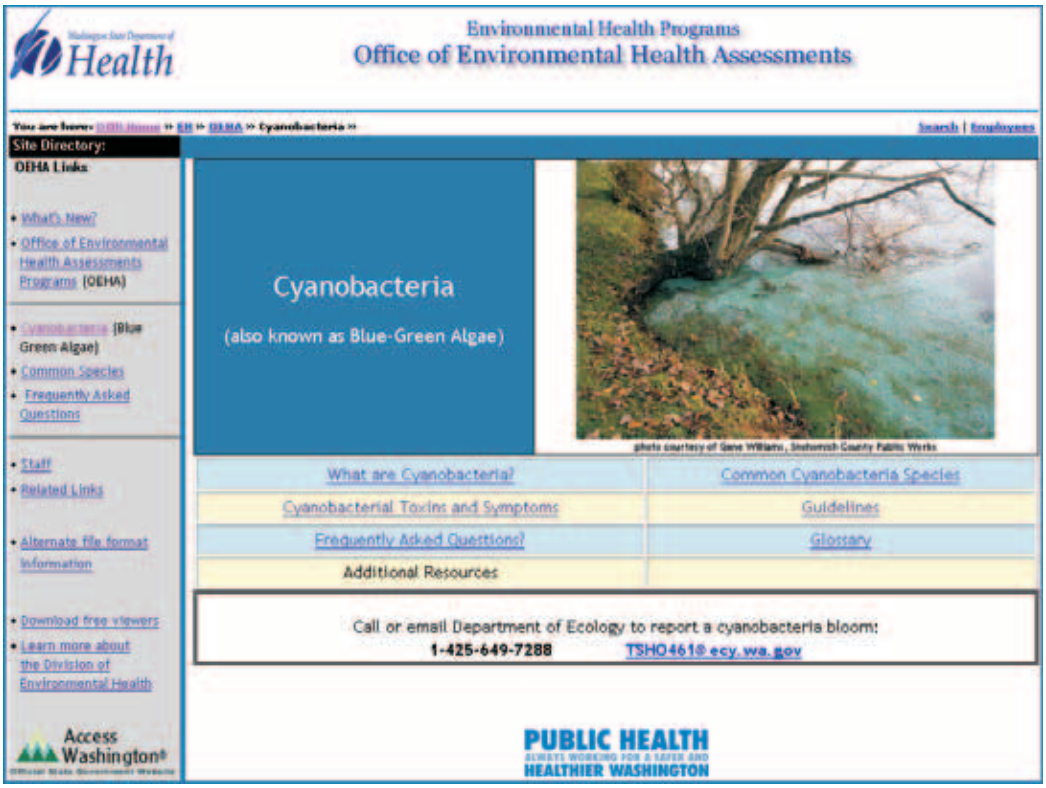
DOH updated and printed 5,000 brochures about toxic blue-green algae. The *Toxic Blue-green Algae Blooms* brochure is available from the DOH website at: *http://www3.doh.wa.gov/here/Materials/PDFs/25_BGAlgae_E07L.pdf*

Because veterinarians may see cases of algae poisoning in pets and livestock, DOH is developing a fact sheet for veterinarians about algae toxins and symptoms of algae toxin poisoning in animals. This fact sheet is a companion to DOH's *Toxic Blue-green Algae Blooms* brochure.

DOH and Ecology are planning a series of statewide workshops for local health jurisdictions in the spring of 2008. The agencies will share information about toxic blue-green algae. Other outreach efforts will include placing information in Washington Lakes Protection Association newsletters and speaking at regional and national conferences about toxic algae blooms.

Ecology applies about two thirds of its Freshwater Algae Control Program funding to the grant program.

The Department of Health's Toxic Blue-green Algae Blooms *brochure.*



Nutrient reduction planning and implementation are the only long-term solutions to reducing toxic algae blooms.

Freshwater Algae Control Grant Program

Ecology used the funds provided by the Legislature to establish a small grants program for freshwater algae control projects. The Freshwater Algae Control Grant Program provides financial assistance to state and local governments, tribes, and special purpose districts to prevent and control excessive freshwater algae growth (algae blooms), with an emphasis on lakes with harmful algae blooms. Projects involving any public or private lake, river, or stream are eligible for funding.

The grant application period opens October 1 and closes November 1 of each year.

Ecology applies about two thirds of its Freshwater Algae Control Program funding to the grant program (approximately $150,000 per year). Ecology limits grant amounts to $50,000 per project and requires 25 percent local match.

Eligible freshwater algae projects include:

- Education and outreach.
- Control and management.
- Management plan development.
- Monitoring programs.
- Pilot projects.
- Research.
- Sampling equipment.
- Nutrient reduction activities.

Ecology provides grant guidelines on its website at *http://www.ecy.wa.gov/biblio/0710076.html* and the grant application at *http://www.ecy.wa.gov/biblio/ecy070288.html*.

In late September, Ecology held grant workshops in Lacey and Spokane to inform those interested in applying for grant funds. The first competitive grant funding cycle closed on November 1, 2007. Ecology received seven applications for projects totaling $271,093.

Freshwater Algae Control Grant Program Applicants

Ecology reviewers selected the following four projects for grant funding:

- **Snohomish County**

Cyanobacteria Prevention and Early Detection Project

Snohomish County will work with lake residents to reduce nutrients that fuel algae growth and create an early detection system for toxic blue-green algae blooms. This project focuses on three lakes-Cassidy, Ketchum, and Loma-that have suffered from toxic blooms in recent years.

$28,500

- **Jefferson County Public Health**

Jefferson County Lake Assessment and Toxic Cyanobacteria Monitoring Project

This project will assess the ecology of three publicly accessible lakes that have experienced toxic cyanobacterial blooms in the past two years. Jefferson County will modify its existing lake monitoring program based on the results of their assessment.

$43,507

- **City of Lakewood**

Lake Steilacoom Calcium Hydroxide Application

This project is for the experimental application of a granulated formulation of calcium hydroxide to Lake Steilacoom to reduce soluble reactive phosphorus concentration in the lake. By reducing soluble reactive phosphorus, the applicant will reduce blue-green algae populations in the lake.

$50,000

◆ **Tacoma-Pierce County Heath Department**
Pierce County Toxic Algae Project
This project will create an improved monitoring and communication program regarding toxic algae blooms for Pierce County lakes. The Health Department will accomplish this by education and outreach, better identifying and quantifying toxic algae blooms, and refining and enhancing the existing notification process when a toxic bloom occurs. *$47,993*

Freshwater Algae Control Program Budget

The Freshwater Algae Control Program generates approximately $500,000 per biennium.

◆ DOH received a one-time $150,000 grant from Ecology for development of statewide guidelines for algae toxins. Under this grant, DOH also will produce lake advisory signs, algae sampling kits, algae brochures, and conduct workshops.

◆ Ecology budgets $35,000 a year for laboratory costs for algae identification and toxicity testing.

◆ In 2007 and thereafter, Ecology will dedicate about two thirds of the revenue to the small grants program (about $170,000 per year).

◆ Remaining funds pay staff time for technical assistance and grant administration.

Suggestions for the future

The primary cause of algae blooms is excessive plant nutrients in the water body. Control actions taken without reducing these nutrients are temporary.

Because of its financial limitations, the Freshwater Algae Control Program does not currently target whole-lake or watershed-wide nutrient reduction planning that would preserve the long-term health of Washington lakes. Although costly, nutrient reduction planning and implementation are the only long-term solutions to reducing toxic algae blooms.

A longer-term solution to algae blooms and other lake problems would require a holistic funding program to help local governments implement watershed and water body nutrient reduction programs. No funding programs currently focus specifically on in-lake nutrient reduction activities.

Freshwater Algae Control Program Contacts

For more information about the Freshwater Algae Control Program, contact the following staff:

Ecology

◆ *Kathy Hamel,* (program coordination), 360-407-6562, *kham461@ecy.wa.gov*

◆ *Joan Clark* (grants); 360-407-6570, *jcla461@ecy.wa.gov*

DOH

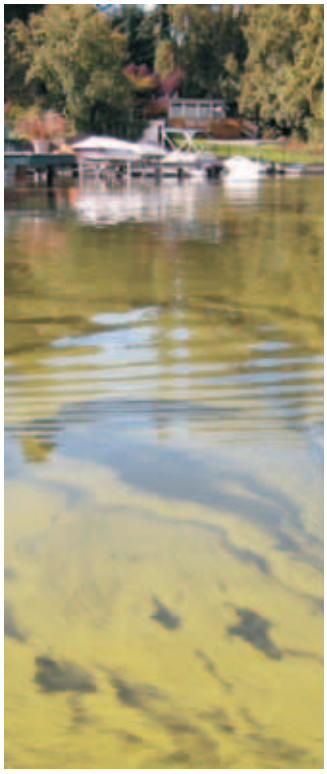
◆ *Joan Hardy* (algae toxicity issues, recreational guidance for algae toxins), 360-236-3173, *joan.hardy@doh.wa.gov*

◆ *Rob Banes* (outreach efforts), 360-236-3243, *rob.banes@doh.wa.gov*

On-Line Resources

◆ Ecology's algae website: *http://www.ecy.wa.gov/programs/wq/plants/algae/index.html*

◆ DOH's website: *http://www.doh.wa.gov/ehp/algae.htm*



Lake Steilacoom