



Evaluating Portland Water Bureau's Algae Monitoring Programs

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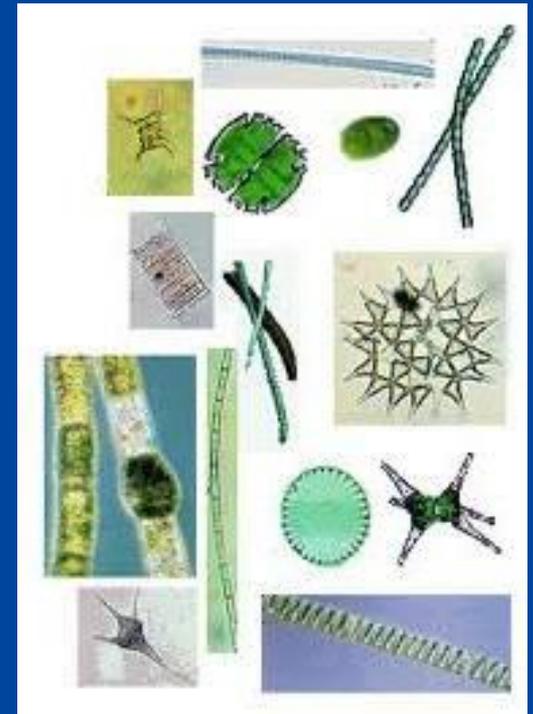


Presentation Outline

1. What is algae and why do we care?
2. Background to Portland's system and algae issues
3. Case studies of past algae blooms
4. Internal "Algae Summit" process
5. Upcoming issues and where we are now

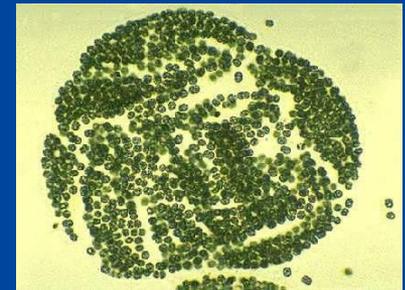
What is algae?

- Phytoplankton - Small or microscopic plants, usually drifting or suspended in water
- Dominate the primary production in most aquatic systems
- Growth regulated by:
 - light, heat, water movement, carbon dioxide, nitrogen, phosphorus and other nutrients.



...and why do we care?

- Source water management and stewardship
- Large blooms create the potential for :
 - toxin production (cyanobacteria)
 - DBP formation
 - taste and odor
 - disruption of treatment or distribution system equipment or instruments
 - clogged point-of-use filters or screens



Cyanobacteria (Blue-Greens)

- Common in eutrophic lakes in the warm waters of summer and fall
- Can have a competitive advantage by:
 - Regulating position in water column
 - Shading out other algae, forming surface mats
 - Fixing atmospheric nitrogen (some types)
 - Producing toxins (some types)



Just *some* common algae types in Portland's Bull Run Reservoirs

Type

Cryptomonas

Mallomonas

Ochromonas

Dinobryon

Kephyrion

Achnanthes

Cocconeis

Fragilaria

Gomphonema

Tabellaria

Palmella

Sphaerocystis

Chlamydomonas

Group

Cryptophyta

Crysophyta

Crysophyta

Crysophyta

Crysophyta

Diatom, Bacillariophyta

Diatom, Bacillariophyta

Diatom, Bacillariophyta

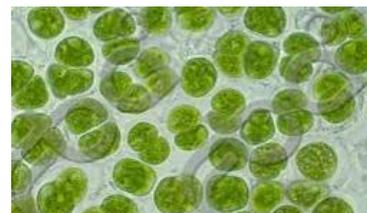
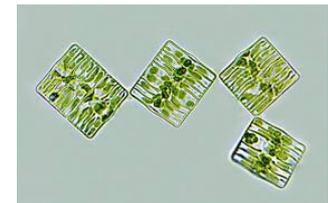
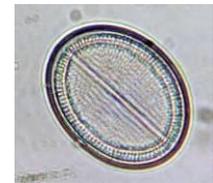
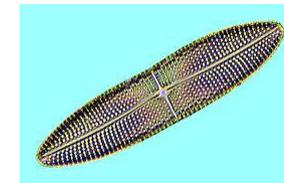
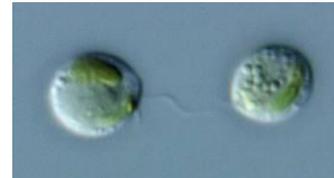
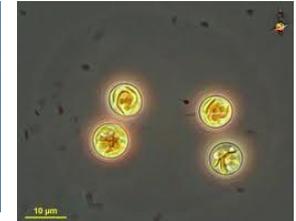
Diatom, Bacillariophyta

Diatom, Bacillariophyta

Green, Chlorophyta

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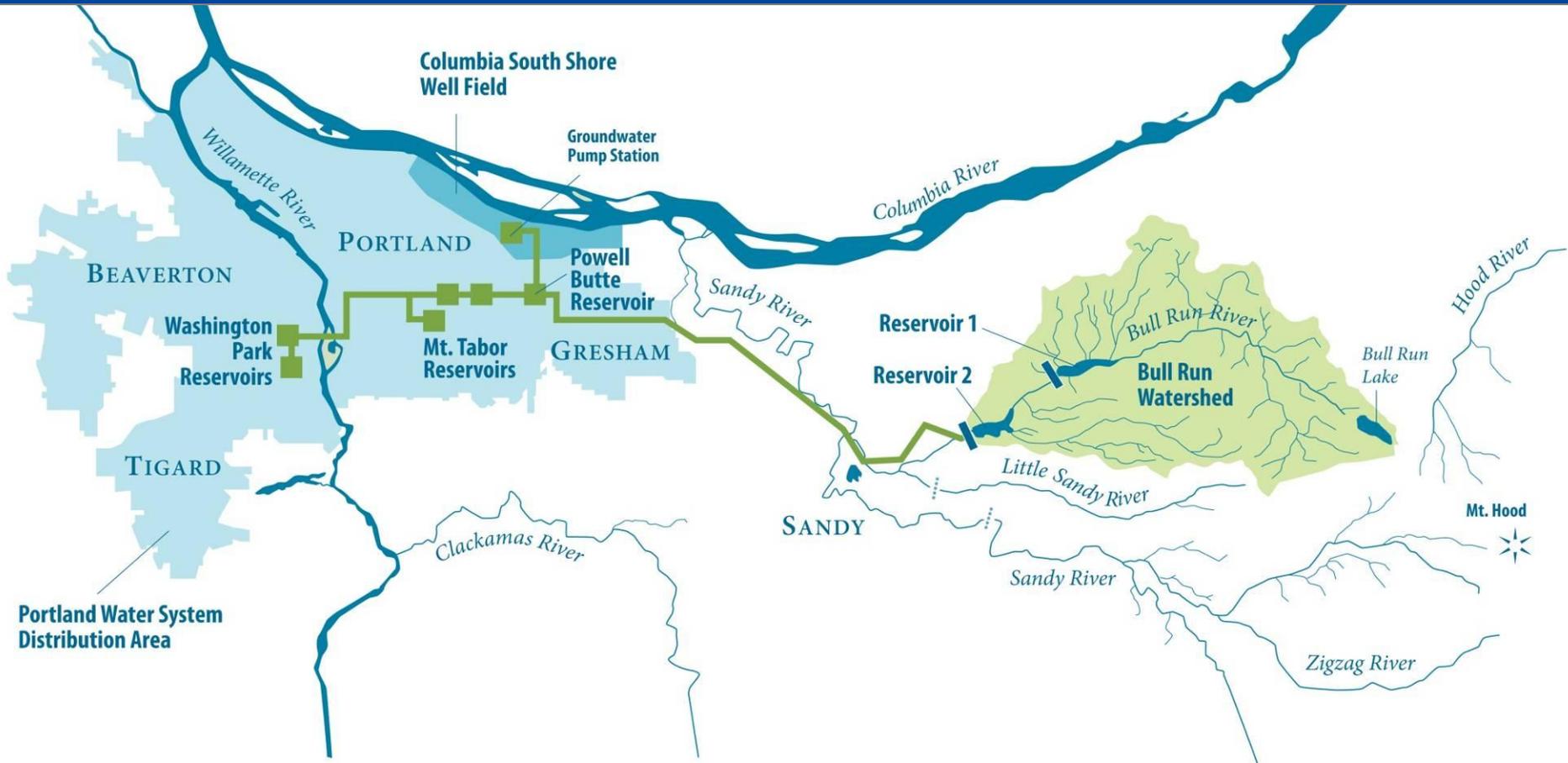


Background to Portland's system and algae issues

- Bull Run Reservoirs – oligotrophic (low nutrients)
 - Highly protected watershed
 - Unfiltered
 - Chlorine disinfection
- Open finished water reservoirs

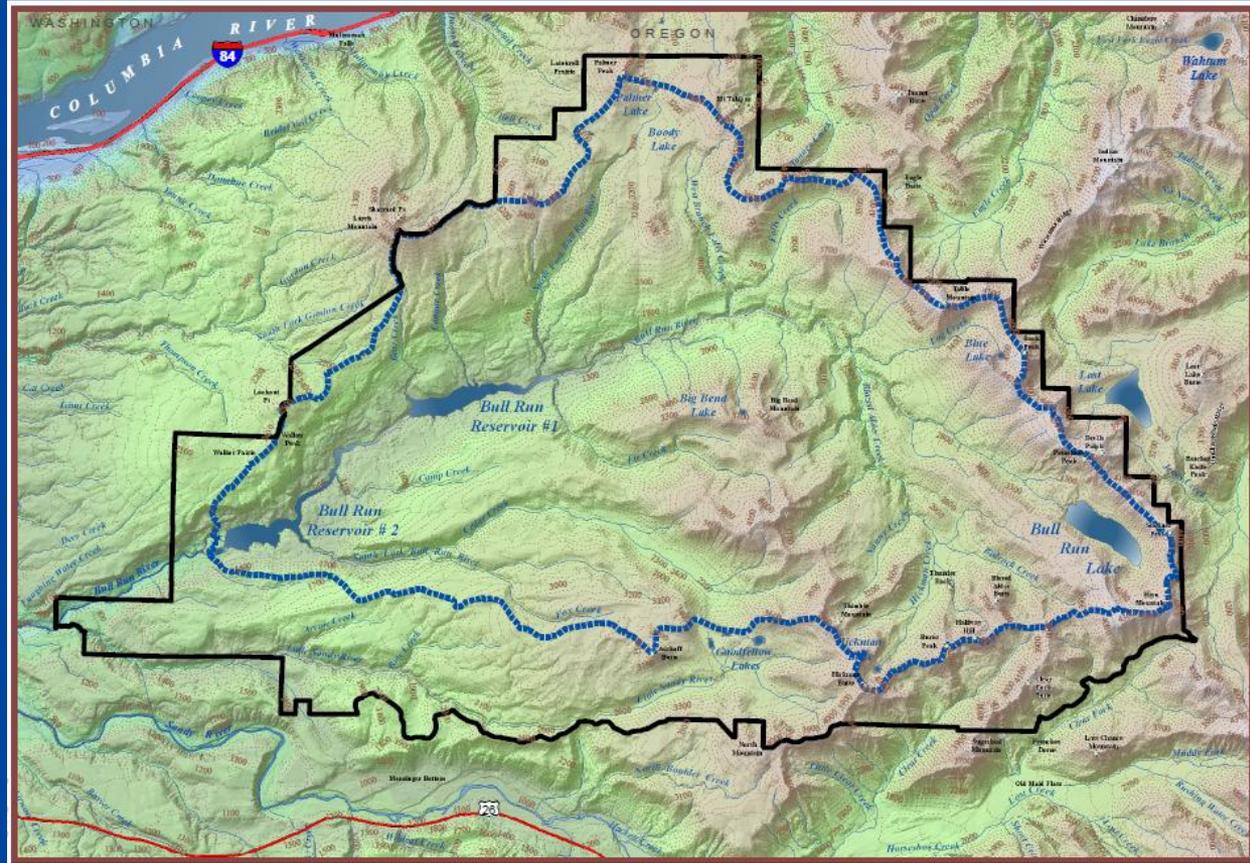


Portland's Water System



Bull Run Watershed

- Highly protected
- Heavily forested
- Closed to the public, no development
- No anthropogenic nutrient inputs



Bull Run Reservoirs



Reservoir 1

388 acres
9.9 billion gallons
194 ft depth

Reservoir 2

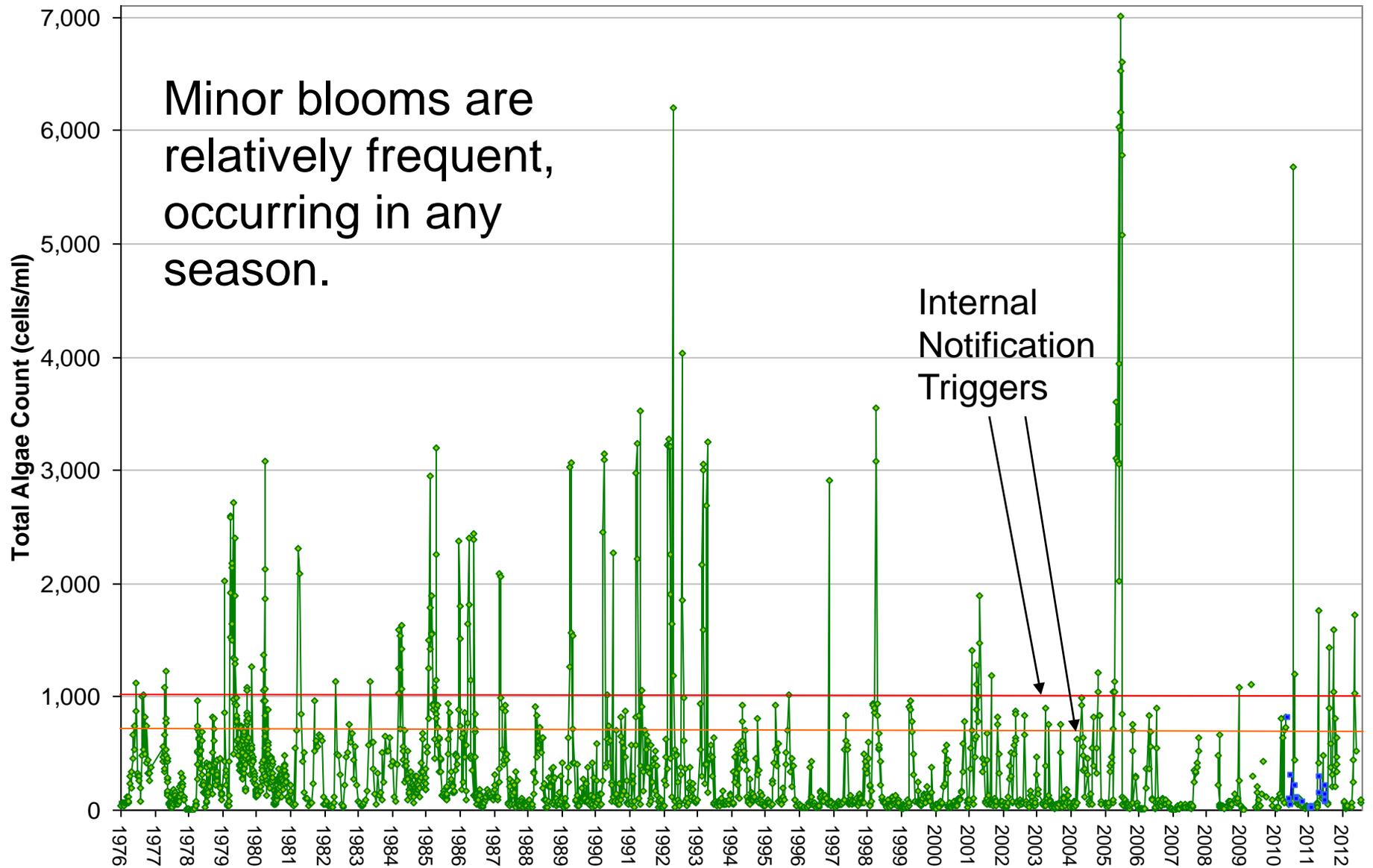
443 acres
6.8 billion gallons
130 ft depth

Average Nutrients:

TN = 0.085 mg/L
NO₃ = 0.03 mg/L
TP = 0.005 mg/L
SRP = 0.002 mg/L



Bull Run Reservoir 2 Historical Algae Data



Open Finished Water Reservoirs



- Sunlight
- Warming
- Loss of Cl residual
- Free ammonia
- Other nutrients



Limited methods to control algae

<u>Traditional Algae Control Measures</u>	<u>Present Option for Portland?</u>
Raw water:	
Dam/Reservoir operations	Yes, but limited
Switch source / dilute with groundwater	Yes, costly
Source Control	No, source already well controlled
Copper sulfate and other algicides	No, ecological & health concerns
Alum treatments	No
Biomanipulation	No
Aeration	No
Treated Water:	
Reservoir shutdown	Yes, can shut down and clean
Covering / replacing	Yes, by 2015 / 2020

Why revisit our algae monitoring program?

- Algae is generally not a problem, *until it becomes a problem.*
- Our monitoring regime and analysis method has not changed much in over 30 years, but
- Algal issues, guidance and technologies are changing around us.
- Past “mystery” algae blooms: are they trying to tell us something?
- Changes to reservoir operations are on the horizon.

Existing Monitoring Program in 2012

Locations	Frequency	Algae Samples
Bull Run Reservoir 1	Every 2 weeks	3 grab samples (1 m, 2nd level, intake level)
Bull Run Reservoir 2	Every 2 weeks	2 grab samples (1 m, 2nd level)
Raw Water Intake	Weekly	1 sample
In-Town Open Reservoirs	Weekly	1 sample at each outlet, 2 to 3 reservoirs in operation.

Equates to ~300 algae samples per year,
about 3 to 9 samples per week.

Case studies of past algae blooms

Bull Run:

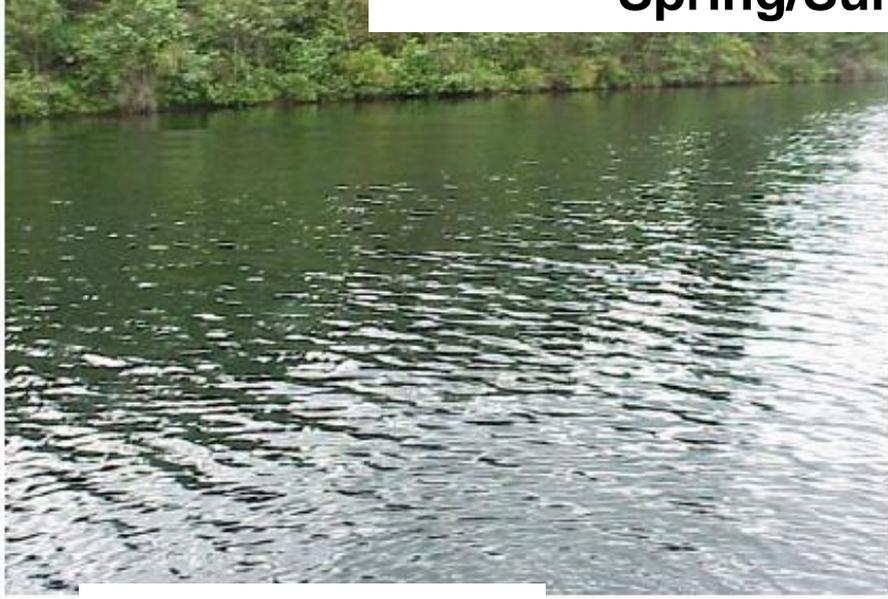
#1. 2005 Bull Run Reservoir 2 bloom

In-town:

#2. 2011 In-town bloom with suspicion of cyanobacteria

#1

Algae Bloom in Bull Run Reservoir 2, Spring/Summer 2005



Normal water clarity
in upper reservoir



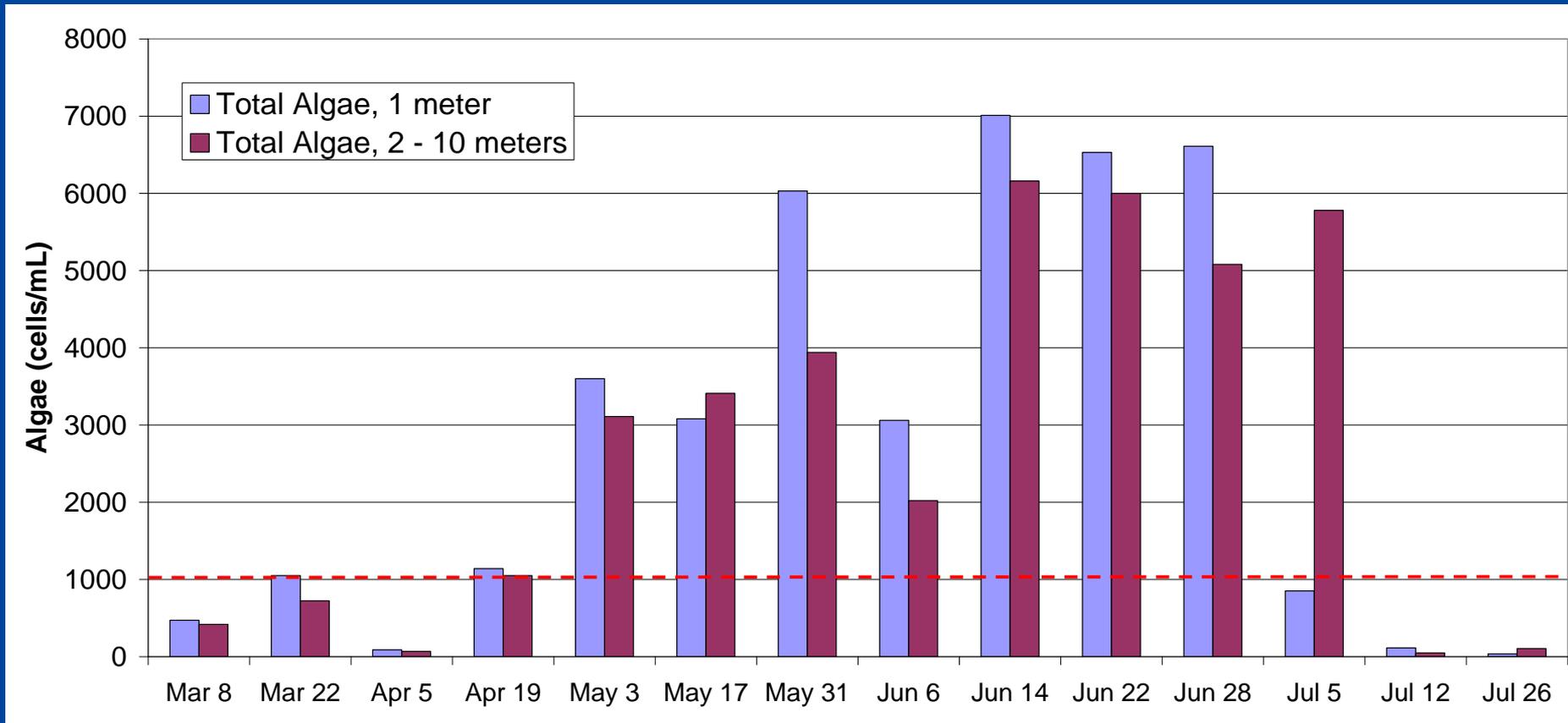
June 22, 2005
(Not Normal)



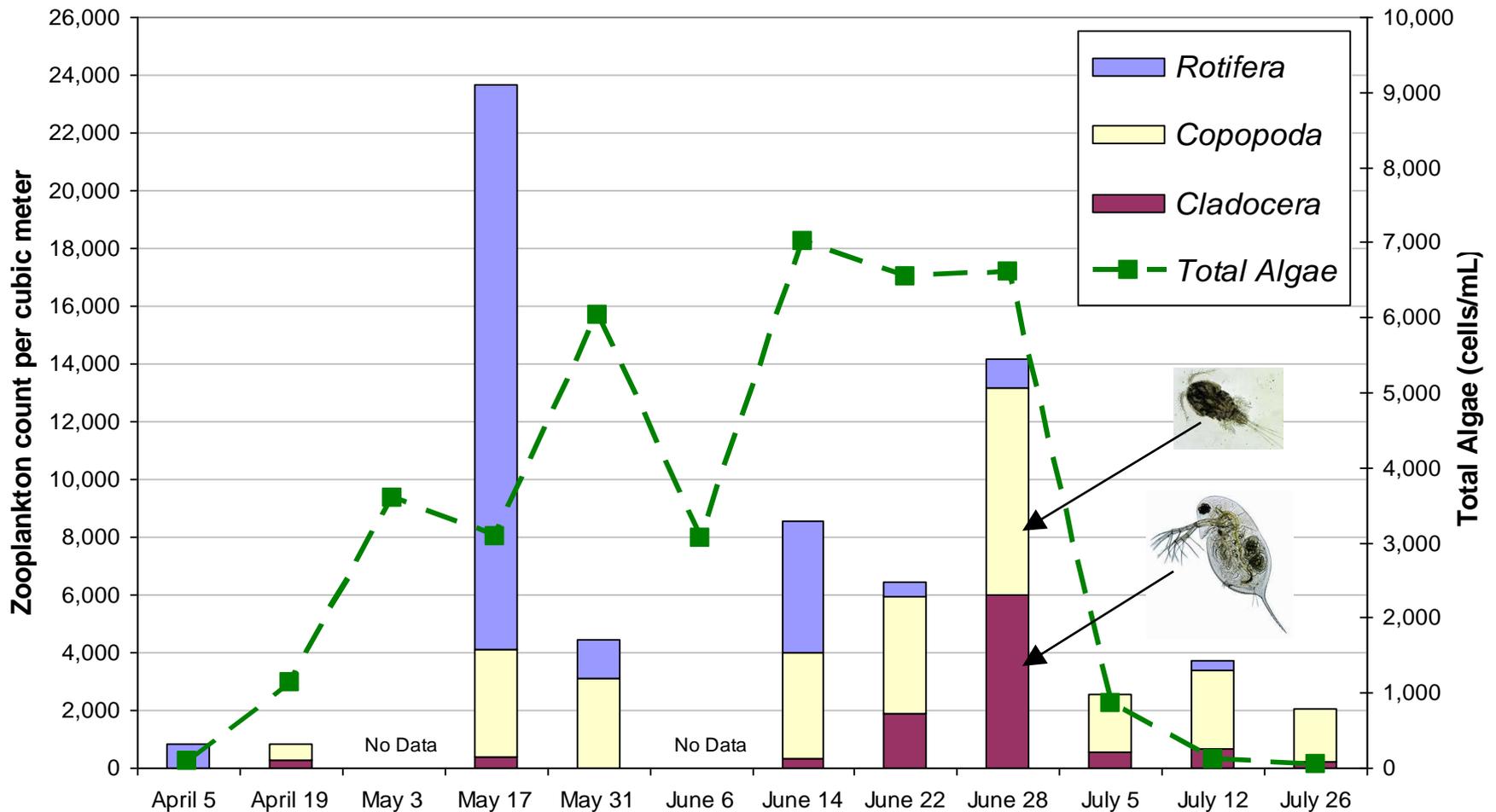
Small Green Blobs



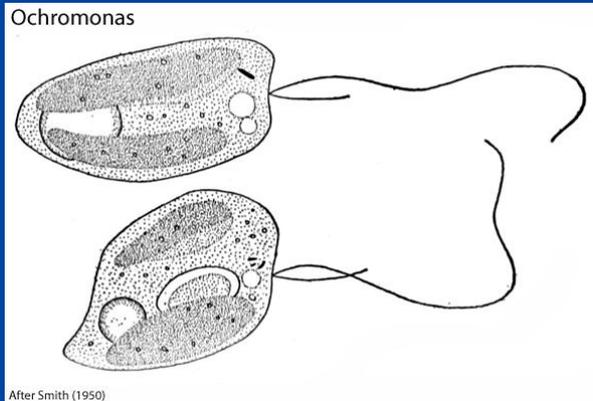
2005 bloom lasted over two months



Zooplankton likely ate well



2005 Bloom – Dominant genus later determined to be *Ochromonas*



- Chrysophyte division
- Not known for taste, odor or toxins
- Required a few months and five analysts to make the identification. Flagella are destroyed on the membrane filter.

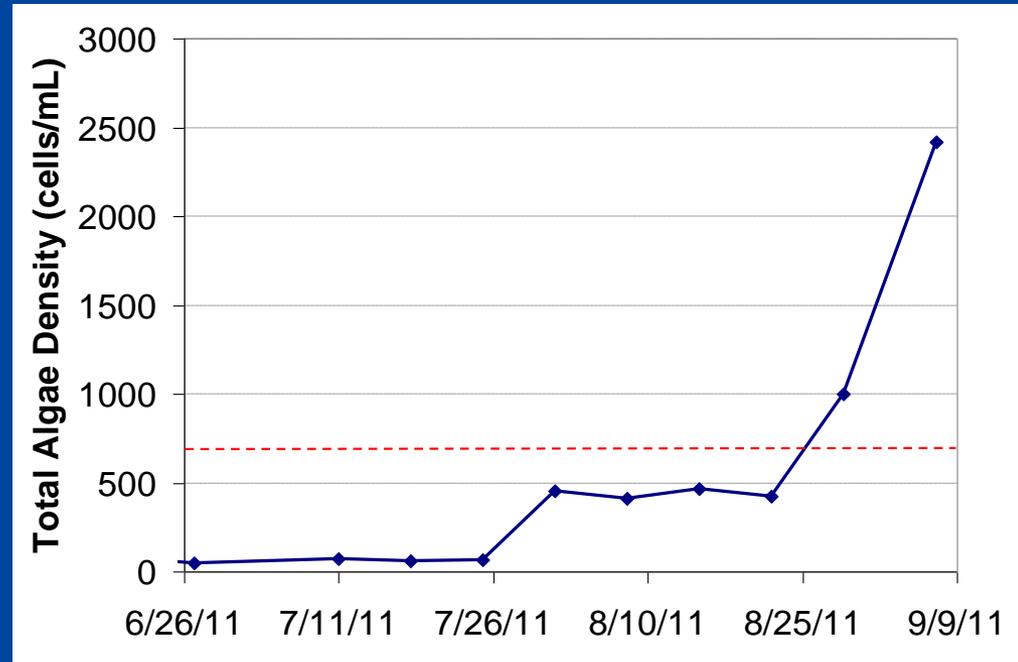
2005 bloom: a wake-up call

- We don't know why it occurred.
- We couldn't control it.
- We couldn't make a timely taxonomic ID.
- We were lucky it didn't reach the raw water intake.

#2

Open In-Town Reservoir Bloom in Summer 2011

- Appeared to be similar to a type of cyanobacteria
- Reservoir shut down
- Consultation with OHA
- Additional samples for ID and toxin testing
- Trace amount of microcystin detected
- Original species could not be determined



Internal “Algae Summit” Objectives

- Revisit current PWB algae issues and programs
- Synthesize available guidance and external expertise
- Clarify our monitoring program objectives
- Address data availability and identification ability
- Explore other methods or new technologies
- Determine appropriate responses for various incidents
- Document resources, monitoring plan, and responses in a new SOP.

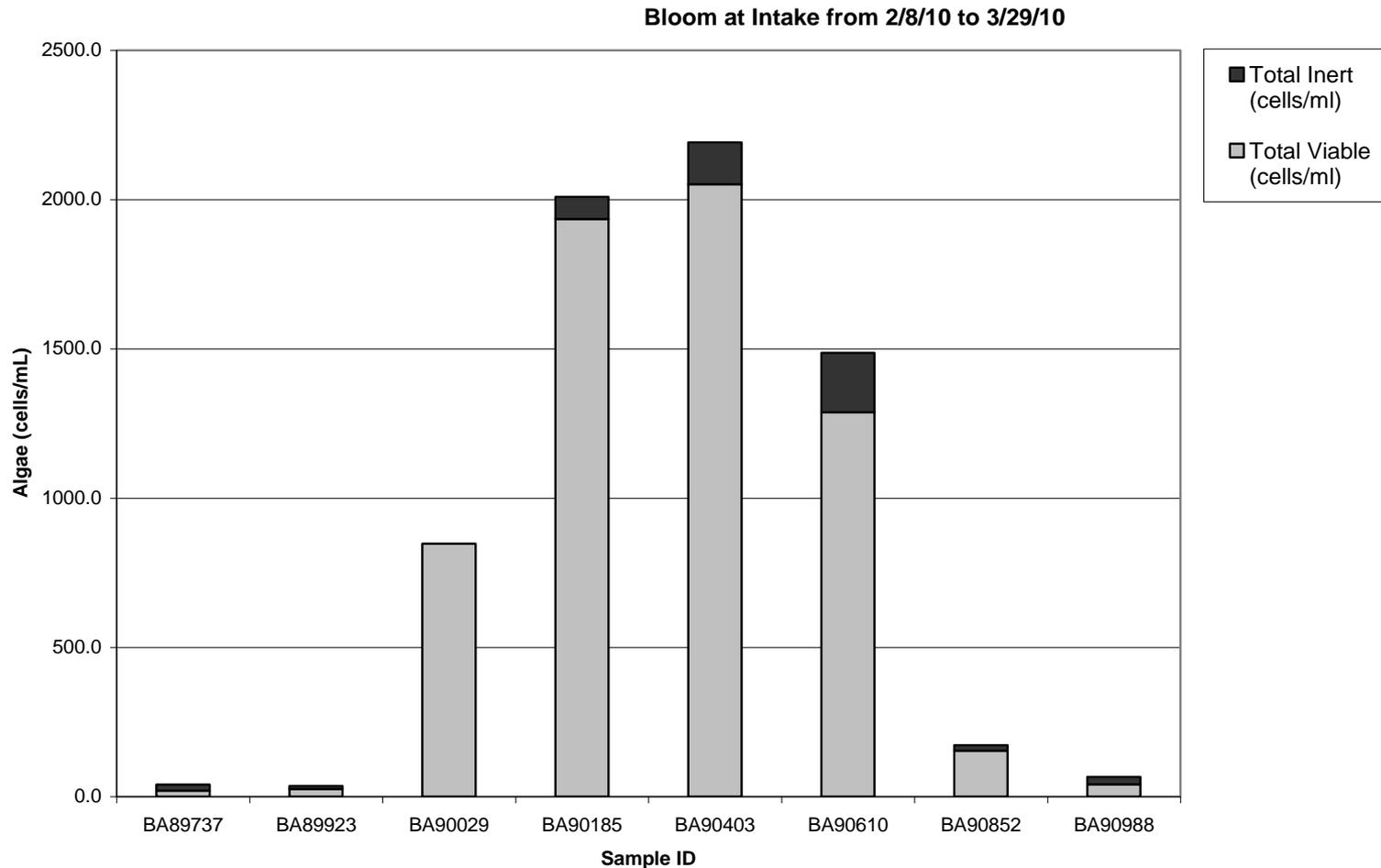
Analysts – experienced phycologists are hard to find

- One in-house phycologist
 - >25 years experience with Portland's algae, now retired.
 - Transitioning into new hires
- Have used a local contracted phycologist
 - Lab overflow / special investigations

Analysis Methods – balancing time and quality of information

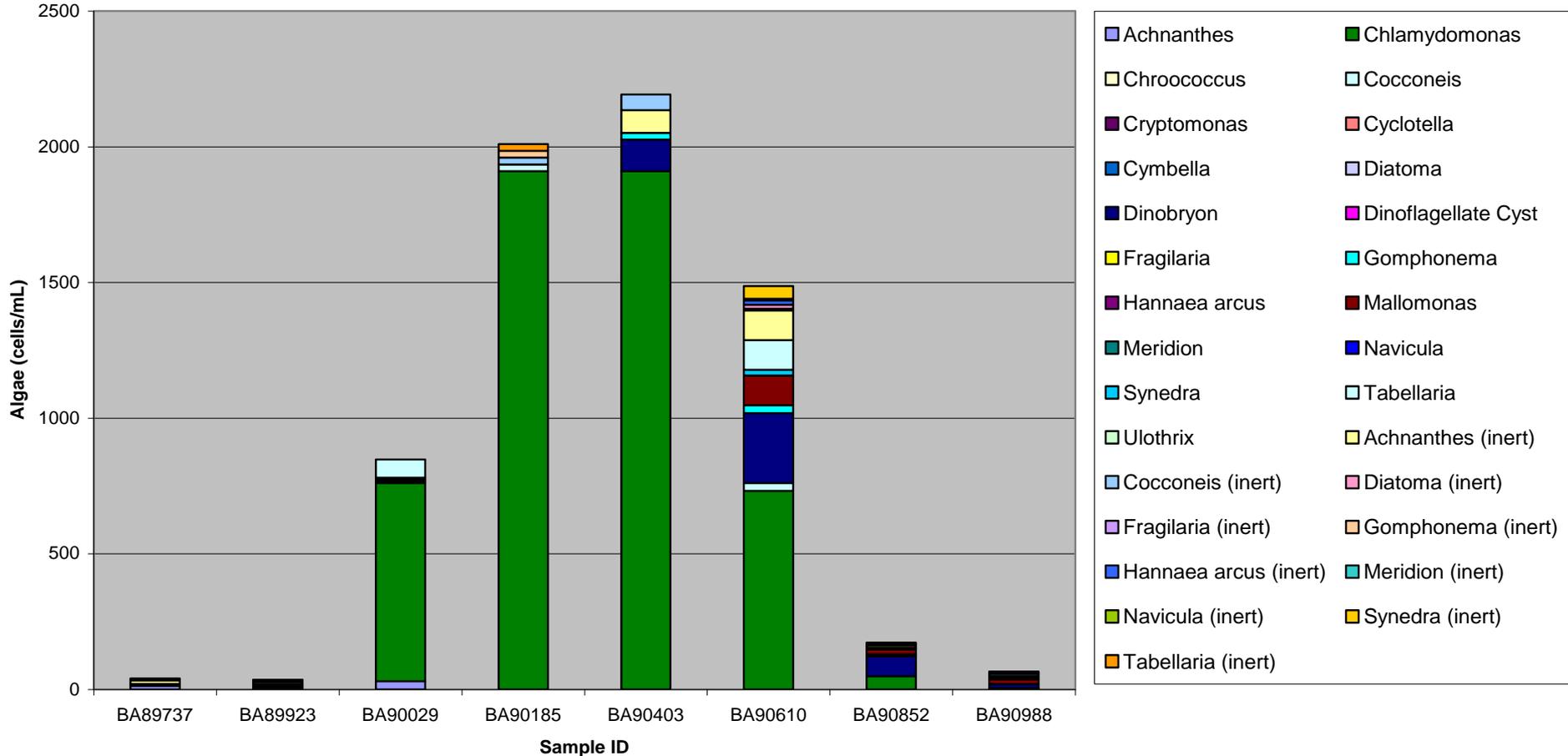
- Cell density by Clarified Membrane Filter / Whipple Grid (Standard Methods 10200A-F)
 - “Fast” processing time, but concentration method can damage small cells and identifying features
 - Settling Chamber method would offer improved information, but adds considerable time.

Reporting: What we can do with our electronic data:



Much more information available on lab bench sheets, paper only.

Chlamydomonas Bloom at Intake from 2/8/10 to 3/29/10 (green algae consisting of unicellular flagellates)



New ESA & CWA Requirements for Bull Run Reservoir 2

- Will result in drawing warmer, more shallow water during the summer (releasing colder water for downstream fish flows).
- Competing operational goals may make it challenging to manage for algae.
- Reservoir monitoring plan under revision to provide more information



Where are we now?

- We are working on our ability to:
 - Make algae taxa data electronically available for analysis.
 - Conduct toxin testing through either agreements with contract labs or in-house
 - Maintain in-house phycology expertise
- Internal “Algae Summit” and SOP to be completed later this year.

Thank You

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www.portlandoregon.gov/water