

THE GREAT SHIPS INITIATIVE

performance assessment of a candidate ship-board treatment system

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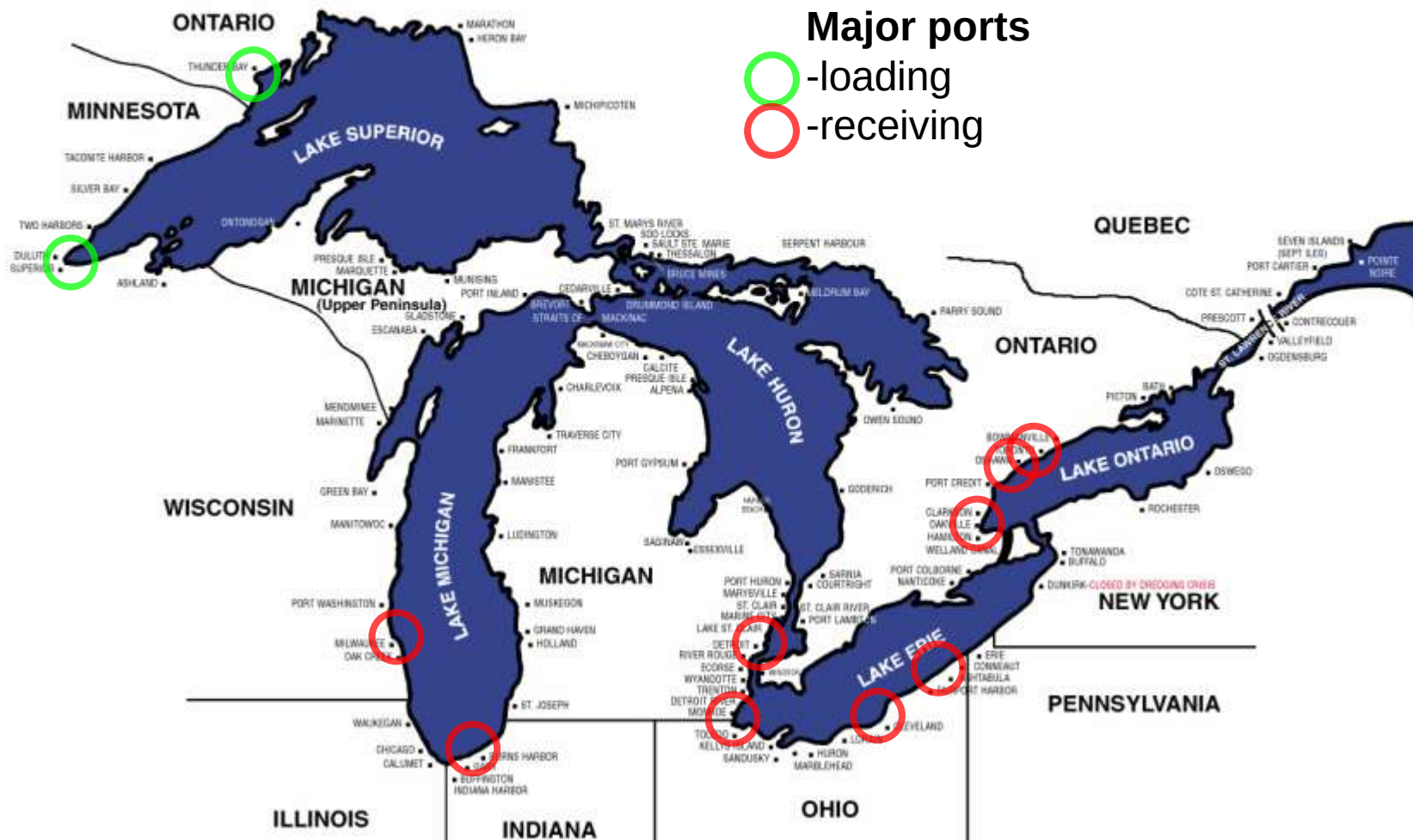


Listed West to East by State and Province



Major ports

- loading
- receiving



Some possible treatments

CHEMICAL

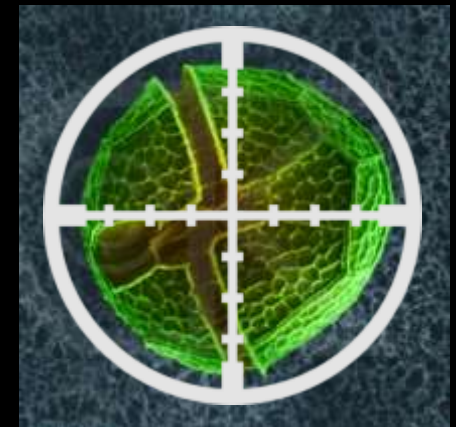
- Chlorine
- Lye
- Ozone
- Seakleen[®] (menadione)

PHYSICAL

- Filtration
- Ultraviolet radiation
- Sonic energy

BIOLOGICAL

- BallaClean[®] (yeast)



How do we
know a
particular
treatment
is working?

Three
scales of
testing:

bench



**land-
based**



ship



Lake Superior



Duluth Harbor /
Superior Bay

Superior, WI



Ballast water treatment test facility



Ballast water treatment test facility



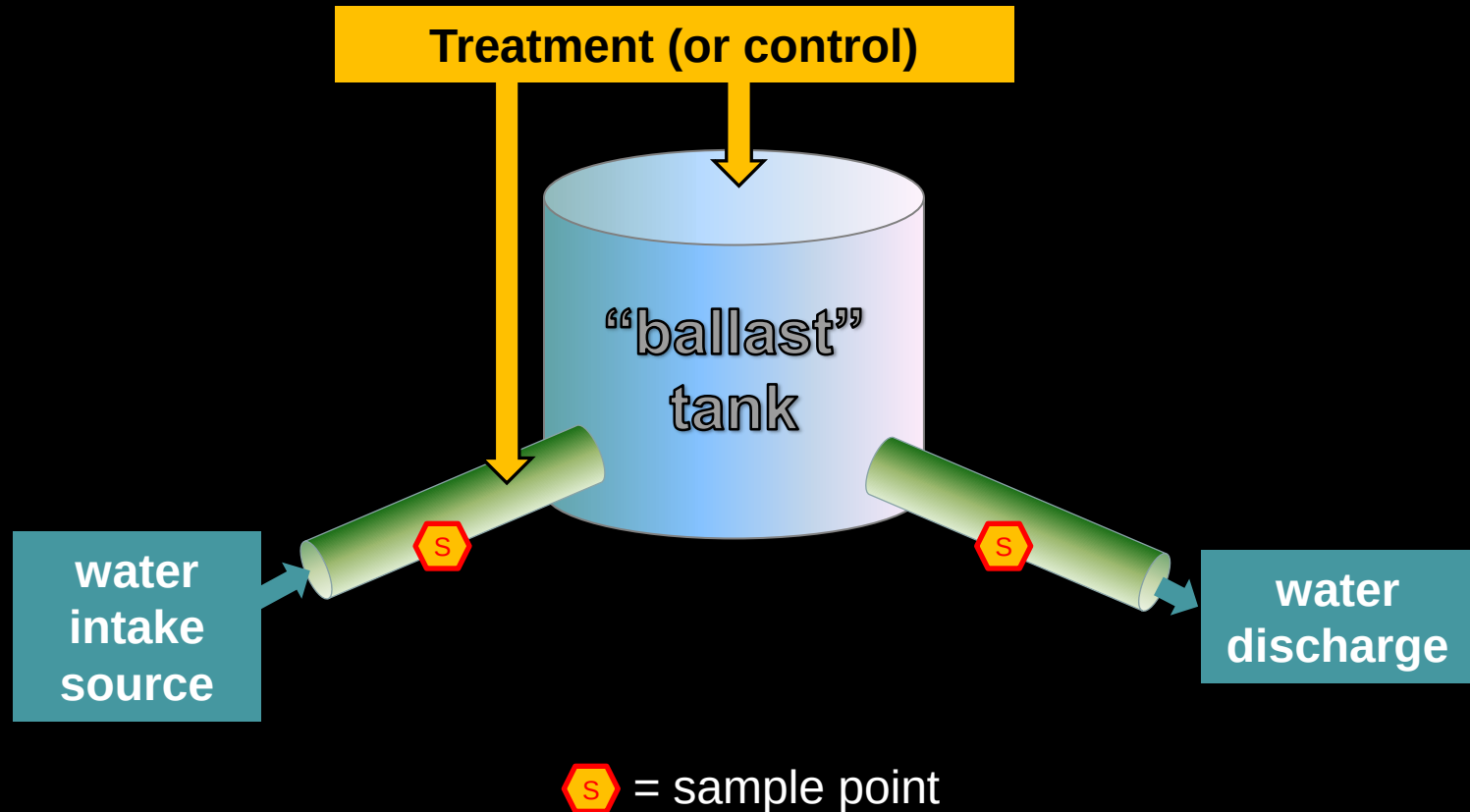
Ballast water treatment test facility



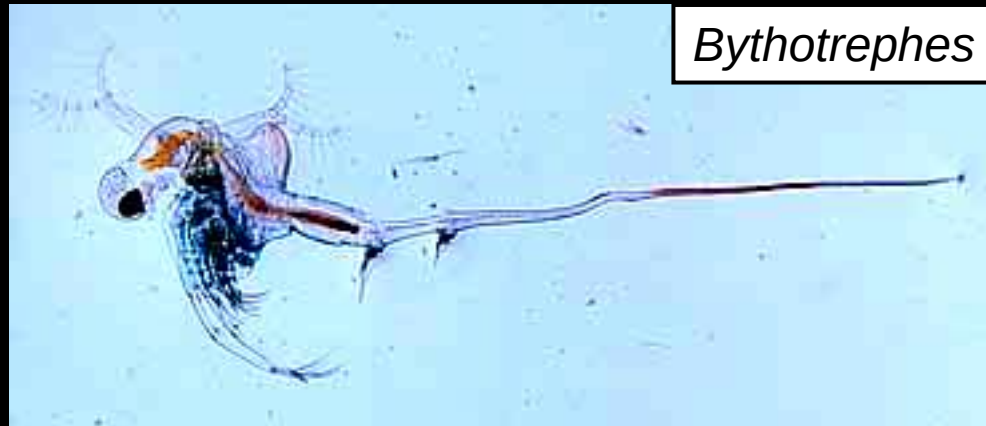
GSI Facility Lay-Out



Simplified land-based protocols



Zooplankton invaders



Bythotrephes

Zebra Mussel



Current International Maritime Organization (IMO) guidelines for ballast water release

“For microscopic organisms $>50\ \mu\text{m}$, <10 viable organisms per m^3 ”

(includes mainly zooplankton and some larger phytoplankton)



Virtual tour –
>50 μ m

Sample collection

- Collect from intake, control, treatment
- Collect during entire tank filling or drain
- Integrate sample in collection tubs
- Concentrate through 20 μm mesh net



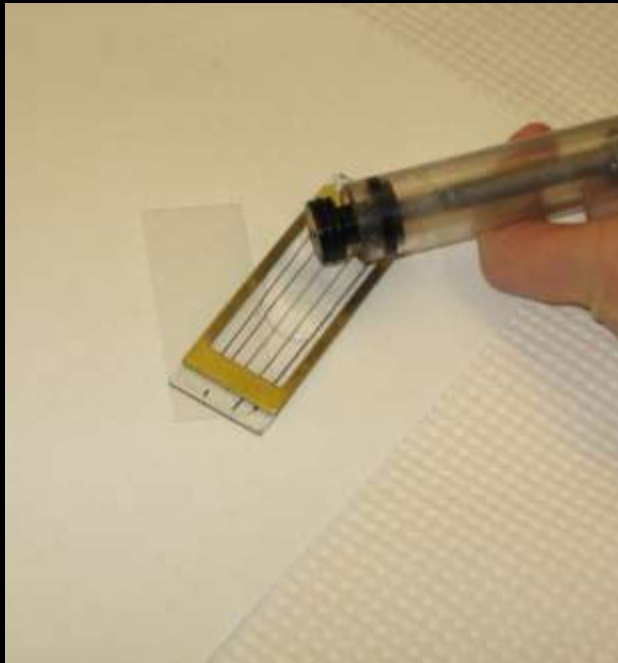
Macrozooplankton

- counting wheel
- Dissecting 'scope



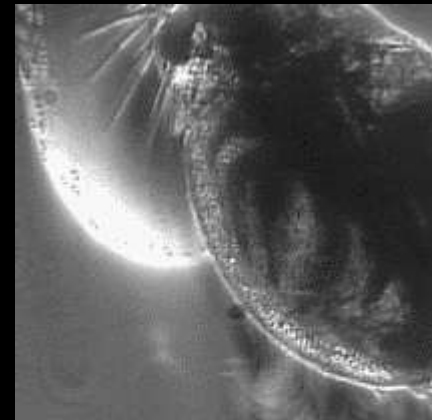
Microzooplankton

- Sedgewick-Rafter slide
- Compound 'scope



Sample Examination

- Identify to major taxonomic groups or dominant genera
- Determine viability of organisms
 - Movement
 - Heartbeat
 - Probe crustaceans



Duluth-Superior Harbor Zooplankton Community Composition

- Rotifers – *Keratella*, *Polyarthra*, *Synchaeta*



Loricated



Soft bodied



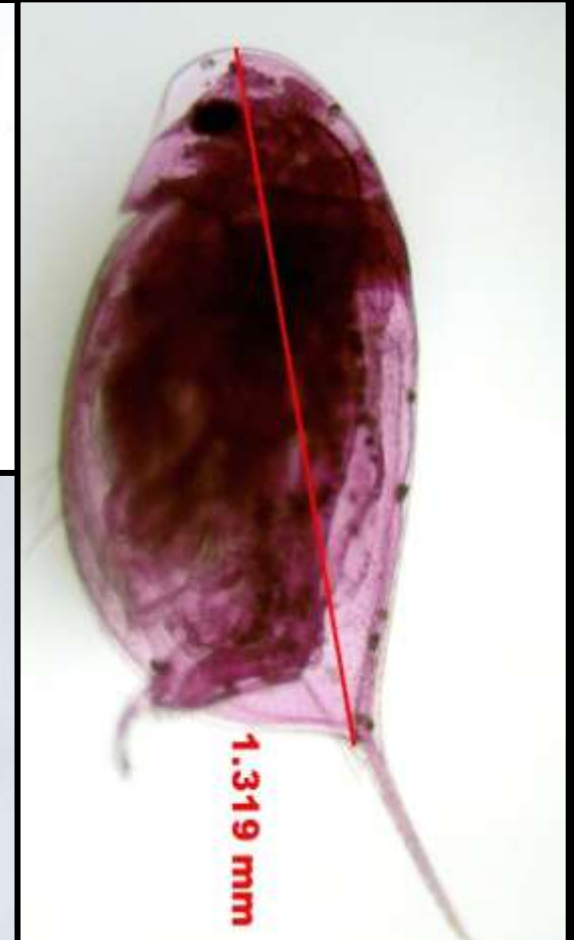
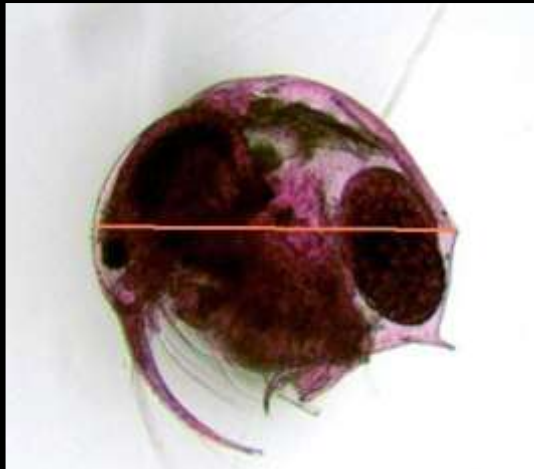
Duluth-Superior Harbor Zooplankton Community Composition

- Mollusca – larval *Dreissena*



Duluth-Superior Harbor Zooplankton Community Composition

- Cladocerans
 - *Bosmina*,
 - *Daphnia*,
 - Sidids



Duluth-Superior Harbor Zooplankton Community Composition

- Copepods –Calanoids, Cyclopoids, nauplii



Algal invaders



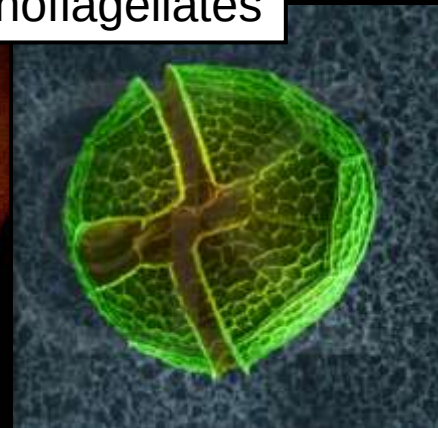
"Didymo"



Cladophora



Dinoflagellates



Current International Maritime Organization (IMO) guidelines for ballast water release

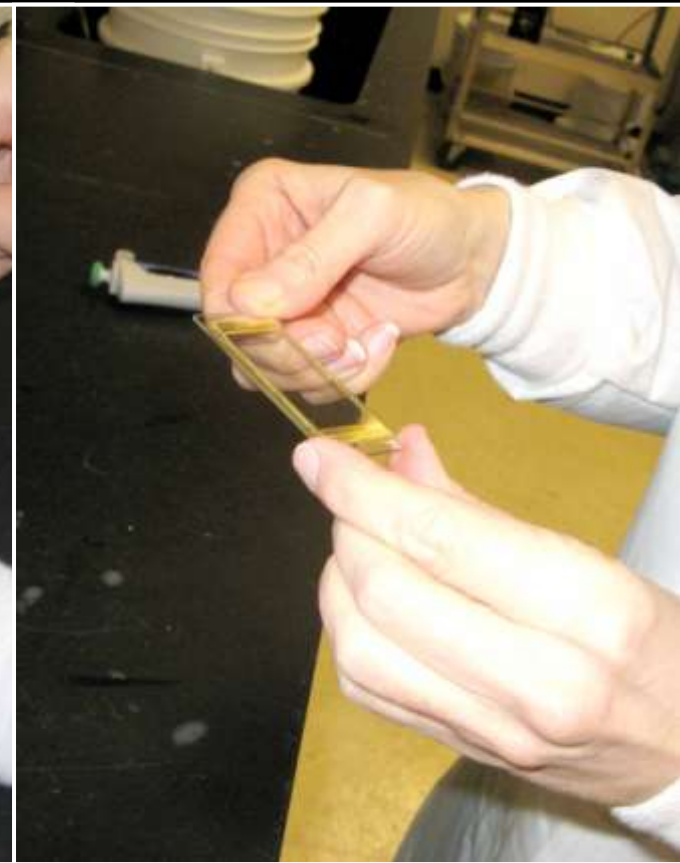
“For microscopic organisms 10-50 μm , <10 viable ‘organisms’ per mL”



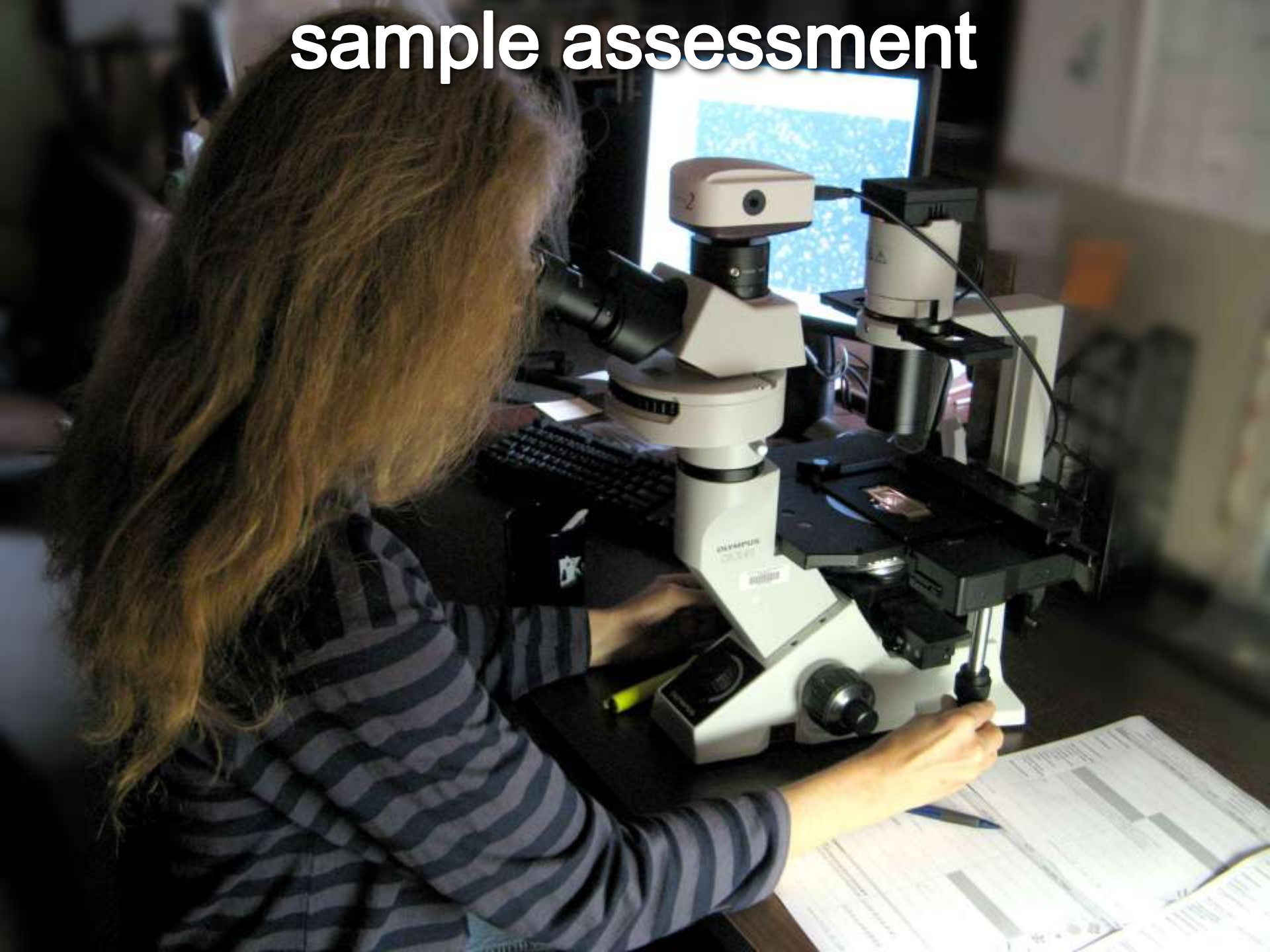
Virtual tour –
10-50 μ m



sample concentration

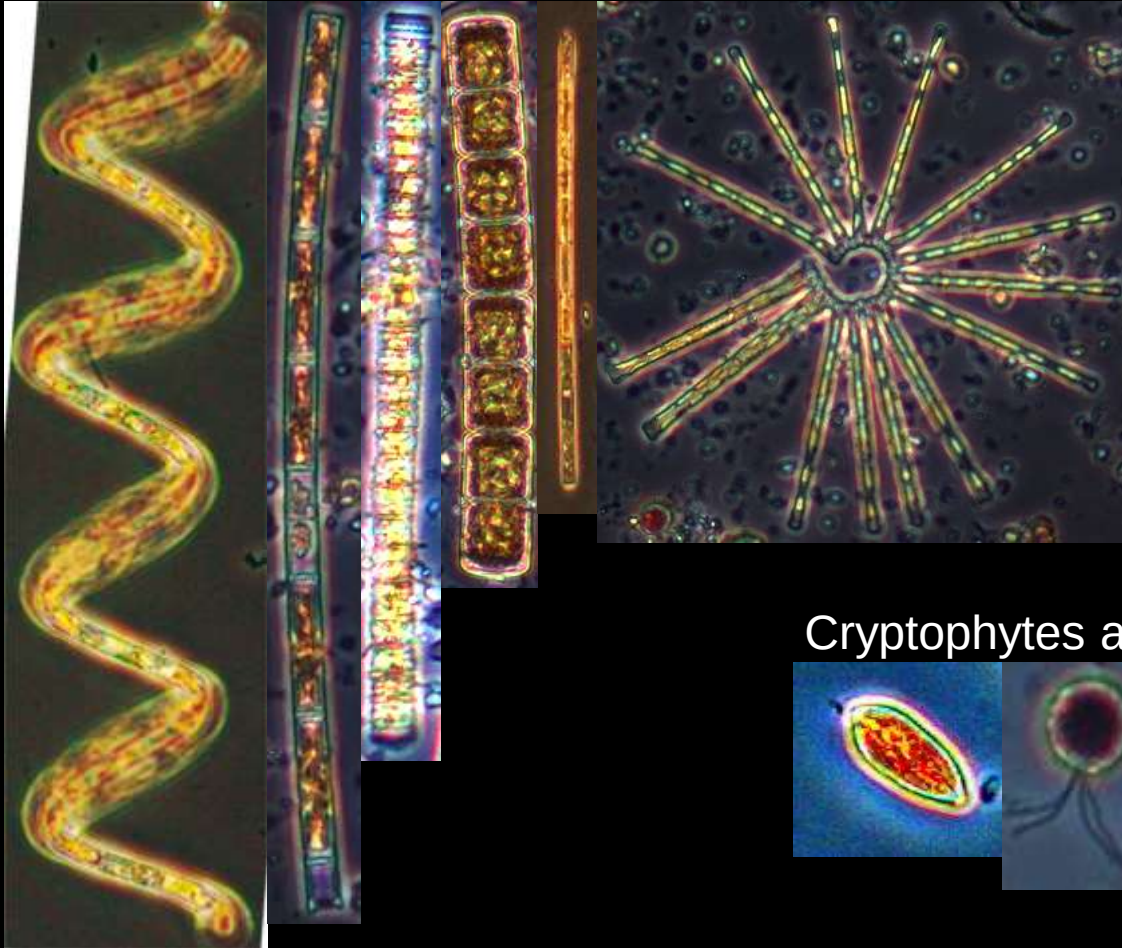


sample assessment

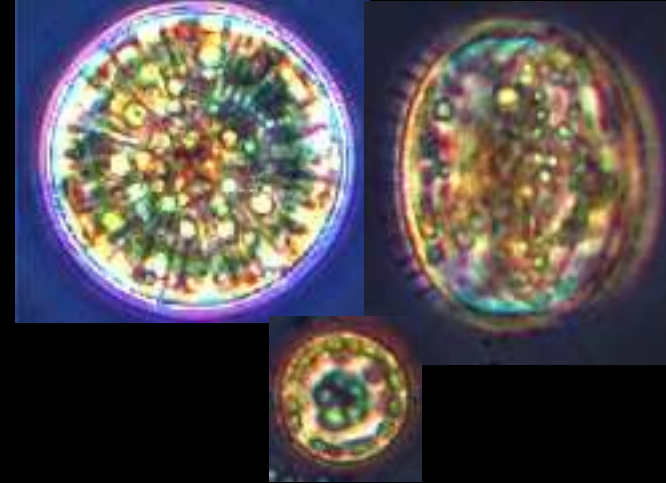


Dominant taxa – Spring, early Summer

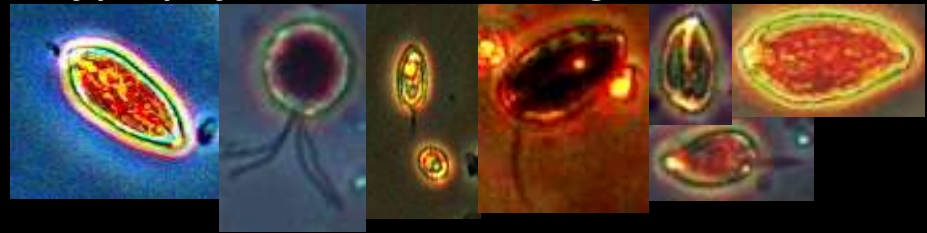
Filamentous and other colonial diatoms



Free-living centric diatoms



Cryptophytes and other flagellates

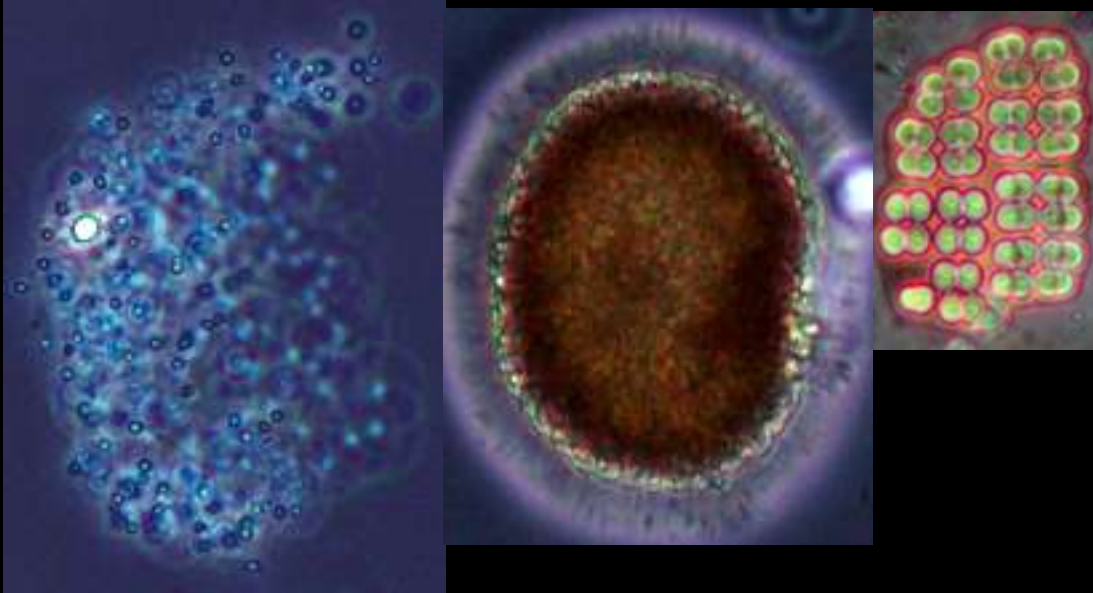


50 microns

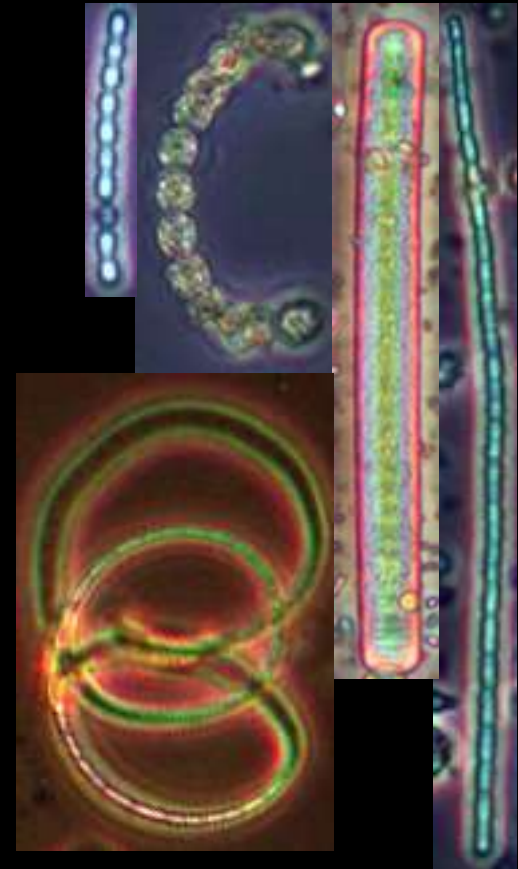
Dominant taxa – Late Summer

Diverse assemblage plus a greater proportion of blue-green algae

Microcystis and other colonial forms

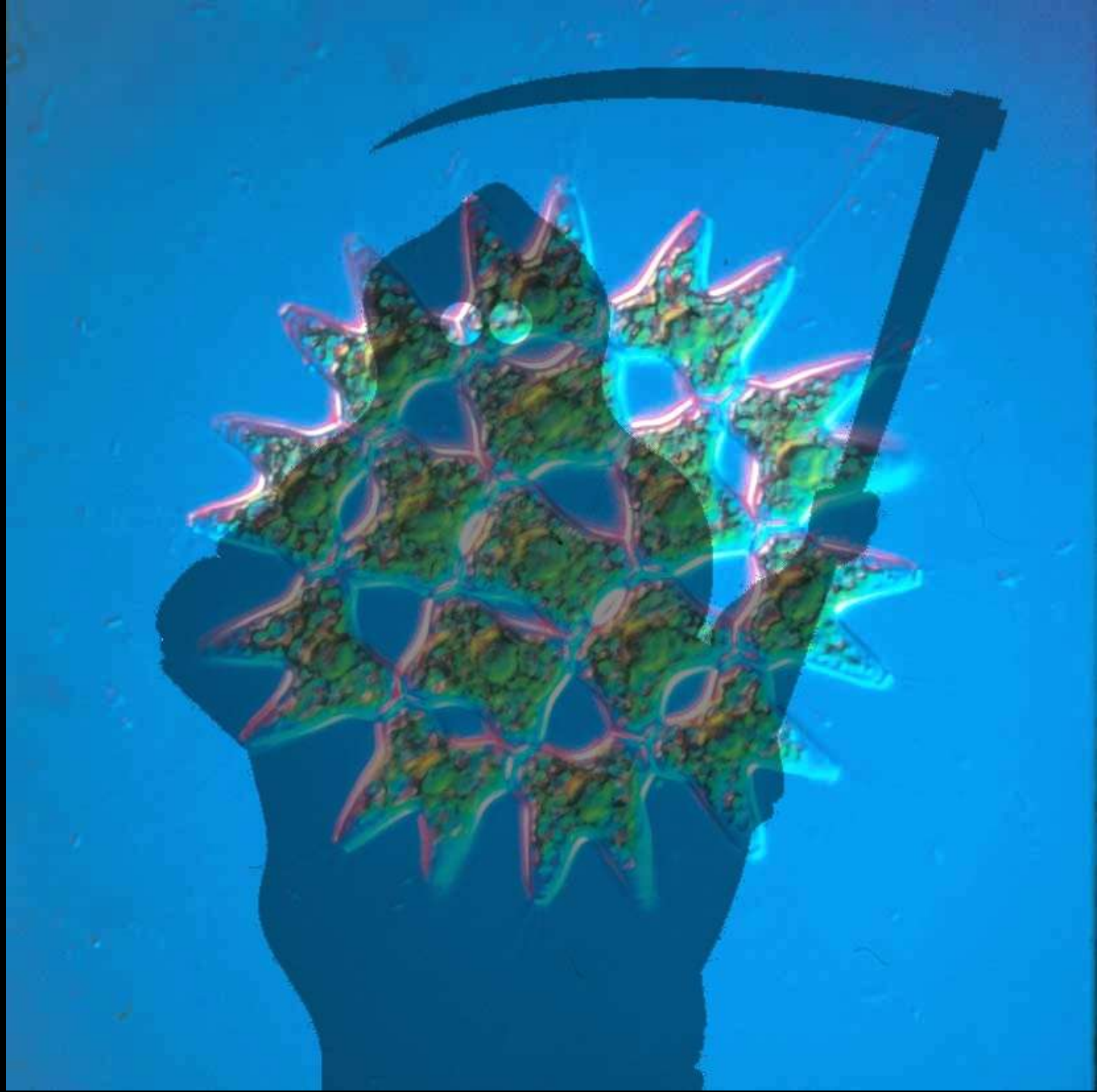


filamentous forms



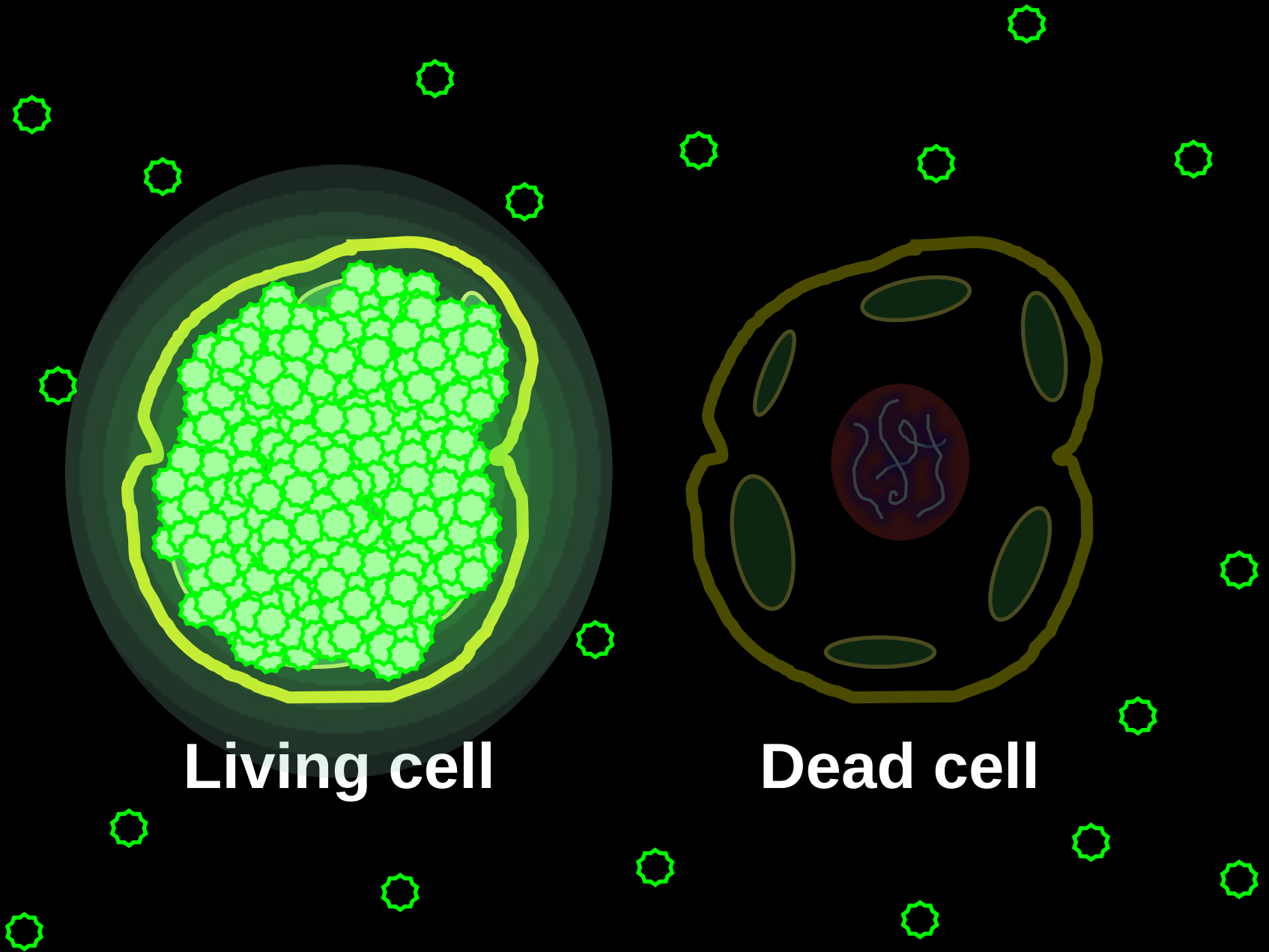
50 microns

How do
we know
they are
dead?



How do we know if something is alive?

- Fluorescein diacetate (FDA)
 - forms **fluorescein** in presence of active metabolism
 - passes through all cell membranes

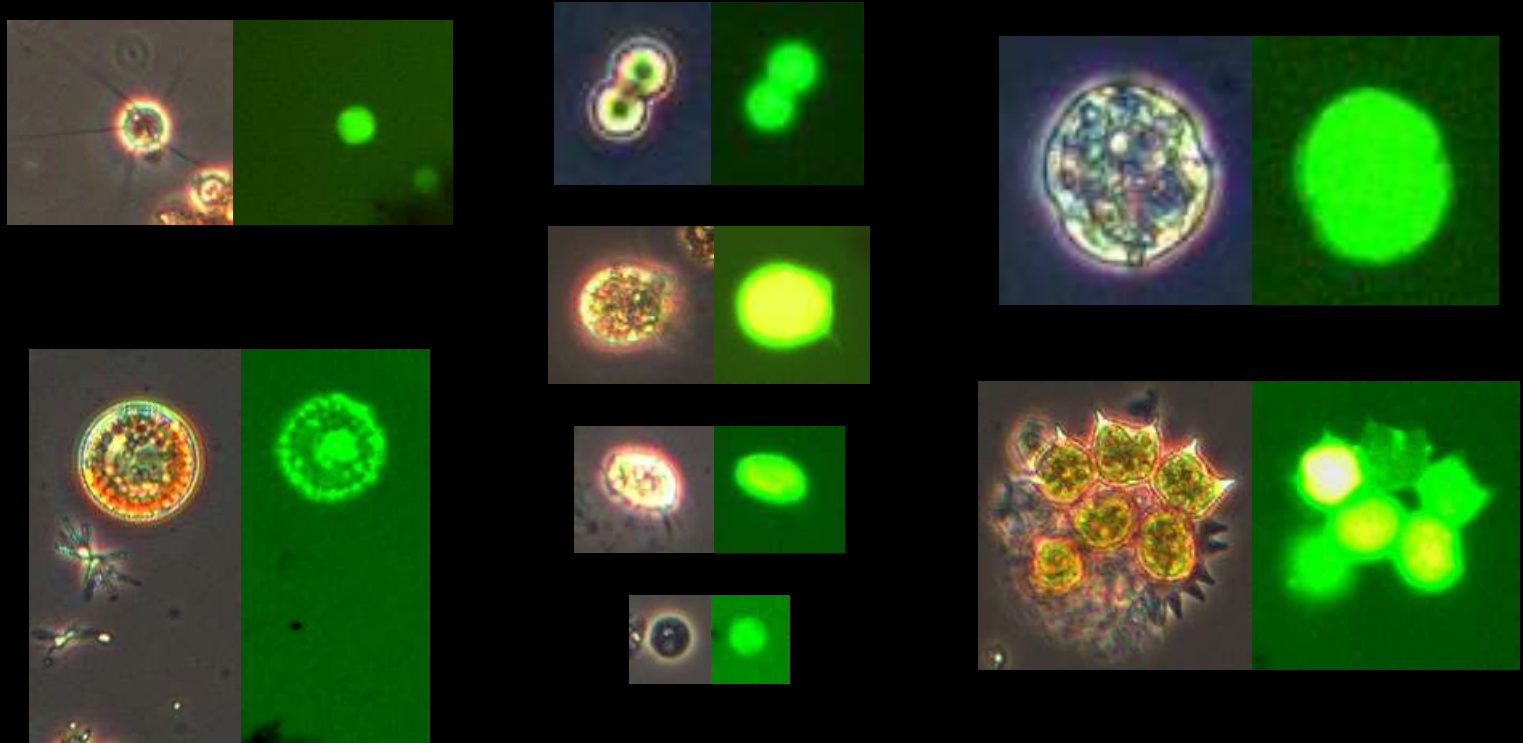


Living cell

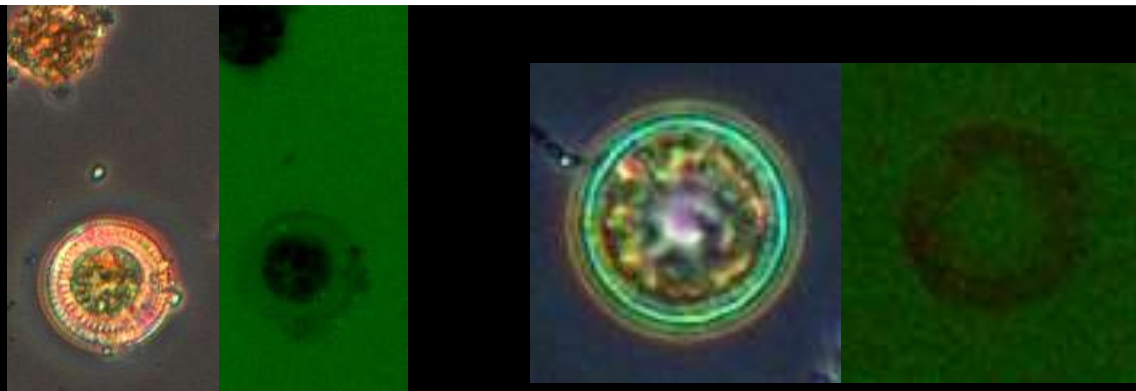
Dead cell

FDA-stained cells

alive

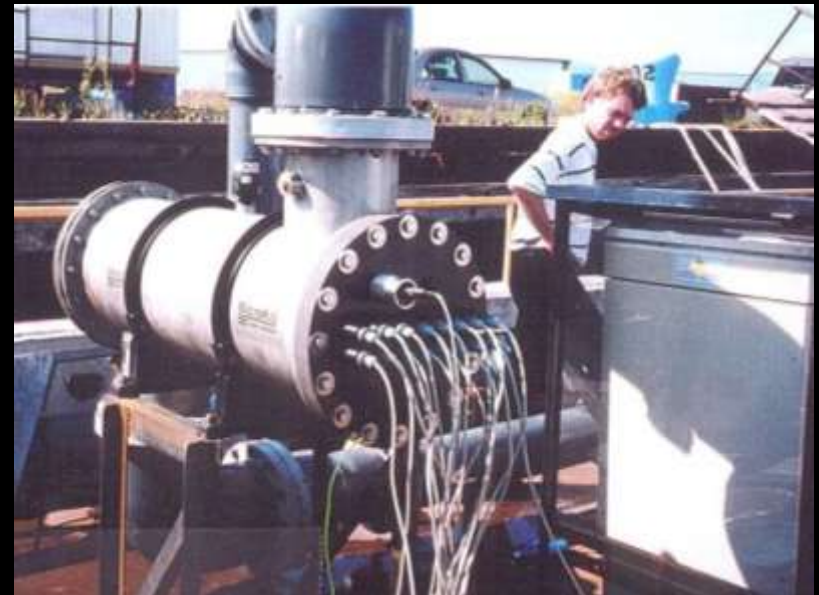


dead



Test Results – zooplankton & phytoplankton

Examples of Ballast Treatments

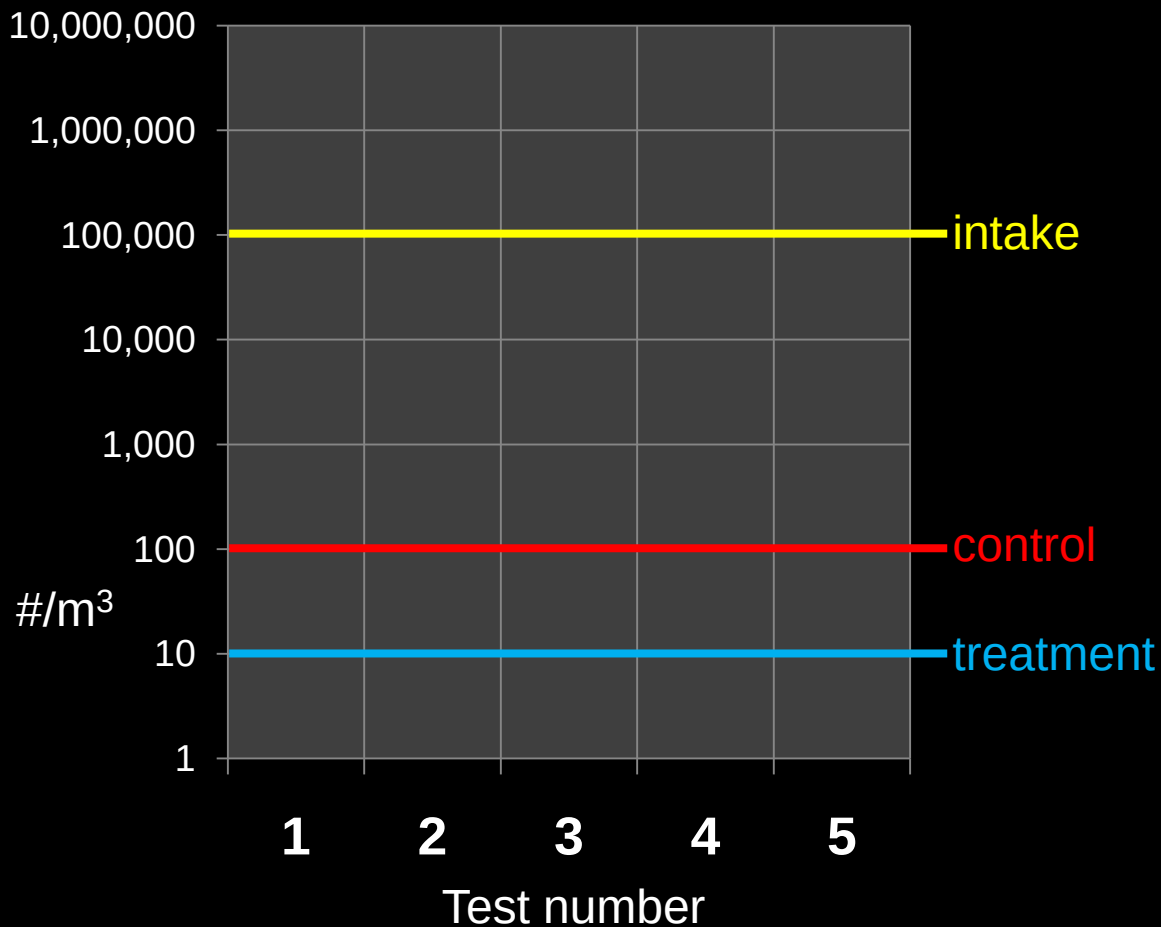


Siemens SiCURE™

- Filtration
- Electrochlorination
- Demand-regulated control logic



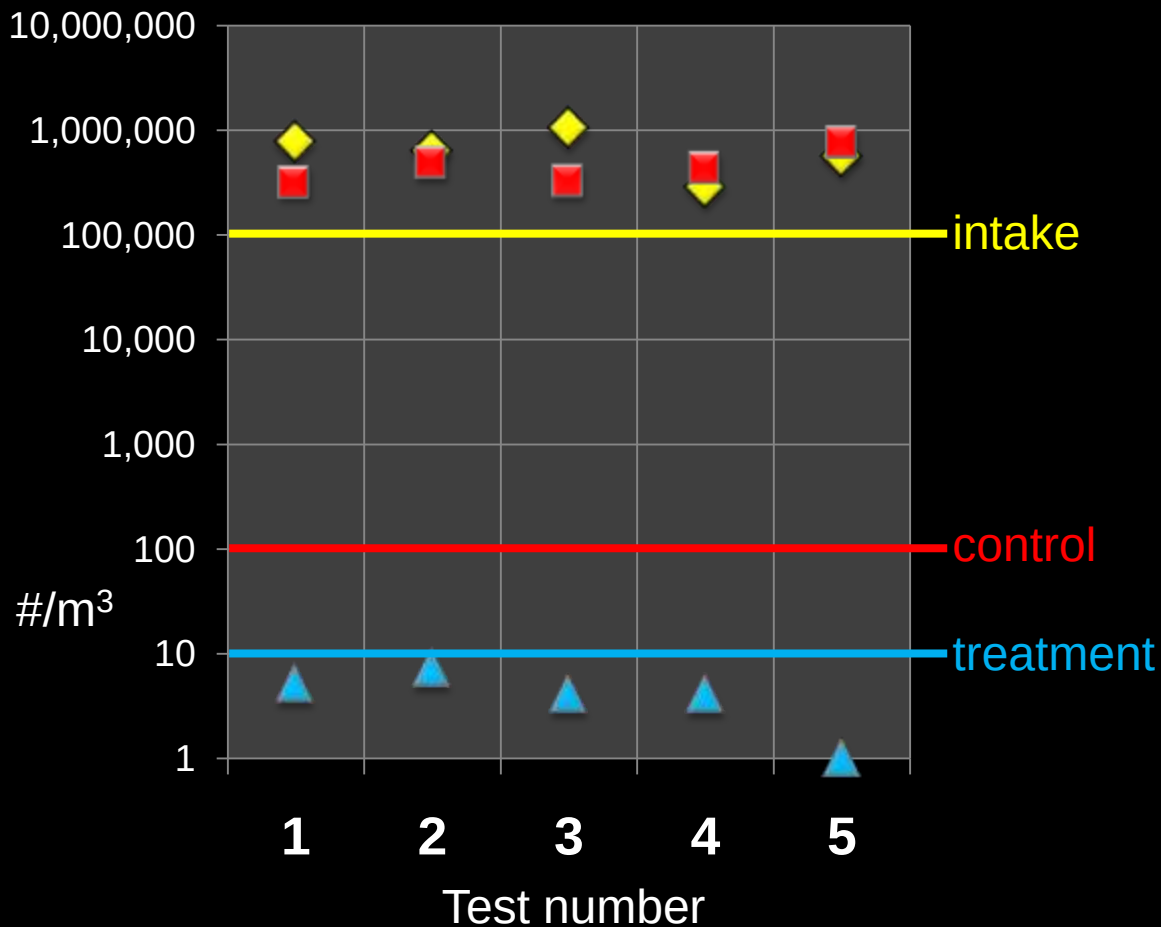
Siemens SiCURE™



- ◆ Intake
- Control
- ▲ Treatment



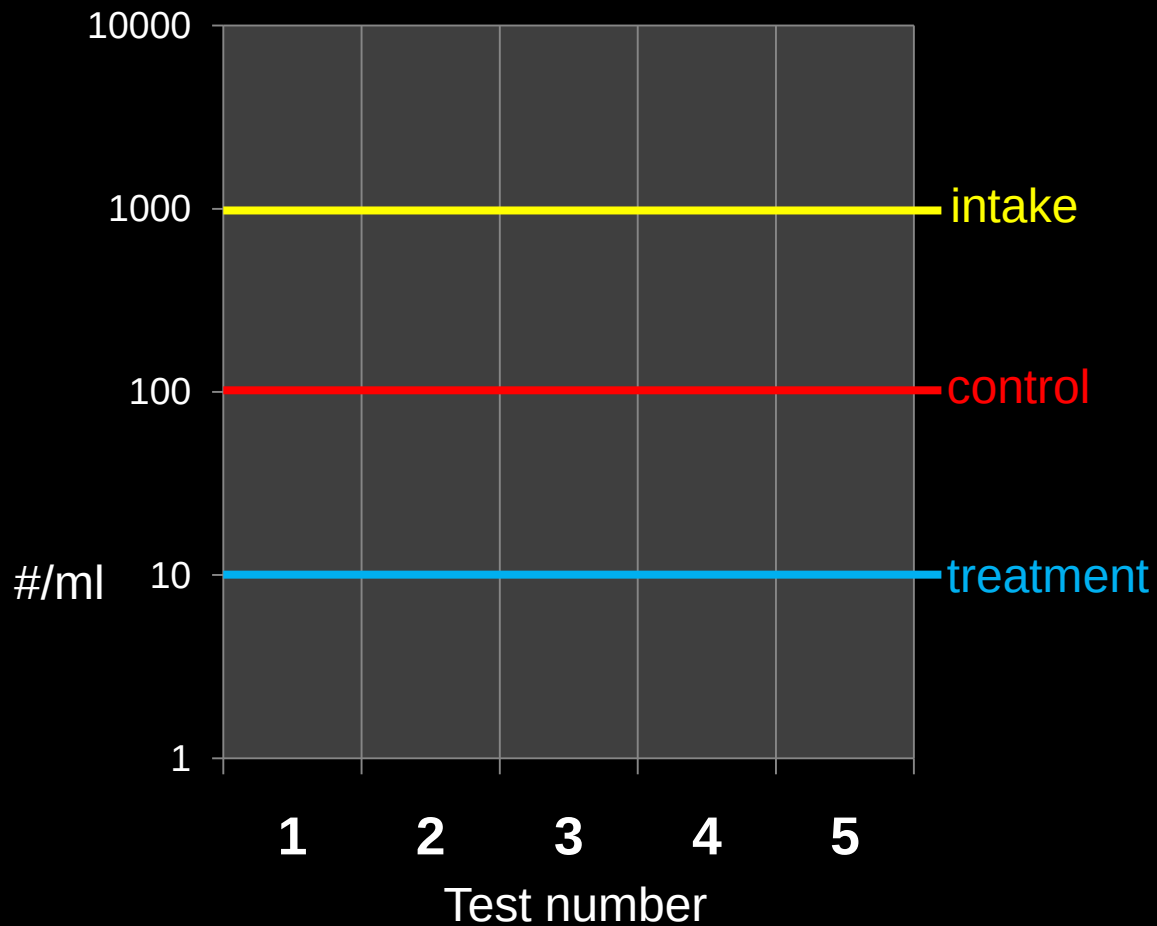
Siemens SiCURE™



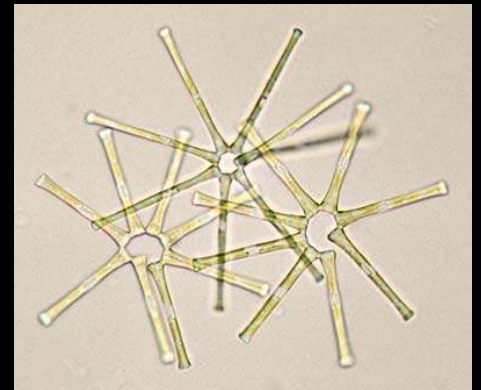
- ◆ Intake
- Control
- ▲ Treatment



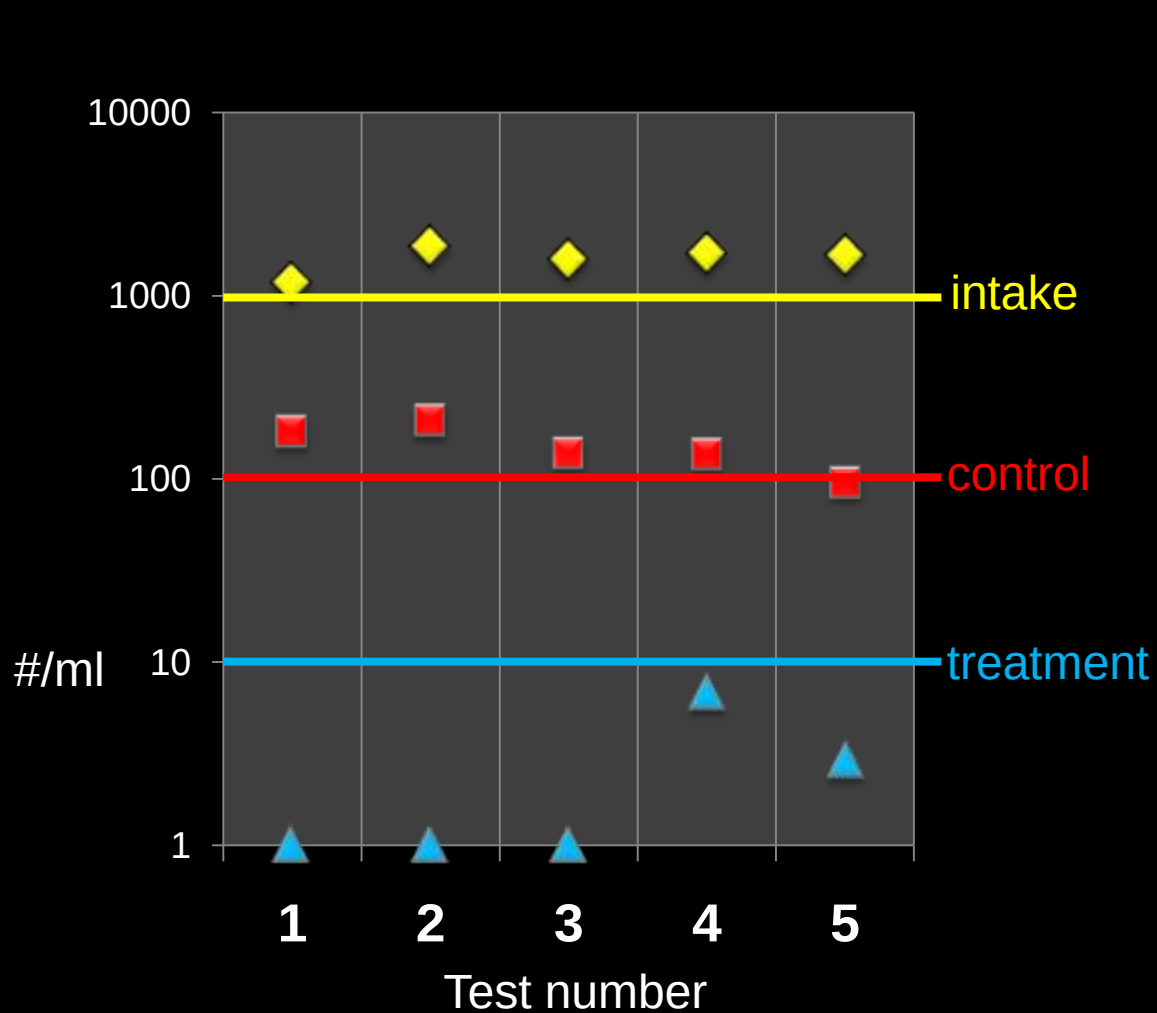
Siemens SiCURE™



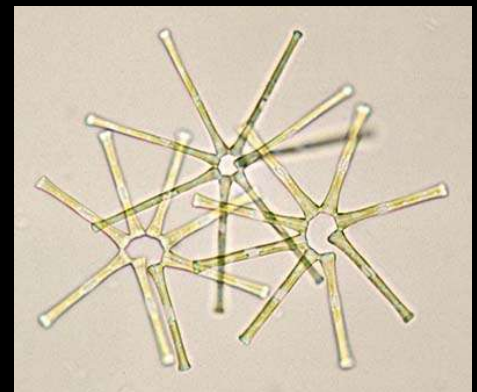
- ◆ Intake
- Control
- ▲ Treatment



Siemens SiCURE™



- ◆ Intake
- Control
- ▲ Treatment



[illegible]

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