

The Emerging Science of Circulation for Improving Freshwater Lakes & Ponds

Implications for Lake Pocotopaug, CT

December 21, 2006

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NE Regional Manager

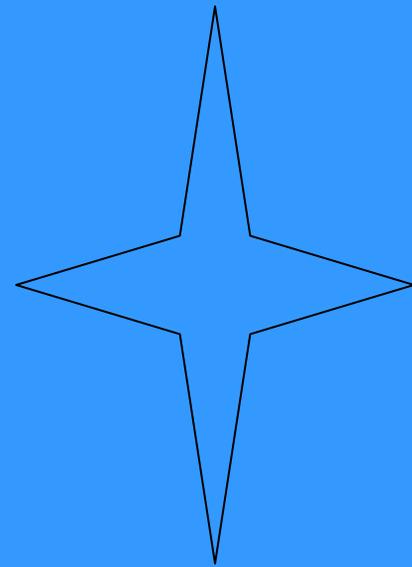
SolarBee Division of Pump Systems, Inc.

Hockessin, DE



Outline

1. Treating Water
2. Lake Cycles
3. Algal Blooms
4. SolarBee for Lake Management
5. Lake Pocotopaug



Why Lake Management?

1. Beauty-Looks Good
2. Recreation-boating, fishing, etc.
3. Economic-Development
4. Receiving Basin
5. Property Values
6. The Biota (animals/plants)

Lake Management

1. Chemical Treatment
2. Alum
3. Drawdown
4. Dredging
5. Bubbler Systems
6. Circulation--SOLARBEE

Alum Treatment

Welch & Cooke 1995

N=21

Effective Treatment in 6 of 9
Shallow Lakes

8 year average

Not Effective on External Loading

Chemical Treatments

Very Fast Reactions

Detrimental to Non-Targeted
Species (zooplankton, frogs)

Release of NH_3 causing increase
in Macrophyte growth

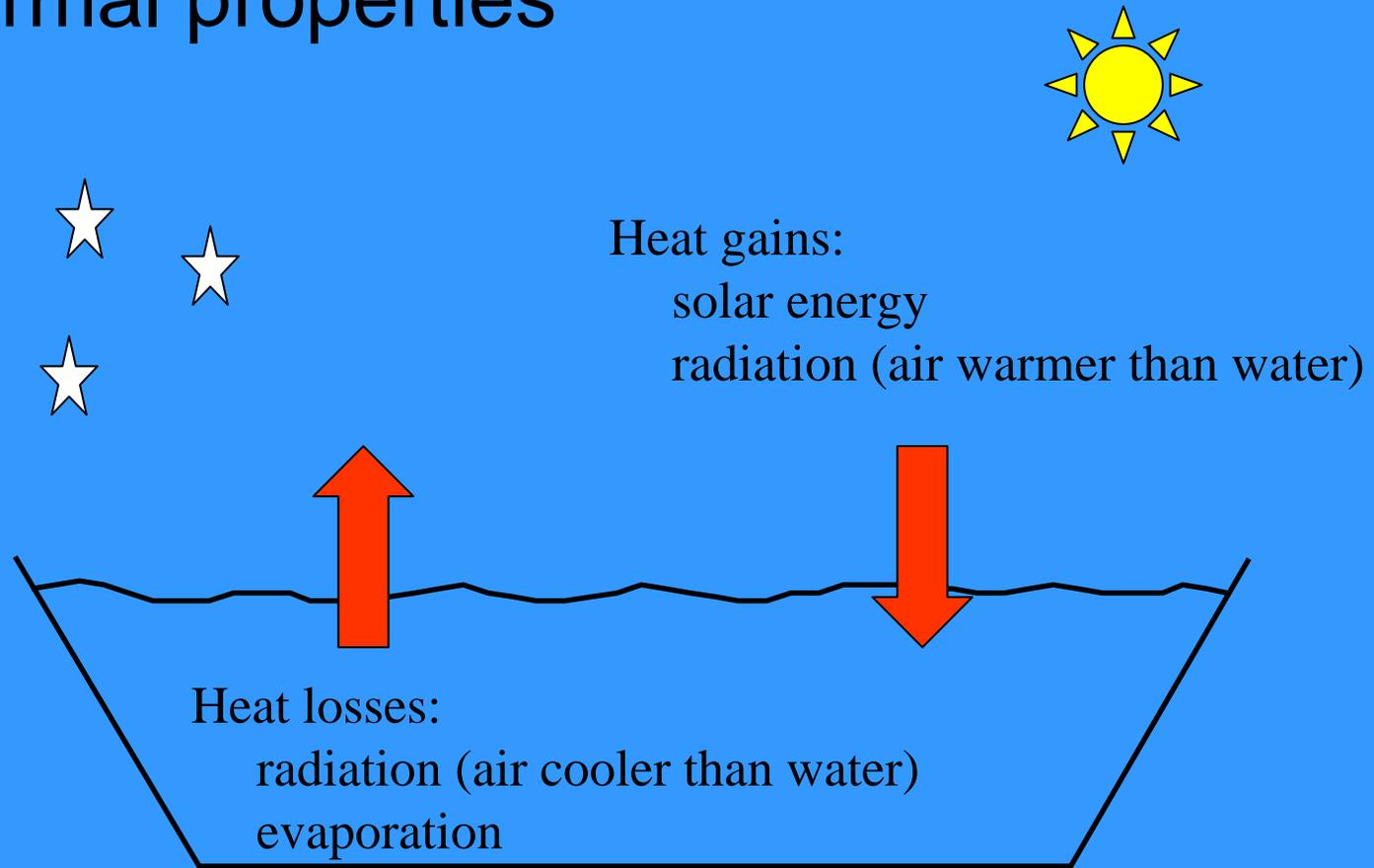
States Increasingly Hesitant

Public Health Concerns

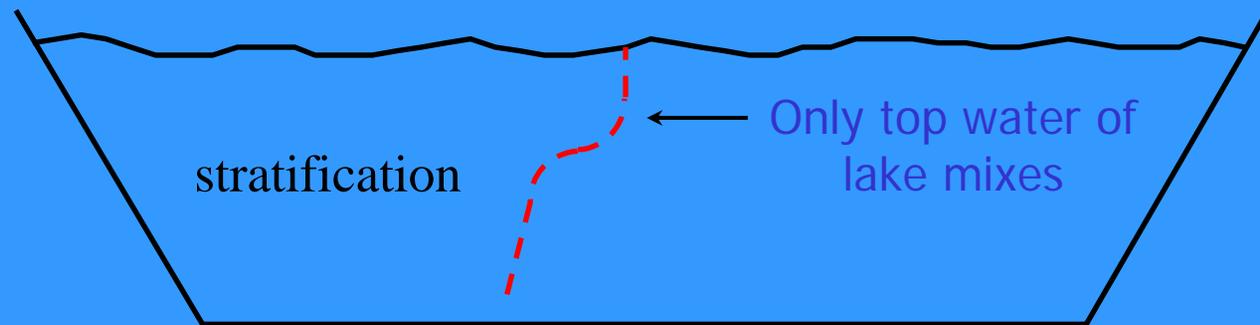
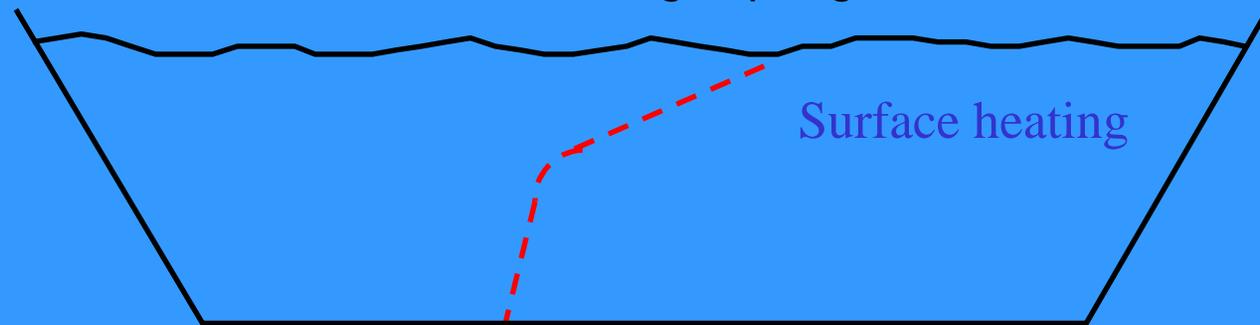
Increased Cost (Chemical &
Application by Technician)

Lake Physical Properties

Thermal properties

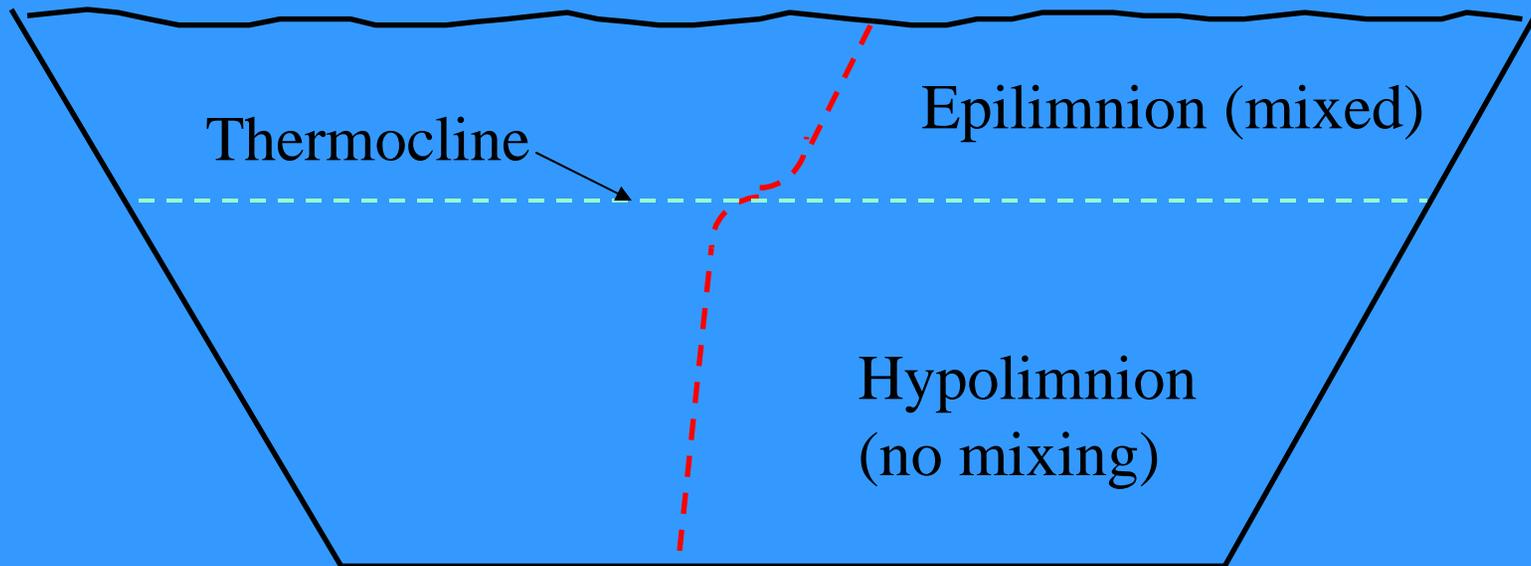


Seasonal Mixing Patterns



Water Temperature

Summer Thermal Stratification



Water Temperature

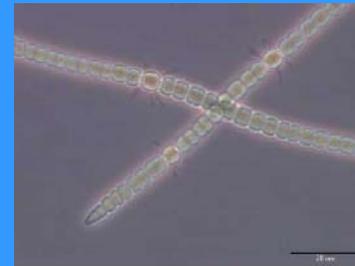
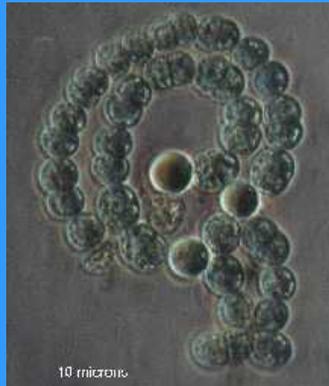
Most Common Problem:

Micro-algal Blooms

Cyanobacteria or “blue green
algae”

SolarBees have effectively controlled blooms of:

Anabaena sp.



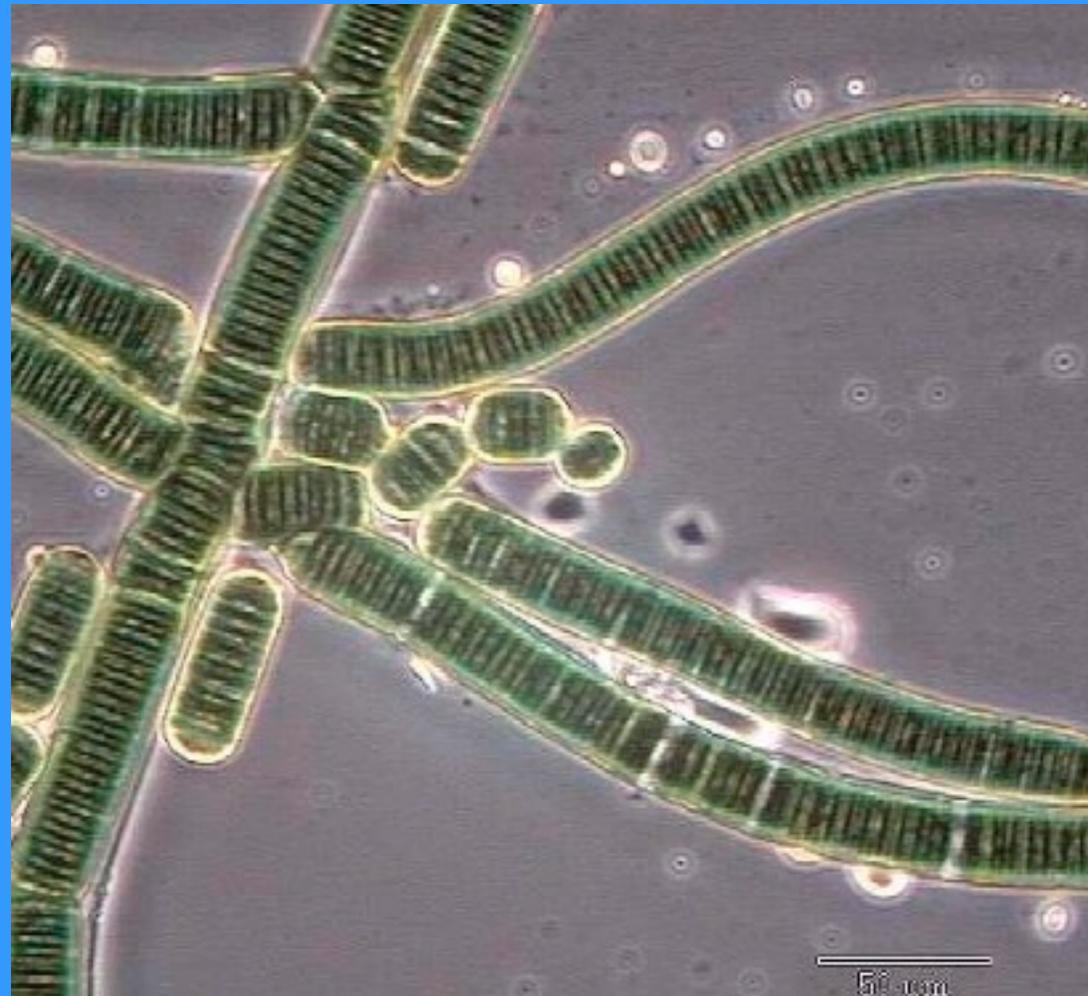
Aphanizomenon sp.

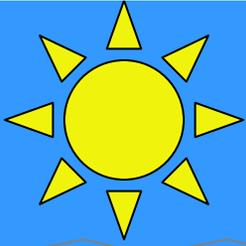


Microcystis sp.

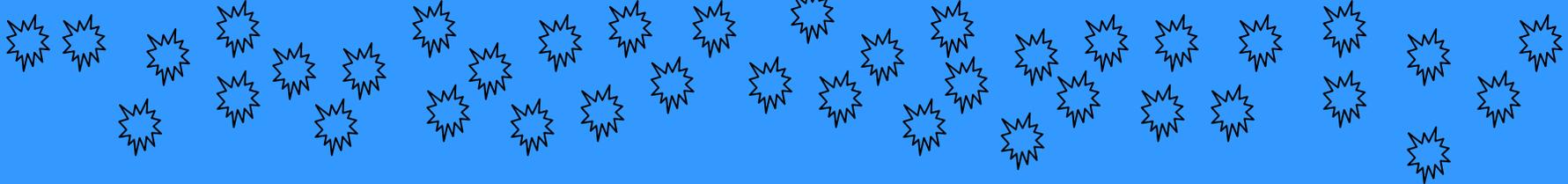


Lyngbya



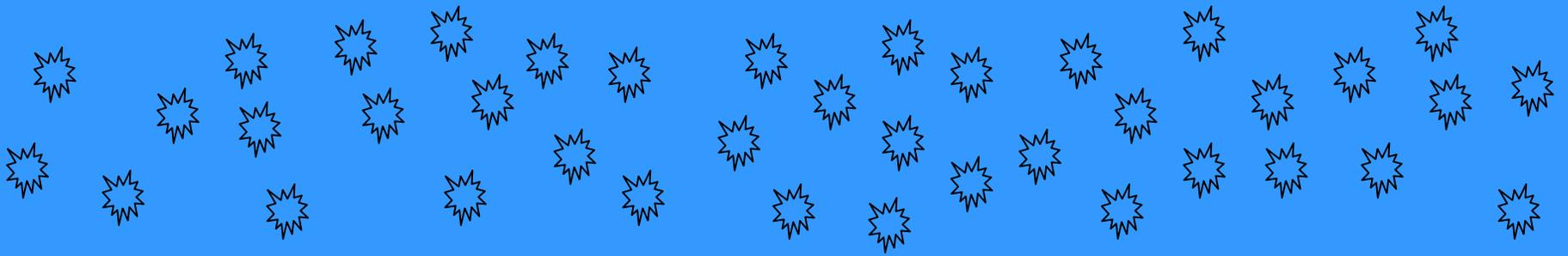


High Oxygen Production
Photosynthesis Exceeds Respiration





High CO₂ Production
Respiration Exceed Photosynthesis



Favorable for b-gs

Red = detrimental

Blue = beneficial

N & P Input

+

Quiescent, warm surface waters



Buoyant blue-green algae have a competitive advantage for nutrients & light



Blue-green algae bloom

Favorable for b-gs

Red = detrimental
Blue = beneficial

N & P Input

+

Quiescent, warm surface waters



Buoyant blue-green algae have a competitive advantage for nutrients & light



Blue-green algae bloom

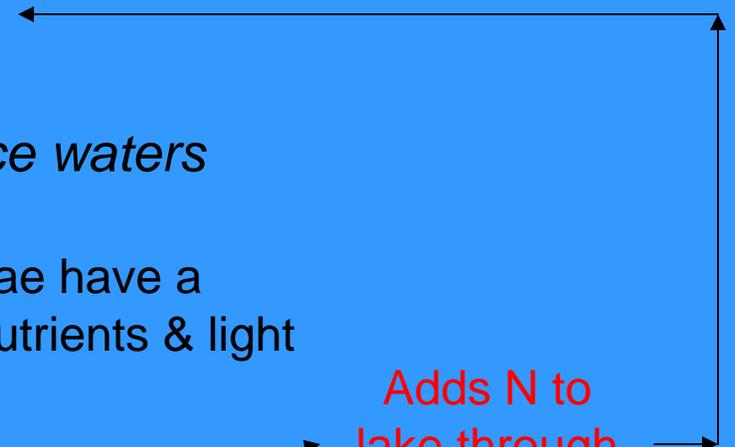
Cyanotoxins



Lethal effects
decrease
biodiversity

Adds N to
lake through
N₂ fixation

Taste & odor
(MIB & geosmin)



Favorable for b-gs

Red = detrimental
Blue = beneficial

N & P Input

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Quiescent, warm surface waters



Buoyant blue-green algae have a competitive advantage for nutrients & light



Blue-green algae bloom

Cyanotoxins

Not edible

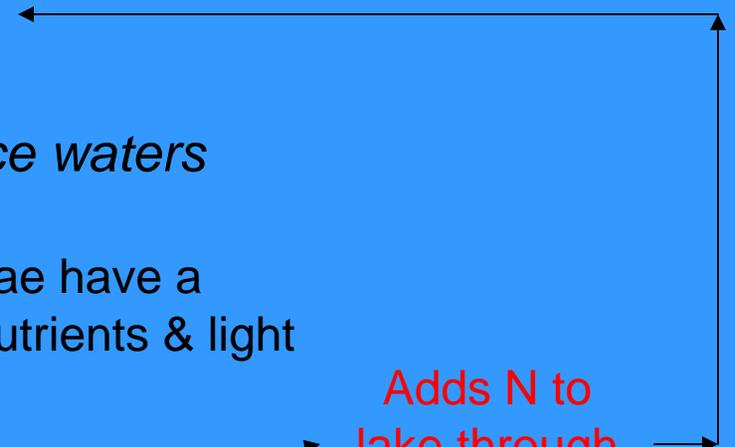
Adds N to lake through N₂ fixation

Lethal effects
decrease
biodiversity

Surface
scum &
odors

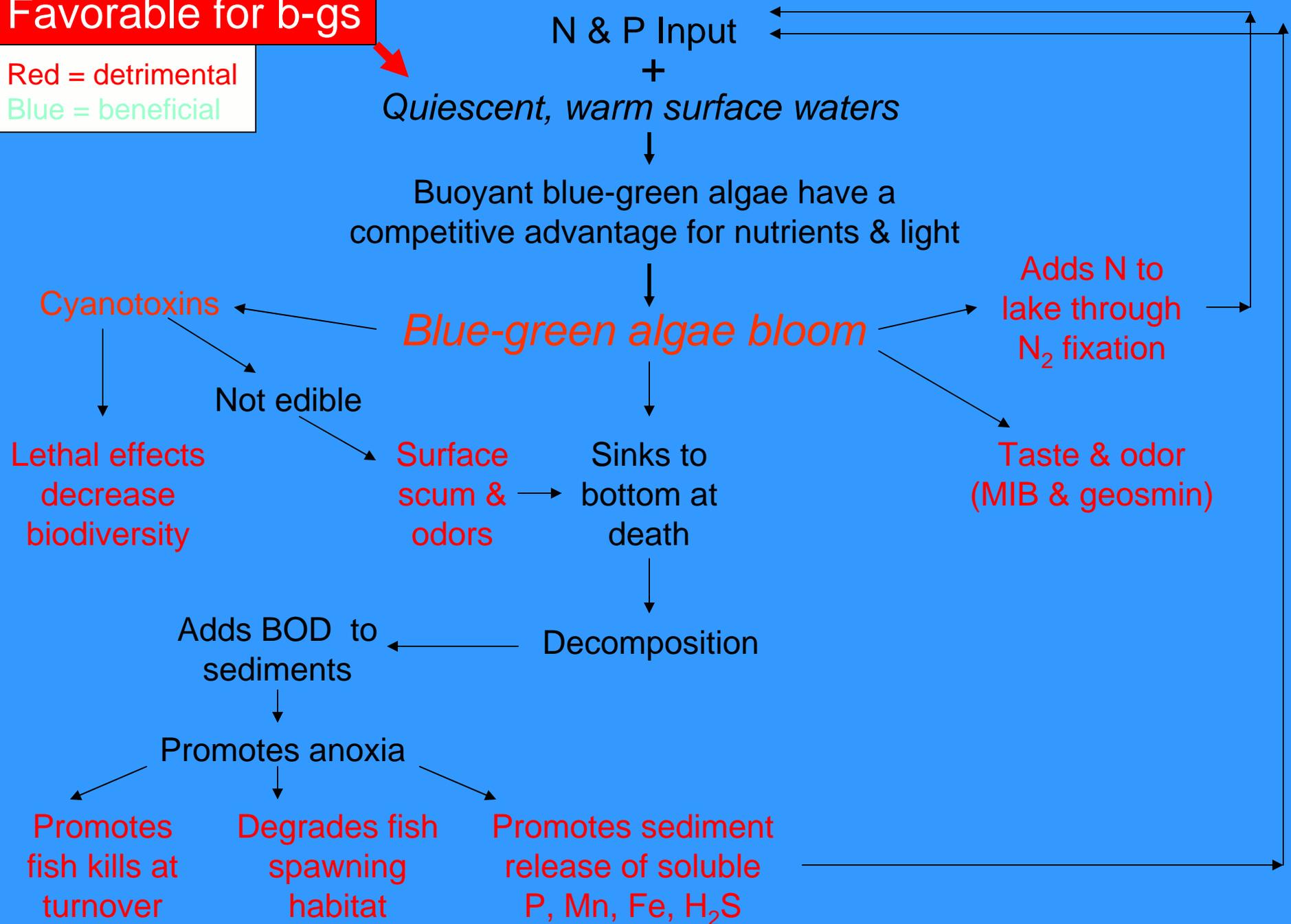
Sinks to
bottom at
death

Taste & odor
(MIB & geosmin)



Favorable for b-gs

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Blue = beneficial



Consumption vs. Decomposition Algal Pathways

N + P +  + warm temp.



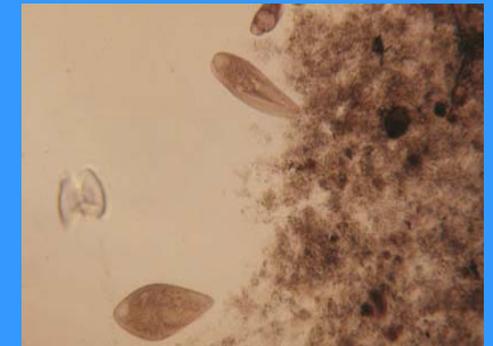
Edible algae (e.g., diatoms, greens, etc.)



Non-edible blue-greens

Consumption

Decomposition



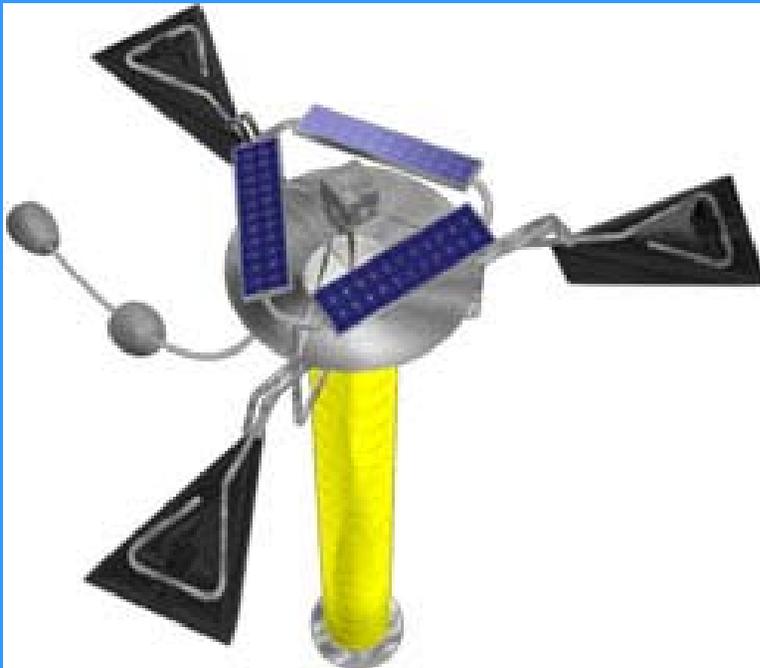
Problem vs. Symptoms

- **Problem:** Blue-green algae blooms
- **Cause:** Warm quiescent waters & nutrient inputs from surface water runoff
- **Consequences & symptoms:**
 - Poor water clarity
 - Poor food chain dynamics (blue-greens tend to be inedible)
 - Public health concerns of cyanotoxins
 - Taste and odor issues with MIB and geosmin
 - Higher chlorophyll *a* concentrations and algal biomass
 - Higher total phosphorus concentrations (P in algal biomass)
 - Depletion of bottom water dissolved oxygen upon blue-green algae death, settling and decomposition
 - Seasonal fish kills
- **Solution:** Prevent blue-green algae blooms

How to Prevent Blue-green Algae Blooms?

- **Nutrient Reduction:** Difficult and costly for non-point sources, and does not necessarily affect algal speciation
- **Chemical applications:** Kills many non-target, beneficial organisms as well; short-term benefit
- **Habitat disturbance through circulation:** Effective; but has been difficult to achieve in larger lakes until recent technological capabilities

The SolarBee®
creates long-distance,
radial flow circulation

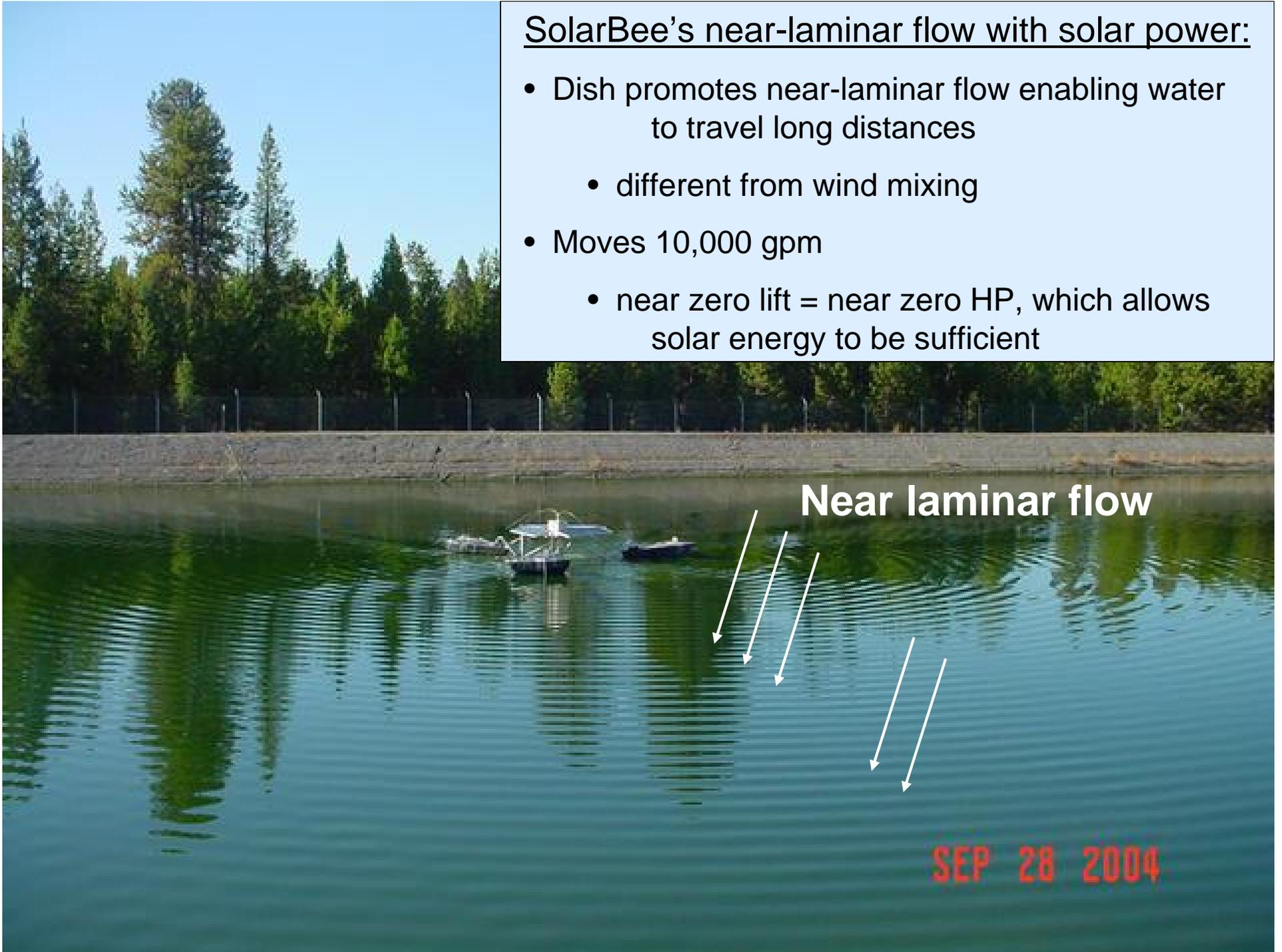


SolarBee's near-laminar flow with solar power:

- Dish promotes near-laminar flow enabling water to travel long distances
 - different from wind mixing
- Moves 10,000 gpm
 - near zero lift = near zero HP, which allows solar energy to be sufficient

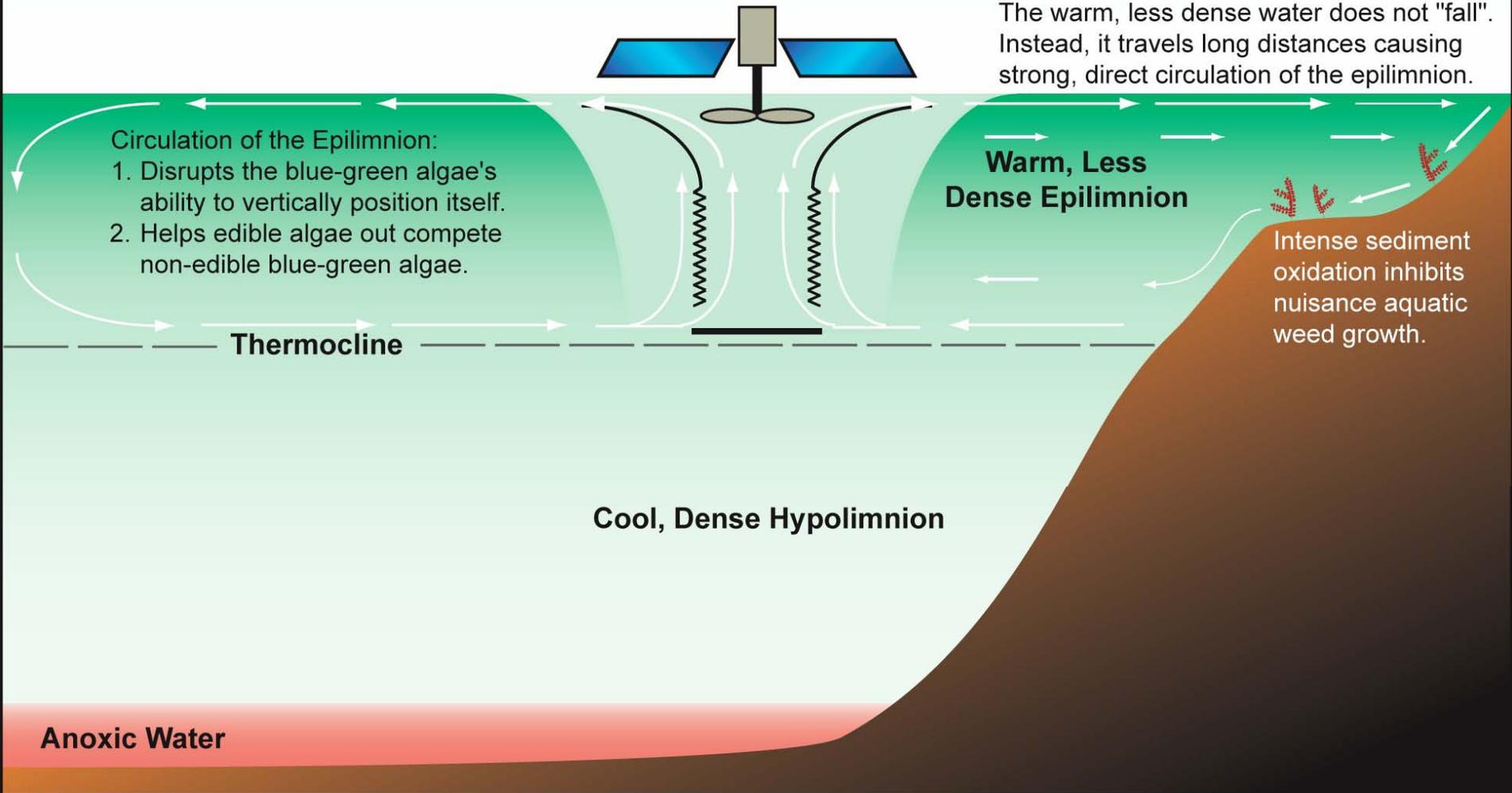
Near laminar flow

SEP 28 2004

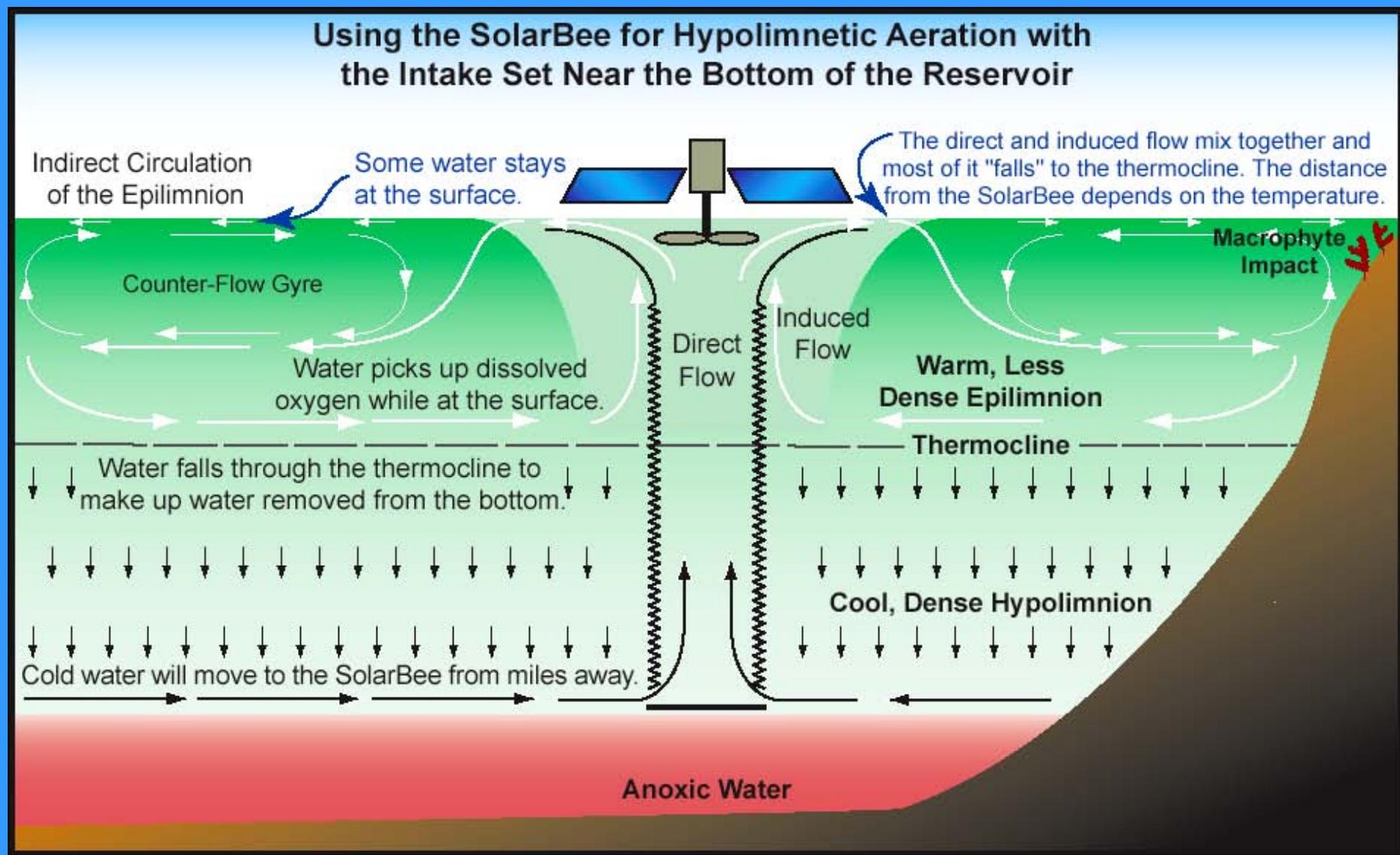


SolarBee for Blue-Green Algae Control

Intake Set Above the Thermocline



Hypolimnetic oxygenation:





California Winery - WWTF



A photograph of a lake in winter. The water is a dark, still green. The surrounding area is covered in snow, with many bare trees and some evergreens. A utility pole is visible on the right side. In the foreground, there are some bare, snow-dusted branches.

MICHIGAN Industrial W W Lake

SolarBee



INDIANA
Stormwater Lake

SolarBee

MAY 2 2002

Nevada Lake



South Dakota



DE Inland Estuary



Lloyd Lake, NY

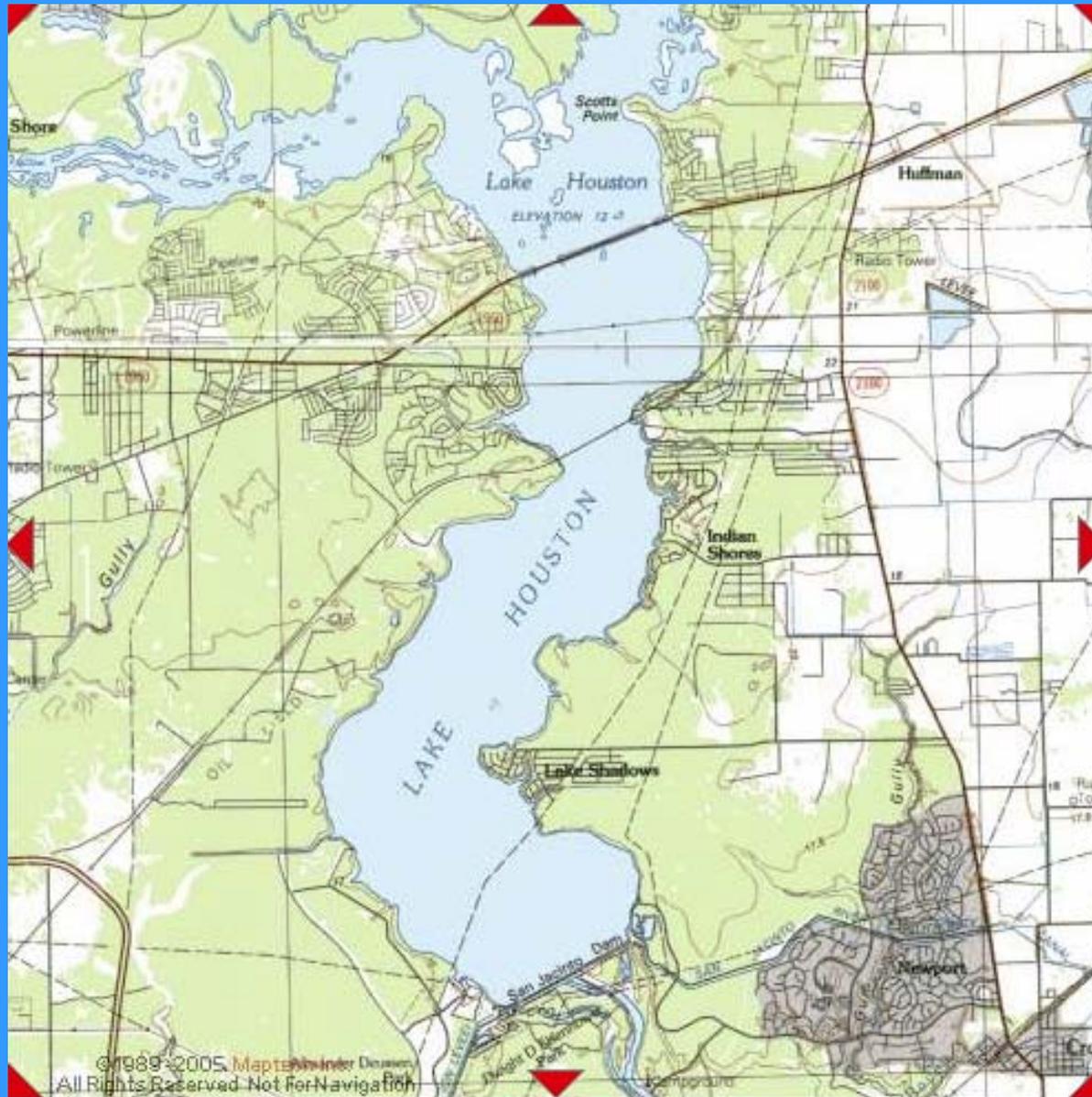


Sheerness Lake

1,300 acres



Lake Houston TX 11,800 acres



Lake Houston-- 20 units installed Summer 2006

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Long:

Image Size: 16.00 km x 16.00 km

Provider: AirPhoto USA

Nearest City: CROSBY, TX

Date: 1/1/1999

Best Res: 0.6096 Meter

Scale: 1 Inch = 2.304 km

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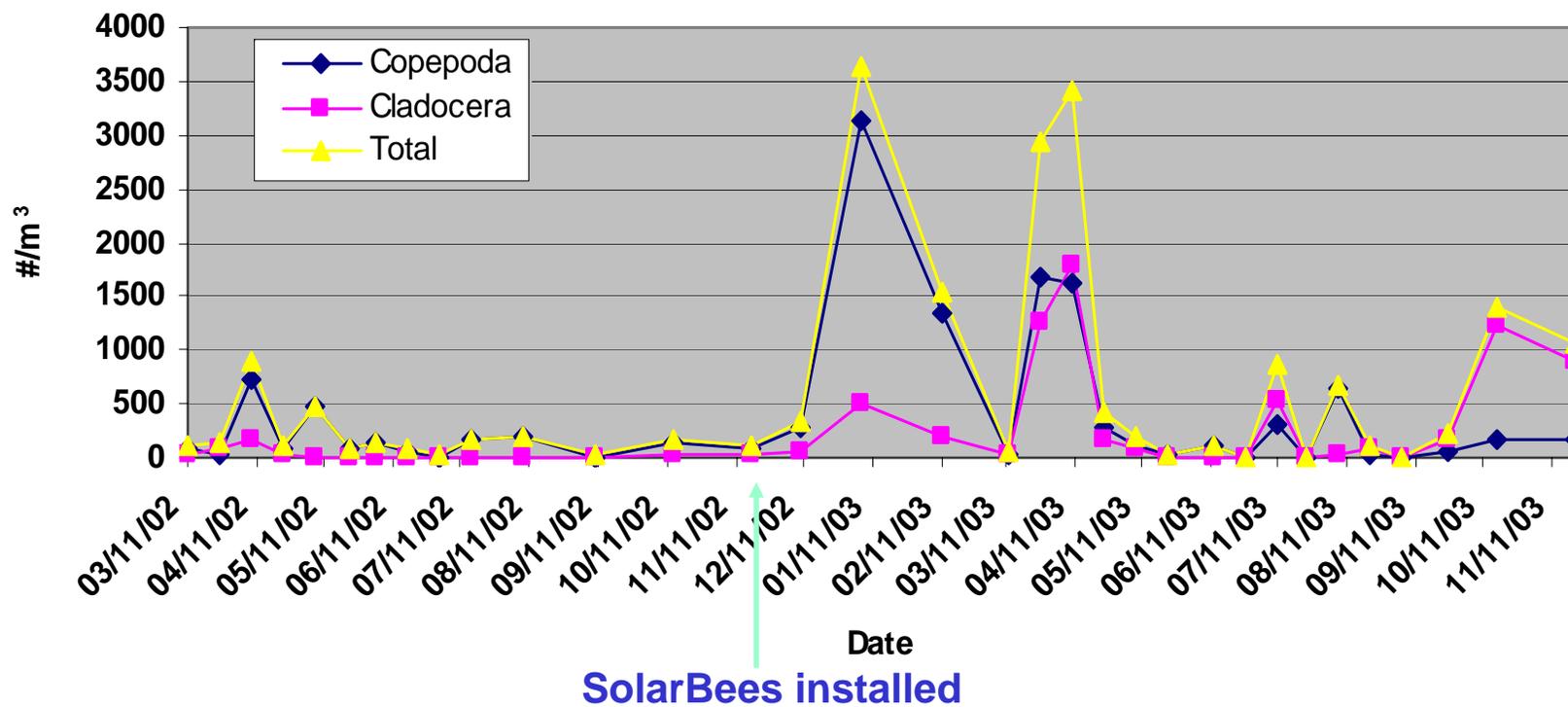
Quick Zoom

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Palmdale Lake Zooplankton (2002-3)

Crustacean Zooplankton Population - Palmdale Lake



Symbiotic Relationship between Blue-green Algae & Aquatic Macrophytes

Blue-green algae are often associated with aquatic macrophytes:

- macrophytes provide quiescent waters for blue-greens
- blue-greens' settling and decomposition provides $\text{NH}_4\text{-N}$ for aquatic macrophytes



Duck Lake (Denver, CO) May 27, 2005



No ducks swimming,
only a few dead ducks floating

Stagnant water, high surface tension,
no fish visible,
lake has unhealthy atmosphere



Duck Lake (Denver, CO) June 9, 2005



Ducks & geese, young & old,
swimming and bathing in lake

No stagnant water,
schools of little fish swimming,
lake has a healthy atmosphere



With SolarBees

Red = detrimental
Blue = beneficial

N & P Input

+

Horizontally & vertically circulating epilimnetic (surface) waters

Disrupts blue-greens' habitat
(eliminates competitive advantage)

Oxidizes littoral sediments

Prevents **blue-green blooms**

Inhibits release
of soluble P, Fe,
Mn, & H₂S

Improves
fish habitat
for
spawning

Allows diatoms, greens, etc.
("good algae") to grow

Edible

Increases secondary production
(e.g., zooplankton & fish)

Reduces
chlorophyll *a*,
pH, & total P

Increases
water clarity,
biodiversity

Reduces N &
BOD inputs to
sediments

Reduces risk of
seasonal fish kills



Image courtesy of the U.S. Geological Survey

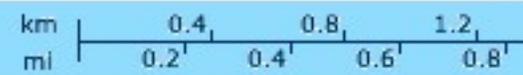




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© LandVoyage

Size

Aerial Photo | **Topo Map**

OUT

IN

WEST

NORTH

EAST

SOUTH

Image courtesy of the U.S. Geological Survey

m
yds

100 200 300
100' 200' 300'

An interactive web interface for viewing an aerial photograph. The main window shows a grayscale aerial view of a landscape with a large, dark, circular feature in the center. The interface includes a zoom control on the left with 'OUT' and 'IN' labels and a vertical slider. Navigation arrows for 'NORTH', 'SOUTH', 'WEST', and 'EAST' are positioned around the photo. At the top, there are tabs for 'Aerial Photo' and 'Topo Map', and a menu with 'Download', 'E-mail', 'Info', 'Print', and 'Order Photo'. A scale bar at the bottom right shows distances in meters (0, 100, 200, 300) and yards (0, 100, 200, 300), with a yellow dot at the 200 mark. The text 'Image courtesy of the U.S. Geological Survey' is located at the bottom left of the photo area.



Image courtesy of the U.S. Geological Survey



Thanks For Your Attention.....

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