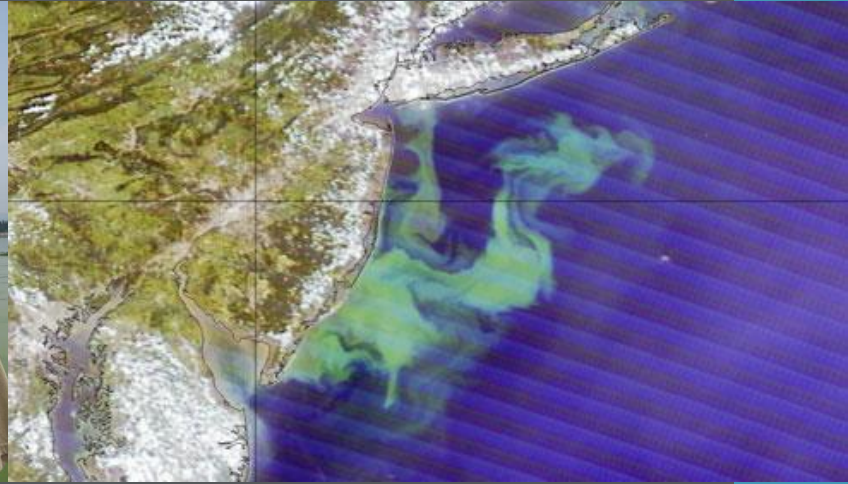
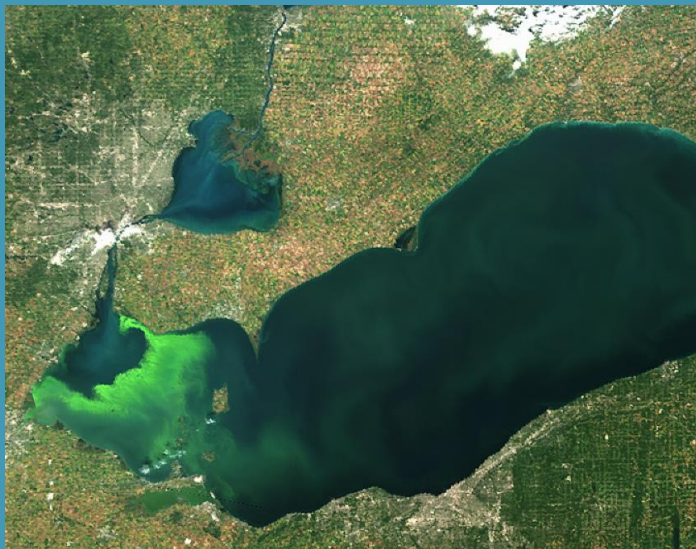




MONITORING & MODELING OF HABs

Andy Thuman, PE
HDR Water Quality Practice Lead





01 **Problem**

02 **Monitoring**

03 **Modeling**

04 **Control**

PROBLEM

- Harmful Algal Blooms (HABs)

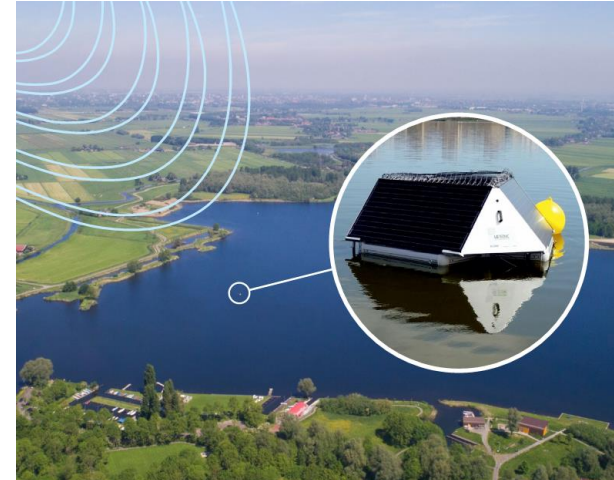
- NOAA – HABs occur when colonies of algae (simple plants that live in the sea and freshwater) grow out of control and produce toxic or harmful effects on people, fish, shellfish, marine mammals and birds

- Causes

- Nutrients (nitrogen & phosphorus)
- Temperature (climate change)
- Circulation (residence time)
- Other (??)

- Control

- Nutrient reduction
- Physical controls (mixing/aeration, chemical, ultrasonic)



NEWS

- West Coast – Detroit Reservoir & City of Salem
 - Oregon Governor Deploys National Guard, Declares Salem Water Situation Emergency (OPB, 5/31/2018) – bottled water/portable water tanks
 - Detection of low levels of cyanotoxins in drinking water supply
- Mid-West – Lake Erie & City of Toledo (August 2014)
 - 500,000 residents under water advisory after toxins detected in water supply
 - State of Ohio declares western Lake Erie as impaired (2018)
- East Coast – James River (VA) & NY State
 - James River – freshwater blue-green & marine dinoflagellate blooms
 - Upstate NY lake blue-green blooms & Long Island marine blooms



*Behind Toledo's Water Crisis,
a Long-Troubled Lake Erie*



Algae-infested water from Lake Erie on Monday washed up onshore at Maumee Bay State Park in Oregon, Ohio, near Toledo. Joshua Lott for The New York Times



MONITORING

- Dubai Algal Bloom Forecasting
 - Linking monitoring (satellite & buoy) with interpretation & modeling to provide an alert system
 - Real-time buoy monitoring to provide measure of current/pending conditions that may support a bloom



A TOXIC RELATIONSHIP



RECREATION

- Property Values
- Regulation



FOOD & WATER SECURITY

- Desalination
- Fisheries



HEALTH

- Human Health
- Biodiversity

Red tide blooms along UAE coastline

Ministry of Climate Change and Environment advises fishermen not to harvest fish in identified areas

Derek Baldwin, Chief Reporter

22:25 January 24, 2018

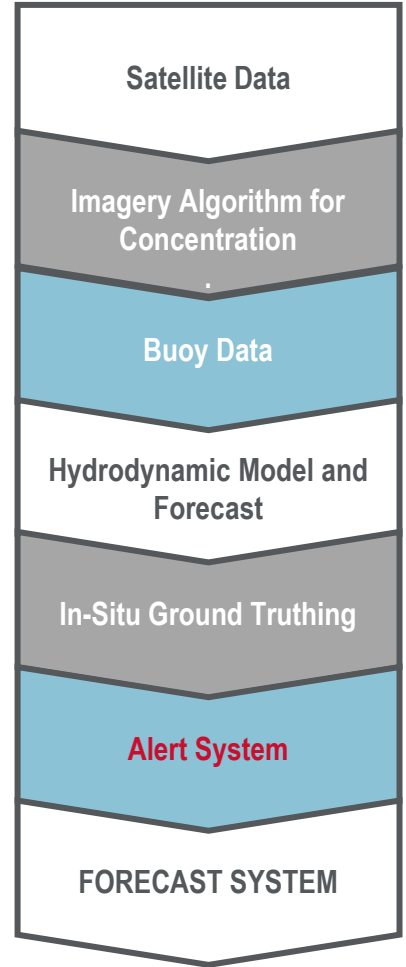
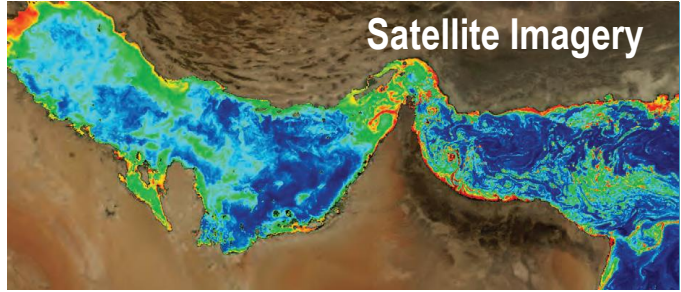


Satellite images have shown that the biological activity extended to the Indian Ocean and adjacent countries.

Image Credit: Ministry of Climate Change and Environment

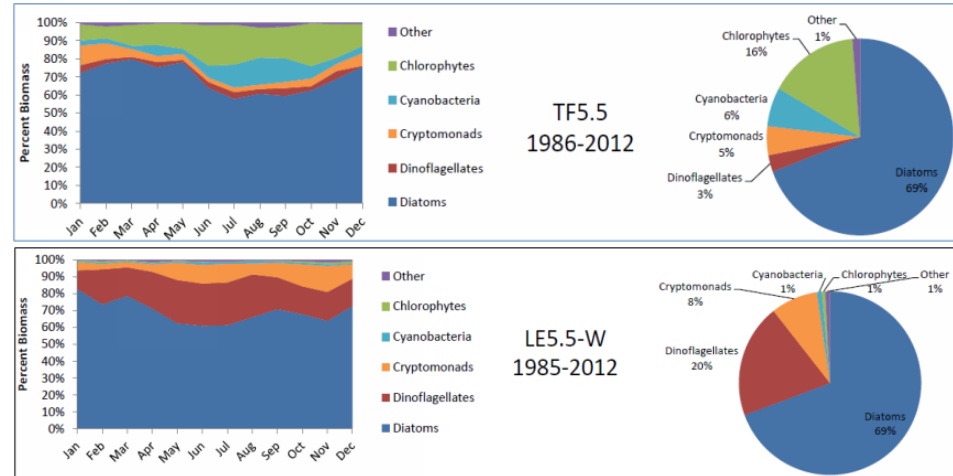
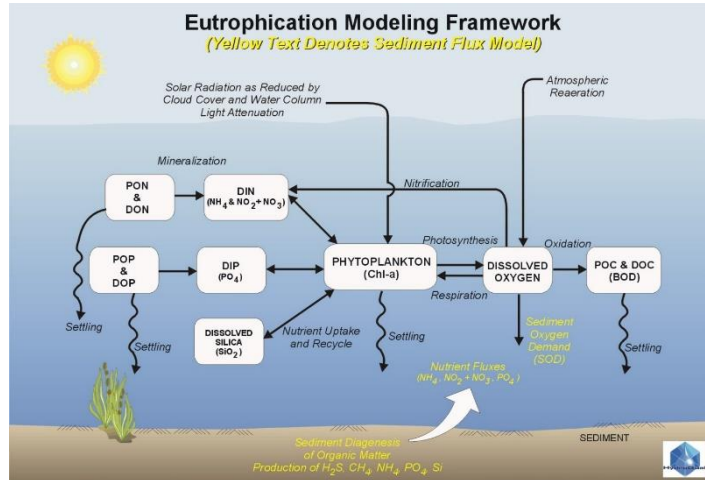
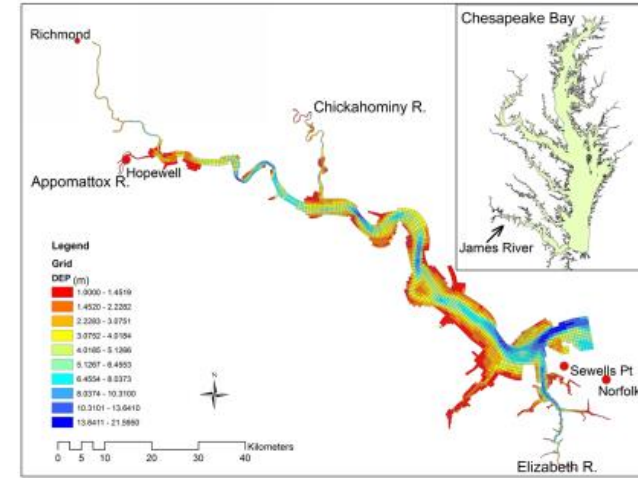
DUBAI FORECAST SYSTEM (PROOF OF CONCEPT)

- HDR funded innovation idea to build off existing Dubai buoy monitoring system
- Linking multiple technologies to provide HAB forecasting system



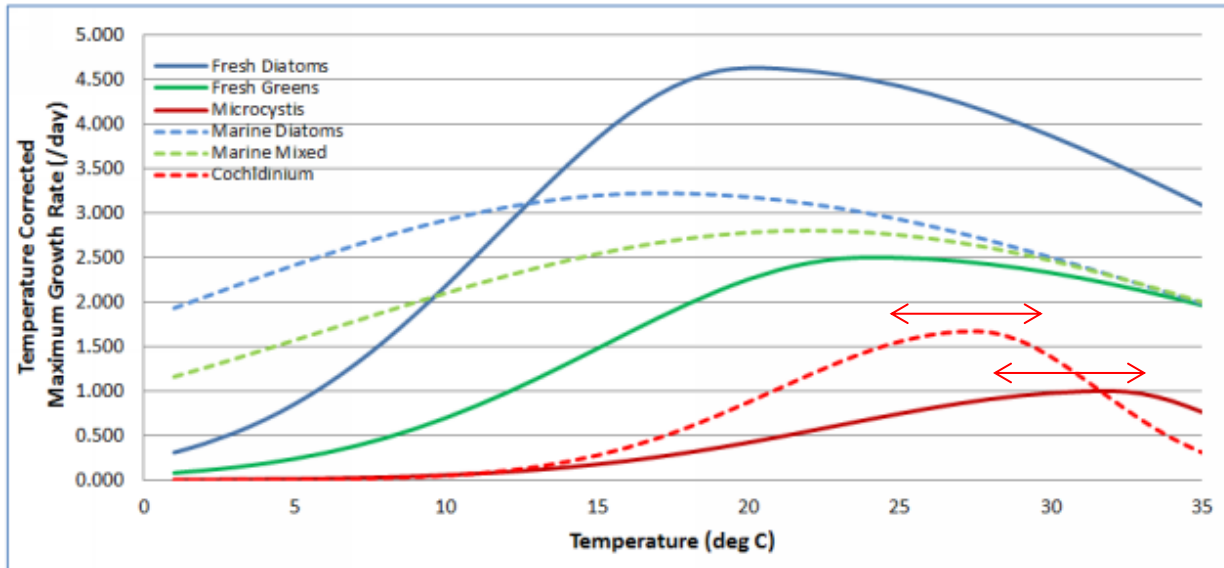
MODELING

- James River Chl-a Study (Virginia DEQ)
 - Multi-disciplinary team (academics/consultants)
 - Expanded standard eutrophication model to include algorithms for HABs
 - HAB modeling was successful but foundation is hydrodynamics/circulation of water body



TEMPERATURE CONTROL OF ALGAL GROWTH

- Different algal groups have different optimum temperature regimes
 - Model temperature growth curves derived from literature
- HAB growth more optimum at higher temperatures
 - Climate change impacts (warmer and earlier springs/late falls) – provides competitive advantage to HABs



NOAA LAKE ERIE HAB FORECASTING SYSTEM

- 7/9/2018 (Bulletin 06) provides nowcasts & forecasts of bloom severity index based on expected meteorological conditions and lake circulation modeling
- River phosphorus loading projections to assess potential for HAB events

The images below are "GeoPDF". Please visit <https://go.usa.gov/xReTC> for instructions on viewing longitude and latitude.

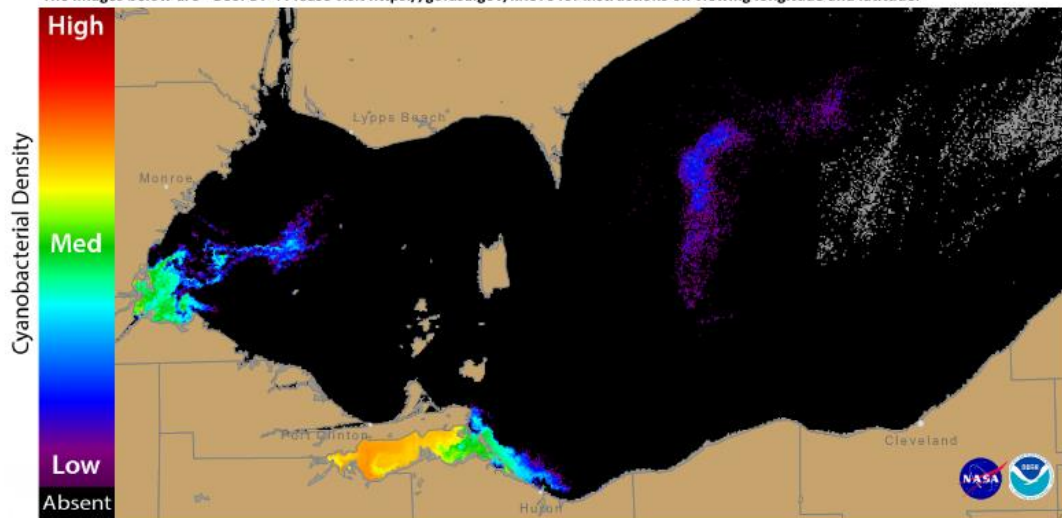
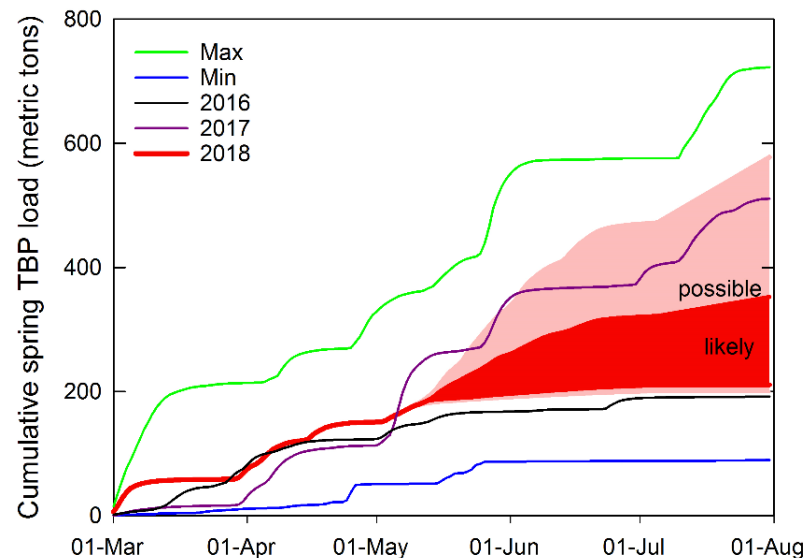


Figure 1. Cyanobacterial Index from modified Copernicus Sentinel 3 data collected 08 July, 2018 at 12:04 EST. Grey indicates clouds or missing data. The estimated threshold for cyanobacteria detection is 20,000 cells/ml



CONTROL

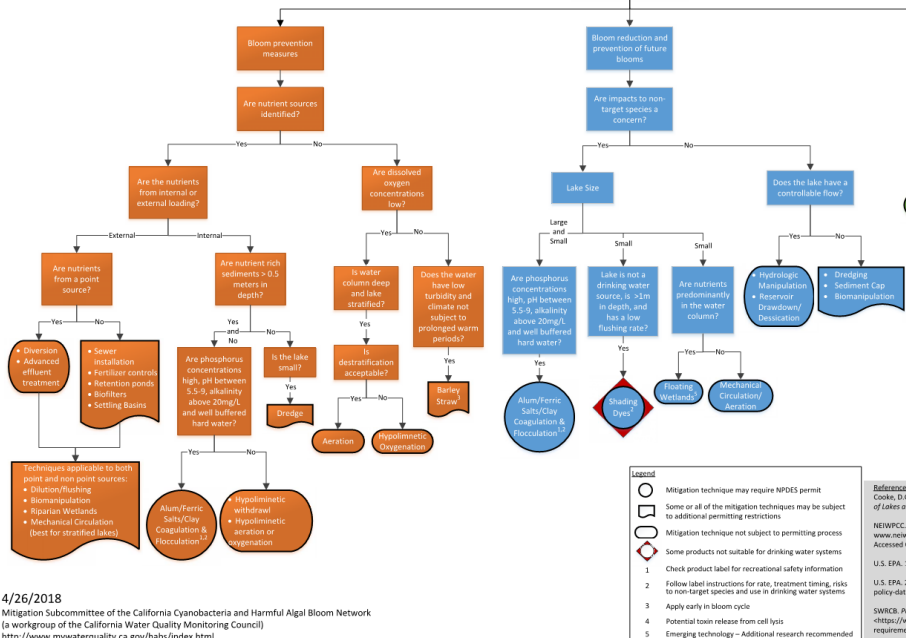
■ CA HAB lake mitigation approach

- Bloom prevention measures
 - External or internal nutrient sources
 - Point vs. nonpoint source
- Bloom reduction & prevention or no prevention of future blooms
 - Chemical treatment (coagulation/flocculation, algacides)
 - Shading
 - Mechanical (mixing/aeration)
 - Ultrasonic
 - Reservoir operation

DISCLAIMER:

Mitigation techniques presented on this page do not constitute a recommendation or endorsement by California EPA.

Please note: Multiple mitigation techniques may be necessary for long term harmful algal bloom management

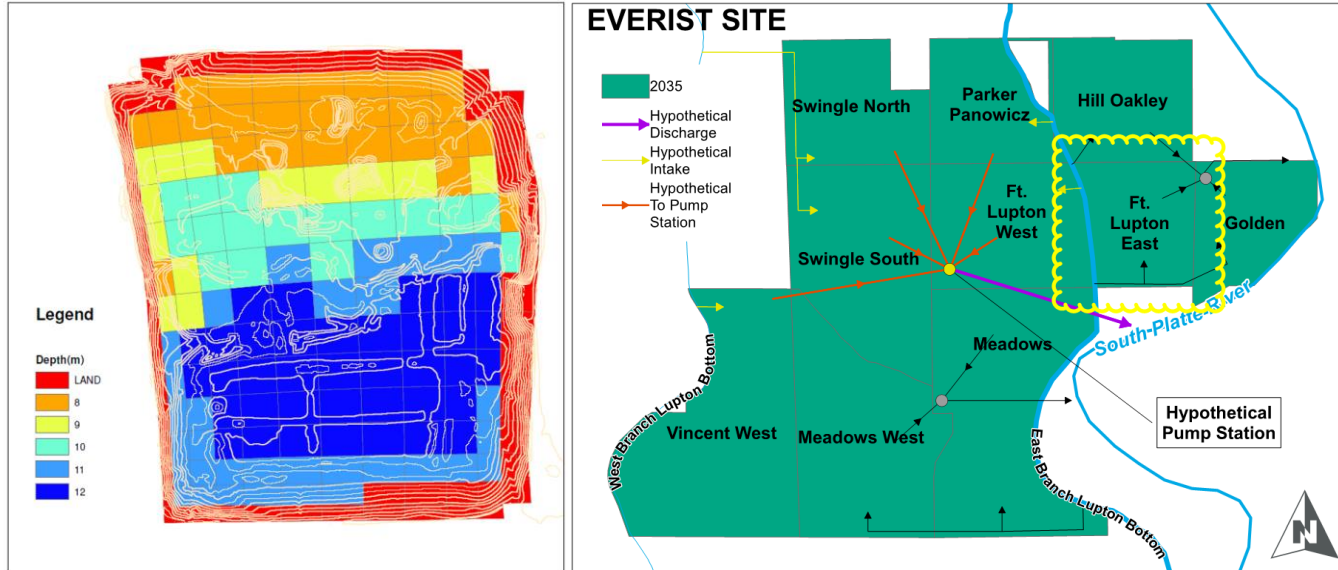


4/26/2018

Mitigation Subcommittee of the California Cyanobacteria and Harmful Algal Bloom Network
(a workgroup of the California Water Quality Monitoring Council)
<http://www.mywaterquality.ca.gov/haba/index.html>

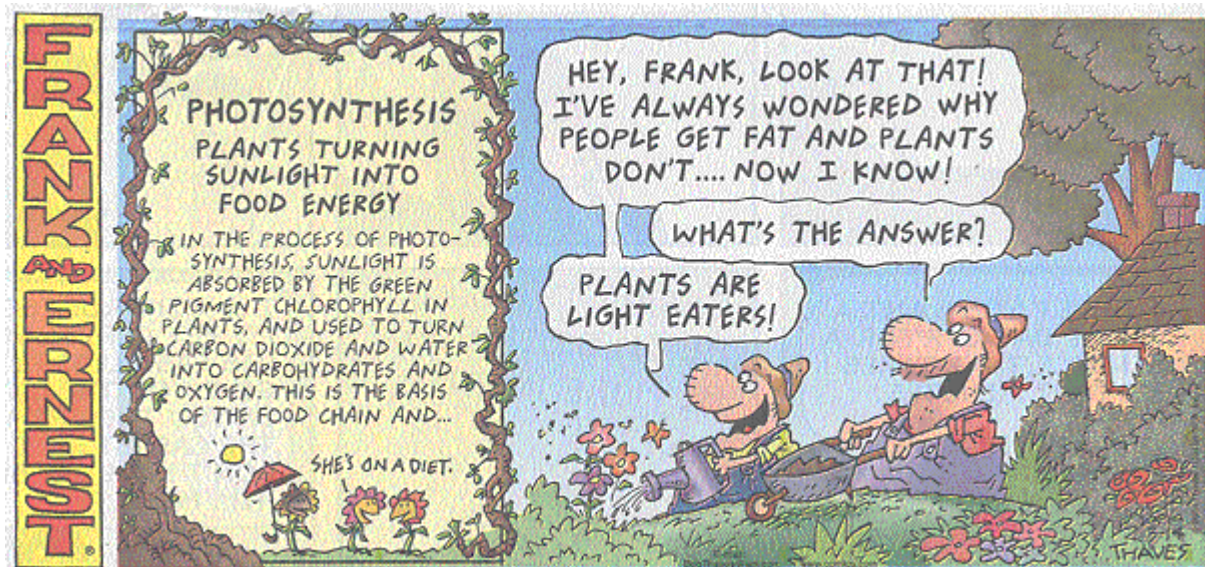
CONTROL

- Aurora project to evaluate eutrophication controls in reservoir that have been experienced since construction in 2015
- Model built to evaluate options
 - Nutrient reduction, vertical mixing/aeration, chemicals, Fe/Mn related to low DO



QUESTIONS

- Andy Thuman (HDR)
 - Water Quality Practice Lead
 - andrew.thuman@hdrinc.com





PROBLEM

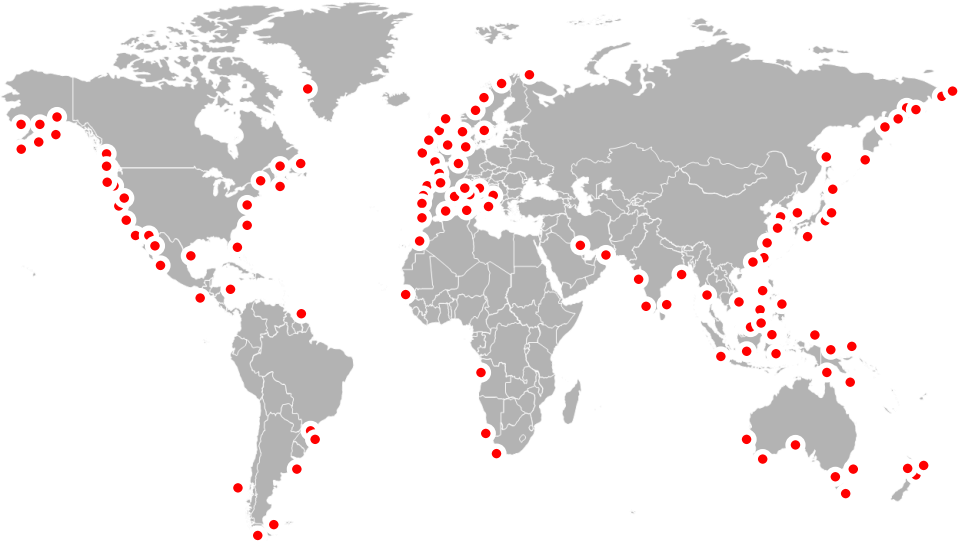
- Paralytic shellfish poisoning (PSP) toxins in shellfish and fish

1970



Source: US National Office for Harmful Algal Blooms

2011



Source: US National Office for Harmful Algal Blooms