Choosing Appropriate Approach(es) for HAB Mitigation: A Real-life Example

(Subtitled: One Size Does Not Fit All; Know Your System!)

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Qualifier: This presentation is NOT meant to be an exhaustive overview of specific management practices, but rather and example to illustrate that ***understanding*** your ecosystem is fundamental to choosing an ***appropriate*** approach for prevention, mitigation or remediation of HABs.

Great Plains and Midwest Harmful Algal Blooms Conference
Kansas City , KS, Feb 4-6, 2020

Great diversity of aquatic ecosystems

(size, hydrography, chemistry, etc.)

Great diversity of uses

(drinking water, recreation, fisheries, etc.)

But even systems that...

...are of similar size

...exist in the same geographic region

...appear to experience similar environmental parameters

...can actually have quite different plankton communities and HAB issues

Put a different way…

Our state-of-knowledge with respect to the *general* factors leading to a phytoplankton bloom is **Limnology 101**.

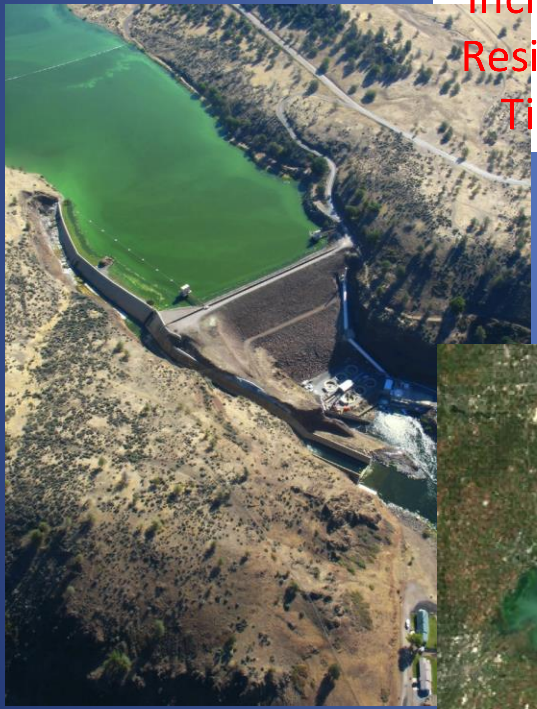
Our ability to predict the *SPECIFIC* phytoplankter that will dominate a bloom (and produce toxin(s)) is more akin to **Rocket Science** (so far).

(there are some exceptions: where the system has been studied extensively, or where it is exceptionally 'simple')
(e.g. *Karenia* blooms off Florida; Picocystis in Mono Lake)

These varying features dictate different approaches.

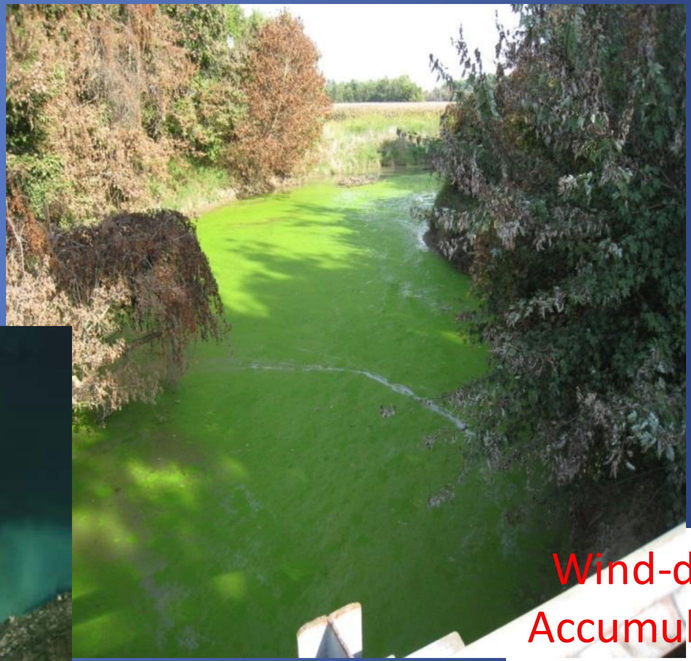
Take home: the approach for each water body should be tailored to the *system*, the *specific problem*, the *desired outcome(s)*…

…and be based on the most thorough scientific understanding possible.



Increased Residence Time?

Nutrient Loading?



Wind-driven Accumulation?

A real-life example:

Alum/phoslock applications: ‘Proven’ approaches for reducing phosphorus concentrations in surface waters.

Shown to be highly effective in some lakes (up to 20 years!).

Excellent, let’s go for it, right!?!

But…

…not always so effective.

Canyon Lake to Receive Fifth Alum Treatment

MONDAY, SEPTEMBER 21, 2015

(…and a sixth, and seventh time!)

https://sepro.com/

What are your best weapons in choosing an approach(es)?

(aka how can I avoid wasting my time & money?)

Guiding Principles:

- Know your endgame (what is the intended use(s) of your resource?).
  - Are there competing uses/interests? (that may change your approach)
- Understand the *upsides* and the *downsides* of possible approaches.
  - BOTH exist: Cost, effectiveness, longevity, aesthetics, etc.
- Try to let sound science dictate action, not politics.
  - Ultimately, only a sound scientific approach will be sustainable.

A few more Guiding Principles:

- Acquire basic information on the nature, magnitude and composition of your problem (a solid PLE is essential).
  - ESTABLISHING THE PRIMARY DRIVER(S) OF THE PROBLEM IN *YOUR* ECOSYSTEM IS FUNDAMENTAL.
  - Species, toxins, water chemistries, hydrographies, seasonalities all vary from location to location (sometimes even with an ecosystem).

- Common sense goes a long way.
  - Accumulate data on your system. Evaluate if your approach is working. If not, it may be time to reevaluate your approach (i.e. stop wasting money).

- Be in it for the long haul.
  - Attempt to design & enact a good long-term strategy for management.
    - Try not to be soley 'reactive'.
  - Don't expect an immediate, easy, or cheap solution.
    - There is often no 'silver bullet'.

Try to define the causes of your algal bloom(s)

(no real surprises here)

Primary Drivers (generally speaking):

Loading of major nutrients is ultimately the problem:

N, **P*** are key, Nutrient *ratios*

'Higher level' physical/environmental effects

Climate (including drought)

Residence time***

Weather

affects physical structure of water body

affects nutrient availability

Light (daylength)

NOT strong drivers, per se (but certainly play a role)

Temperature (although it *can* affect timing, composition)

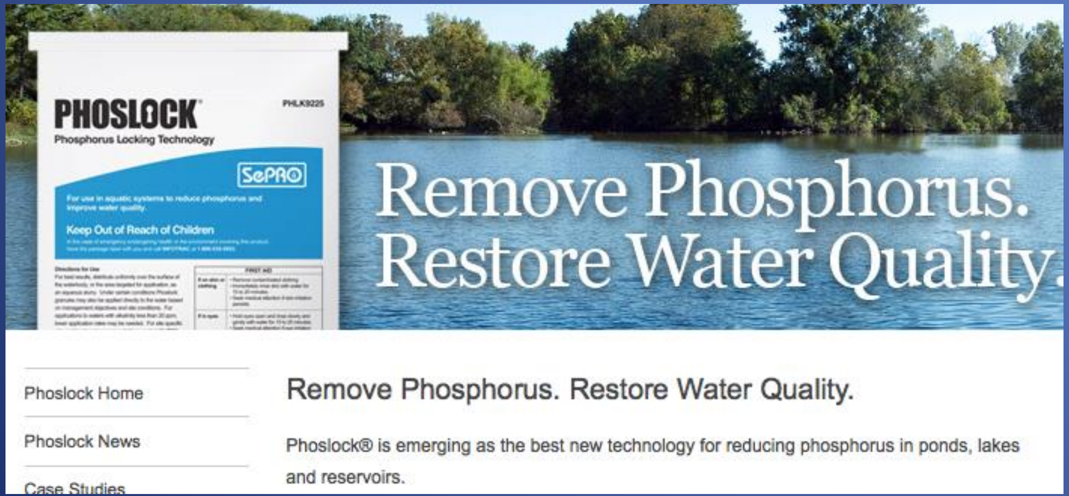
'Pollution' (unless severe or comes with nutrients)

Management: The desirability of 'quick fix' solutions

Alum (potassium aluminum sulfate) (aggregation & sedimentation)

Chelated or unchelated toxic metals (why chelated?)

Lanthanum-rich bentonite clay (aggregation & sedimentation)



<u>And other treatments</u>:

Aeration, mixing, water replacement, UV, sonication, ozone (& other chems), hay, floating islands, biological manipulation, etc, etc…

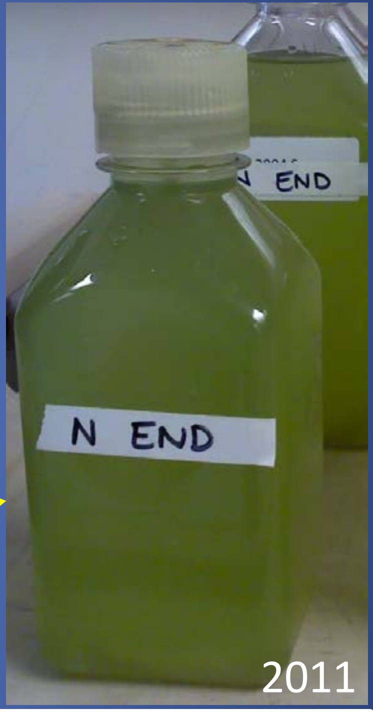
'Quick fix' solutions: The good and the bad of it
(from a scientist's perspective)

Advantages:
- Immediate improvement in water clarity*,**
- Reduced abundances of 'problem' algal/cyanobacterial species*,**
- Removal of nutrients from surface waters*

Potential disadvantages:
- Killing ALL algae/cyanobacteria (& the food web) *,**
  - (& sometimes desirable micro- & macrofauna)
- Problematic nutrients are not really removed**
- Potential release of intracellular toxins into the water**
- Delivery of toxins in high concentrations to the benthos*,**
- Delivery of high biomass to the benthos (increased O_2 demand) *,**
- Survival and proliferation of more-resistant species*,**
  - (Community may shift to less-desirable species)
- Continued remedial activity generally will be required**

*aggregation & sedimentation
**toxic chemical treatments

A case study (addressing the core issue):
The Huntington Library, Art Collections and Botanical Gardens



250-310 µg
Chlorophyll per liter!

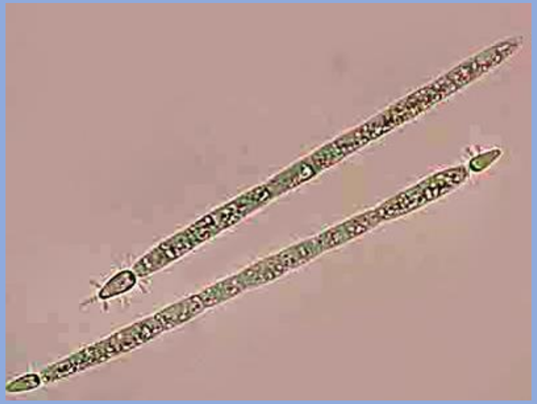
TABLE 3. A classification of lakes according to the extent of their eutrophication

Parameter	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic
Average total phosphorus	8.0	26.7	84.4	> 200
Average total nitrogen	661	753	1875	high
Average Chlorophyll *a*	1.7	4.7	14.3	>100, range 100-200>
Chlorophyll *a*, peak concentration	4.2	16.1	42.6	> 500

Organization for Economic Cooperation and Development (OECD) in the 1970s and 1980s

Issues with Chinese Garden Lake

The Problem: Phytoplankton biomass & community composition



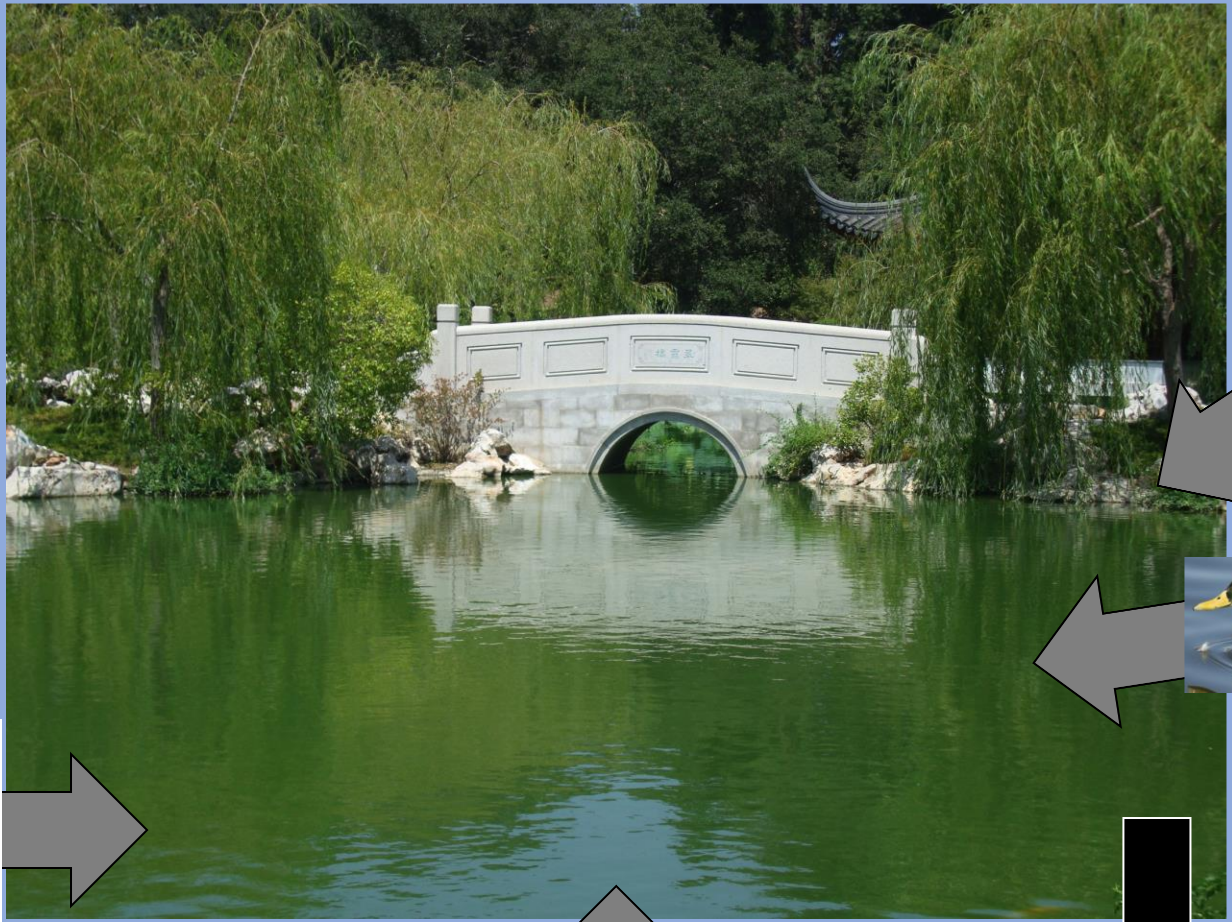
Dominant species: *Cylindrospermopsis*
Filamentous cyanobacteria
Nitrogen-fixer (can 'make' nitrogen)
Can store phosphorus
Known to be a bloom former and
a toxin producer: (saxitoxins, cylindrospermopsin)

Started with an assessment of nutrient sources in CGL

- Significant fish population (large koi)
- Fish food additions
- Drainage from fertilized lawn and landscape
- Significant water fowl population (ducks, gulls, etc)
- No turnover of the water in the lake water
  (no removal, replacement of evaporative losses)

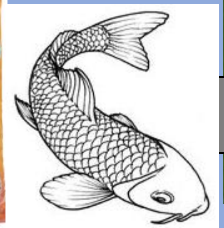
Redesigning the Lake (addressing multiple issues)

Mass Balance approach!



Land Plant Fertilizers

Fowl waste



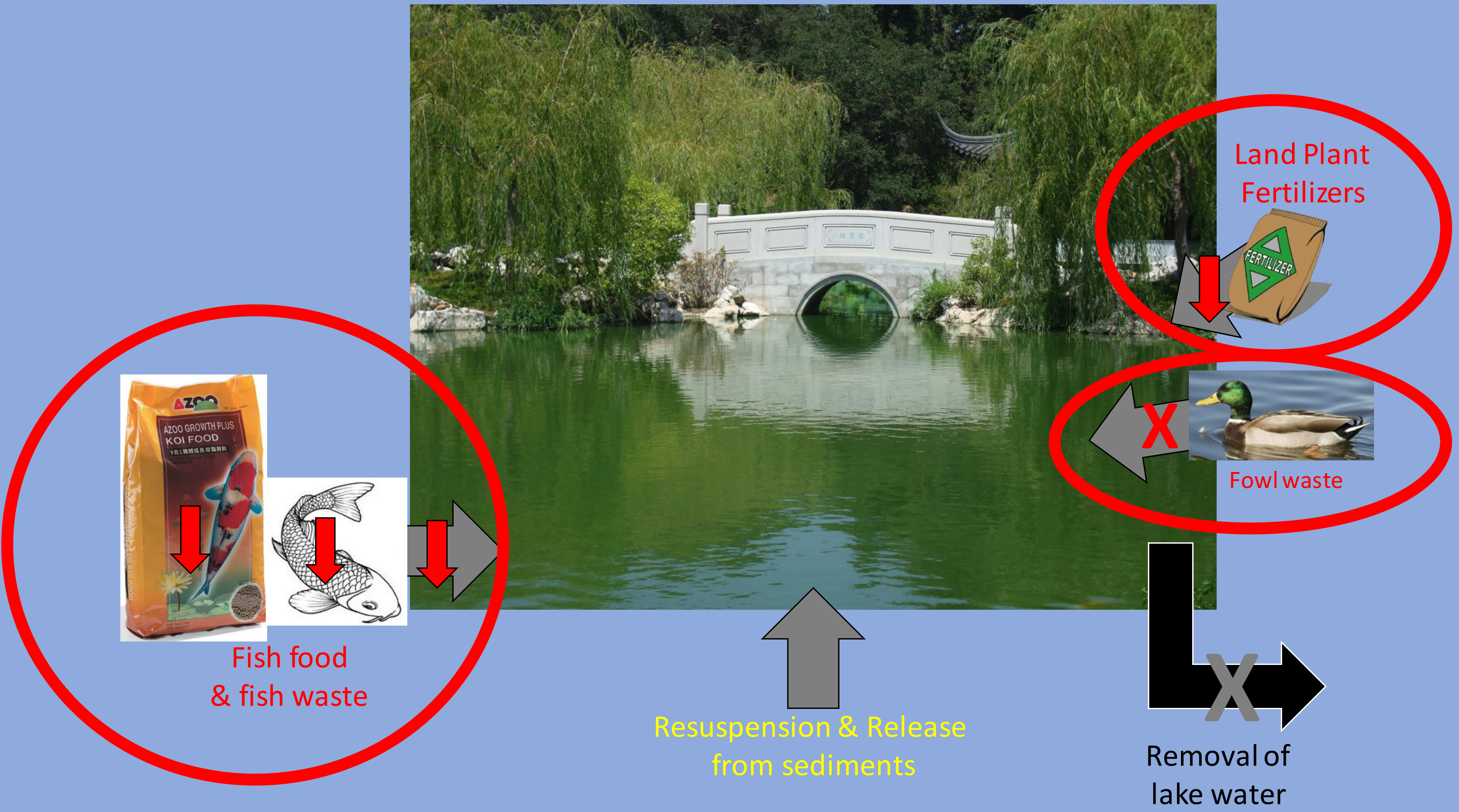
Fish food
& fish waste

Resuspension & Release
from sediments

L_x

Removal of
lake water

Redesigning the Lake (addressing multiple issues)



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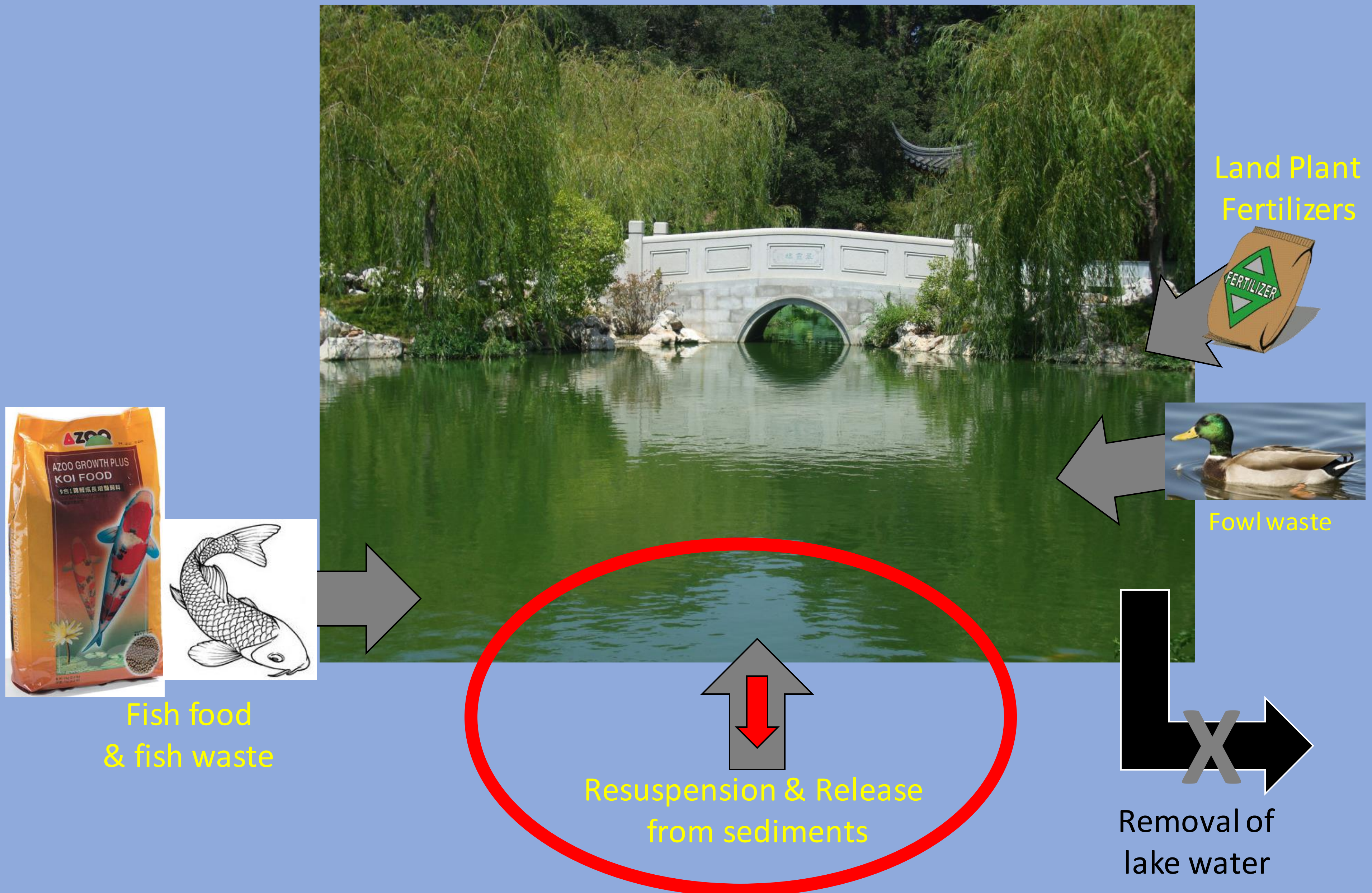
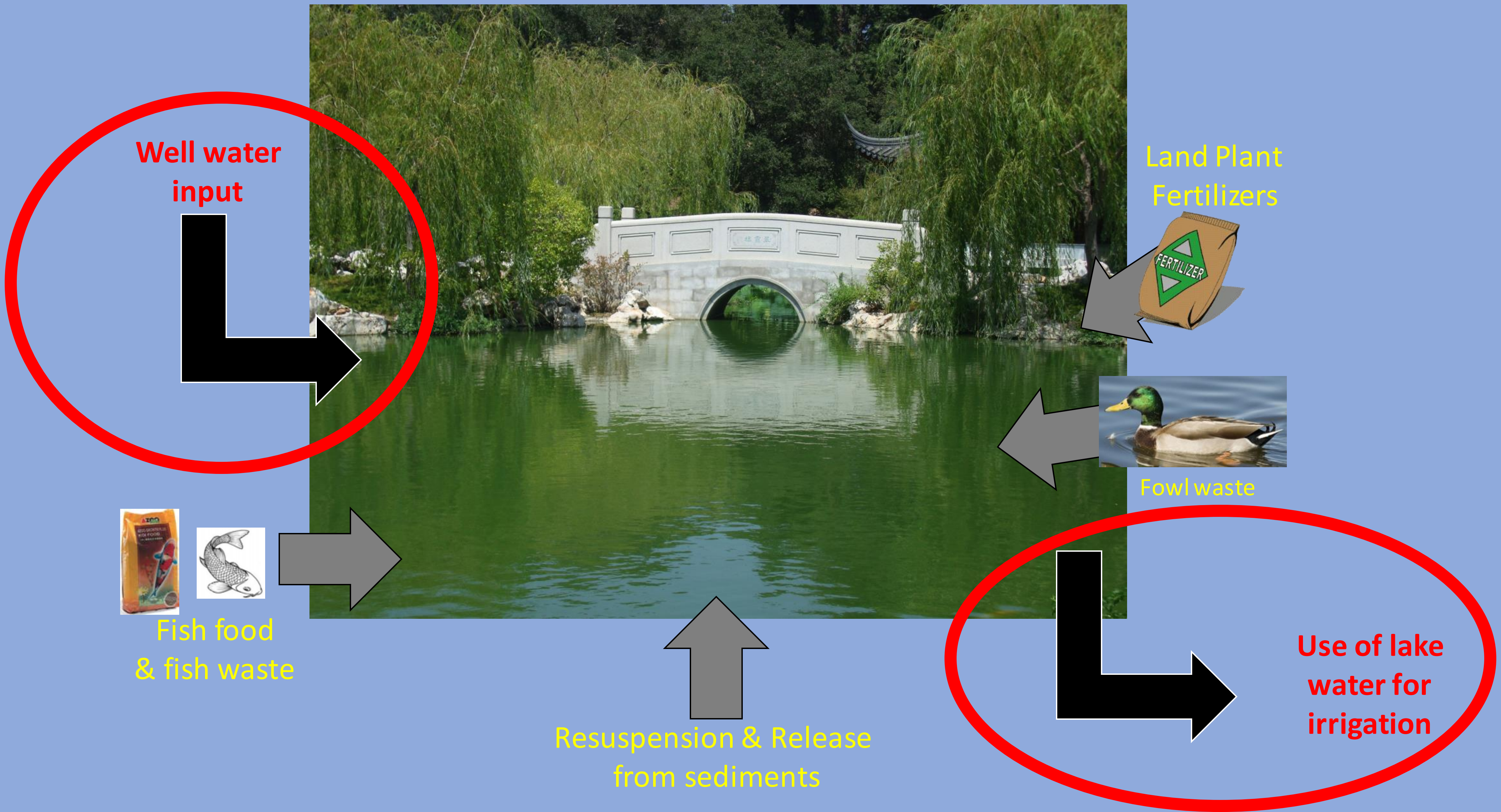
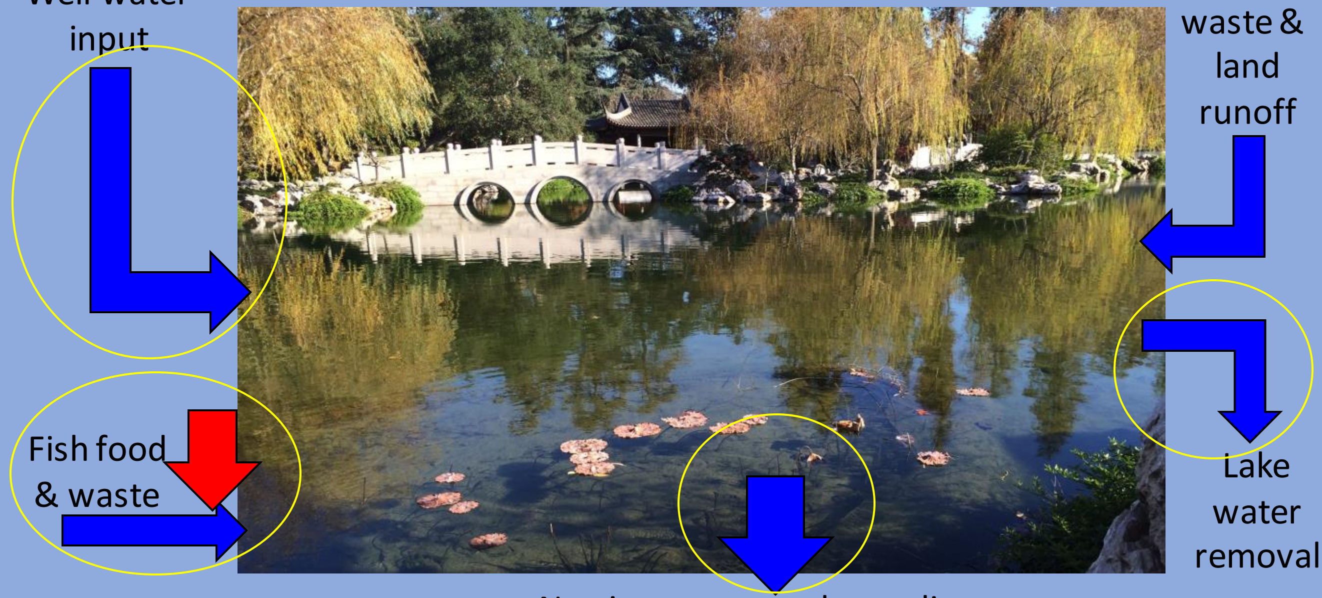


Redesigning the Lake (addressing multiple issues)



BEFORE

AFTER



Such a multi-faceted approach may not be necessary for your water body, but the basic principles will be the same.

Before you choose an approach, you might want to…

- Establish the intended uses of your system.
  - Drinking water supply? (maybe you don't want to break those cells open).
  - Recreational use? (scums are highly undesirable).
  - Fisheries? (do you have fish-killing species present?)
  - *Use(s) will strongly influence appropriate remediation & management.*

- Assess the root cause(s) of your problem.
  - Too much algae or cyanobacteria? Toxic species present?
  - *Don't simply pick a method off the shelf and apply it.*

- Try to choose the *most appropriate* approach.
  - Based on scientific principles informed by ecosystem assessment (magnitude, hydrography, biology, etc.) & public acceptability.
  - *Avoid the 'quick fix' (unless it's right!). Look for long-term sustainability.*

Thanks to…

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