System Principles

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Topics for this presentation…

- Quick overview of World production
- System types and considerations
- Fish feed and it's affect on various systems
- Pros and cons of indoors & outdoor systems

See the forest; not the trees

- Unfortunately, we are drastically behind other countries in production, public acceptance, and government support
- With such a large deficit, we must focus on increasing public acceptance of all types of sustainable aquaculture in the U.S.
- That's not going to happen overnight

Blue marble view first

Production dominated by Asia

- 89% total; steady last 2 decades
- China production of ca. 67%
- Indonesia production of ca. 5.8%
- Vietnam production of ca. 4.6%
- Exclusively pond culture
- Surface water used in production
- Catfish-like species
- Carps

Blue marble view first

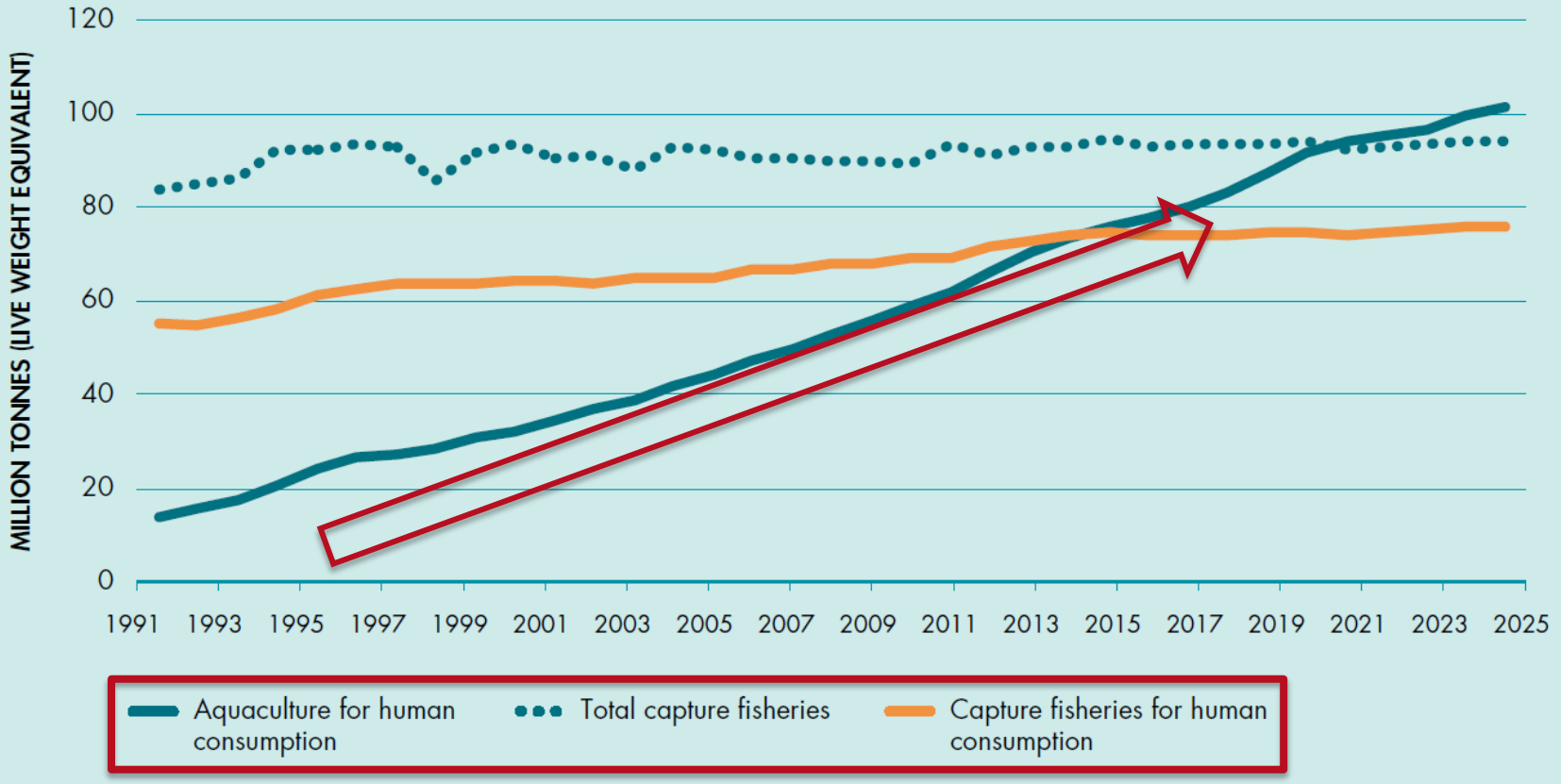
Value of aquaculture

- $166 billion farm-gate
- Economic multipliers?
- 102 million metric tons
- 5.8% annual increase as a whole
- Stagnant/declining in some

Blue marble

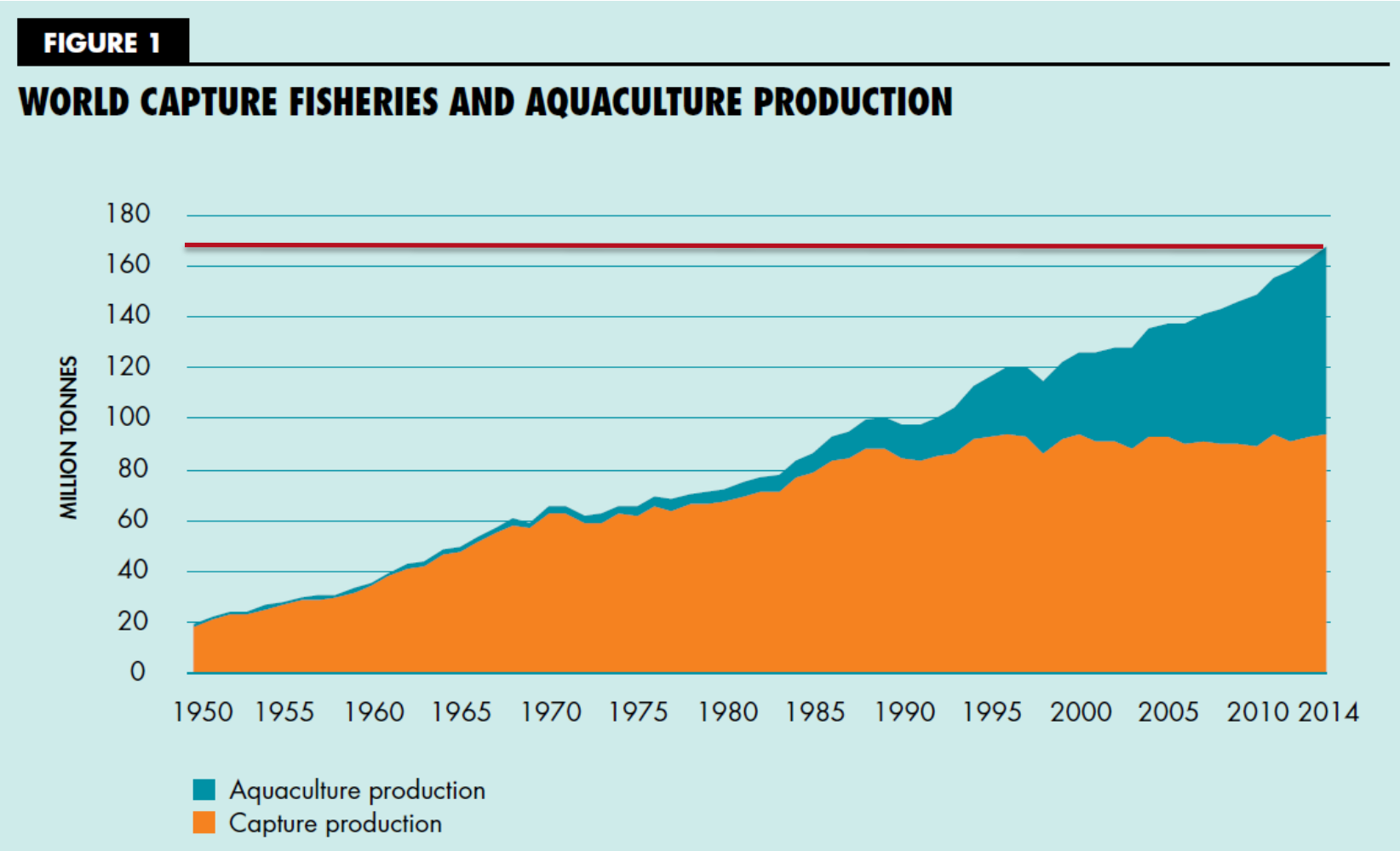
FIGURE 34

GLOBAL CAPTURE FISHERIES AND AQUACULTURE PRODUCTION TO 2025



SOURCE: OECD and FAO.

Blue marble



Source: FAO SOPHIA 2016

Supplying the world through both wild and farmed organisms

Some systems applicable to Ohio

- Ponds
- Aquaponics
- Traditional RAS
- Raceways

- Biofloc
- Pond-side tank RAS
- Cage culture
- *Ranching

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- **Ponds**
- **Aquaponics**
- **Traditional RAS**
- Raceways

- **Biofloc**
- Pond-side tank RAS
- Cage culture
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Culture systems

Earthen levee ponds

- Golden shiners
- >1 billion fish a year

Above photo from googlemaps.com


Culture systems

Levee ponds – partial LMB farm

Concrete levee ponds

Ponds

- Average in Ohio is 1 acre; 6-8’ (winter refuge)
- Erosion vs. weeds
- Smaller if no tractors on levees – Increases erosion

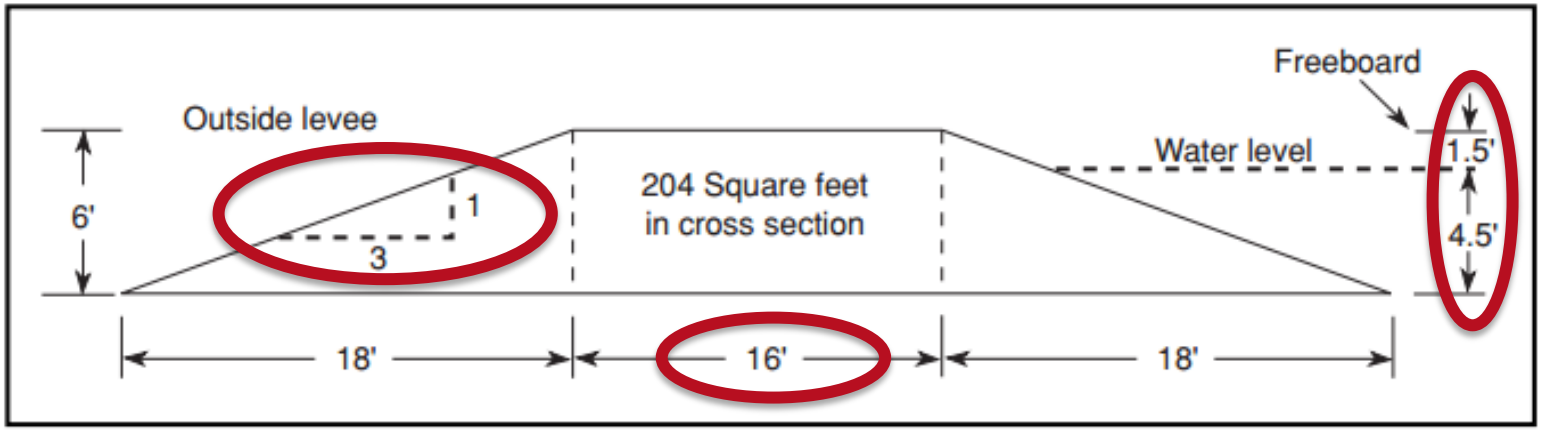


Figure 2. Cross-section of a typical levee for a commercial catfish pond. Each linear foot of this levee contains 7.6 cubic feet of fill material.

Ponds

- Drainable
- 20% clay
- Test the soil
- Height

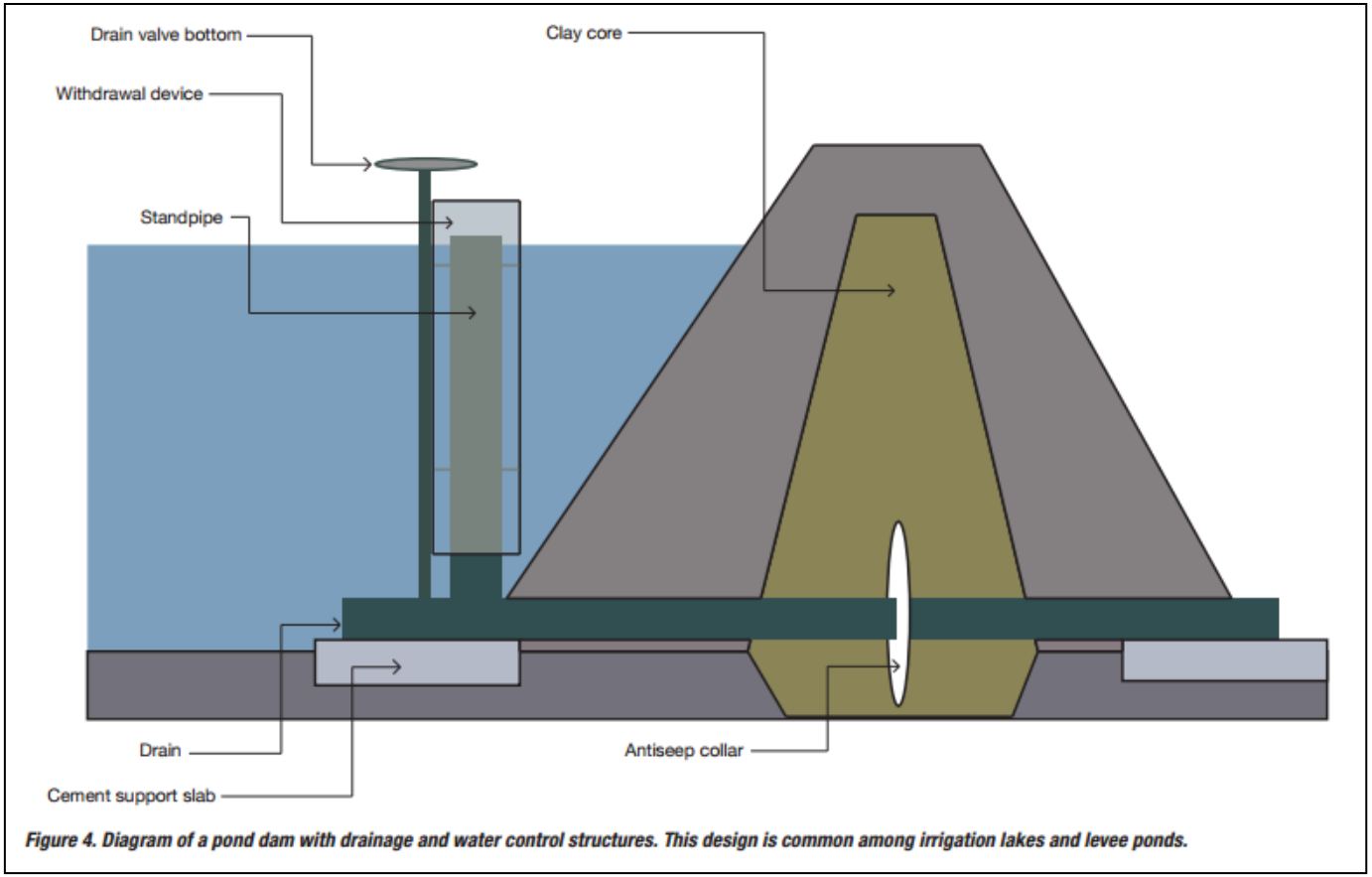


Figure 4. Diagram of a pond dam with drainage and water control structures. This design is common among irrigation lakes and levee ponds.

Ponds

- Smaller ponds easier to manage
- Watershed vs. levee
- Drainable
- Correct height
- Test the soil

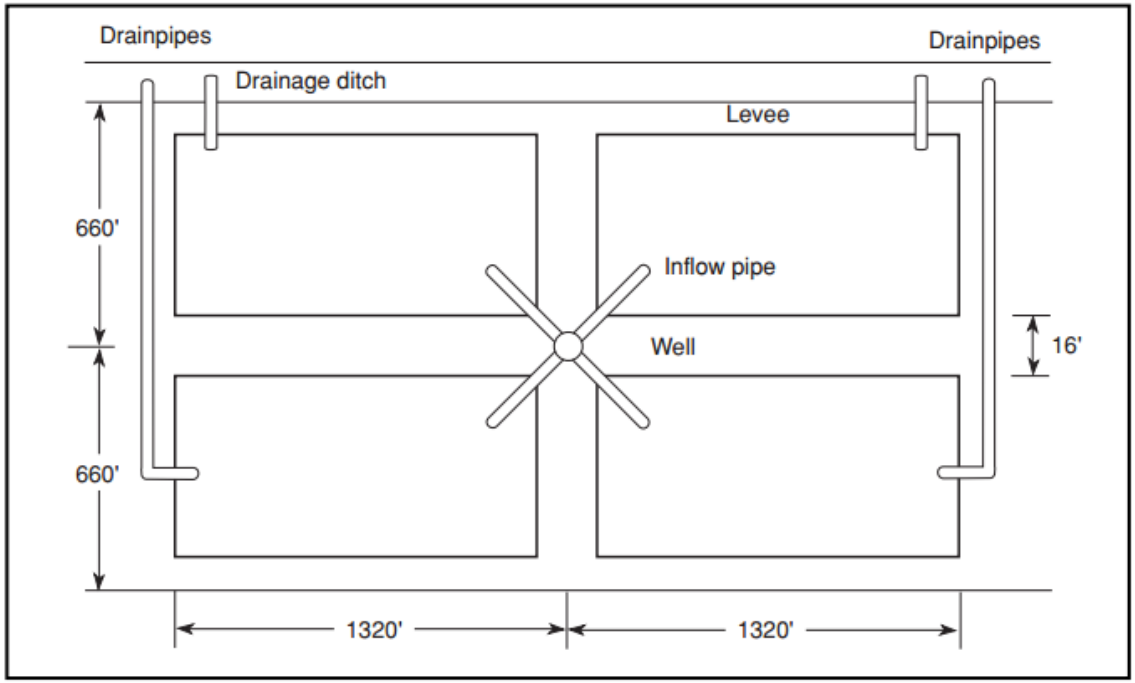


Figure 1. Layout of a typical levee-type catfish pond.

Ponds

- Smaller ponds easier to manage
- Predation, biosecurity, theft/vandalism
- Much more forgiving than indoor systems
- Requires a good bit of land

Principles of ponds

- Ponds “work” because of photosynthesis
- Phytoplankton
- Zoops
- Small fish
- Big fish
- Us

Principles of ponds – SRAC 468

“A pond breaths in and out once a day”

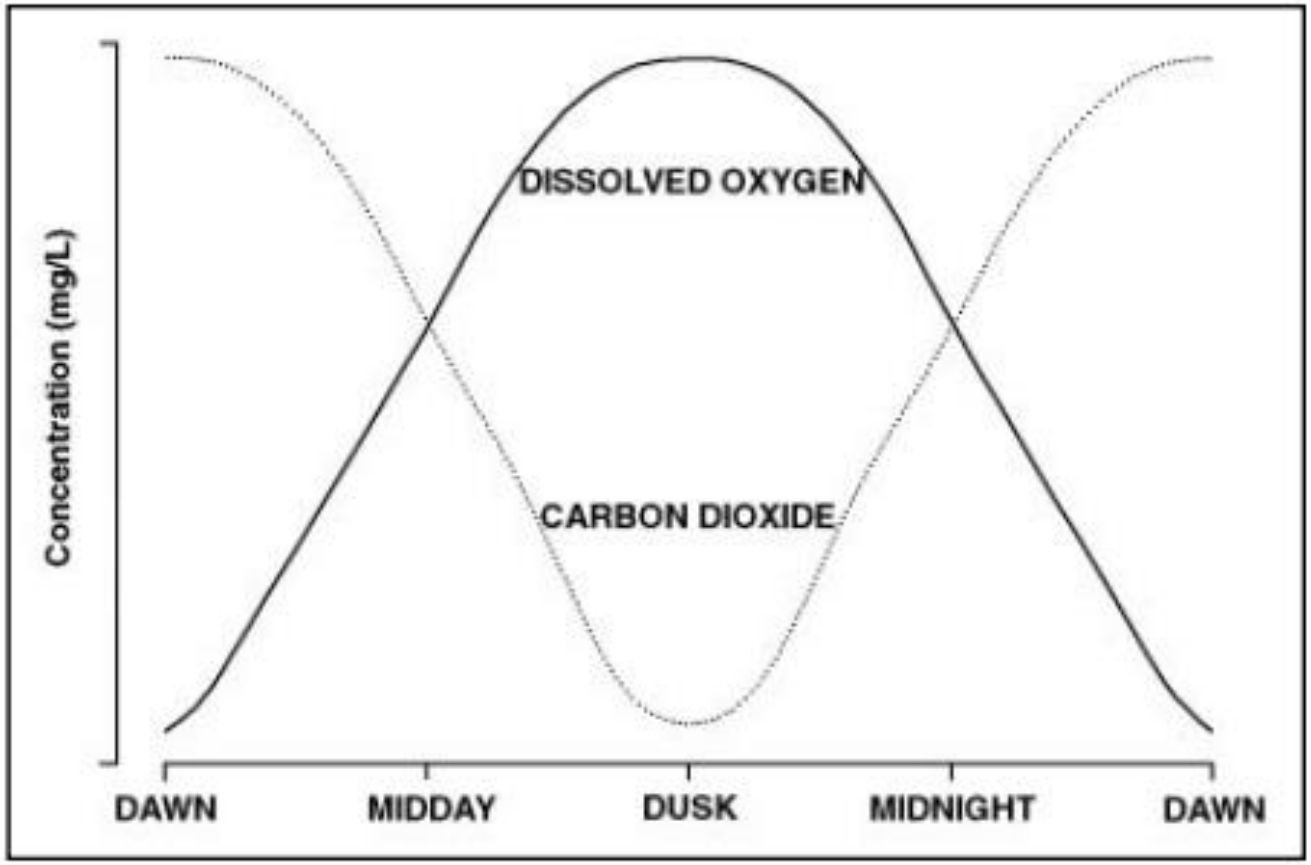


Figure 1. The daily cycle of oxygen and carbon dioxide in a fish pond.

Principles of ponds

- At the mercy of mother nature
- Fish are poikilothermic
- Water too hot/cold?
- Inside or outside systems… still many of the same concerns

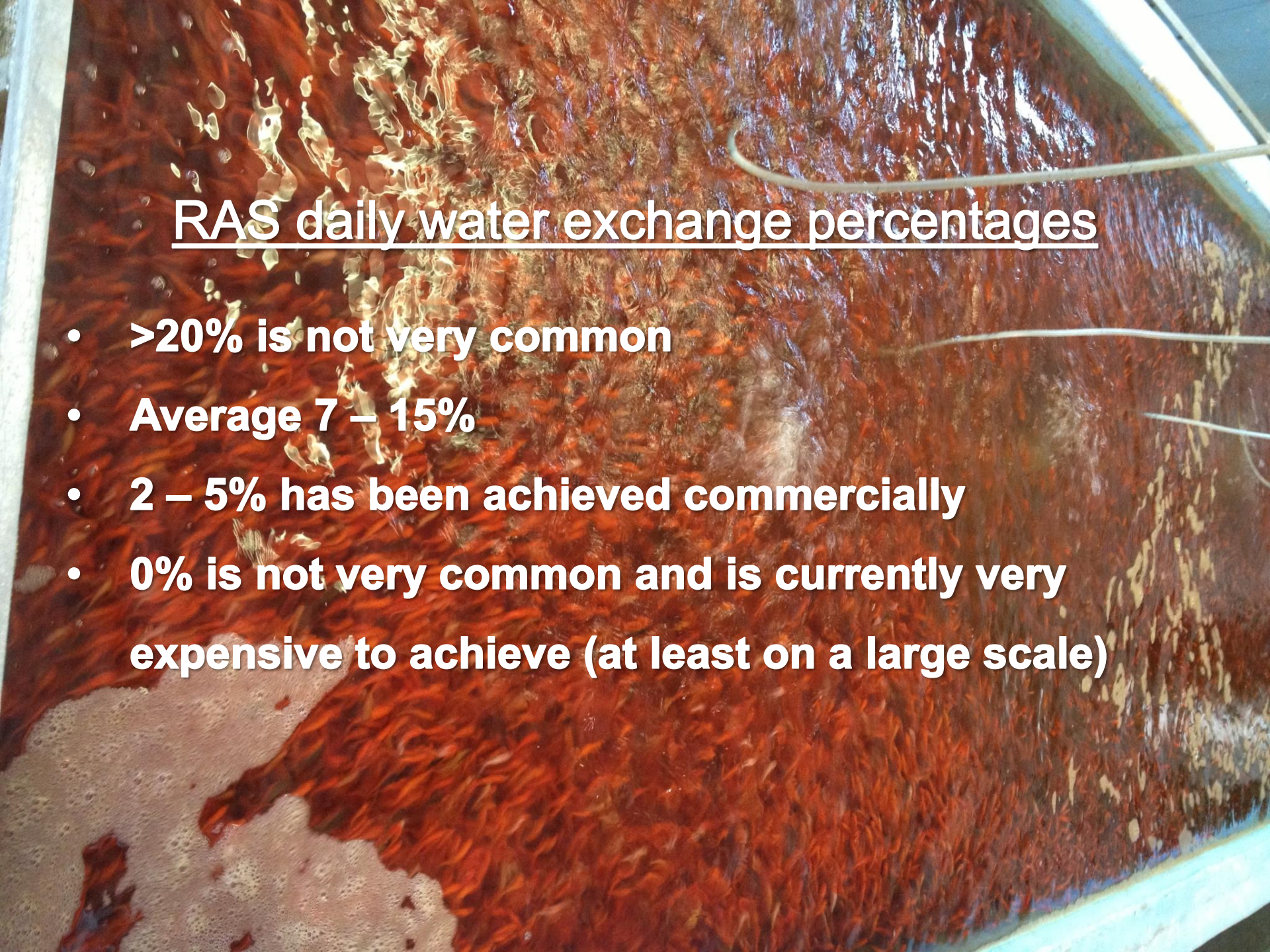
What is the recirculating aquaculture system (RAS)?

- General description
  - A land-based aquaculture system that recycles and reuses water through treatment devices for the culture of aquatic organisms (assumed indoors for this talk)
- Categories
  - Not well defined and usually is based on the volume of water exchanged each day → less exchange needed means more efficient water usage

SRAC 451

- "Assuming an annual pond yield of 5,000 pounds of fish per acre, approximately 100 gallons of water are required per pound of fish production." (equal to 0.005 pound of fish per gallon of pond water)
- "The carrying capacity of tank systems must be high to provide for cost effective fish production because of the higher initial capital costs…"
- ****RAS can/should push 0.50 pound of fish per gallon of tank water to improve economic viability**

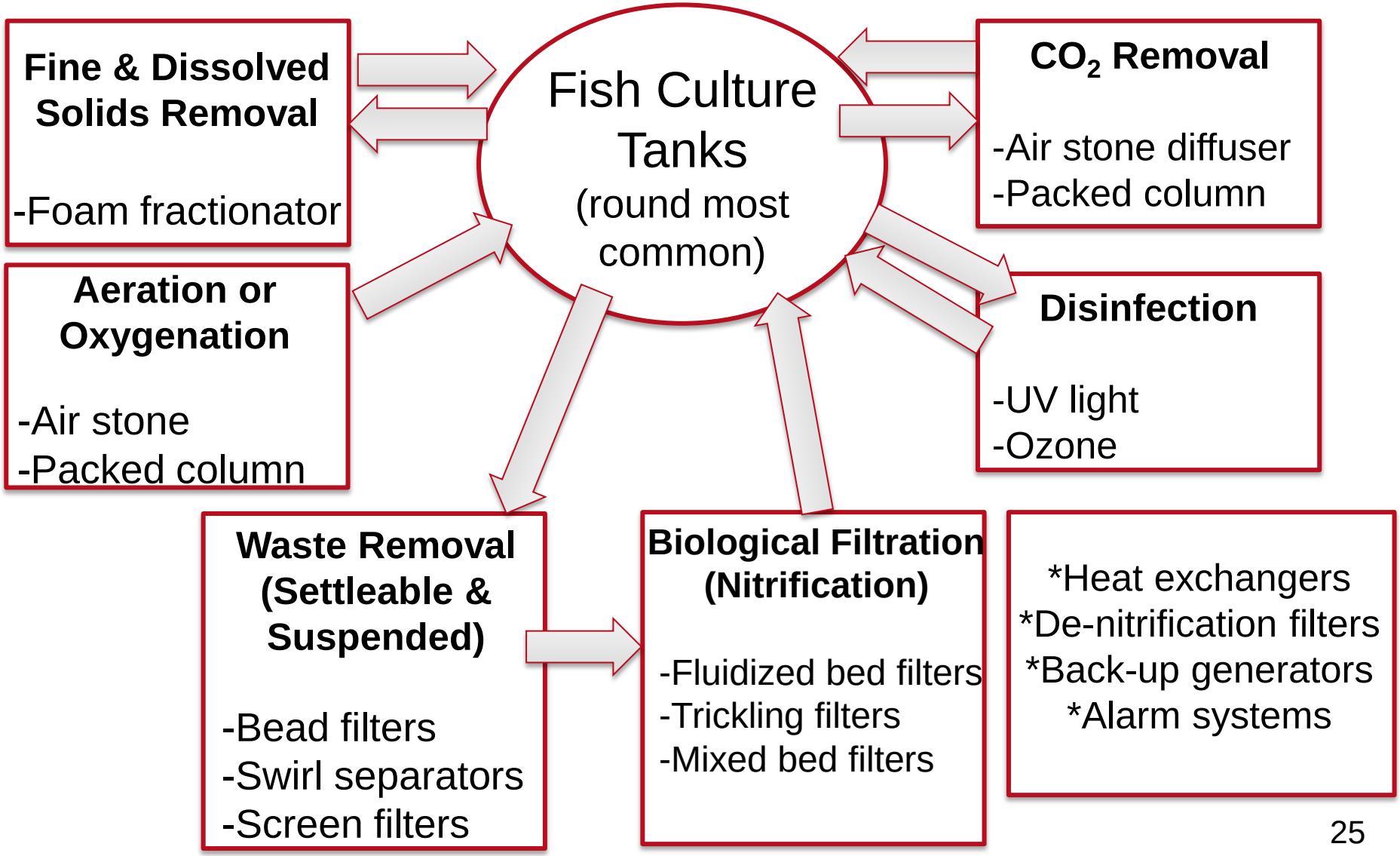
**This is worth taking notes on…



RAS daily water exchange percentages

- >20% is not very common
- Average 7 – 15%
- 2 – 5% has been achieved commercially
- 0% is not very common and is currently very expensive to achieve (at least on a large scale)

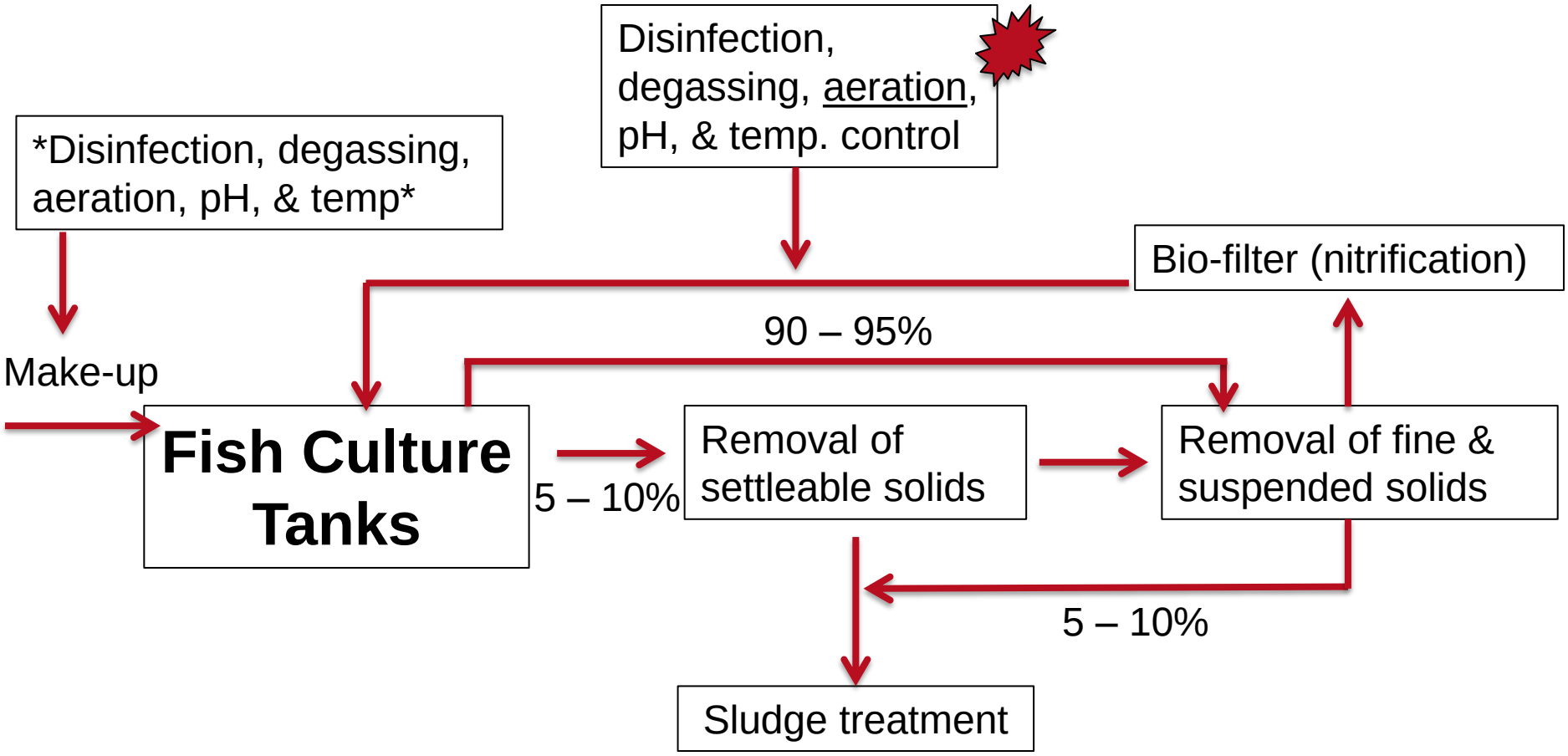
System design/considerations (SRAC 451)



Why are there so many filters/disinfectors involved?

- ✓ Approx. half the feed consumed is excreted as solids
- ✓ Multiple filters improves efficiency (micrometer size specific)
- ✓ Those bi-products produced must be treated/removed or else the water will become toxic to the fish (&/or too turbid)
- ✓ Pathogens can be present in a system and need to be killed
- ✓ Water quality parameters to test for and that cause stress are available on our website…pH, temp, DO, ammonia, nitrite, alkalinity, etc.
- ✓ Alkalinity/pH/nitrifying bacteria relationship

General water flow in a RAS



Aquaponics

- As most have figured out already...
- Multiple system types
- DWC vs. ebb and flow vs. NFT
- Coupled vs. de-coupled

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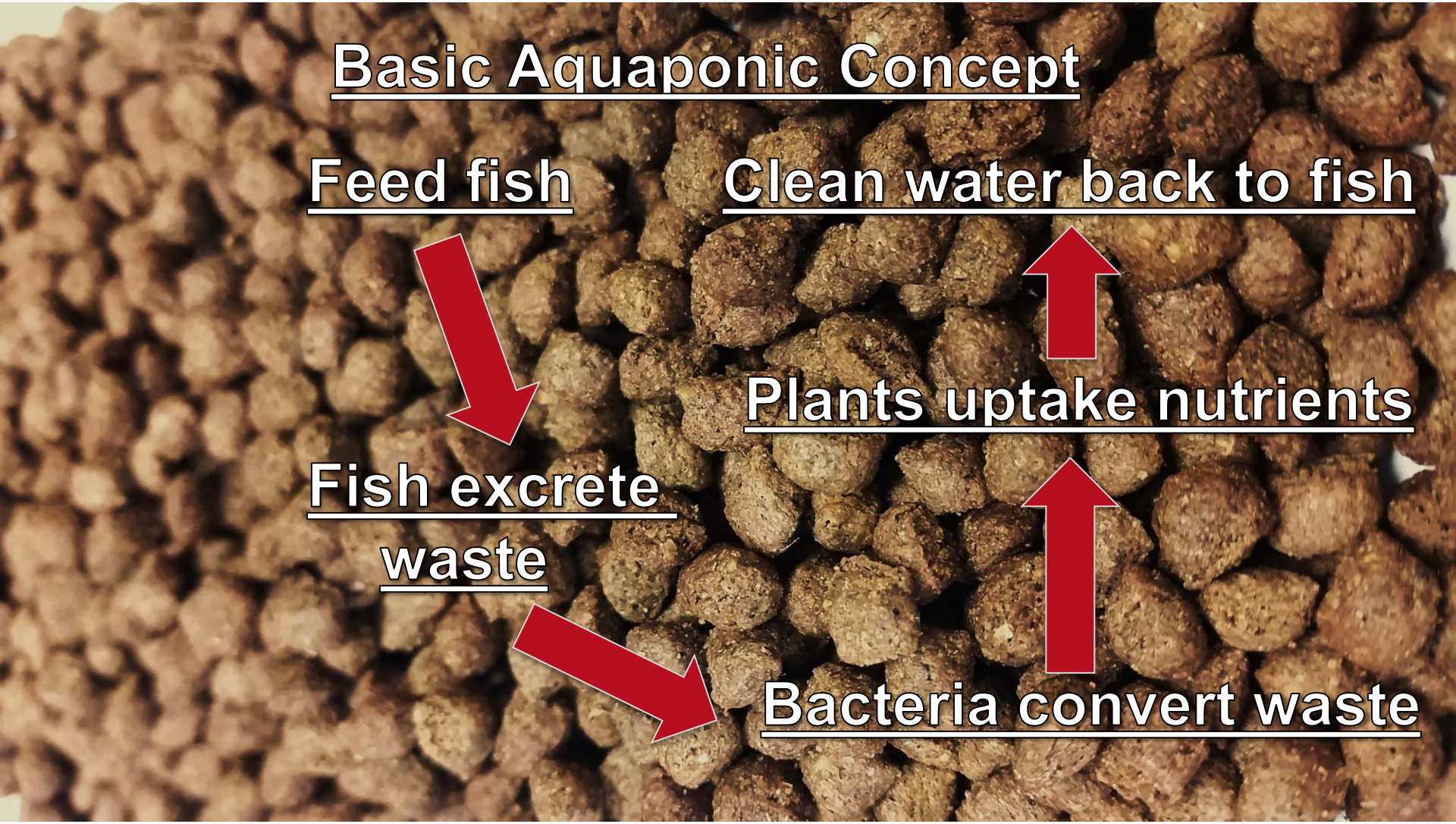

Basic Aquaponic Concept
Feed fish
Clean water back to fish
Plants uptake nutrients
Fish excrete waste
Bacteria convert waste

Fish food

- Micro and macronutrients supplied, mostly
- Deficiencies; depend on the amount of feed fed (your nutrients) and the source water
- Missing are sometimes enough…
  - Iron, calcium, potassium
  - Important to remember most systems are closed loop but de-coupled gaining in popularity
- Many types of fish feed – depends on the species, size, and cost
- Source water (well, city, rain, etc.)

What happens when you feed fish?

2.2 lbs Feed

0.4 – 0.9 lb
Alkalinity

0.6 – 2.2 lbs
Oxygen

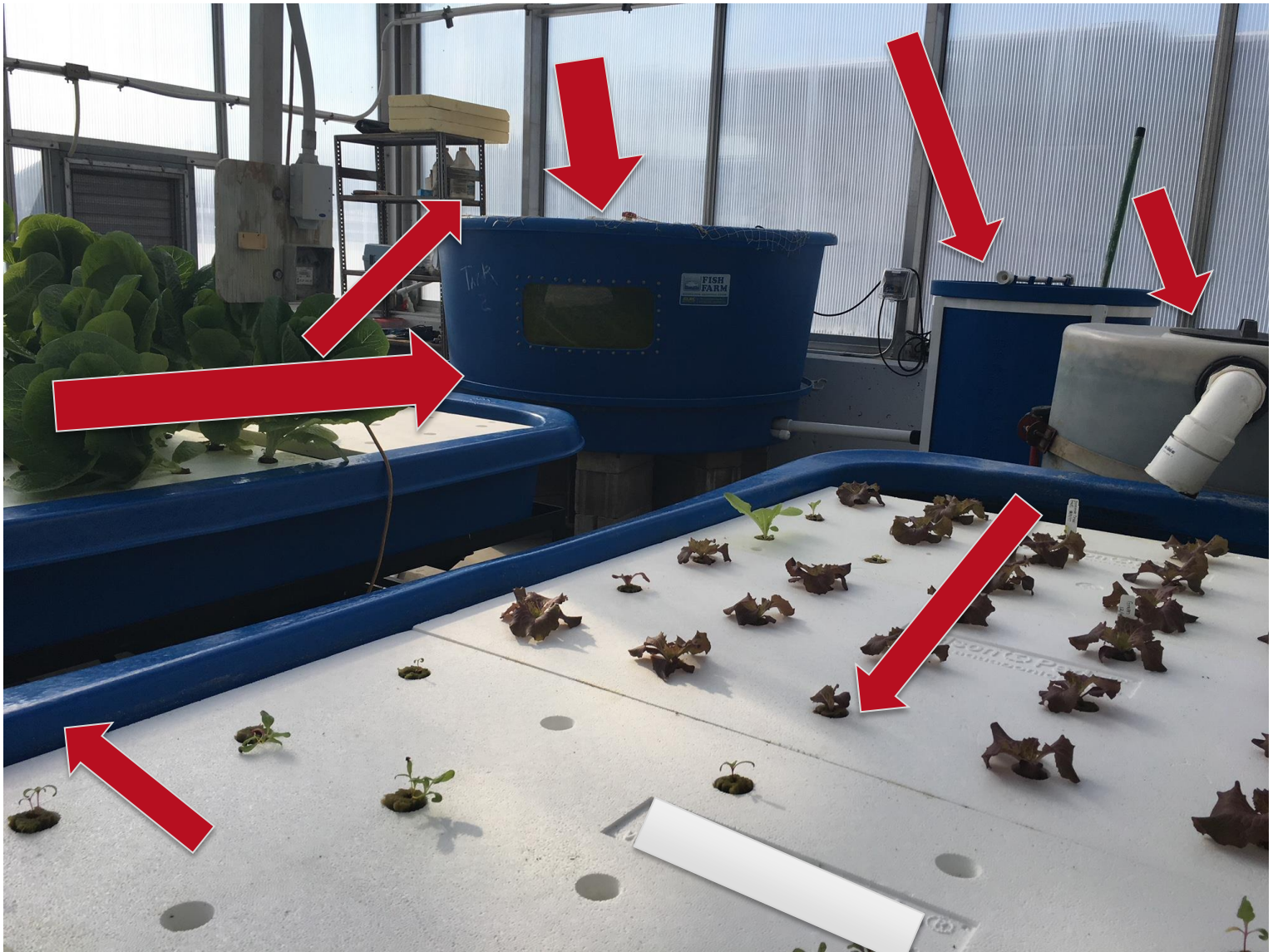
0.8 – 3.0 lbs
Carbon Dioxide

0.6 – 1.1 lbs
Waste Solids

0.05 – 0.12 lbs
TAN

OSU South Centers 2017

OSU South Centers 2018



Biofloc

- Small water usage
- Rely on microbial communities heavily
- Control biofloc
- “bio” – living/life
- “floc” – loosely clump of fine particles
- Settling chambers
- Saltwater shrimp most common but many other species possible

Research biofloc system at Kentucky State University
(Photo by Dr. Andrew J. Ray)

Positives of indoor systems: improved biosecurity/survival

- Limited predation
  - Fish raised outdoors commonly fall prey to
    - Waterfowl and other migratory birds
    - Resident herons/egrets
    - Snakes, turtles, otters, humans

Positives in indoor systems

- Limited pathogens
  - The best water source for outdoor aquaculture is ground water. Surface water usage is a big risk!
  - Indoor systems can use ground water or potentially city or rain (may not be suitable or need treating before adding to the system)

Some impediments

- Foreign imports
- U.S. industry as a whole believes in regulations to protect our natural resources – redundant or unnecessary regulations are the problem (testing a species for a disease it can't get!)
  - U.S. had the 3rd most stringent set of regulations (Abate et al. 2016)
- Often viewed in a negative light (especially when lumped in with fish imported from certain countries)
- Regulations pushing farmers indoors – capital intensive
- Aquatic organisms that are farmed are classified as wildlife, not agriculture to some agencies
- Banks don't understand aquaculture
- Lack of capital

Do you need a business plan?

- **Can anyone tell me how healthy this crop is?**

Credit: United Soybean Board

Do you need a business plan?

- **Can anyone tell me how healthy this crop is?**
- **Approximately 20 acre pond of golden shiners**
- **Survival? Growth? Diseases?**

Questions?

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