Introduction to Aquaponics

Presented by JustAquaponics

Aquaponics

Recirculating Aquaculture

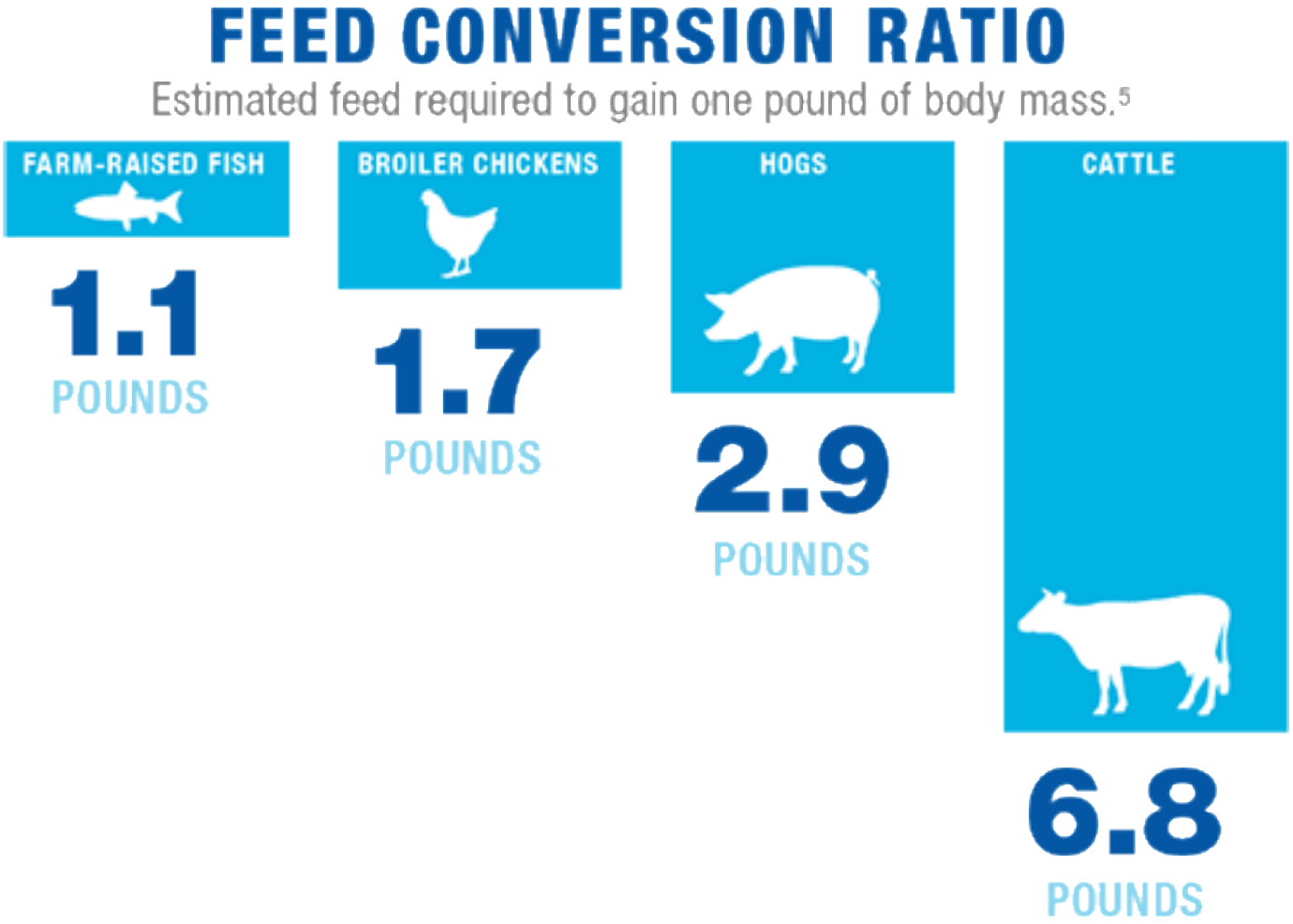
- Farming fish in a closed loop of water
- Mechanical and biological filtration remove waste and clean water

Nutrients

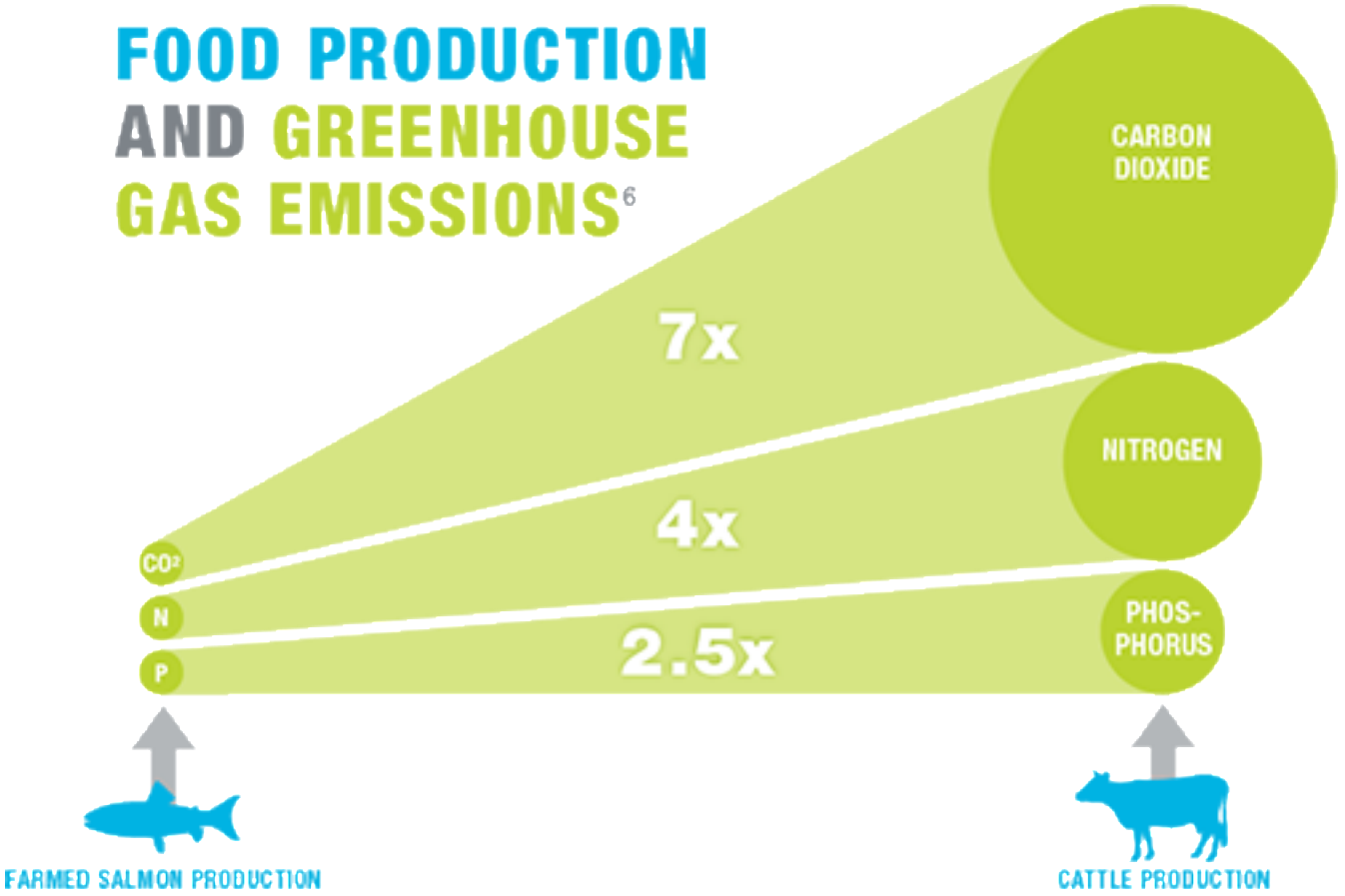
Nutrient rich water that would normally be wasted is used to grow plants in a hydroponic environment.

In this example, plants are growing in rafts that float on nutrient rich water.

Why Aquaculture?



Why Aquaculture?



Why Hydroponics?

Uses 90%
Less Water

Uses 25%
Less Land

Grows Food
2x Faster

Aquaponics is greater than the sum of its parts

- Has the benefits of recirculating aquaculture and recirculating hydroponics, but reduces the discharge to near zero.
- Single input of fish feed results in two crops
- Harnesses beneficial bacteria to stimulate healthy root growth and to crowd out pathogens

Types of Systems – Mini Systems

Types of Systems – Backyard

- Explosive growth in last 15 yrs
- Estimated 3000-5000 in US
- 5000 in Australia
- Additional 1000 in US schools

Types of Systems – Small Commercial

Types of Systems – Small Commercial

Types of Systems – Small Commercial

Types of Systems – Medium Commercial

Common Hydroponic Components

Media Bed

Deep Water Culture (DWC)

Nutrient Film Technique (NFT)

Vertical

Vertical System in a Warehouse

Vertical System in a Warehouse

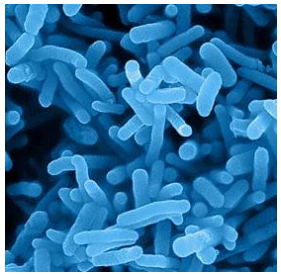
The Unseen Element

At least five distinct microbiotas, or microbial communities, can be identified in aquaponics:

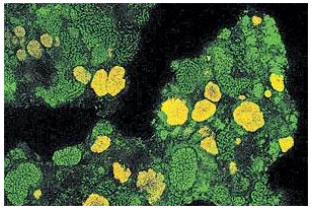
- The populations within the water column
- Fish gut microbiota
- The root's rhizosphere communities
- Biofilms
- The bioreactor: converts organics into plant nutrients
  - Ammonia to nitrates (minimum requirement)
  - Solids mineralization in digester (optional item)

Bioreactor: The Nitrogen Cycle

Fish Produce Ammonium NH_3 / NH_4^+



Nitrosomonas produce Nitrite NO_2



Nitrospira produce Nitrate NO_3^-

Plants absorb Nitrate

What Can You Grow?


Lettuce


Watercress


Basil


Mint

Most Herbs


Cabbage


Tomatoes


Melons


Peppers & Chillies


Cucumber


Strawberries


Bok Choi

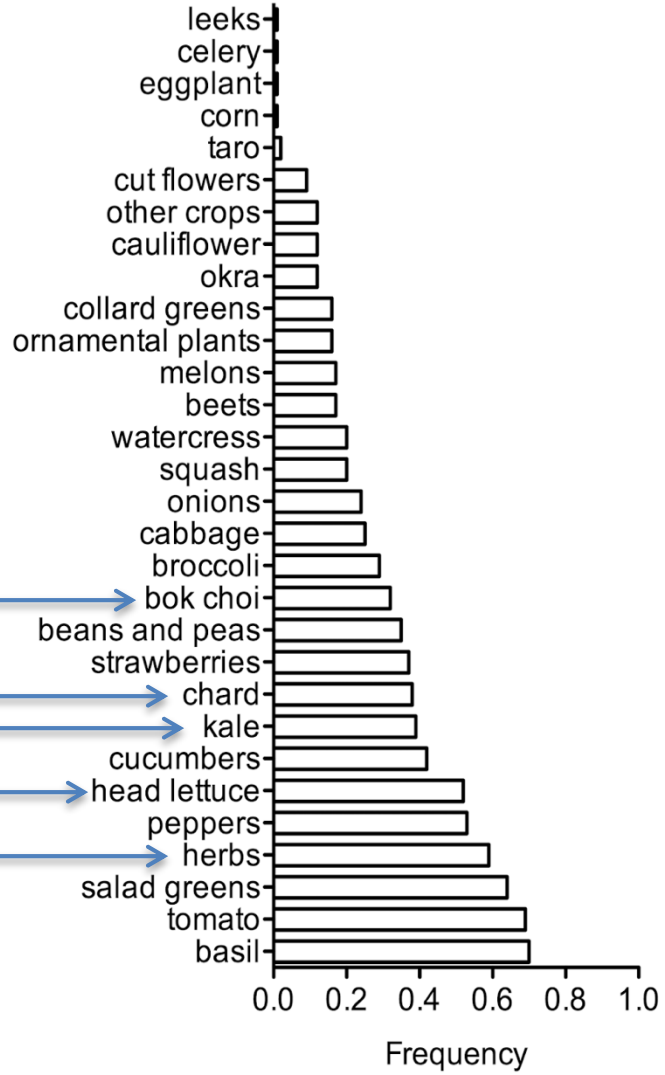
Almost any kind of plant will grow in an aquaponic systems but some are not as practical as others. At the Crop Diversification Centre, Dr. Savidov's team has tested over 60 different crops since 2002 including vegetables, leafy greens, culinary herbs, flowers, medicinal herbs and more.

Visit http://www.canadianaquaponics.com/p/resources.html to download some of Savidov's research.

What Are People Growing?

For more info on specific plants:
Look at the “Recommended Crop List”
Nate Storey’s Bright Agrotech Publication

Best For Beginners



For source visit: http://www.canadianaquaponics.com/2014/07/survey-reveals-current-state-of.html

Plants – Nutrients from fish waste

Table 2-2. Average concentrations of mineral nutrients in plant shoot dry matter that are sufficient for adequate plant growth.[z]

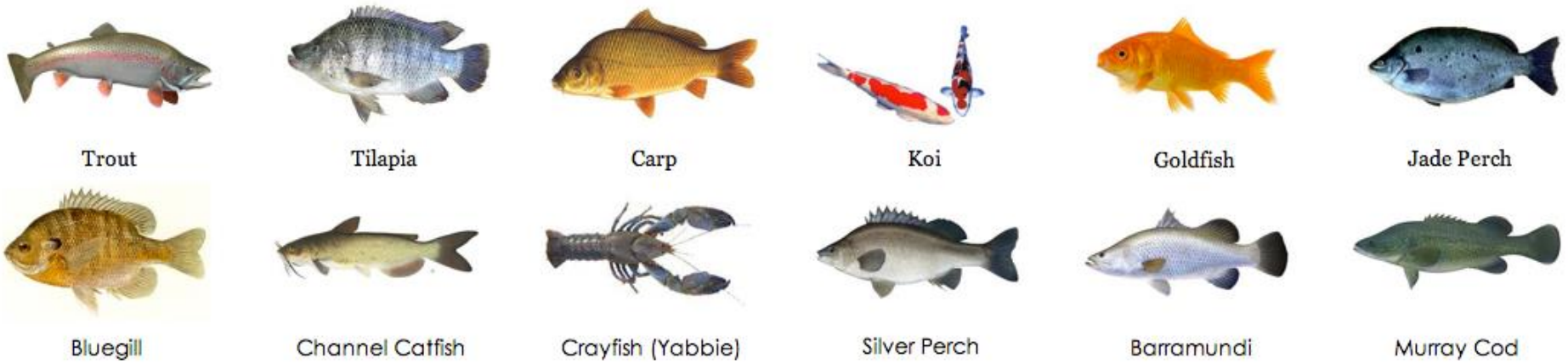
Element	Abbreviation	µmol/g dry wt	mg/kg (ppm)	%	Relative number of atoms
Molybdenum	Mo	0.001	0.1	-	1
Nickel	Ni	~0.001	~0.1	-	1
Copper	Cu	0.01	6	-	100
Zinc	Zn	0.30	20	-	300
Manganese	Mn	1.0	50	-	1 000
Iron	Fe	2.0	100	-	2 000
Boron	B	2.0	20	-	2 000
Chlorine	Cl	3.0	100	-	3 000
Sulfur	S	30	-	0.1	30 000
Phosphorus	P	60	-	0.2	60 000
Magnesium	Mg	80	-	0.2	80 000
Calcium	Ca	125	-	0.5	125 000
Potassium	K	250	-	1.0	250 000
Nitrogen	N	1000	-	1.5	1 000 000

Micro-nutrients

Macro-nutrients

[z] From Marschner, H. 2003. Mineral nutrition of higher plants. Academic Press, Elsevier Science Ltd.

What Fish Are People Growing?



- The most common fish used in aquaponics is Tilapia
- In second place are the ornamentals
- Everything else is a distant 3rd

Source: http://www.canadianaquaponics.com/2014/07/survey-reveals-current-state-of.html
This lecture will focus on Tilapia. Here is a good reference for Koi and Goldfish
http://www.fishchannel.com/freshwater-aquariums/fish-food/feeding-koi-and-goldfish.aspx

Fish – Why Tilapia

Coldwater Coolwater Warmwater Tropical

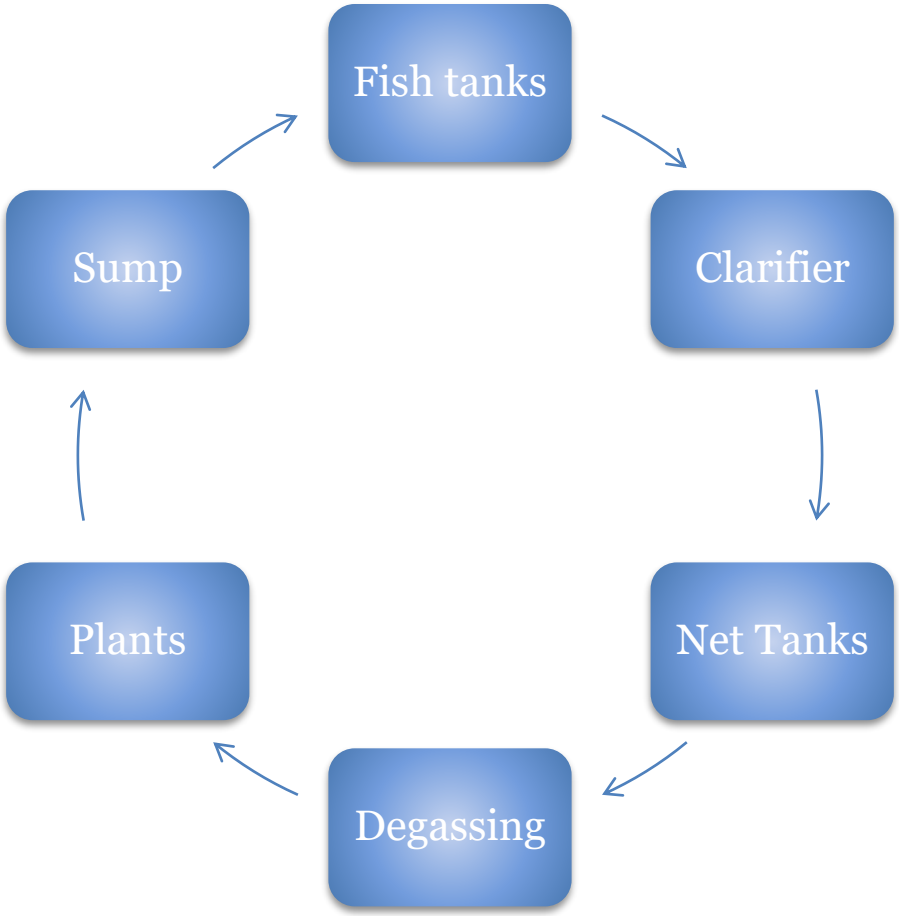
Protein Requirement

More Protein ← Less Protein

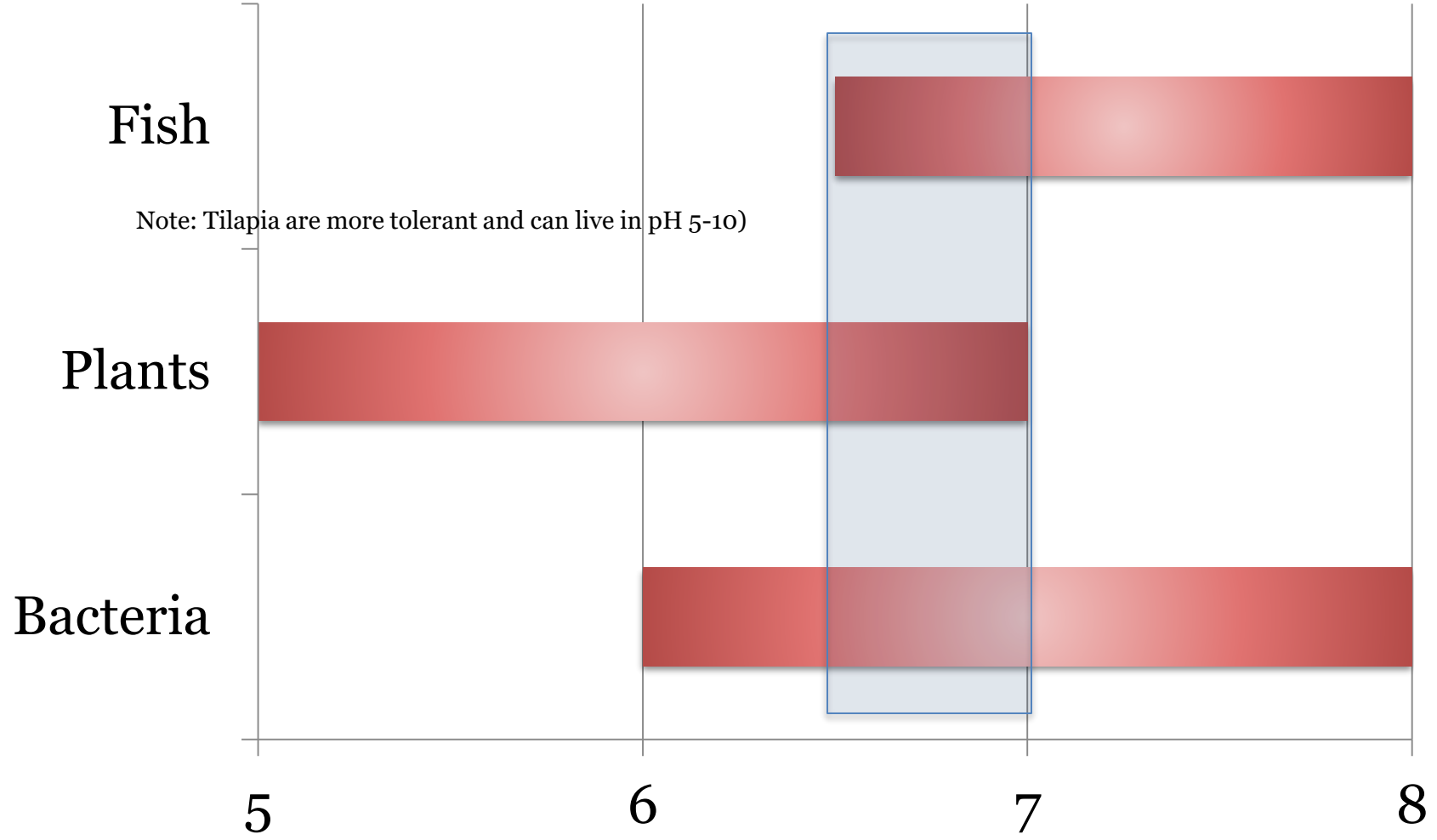
Water Quality

Least Tolerant → Most Tolerant

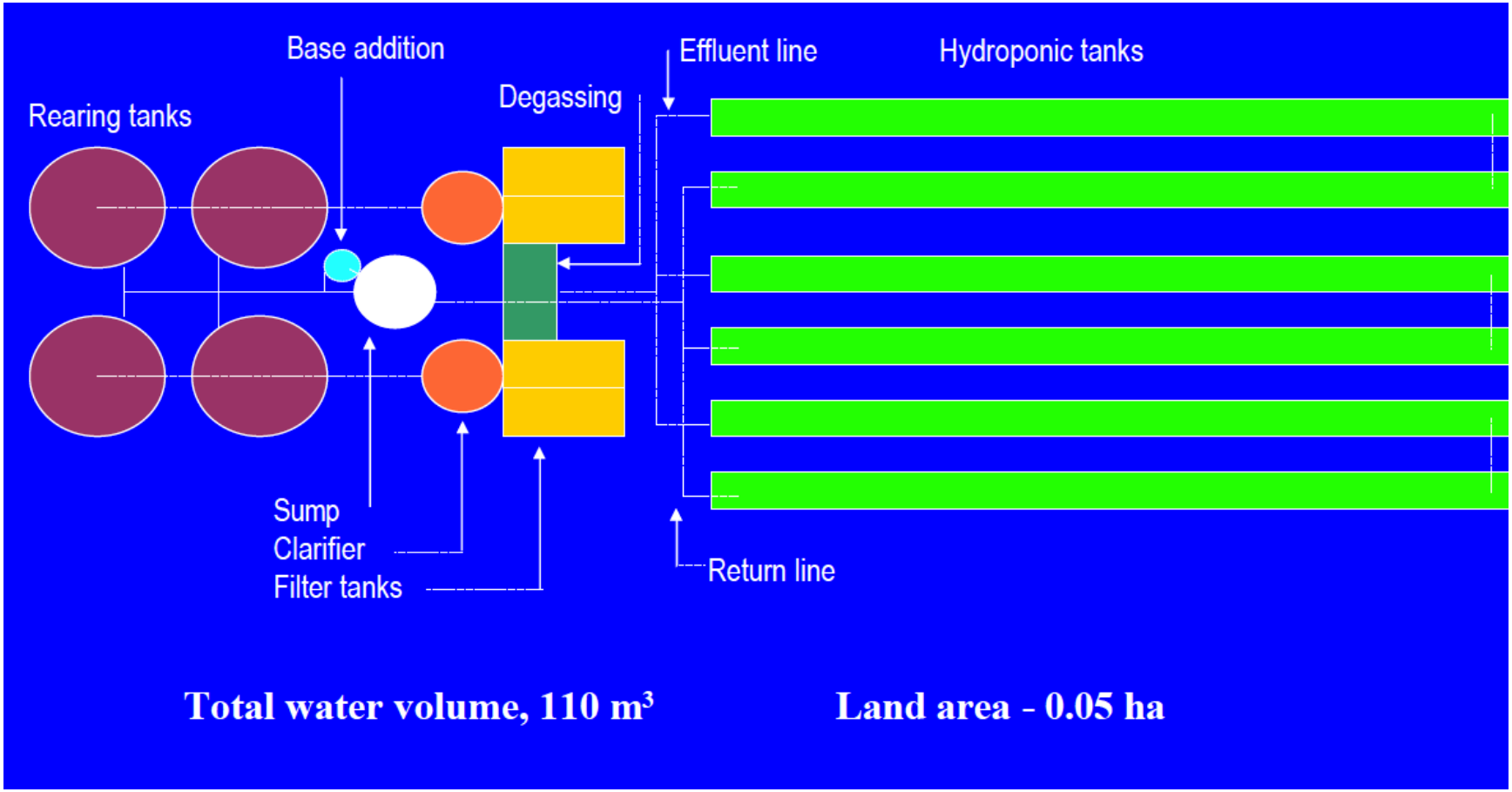
Typical small closed loop system (UVI)



Single loop systems are a compromise



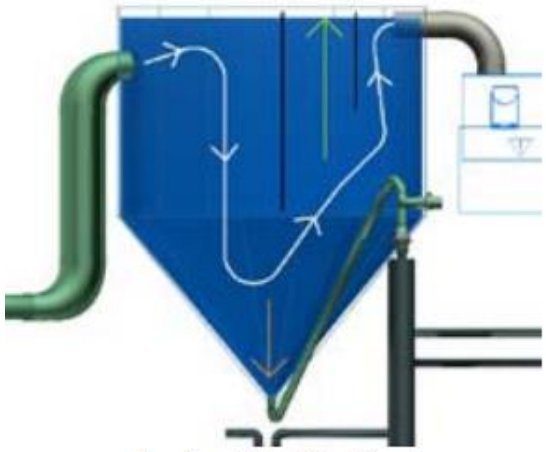
UVI System


Base addition
Effluent line
Hydroponic tanks
Degassing
Rearing tanks
Sump
Clarifier
Filter tanks
Return line
Total water volume, 110 m³
Land area - 0.05 ha

UVI System

UVI System

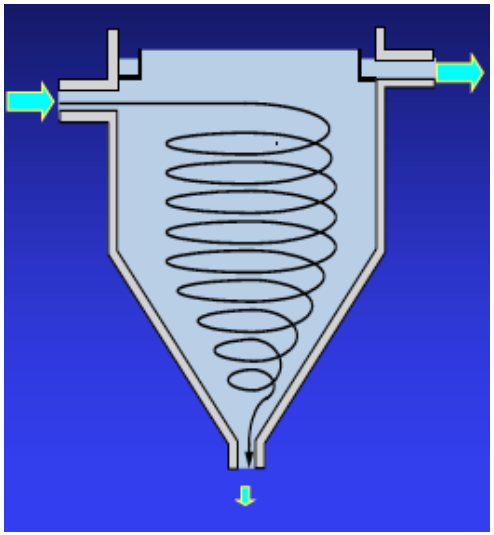
Crude Solids Removal



Conical Clarifier Design

Left: Cut-away view shows the incoming and exiting water and baffles.

Rule of Thumb: 20 Minute retention time for clarifier



Swirl Separator

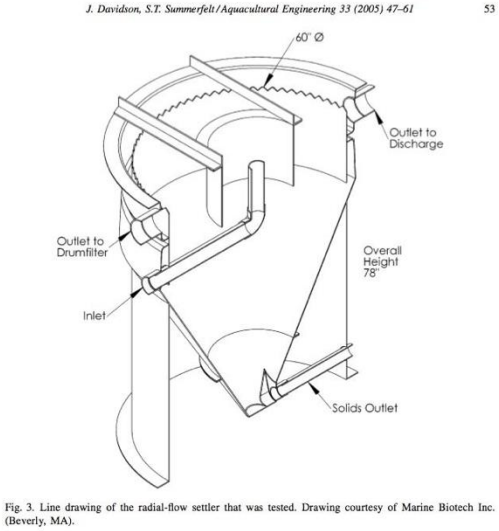
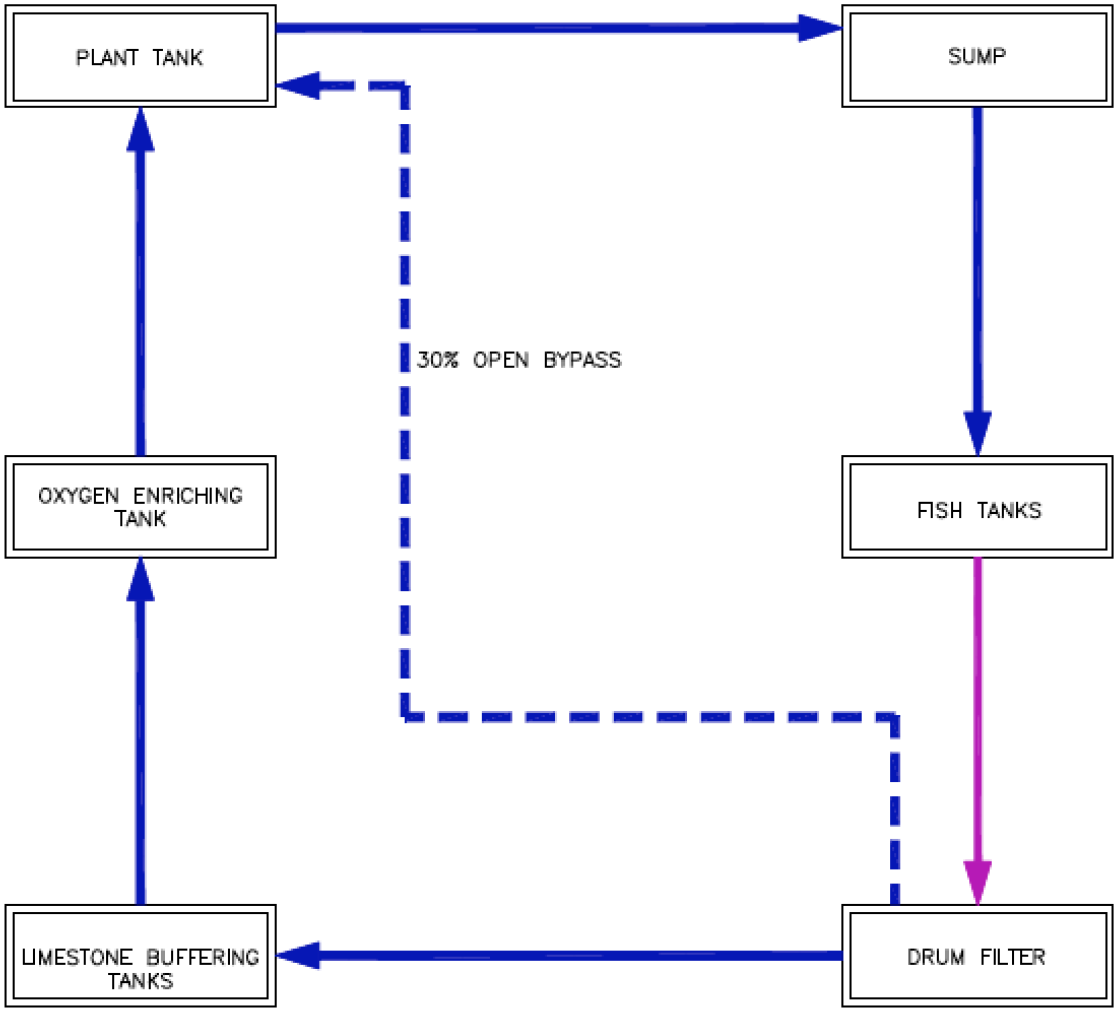


Fig. 3. Line drawing of the radial-flow settler that was tested. Drawing courtesy of Marine Biotech Inc. (Beverly, MA).

Radial Flow Settler are more efficient than swirl separators but harder to build yourself

Modified Single Loop System (Brooks)



Modified Single Loop System (Brooks)

Rotating Drum Filter

- In Aquaponics a more course filter is used than in aquaculture
- 50 µm to 90 µm membrane in drum filters, which are most common for conventional aquaculture can plug up in aquaponics
- 300 µm is used by Dr. Savidov
- These are a more expensive solution

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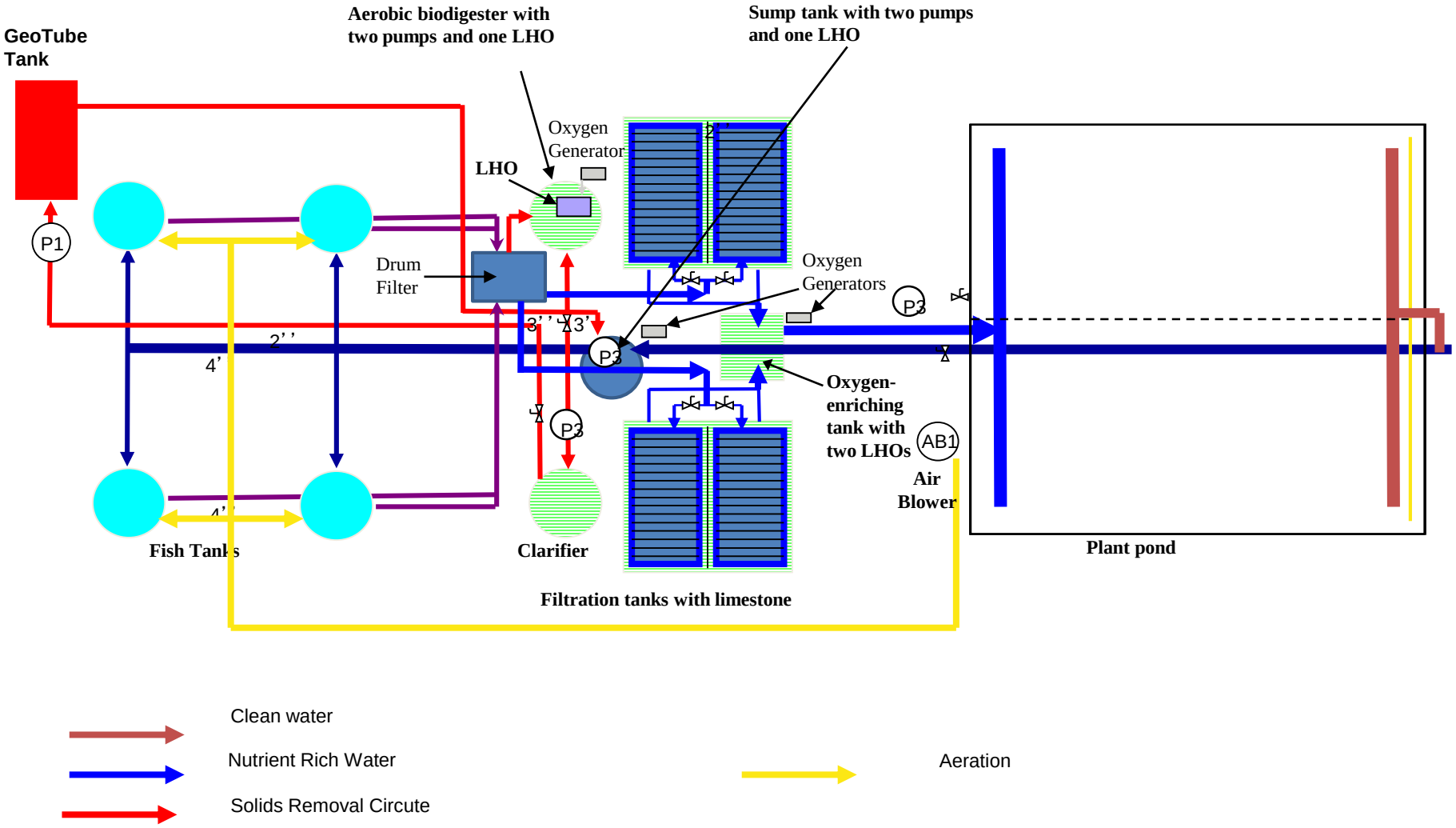

Modified Single Loop System (Brooks)

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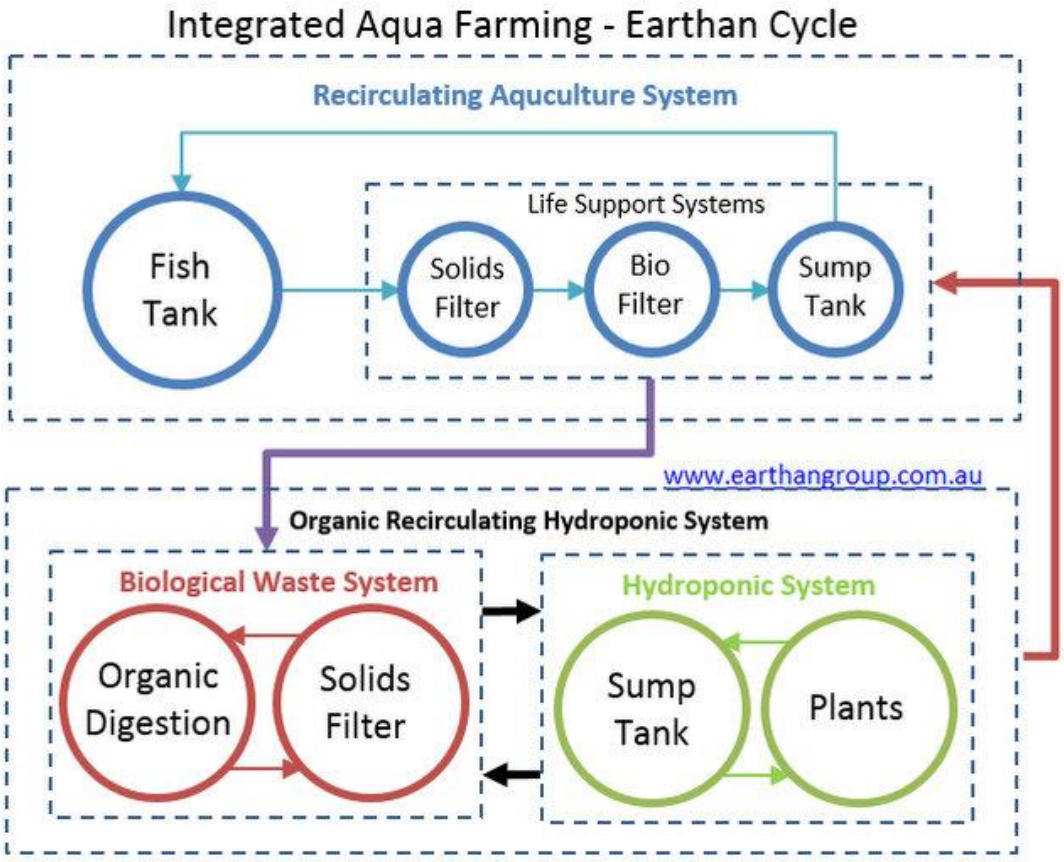
Modified Single Loop System (Brooks)

Multi-loop or decoupled system



Questions?