

# The green shift Our path to water reduction

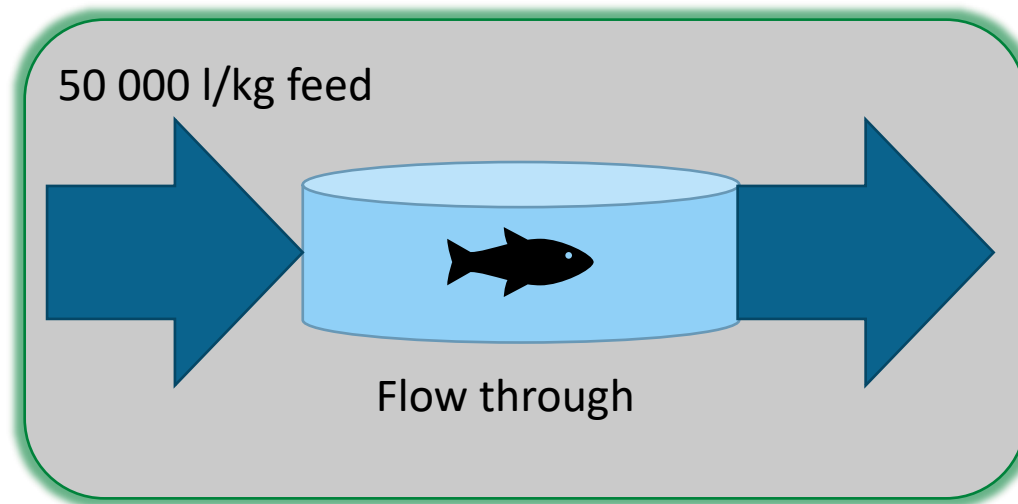
*Fremtidens smoltproduksjon 2022*

*Christian Rønning*

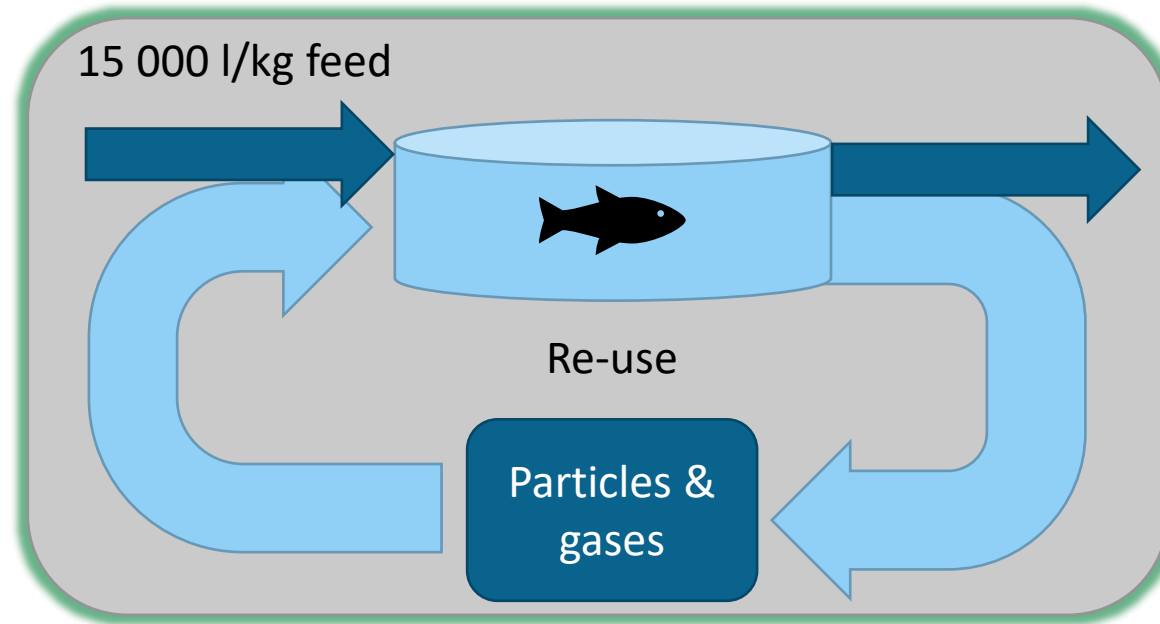
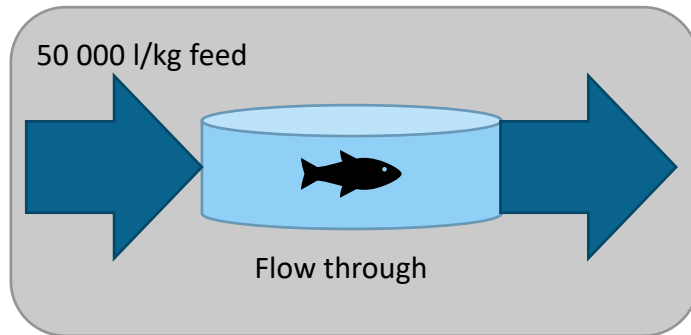
# Pure Salmon Kaldnes

- Bought by Pure Salmon in June 2021
- Supplier of land based farm solutions
- Digitalisation, fish health, service and aftermarket
- From 55 to 110 employees in Norway
- Continued focus on R&D and industrial cooperation
- Land based salmon farming internationally for Pure Salmon

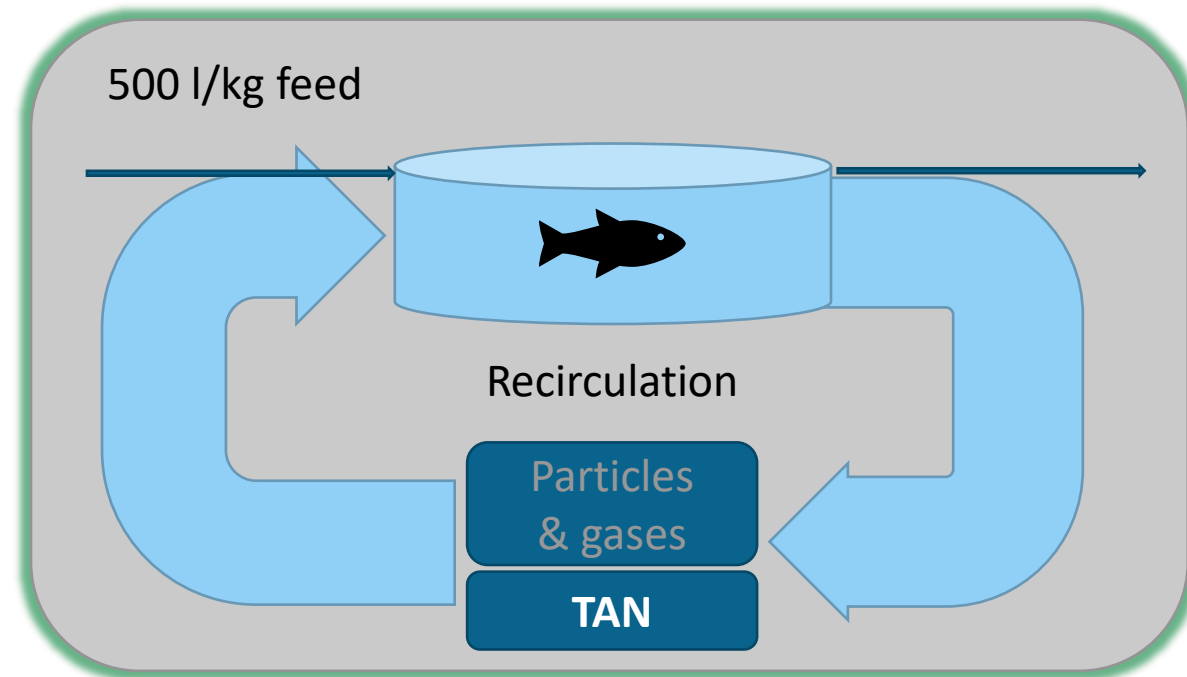
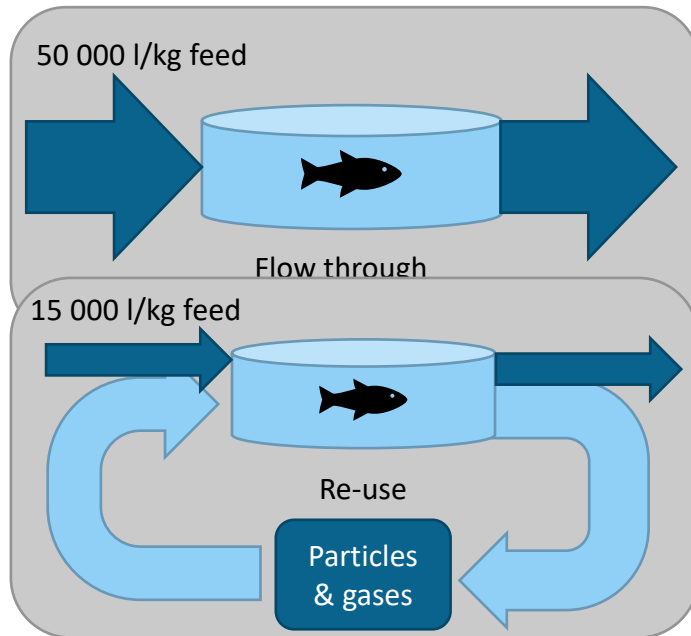
# Specific water use



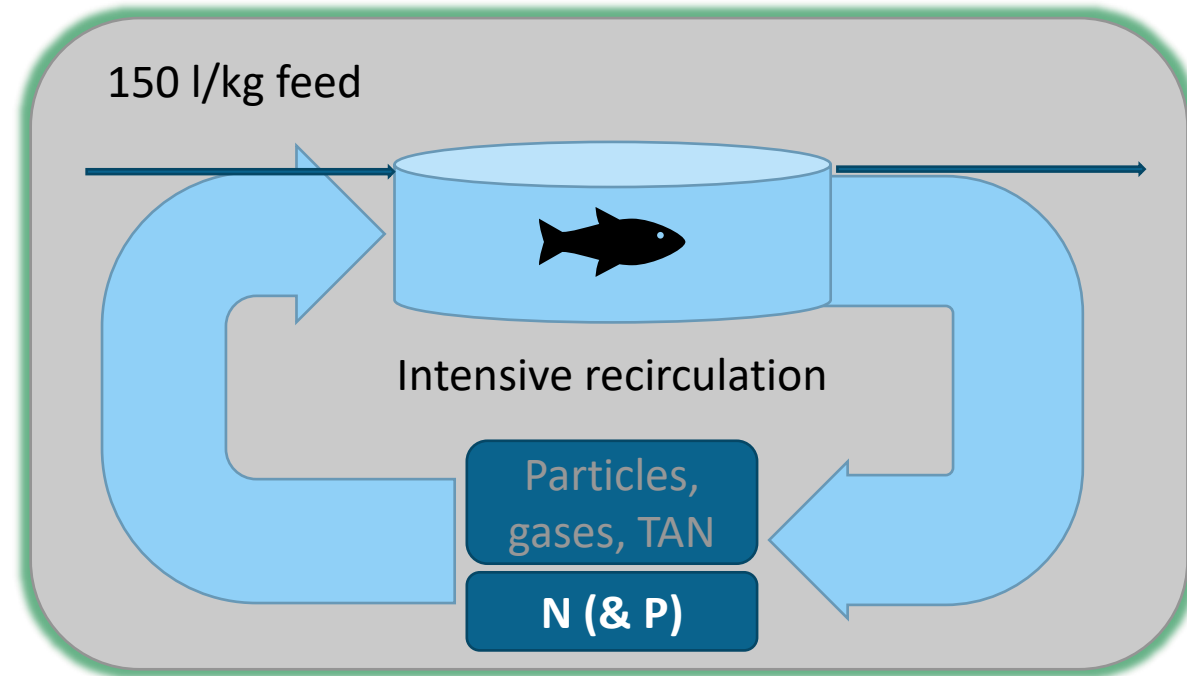
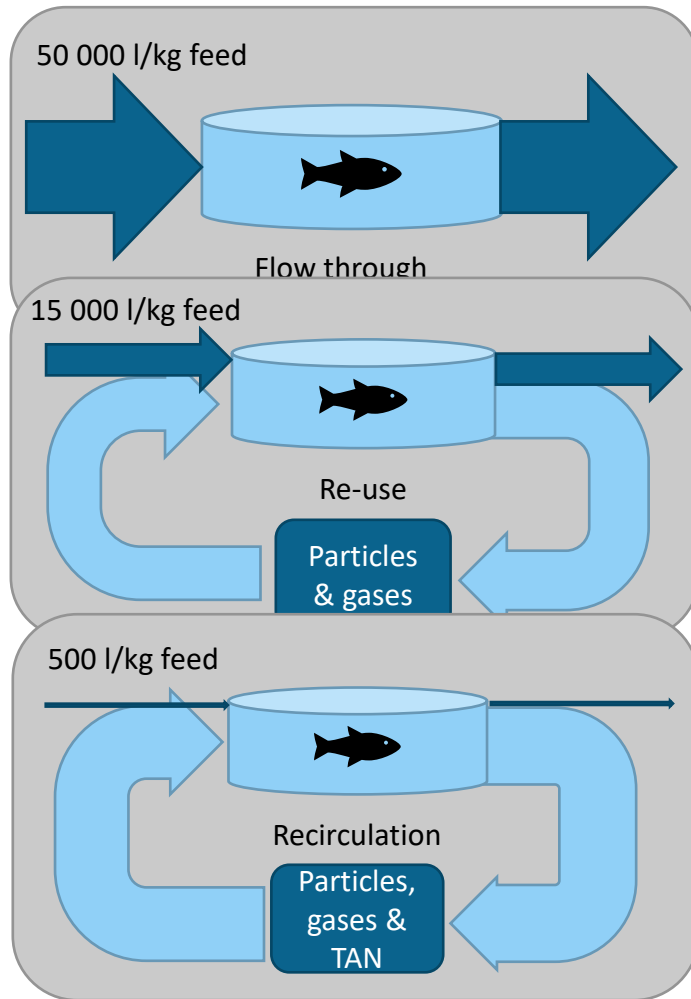
# Specific water use



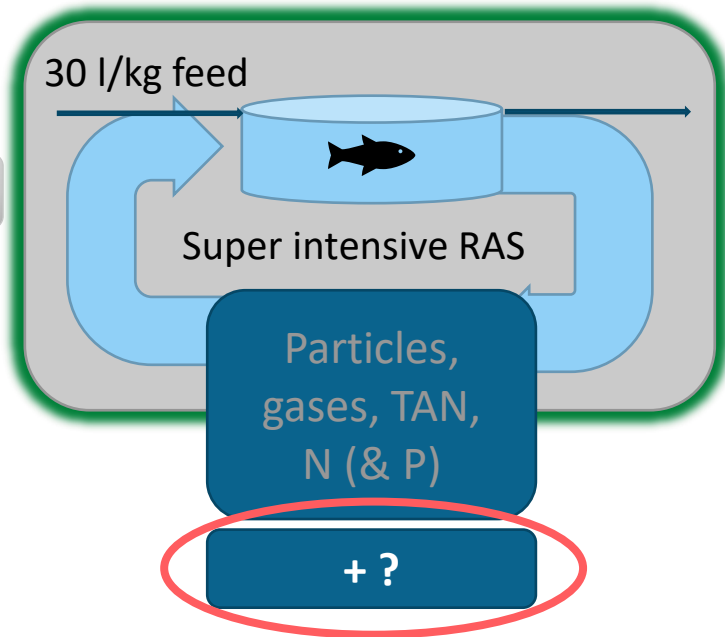
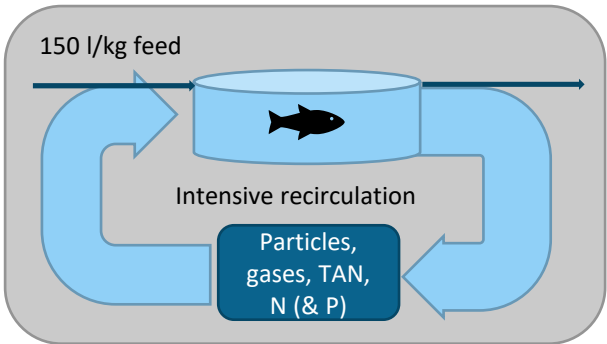
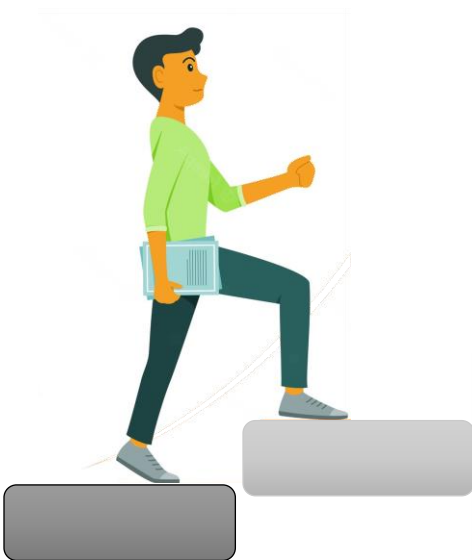
# Specific water use



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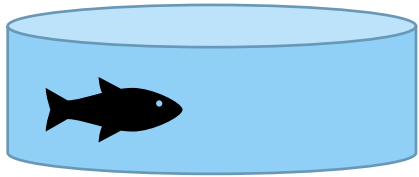
# Specific water use



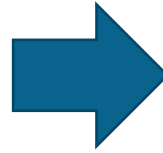
Zero discharge



# What is “good” water quality?



✓ O<sub>2</sub>  
 ✓ TSS  
 ✓ CO<sub>2</sub>  
 ✓ TAN, NO<sub>2</sub>  
 ✓ NO<sub>3</sub>  
 ✓ TGP  
 ✓ Alk., pH, °C



- Metals?
- Organic compounds?
- Other components?

Table 2.2a Water Quality Criteria for Aquaculture

Parameter	Concentration (mg/L)
Alkalinity (as CaCO <sub>3</sub> )	50-300
Aluminum (Al)	<0.01
Ammonia (NH <sub>3</sub> -N unionized)	<0.0125 (Salmonids)
Ammonia (TAN) Cold-water fish	<1.0
Ammonia (TAN) Warm-water fish	<3.0
Arsenic (As)	<0.05
Barium (Ba)	<5
Calcium (Ca)	4-160
Carbon Dioxide (CO <sub>2</sub> )	
Tolerant Species (tilapia)	<60
Sensitive Species (salmonids)	<20
Chlorine (Cl)	<0.003
Hardness, Total (as CaCO <sub>3</sub> )	>100
Hydrogen cyanide (HCN)	<0.005
Hydrogen sulfide (H <sub>2</sub> S)	
Iron (Fe)	
Lead (Pb)	
Magnesium (Mg)	
Manganese (Mn)	
Mercury (Hg)	
Nitrogen (N <sub>2</sub> )	
Nitrite (NO <sub>2</sub> )	
Nitrate (NO <sub>3</sub> )	
Nickel (Ni)	
Oxygen Dissolved (DO)	
Ozone (O <sub>3</sub> )	
pH	
Phosphorus (P)	
Potassium (K)	
Salinity	
Selenium (Se)	
Silver (Ag)	
Sodium (Na)	
Sulfate (SO <sub>4</sub> )	
TGP (total gas pressure)	
Sulfur (S)	
Total dissolved solids (TDS)	
Total suspended solids (TSS)	
Uranium (U)	
Vanadium (V)	

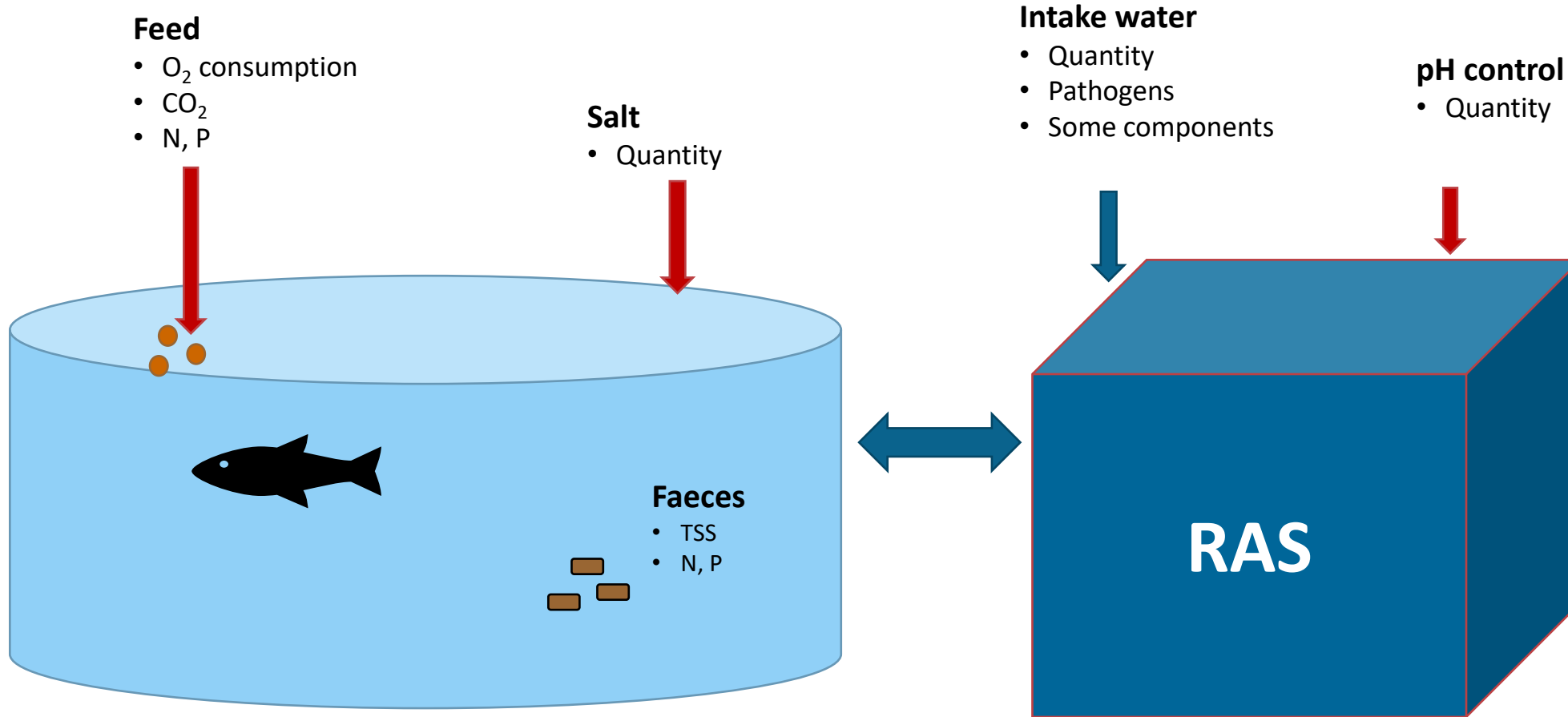
Elements	NOAA/FAO limits (min. - max.) (mg L <sup>-1</sup> )	FAO/WHO limits (mg L <sup>-1</sup> )	USEPA limits (µg L <sup>-1</sup> )
Aluminum	0.00 - 0.015	0.01 - 1.00	0.2
Arsenic	0.001 - 0.0014	0.05 - 0.40	0.025
Barium	0.005 - 0.009	<5	0.013
Beryllium	BDL	0.01 - 1.10	0.01
Boron	1.31 - 1.49	<5	0.08
Cadmium	0.00001 - 0.00004	0.0003 - 0.0700	0.02
Calcium	126.35 - 154.68	4 - 160+	2.0
Chromium	BDL	0.03 - 0.10	0.005
Cobalt	0.00003 - 0.00008	0.010 - 0.05	0.004
Copper	0.0016 - 0.0024	0.006 - 0.070	0.03
Iron	0.004 - 0.017	0.1 - 1.1	0.02
Lead	BDL	0.01 - 4.0	0.002
Magnesium	377.69 - 458.77	15-28+	0.10
Manganese	0.0006 - 0.0011	0.05 - 1.00	0.006
Mercury	BDL	0.0001 - 0.0020	0.001
Molybdenum	0.004 - 0.006	8+	0.02
Nickel	0.0003 - 0.0008	0.01 - 0.40	0.015
Phosphorus	0.032 - 0.992	3+	0.4
Potassium	111.29 - 142.55	5 - 10+	5.0
Selenium	BDL	0.005 - 0.020	0.15
Silver	BDL	<0.003	0.02
Sulfur	281.63 - 345.06	NA	10.0
Vanadium	0.0008 - 0.0011	<0.1	0.0003
Zinc	0.0008 - 0.0013	0.1	0.0003
Zinc	0.0018 - 0.015	0.005 - 0.260	0.075

Source: Mzida, 1983; Páez et al.

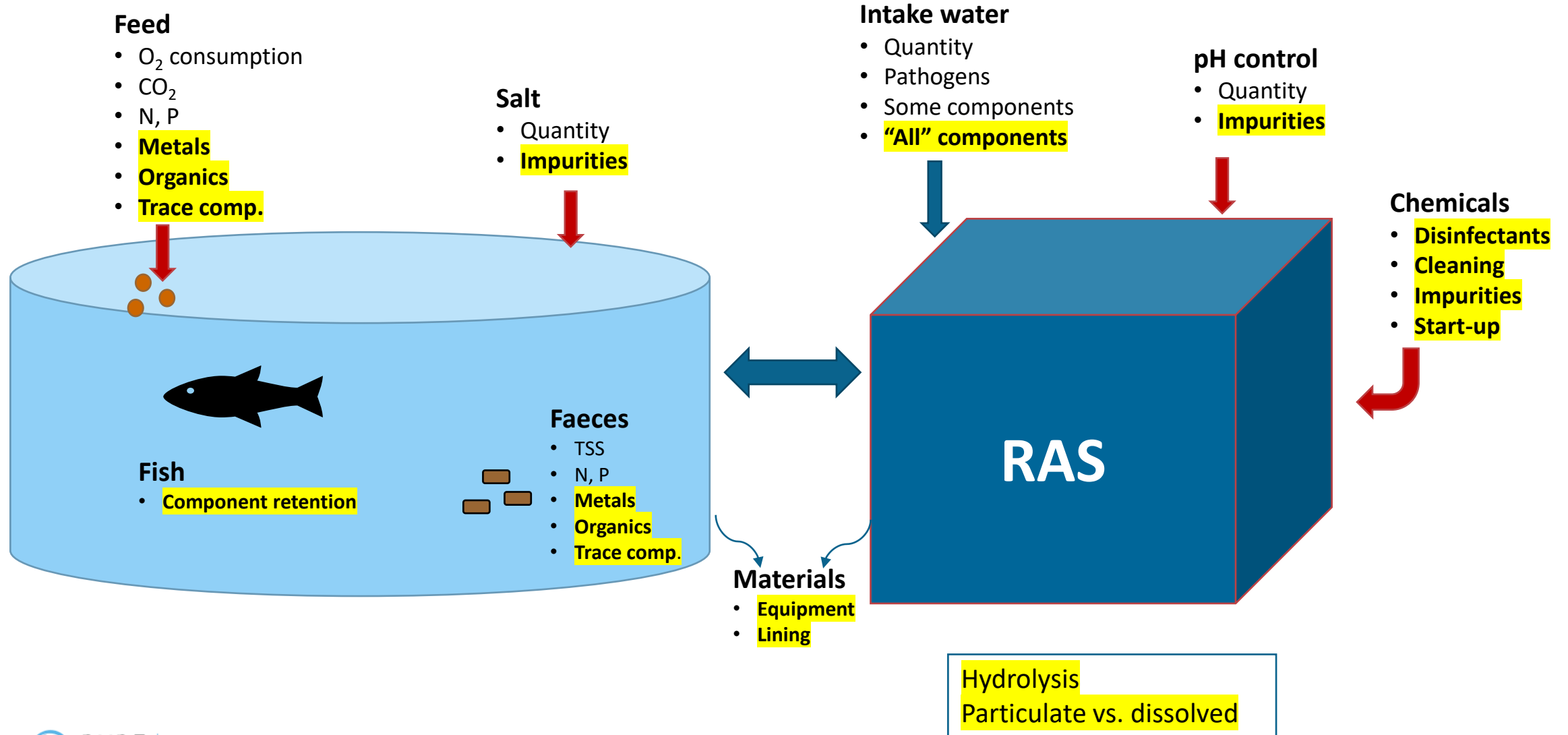
- Which values to use?
- Is “not toxic” = good enough?
- What about non-listed components?
- Effect of variations?
- Combinations of substances?
- Mitigating factors?
- Relevant experience?



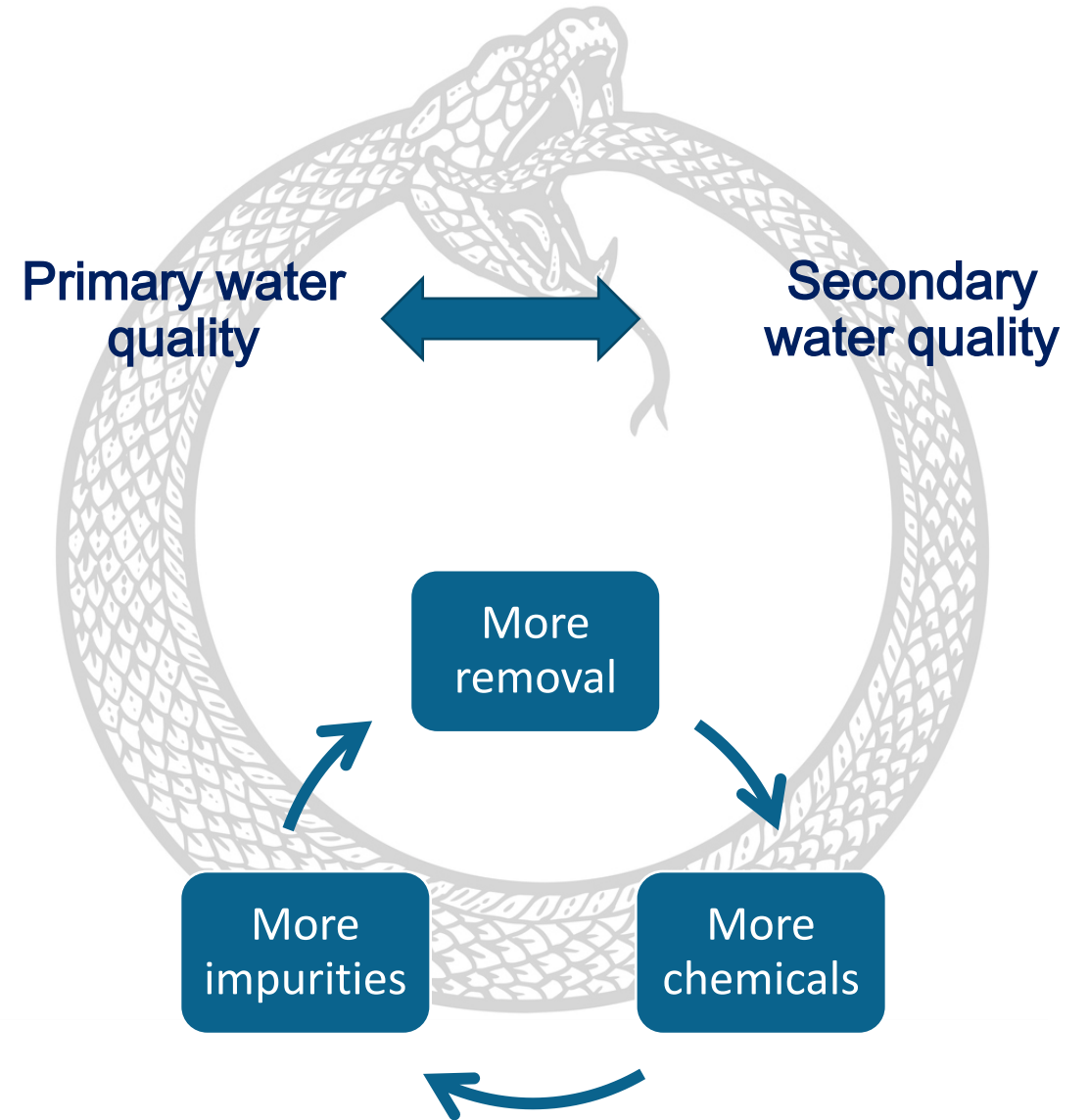
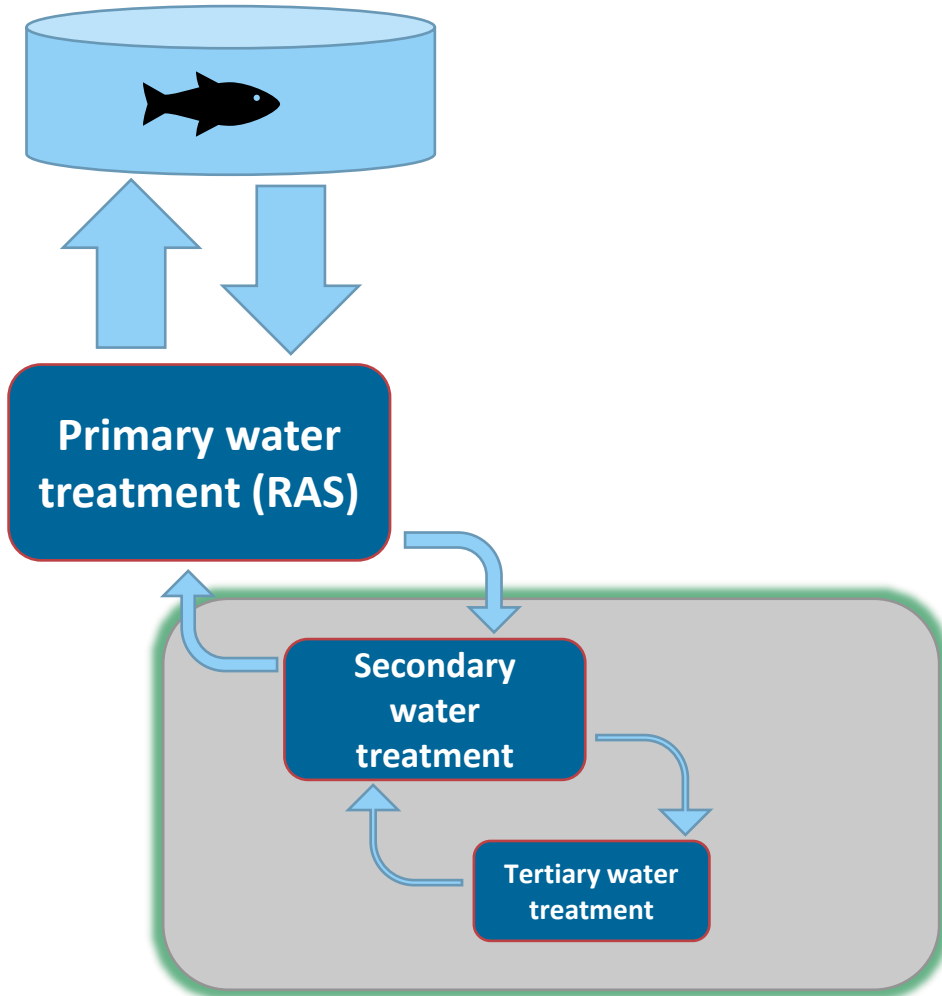
# What influences the water quality?



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# Water treatment

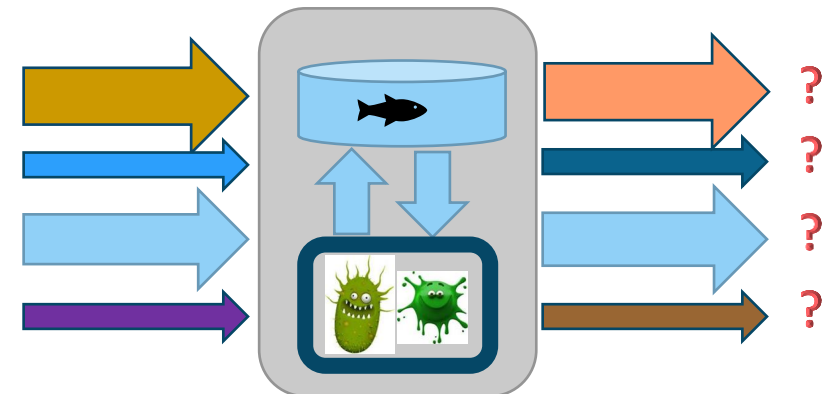
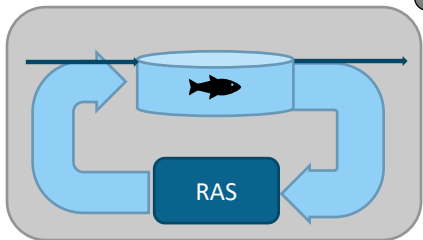


# Knowledge gaps



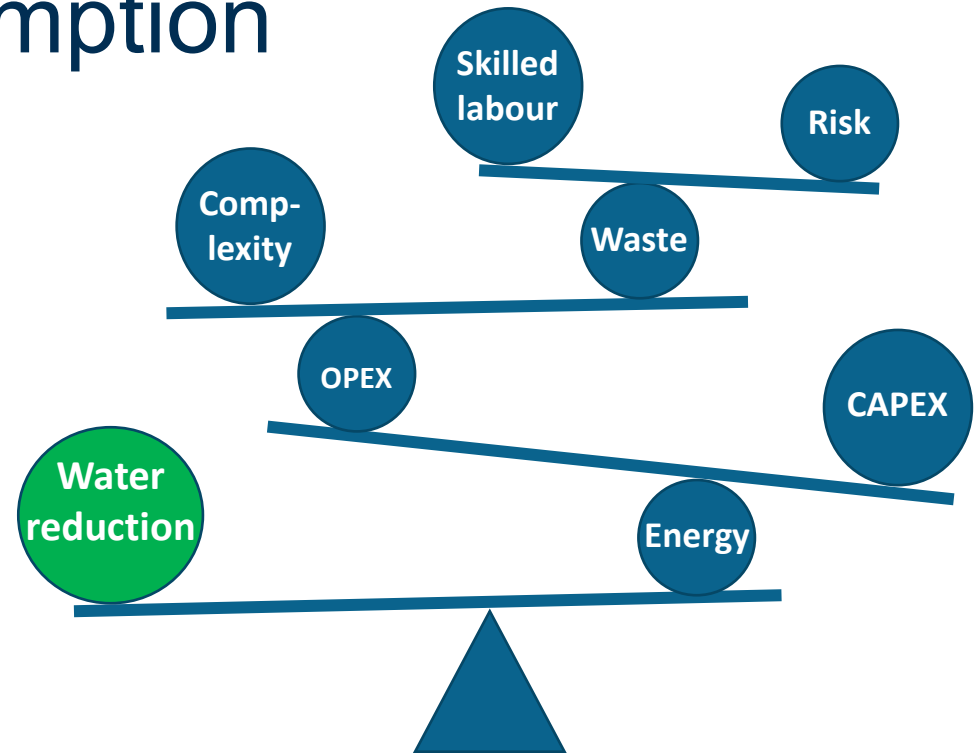
What is «good»  
water in closed  
systems?

Where do the  
inputs go?



# The green shift

- Energy reduction
- **Enable reduction in water consumption**
- Alternative energy sources
- Feed utilisation
- Competence





PURE  
salmon

Kaldnes