Applying the Concept of Sato-Umi to Pond Aquaculture in Karawang, Indonesia

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Aquaculture Pond Effects on Marine Ecosystems — Nutrient Flux

1. Increased inputs of N and P
    - small scale increases can be good, but large scale increases lead to eutrophication.

2. Altered nutrient input ratios
    - Changes in nutrient ratios leads to changes in the composition of phytoplankton assemblages
    - Less nutrition for marine fisheries

Pond Aquaculture — Sato-Umi

Purpose: To investigate the effect of integrated multitrophic aquaculture (IMTA) to:

1) Increase the economic return of pond operation, and
2) Improve the water quality of the ponds to reduce the release of nutrients to coastal waters

Pond Aquaculture — Sato-Umi

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1) Increase the economic return of pond operation, and
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Nutrient Input: 1.3 kg of fish meal is added to ponds for every 1 kg of Tilapia harvested

For 1000 m^3 pond = 1000 kg Tilapia/pond
= 300 kg excess food
= ~ 70% protein, or ~34 kg N
= **~ 0.15 moles NO_3/L (~ 10,000 x greater than natural levels)**

Pond Aquaculture — Sato-Umi

<u>Hypothesis</u>: The addition of bivalves (*Anadara*) and seaweed (Gracillaria) into the aquaculture ponds of tilapia or shrimp will:

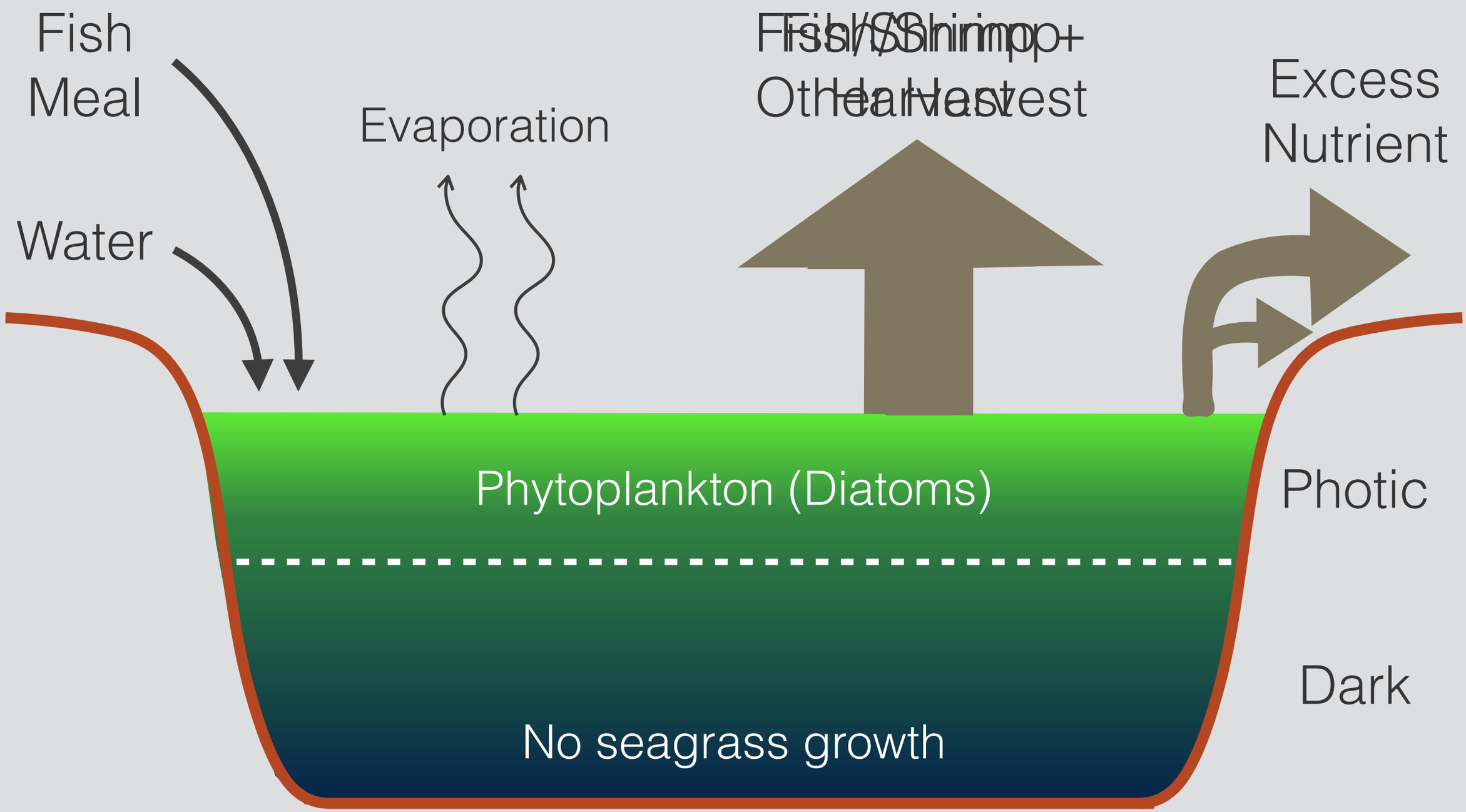
1) allow successful growth of all species, and

2) decrease dissolved nutrient concentrations (nitrite/nitrate, ammonia, phosphate).

Traditional Pond Aquaculture

- Practiced by local communities — distinguished from larger scale commercial operations by their simplicity.
- Low cost: no mixing of the pond waters by water wheel or other means — more prone to low oxygen and hypoxia.
- Thus, these are low intensity aquaculture ponds
  - ~15 shrimp/m^2 versus the >300 shrimp/m^2 in high intensity aquaculture ponds
  - same level of differences for Tilapia ponds

Conceptual Pond



Experimental Design

The experiment has 5 x 1000 m^2 ponds at the National Center for Brackishwater Aquaculture, Karawang.

Pond 1) Only Shrimp

Pond 2) Only Tilapia

Pond 3) Shrimp + *Gracilaria* + *Anadara*

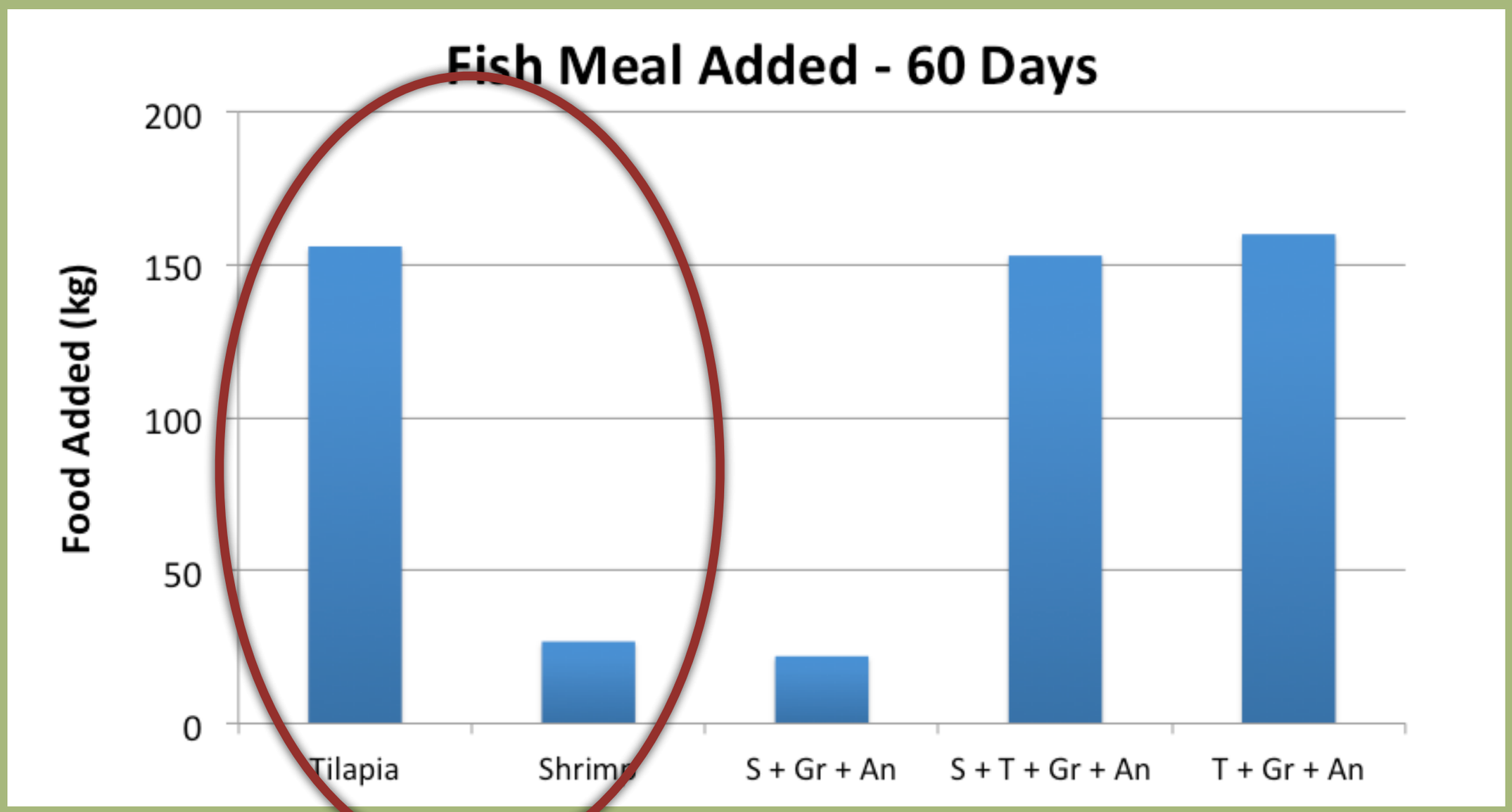
Pond 4) Tilapia + *Gracilaria* + *Anadara*

Pond 5) Shrimp + Tilapia + *Gracilaria* + *Anadara*

Example Shrimp/Tilapia/Seaweed Pond

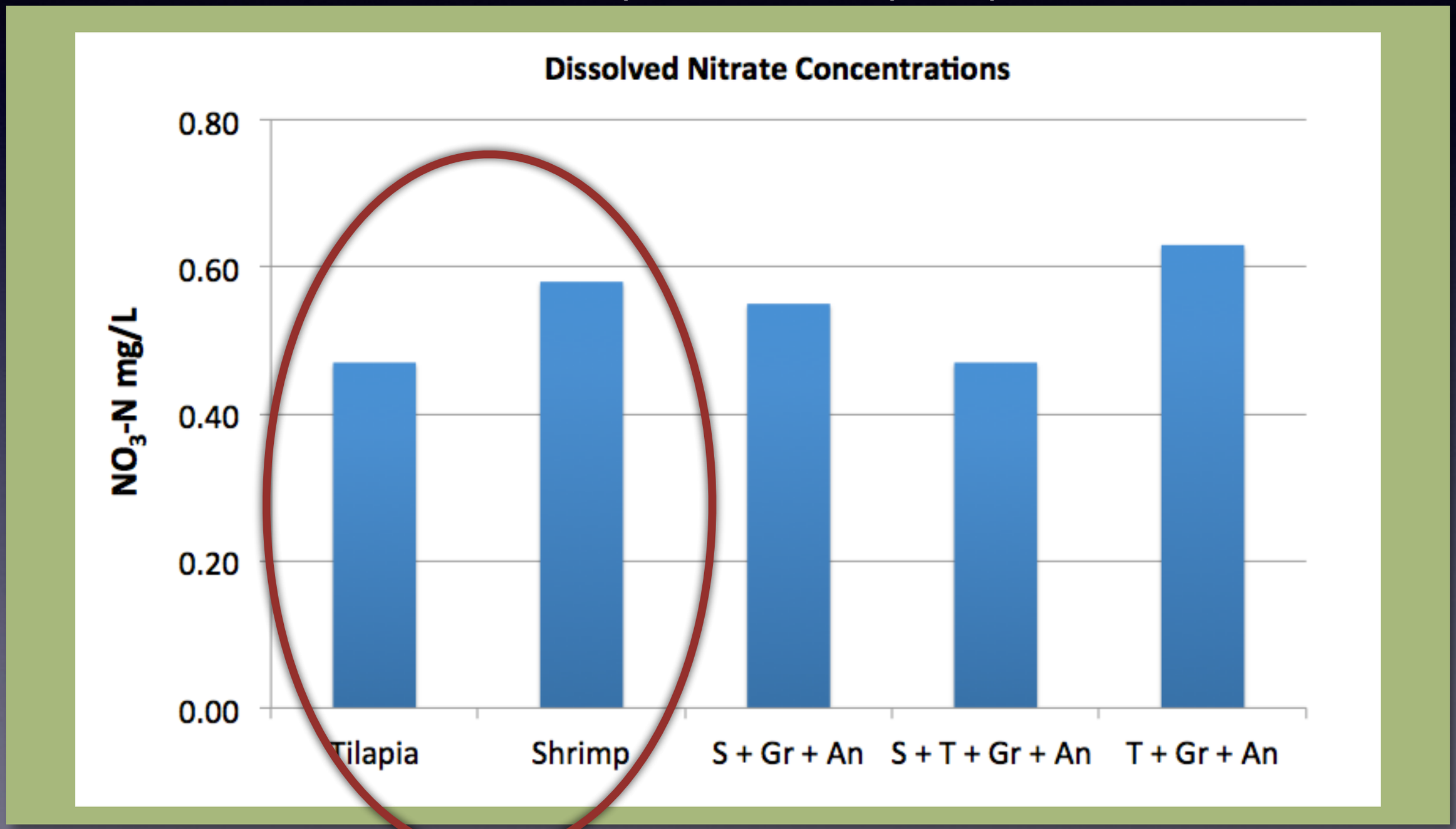
“Nutrient” Input - Fish Meal

There is a large difference in the amount of food added to the Shrimp and Tilapia ponds



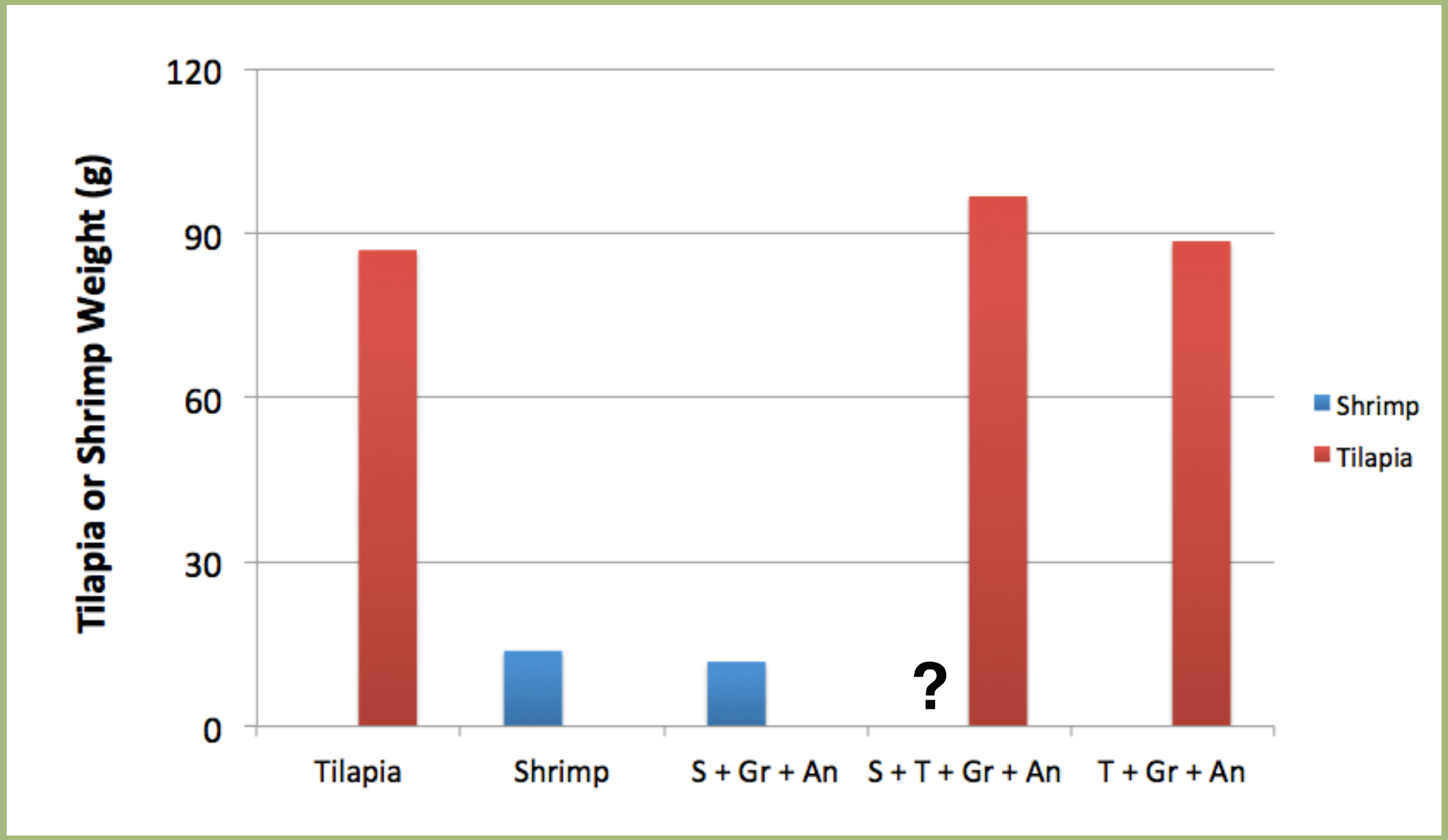
“Nutrient” Input - Dissolved N

There is little difference in nitrate concentrations in the Shrimp and Tilapia ponds



Effect on Product Size

Adding seaweed or oysters does NOT affect the size of Shrimp or Tilapia



Phytoplankton Community Differences

Green Algae - Dominated

Shrimp + Tilapia + Seaweed

Diatom - Dominated

Shrimp + Tilapia + Seaweed + Anadara

Summary

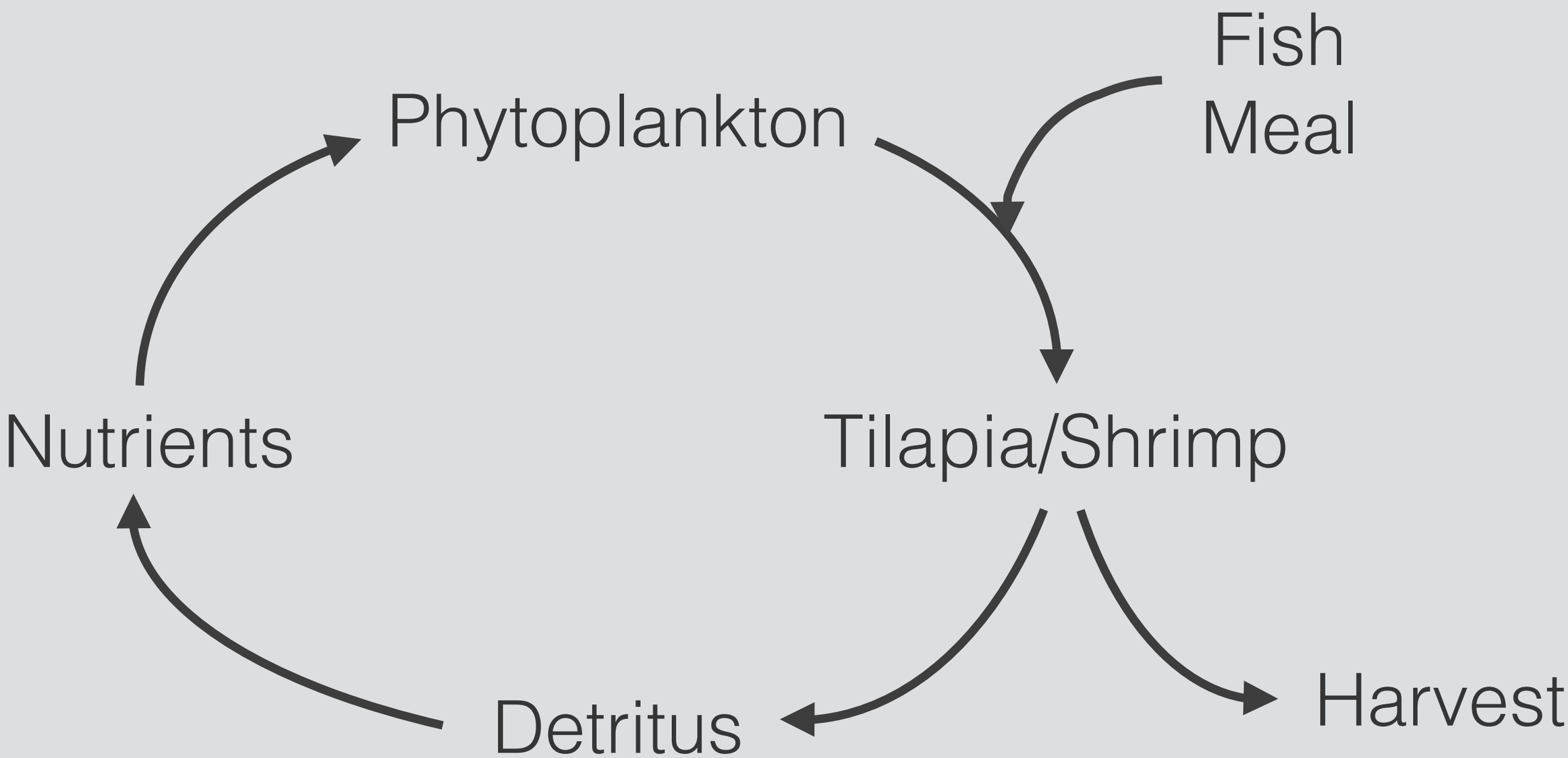
1. Nutrient release must decrease from Shrimp and Tilapia pond aquaculture to coastal waters.

2. We are testing whether the co-culture of *Gracillaria* (seaweed) and *Anadara* (Clam) with Shrimp and Tilapia will decrease dissolved nutrient levels — too soon to tell.

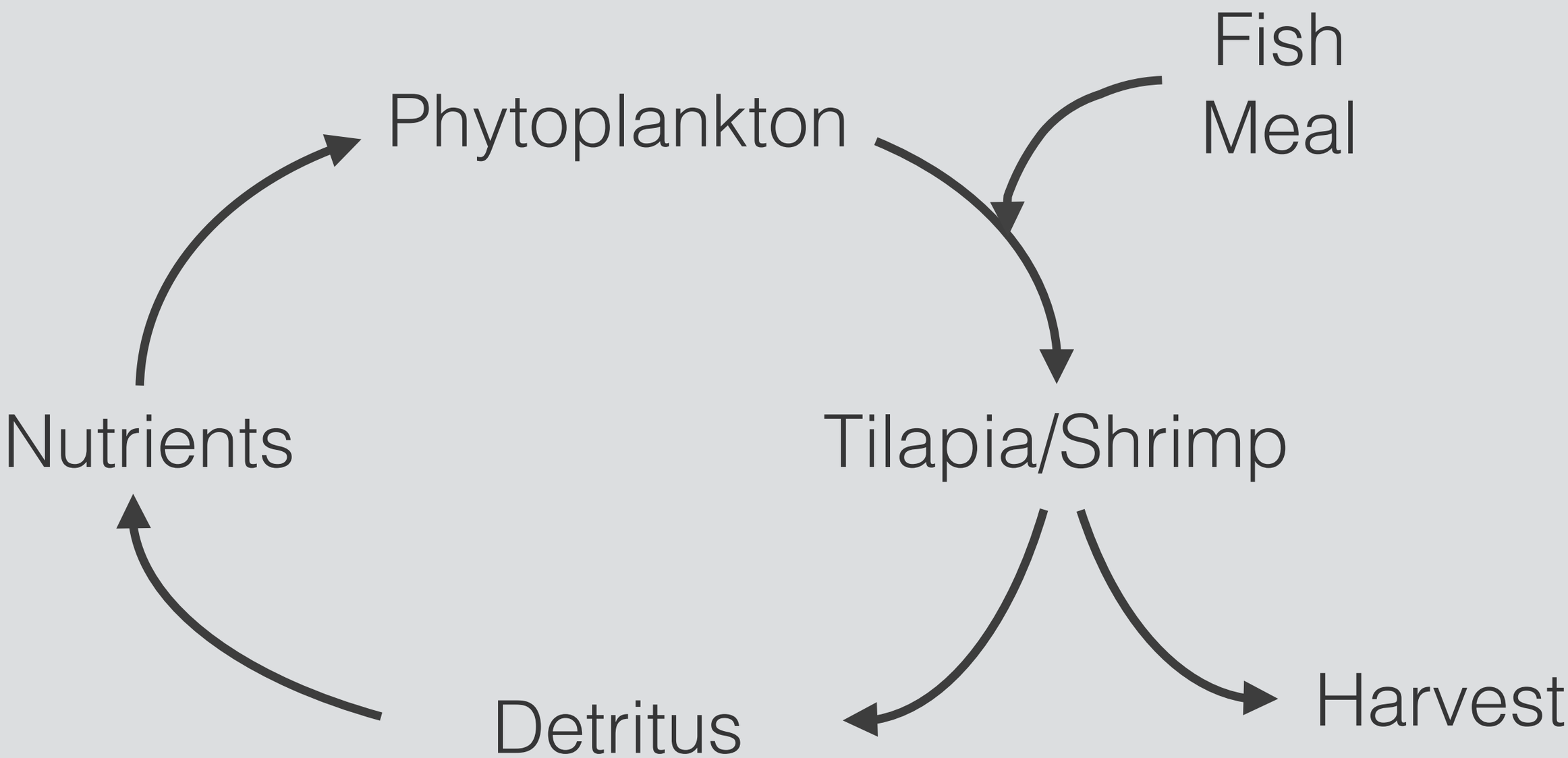
3. Early results indicate that inclusion of *Gracillaria* (seaweed) and *Anadara* (Clam) does not decrease the growth of Shrimp or Tilapia — These may be an important source of additional income for communities.

4. The addition of co-cultured species into the ponds affects the phytoplankton community composition — benefits to the quality of Shrimp and Tilapia

Towards Sato-Umi



Towards Sato-Umi



Aquaculture Pond Effects on Marine Ecosystems

1. **Loss of Mangrove forest systems**
   a) Increased shore erosion
   b) Loss of biodiversity (including fisheries)

Aquaculture Pond Effect on Coastal Marine Ecosystems

1. **Loss of Mangrove forest systems**
   a) Increased shore erosion
   b) Loss of biodiversity (including fisheries)
2. **Altered nutrient flux into coastal waters**
   a) Increased inputs of N and P
      - small scale increases can be good, but large scale increases lead to eutrophication.