Determination of optimal biofloc concentration. Methodology and preliminary results

Yoram Avnimelech & Malik Kochba

Dept. of Civil & Environmental Engineering

Technion, Israel Inst. Of Technology

agyoram@technion.ac.il

Introduction

One of the management variables in biofloc technology (BFT) systems is the definition of the desired biofloc concentration.

Several authors (e.g. Ray (2013), Shveiter et al. (2013, Browdy, Wasielesky and Taw) found that excessive biofloc concentrations reduce shrimp growth. It was suggested that high biofloc concentrations may clog shrimp gills Schveiter, Emerenciano).

How much is too much?

- Different values are published, partially not rigorously obtained:
- For Example:
- Ray & Lotz suggested that 200 mg/l is OK, while 310 mg/l is too much (Shrimp)
- Schvieter et al. found that a biofloc concentration of 400-600 mg/l is optimal for shrimp (200 mg/l, too low, 800-1000 too high).

Nyan Taw suggested that floc volume should be less than 15 ml/l (roughly equivalent to 200 mg/l).

Avnimelech suggested optimal biofloc concentration at around 200 mg/l for shrimp and 400 mg/l for tilapia.

As Mentioned, these values are not based upon a set of rigorous studies.

Functions of bioflocs

- A. Controlling water quality
- B. Recycling feed and feeding the fish (shrimp)
- C. YET, bioflocs consume oxygen

Working hypotheses

- **1. Even a low standing biofloc population is enough to control water quality. (We found that we can easily control TAN even with a floc volume of 2-5 ml/l) .**
- **The advantage of biofloc can be represented by the feeding potential as a function of concentration.**
- **The limitation of biofloc can be represented by the oxygen demand (BOD) as a function of concentration.**

Experimental program

- **1. Preparation of ^{15}N biofloc suspension.**
- **40 l water were enriched by fish feed, bran and our inoculum seed. The system was continually aerated. Feed was added daily**
- **After 5 days, when floc volume reached 30 ml/l and TSS 388 mg/l, we added ^{15}N salt to get its level in the TSS suspension to 1.5% (5 times natural abundance).**

Experimental 2

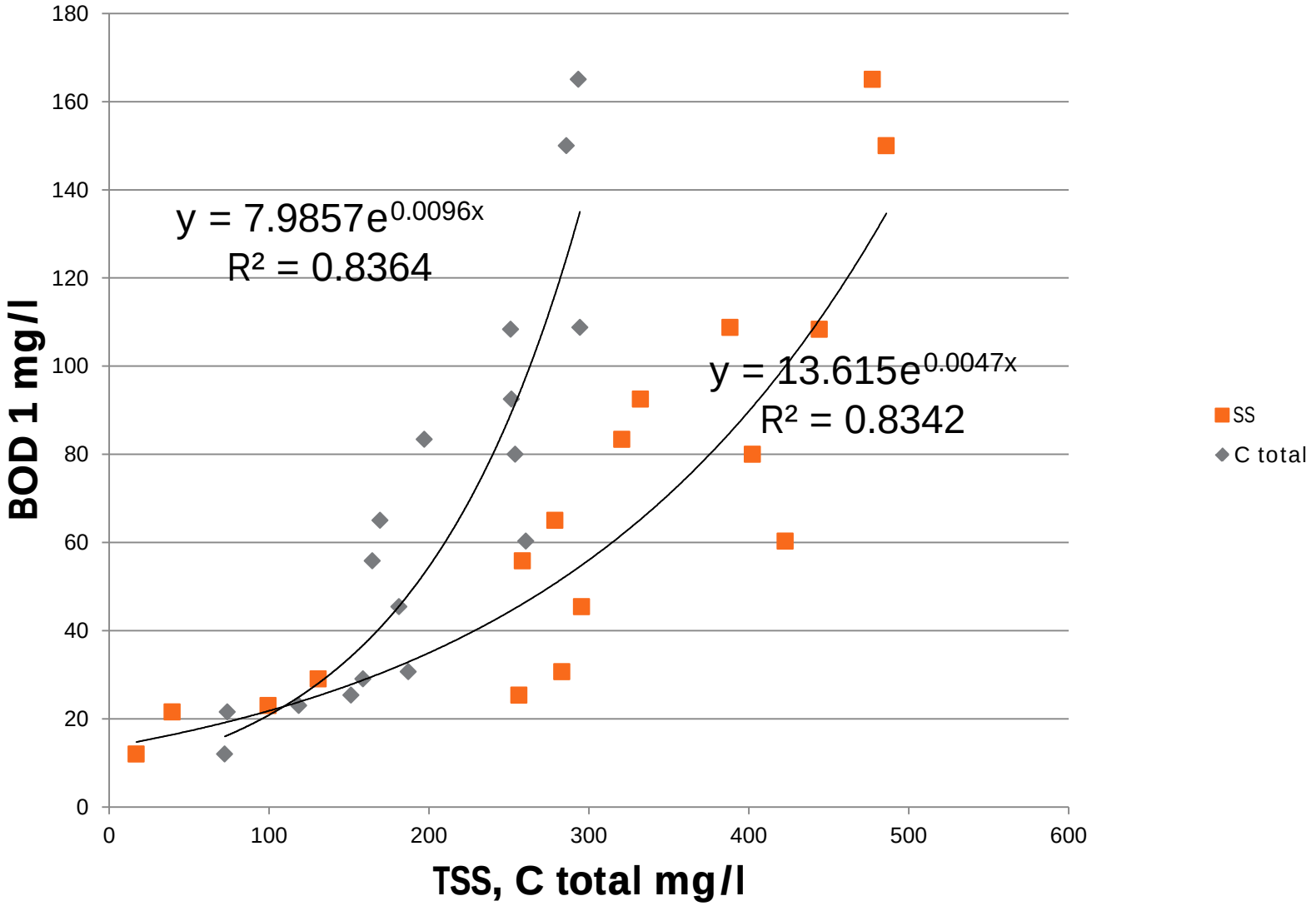
1. **Testing Microbial protein uptake**

- **The tagged suspension was diluted to**
- **100, 75, 50, 25 and 12.5% with water and transferred to 5 l glass containers.**
- **3 tilapia fingerlings (48.7± 10.3) were introduced for 24 hours.**
- **Portions of fish meat were dried, pulverized and sent for ^{15}N determination.**

Results

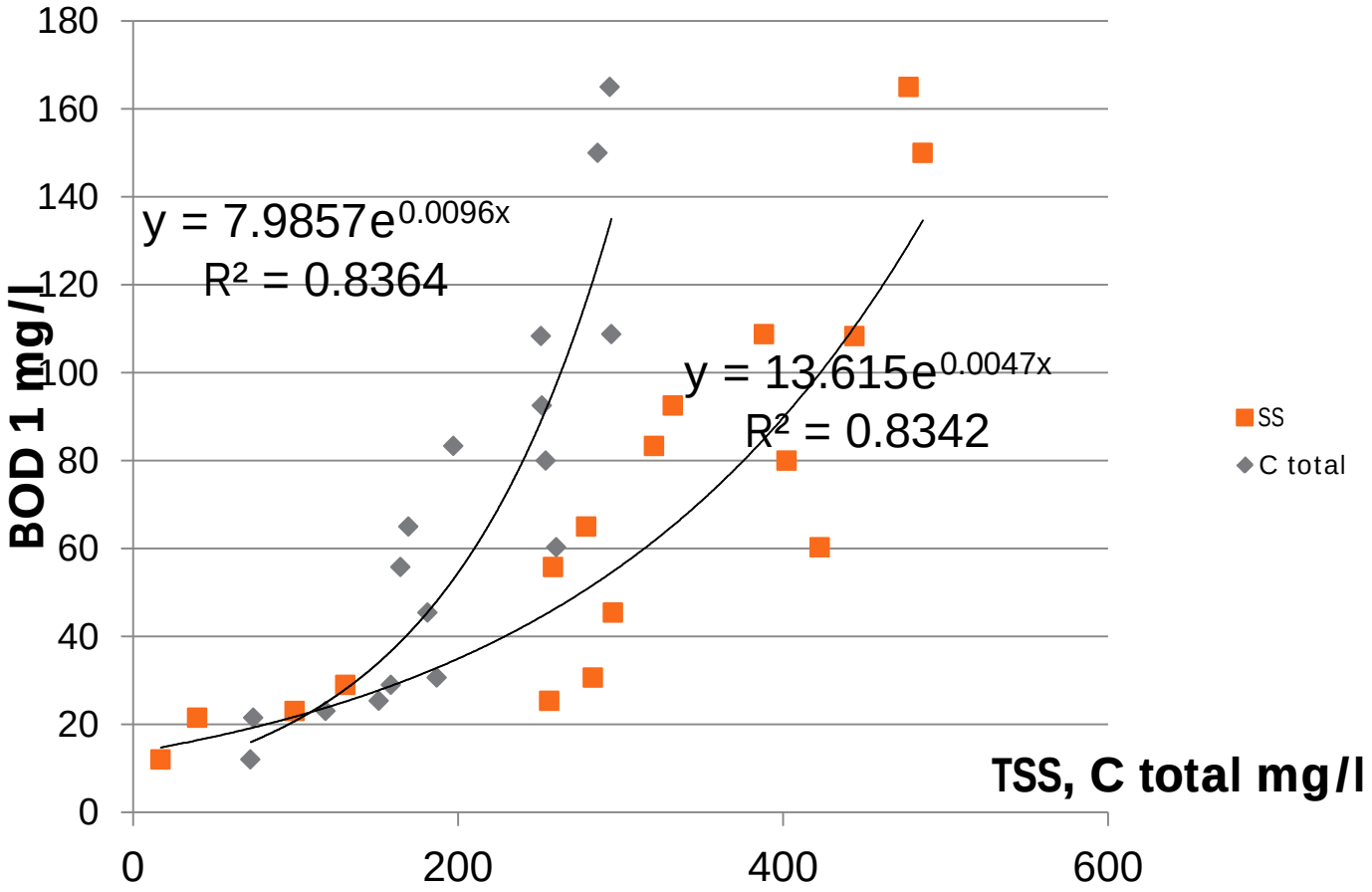
- **BOD**:
- Suspension samples were transferred to a manometric BOD measurement system (Oxitop) for 24 hours.
- Average results of a few experiments are presented.

BOD AS A FUNCTION OF TSS AND TOTAL CARBON



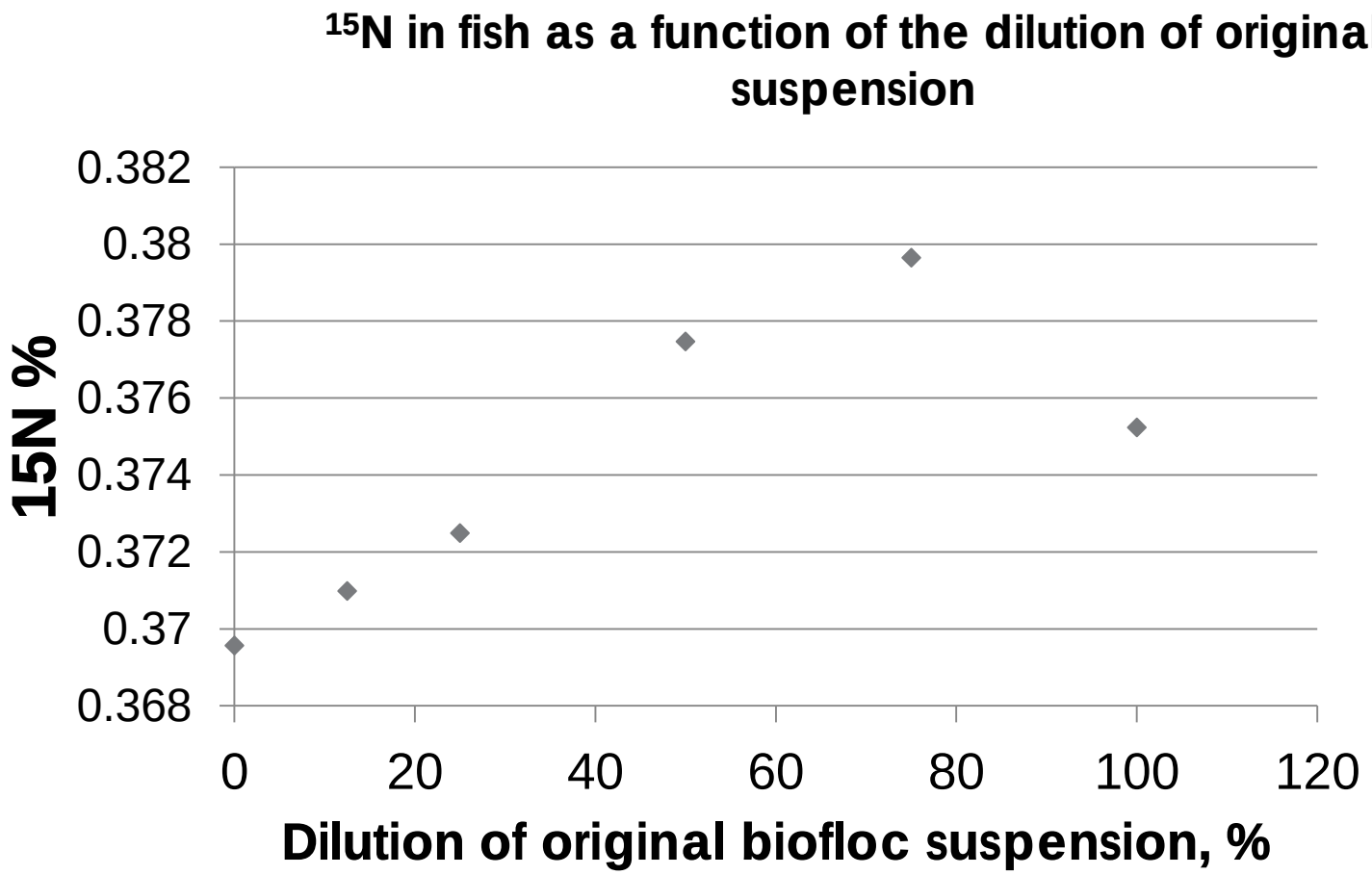
Significance of results

- For BOD = 100mg/l -> 100g O_2/m^3 (0.1 kg)
- Take SAE ~ 1 KWH per 1kg O_2
- And US$ 0.15/KWH
- Then:
- You need 100 KWH/ 1000m^3 pond per day,
- == 15 US$ /1000m^3 pond per day.
- BOD seems to be EXPONENTIAL to TSS or Total Carbon. Steep increase above ~ 300 mg/l as TSS

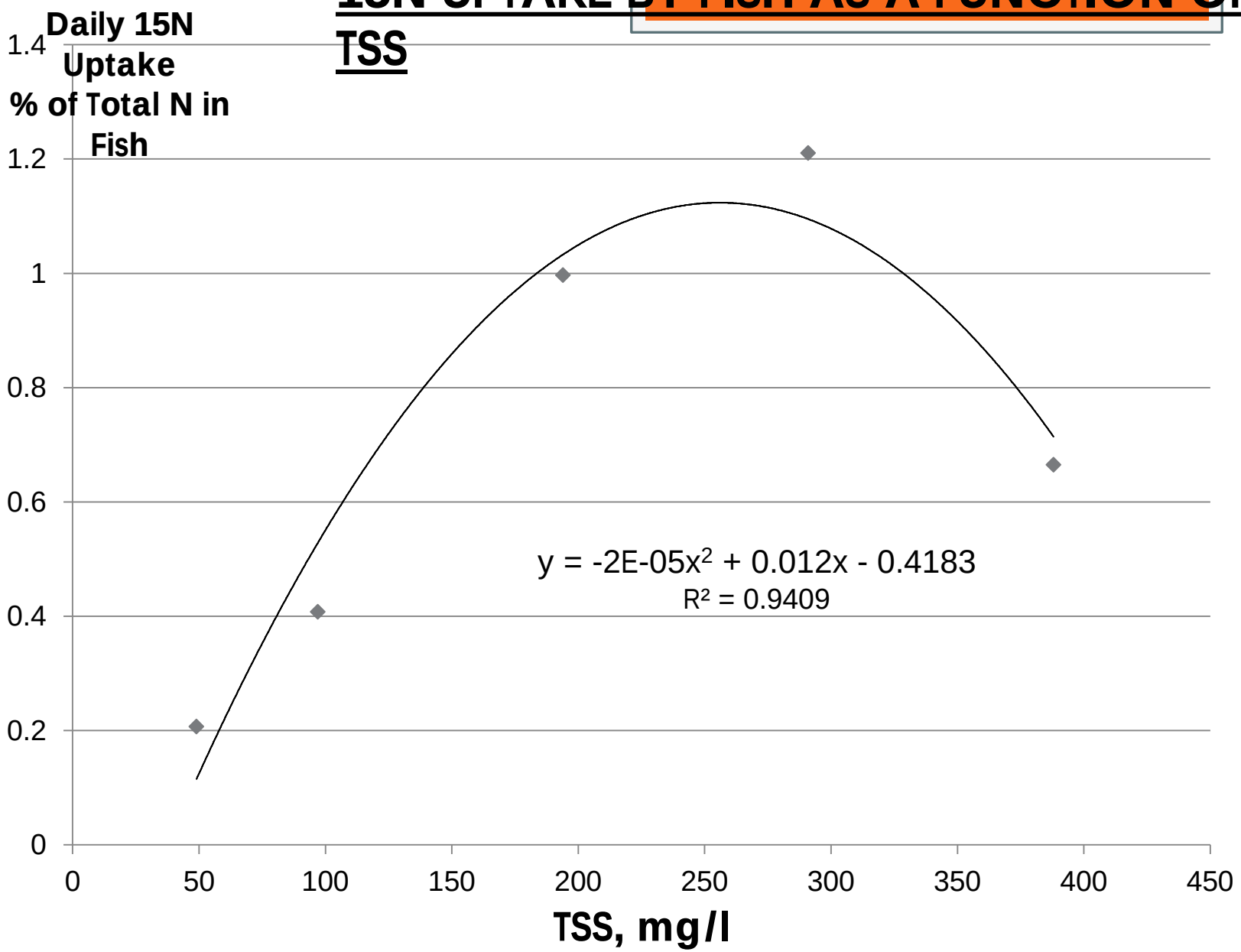

180
160
140
120
100
80
60
40
20
0
BOD 1 mg/l
y = 7.9857e0.0096x
R² = 0.8364
y = 13.615e0.0047x
R² = 0.8342
0
200
400
600
TSS, C total mg/l
SS
C total

^{15}N UPTAKE

- Concentration of ^{15}N in the bioflocs (filtered suspension samples) and fish (Dried and pulverized muscle samples) was determined
- (Analytical Lab, Marine Science Institute,
- University of California Santa Barbara).
- Uptake of 15 N was calculated.


15N in fish as a function of the dilution of original suspension
15N %
0.382
0.38
0.378
0.376
0.374
0.372
0.37
0.368
0
20
40
60
80
100
120
Dilution of original biofloc suspension, %

15N UPTAKE BY FISH AS A FUNCTION OF TSS



Conclusions

- 1. We do not intend to give exact specific results.
- 2. We think that we bring forth here a methodology enabling to evaluate the optimal total suspension concentration for any given system, fish species and size as well as economic data.
- 3. We hope that we provide a way of thinking and making decision toward the need and means to control suspension concentrations.


THANKS FOR NOT RUNNING OUT