Combined Experiment on nutrition in catfish and monitoring and management of water quality in Recirculation Aquaculture Systems (RAS)

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Research Questions

- Growth monitoring
- Comparison of different feeding levels
- Water quality sustainability

Aims and Objectives

- Design and management of RAS
- Water quality management on daily bases (pH, conductivity, O_2 content, Temperature, NO_2, NO_3, NH_4)
- Relation between feeding ratio and growth
- Analyzing of feed conversion efficiency

Introduction

- Design, set-up and start up of a RAS (142 litres)
- Growing African catfish (*Clarius gariepinus*) at a fixed feeding schedule.
- Measuring water quality on a daily bases to insure health and best performance of fish.

Materials

- Recirculation system construction
  - Culture tank
  - Solid removal unit (remove solid particles, faeces)
  - Pump tank (pump water to trickling filter)
  - Bio reactor (trickling filter, nitrification)
  - Biofilter sump (collect H_2O and biomass)
  - Pump
  - Water inlet and water outlet pipe

Methods

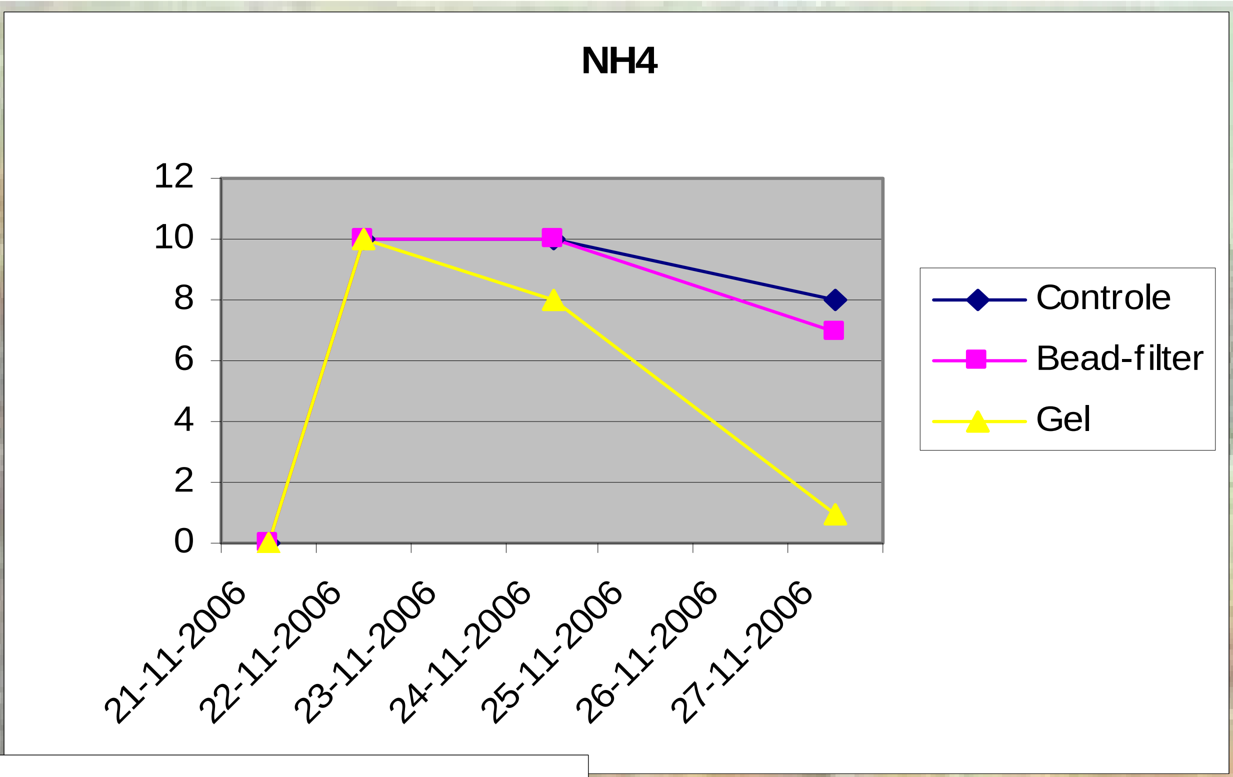
- Temperature (testo 110)
- pH (WTW pH 340)
- Conductivity (WTW LF 318)
- O_2 (Oxyguard Handy Mk III)
- NO_2 (Merck, Aquamerck, 1.11118.0001)
- NH_4 (Merck, Aquamerck, 1.11117.0001)
- NO_3 (Merck, Merckoquant, 1.10020.)

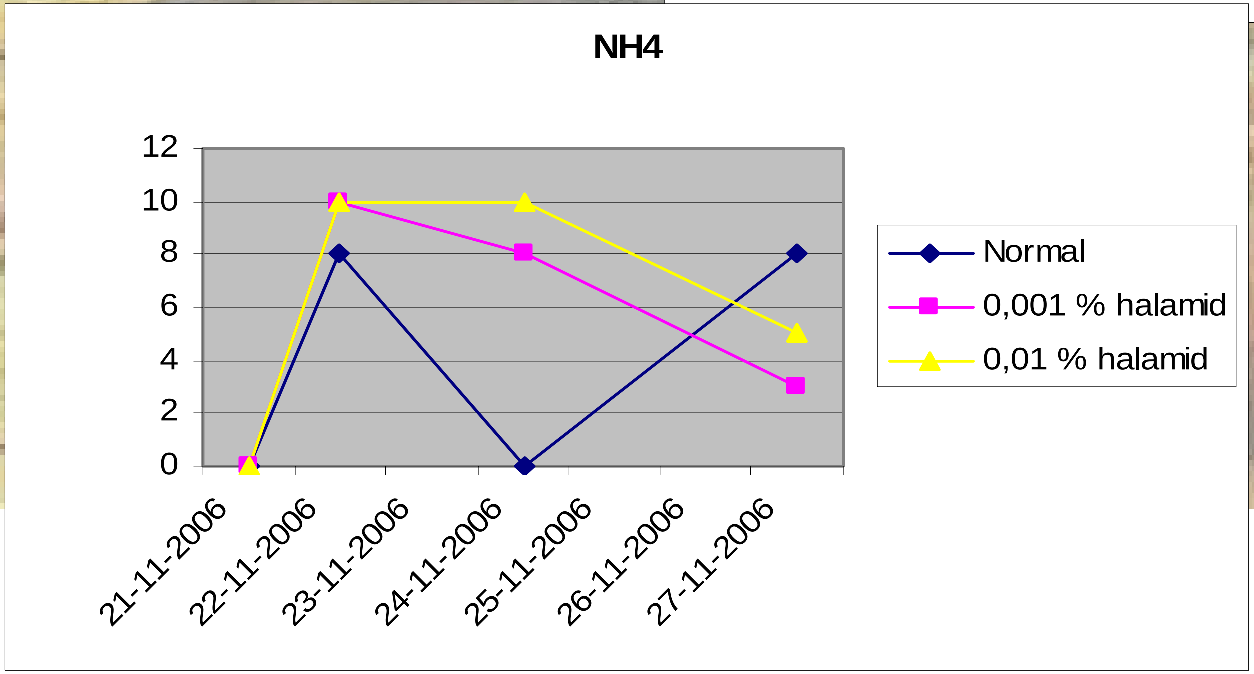
Water quality limits

Parameter	Practical values	Limit range
Temperature (°C)	**27.2**	**25-30**
pH	**7.5**	**6.5-8**
Conductivity (µS)	**3510**	**3000-4000**
O_2 (g/m^3)	**7.8**	**>3**
CO_2 (g/m^3)	**-**	**<25**
NH_3-N (g/m^3)	**-**	**<0.05**
NH_4-N (g/m^3)	**0**	**<8.8 at (pH 7)**
NO_2-N (g/m^3)	**1**	**<1-2 at (3000µS)**
NO_3-N (g/m^3)	**250**	**<150**
N_2 (%saturation)	**-**	**<105**
Suspended Solids (g/m^3)	**-**	**<25-50**

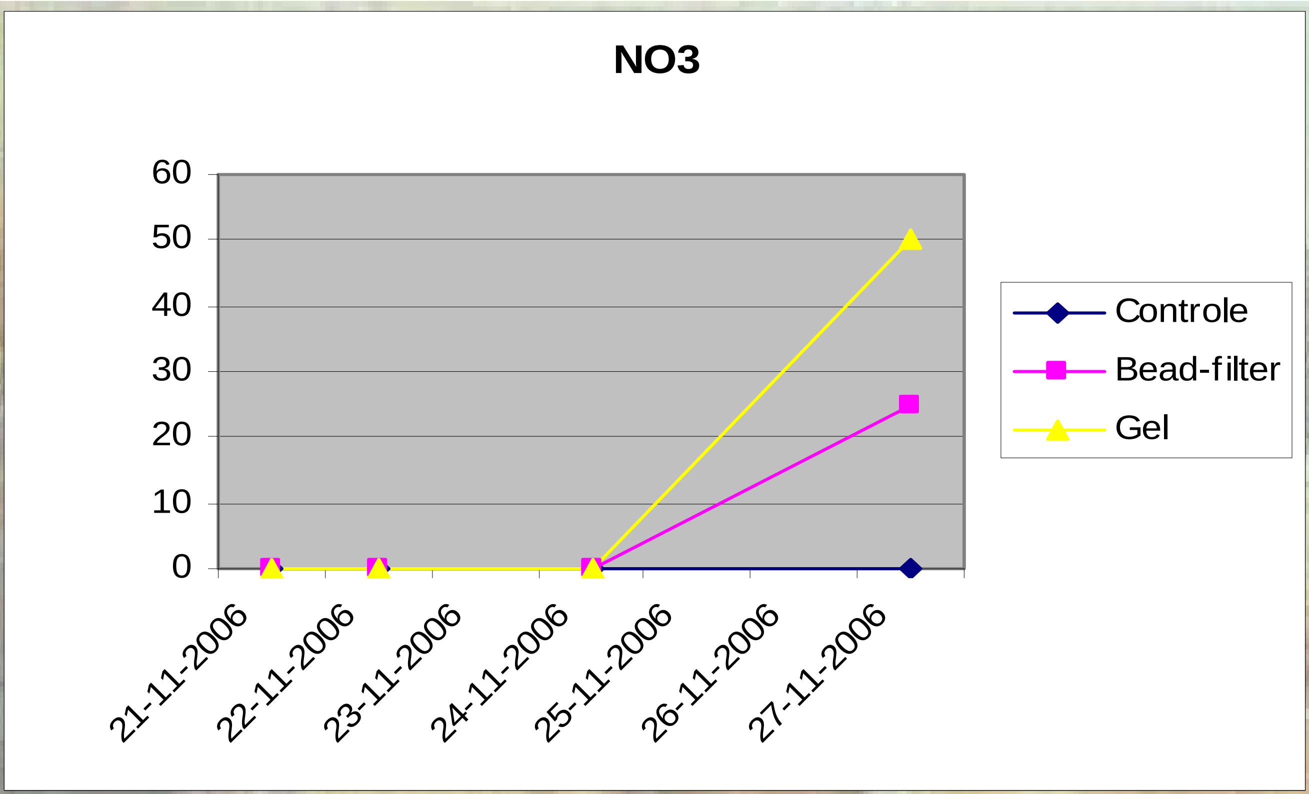
Starting up

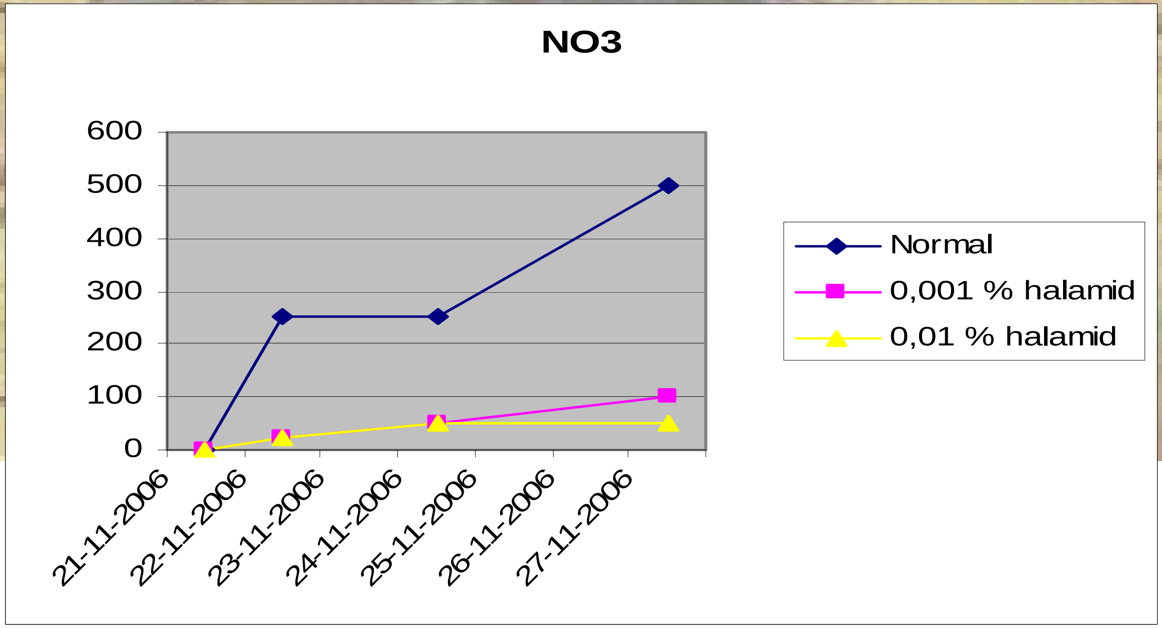
NH4


NH4
12
10
8
6
4
2
0
21-11-2006
22-11-2006
23-11-2006
24-11-2006
25-11-2006
26-11-2006
27-11-2006
Controle
Bead-filter
Gel

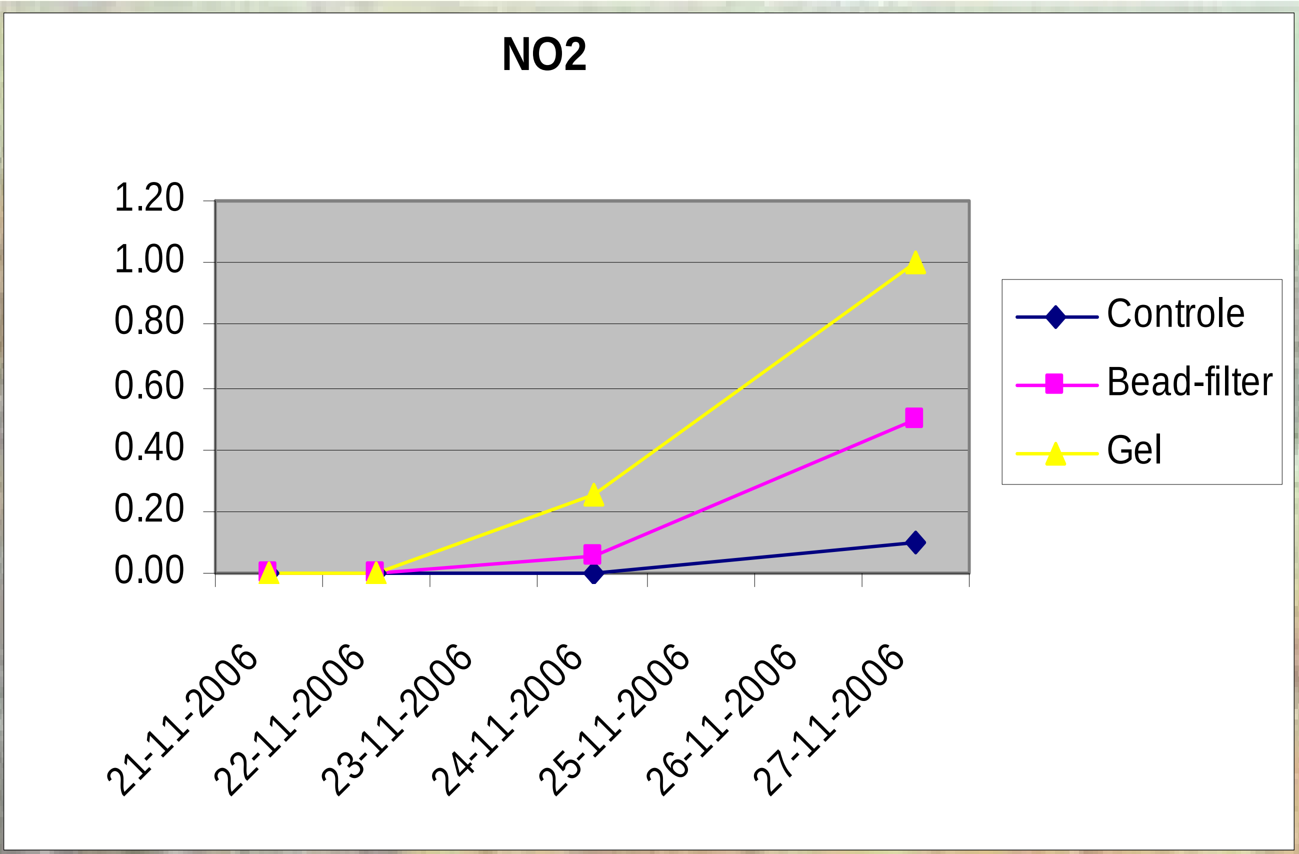

NH4
12
10
8
6
4
2
0
21-11-2006
22-11-2006
23-11-2006
24-11-2006
25-11-2006
26-11-2006
27-11-2006
Normal
0,001 % halamid
0,01 % halamid

NO3

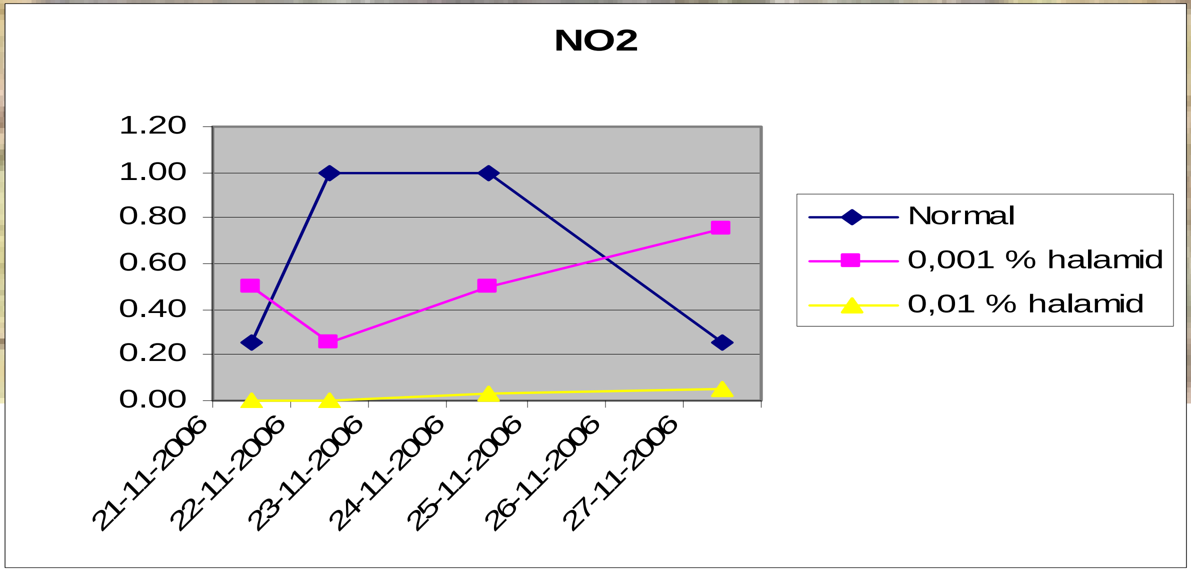

NO3
60
50
40
30
20
10
0
21-11-2006
22-11-2006
23-11-2006
24-11-2006
25-11-2006
26-11-2006
27-11-2006
Controle
Bead-filter
Gel


NO3
600
500
400
300
200
100
0
21-11-2006
22-11-2006
23-11-2006
24-11-2006
25-11-2006
26-11-2006
27-11-2006
Normal
0,001 % halamid
0,01 % halamid

NO_2



NO2
1.20
1.00
0.80
0.60
0.40
0.20
0.00
21-11-2006
22-11-2006
23-11-2006
24-11-2006
25-11-2006
26-11-2006
27-11-2006
Controle
Bead-filter
Gel

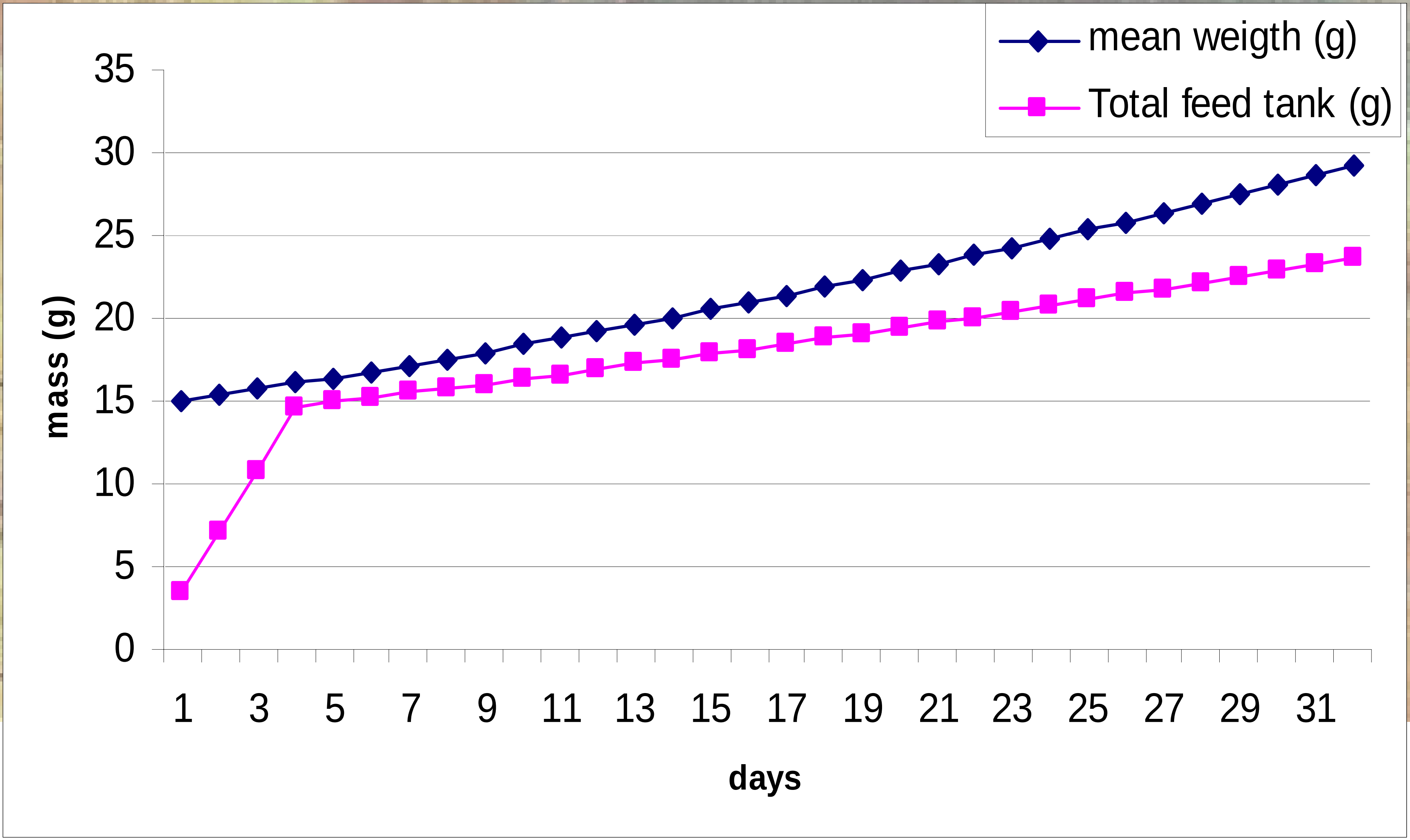


NO2
1.20
1.00
0.80
0.60
0.40
0.20
0.00
21-11-2006
22-11-2006
23-11-2006
24-11-2006
25-11-2006
26-11-2006
27-11-2006
Normal
0,001 % halamid
0,01 % halamid

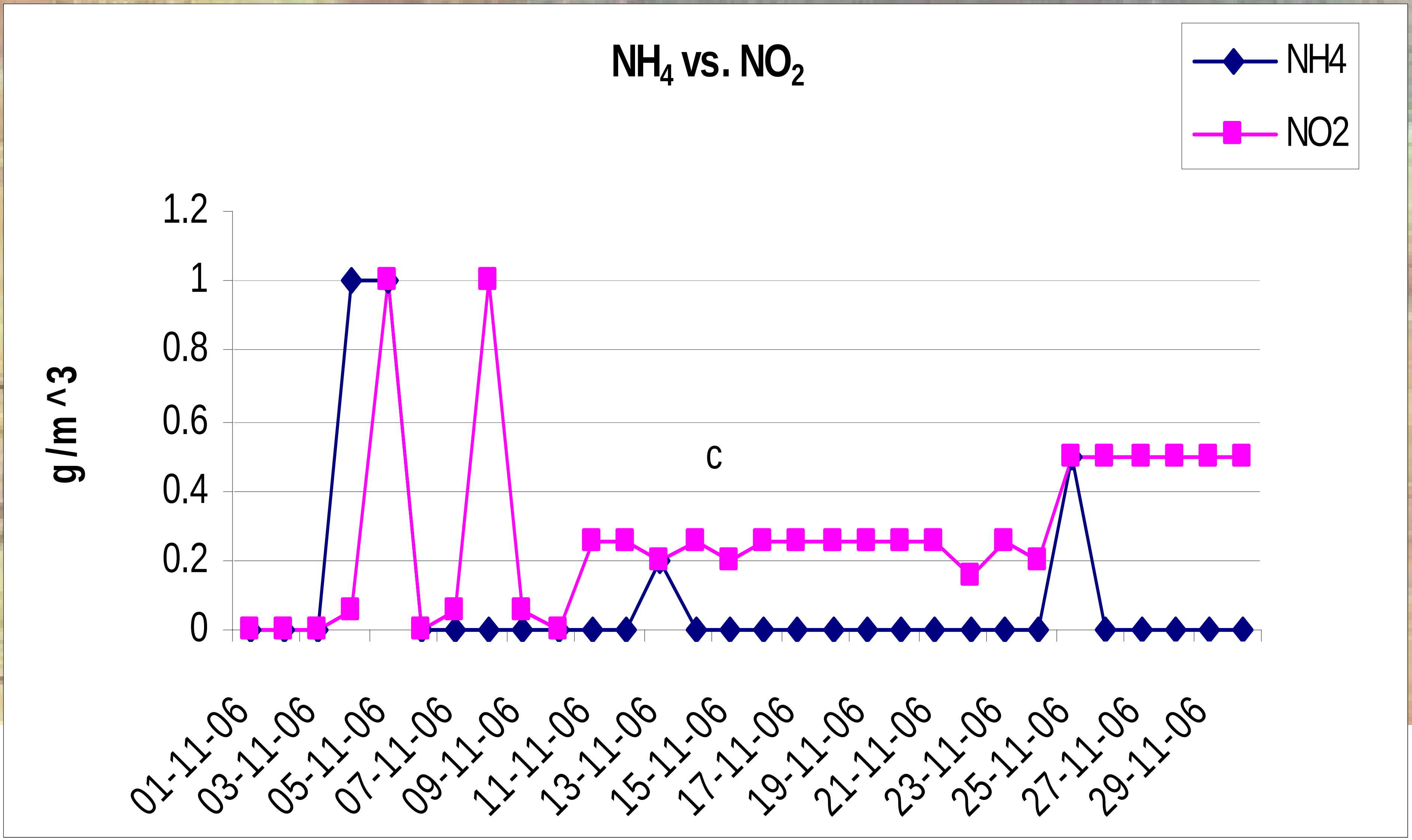
Results

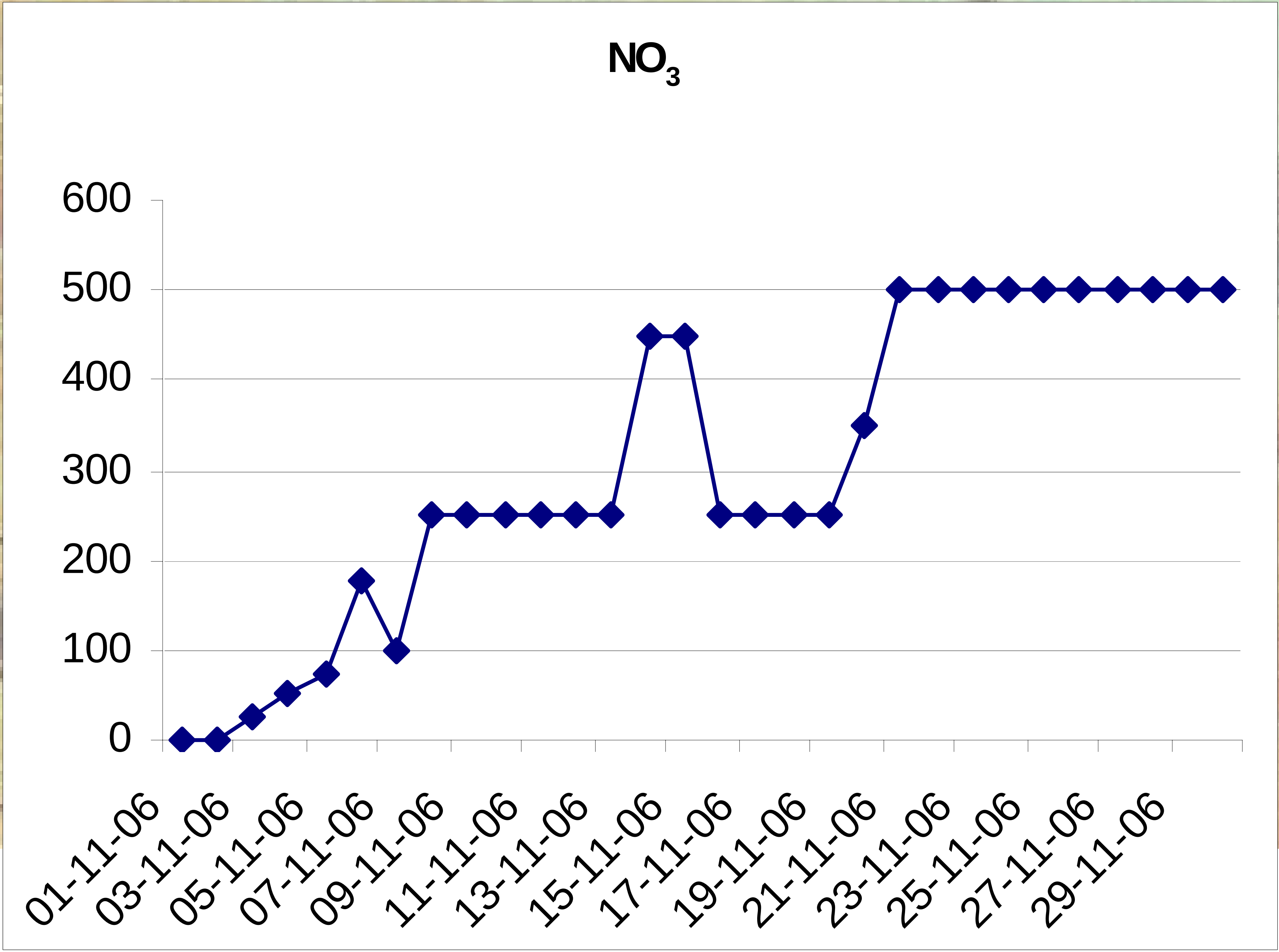
- Growth (weight/feed relationship)
- Changes in water quality
- Mortality
- Feeding level differences

Weight/Feed relationship

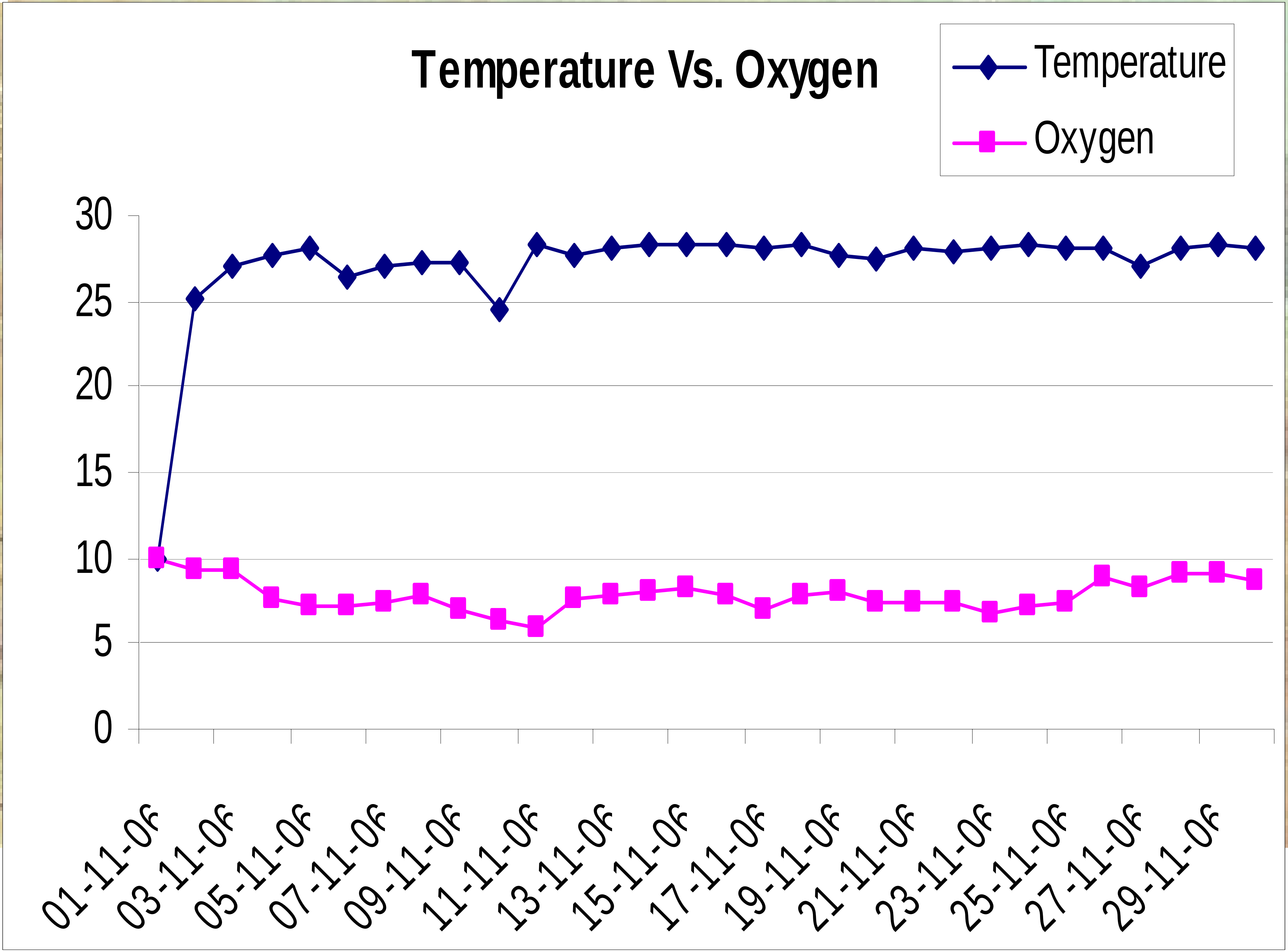


Water Quality

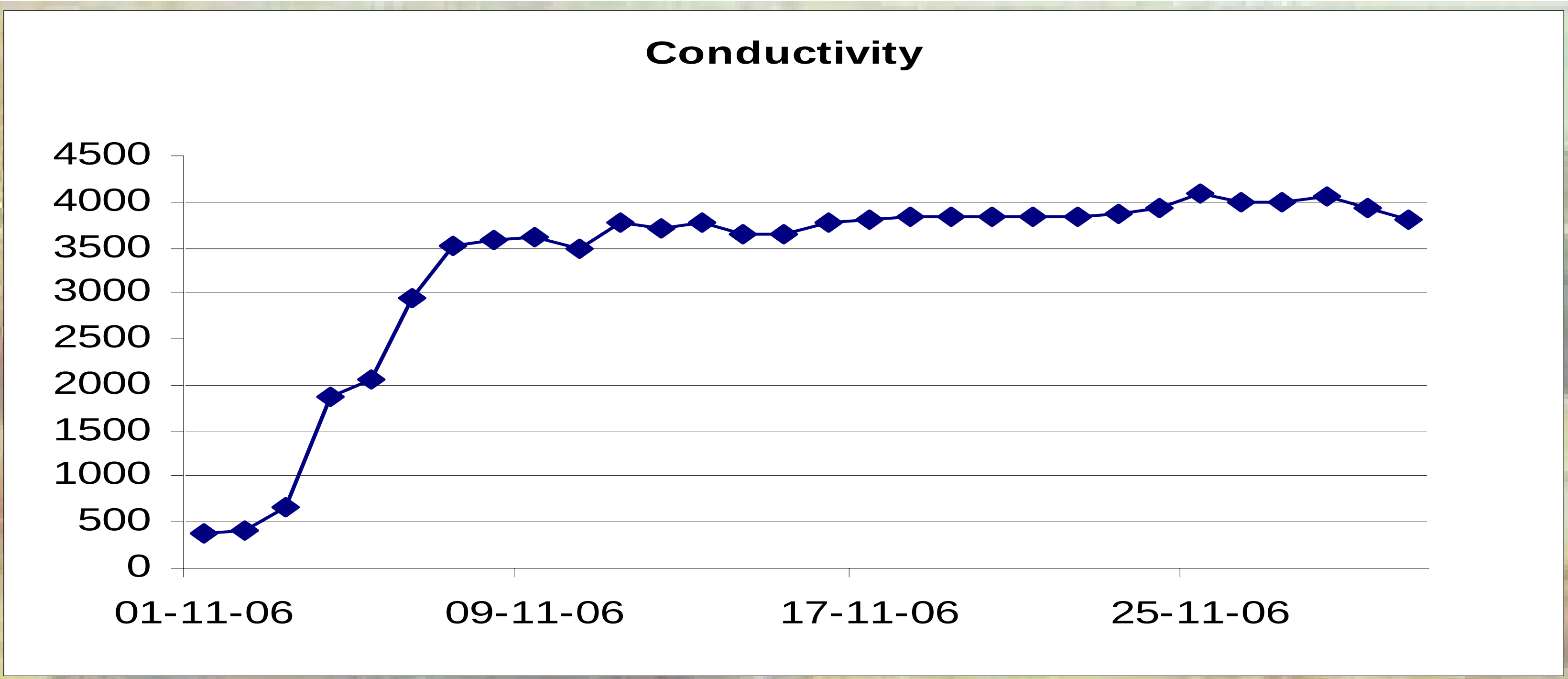




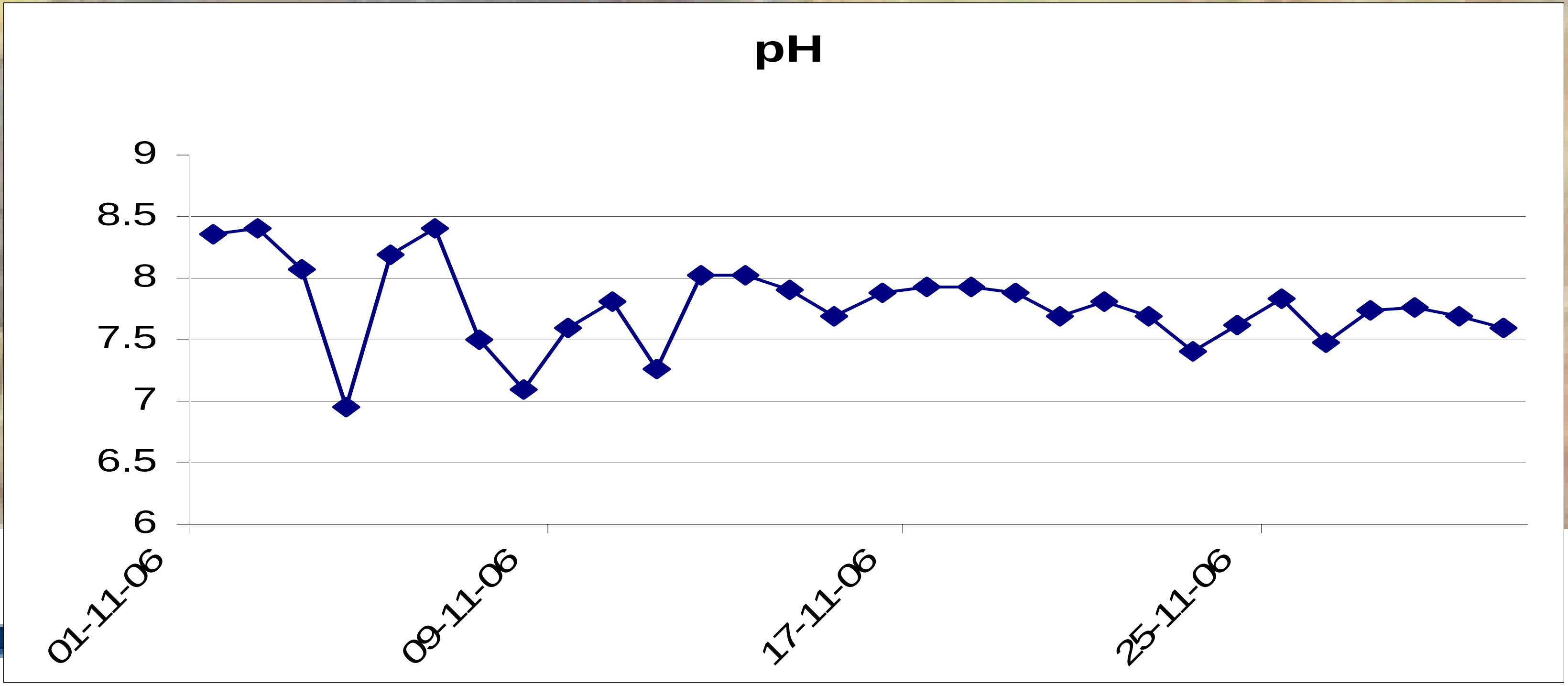
NO3
600
500
400
300
200
100
0
01-11-06
03-11-06
05-11-06
07-11-06
09-11-06
11-11-06
13-11-06
15-11-06
17-11-06
19-11-06
21-11-06
23-11-06
25-11-06
27-11-06
29-11-06



Temperature Vs. Oxygen
Temperature
Oxygen
30
25
20
15
10
5
0
01-11-06
03-11-06
05-11-06
07-11-06
09-11-06
11-11-06
13-11-06
15-11-06
17-11-06
19-11-06
21-11-06
23-11-06
25-11-06
27-11-06
29-11-06



Conductivity
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01-11-06
09-11-06
17-11-06
25-11-06



pH
9
8.5
8
7.5
7
6.5
6
01-11-06
09-11-06
17-11-06
25-11-06

Feed conversion vs. feeding ratio

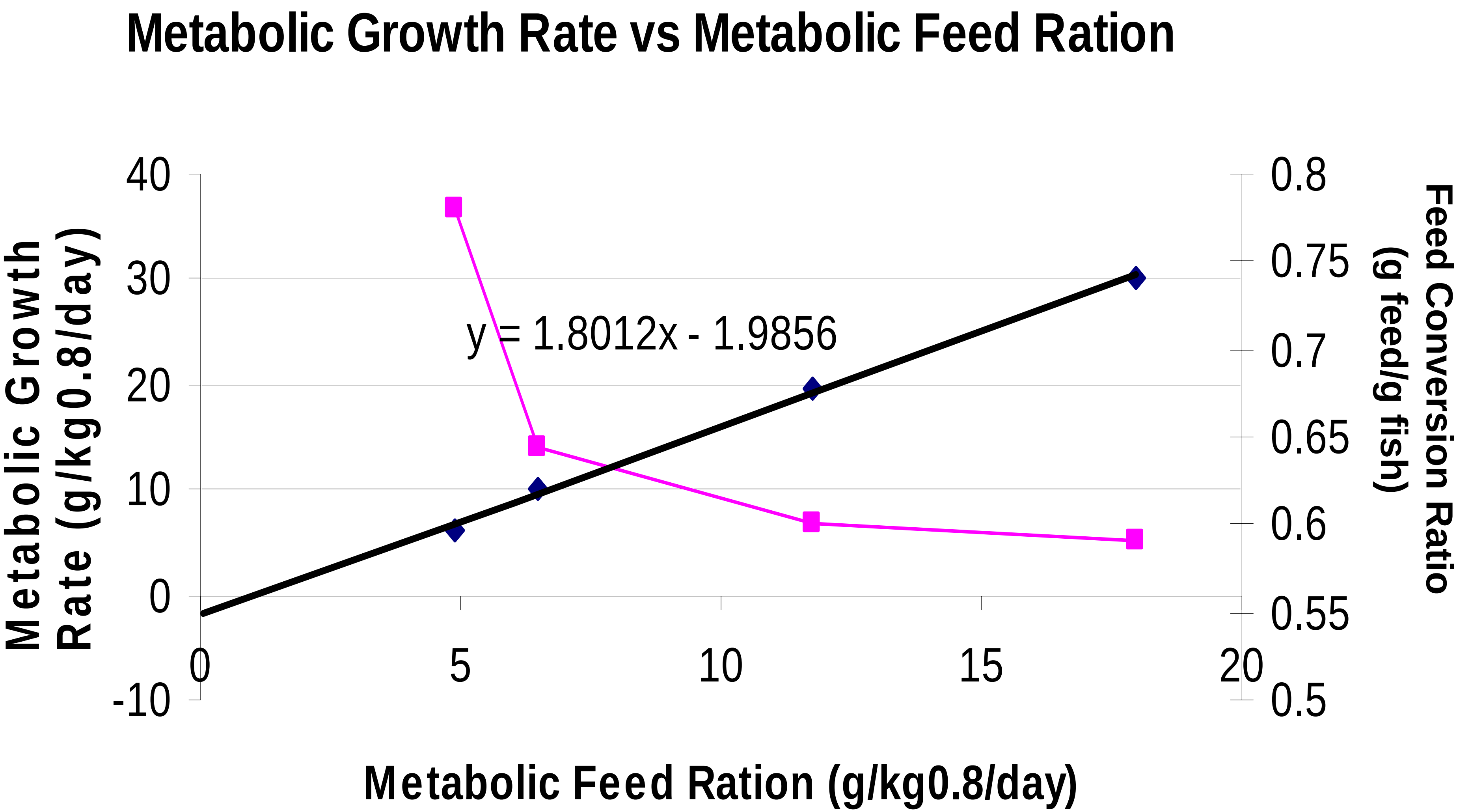
Overall measurements:

- Growth 14.18 g/kg catfish
- Growth rate 0.47
- Feed ratio 0.46
- Feed conversion 99.3 %

Feeding level differences

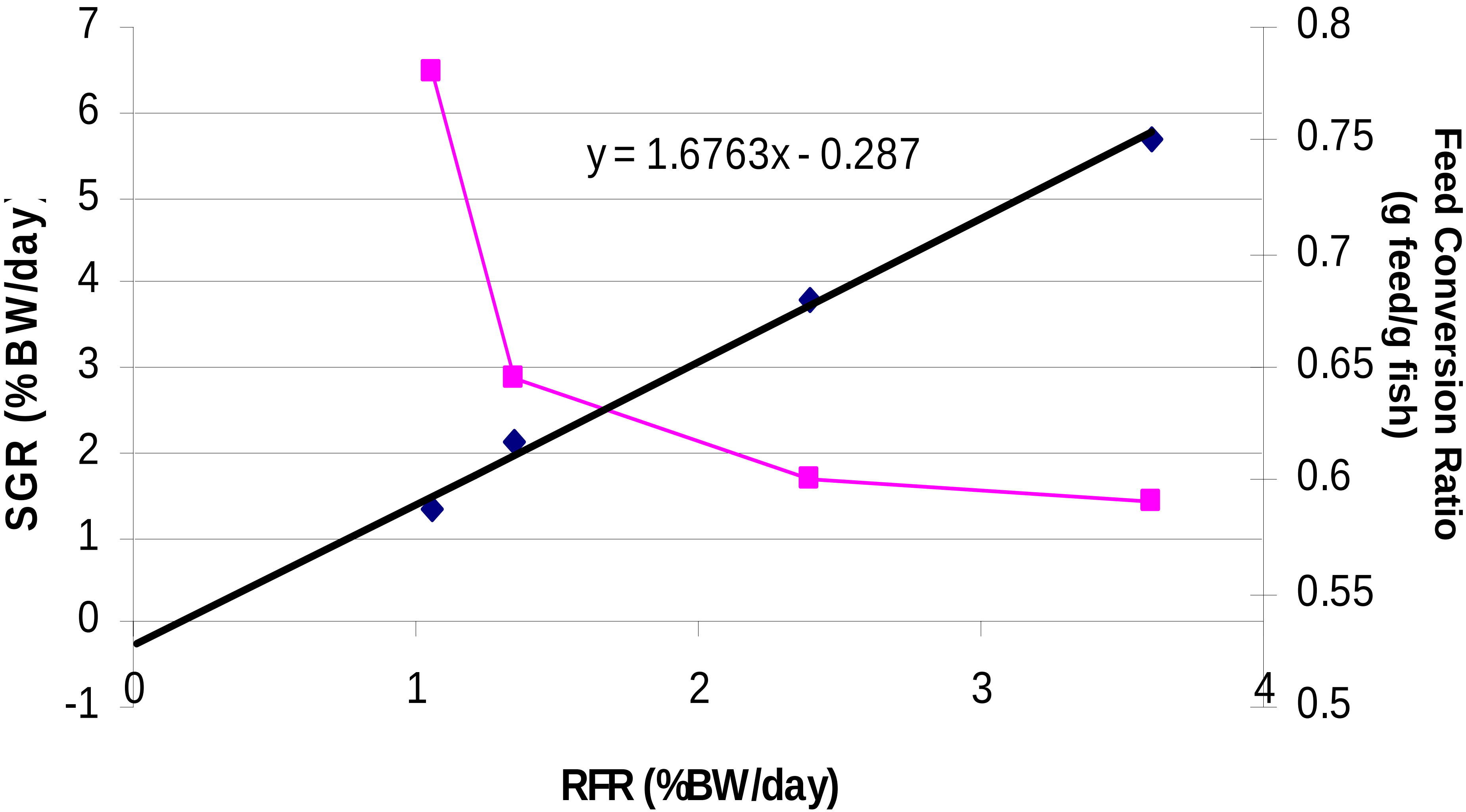
Feeding level (gkg0.8 /day)	Wo (g)	Wt (g)	VC (%)	Total FI (g)	No (N)	Nt (N)	Wg (g)	RGRm (g/kg0.8 /day)	Rm (g/kg0.8/ day)	FCR (gfeed/gfish)	SGR (%BW /day)	RFR (%BW /day)	PER (g/g)	NPUa (%)
6	**17.5**	**24.3**	**21**	**193.3**	**40**	**37**	**20.6**	**6.26**	**4.87**	**0.78**	**1.35**	**1.06**	**2.73**	**39.4**
10	**18.8**	**35**	**30.81**	**415.88**	**41**	**40**	**25.7**	**10.07**	**6.49**	**0.645**	**2.1**	**1.35**	**3.3**	**48.2**
15	**19.5**	**48.6**	**34.25**	**679.95**	**40**	**39**	**30.87**	**19.63**	**11.76**	**0.6**	**3.8**	**2.4**	**3.55**	**52.44**
20	**17.125**	**62.95**	**27.86**	**1074.5**	**40**	**40**	**32.83**	**30.09**	**17.96**	**0.59**	**5.7**	**3.6**	**3.63**	**53.94**

Feeding level relationships

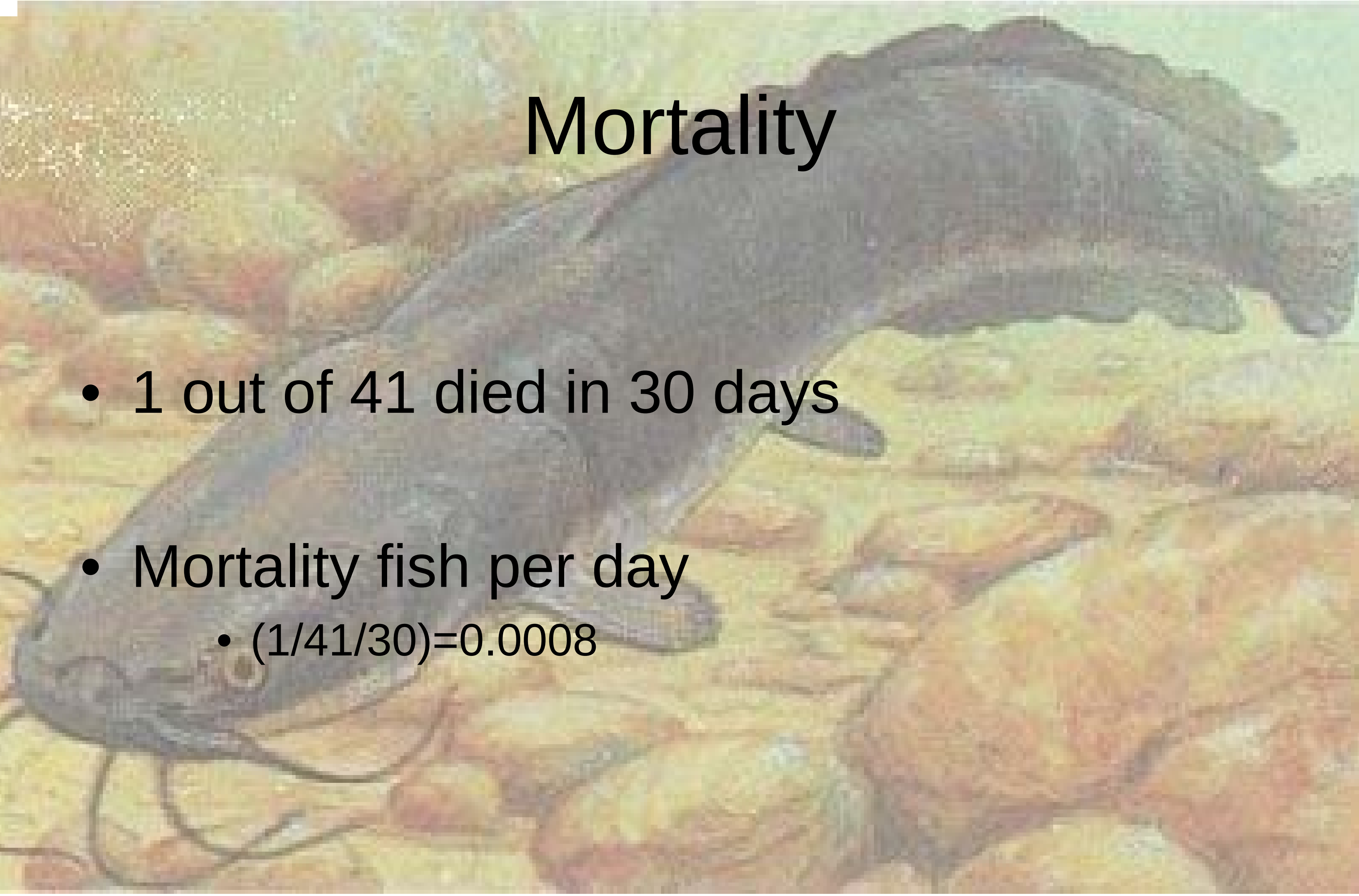


- $G_{starvation}$: -1.98 $g/kg^{0.8}/d$
- G_{opt}:~ 30 $g/kg^{0.8}/d$
- G_{max}: cannot be determined
- R_{maint}: 1.1 $g/kg^{0.8}/d$
- R_{opt}: ~ 0.6 g feed/g catfish
- R_{max}: cannot be determined

Specific Growth Rate vs Relative Feeding Rate



- $SGR_{starvation}$: -0.28 %BW/d
- RFR_{maint}: 0.17 %BW/d
- RFR_{opt}: ~ 3.6 %BW/d
- RFR_{max}: cannot be determined
- SGR_{opt}: ~ 5.7 %BW/d
- SGR_{max}: cannot be determined



Mortality

- 1 out of 41 died in 30 days
- Mortality fish per day
    - (1/41/30)=0.0008

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Discussion

- Territorial habits are suppressed by a high stocking density/lack of space.
- Territorial/aggressive behavior will result in more skin lesions.
- At low feed ratio and low stocking density catfish can show cannibalistic behavior.
- High stocking can result in more “active resting”, because of less competition.

Conclusions

- High stocking density is required
- At start up of system nitrification and denitrification have to work properly
- During the experiment the maximum feeding level was not determined
- The optimal feeding ratio and growth rate were assumed to be the highest feeding level (20 $g/kg^{0.8}/d$)

- Higher feeding levels result in higher growth rate until max is reached
- When reaching optimum feeding rate the growth rate will remain constant
- The water quality has to be maintained in compliance with the given limit range
- In future repetition experiments a higher feeding level should be tried

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QUESTIONS???