



Royal Netherlands Institute for Sea Research

# Re-growth of algae and bacteria after treatment with UV- or active substance-based ballast water treatment systems

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NORTH SEA BALLAST WATER

The Interreg IVB  
North Sea Region  
Programme





# Ballast water treatment systems

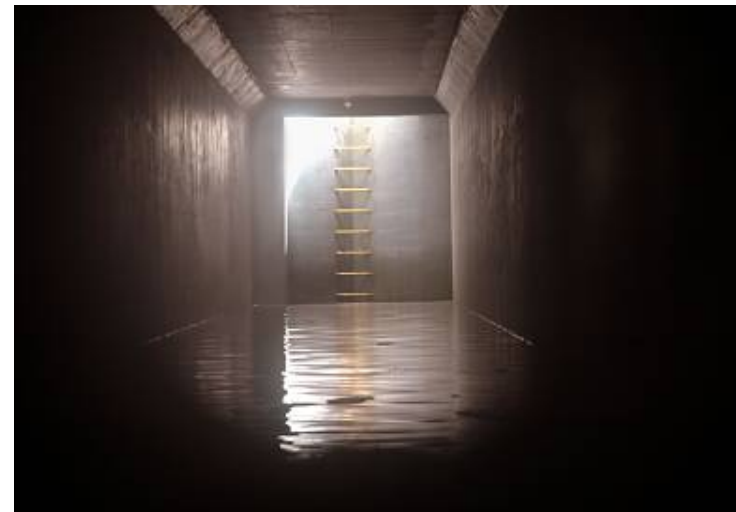
- Development of technologies to make ballast water meet the IMO D2-Standard (phytoplankton < 10 cells/mL)
- Different BW techniques. Mechanical + disinfection (UV light, active substances, cavitation, heat, etc.)
- IMO regulations on testing of these systems





## Ballast water testing at the NIOZ

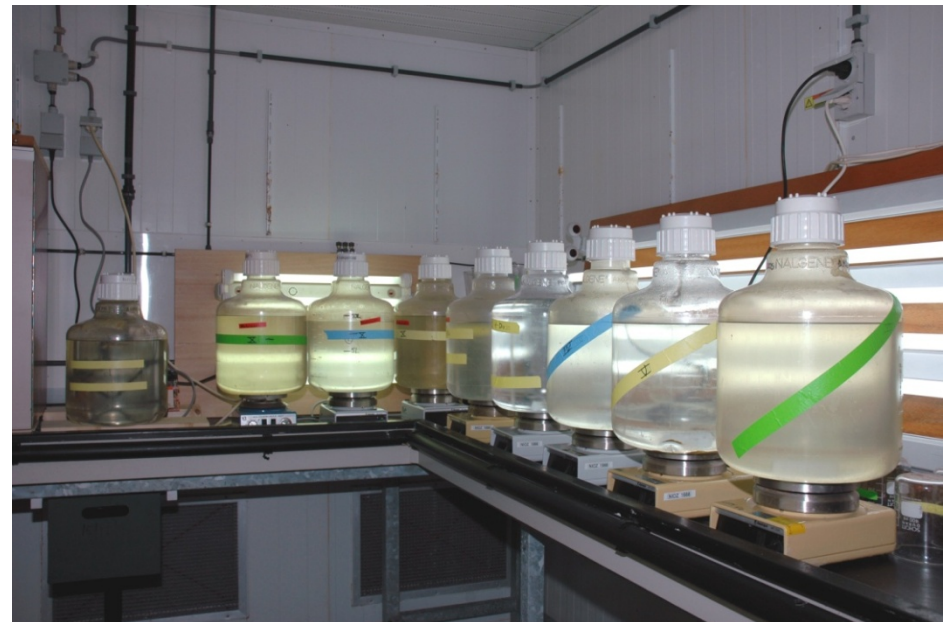
- Facilities and scientific expertise at the NIOZ to perform tests according to IMO regulations
- Part of the experiments: survival of plankton in the ballast tank
- Phytoplankton survival will be reduced in dark tanks but: Cysts/resting stages





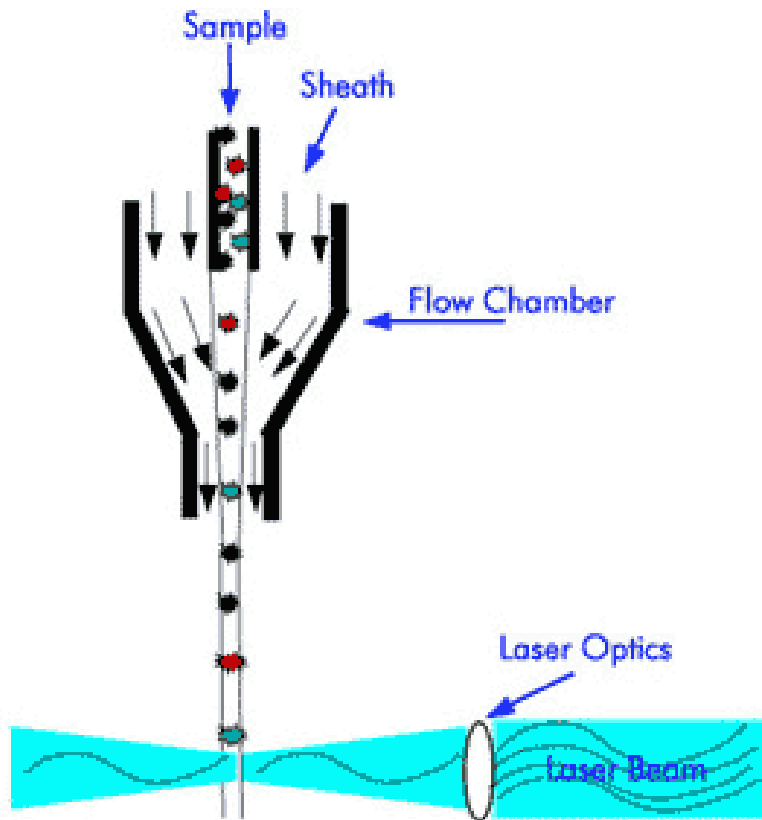
# Incubation experiments

- 10 L samples taken at ballasting (T0) and de-ballasting (T5),
- Samples put in 15 °C climate room, 16/8 light-dark regime, nutrients added
- experiments monitored for up to 25 days





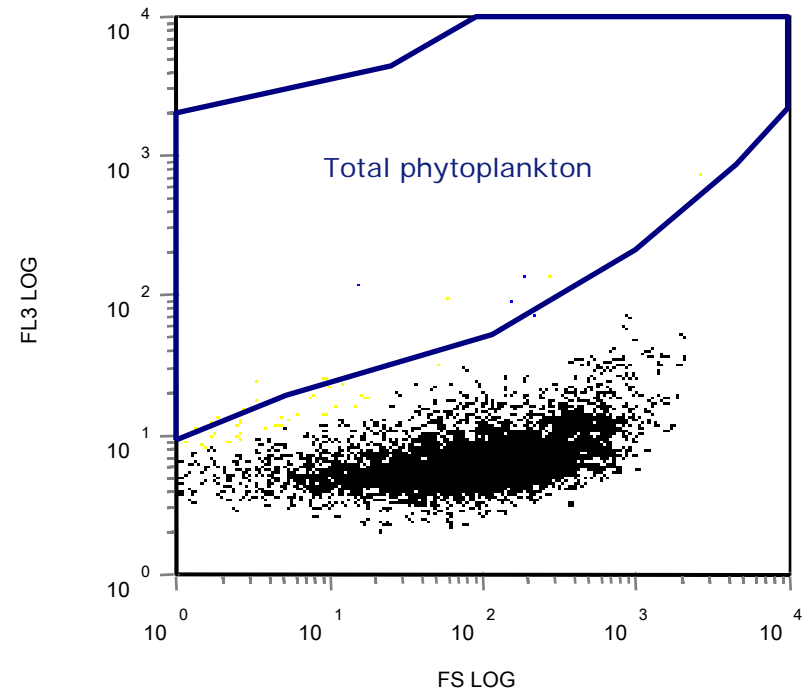
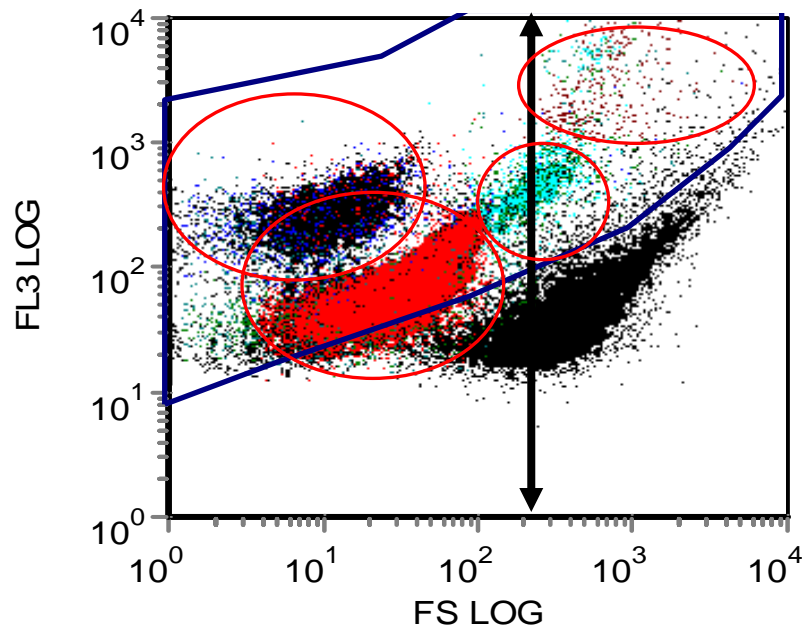
# Flow Cytometry





# Flow Cytometry

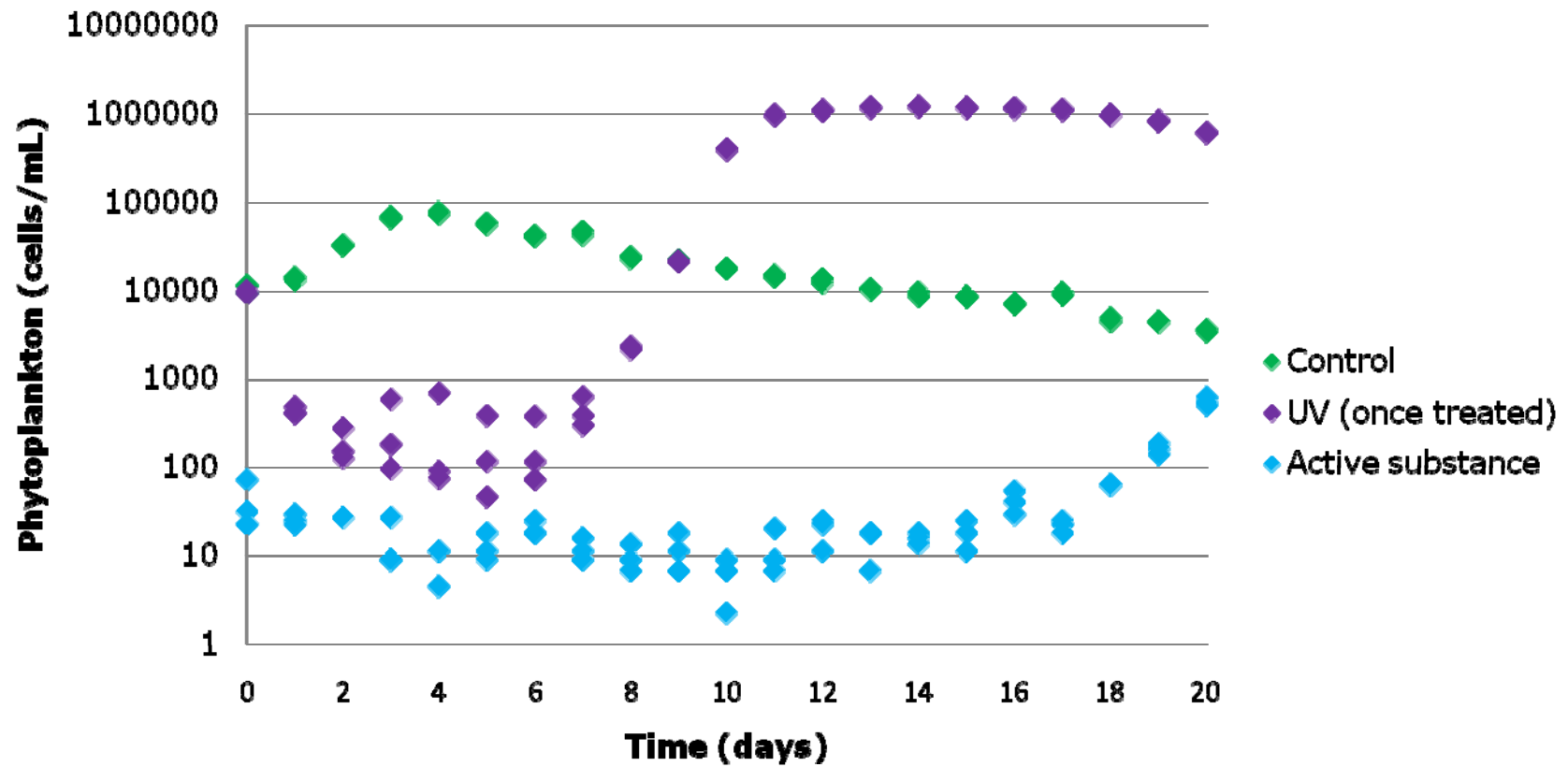
field phytoplankton





# Phytoplankton Re-growth

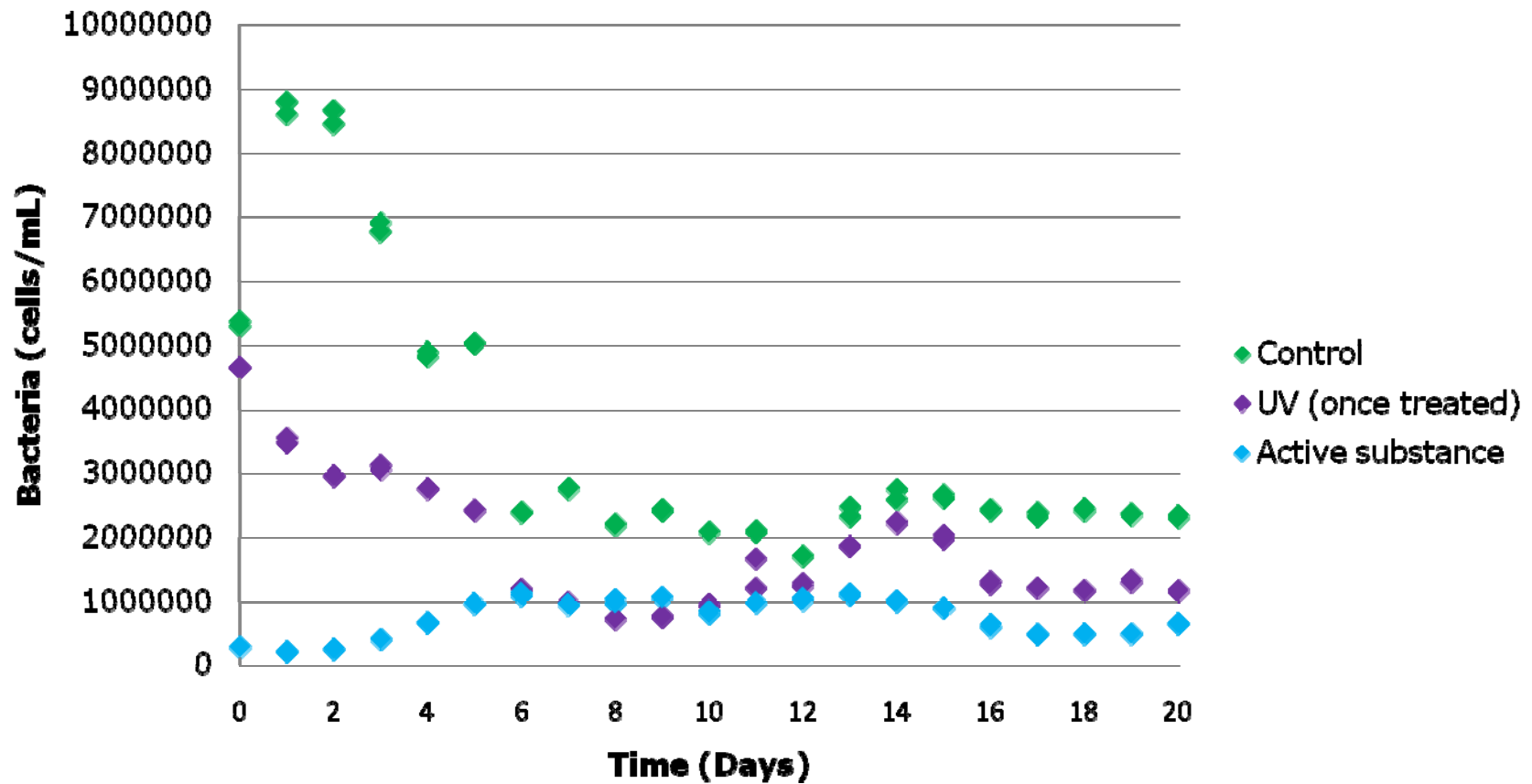
## Comparison of treatment types





# Bacteria Re-growth

## Comparison of treatment types







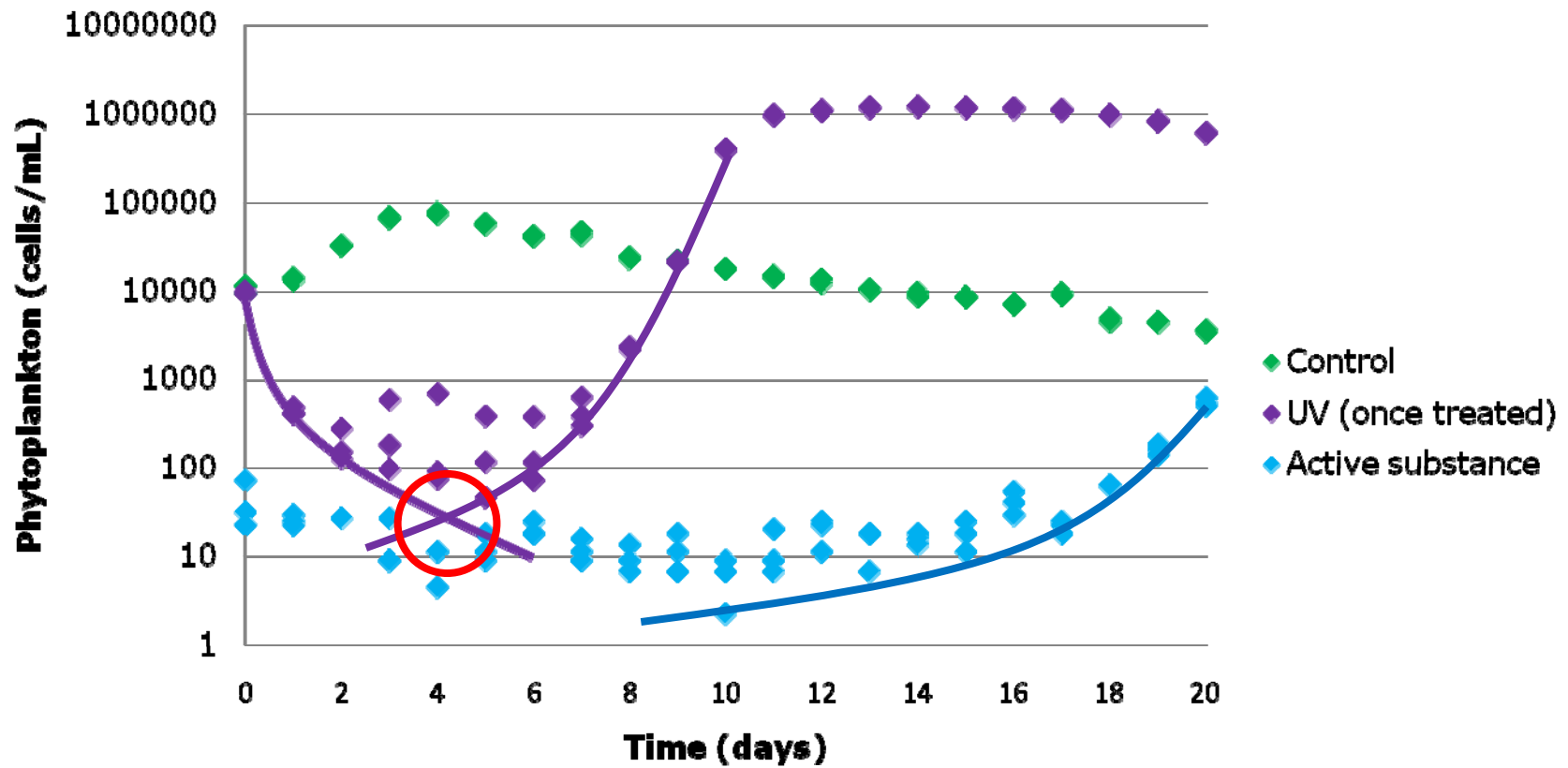
## Estimated Minimum Number

- Survival model and Growth model
- $y = a * e^{(bx)}$
- Calculate number of organisms below detection limits of equipment



# Estimated Minimum Number

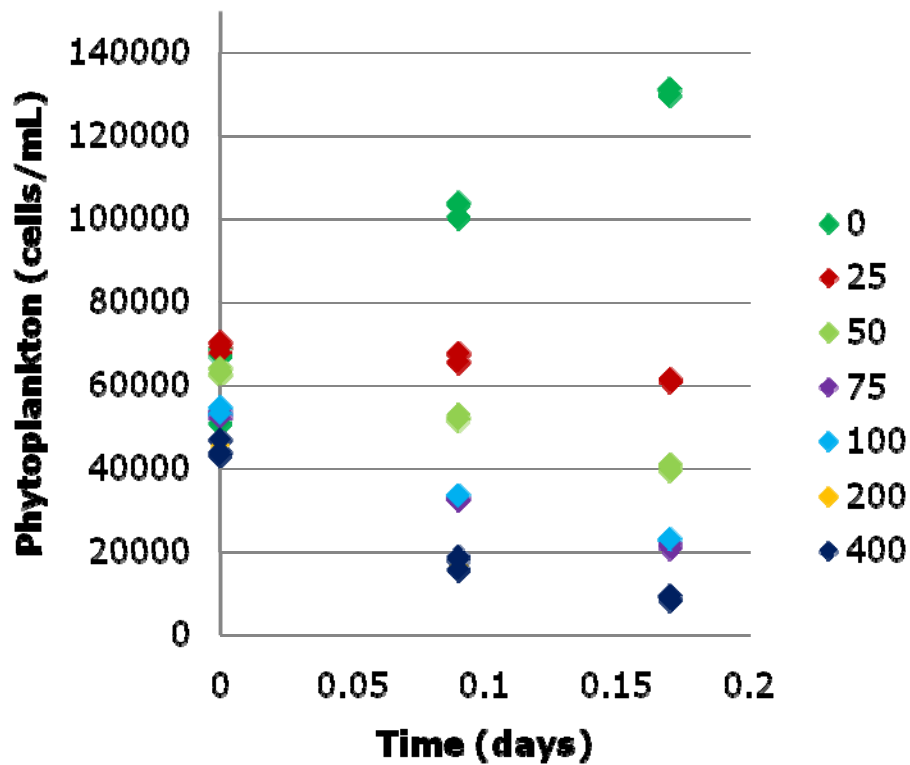
## Comparison of treatment types



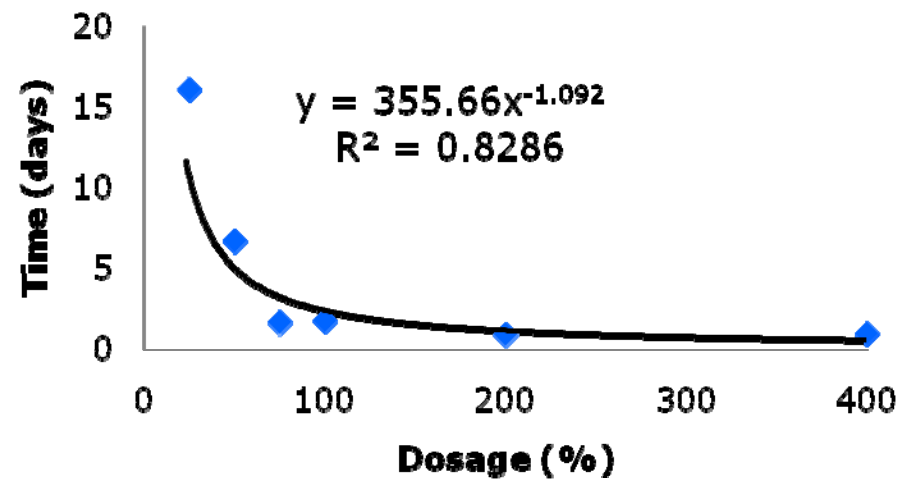


# Estimated Minimum Number

## UV dosage experiment



## Power



Dosage	Days until 10 per mL
0	-0,97
25	16,08
50	6,666
75	1,599
100	1,694
200	0,851
400	0,8864



## Conclusions

- Re-growth does occur after treatment with ballast water treatment systems, both for UV and active substance.
- Estimated minimum number especially important at extreme low numbers (below ordinary detection limits)
- Good relation between UV-dose and time needed to reach the 10 organism limit