



Royal Netherlands Institute for Sea Research

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**The Interreg IVB
North Sea Region
Programme**



*Investing in the future by working together
for a sustainable and competitive region*

Degradation of PERACLEAN® Ocean in Ballast Water

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Introduction: SEDNA® BWT System

- Type Approved (2008)
- Hydrocyclones
- 50 μm filter
- Active Substance:
PERACLEAN® Ocean
172.5 mg/L





Introduction: Composition of PERACLEAN® Ocean

1. Peracetate (14%-17%)



Acetate

- Main disinfectant

2. Hydrogen peroxide (13%-15%)



Oxygen + Water

- Bacteriostatic

3. Acetate (24%-29%)

- End product: Acetate, Oxygen, Water
- Acetate is biodegradable...



Degradation and Residual Effects of PERACLEAN® Ocean in Ballast Water

Not: Is PERACLEAN® Ocean effective as
Ballast water treatment?



Material & Methods: Lab-Scale Experiment

- Incubation of seawater with **PERACLEAN® Ocean**
- 50 µm filtered
- Incubation in the dark

- At five different temperatures:

<-1 °C
°C

4 °C

10 °C

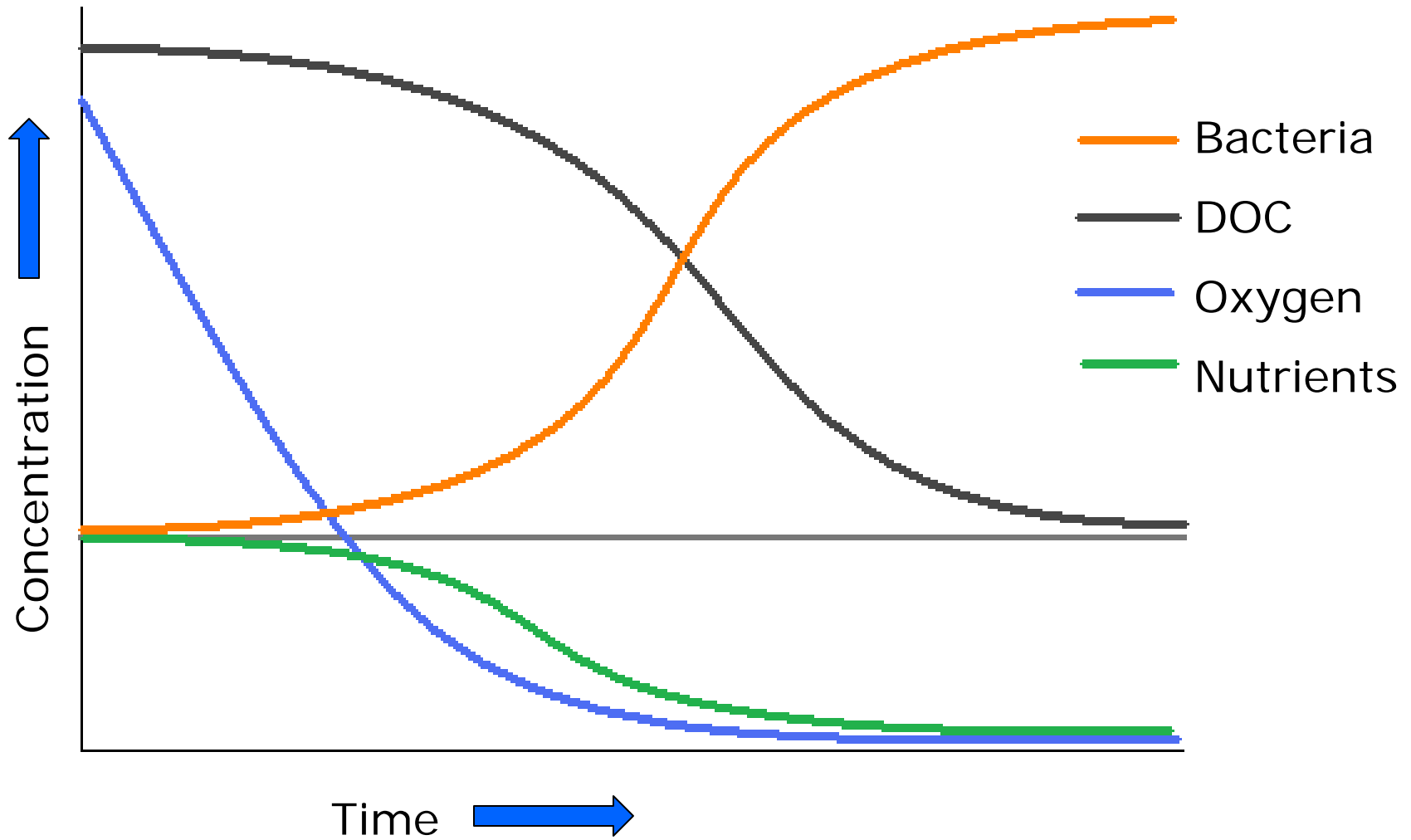
15 °C

25

- 69-88 days



Expected water properties over time





Results: DOC and Nutrients at T₀

INCREASE DUE TO 172.5 mg/L PERACLEAN

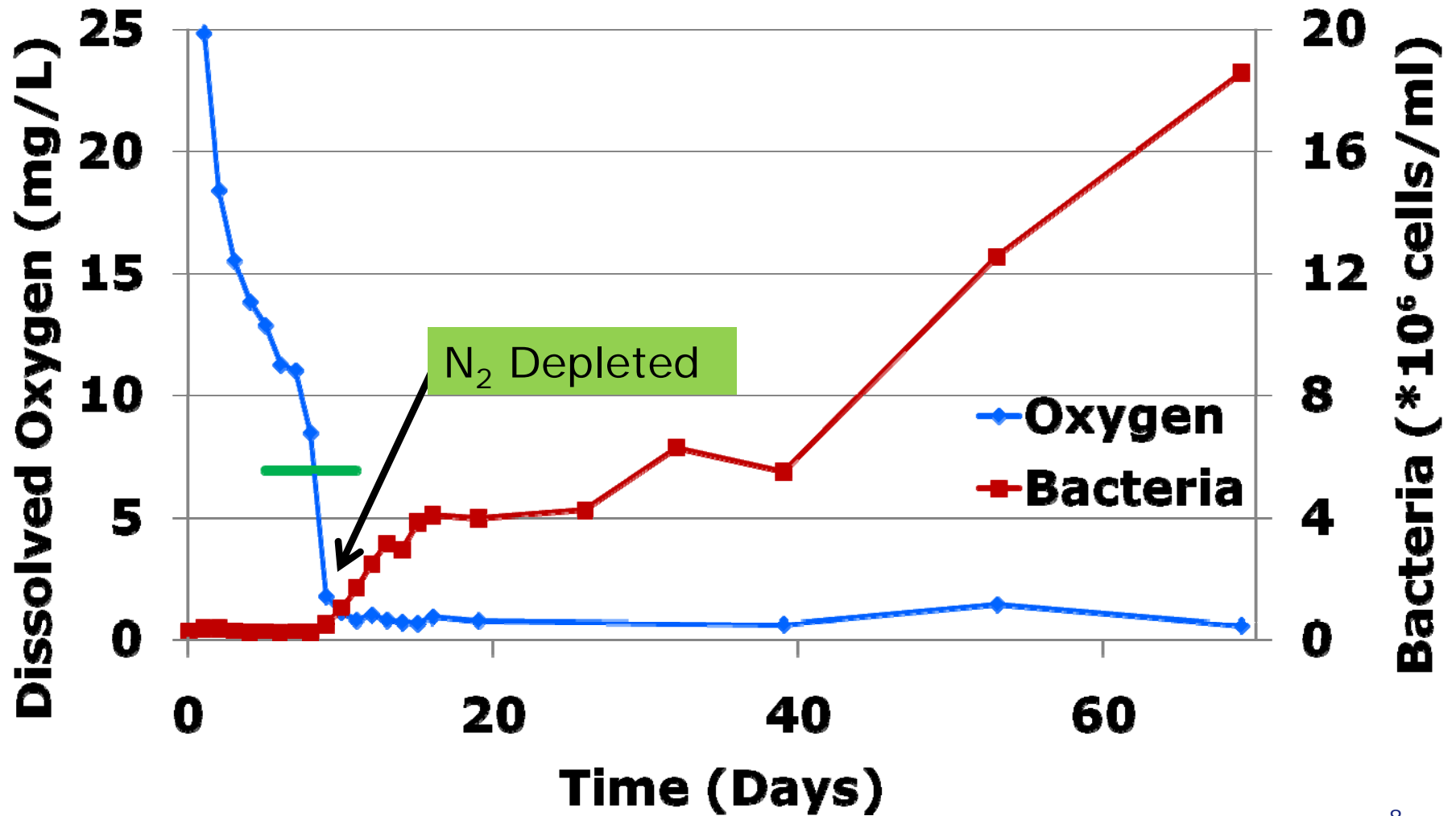
μM	C	P	Increase
DOC	112	2116	2004
NITROGEN	38.5	43.3	5
PHOSPHATE	1.11	7.35	6

Phosphate enrichment due to stabilizing agent
(de Lafontaine, 2008)



Results: D.O. vs Bacteria over time

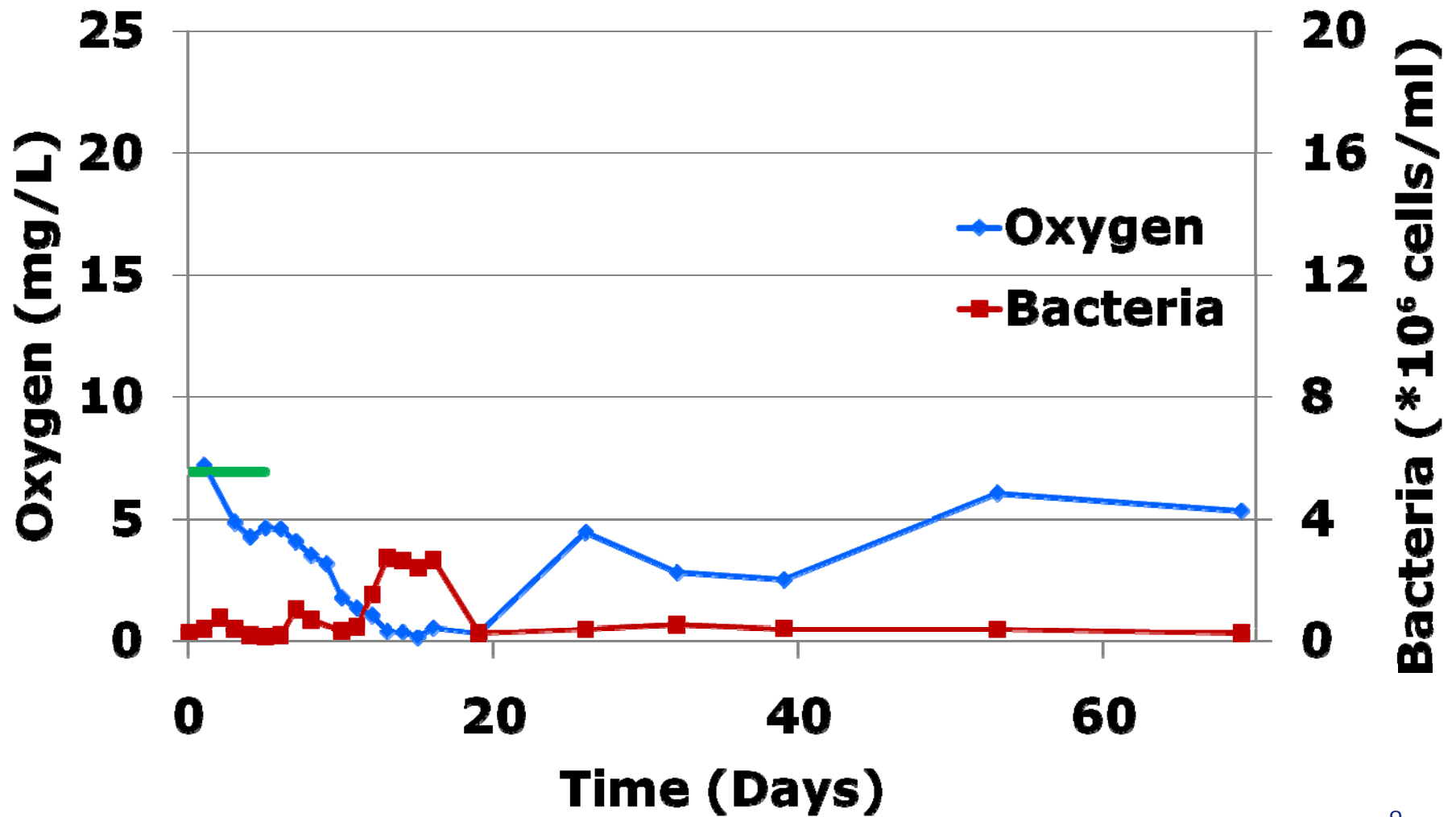
PERACLEAN 25 °C





Results: D.O. vs Bacteria over time

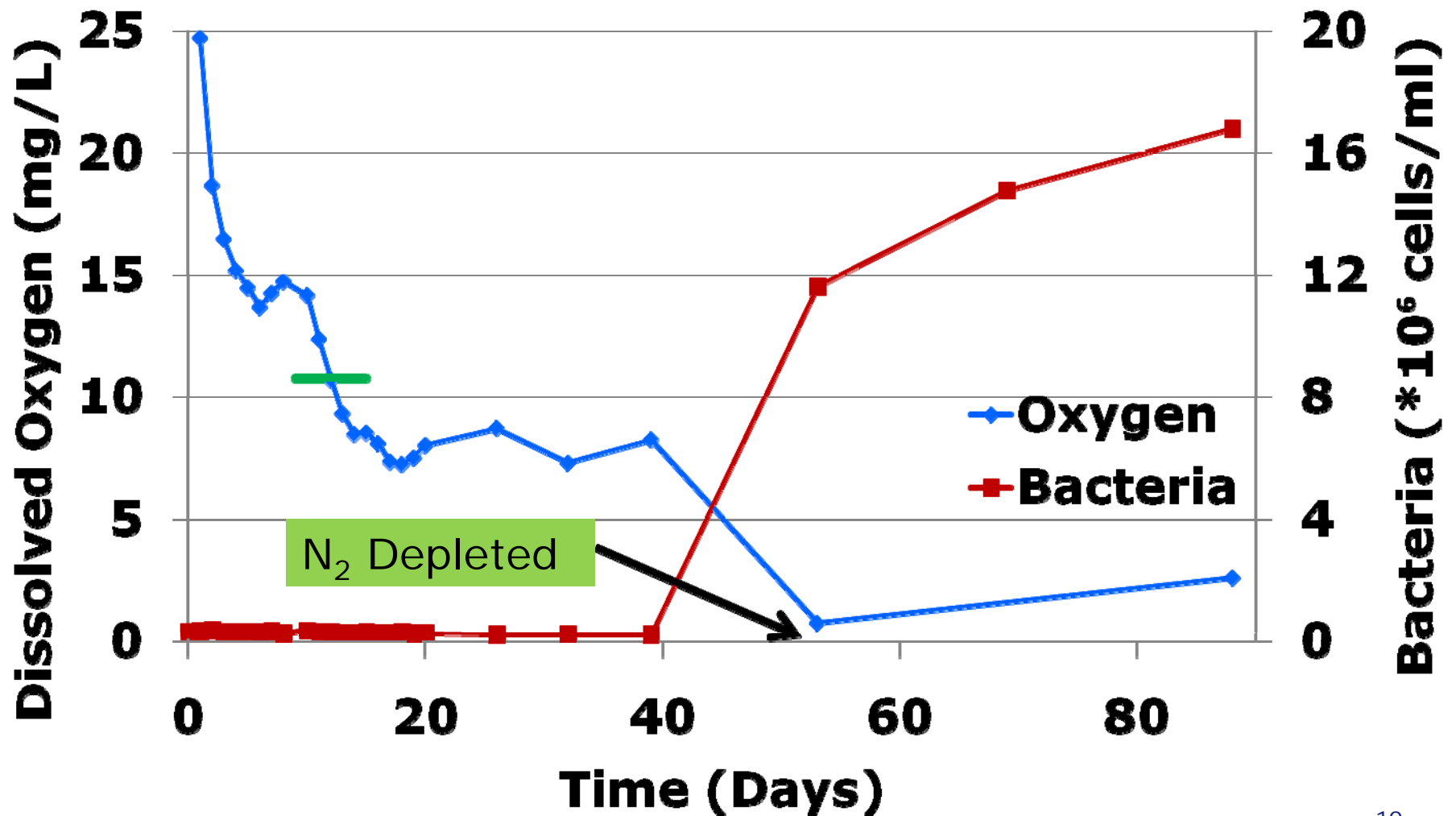
CONTROL 25 °C





Results: D.O. vs Bacteria over time

PERACLEAN 4°C





Results: Overview

PERACLEAN TEST

Temp.	lag-phase	anoxic after	N ₂ depletion	max. bact. dens.
	days			*10 ⁶ cells/ml
<-1	nd	nd	nd	0.3
4	39-53	39-53	39-53	16.8
10	13	13	13	18.1
15	12	13	12	15.0
25	10	10	10	18.6



Results: Acetate Degradation over time?

ACETATE EXPERIMENT

Temp.	Period	Δ DOC		Respired
	<u>days</u>	<u>μM</u>	<u>%</u>	<u>%</u>
<-1	26	176	9	98
4	8	496	25	98
10	6	919	46	99
15	6	1147	50	99
25	3	1633	76	99



Conclusions: Acetate Experiment

- **Bacteria** responsible for degradation
- Acetate degradation observed in **all** temperatures
- Temperature greatly affects acetate **degradation rate**



Conclusions: PERACLEAN Experiment

- Temperature greatly affects bacterial **lag-phase**
 - Peroxide

- In $< -1^{\circ}\text{C}$ seawater: PERACLEAN® Ocean **prevents** bacterial regrowth for > 88 days
 - Peroxide

- Possible discharge of acetate/phosphate-enriched ballast water in **cold** regions.
 - Dilution

- Anoxic water
 - Discharge into **open air**



Acknowledgements

- Peter Paul Stehouwer
- Isabel van der Star
- Viola Lieblich
- Frank Fuhr
- Josje Snoek
- Eveline Garritsen
- Patrick Laan



Ref: De Lafontaine et. al. (2008): Effectiveness and potential toxicological impact of the PERACLEAN® Ocean ballast water treatment technology. *Ecotoxicology and Environmental Safety*. Volume 71, Issue 2, October 2008, Pages 355-369