Royal Netherlands Institute for Sea Research

Testing Ballast Water Technologies

a challenge for marine research in the Netherlands

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outline

- Introduction of *Royal*-NIOZ and history BWT activities
- Why is NIOZ so unique for land-based testing
- Collaborating partners
- Mission of academic research institute in BWT testing
- Standard-D2, CA and the NIOZ approach
- Results (Hamann AG, Ecochlor & Hyde-Marine/LAMOR)
- Future plans

- Representing view of NIOZ and not necessary of NA's

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Zoological Station

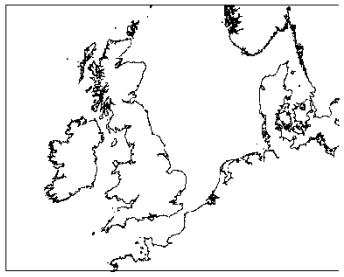
Texel - NIOZ

Den Helder - Zoological Station/NIOZ

2007

Why is NIOZ so unique for land-based testing

- testing since 2004; 2007 & 2008 Final/Type Approval tests
- 3 test series for Certification by NA, 16 companies pilot studies
- Tidal system with coastal water varying in salinity (24 – 30 PSU) and turbidity (10 - > 100 mg/l)
- Organisms diversity > 50 different species belonging to numerous genera



Why is NIOZ so unique for land-based testing

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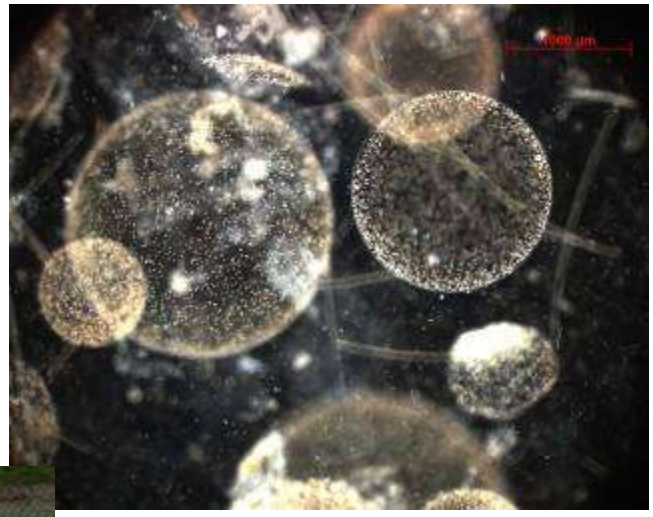
Why is NIOZ so unique for land-based testing

The ultimate challenge: treating huge blooms of slimy phytoplankton



Partners

- Bundesamt für Seeshifffart und Hydr. German administration
- Marine Coastguard Agency (MCA)
- Dutch Min. Verkeer & Waterstaat (NL),
- Lloyds Register (London, Rotterdam),
- TNO-Imares, AquaSense (toxicology studies),
- VITENS (human pathogens)
- CaTO Marine Ecosystems Research and Manage
- KiTe ARC, GoConsult
- US-Coastguard
- NL-Royal marines
- GSI
- IMO/GESAMP

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Mission academic research institute in BWT testing

- Public organization bound to publish all research in international peer reviewed journals
- Developing generic and specific tools and technologies
- Viruses, bacteria, phytoplankton and zooplankton (life stages)
- Holistic approach multiple tools to asses numbers and viability, applying state of the art tools and technologies
- Critical review of G8/G9 and legal aspects,
- Fundaments for future legislation based on acquired data
- Specialized studies of 'silver bullets'

Mission academic research institute in BWT testing

- holistic approach multiple tools to asses numbers and viability
  - Microscopic counts (time consuming)
  - FlowCam; semi-automated (larger organisms)
  - Flow cytometry; automated (smaller organisms), including <10 µm (phytoplankton, bacteria, viruses)
- viability of remaining organisms but also vitality of discharged water

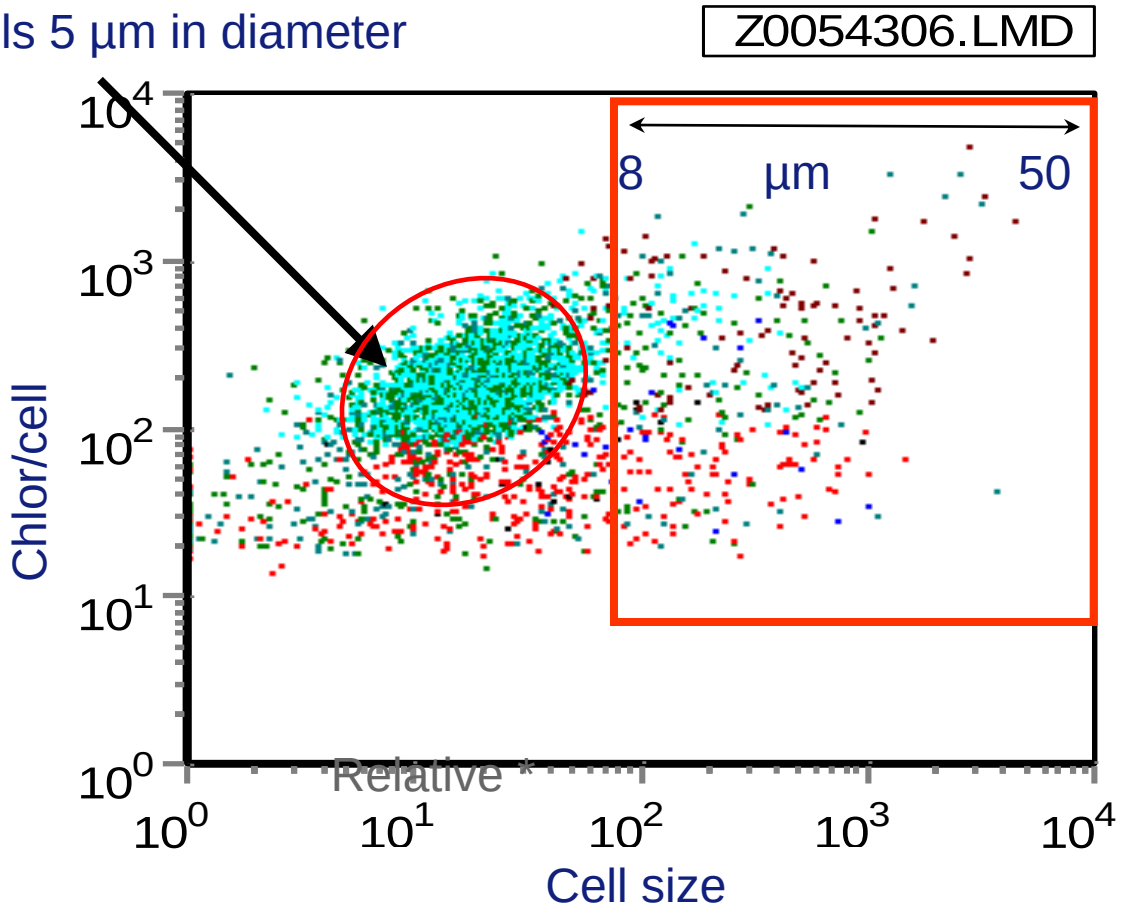
Standard-D2, Ballast water management Act (US), CA-standard and the NIOZ approach

Management approach	IMO Standard-D2	BW management -Act	2008 California Standard	NIOZ	nature
Org. > 50 µm	< 10 viable/m^3	< 0.1 viable/m^3	0 (/m^3?)	n.d.	10^2-10^5/m^3
Org. 10- 50 µm	<10 viable/mL	< 0.1 viable/mL	< 0.01 viable/mL	n.d.	10-10^4/mL
Org. < 10 µm (phytoplankton)	-	-	-	n.d.	10-10^6/mL
Bacteria	-	-	< 10 cfu/mL	-	10^5-10^8 /mL
viruses	-	-	< 10^2/mL	-	10^4-10^8 /mL
n.d.= non-detectable		- = no standard			

The forgotten fraction: Org. < 10 µm (phytoplankton)

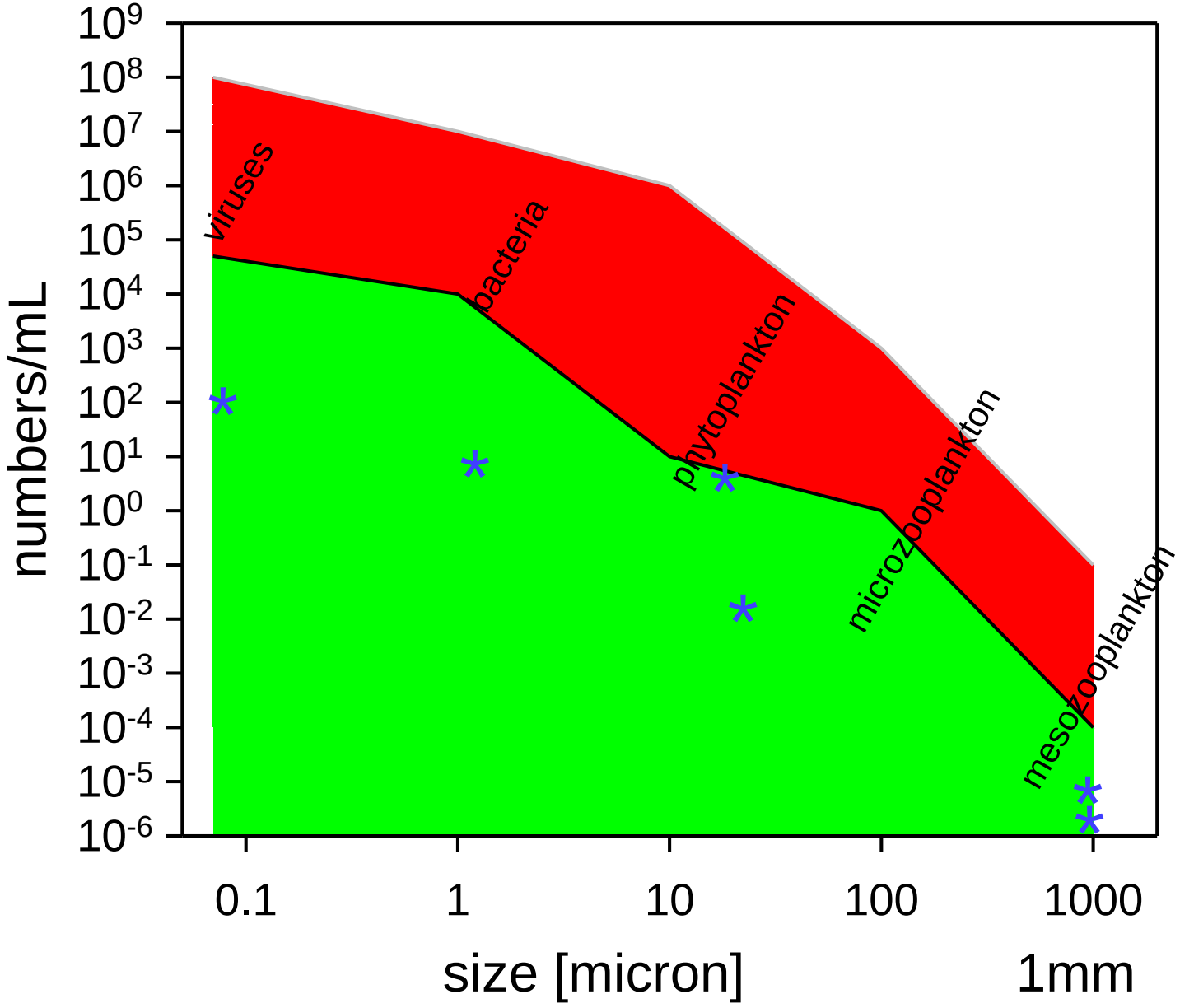
Large number [± 40,000/ml]

of phytoplankton cells 5 µm in diameter



A lot more phytoplankton cells than the size range of interests !!!!

Sample before treatment


numbers/mL
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
viruses
bacteria
phytoplankton
microzooplankton
mesozooplankton
0.1
1
10
100
1000
size [micron]
1mm

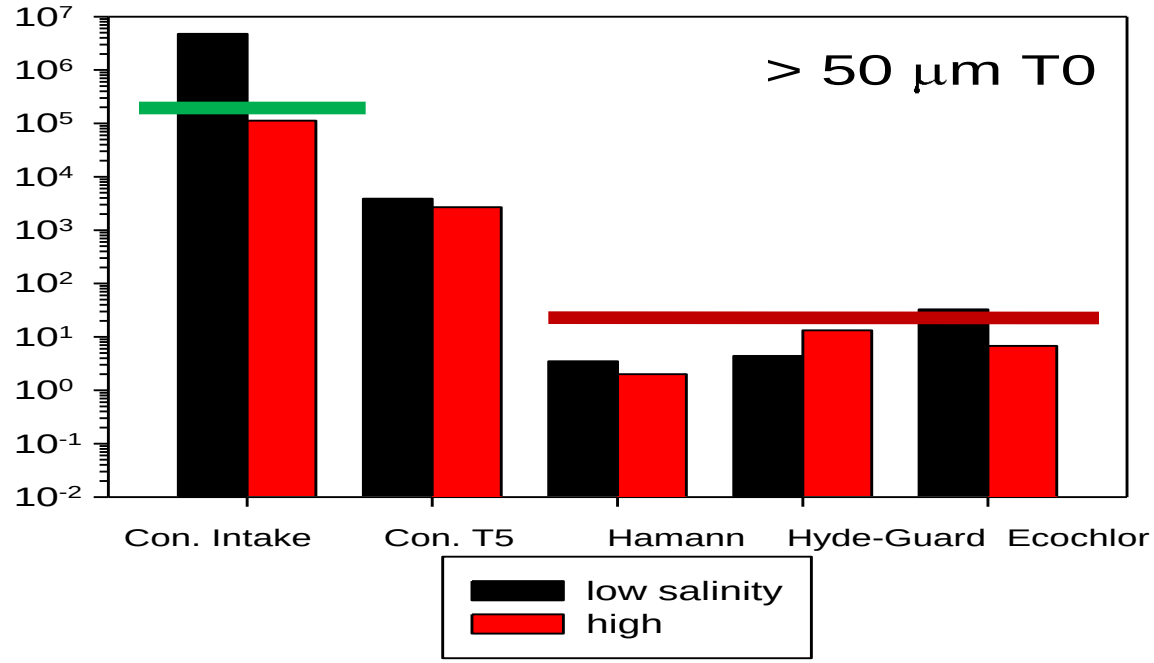
Results: Interactions with stakeholders

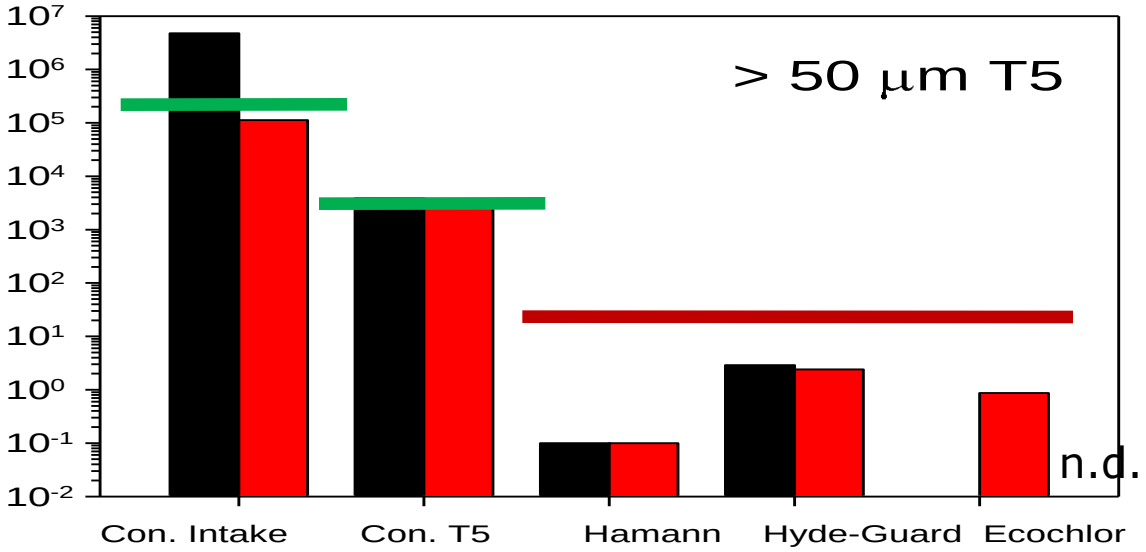
- Intermediate between national administrations/IMO/ industry
- Define protocols for certification; required documentation, conducting land-based testing, data reports (ex/internal review)
- Legal aspects; transparent and sound data to be transferred into legally defendable results
- Trying to harmonize the requirement of different NA (Who is pushing the ON and OFF buttons)

Results: Interactions with stakeholders

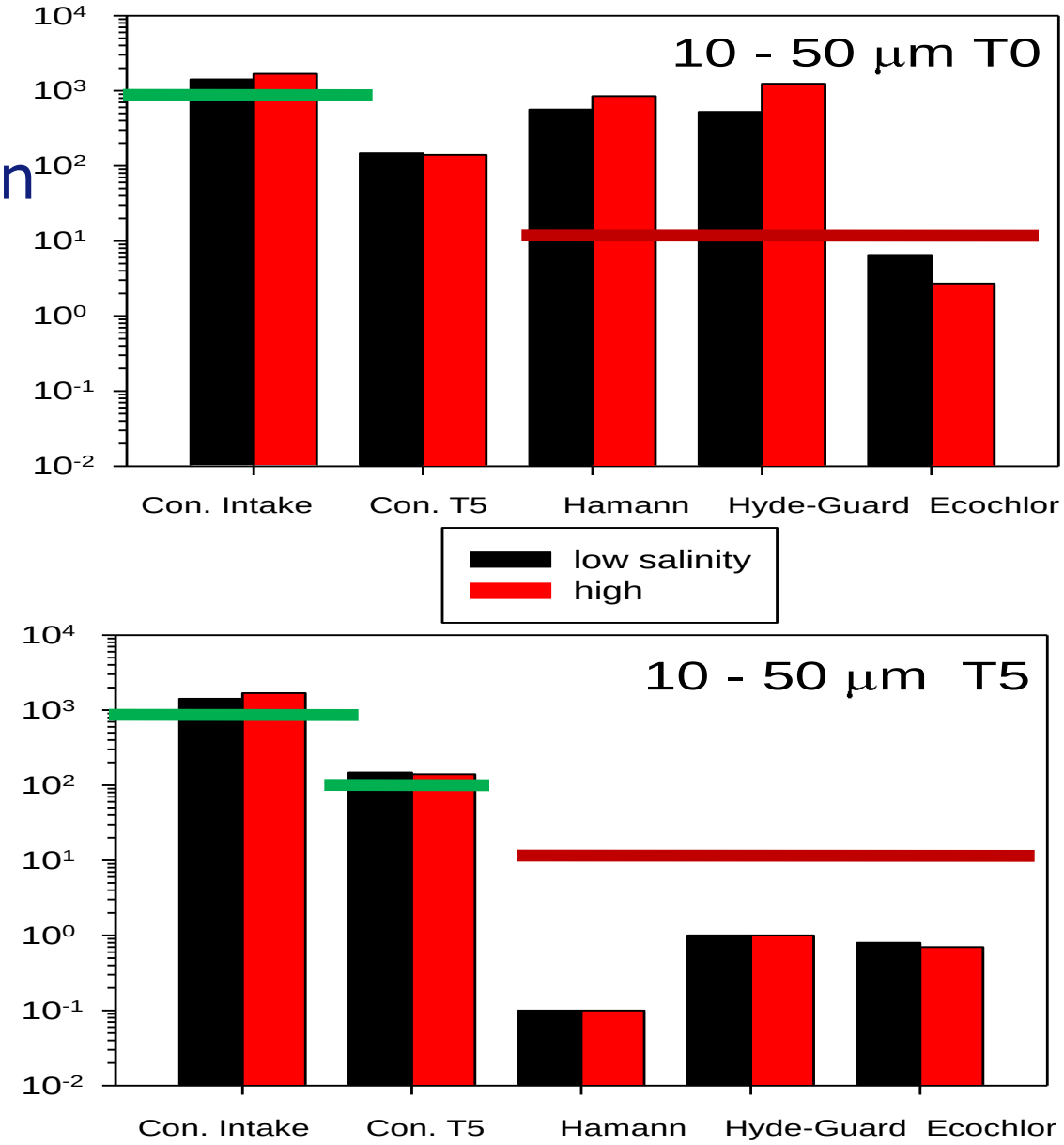
- Improve and expand present set of (multiple) test protocols (active substances)
- Compare present standard(s) with current achievements
- legal/statistical aspects of numbers and sample volumes
- (semi)automated analysis
  - TSS,POC,DOC, turbidity, salinity ~ 400 samples
  - Life -microscopy (> 10 µm) ~ 120 samples
  - Phytoplankton (PAM, FCM, micro) ~ 500 samples
  - Bacteria (counts, hum. Path.) ~ 500 samples
  - Viruses ~ 250 samples
    - Total **~ 1770 samples**

Test results SEDNA-Hamann Hyde-Guardian Ecochlor



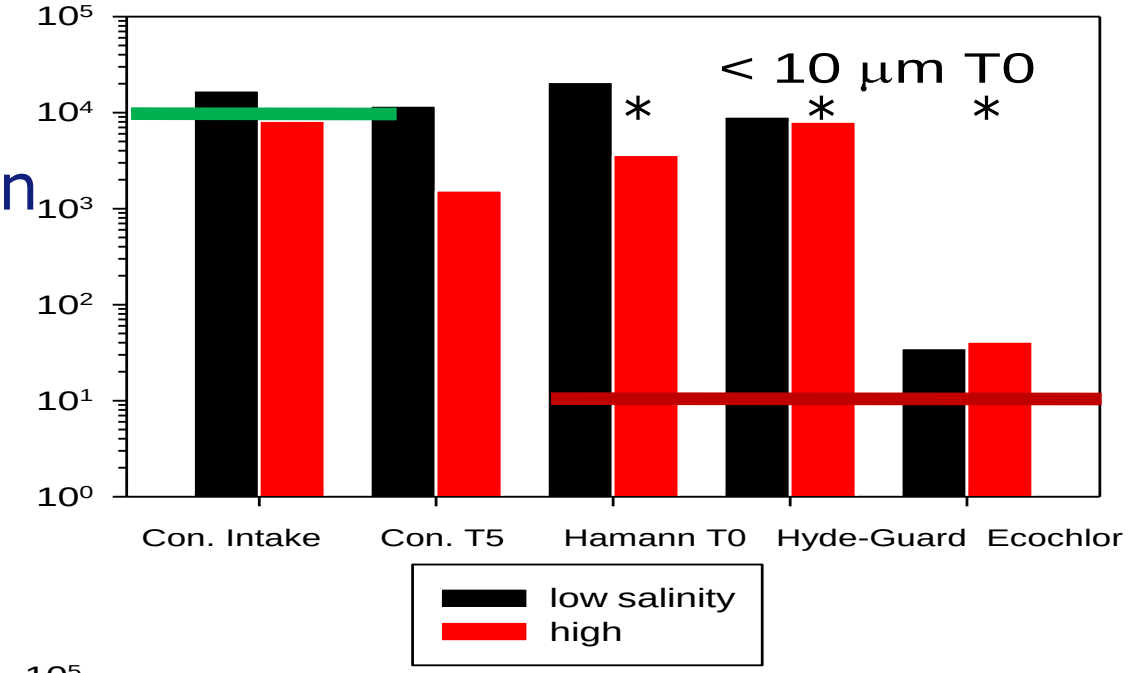


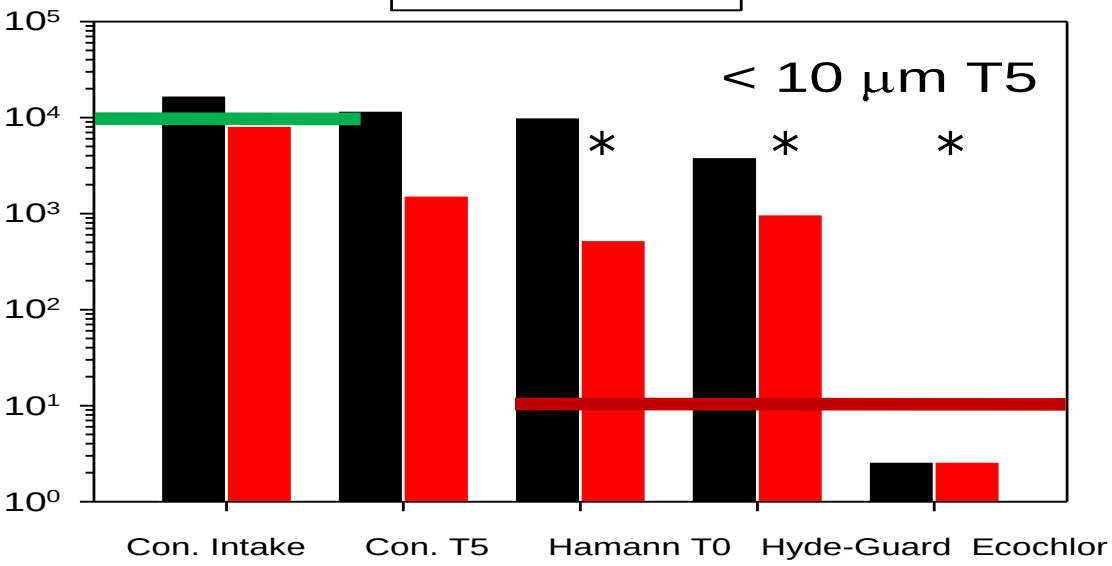
Test results SEDNA-Hamann Hyde-Guardian Ecochlor



Test results SEDNA-Hamann Hyde-Guardian Ecochlor

~ bacteria standard





* = non-viable

Future plans

- Search for (innovative) tools addressing numbers & viability
- Test bed for innovative BWT technologies
- Transfer of academic knowledge into legislative process
- tools for examining efficacy of BWT systems, research regarding tools for compliance enforcement and monitoring (EU-project submitted; EU-Interreg North Sea)

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there is no wisdom without ballast