Hvordan vet vi at brønnbåten er godt nok rengjort?
- Vask, desinfeksjon og dokumentasjon

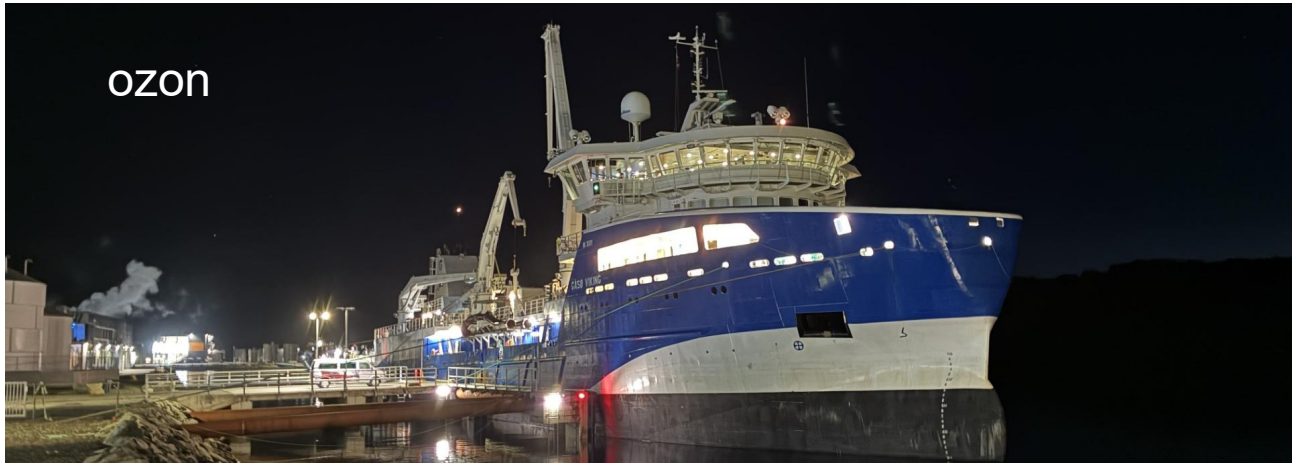
David Persson
Førsteamanuensis, Veterinærhøgskolen, NMBU

BKD-Safeguard (FHF-prosjekt 901942)

FHF Dialogmøte Brønnbåtoperasjoner, 17.11.2026

Vask og desinfeksjon





Målemetoder

ATP



Levende biologisk materiale/aktivitet

Relative Light Units **(RLU)**

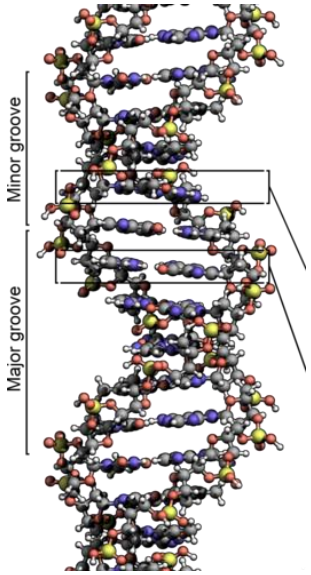
Vekst av bakterier



Levende (dyrkbare) bakterier

Colony-forming unit **(CFU)**

DNA-konsentrasjon



Mengde DNA fra biologisk materiale (levende og dødt)

ng/uL

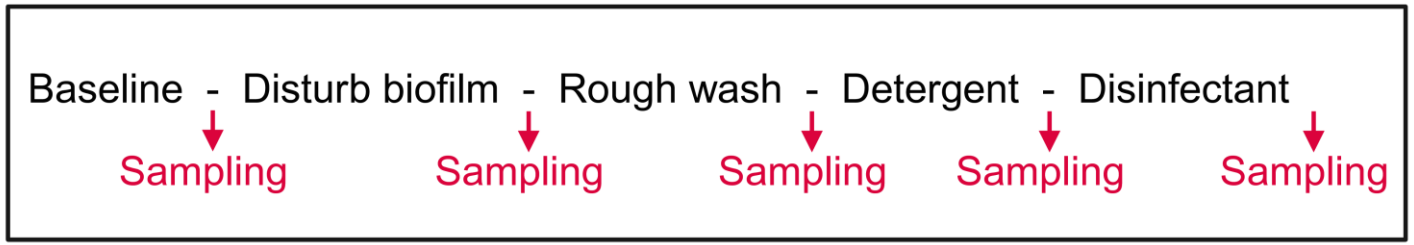
Figur DNA: Av Zephyris – Eget verk, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=15027555

Validering av vaskemetode i kar

- Kontrollerte karforsøk
- Effekt av vaskestegene

6 kar
1 uke lukket vannmiljø med omrøring for biofilmdannelse og modning

Protokoll designet rundt standard vaskeprotokoll

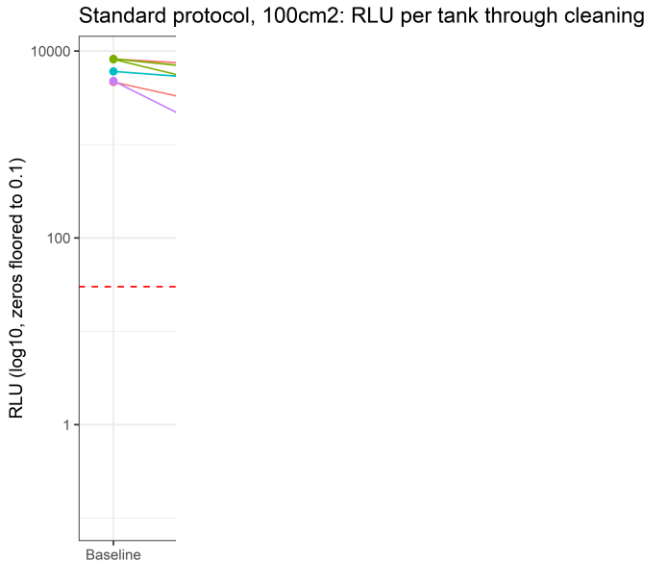




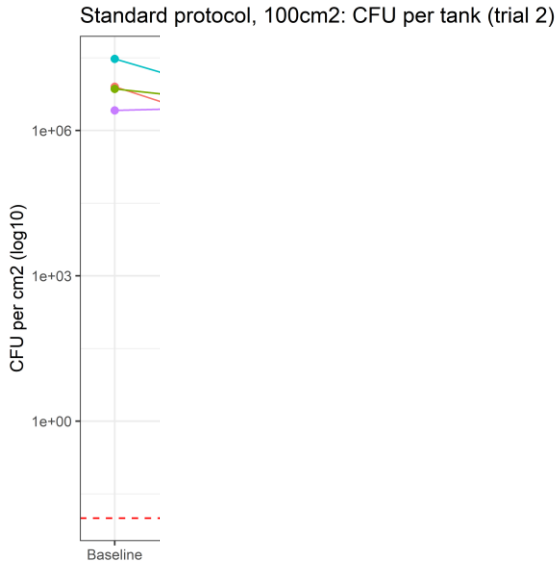
Validering av vaskemetode Standard protokoll

Utgangpunktet

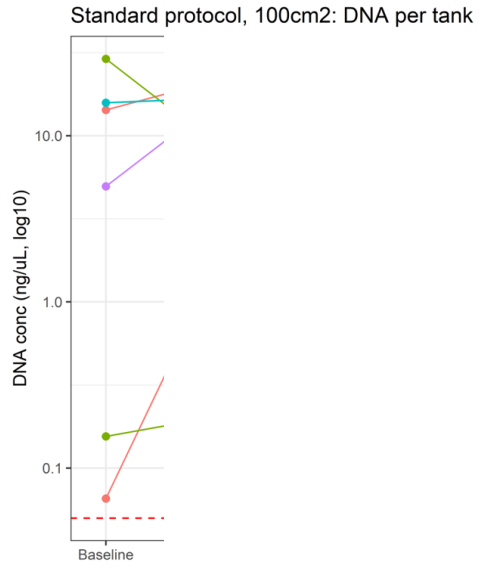
RLU



CFU



DNA



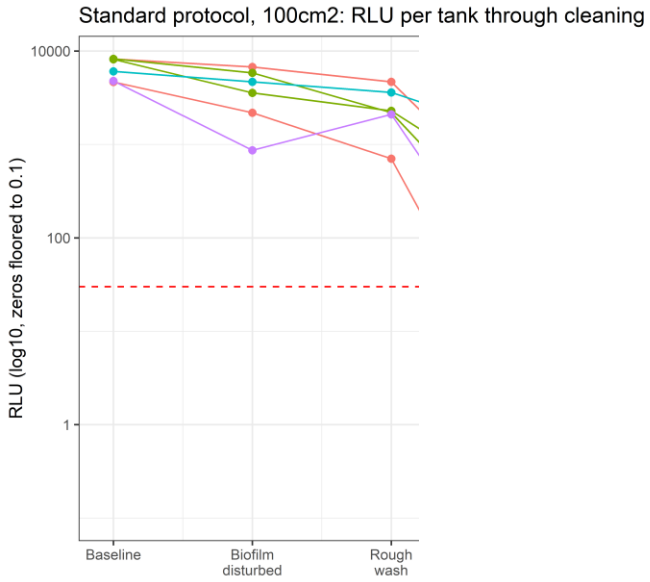
4 600 – 8 200 RLU

2.6-30 millioner CFU/cm2

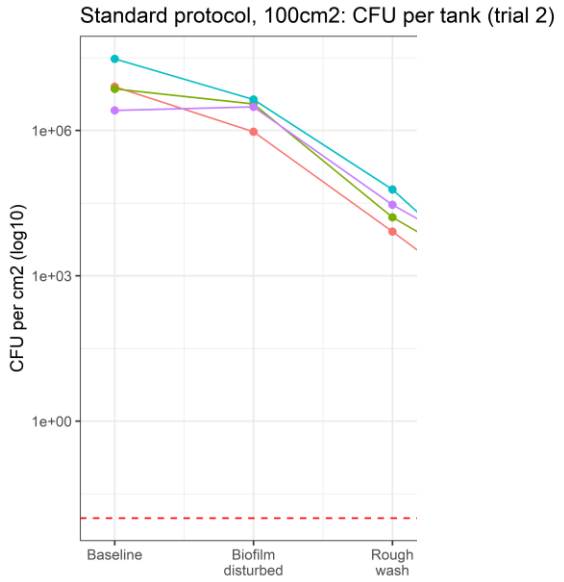
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Etter Grovvask

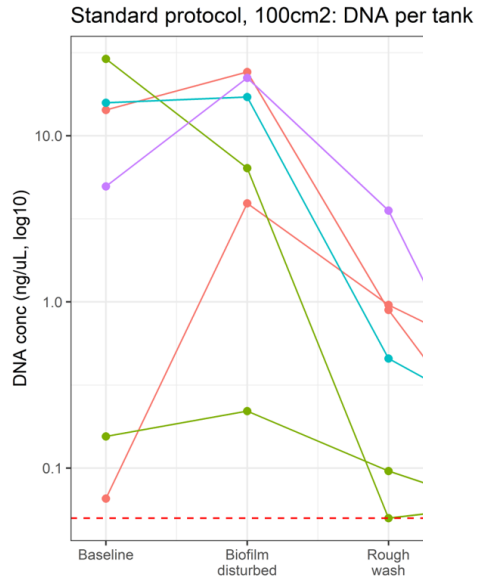
RLU



CFU



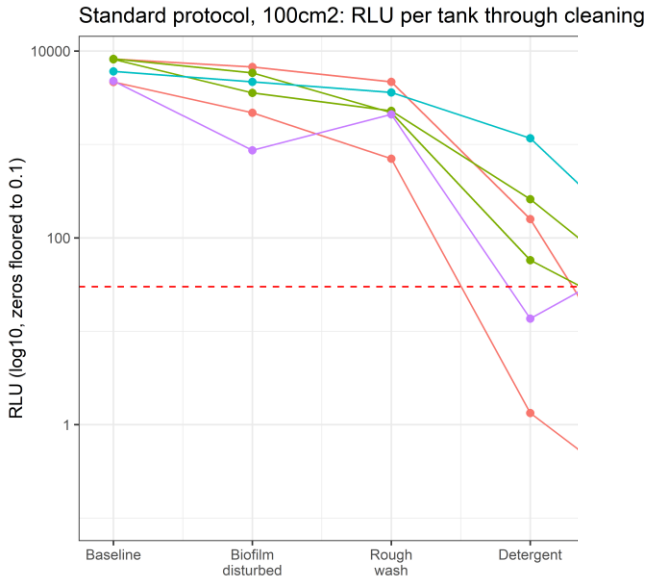
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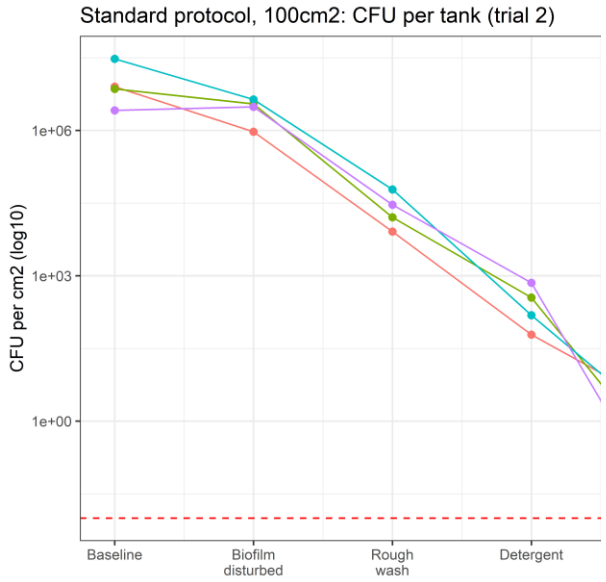
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Etter Vaskemiddel

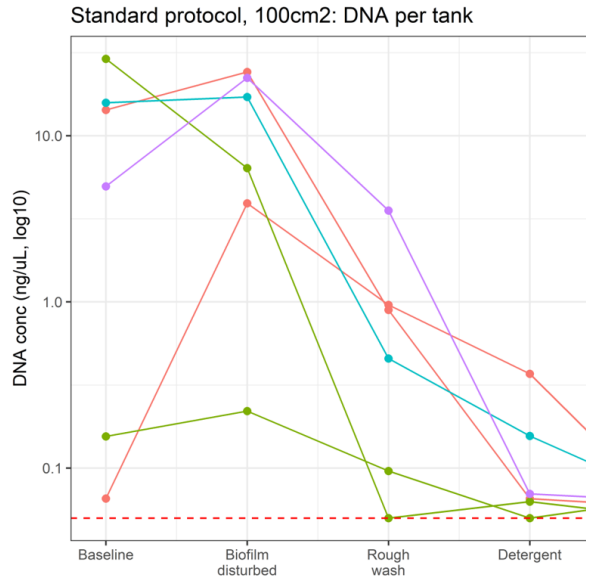
RLU



CFU



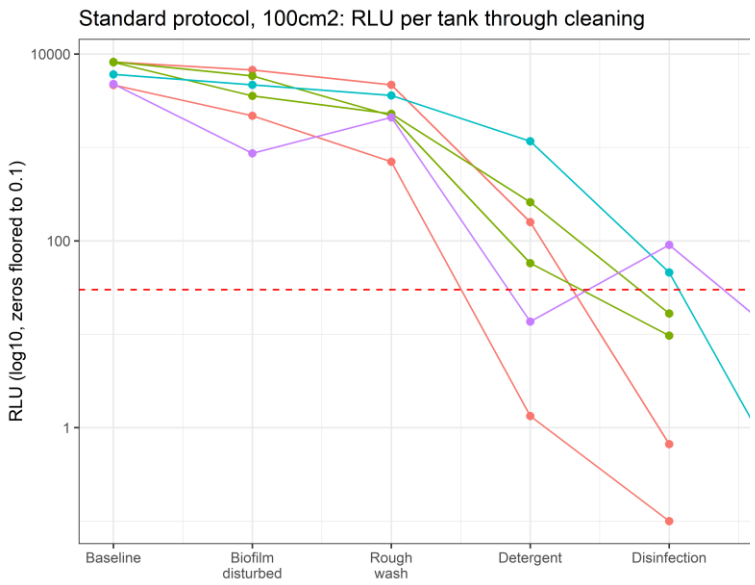
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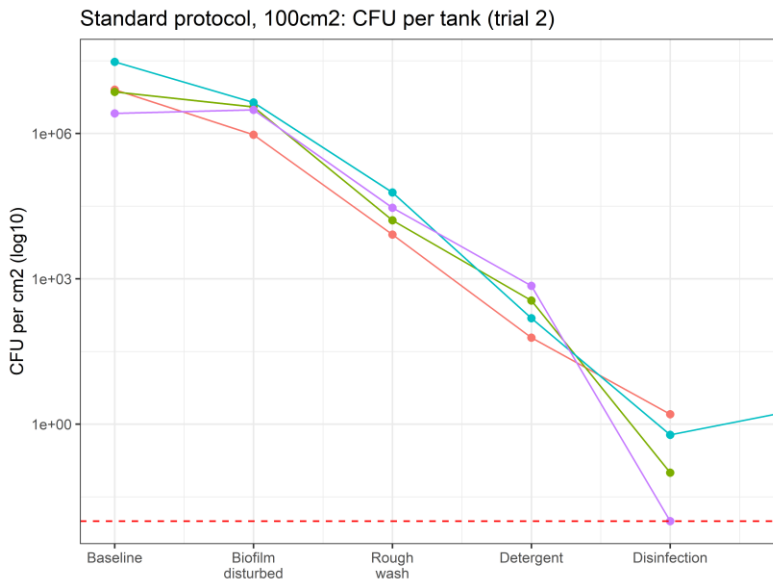
Validering av vaskemetode Standard protokoll

Etter Desinfeksjon

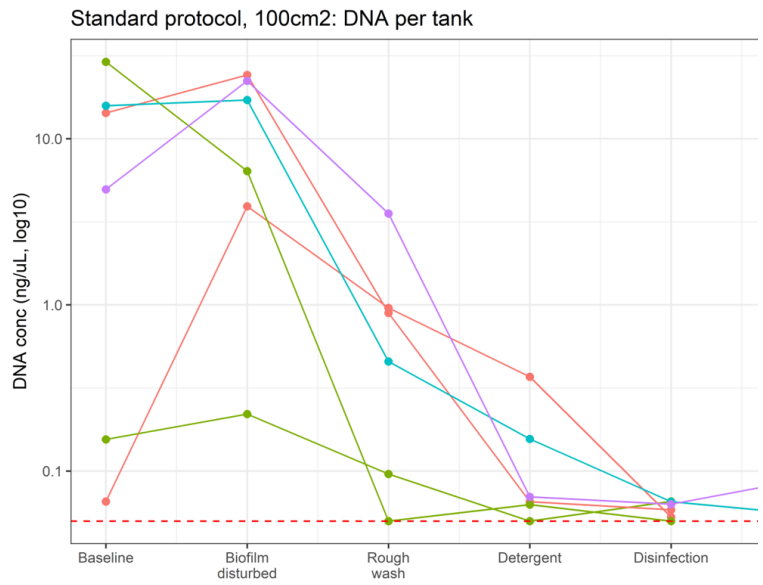
RLU



CFU



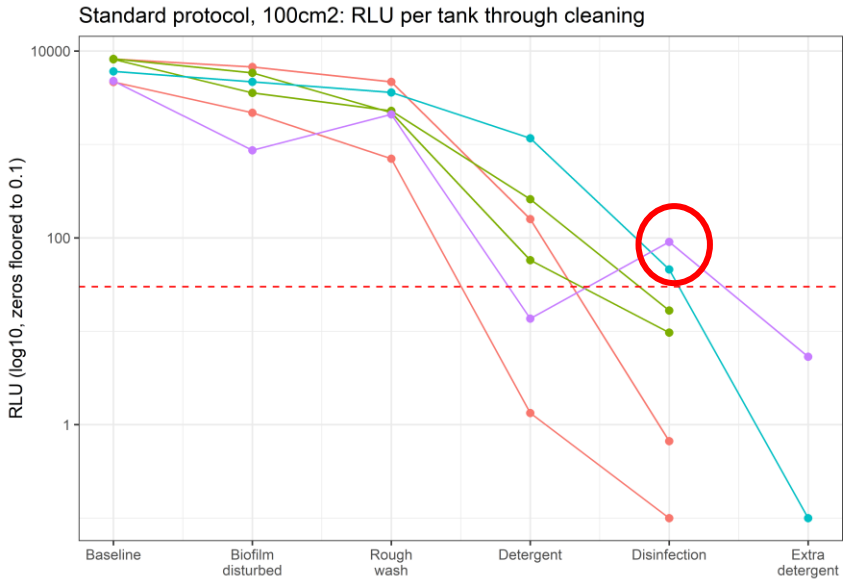
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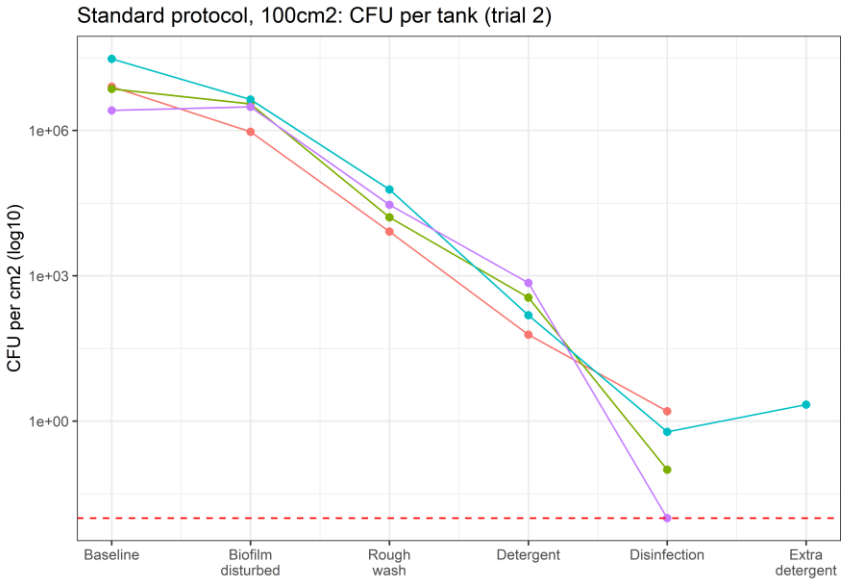
Validering av vaskemetode Standard protokoll

Etter Omvask

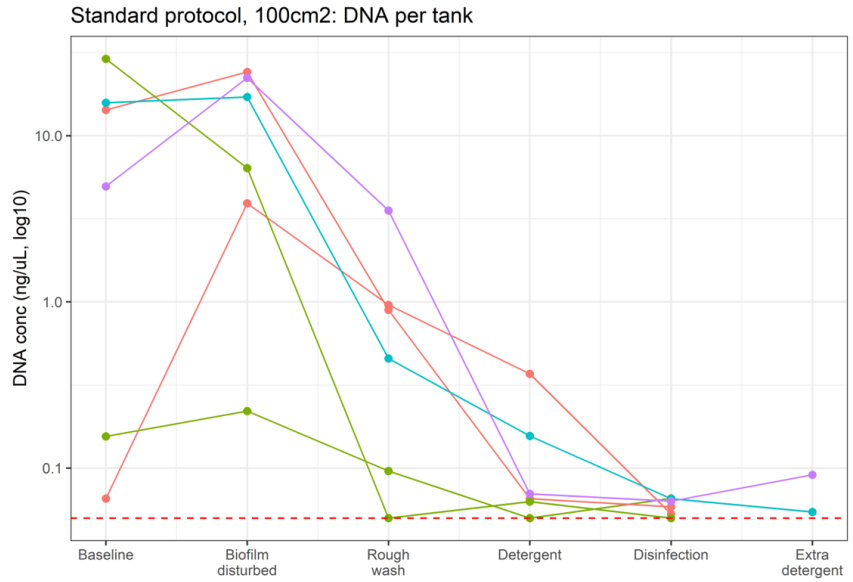
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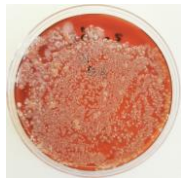
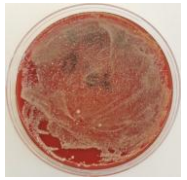
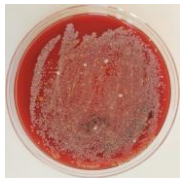
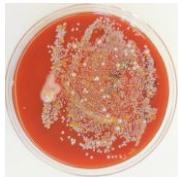
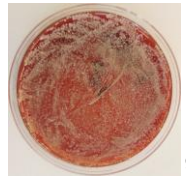
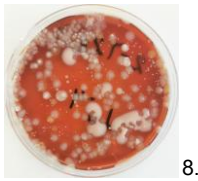
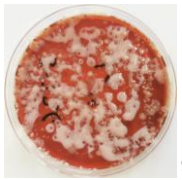
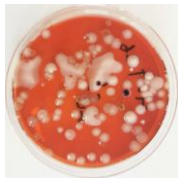
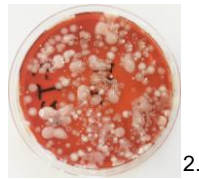
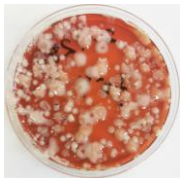
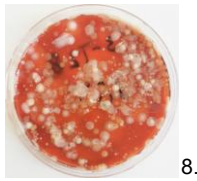
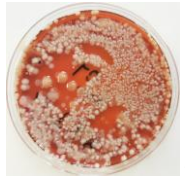
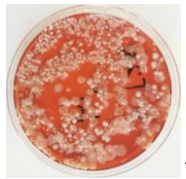
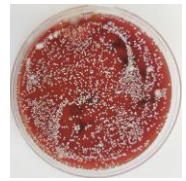
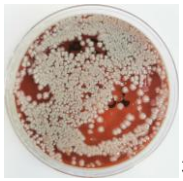
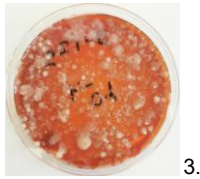
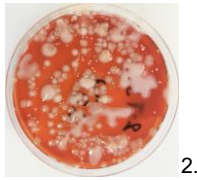
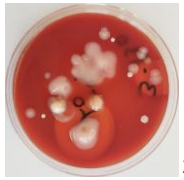
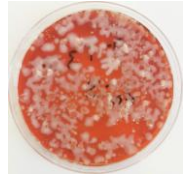
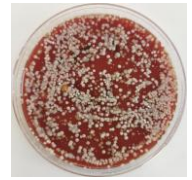
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DNA



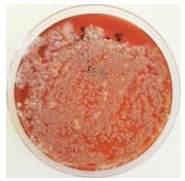
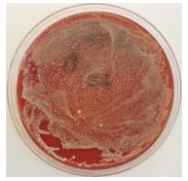
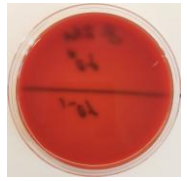
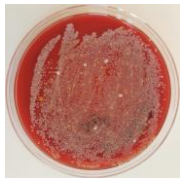
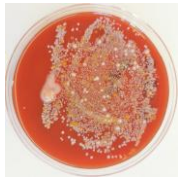
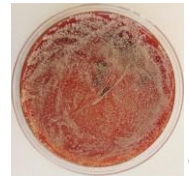
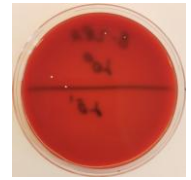
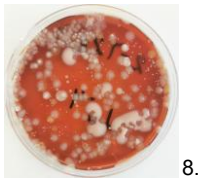
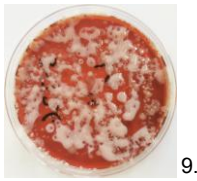
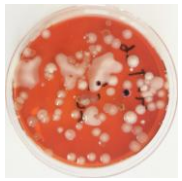
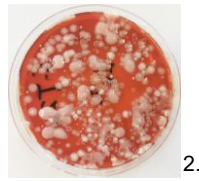
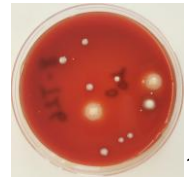
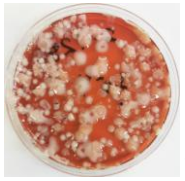
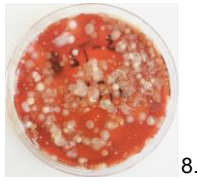
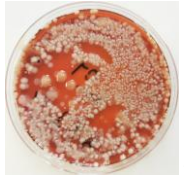
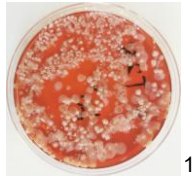
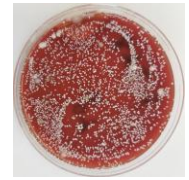
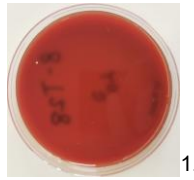
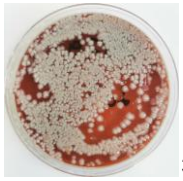
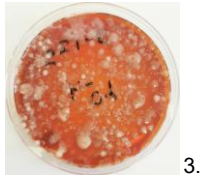
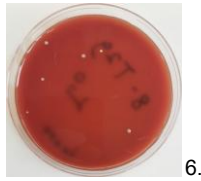
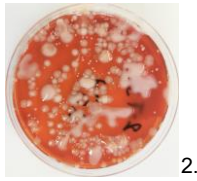
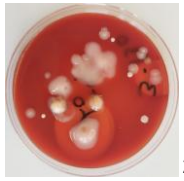
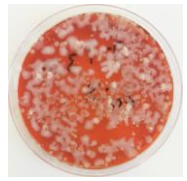
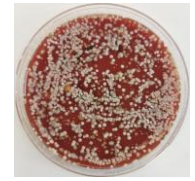
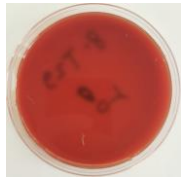
Vekst av bakterier…

	Before washing		After rough wash		After detergent
Kar 1	 1.94E+02	 1.78E+03	 1.26E+04	 1.32E+03	 1.82E+02
Kar 2	 4.50E+02	 ∞	 9.08E+03	 4.72E+02	 9.40E+01
Kar 3	 8.00E+06	 9.60E+06	 9.40E+05	 2.80E+03	 6.10E+01
Kar 4	 7.20E+06	 8.60E+06	 3.52E+05	 1.61E+04	 3.56E+02
Kar 5	 3.00E+07	 3.16E+06	 4.36E+06	 6.04E+04	 1.54E+02
Kar 6	 2.60E+06	 2.10E+05	 3.06E+06	 2.92E+04	 7.16E+02

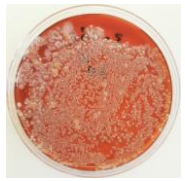
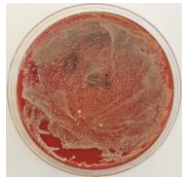
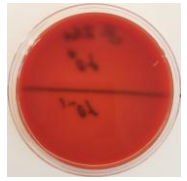
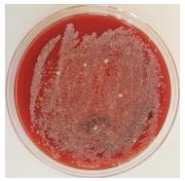
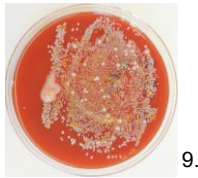
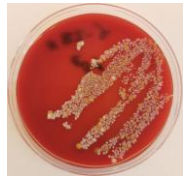
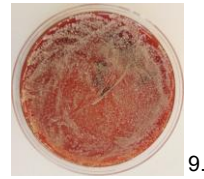
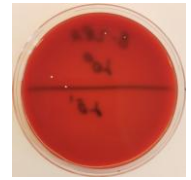
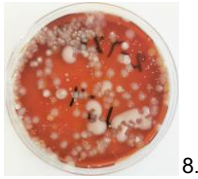
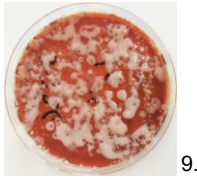
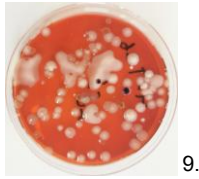
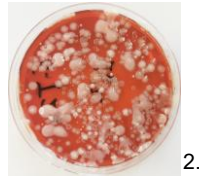
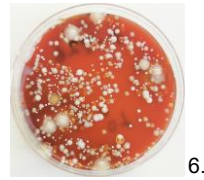
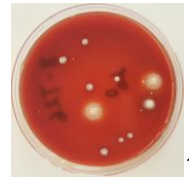
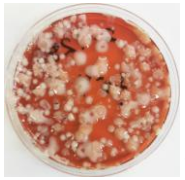
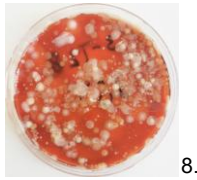
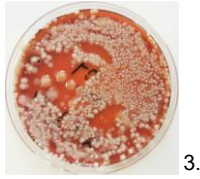
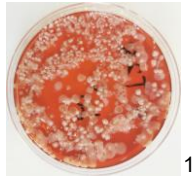
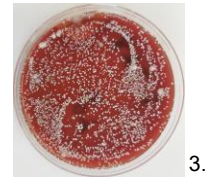
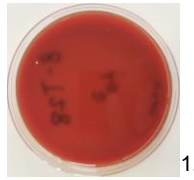
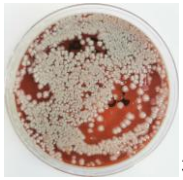
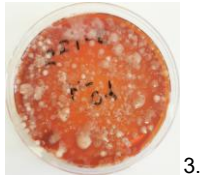
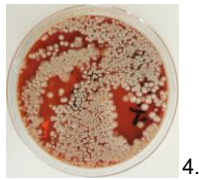
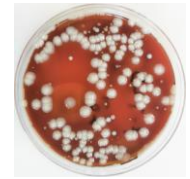
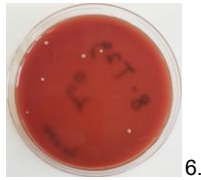
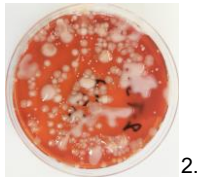
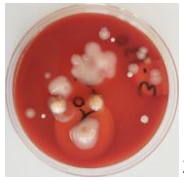
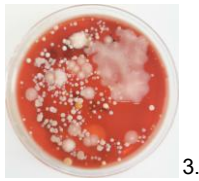
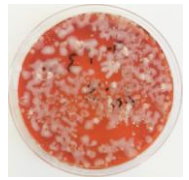
Bacterial culture during cleaning of a fish tank



Bacterial culture during cleaning of a fish tank

	Before washing		After rough wash		After detergent	After Disinfectant
Kar 1	 1.94E+02	 1.78E+03	 1.26E+04	 1.32E+03	 1.82E+02	 0.00E+00
Kar 2	 4.50E+02	 ∞	 9.08E+03	 4.72E+02	 9.40E+01	 8.00E-01
Kar 3	 8.00E+06	 9.60E+06	 9.40E+05	 2.80E+03	 6.10E+01	 1.60E+00
Kar 4	 7.20E+06	 8.60E+06	 3.52E+05	 1.61E+04	 3.56E+02	 1.00E-01
Kar 5	 3.00E+07	 3.16E+06	 4.36E+06	 6.04E+04	 1.54E+02	 6.00E-01
Kar 6	 2.60E+06	 2.10E+05	 3.06E+06	 2.92E+04	 7.16E+02	 0.00E+00

Bacterial culture during cleaning of a fish tank

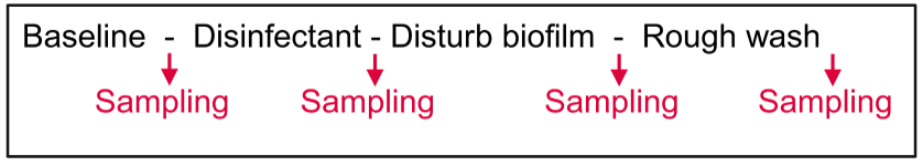
	Before washing		After rough wash		After detergent	After Disinfectant
Kar 1	 1.94E+02	 1.78E+03	 1.26E+04	 1.32E+03	 1.82E+02	 0.00E+00
Kar 2	 4.50E+02	 ∞	 9.08E+03	 4.72E+02	 9.40E+01	 8.00E-01
Kar 3	 8.00E+06	 9.60E+06	 9.40E+05	 2.80E+03	 6.10E+01	 1.60E+00
Kar 4	 7.20E+06	 8.60E+06	 3.52E+05	 1.61E+04	 3.56E+02	 1.00E-01
Kar 5	 3.00E+07	 3.16E+06	 4.36E+06	 6.04E+04	 1.54E+02	 6.00E-01
Kar 6	 2.60E+06	 2.10E+05	 3.06E+06	 2.92E+04	 7.16E+02	 0.00E+00

Validering av vaskemetode Desinfeksjon først

2 kar
1 uke lukket vannmiljø med omrøring for biofilmdannelse og modning



Protokoll designet rundt standard vaskeprotokoll

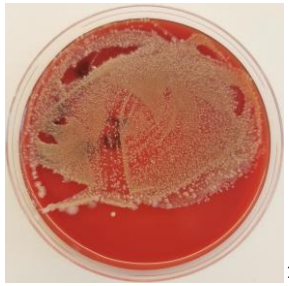


Validering av vaskemetode Desinfeksjon først

Baseline

After Disinfectant

1-T29



1.42E+03

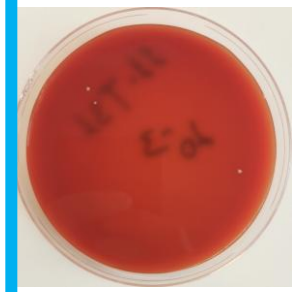


1.02E+03

2-T31



1.90E+05

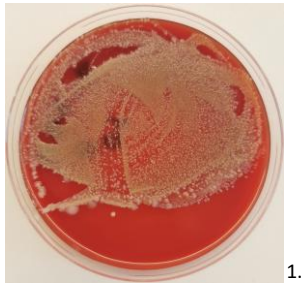
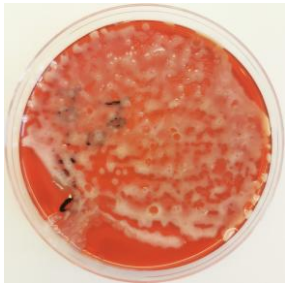
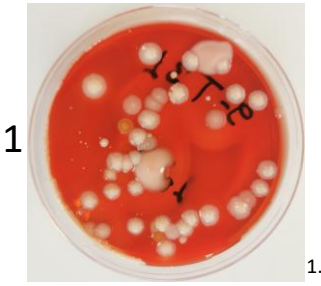
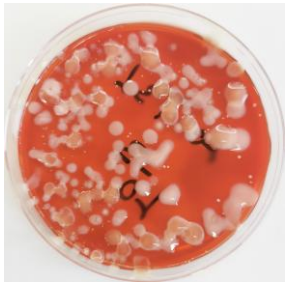
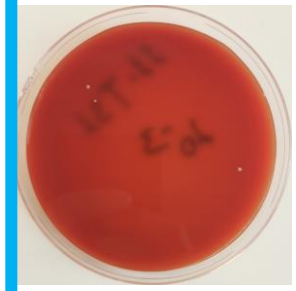


3.00E+02

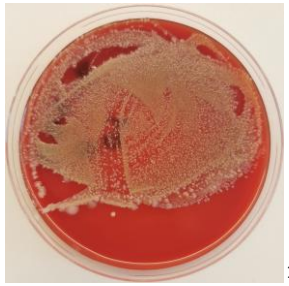
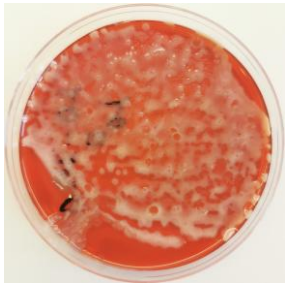
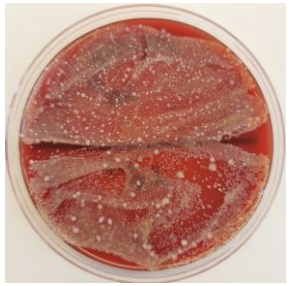
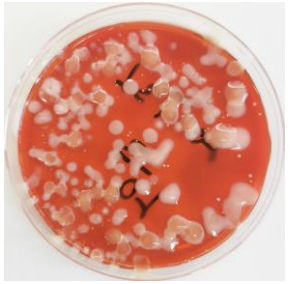
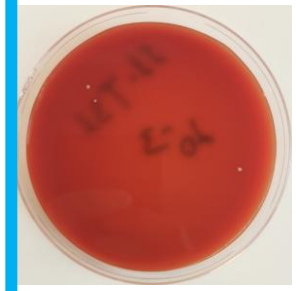
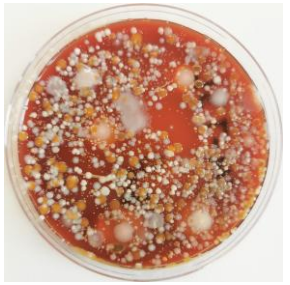
-4log

-3log

Validering av vaskemetode Desinfeksjon først

	Baseline	Baseline biofilm scrape	After Disinfectant	After disinfectant biofilm scrape
1-T29	 1.42E+03	 ∞	 1.02E+03	 ∞
2-T31	 1.90E+05	 1.51E+04	 3.00E+02	 2.92E+04
	-4log	-3log	-3log	-3log

Validering av vaskemetode Desinfeksjon først

	Baseline	Baseline biofilm scrape	After Disinfectant	After disinfectant biofilm scrape	After disturbing biofilm	After roughwash
1-T29	 1.42E+03	 ∞	 1.02E+03	 ∞	 2.60E+00	 1.40E+03
2-T31	 1.90E+05	 1.51E+04	 3.00E+02	 2.92E+04	 1.60E+03	 3.22E+02
	-4log	-3log	-3log	-3log	-3log	0log

Veterinærhøgskolen
Institutt for produksjonsdyrmedisin

Oppsummering

- **Standard rengjøringsprotokoll fungerer**
  - Fører til en stadig nedgang i biologisk belastning gjennom prosessen
  - RLU 4000/10000 → < 30 (i de fleste tilfeller)
  - CFU reduksjon med 6 – 8 log (fra millioner i CFU/cm2 → under deteksjonsgrense
- Grovvask: Fjerner mesteparten av biologisk materiale
  - Kraftig reduksjon i DNA (1-2 log)
  - Mindre effekter på RLU og CFU
- Vask: Fjerner og dreper bakterier
  - Største reduksjonen i CFU
  - Tilsvarende reduksjon i RLU (1.5 – 2.7 log)
- Desinfeksjon: Sikkerhetsnett
  - Ytterligere 1 - 3.5 log reduksjon i RLU
  - Fungerer godt som et sikkerhetsnett dersom man har fått redusert biologisk materiale tilstrekkelig i stegene før.
- Omvask er effektivt på områder med hardfør biofilm
- Potensiale for falske negative RLU-prøver
- Potensiale for å redistribuere levedyktige agens
- Underliggende bakterier i biofilm overlever


VIKING

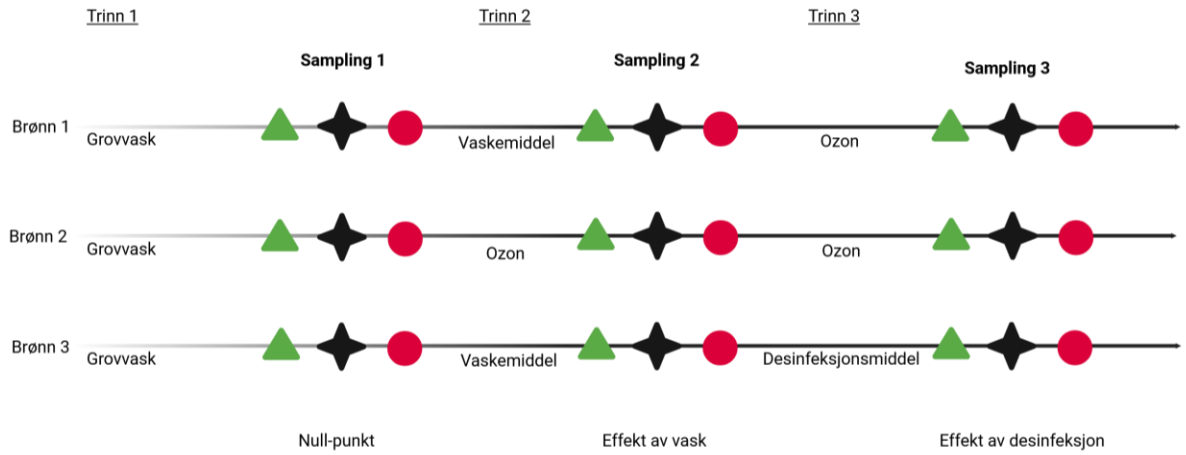
Effekt av ozon ved rengjøring av brønnbåter

Forsøksoppsett

- To runder, med ulike fartøy/selskap
- Begge etter kjøring av slaktefisk
- Tre brønner, hver med ulikt regime

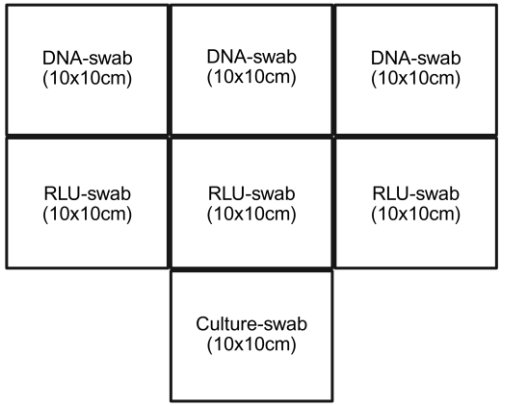
	Vask	Desinfeksjon
Brønn 1	Kjemisk	Ozon
Brønn 2	Ozon	Ozon
Brønn 3	Kjemisk	Kjemisk

NB! Lavt N
Deskriptivt studie!!



Uttak

DNA konsentrasjon	4 områder á 3 prøver = 108 prøver
Bakteriologi	4 områder á 1 prøve = 36 prøver
RLU-målinger	4 områder á 3 prøver = 108 prøver



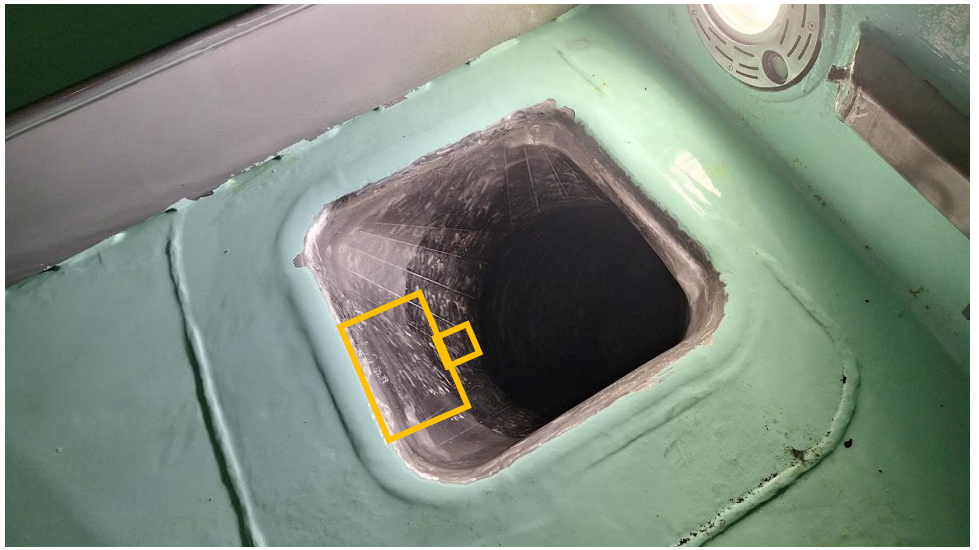
Veterinærhøgskolen
Institutt for produksjonsdyrmedisin

Effekt av ozon ved rengjøring av brønnbåter



Sammenlignbare prøvetakingspunkter (4 i hver brønn), men ikke helt like mellom brønnbåtene





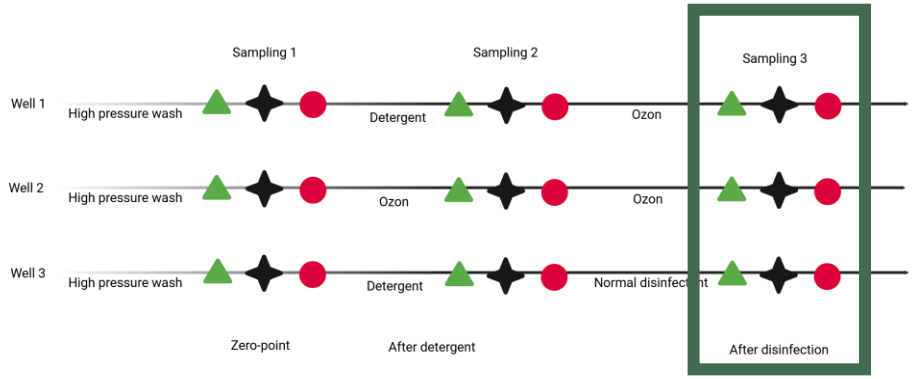
Veterinærhøgskolen
Institutt for produksjonsdyrmedisin

Effekt av ozon ved rengjøring av brønnbåter

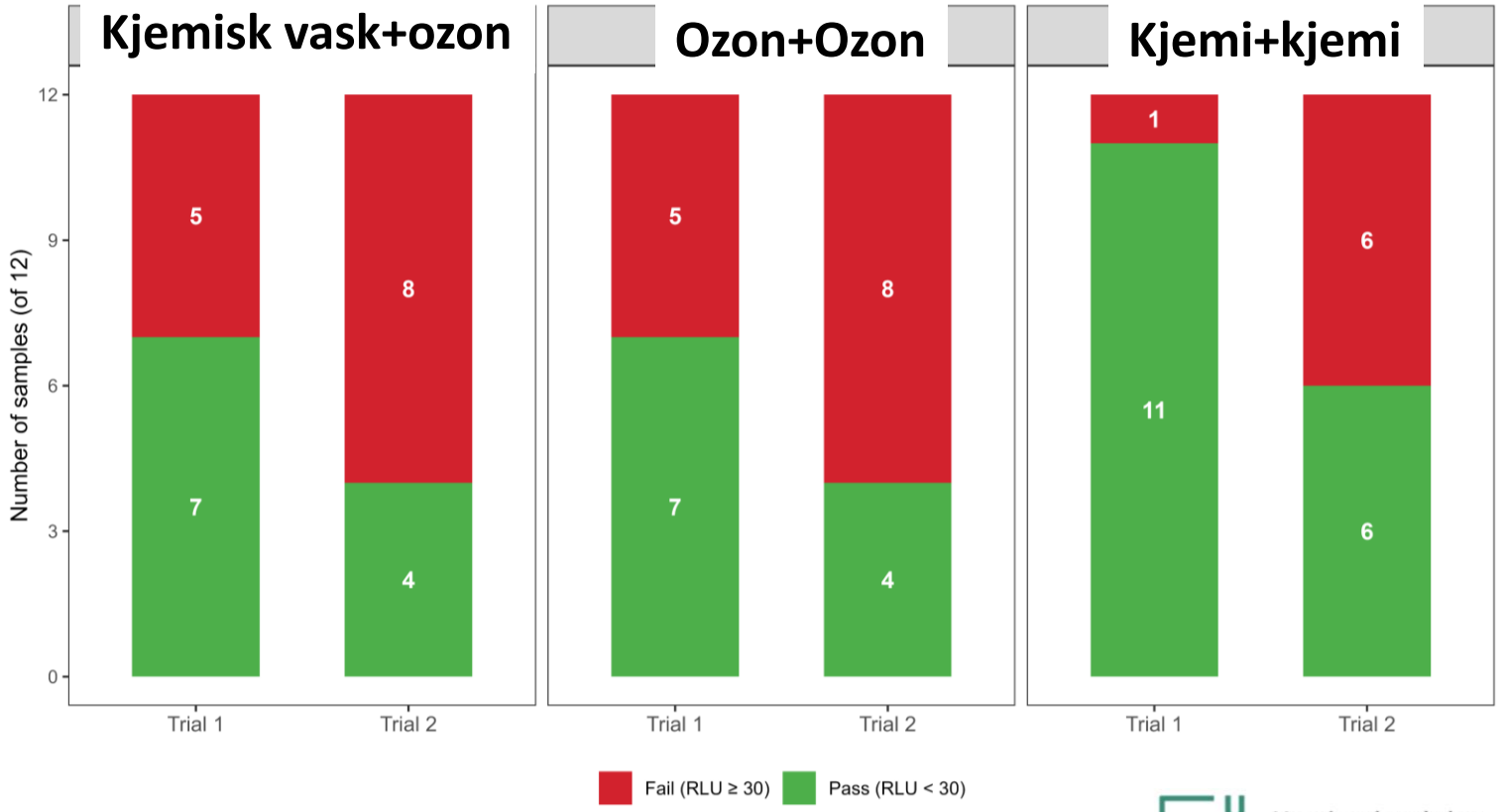
Ble brønnene rene etter fullført regime

Fartøy 1:
- Ozon brønner 58 % godkjente verdier
- Kjemisk kontroll 92 % godkjente verdier

Fartøy 2:
- Ozon brønner 33 % godkjente verdier
- Kjemisk kontroll 50 % godkjente verdier



ATP-målinger etter desinfeksjon



Veterinærhøgskolen
Institutt for
produksjonsdyrmedisin

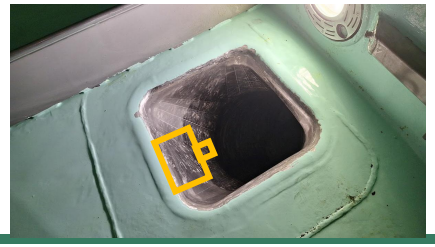
Effekt av ozon ved rengjøring av brønnbåter

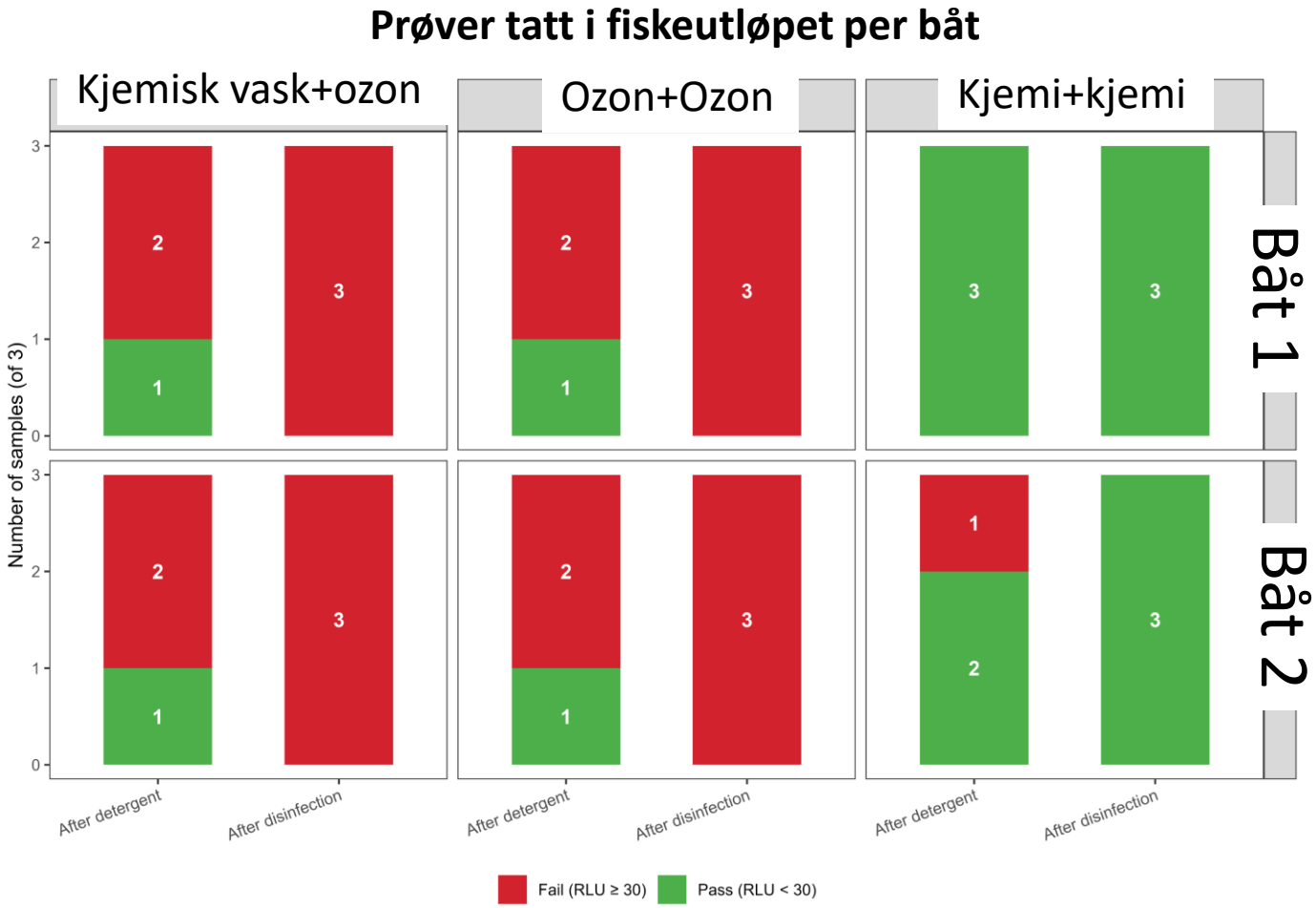
Fiskeutløpet er et kritisk KKP ved bruk av ozon

- RLU økte konsekvent etter ozonbehandling
- Lik men konsekvent trend i flere områder

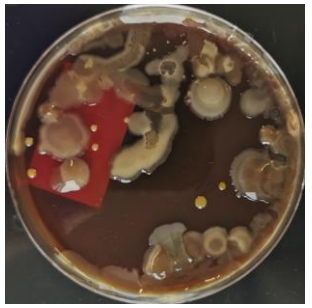
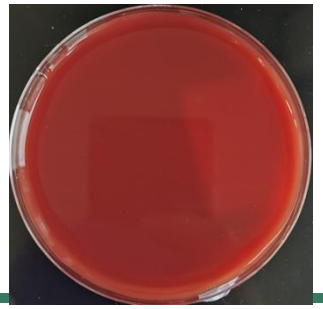
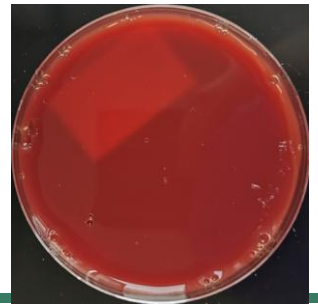
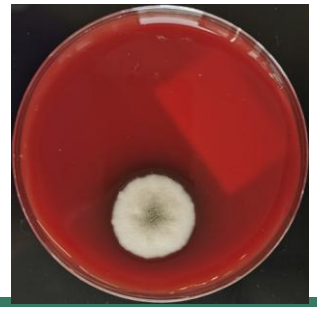
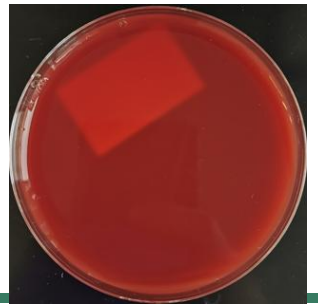
- Hypotese
  - Ozon løser opp og suspenderer biofilm og organisk materiale
  - Rengjør overflatene, men organisk materiale podes tilbake og redistribueres på overflatene når vannet slippes ut igjen
  - Fiskeutløp er punktet som er i kontakt med mest vann.

- Men er biosignalet levende?

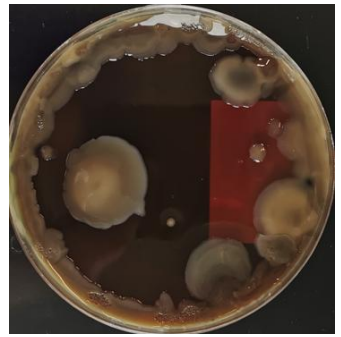
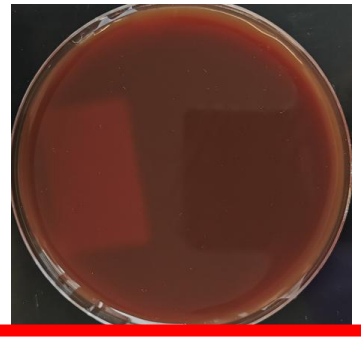




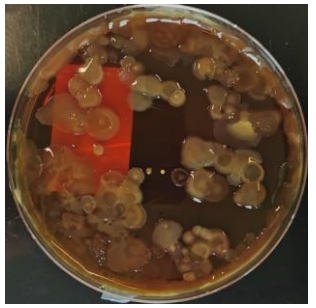
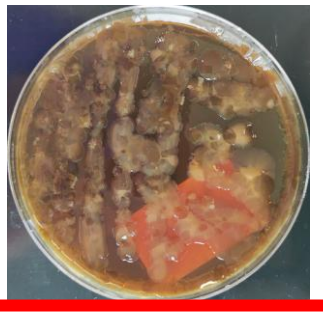
Boat 1: RW – Chem. Deterg. – Chem. Disinf.

	Area: 1	Area: 2	Area: 3	Area: 4
After Rough-wash				
After Chem. detergent				
After Chem. Disinf.				

Boat 1: RW – Chem Det. – Ozon

	Area: 1	Area: 2	Area: 3	Area: 4
After Rough-wash				
After Chem. Detergent				
After Ozon Disinf.				

Trial 1: RW – Ozon – Ozon

	Area: 1	Area: 2	Area: 3	Area: 4
After Rough-wash				
After ozon as detergent				
After Ozon Disinf.				

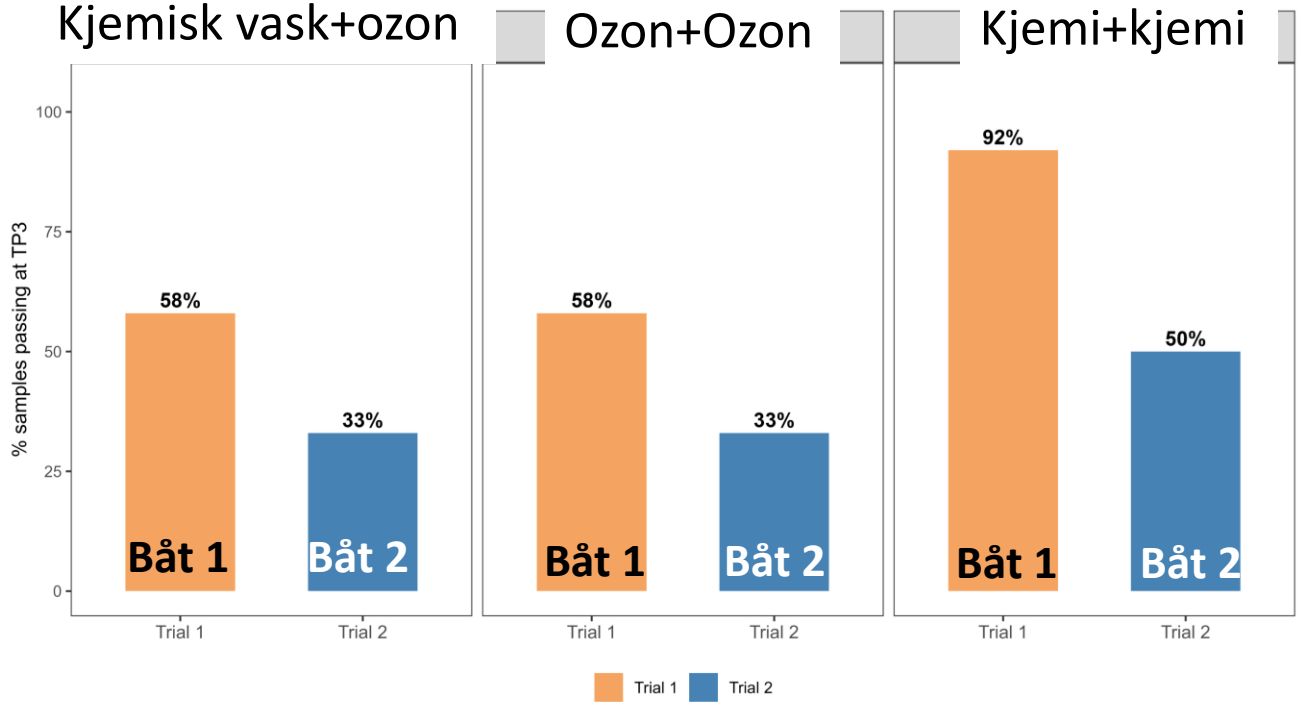
Effekt av ozon ved rengjøring av brønnbåter

Fartøy og mannskap er viktige faktorer

- Resultatene av rengjøringsprotokollene var ulike mellom brønnbåtene.
- Fartøyets utforming og installasjoner er mest sannsynlig avgjørende faktorer

- **På tvers av begge fartøyene ga tradisjonell vask (kjemisk, automatisk vask) det reneste resultatet. Selv om resultatet der også ga underkjente resultater.**

Antall godkjente prøver (ATP) etter desinfeksjon



Effekt av ozon ved rengjøring av brønnbåter

Hovedfunn

- Effekten av ozon som vaskemiddel var ikke konsekvent.
- Effekten av ozon som desinfeksjonsmiddel ga konsekvent underkjente verdier, spesielt ved fiskeutløpet.
- Virker ikke som om ozon penetrerer biofilmen godt nok, og har ikke drepende effekt på bakteriene.

- Kontroll av brønner etter kjemisk vask men før ozonering kan gi falske negative RLU/CFU-resultater



BKDsafeguard

- **University and research institutions**
  - NMBU, Norway
  - Foundation Edmund Mach (Italia)
- **Fish health services**
  - VETAQ (Island)
  - Aquakompetanse
  - Veterinærforeningen
- **Fish farmers**
  - Lerøy Midt
  - Samherji (Island)
- **Analytic companies**
  - Pharmaq
  - NordicDX
- **Wellboats**
  - Oppdretternes miljøservice
  - Frøy



FHF prosjekt: BKDsafeguard (901942)