



Kan lyd hindre lusa?

Geir Magne Knutsen

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Lakseluskonferansen 2025

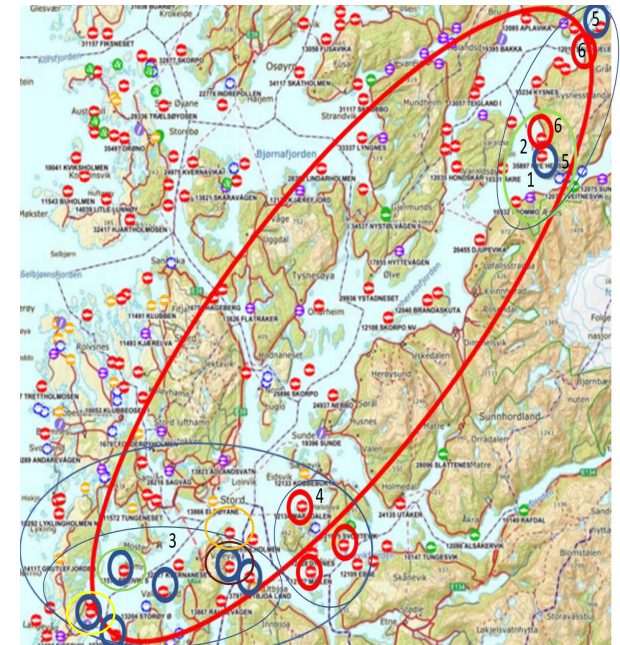
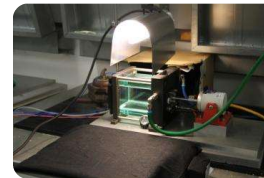
An underwater scene showing light rays filtering down from the surface. A diver is visible on the left side of the frame. The water is dark, and the light rays create a dramatic, ethereal atmosphere.

Lydens påvirkning på objekter og levende organismer.

History/ Testfarms / partners

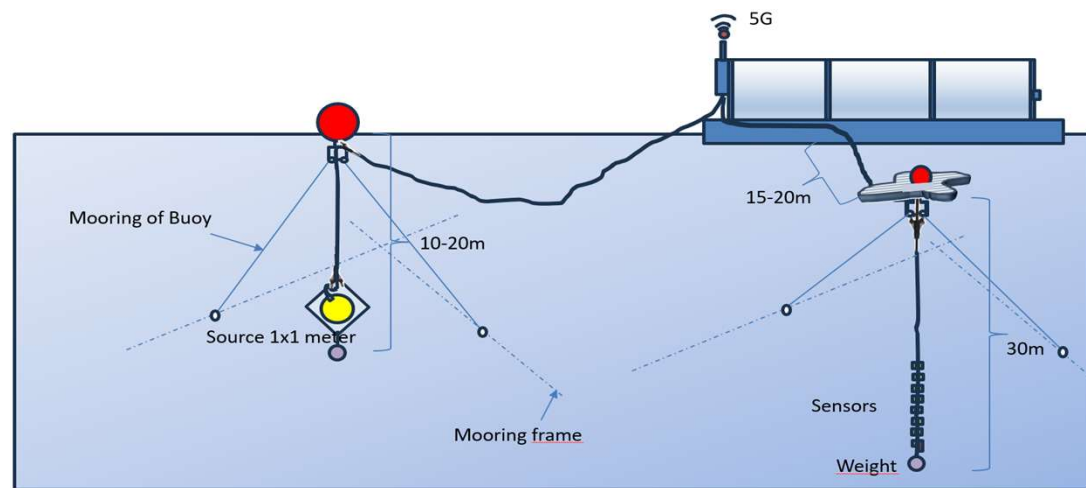
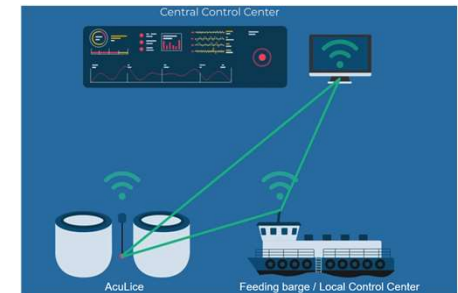
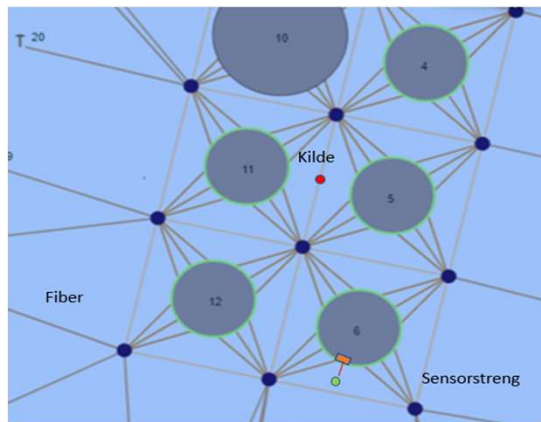
From idea in 1998 to researching 2011-2018.

Full scale tests 2018-2024. 



Exiting founding's in the laboratory led to executing of several controlled full-scale tests
Organized by the organization PO3/PO4.

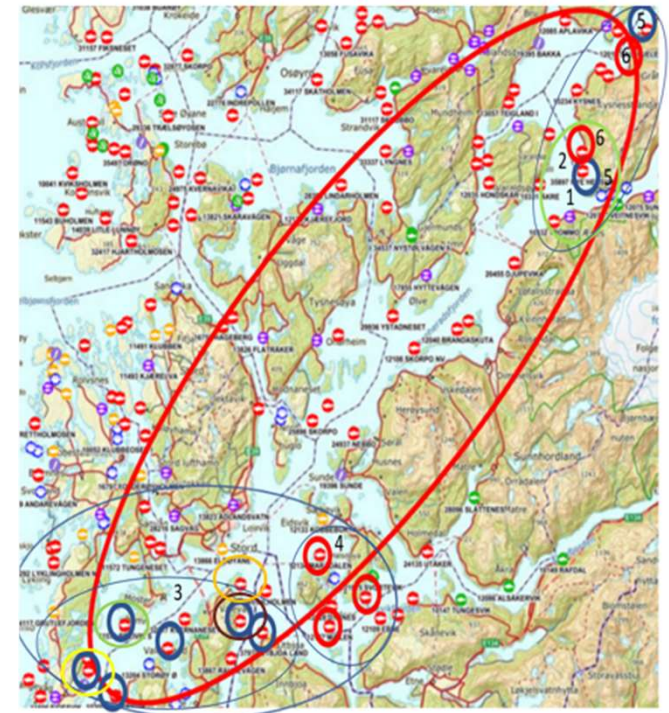
Arrangement AcuLice



- AcuLice is a computer controlled electromechanical system that calculate and produces a rank of complex acoustic sounds.
- The system is operated from a central control room and linked with local equipment via internet/5G.
- The system is normally installed between net(sometime outside) in a fish farm, and it will not disturb other operation processes
- Production time/ delivery time approx. 6 months.

Where have we investigate ?

Ref	Full scale tests	Fish farms/ Cages	2018	2019	2020	2021	2023	2024	Analyseperiode
1	Pilot 2018 - Nye Hesvik -Test	1 / 5	X	X					Uke 13/18 – 27/19
2	Pilot 2018 - Apalviknes - Control	1 / 6	X	X					Uke 13/18 – 27/19
3	AcuLice I - 2019 – Region Sunnhordland - Test	6 / 26		X	X				Uke 13/19 – 20/20
4	AcuLice I - 2019 – Region Sunnhordland - Control	3 / 17		X	X				Uke 13/19 – 20/20
5	Hardanger - 2020 - Nye Hesvik, Vikane -Test	2 / 9			X	X			Uke 13/20 – 6/21
6	Hardanger - 2020 - Apalviknes-Saltkjelen-Control	2 / 14			X	X			Uke 13/20 – 6/21
7	AcuLice II - 2021- Region Sunnhordland - Control	7 / 31			X	X			Uke 12/21 – 20/22
8	Hattasteinen 2023- Test	1 / 5					X	X	Uke 13/23 – 20/24
9	Hattasteinen 2023- Control	3 / 15					X	X	Uke 13/23 – 20/24
	Sum Control	16 / 83							
	Sum Test	10 / 45							



- Total fish farms 36, cages 128. ~18 million fish
- Continuously from 2018 – 2024, 7 years, Average per trail, 58 weeks.
- Following Hattasteinen & Hesvik through Four Seasons. With and without AcuLice

Sumerizing results from all full-scale tests in period 2018 - 2023/2024

- ✓ No negative findings regarding fish wealth, mammals and clean fish.(UiB, AkvaPlan Niva in 2018, 2019 and 2023)
- ✓ **Reduced delousing above 50%**($p < 0,001$) and **Increases the production time** before delousing is needed, 38%($p < 0,001$)
- ✓ **Significant changed behavior and physical changes**, investigate detail conditions from above 15.000 lice in every stages(food in stomach, placement, dead and transparency)
- ✓ **Significant less adult female** (38-61%) and **Scottish sea lice**(53-82%) and significant and **higher mortality**(40-59%) in all stadium of sea lice.
- ✓ **Lower level of adult female in test farm when they executed delousing**, ($p < 0,005$), slow down the rate of accumulation.
- ✓ **Larger relative drop** of lice when delousing, 82% Vs. 75%($p < 0,04$)-(reduced robustness of the sea lice)
- ✓ We found significant increasing of number of sea lice when increasing distance from AcuLice source(63%)
- ✓ Repeating pattern over a longer period of time from 2017 – 2024, with and without AcuLice(Hattasteinen & Hesvik). Reduced delousing 72% in periods with AcuLice.
- ✓ **The model shows that we don't need to execute delousing, if all farms in same area have the system installed.**



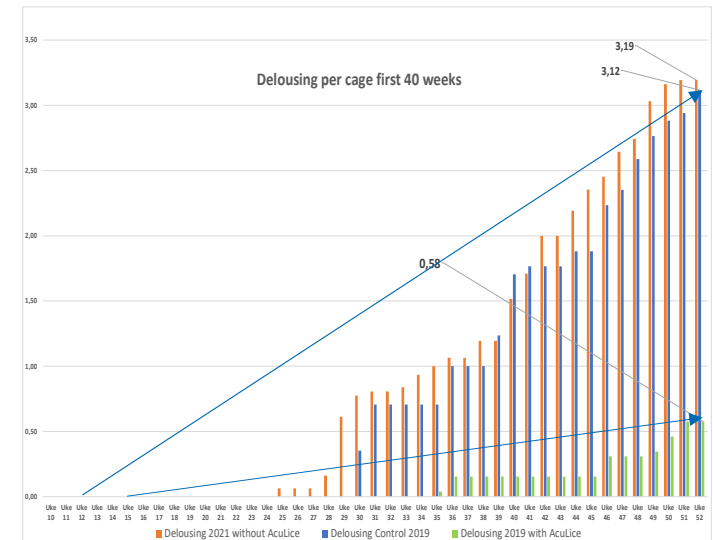
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Hattasteinen 2017-2024-AcuLice(9 net)	1,44	11,19	2 seasons
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Difference	66,47 %	0,53	
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Nye Hesvik 2016-2022-AcuLice(9 net)	1,00	10,88	2 seasons
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Difference	76,92 %	0,71	
T.test(2-side)	$P < 0,001$		
Average reduced compared to Control	71,70 %		
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Number of delousing time series

50-70%

Number of delousing per region-project



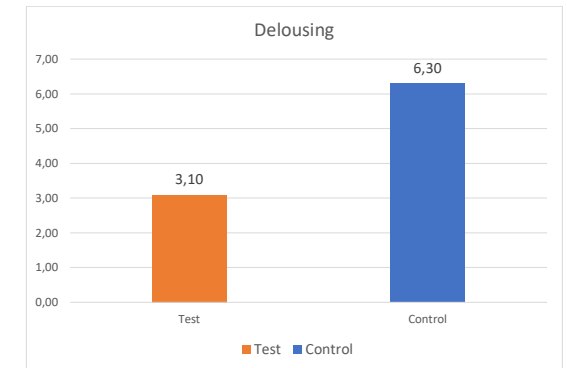
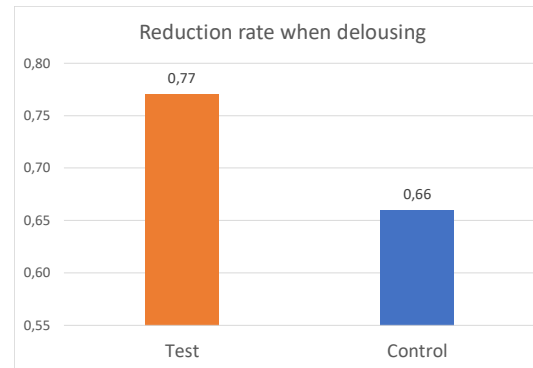
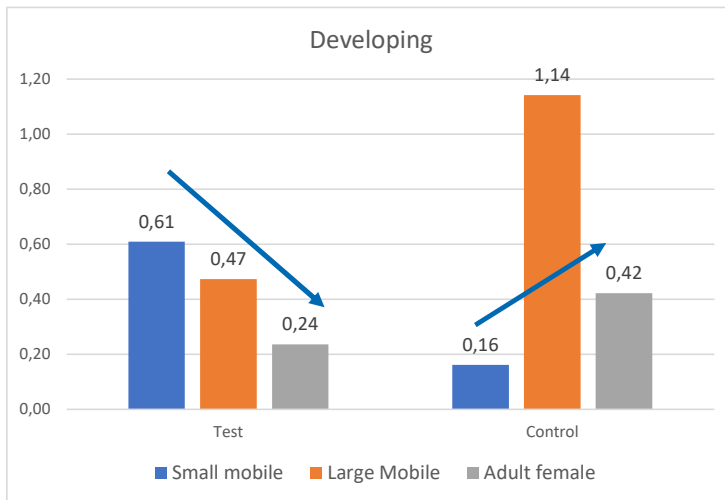
After 40 weeks, 18-19% of delousing in AcuLice with compared to control.

Findings from AcuLice I - Region full Scale test 2019

- Does the test give reduced number of sea lice, reduced robustness and delousing according to the hypotheses ?



Location	PA1	Pa2	A. female	Delousing	Reduction rate w/ delousing	Amount Adult female w/ delousing	Normalized delousing
Test	0,61	0,47	0,24	3,10	0,77	0,69	1,81
Control	0,16	1,14	0,42	6,30	0,66	1,18	6,30
Difference	74 %	59 %	44 %	51 %	14 %	42 %	71 %
T-test	p<0,001	p<0,001	p<0,001	p<0,001	p<0,02	p<0,001	p<0,02



- The result shows statistic significant reduced number of Sea lice, reduced robustness and reduced number of delousing in test compared to control farms.

Findings from AcuLice I - Region full Scale test 2019 Testfarms (6/25), Control farms (3/17)



➤ Does the test give indication according to the hypotheses about biological changes or behavior ?



Normal placement



Increased number at head



Increased number of transparent

Behandling	Andel kjm på hode	Andel PA2 på hode	Andel PA1 på hode	Andel gjennomiktig
Test farms	7%	11%	16%	29%
Control farms	2%	5%	7%	11%
T.test(2 sidig)	P < 0,002	P < 0,0001	P < 0,0001	P < 0,0001

Location	Merder	Antall undersøkt fisk	Registrert(Pa1, PA2, Kjm)	Antall kjm
Testanlegg	26	17160	20132	3361
Kontrollanlegg	17	11220	14627	3244
Sum	43	28380	34759	6605

➤ The result shows statistic significant different behavior and biological changes between test and control farms.

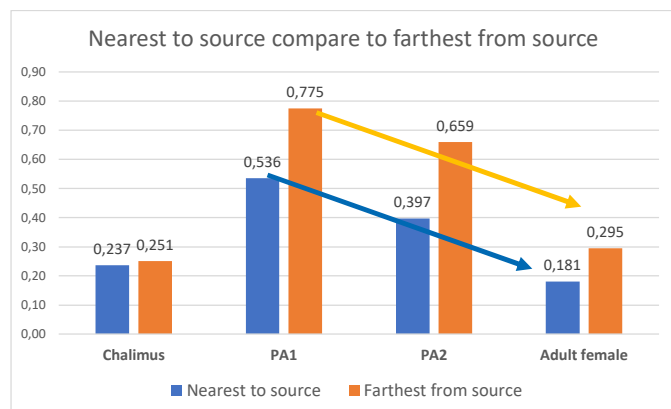
Findings from AcuLice I - Region full Scale test 2019

- Does the test give reduced effect with increasing distance from AcuLice, according to the hypotheses ?
- Compare results internal in test farms –cages sorted by nearest(median 34 m) and farthest(median 100 m) from source.
- Same facilities, same conditions.



Position	Chalimus	PA1	PA2	Adult female	Delousing	Distance from source
Nearest to source	0,237	0,536	0,397	0,181	2,000	34
Farthest from source	0,251	0,775	0,659	0,295	3,000	100
Increasing/decreasing %	5,82 %	44,69 %	66,14 %	62,68 %	50,00 %	
T.test more /less	0,3758	0,0491	0,0039	0,0028	0,1468	

- ✓ Significant higher number of average Sea Lice when increasing distance from source. Not Chalimus and number of delousing.



- ✓ We observe that both groups exhibit the same developmental trend from PA1 to adult female

- The result shows strong indication of different between nearest to source and farthest from source.
- Even it not significant, interesting to see that number of delousing increasing with 50% when increasing distance.

Modell

The model shows a lot of new dynamics both internal and external effects as for example from delousing from neighbors

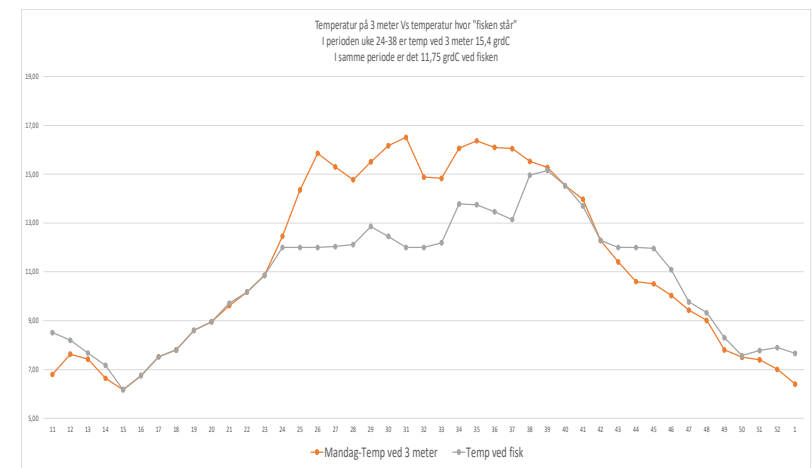
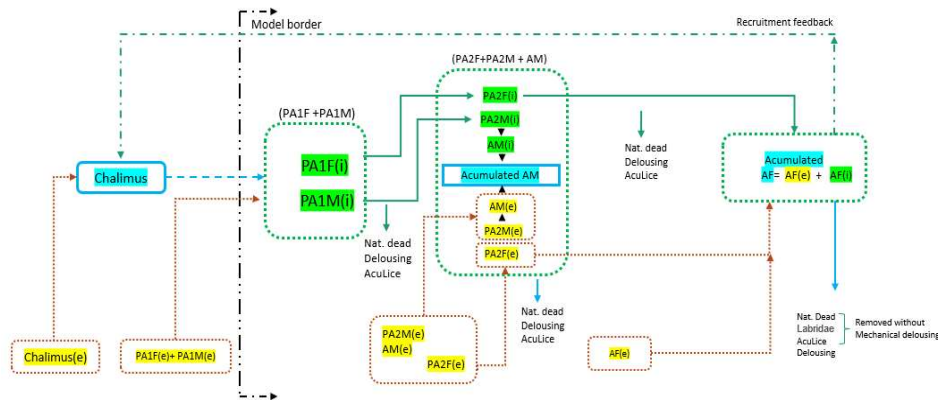
We follow the developing from small registered Sea Lice to Adult female.



Internal sea lice means lice that are registered as PA1 and its biological development to AF and AM, marked with green - index (i) - See boxes and lines in green. Sum of values in green dotted boxes are observed.

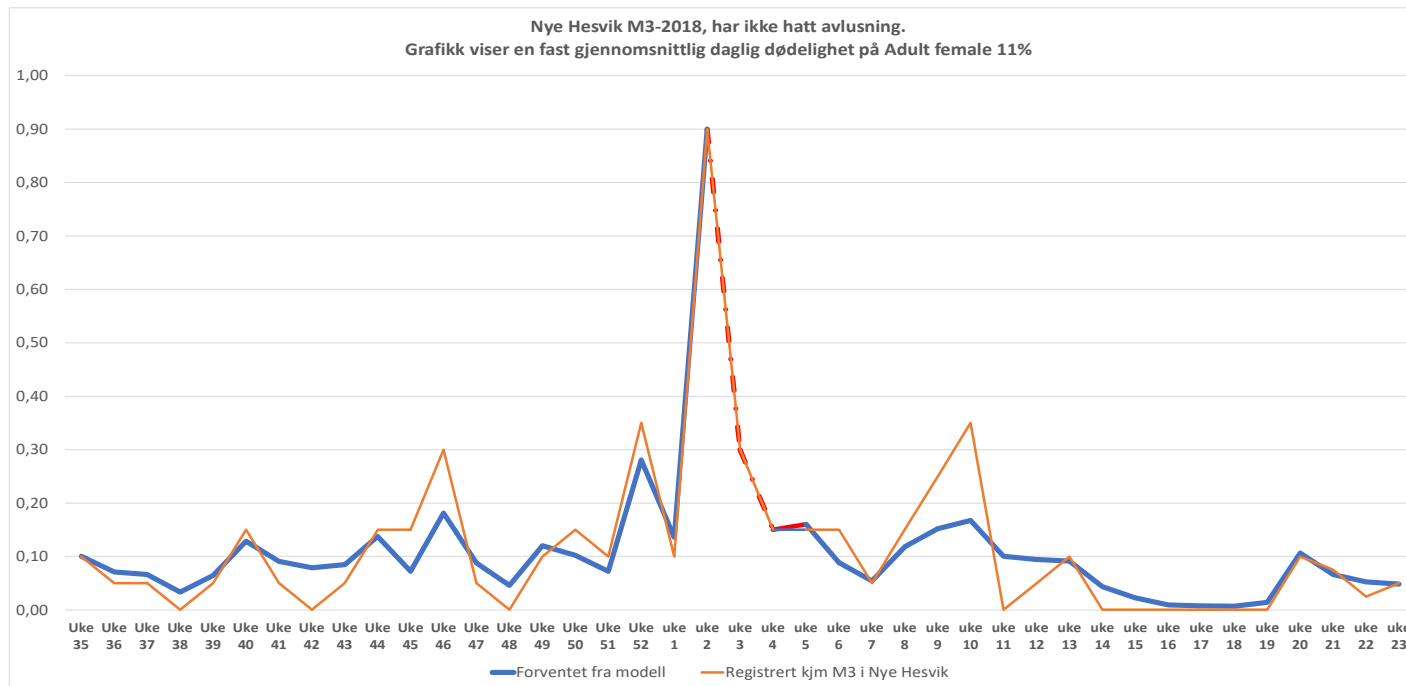
External sea lice developed from different stage outside the net are labeled yellow and index (e). See the red dotted boxes and lines. Values within red boxes connected with dotted red lines represent development of external sea Lice.

Accumulated externally and internally sea lice in turquoise



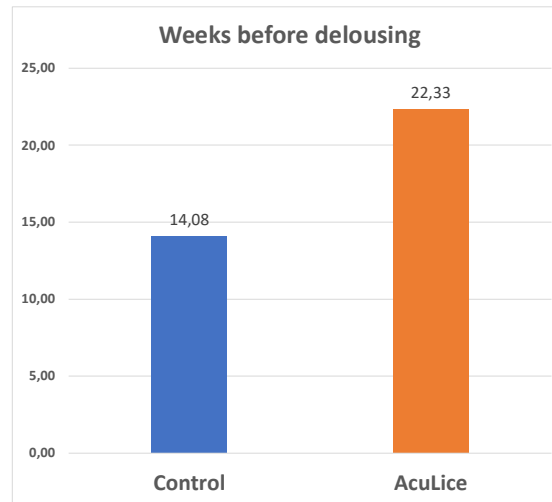
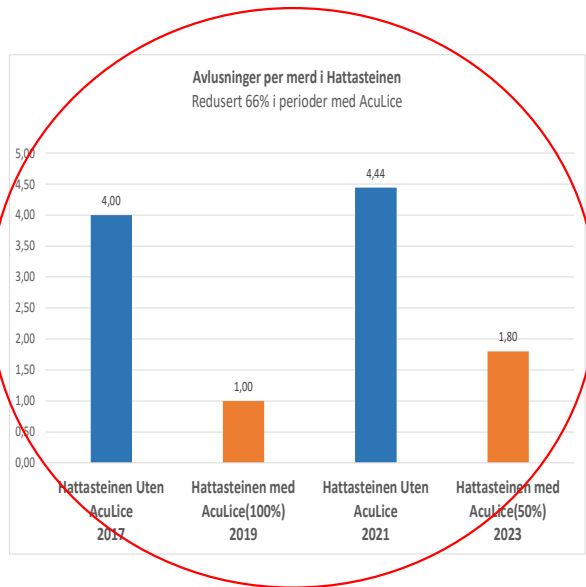

- It is a lot of interesting information from this model.
 - Shows the external Sea Lice in all stage and how the internal lice developing
 - Shows gender composition in the stage large mobile. Deviation +/- 0,49% compared to the physical registered.
 - No farms with AcuLice develops number of Sea Lice from internal mobile to the lice limit.
- From the model its show's significant different daily and increased mortality in the test farms compared to control. ➡

Same cages where the model shows estimated number of Sea Lice(blue graphic - raw data orange)



- No delousing in the period.
- The model calculate an average daily mortality through the production period 11%.

Delousing & number of weeks before delousing in Hattasteinen 2017 – 2024

Location	Pen	Delousing	Weeks before delousing	Treatment	Year
Hattasteinen	M1	4	6,00	Control	2017
Hattasteinen	M2	4	6,00	Control	2017
Hattasteinen	M3	4	7,00	Control	2017
Hattasteinen	M5	4	7,00	Control	2017
Hattasteinen	M3	4	18,00	Control	2021
Hattasteinen	M4	4	18,00	Control	2021
Hattasteinen	M5	5	18,00	Control	2021
Hattasteinen	M6	4	18,00	Control	2021
Hattasteinen	M8	4	17,00	Control	2021
Hattasteinen	M9	4	17,00	Control	2021
Hattasteinen	M10	5	17,00	Control	2021
Hattasteinen	M11	5	17,00	Control	2021
Hattasteinen	M12	5	17,00	Control	2021
Hattasteinen	M1	1	27,00	AcuLice	2019
Hattasteinen	M2	1	27,00	AcuLice	2019
Hattasteinen	M3	1	26,00	AcuLice	2019
Hattasteinen	M4	1	26,00	AcuLice	2019
Hattasteinen	M4	2	19,00	AcuLice	2023
Hattasteinen	M5	2	19,00	AcuLice	2023
Hattasteinen	M6	2	19,00	AcuLice	2023
Hattasteinen	M10	2	19,00	AcuLice	2023
Hattasteinen	M12	1	19,00	AcuLice	2023
AcuLice		1,44	22,33		2019 & 2023
Control		4,31	14,08		2017 & 2021
Difference		66,5 %	37,0 %		
T.test(2-side)		0,0000	0,0008		

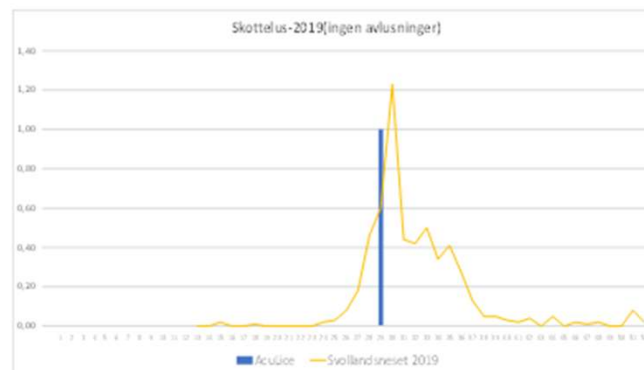
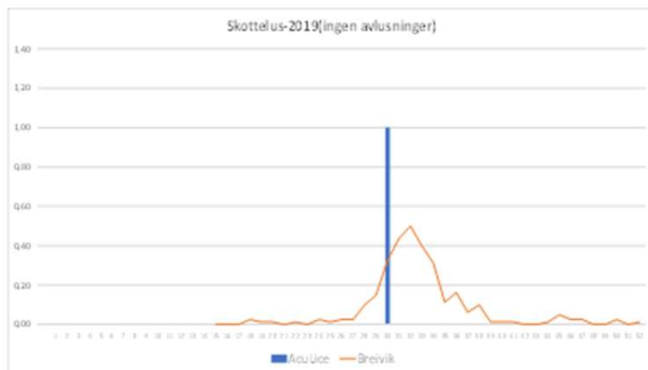
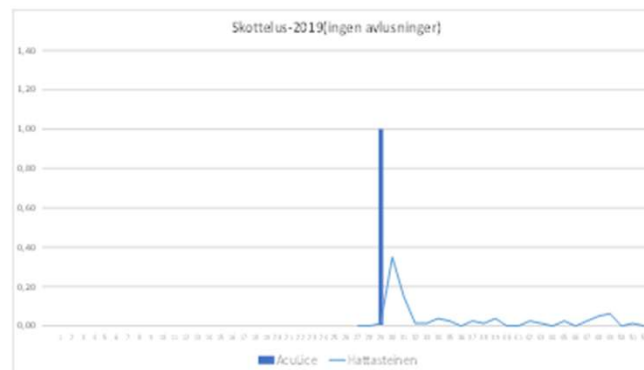
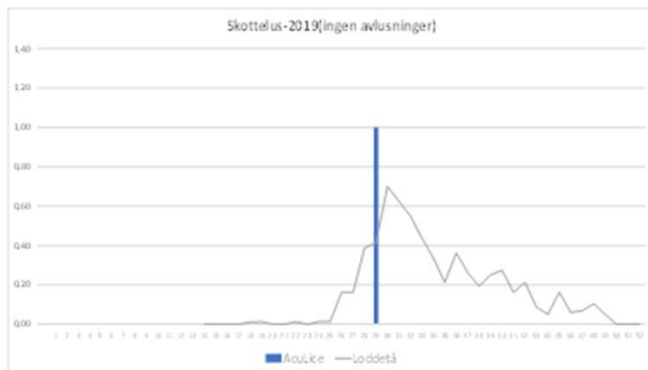
We have followed Hattasteinen for a longer period and searched to see if we can find any pattern when the location has had AcuLice and when it has not.

✓ Significant drop in number of delousing in Hattasteinen in periode with AcuLice, **reduced with 66%(p<0,01)**

✓ Significant longer production time before first delousing in testfarms, 22 Vs. 14 (p<0,01)

➤ We found a recurring pattern for each period with AcuLice compared to period without AcuLice

Caligus elongatus (skottelus)



Fish welfare/ environmental effects



Salmon welfare

Wrasse/lumpsucker welfare

Porpoise

Harbor seal

Shrimp

Så langt ingen effekter

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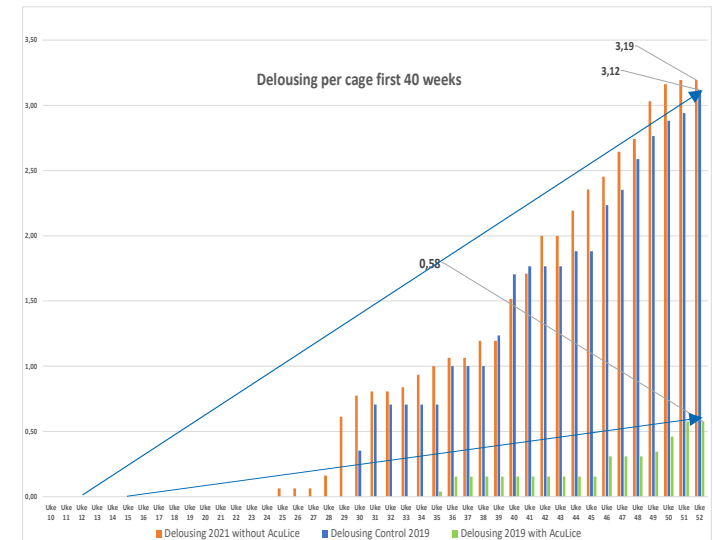
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