Use of Ultrasound to control Chilean sea lice (Caligus rogercresseyi)

Endemic species of the Chilean coastal sea.

Male

Female
Sea Lice has cost around USD 300 million dollars per year to the chilean salmon industry since 2009.

Also this ectoparasite was among the principal causes of the ISA outbreak in 2009, which severely affected the industry.
Lifecycle of Caligus Roger Cresseyi - 26 to 45 days

Bounded by suction
- Adult stage - 20/30 days

Planktonic Life - 2 days
- Egg
- Nauplii I
- Nauplii II
- Copepod

Juvenile stage - 10 days
- Chalimus I
- Chalimus II
- Chalimus III
- Chalimus IV

Bonded by frontal filament

- Adult female
- Adult male
The innovation of USonic is the capacity to control sea lice population through the application of ultrasound waves.

It has been shown that the use of ultrasound applied underwater, directly in the fish pens, does not affect salmon, fish, neither marine mammals. This is due to the low power and frequencies used: Only 20 watts per transmitter, and 20 KHz.
EXPERIMENTAL SCALE IN TANKS

Evaluation of possible effect on fish. The experiment lasted 32 days. **We used 2 tanks one 'with' and the other 'without' ultrasound application.** 20 fish were placed in each tank, marked and controlled individually.

![Diagram showing two tanks: one with ultrasound (US) application and another without (caligus).](Vista Lateral)  (Vista Aérea)
Performance results (% growth, SGR and FCR), demonstrated that fish and evaluated parameters are not affected by the application of ultrasound.
APPLICATIONS OF ULTRASOUND

ULTRASOUND: It is represented by the Sound waves beyond the capacity of human hearing (20,000 Hz).

There are several uses of ultrasound: internal characterization of materials, water purification, Algae control in water ponds, insect and mouse repellent, among others.

In Particular

MEDICINE:
There are several applications. The best known are: fetal imaging, Doppler Techniques for heart, blood flow evaluations, etc.

NAVIGATION AND FISHING – SONAR:
Echolocation used in Navigation to detect underwater objects. Also application in fisheries to evaluate distribution and size of fish stocks.
USONIC Ltda. is a Chilean company created to help the Salmon Industry to control harmful organisms in the water column (such as sea lice larvae, microalgae and fouling). It was created under a project co-financed by the Chilean National Agency of Economic Development (CORFO).

The technology and their specific applications are in the process of being patented in Chile and in other countries (PCT Protocol):

- 1° A method for removing specific larvae from the zooplankton.
  
  # 2010933 – Chile

- 2° Application of underwater sound waves to clean and maintain nets in sea cage fish farming.

  # 200702238 – Chile

- 3° Use of ultrasound against specific larvae – Worldwide Patent – PCT/CL 2011000051
  
  • In Norway patent application has been initiated.
To study the effect of ultrasound waves over caligus, we run tests in aquariums. We evaluated effects over juveniles, adults, spawning females and the first stages of caligus, known as nauplii larvae.

The result did not show significant effects over juvenile to adult stages, male and female.

However, strong effects were evident over the early stages, nauplii, showing almost an instantly significant structural destruction.
The images show the effect of ultrasound on larvae. Internal organs are destroyed.

Normal Nauplius

Nauplius after the effect of ultrasound
Lifecycle of caligus rogercresseyi - 26 to 45 days

Bounded by suction

Adult stage - 20/30 days

Female with eggs

Adult Female

Adult Male

Egg

Nauplio I

Nauplio II

Planktonic Life - 2 days

Juvenile stage - 10 days

Bonded by frontal filament

ultrasonic target
Results in sea cages
PILOT SCALE   In two salmon farms in Southern Chile. Only two (2) ultrasound transmitters were installed in one cage during 3 weeks until harvest. Total parasite load of juveniles decreased to an averaged of 0.5 per fish, without use of chemical antiparasitic. (blue line)

The ultrasound was not applied to all the farm, and still had a control over total number of sea lice in it (yellow line).
PILOT SCALE  2 USonic transmitters were installed in cage 112 during 5 weeks. It was observed that total parasite load decreased clearly in the cage treated with ultrasound since the beginning. Although general tendency was a decrease in sea lice load in all farm, this was more marked in the treated cage.
FULL SCALE APPLICATION OF ULTRASOUND IN SALMON FARMS
Diagrams of the full scale trials

8 Ultrasound transmitters were installed in a Salmon module of 16 cages, each 30 x 30 m. and 25 m. depth.

This trial run for 3 month and the transmitters were shut down to evaluate the effect of “no ultrasound” in the same previously treated cages. Then equipments were reactivated for an extra month to test if the control effect was retaken.
FULL SCALE

Results for treatment with ultrasound in a farm, are presented in the following figure, which shows also antiparasitic treatments. Total Adult count (in red) and young stages (in blue).
- Antiparasitic chemical treatments are more frequent (even each 15 days) from winter to spring (warmer water) and bigger fish.

- When ultrasound was introduced, chemical antiparasitic treatments become less frequent, despite the environmental challenges and fish size.

- Ultrasound treatment was kept for 13 weeks reducing sea lice load. Then equipments were turned off during 5 weeks, showing a clear increase of total load and particularly of juvenile Caligus load. Finally both were reduced again when the ultrasound was reactivated.

- In general, we noted that under ultrasound application load standard deviation is smaller in the samples, suggesting a widespread effect on the population.
CONCLUSIONS

- Ultrasound application has shown experimentally a control effect over sea lice in Chile, destroying the first stages of Caligus rogercresseyi (Nauplius).

- The lethal effect over nauplius is also evidenced in full scale trials. In fact, control of total load and specifically of nauplius stage was clear in traetted sea cages of full scale modules.

- In general, when ultrasound is used, standard deviation of load is smaller in the samples, suggesting widespread effect over the population.

- The ultrasound has almost none effect over adult sea lice, which means that re-infestation from them can occur but interrupted again in nauplis phase.
CONCLUSIONS

- In general the application of ultrasound reduces frequency of antiparasitic treatments, but this effect will be modulated by environmental challenges that can cause re-infestation.

- **USONIC ultrasound technology** is effective to reduce Sea lice load in Atlantic Salmon.
After 5 years investigating ultrasound to control Sea Lice, and after 8 full scale trials in the sea, We do not have doubts that this is a great technology, specially with no environmental effects, that should be consider among the solutions to control sea lice in salmon farming in Chile.

Results were almost the same in all the experiences, very good indeed, with reductions between 30 to 50% in total sea lice loads per fish.

Further experiences must be run in Norway and other countries, to control local sea lice species. Certainly we are optimistic about to obtain very good results again, based in this proven effective technology.

Rodrigo Prado
Usonic ltd.
Thank you very much to GAA for this beautiful award, also to all people that truly believe in Innovation ...

for further questions, please contact

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