ANSS Summary Report

AA-01-043

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Summary
The ANSS – the Ace Aquatec Silent Scrammer – successfully completed six months of trials at four sites in Scotland between December 2001 and June 2002. At sites where there had previously not been a seal scarer the system was 100% efficacious.

The speed and efficiency with which the Ace Aquatec Silent Scrammer (ANSS) teaches seals is remarkable. After a handful of scrams, predation ceases and the system can revert to LISTEN mode. The invention of AUTO mode allows the machine to automatically switch between LISTEN and SCRAM. This mode has made it possible to dramatically reduce the scram rate from 0.5 per hour (SCRAM mode) to less than 1 per day. The Airmar dB II Plus thus makes over 1,000 times more noise than the ANSS.

The ANSS was not able to stop predation at the 2nd trial site where it took over from another seal scarer. Although a minor fault in the system design was subsequently found it could not, by itself, explain this result. It is probable that the seal – which was actively predating at the site prior to the ANSS – had become habituated to sound. Although the ANSS has a much more complex noise structure than the continuous noise-maker it replaced this difference was insufficient to halt predation.

It is well known that predation stresses the fish which results in poorer growth. Ace Aquatec has already shown that Silent Scrammers can monitor this and evidence collected during the first trial confirmed this finding yet again. It was also shown that seal attacks do not necessarily result in fish mortality but do stress the fish for several days. It is postulated that these unsuccessful attacks are frequent and may explain some of the variability in growth rates.

All users (who expressed an opinion) reported that the system was easy to use, informative and trouble-free. One of its most attractive features seems to be that an attached battery lasts for weeks not days.

The Ace Aquatec Silent Scrammer would seem to have a valuable role to play in monitoring and relieving stress in farmed fish. The trials proved that the system is efficacious, reliable, easy to use and produces so little sound that seal habituation is unlikely and disturbance of cetatea is remote.

Consequently Ace Aquatec has no hesitation in recommending the ANSS as a humane, non-lethal alternative to anti-predator netting and suggests that the system be the anti-predator control of choice. [?]

1 [?] Ace Aquatec, 2002.

1. Introduction

The Ace Aquatec Silent Scrammer – ANSS – uses the same principles as the Silent Scrammer (AA-01-032) but applies them in a more intelligent manner.

The Silent Scrammer was a modification to the Ferranti-Thomson scrammer. Whilst it improved the performance of the scrammer many-fold it grafted new technology onto old. The ANSS (see Figure 1) is a completely new design and incorporates over 10 years of experience with seal scarers.

Some of these innovations might seem small but they all add up to a more reliable, intelligent, robust and efficacious design.

1.1 Batteries

The performance of all seal scarers is dependent on the quality of their power-supply. Manufacturers have traditionally blamed poor batteries on poor system performance. Ace Aquatec was able to establish this link in AA-01-032. As a consequence the ANSS has internal batteries which the machine intelligently re-charges from an attached battery or mains electricity or solar cells. By making the ANSS responsible for its own power-supply every scram is a “perfect” scram.

The traditional power source for seal scarers is a 12V leisure battery. At sea these batteries rapidly deteriorate with the result that fish farms rarely have batteries capable of being fully charged. The ANSS has been designed to expect this sort of battery and quietly sips at the power source. This, along with a very low-power design, means that ordinary farm batteries last for weeks.

Figure 1 – The Ace Aquatec Silent Scrammer (ANSS)

1.2 Intelligence

As far as Ace Aquatec is aware the ANSS is the world's first seal scarer to contain a microprocessor. As a consequence the ANSS can and does "learn" about the fish it is protecting and can be made to react to circumstances without the need for operator intervention.

To tell the ANSS about the fish the Trigger Devices were altered to telemeter the degree of panic of the fish. This 'V' standard Trigger has an additional "beep" which the ANSS control box decodes. The ANSS remembers several weeks worth of data to discriminate between fish which accidentally brush a detector from those produced by panicking fish, whatever their size and whatever the stocking density.

A second innovation was the AUTO mode which allows the ANSS to automatically swap between LISTEN and SCRAM. The AUTO mode was introduced during the proving trials to reduce the reliance on the operator spotting the beginnings of a seal attack. The machine is constantly monitoring all triggering activity and will flip from LISTEN to SCRAM within an hour of a seal harassing the fish.

The ANSS shares this knowledge with the operator using an LCD display who simply needs to note down the numbers each day to build up a profile of the monitored fish and the status of the system.

The loud irritating noise of the scrammer has been improved by a custom-designed transducer, a wider range of available frequencies under the control of a dedicated microprocessor with 64 different scramming sequences. To make each scram different the microprocessor uses underwater noise from the sea to pick a sequence.

1.3 Robust design

The ANSS has been designed to withstand rough handling with the result that it can (occasionally) be accidentally dropped, stood-on and generally be abused without damage. The underwater body will withstand immersion to 100m depth, its cable has a breaking stain of over 4 tonnes, its connectors may be mated underwater. Above water the control box has been shrunk for better water integrity and contained within a tough box (APP) that houses an attached battery. The APP starts life as a tool-box designed to be bolted to the flat-bed of a pick-up truck and so is impervious to most things.

1.4 Efficacious

The Ace Aquatec Silent Scrammer was predicted to be more efficacious than previous designs because:

? The internal batteries maintain scramming performance.
? The probability that each scram is administered to a seal in the act of attacking the fish is increased so the seal would more quickly associate its behaviour to the sound of the Trigger Devices and stop.
? By making sound so infrequently its sudden appearance would have a greater effect on the seal.
? By making a wider variety of sounds the seal has little chance of habituation.
? Less demanding maintenance improves system availability.
? Better quality of information to the user increases confidence in the system and so improves maintenance standards.

Any design is only as good as its performance in the field. Three prototypes were built (one for spares) and two were deployed during the period December 2001 to June 2002. In all the ANSS was deployed at 4 sites: one for 4 months, one for two months and two for one month each.

2. Efficacy

At three of the four trial sites the system proved 100% efficacious.

2.1 First Trial

At the first trial the system was deployed in LISTEN mode (zero scramming) for the first 7 weeks. During week beginning 11th February 2002, 32 fresh seal morts were found and the decision was made to switch the scrammer to SCRAM mode. The following week 7 seal morts (all old) were recovered and the scrammer was switched back to LISTEN for the remainder of the trial (to 26th March 2002) without further loss.

2.2 Second Trial

The ANSS was not effective at the second trial site. Predation at the site was on-going even though it was being protected by another seal scarer. The ANSS was swapped on the 29th January 2002 but mortalities increased to 462 fish during the first week. The trial was temporarily halted for investigation. Improvements in the detection algorithm were made and the systems were again swapped on the 11th March 2002. Predation during the first week fell from 462 to 297 but rose to 803 in the following week and the trial was terminated. Subsequently a design error in the 'V' Trigger software was uncovered which reduced the system's performance for small fish but this was not, in itself, sufficient to explain the result.

2.3 Third Trial

The problem with the 'V' Trigger software was resolved and the system was deployed to protect a site containing smolts. The third trial also had an ongoing predation problem (50 per week) but no acoustic scarer. The system was deployed on the 1st April 2002 and no further losses took place during the trial period (to 3rd May 2002). Limited predation re-occurred three weeks after removal of the system.

2.4 Fourth Trial

On the 3rd May 2002 the system was activated at the final trial site. This site was located close to the third site and predation was ongoing. Predation ceased the following week with no further losses during the trial period (to 3rd June 2002).

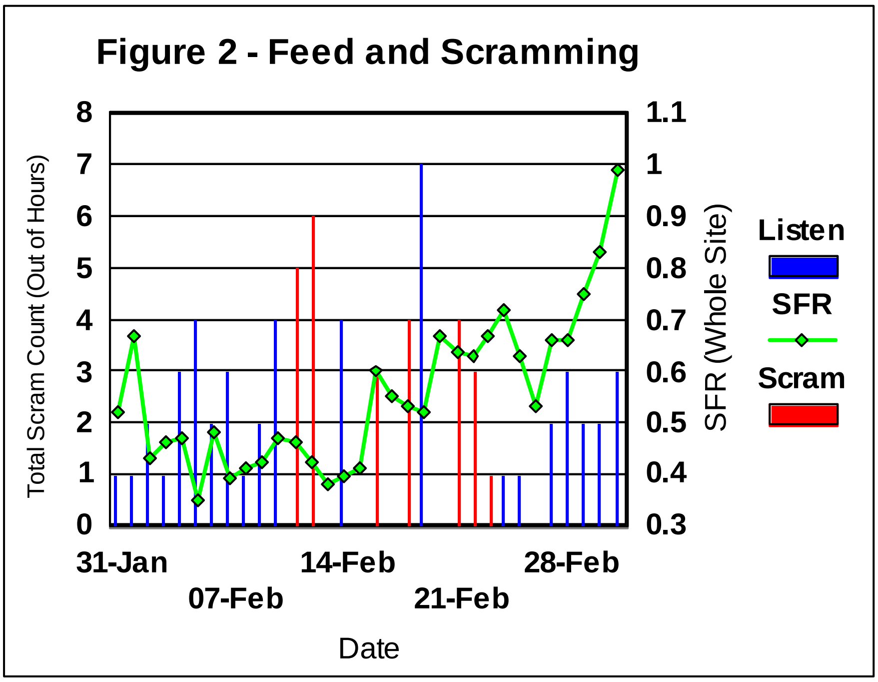
2.5 Conclusions

These results signify that the ANSS is highly efficacious against naive seals but does not work when a seal has become habituated to sound. The resident seal scarer at the second trial site had the same source level as the ANSS but was a continuous noise-maker. Habituation – when the animal's initial response to a stimulus wanes – is made more likely by repeatedly exposing the animal to that stimulus. The fact that predation at the second trial site was ongoing indicates that the animal had habituated to sound. At the time it was reasoned that the ANSS, with its more complex signal structure, would be sufficiently different to deter the seal, which was not the case. A further possibility is that the seal had impaired hearing in which case neither system would perform well.

3. Fish Welfare

As has been previously proven, a reduction in the stress levels of the fish translates into an improvement in appetite. Records at the first trial site (a large and modern farm) are sufficiently detailed to monitor growth rate by pen on a daily basis. This allowed the ANSS triggering activity to be correlated against the Specific Feed Rate (SFR).

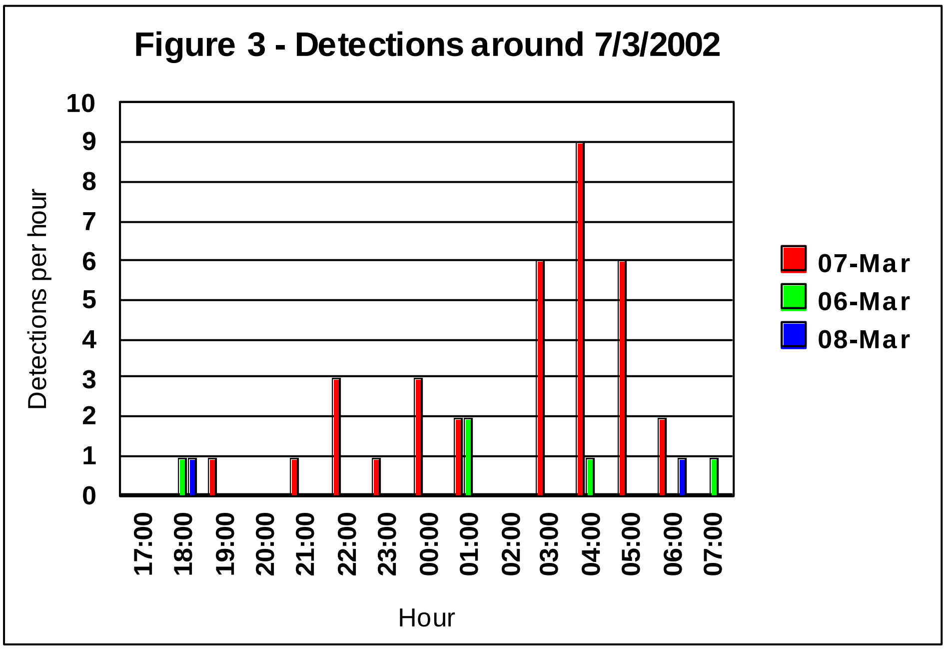
Figure 2 shows the SFR of the whole farm at the first trial site prior to and after the seal attacks around the 11th February 2002. Whilst at a low level (the 'V' standard software had not been corrected) the night-time triggering activity shows a modest rise around the 5th February. This corresponds to the lowest SFR for the month. Whilst the SFR is a variable indicator of fish growth by combining the whole farm some averaging will take place and it is evident that the depression of the SFR precedes the period of seal mortalities by several days. Growth continued to be depressed for some 5 days after switching to SCRAM mode but then rises for the remainder of the month. It is also interesting to note that the period of high triggering activity continued for 7 days after the SFR started to rise. This indicates that the seal was continuing his attacks but his lack of feeding success allowed the fish to cope with the induced stress.

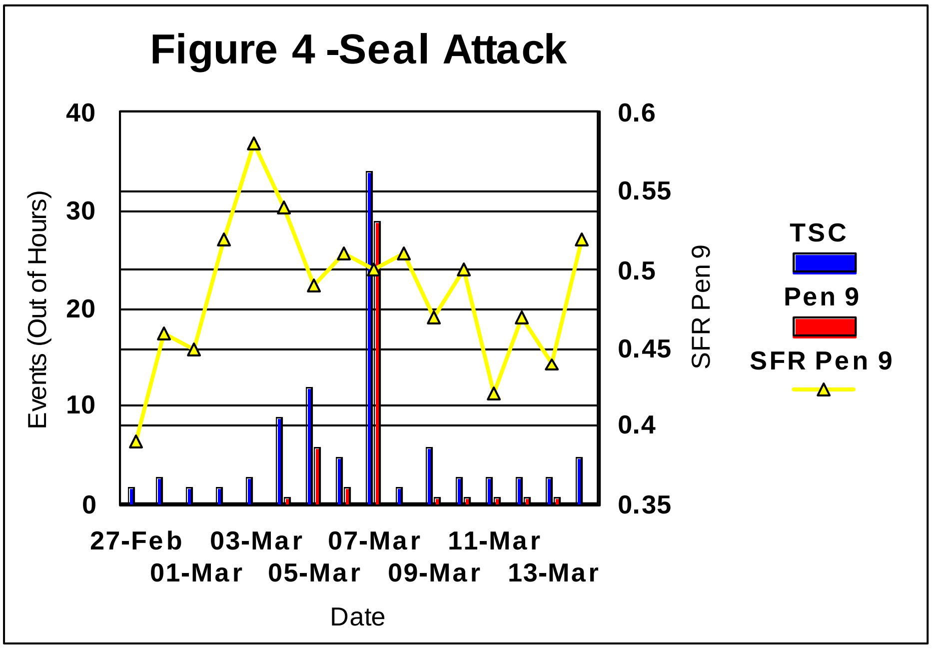


The ANSS witnessed an unsuccessful seal attack which focused on a single pen. The system was in LISTEN mode so the ANSS remained silent. On the night of the 7th March 2002 a seal attacked Pen 9. The attack spanned most of the night but was particularly ferocious between 03:23 and 06:21 on the morning of the 8th. This attack was unsuccessful and, probably because it was, was not repeated (Figure 3).

Whilst the attack was unsuccessful it had its consequences. Figure 4 shows the triggering activity of Pen 9 against the SFR of Pen 9. The SFR has had a 3 point smoothing average applied in an attempt to see the data trends. Until the 4th March the Trigger in Pen 9 had not sounded and the SFR had been on the increase. This situation reversed itself, the SFR started to fall and the proportion of Triggering events belonging to Pen 9 rose. The dramatic attack of the 7th March was successfully thwarted but the SFR did not reverse the downward trend for a further 5 days.

From this evidence it seems that the attempted predation by seals, resulting in stressed fish, is significant in explaining growth variations and the result – irrespective of mortalities - of just one attack can result in several days reduced growth.





4. Scram rates and AUTO mode

The design philosophy of Silent Scramming is make a sound only when the seal is in the act of harassing the fish. The original Ferranti-Thomson produced 5.5 scrams per hour. The Silent Scrammer reduced this to 2 scrams per hour. The ANSS has gone much further.

The farm manager at the first trial site kept the ANSS in LISTEN mode for 79 of the 90 day trial period. When seal morts appeared the system was placed in SCRAM mode. 7 days elapsed before the morts were again counted and the results suggested that the site was no longer under attack. During this period the seal was exposed to 24 scrams. The system was kept on SCRAM mode for an additional 4 days which brought the total scram count to 61. It is probable that the seal was deterred from further predation within the first 24 scrams which is fast learning on the seal's part. During the 11 days when the system was in SCRAM mode it scrammed a total of 61 times. For the 90 day period this equates to a scram rate of 0.7 per day.

Records for the second trial, against the habituated seal, are incomplete but the ANSS was scramming at a rate of 9 per hour in an attempt to ward off the seal.

The initial conflict between predator and machine at the third trial site went unrecorded but for subsequent weeks the background scram rate in SCRAM mode (Figure 5) averaged 0.5 per hour.

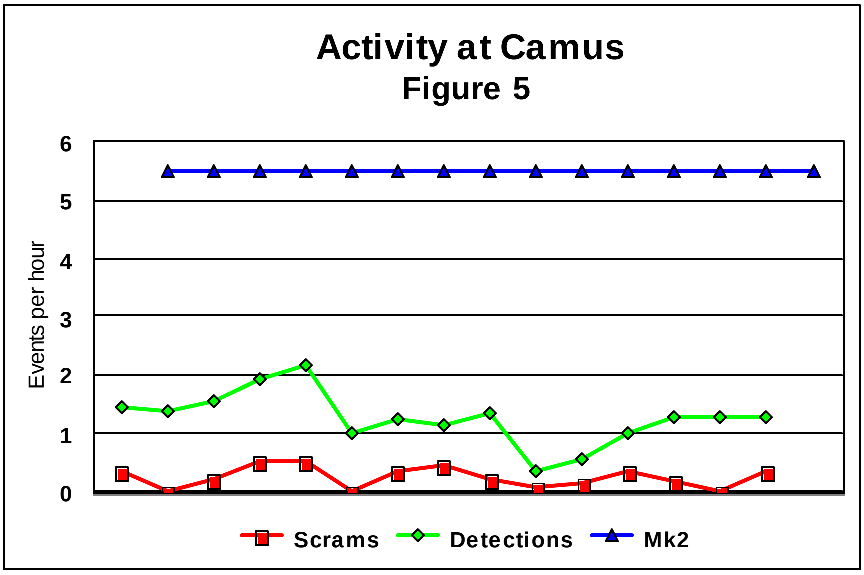
No predating behaviour was discernible from the 4th trial even though it was fully documented. Due to the proximity of sites 3 and 4 it is entirely probable that the predating seal was the same in each case and so conditioning had already occurred. In AUTO mode the system was 100% silent for 19 of the 21 days scramming a total of 19 times – a scram rate of 0.9 per day.

The evidence suggests that the seal is conditioned to the Ace Aquatec Silent Scrammer within the first few dozen exposures and this conditioning – when it occurs – is remembered for several weeks without reinforcement.

When in AUTO mode the system can reduce the scram rate to less than 1 per day.

Such a reduction in emitted noise has to reduce habituation of the seal to a theoretical possibility and should also eliminate the possibility of disturbance to small cetatea. Disturbance of small cetatea by seal scarers has been a cause for concern to environmentalists but only the Airmar dB II Plus has been studied. The Airmar dB II Plus has the same source level as the Ace Aquatec Silent Scrammer but makes noise continually. One scram from the ANSS is equivalent to the noise emitted by the Airmar in 76 seconds. Compared to the ANSS in AUTO mode the Airmar makes over 1,000 times more noise.

It would be reasonable to conclude therefore that adverse environmental impacts claimed from studies using the Airmar unit cannot be applied to the ANSS.



5. System Performance

The two ANSS prototypes suffered no system, hardware or software failures during the six-month trial period. The only significant design changes were the correction of the ' V' Trigger software and the introduction of AUTO mode. Minor design changes to the detection circuitry and associated algorithms were carried out during the trials but these were mainly "tweaks".

In practise the ANSS that went to sea in December 2001 was the same as the one removed on 3rd June 2002.

All users, who expressed an opinion, found the system easy to use, informative and trouble-free. They were impressed by the endurance of the attached batteries and were rather sorry to see the system go.

6. Conclusions

The ANSS is highly effective against naive seals who quickly learn not to attack the protected fish. The speed of conditioning is impressive and seems to last a number of weeks without the need for further reinforcement. There is every reason to think that this is the normal pattern which, if true, means that the ANSS can remain silent for extended periods of time.

From the evidence the above comments do not apply to noise habituated seals. The Ace Aquatec Silent Scrammer is fundamentally different to other seal scarers and cannot work alongside other models.

The results presented in this report go much further than simply proving that the system can scare seals. We can be confident that the ANSS is capable of measuring fish stress prior to the onset of predation and take action to avoid further stress. Breaking the cycle of predation before it starts results in better quality fish and denies the seal the opportunity to develop this unnatural behaviour.

This report has also been able to establish a link between stress by predators and growth even when there are no mortalities. Seals, being opportunistic predators, probably harass farmed fish on a far wider scale than has been previously thought because no measurement of stress has been available. It would also not surprise the author if fish on farms that are fully protected by anti-predator nets also suffer stress through predators.

The ANSS has demonstrated that silent scramming is possible and highly desirable for all: fish, farmer, small cetatea, and even the predating seal who is less likely to be drowned in anti-predator netting or shot. Consequently the ANSS is a viable, more humane and non-lethal alternative to anti-predator netting and should, in the opinion of the author, be the predator control tool of choice.