TEMA
Nr. 26 - Oktober 2014

Testing virtual fences for reindeer

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Virtual fencing systems have been developed for several animal species. The Norwegian NoFence system is guided by pre-determined GPS positions. During the winter of 2011 and 2013 we tested two prototypes of the NoFence collar under controlled conditions. The first prototype had little influence on animal behaviour but the second prototype showed important improvements. The system was however not successful in controlling reindeer movements using warning signals and low current electrical shocks.

In theory, virtual fencing systems may be useful to keep animals away from dangerous roads and railways as well as controlling them within a limited grazing area. Remote movement of these virtual fencelines may also be a possibility. The costs of physical fences are high, they need repair and in several areas such fencing is not viable due to topography and yearly damage by snow.

The NoFence virtual fence system is operated using a sound warning signal followed by a low current electrical shock if the animal does not turn around and crosses the GPS fenceline. The use of electrical stimulation is debated and may inflict stress on the animal. Sheep and goats have shown large individual variation in their ability to learn the system and behave consistently according to the NoFence technology. The aim of our study was to investigate the effect of this new system for virtual fences on reindeer behaviour and welfare.

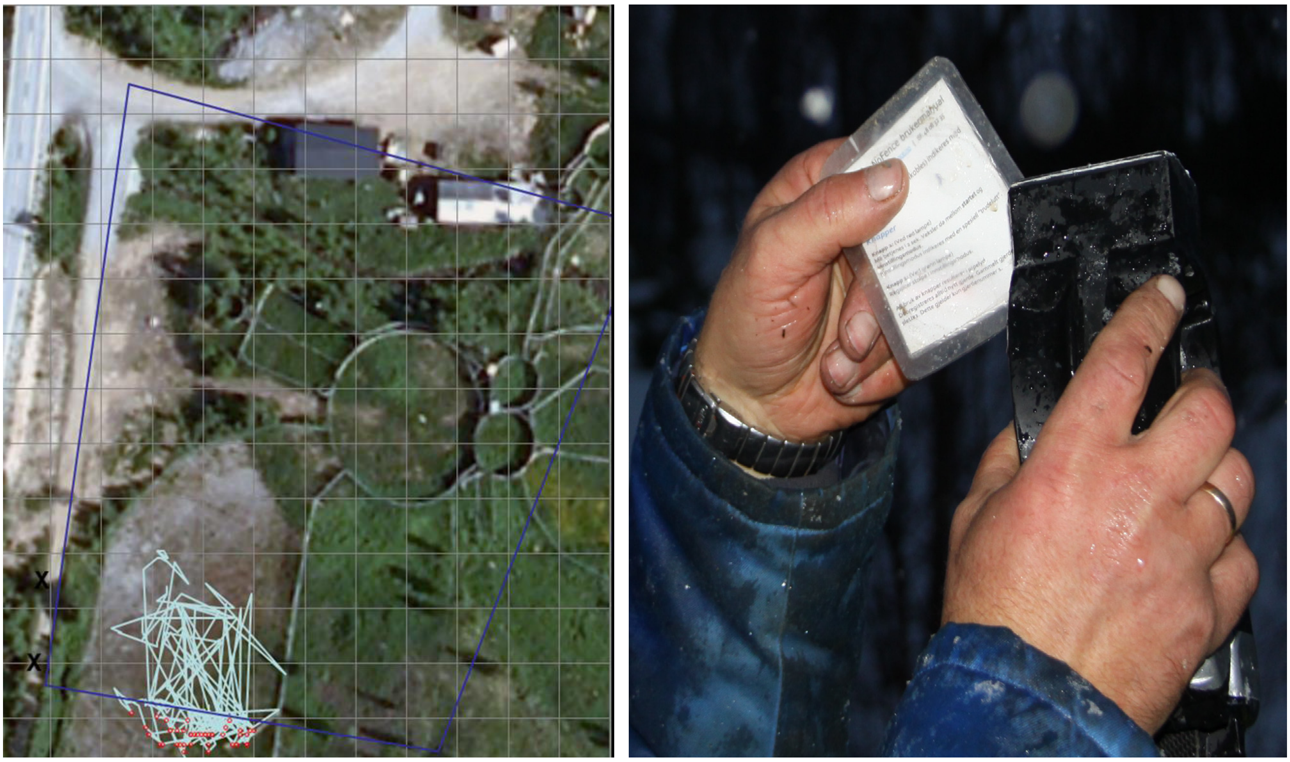
A reindeer is instrumented with a NoFence of prototype 2 collar, Tverrvatnet Mo i Rana, 2013.

Materials and methods

Two prototypes of the NoFence system were tested; prototype 1 in March 2011 and prototype 2 in November 2013. Experiments were performed within the same reindeer enclosure in Tverrvatnet, Rana municipality. We instrumented groups of 6-8 reindeer with the NoFence collars and observed their behaviour and reactions towards a virtual fencing line, set just inside one end of the visual, physical fence (picture 2).

The collars were programmed with pre-determined safety measures. If an animal should cross the virtual fenceline and continue to travel away from it the collar would shut down and not administer more than four electrical shocks until the animal again was registered within the designated fenced area.

NoFence collar prototype 1 (left) and prototype 2 (right).



Physical fencing system and virtual fenceline (blue line) set by GPS endpoints in each corner. The line which animals could cross was just within the lower end of their experimental enclosure.

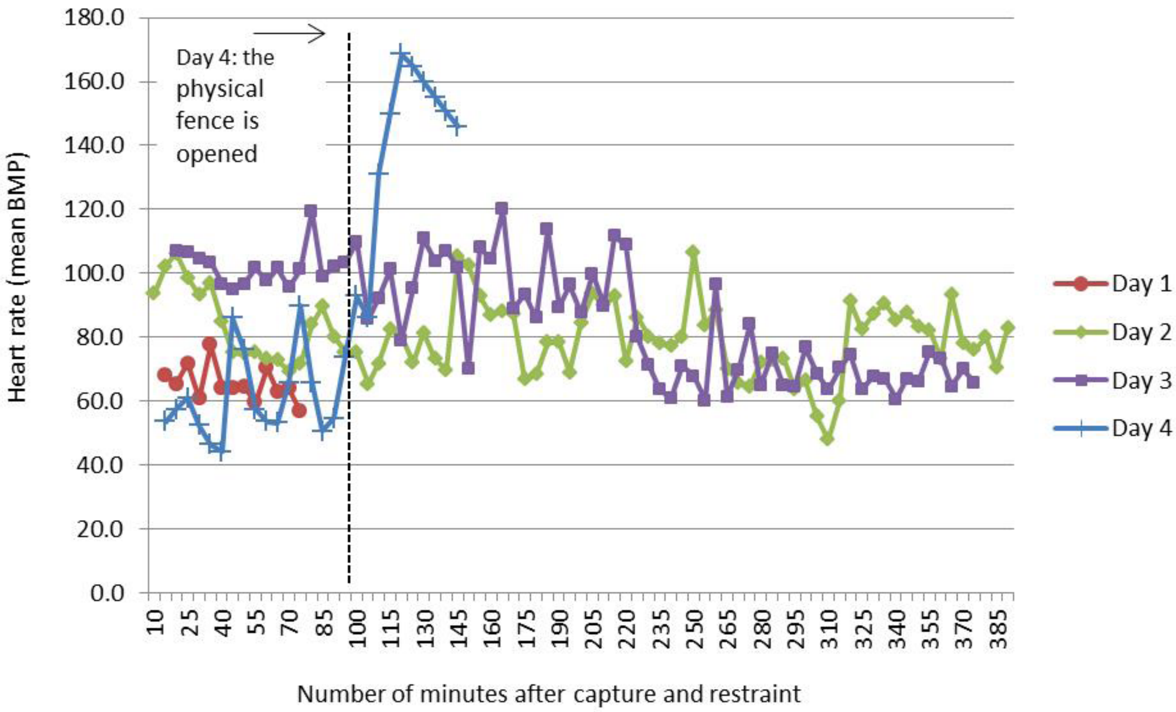


Figure 1. Reindeer showed a marked increase in heart rate as the physical fence was opened.

All reindeer crossed the virtual fenceline (here indicated in red) and ran out of the enclosure, as the physical fence was opened.

Instantaneous sampling of each animal's behaviour was performed using a predetermined ethogram of behaviours in five minute intervals. Feed was provided once a day and animals were gathered and caught for adjustment of NoFence collars every day during the test periods.

In 2011 the reindeer were also fitted with Polar heart rate monitors in order to get an objective measure of stress using heart rate variability calculations.

Results from testing prototype 1

Prototype 1 of the NoFence collar was tested during March 2011. The reindeer displayed very few behavioural changes and no such changes could be connected to signals from prototype 1 collars. During the period of habituation, wearing inactive collars the reindeer had a mean heart rate of (mean ± Std.) 78.1 ± 12.2 beats per minute (bpm). The variation in heart rate ranged from a maximum of 106.4 bpm to a minimum of 47.9 bpm.

In the period with active NoFence collars the reindeer had a mean heart rate of 87.7 ± 27.1 bpm. The heart rate varied from a maximum of 168.6 to a minimum of 44.0 bpm. On day four of testing we registered a large increase in heart rate as the physical fence was opened (Fig 1).

No animals changed directions or learned to stop when hearing the warning signal and all animals crossed the virtual fenceline several times per day during the 2011 trial. The last day of the experimental period the physical fence was opened, and all reindeer ran across the virtual fenceline and out into the neighbouring enclosure without hesitation or signs of motivational conflict.

Results from testing prototype 2

Prototype 2 of the NoFence collar was tested during November 2013. The technical improvements of the collar involved both new design and vibration in addition to audio warning signals. Improvements

Table 2. Behavioural observations in 2013, testing NoFence prototype 2.

	Closed fence (Day 1 and 2)		Physical fence open (Only Day 2)	
Behaviour	# obs	% of tot obs	# obs	% of tot obs
Stops before shock	13	32.5	0	0.0
Circle in the sone	14	35.0	0	0.0
Wander within sone without stopping	8	20.0	0	0.0
Ignoring virtual fenceline (only with open physical fence)	-	-	16	72.7
Shake head/body	3	7.5	3	13.6
Startle	2	5.0	3	13.6
Total	40	100 %	22	100 %

in the software made it possible to continuously monitor the status of each NoFence collar. The collar could also be turned off and restarted remotely via the internet.

The reindeer shook their heads, their bodies or jumped slightly as electrical signals were released. This did not prevent them from crossing the virtual fenceline and when the physical fence was opened, all animals escaped (table 2).

Further development

We experienced several technical difficulties with the prototype 1 of the NoFence collar. Many of the collars stopped working during the limited testing period. This was probably due to low temperatures, battery capacity and a humid outdoor environment. It was therefore also difficult to get good and valid results on the systems effects on animal behaviour and welfare.

The heart rate of the reindeer indicated large individual differences. As the physical fence was opened, heart rate increased and this was probably related to increased human activity, rather than the NoFence-system. Heart rate measures were therefore not included in further testing.

Prototype 2 of the NoFence collars was significantly improved. Software and technology proved more or less stable under field conditions, although satellite conditions and connections could vary. The ability to remotely control the function of each collar also proved somewhat unstable. Animals showed behavioural changes according to release of electrical shock but the system could not control animal movements. It is possible that reindeer need much more time to learn the system. Reindeer move over large rangeland pastures all year around. It is therefore perhaps more important to prevent animals from entering populated areas, roads or railways instead of trying to contain them within a limited area. Natural barriers like rivers or steep rocks could be used as borders in combination with the virtual fencelines. This way the reindeer might be able to learn the system and be able to connect warning signals with avoidance behaviour.

Conclusions

The NoFence system must be further developed and adjusted to reindeer behaviour, the topography of the large pasture areas and the specific needs of the reindeer herders. After further adjustments, controlled learning experiments should be performed.

The experiments were performed as part of the project Animal Sensor Networks. This project represented international cooperation between Sweden, Finland and Norway and was financed via INTERREG, Botnia-Atlantica region. Nordland Fylkeskommune and the Norwegian reindeer herders fund for development (RUF) also participated in funding these experiments.

BIOFORSK TEMA
vol 9 nr 26
ISBN: 978-82-17-01326-6
ISSN 0809-8654

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