

# Retention and recovery of different on-animal sensors for monitoring behavior of beef bulls during breeding

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## Introduction

On-animal sensors (OAS) are utilized to monitor behavioral and physiological characteristics remotely, allowing producers and veterinarians to make inference about the health and reproductive status of livestock. Breeding soundness evaluations (BSEs) performed on bulls prior to the breeding season are useful for identifying preexisting conditions, however, these are not reliable for identifying breeding impediments (e.g., lameness) that develop during the breeding season which can result in subfertility or even infertility. Thus, there is potential for the application of OAS for the monitoring of beef bulls during breeding, however, relatively little research has been done on this topic. The objective of this study was to characterize retention and functional recovery for different OAS on beef bulls during the breeding season. In addition, we explored potential risk factors associated with retention and functional recovery.

## Materials and methods

Angus and Angus-cross beef bulls ( $n = 50$ ) from 6 commercial cow-calf operations located in central and southeastern Ohio were observed during the 2021 breeding season. Bulls, aged 1 to 8 years, were placed into 19 different multi-sire breeding groups with a bull-to-female ratio (BFR) between 1:16 and 1:31. Females in each breeding group were estrous synchronized and timed artificially inseminated (TAI) approximately 10 days prior to bull turnout (5-12 days) and subjected to a breeding season of approximately 50 days (48-55 days). Before turnout, each bull was subjected to a BSE and fitted with 1) a neck-mounted GPS-equipped collar (GPS); and 2) an ear tag-mounted triaxial accelerometer (AX3). Bulls were visually observed thrice weekly for injury, device presence, and functionality. Generalized linear mixed models (GLMM) were fitted to the data and used to estimate the probability of loss (device absent from bull), failure (premature termination due to damage or battery life) and functional recovery (operational device recovered) for each type of device. Number of bulls in the breeding group, bull age, scrotal circumference, body condition score, total number of females in the breeding group, and number of females not pregnant to TAI, were evaluated as potential explanatory variables using stepwise selection.

## Results

Of the 50 GPS collars deployed, a total of 6 caused injury. Injuries ranged in severity from mild abrasion to laceration of the skin. These devices were removed from the bulls at a median of 14 days (range:8-21) into the breeding season, while no injuries were detected for AX3 devices. There was no evidence ( $P = 0.14$ ) for a difference in the probability of device loss between GPS (12.4%; 95% CI: 2.1, 48.3) and AX3 (5.0%; 95% CI: 0.4, 41.6). Device loss occurred at a median of 28 (range:5-45) and 15 (range:7-43) days after turnout for GPS and AX3 devices, respectively. Conversely, there was marginal evidence ( $P = 0.08$ ) for increased probability of device failure in GPS (29.4%; 95% CI: 13.3, 52.9) compared to AX3 (8.6%; 95% CI: 1.7, 34.1) devices. Device failure occurred at a median of 7.5 (range:0-46) and 44.5 (range:0-49) days for GPS and AX3, respectively. The probability of recovering a functional device at the conclusion of the breeding season was greater ( $P = 0.004$ ) for AX3 (78.1%; 95% CI: 62.7, 88.3) than for GPS (46.0%; 95% CI: 32.4, 60.2) devices. None of the evaluated risk factors were significantly associated with the probability of device loss, failure or functional recovery for either GPS or AX3 devices

## Significance

Neck-mounted GPS-equipped collars were less likely to provide data for the entire breeding season than ear tag-mounted accelerometers, due to a greater combined incidence of injury, device loss and failure. Neck-mounted OAS exist for logistical reasons as considerably more hardware can be supported in a collar than on an ear tag, however, further development of OAS technology for beef bulls should focus on advancing ear tag-based systems to mitigate data loss and ensure animal well-being.

