Automated Trace Sighting Data Collection in Remote Livestock Holding Areas

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June 16, 2019

This document is prepared in partial fulfillment of the requirements outlined in the Going Forward 2 Traceability Pilot Program project funding agreement entitled "Automated Trace Sighting Data Collection in Remote Livestock Holding Areas" Grant number AHAD-030452. This document contains content to support the deliverables identified as the Final Report of the project agreement. Content associated with project financial operations, project management and other obligations outside of the assessment of overall project technical findings will be submitted using separately established templates and methods.

1 Executive Summary

This project looked at the suitability of remote pasture readers in production settings in Canada. The objective was to assess whether cellular enabled RFID reader enabled mineral feeders could be used to collect animal sightings data in remote production livestock management settings.

Depending on location and setting it was found that passive collection of animal sightings records in remote and high volume settings was readily achievable with todays technology.

2 Introduction

2.1 Background

This document is presented in partial satisfaction of the requirements of the project entitled: Automated Trace Sighting Data Collection in Remote Livestock Holding Areas. The project application outlines a series of activities

intended to explore and assess the use of mineral feeder mounted RFID readers in the generation of animal sightings data for use in the Canadian livestock traceability system.

This report is intended to summarize the successful completion of these activities, interpret and provide context to the utility of the outcomes of these activities and to suggest next steps in the process of incorporating these findings into general use in the Canadian livestock traceability system.

2.2 Project Overview

The first mention of the idea that passive reads from existing RFID reading equipment could compliment traditional movement reporting data collection processes in Canadian livestock traceability settings was raised as the concept of a by-pass reader in the final report of the CCIA's Radio Frequency Identification Systems Applied Research Study Phase 2B.

This concept refers to a RFID reader that collects and reports traceability data to the CLTS database without human labour requirements.

In 2010 and 2011, the technical state of the art meant that by-pass systems required dedicated computer hardware (laptop or desktop). Further, the output of these by-pass systems was a simple count of the number of head observed at that location in a period of time. While number of RFID reads captured at a location can help identify the importance of that location in the event of an epidemic, individual animal ID's would be a substantial improvement.

This project explores the concept of a ghost reader, which for the sake of this evaluation represents a technological evolution from the by-pass readers discussed previously. Ghost readers as used in this project consist of a RFID reader system that is connected to a private data network which facilitates the real time submission of sightings data to a CCIA landing server with no human labour.

Specifically in this project, the ghost reader configuration is that of a RFID reader equipped mineral feeder.

This project has a set of four main objectives which are supported by a collection of sub-activities.

1. Test existing commercially available salt-lick RFID scanning station in remote animal holding areas
2. Determine feasibility for the collection of sighting data in remote areas for the national traceability system
3. Recommend improvements to existing equipment (if any) to achieve better compliance in large pastures or other co-mingled livestock areas.
4. Review technology solutions to allow reader data to be reported to the CLTS in an automated fashion

3 Materials and Methods

3.1 Ghost reader development

The scope of this activity was to support the development of a fully automated system to support the collection and submission of RFID reads to the CLTS via a sightings landing server at the CCIA. This work has the potential to dramatically change the quality of animal movement data and challenges associated with its collection.

In this activity a ghost reader was configured in the form of a portable mineral feeder:

Remote Pasture Reader A commercially available remote RFID reader product and in the form of a mineral feeder was selected and the project team worked directly with the vendor and CCIA IT to develop appropriate integrations with the CLTS Systems.

The remote reader system was tested in a controlled environment with good cellular data coverage to ensure that in ideal conditions it performed as expected.

3.2 Ghost reader deployment

8 Remote pasture readers were deployed to a collection of locations through out Alberta. These locations constitute a representative sample of the remote grazing holdings of commercial and purebred cattle holdings. The portable nature of the remote pasture readers allowed producers to drag the readers around during use so one reader could support the remote reading needs of producers utilizing shared leases or pasture settings well removed from their primary premises.

The reader had a selection of technical challenges on deployment. Further the readers needed modification to make them resistant to the environment that they were deployed in.

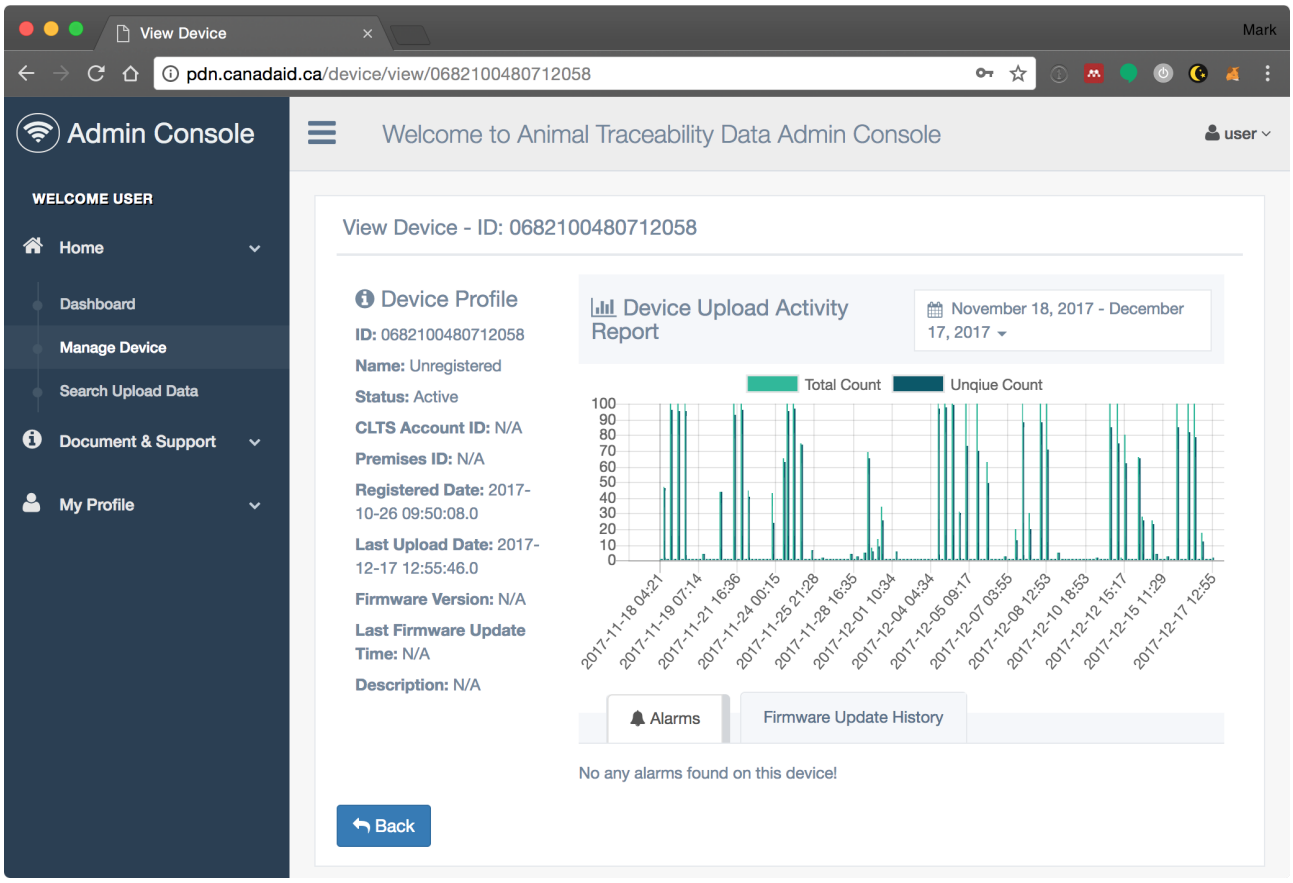

Figure 1: *Remote reader web dashboard*

3.3 Sightings landing server development

The development of temporary landing server for sightings data `http://pdn.canadaid.ca` involved the development of a variety of novel software tools.

Sightings Data Repository The development of a minimal data model for the storage of sightings records was a prerequisite for the development of any of the dashboard or data submission API endpoints.

Sightings Data Dashboard The development of a web based monitoring dashboard for the remote readers (Pasture and Loggers separately) helped support project operations. Figure 1 shows one of the views in this dashboard.

Sightings Data API Endpoint A modern authenticated and RESTFUL web endpoint to support the submission and verification of sightings events to the Sightings Data Repository were developed.

3.4 Movement synthesis from sightings data

Inferring movement records from sightings data is an activity that is readily automated, this project was restricted in it's ability to create movement records as the deployment model chosen was to place readers on single premises.

The ability to develop algorithmic approaches to convert sightings data from different settings into movement records will vary based on setting and species.

4 Results

4.1 Ghost reader and sightings data landing server development and deployment

The two activities associated with deploying a remote RFID reader system to Albertan livestock management settings were deemed to be successful in this project.

Table 1: *Remote reader statistics*

RFID System	Batches	Unique Tag Cnt.
Rmt. Pasture Rdr.	7,170	1,044

Table 2: *Sightings model detail*

Variable	Description
LOGGER_ID	Remote reader ID
UPLOAD_TIME	Date and Time of Batch Upload
LATITUDE	Latitude of sighting record
LONGITUDE	Longitude of sighting record
UPLOAD_ID	Batch ID
LINE_NUM	Within batch record count
TAG_ID	Individual Animal Tag ID

Remote pasture reader The customization of a novel hardware solution for RFID reading from an international vendor to the Alberta setting was a success of this project. Challenges with solar deployments and battery management are magnified in a cold climate, cellular connectivity, and equipment durability all presented logistical and engineering challenges. These challenges were all addressed and successful deployment of 8 remote pasture readers units with multiple uploads of identification data per day from October 19, 2016 through November 1, 2017 was achieved. Table 1 contains counts of batches and unique tag reads for each the remote reader during the study period.

Sightings data landing server The development of a set of data models and the associated web application software to provide an interface to support the real time reporting of automated sightings data without human intervention was a success of this project. A minimal set of variables was defined and exposed via an authenticated API interface to allow the Remote logger and pasture readers to automatically submit sightings records. Table 1 shows counts of batches and tag reads submitted. Details of the sightings model are presented in Table 2. Minimally a sighting has elements to record ID, date and time, and location. The model as defined has capacity to include detail on batch submission if reader location and design justifies batch submission.

4.2 Movement synthesis from sightings data

The ability to algorithmically create movement records from sightings data will vary from setting to setting. In this project the generation of movement records based on GPS based change in animal location to a point not encompassed by a premises definition was not explored, rather rules based approaches were considered.

Remote pasture readers Focusing on observations submitted by the Remote pasture reader equipment, this project did not deploy remote pasture readers into settings that would constitute movements in the traditional sense.

5 Discussion

This project was centered around four objectives. To test existing commercially available salt-lick RFID scanning station in remote animal holding areas, to determine the feasibility for the collection of sighting data in remote areas for the national traceability system, to recommend improvements to existing equipment (if any) to achieve better compliance in large pastures or other co-mingled livestock areas, and to review technology solutions to allow reader data to be reported to the CLTS in an automated fashion.

Improvement or success in these objectives has the potential to lead to increased compliance with pending regulatory changes associated with animal movement reporting, and the potential to improve the utility of the CLTS movement dataset in the case of an epidemic or reportable disease outbreak animal traceback scenario.

To achieve the objectives above, the development and deployment of a new to the Canadian market traceability product was undertaken. This product supported the novel application of automated collection of RFID based animal sightings data in Canada. This pilot deployment faced meaningful challenges and delivered notable successes.

5.1 Objective 1

In the Remote pasture reader setting, accurate and timely capture of animal identification and location was achieved with only trivial increases in management burden over and above the maintenance of a portable mineral feeder in pasture. The daily operation of the Remote pasture reader once initial configuration was complete was as simple as ensuring that the equipment was moved to new pastures when animals were moved, the design decision to mount the equipment on the equivalent of a calf sled made this responsibility something that was readily achieved.

5.2 Objective 2

Supported by newly developed technical solutions to capture remote-submitted sightings data to the CLTS landing server, the feasibility of collection of remote sightings data for use in the national traceability data system was demonstrated.

5.3 Objective 3

Deployment of solar and battery powered solutions in the Canadian environment is a technical challenge, however technical troubleshooting and engaged vendors allowed the project team to support the deployment while mitigating challenges as they arose. While efforts to ruggedize and make portable the solution deployed were undertaken, the key recommendation for improvement would be a system of supplementary monitors and notifications pertaining to system status. Notification that battery charge levels were getting low, or that solar ouput was diminished for example, would help operators maintain the systems in an optimal state.

5.4 Objective 4

The successful development and operation of a pilot set of technical solutions to ensure sightings data was appropriately captured, and added to the CLTS was a major success of the project. Further work in generalizing this set of tools, and development of deeper integrations and algorithmic operators for the sightings data is work to be considered.

5.5 General Comments

The use case and varied settings for deployment of the Remote pasture reader could lead to a variety of opportunities to automate the synthesis of movement records through passive environmental RFID scans. As deployed in this project, the Remote pasture readers were successful in the real time submission of animal sightings to the CLTS landing server. Three specific scenarios were considered where movement data could be synthesized from the sightings data generated by the Remote pasture reader.

Scenario 1: Move-In record synthesis Remote pasture reader equipment in holding yards could be used to reliably generate sightings data records for inbound loads of animals. These sightings coupled with move-out sightings from other locations could reliably lead to the automated generation of movement records.

Scenario 2: Inventory registry In epidemic modeling activities, the reliable quantification of animal inventory by premises is a key concept used in the estimation of any specific sites overall risk to epidemic spread. In this project, it was very common for participating sites to raise questions about the utility of the reader data to operations and herd management.

Scenario 3: Move-Out record synthesis In the same way that a sighting on arrival at a premises could contribute to the creation of a movement record, the final sighting on record at a premises could represent one half of a movement record assuming a suitable sighting at a new premises could be matched.

The Remote pasture reader systems have the capacity depending on placement and configuration to contribute to automated or algorithmic creation of movement records. Broad adoption of passive RFID reader equipment would be necessary to support fully automated movement reporting.

The utility of sightings data in the generation of movement records is high. A variety of factors contribute to the utility of sightings data generated in an individual setting in the generation of movement data.

6 Conclusions

This project found success in a variety of places and raises a set of new policy and technical questions to be considered.

The overall activity of developing, deploying and testing ghost reader solutions in the Alberta environment is a clear success.

Ghost reader systems can reduce the burden of animal traceability data collection in important settings. While the extension of these findings to other settings should only be done with structured testing and assessment, this project provides no reason to suggest that ghost reader equipment couldn't reduce burden of traceability data collection in other settings.

The accuracy of traceability data reported by ghost reader systems will be as high as RFID chip reader systems themselves. Future work could explore opportunities to increase the security of transmitted data, or to improve on system performance in poor network quality environments.

The true utility of sightings data will only be understood and realized once regulatory and policy questions around the suitable use of such data are raised and addressed.

At this moment there is a lack of clarity on whether inferred movement data based on multi-part sightings data constitutes an acceptable movement reporting record.

Clarity around the power of the delegated authority for a species under regulation to establish policy on the acceptable use of sightings data in informing full movement records is needed.

The definition of a fully functional livestock traceability system for Canada is a subjective concept. Current or proposed regulation does not outline hard statistical metrics with which to assess traceability system functionality. The authors of this paper hope to spend time in 2019-2020 in support of the development of a suitable framework for this assessment. The development of such a framework would allow us to quantify the true benefit from a functionality and cost benefit analysis to traceability resulting from any change in national disease surveillance strategies.

6.1 Recommendations

This project has supported the assessment of the utility of sightings data in the synthesis of movement records. While there is great potential to improve the national livestock traceability system through the use of ghost readers and sightings data, the authors of this report feel that undertaking activities in the following 4 themes could help drive adoption and formalize the CCIAs goal of a industry sustained, continuously improving traceability system for Canada.

1. Continue to refine and extend the sightings data submission framework to support a broad network of ghost reader equipment.
2. Support the development of policy and guidance on the use of sightings data in the synthesis of individual animal movement records.
3. Support the development of a set of metrics for the quantitative assessment of national traceability system efficacy.
4. Extend the testing of ghost reader equipment to settings outside of cow-calf and feedlot, and to a national scale.