Technology To Remotely Monitor Outplanting Sites

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Abstract

The U.S. Department of Agriculture (USDA), Forest Service, National Technology and Development Program (NTDP) evaluated the use of satellite telemetry to monitor outplanting sites in remote areas. These areas do not have access to cell service and require hours of drive time to inspect planting sites. Remotely accessible camera and sensor systems provide Forest Service personnel with the capability to inspect sites without leaving the office. This system enables reforestation personnel to plan planting contracts at the optimum time for planting. NTDP evaluated the Nupoint Systems Remote Viewer Satellite Camera System using a Campbell datalogger and air and soil temperature probes. The user receives an image via email that contains the air and soil temperature data. A snow depth gauge in the image provides a reference for determining snow depth. NTDP deployed the system in the fall of 2017, and the system has been transmitting images since February 2018. This paper was presented at the Joint annual meeting of the Western Forestry and Conservation Nursery Association and the Pacific Northwest Reforestation Council (Corvallis, OR, October 11–12, 2017).

Introduction

The U.S. Department of Agriculture (USDA), Forest Service, National Technology and Development Program (NTDP) provides practical solutions to problems that USDA Forest Service employees and cooperators identified. The solutions help the Forest Service do its work more efficiently and more safely. The program has a history of developing and evaluating solutions for monitoring remote site conditions using various forms of telemetry. Two Forest Service reforestation specialists proposed a project to the NTDP to investigate the use of cameras to monitor outplanting sites in remote areas. Using remote monitoring, reforestation staff can monitor sites in the spring to determine the optimum planting window. The planting window occurs soon after snow melt and before the soil dries out and refers to the period when weather and soil conditions are favorable for seedling establishment success. The current method to evaluate remote areas requires employees to drive to various sites to assess snow cover and soil temperature. Remote monitoring would save the money and time spent visiting each site, reduce employee travel, and produce a historical record of site-specific monitoring data.

Remote Monitoring System Design

The NTDP project team started this project by evaluating the requirements for connectivity, power, data, and physical mounting to aid in the selection of a prototype monitoring system. Many of the sites lack cell service and are too far from standard terrestrial internet services, thereby making satellite connectivity the ideal solution for data transport. The reforestation specialists requested daily averages of ambient air and soil temperature and an image to evaluate snow depth. NTDP identified Nupoint Systems' (Delta, BC, Canada) Remote Viewer Satellite Camera System as an off-the-shelf product for testing. The tripod mounted camera operates off a battery and saves data to a Campbell datalogger (Campbell Scientific, Inc., Logan, UT). The battery is charged from a solar panel mounted on the north-facing side of the tripod. Air and soil temperature probes are attached to the Campbell datalogger using existing ports contained in the secure system case. The remote viewer system utilizes the Iridium satellite network (McLean, VA) for connectivity. Figure 1 shows the system with its components.

Figure 1. Remote monitoring system with tripod-mounted camera, solar panel, and battery. (USDA Forest Service photo)

At the request of NTDP, Nupoint Systems modified their remote camera system to integrate with the Campbell datalogger and attached soil and air temperature probes. The Nupoint system requires a service plan based on the number of images transmitted per month. The selected plan provides 40 images per month at a cost of $60.00 per month. Additional images are $1.50 per image, or another plan is available for $340.00 per month that includes 3,000 pictures per month. The system sends the site image along with soil and air temperature data to the user via email. Users can configure intervals for delivery, email addresses, and imagery resolution by sending an email to the camera system. Nupoint Systems also has a web portal by which users can view the imagery and historical monitoring data. Nupoint Systems is currently adding additional capability to their web portal to allow for camera configuration directly from a browser.

When not transmitting data, the system remains in a dormant state until it activates to capture an image and send data over the satellite link. Users can also manually trigger a photo and monitoring data transmission by sending an email to the system. The Nupoint Remote Camera viewer will go completely offline once snow cover exceeds the height of the solar panel and will come back online once charging resumes after snow melt. NTDP configured the test unit with a tripod mounted solar panel height of 5 ft (1.5 m) after analyzing the average snow depth at the selected site. This solar panel position will enable the system to remain connected for data transmission throughout the winter season unless snow depths reach higher-than-average depths. During the fall and winter seasons, users can reduce the resolution of the imagery delivered to reduce the bandwidth utilized for each transmission.

In the spring, the user configures the system to transm it higher resolution imagery and a shorter interval for data transmission to facilitate site planning. NTDP also installed a depth gauge in the field of view so that the user can monitor snow depth. The view of the snow depth gauge in the imagery combined with air and soil temperature data contained in the email reduces the travel required to the site to determine optimal planting and travel conditions.

First Evaluation

NTDP installed the system on the Beaverhead-Deerlodge National Forest (Montana) in the fall of 2017. Figure 2 shows an image received from the unit once installed at the site. The site selected for testing is

Figure 2. Image sent from the remote monitoring system showing the snow depth gauge and temperature data. (USDA Forest Service photo)

within the boundary of the 2013 Eureka Basin Fire. Drive time to the site from the nearest Forest Service office is approximately 2 hours. The elevation at the site is approximately 8,400 ft (2,560 m). The Beaverhead-Deerlodge National Forest plans to plant 50,000 whitebark pine (*Pinus albicaulis* Engelm.) seedlings across 180 to 200 ac (73 to 81 ha) in the spring of 2018. The seedlings require minimum soil temperatures of 40 °F (4.4 °C) at a soil depth of 4 to 6 in (10 to 15 cm). The silviculturist does not expect the planting window to occur until early June.

The Beaverhead-Deerlodge is monitoring the data and imagery and evaluating the effectiveness of the system. The forest silviculturist estimates that the use of the camera will result in annual savings of $2,000. The following is an example of the data displayed in the email.

USFS_13000154_20171003183606.jpg taken at 2017-10-03 18:36:06 UTC

Location: 44.81570, -111.89968

Unit: 13000154 Battery 14.4V

Temperature: 33 F

Trigger: S

Logger: ATMax:54.45,ATMin:37.12,STMax-:62.16,STMin:36.47

Conclusions

To date, the system has worked very well. The depth gauge needs larger numbers so that they are easier to view in the photo. The system currently provides temperature data as text in an email. The user would like tabular data so that they can easily record and view trends in the data.

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