Japanese Knotweed Detection and Management Using Drones

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Introduction

Knotweeds are a group of large, rhizomatous, and herbaceous perennial plants. Unlike many other invasive plants which arrive to a new place accidentally, they were introduced intentionally as ornamentals. Knotweeds have two characteristics to distinguish them from most other related native or non-native plants: alternate leaves grow on hollow, bamboo-like stems that grow in clumps; and the nodes (which are not hollow) have a papery or membranous sheath (Fig. 1). Knotweed can form extensive and monotypic stands especially in the banks of creeks and rivers, associated with changes in water quality and food chains, and they may impact fisheries (2). An integrated management strategy including a combination of treatments over multiple years is recommended for controlling existing patches. The area within a 60-foot radius of the original patch should be monitored regularly for several years following treatment, even after the patch appears to be eradicated. Therefore, alternative methods such as unmanned aerial systems and image analysis are needed to conduct low-cost and rapid surveys of knotweed patches, which can inform timely and effective management decisions (1).

Objective: to develop an aerial survey method for detecting and mapping knotweeds

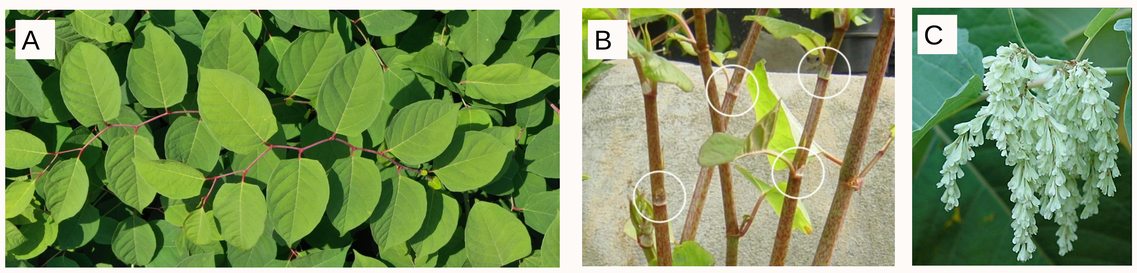

Fig. 1. Japanese knotweed leaves (A) membranous sheaths at stem nodes (B) greenish to creamy-white flowers

Materials and methods

This study was conducted in organic farm of West Virginia University. Aerial images were collected with rotary-wing drones equipped with an RGB camera with 48-megapixel photography and 4K videography capability. The drones were flown from 5 to 80 m above the knotweed canopy and images were taken every 5 m (Fig. 2). After flights, aerial images were downloaded from the drones, and knotweeds were identified on images taken from different altitudes based their key characteristics (leaf shape, alternate leaf arrangements with only one leaf per node and zigzag shape and reddish color stems) (Fig. 1).

Results and discussion

Key characteristics including leaf shape and zigzag pattern and reddish color stems, and therefore knotweed plants were detectable on images taken from 5-30 m above canopy level. With the availability of small rotary-wing UAS equipped with high-resolution cameras, it is now possible to detect invasive weeds directly from aerial images. Such high image resolution was also observed in our study (Fig. 2). Typical drone flights over agricultural lands or forests could be conducted with a small crew, covering large areas in a short amount of time. The flexibility of the drone and the modularity of the onboard payload allows for easy retrofits with a wide range of high-resolution imaging payloads. With the implementation of an onboard control system, drone flights could be tailored to meet site-specific monitoring strategies, as they can be programmed to cover specific areas that need additional monitoring.

In addition to detection of knotweed patches, drones can be used to release natural enemy insects to minimize the impact and spread of invasive plants. Therefore, we aim to develop, customize, and implement the aerial release system for knotweed psyllid *Aphalara itadori* (Hemiptera: Psyllidae) for classical biological control of knotweeds in the future studies.

Fig. 2. Example aerial view of knotweed from aerial images obtained with drones: 5m (A), 10 m (B), and 15 m above canopy (c).

References

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