eCognition Helps Root out Wily Vegetation

## Solution for precise vegetation and land cover mapping

Using Trimble's advanced geospatial image analysis technology, eCognition, the United States Army Europe (USAREUR) directly identified Blackthorn and mapped it's encroachment and extent.

Highlights

▶ 15 hours to run a workflow versus several weeks

▶ 40 different Blackthorn bush classifications correctly matched

▶ 50 sq km (19 sq. mi) determined as most impacted training area with Blackthorn

▶ 100 percent accuracy for a 5-year forecast of Blackthorn growth pattern

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overview

One of the toughest challenges the leadership at the U.S. Army Europe's Joint Multinational Readiness Center (JMRC) in Germany has faced hasn't had anything to do with training its troops. The problem, instead, has stemmed from the advancement of a hearty, thorny bush called Blackthorn, which has reduced available training space and made it difficult for soldiers to maneuver at its Hohenfels Training Area (HTA).
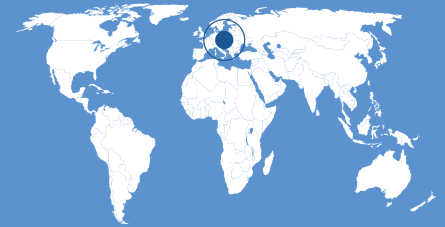
Location
Bavaria, Germany

CHALLENGE

Compounding the encroachment issue is the fact that approximately 92 percent of the 160-sq-km (61-sq-mi) training area has been designated a flora-fauna and bird habitat protection area under the European Union's directive known as Natura 2000 FFH. Together, the encroachment and designation have produced an operational and environmental conundrum for USAREUR—how to balance the military's training needs with an elevated responsibility to protect threatened species and habitats.

To resolve this challenge, the JMRC launched a first-of-its-kind project to bring the Blackthorn under control, while staying true to the protected nature of the site. Using a combination of high-resolution 3D Light Detection and Ranging (LiDAR) data, satellite and aerial imagery and Trimble® eCognition® image analysis technology, the JMRC

was able to not only identify and map the Blackthorn's movements, it also gathered the needed intelligence to develop strategies to proactively manage the invasive bush.

Blackthorn grows long, spreading roots that send up shoots. Left unchecked, those shoots can quickly become healthy, hearty trees and a sizeable problem for the military, both physically and financially.

At the HTA, the Blackthorn's encroachment on its open space had become so significant that USAREUR had to activate a plan in 2010 to resolve the problem. To do that successfully, it had to understand the bush—where it had taken root, its growth pattern and its extent. Since the expanse of the HTA and its several protected-status zones made it unfeasible to physically walk the ground to acquire that inventory, the Center's leadership needed a more viable method to size up the Blackthorn.

To both assess the Blackthorn's present extent and its growth over time, the JMRC needed to have geospatial imagery that would provide vegetation-height detail and image analysis technology that could directly identify Blackthorn within a sizeable heterogeneous landscape and map its encroachment patterns and extent. As they aimed to map the bush's growth over time, the land classification solution also needed to be able to sufficiently handle the complexities of comparing and classifying spatial imagery with different resolutions and accuracies.

With the classification maps, the JMRC leadership have begun eradication plans. To date, approximately 200 hectares of Blackthorn have been treated.

SOLUTION

As USAREUR had commissioned IABG, a geospatial technology company based in Ottobrunn, Germany, to update a LiDAR dataset of the HTA in 2012, it tasked IABG to produce the land-classification maps.

An IABG team acquired a 1-m-resolution, LiDAR-derived DEM from 2007 and the 0.5-m-resolution LiDAR-derived DEM from the 2012 flight. They also procured 8-band, 1-m-resolution optical imagery from the Worldview-2 satellite, existing aerial photos, and ancillary datasets. That data was integrated into the eCognition object-based image analysis software to build a customized rule set.

To bring the HTA down to manageable size, the team initially chose four, 0.8 x 0.8-sq-mi (2 x 2-sq-km) test sites to classify.

After pre-processing and validating the raster data quality, they calculated a Normalized Vegetation Index and texture layers to separate vegetation from non-vegetation areas—detail that would be integrated into the classification process. They then wrote rules to instruct eCognition to distinguish Blackthorn from other vegetative types based on height, spectral qualities and textural features. Although the rule set took months to build, it only took 15 hours to run the workflow and produce land-use maps for 2007 and 2012, indicating the bush's growth in each test site between those two years.

A subsection of the eCognition classification. IABG integrated LiDAR-derived DEMs, optical satellite imagery, aerial photos and other data into eCognition to distinguish Blackthorn from other vegetative types. There was not a single mismatch between what eCognition classified as Blackthorn (including its varying heights) and what was on the ground.

The IABG team presented the preliminary results to the JMRC to validate the data on the ground and to show the leadership how the data could be used for building vegetation-management strategies. For the field verification, they chose 40 different Blackthorn bushes in each site and measured them using a yardstick, comparing their real-world height and shape with their classified counterpart on the map. There was not a single mismatch between what eCognition classified as Blackthorn (including its varying heights) and what was on the ground.

Based on the quality of the test sites classifications, the classification methodology was extended across the entire site. And in September 2013, IABG delivered the classification results to the Center's leadership, showing that Blackthorn was highly impacting one-third, or about 50 sq km (19 sq mi), of the training area.

RESULTS

With an accurate inventory and map of the Blackthorn's growth stages and extent, JMRC environmental and training planners can better create cost-effective and efficient removal and control strategies.

Traditionally, the military has controlled the invasive Blackthorn species with a mix of training exercises to impede the bush's growth, spot burning, mowing and a herd of nearly 10,000 sheep, who feed on the early Blackthorn growth. That costs about $30,000 US per sq km. From there, the removal costs and management efforts can reach as high as $1 million US per sq km.

Using the classification maps, the JMRC leadership have begun developing smart eradication plans. They have identified a number of target areas throughout the training area and determined the best cost-effective and efficient methods to either remove the Blackthorn or greatly reduce it.

To date, approximately 200 hectares of Blackthorn have been treated. And because the classification datasets show them Blackthorn's extent and current heights, the military has the ability to accurately forecast the bush's growth pattern for the next five years and develop sufficient control measures to properly manage its spread.

Using this high-tech strategy, USAREUR's JMRC may have found a way to manage Blackthorn, rather than Blackthorn managing them.

The HTA's hills, forest and rocky outcrops have served as fertile grounds for military exercises since 1938. Since 2010, more than 60,000 soldiers (US and allied) have deployed to HTA every year to train.

Shrub Encroachment 2007-2012

- ▢ Grassland and Open
- ▢ Mulched, Clearcut
- ▢ Shrub grown
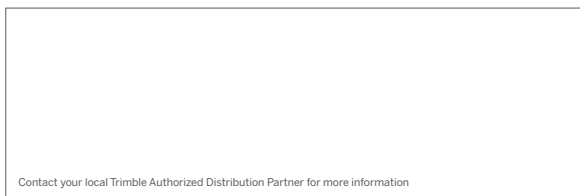- ▢ Shrub constant
- ▢ Forest
- ▢ Infrastrucure

Change analysis map of HTA vegetation and infrastructure growth, 2007-2012. Red areas display Blackthorn's encroachment growth. eCognition shows Blackthorn is highly impacting one-third of the HTA's 160 km2 (61 mi2).

"Now the military not only has a detailed comparison of Blackthorn between 2007 and 2012, they have a completely new, informative tool that can help them develop cost-effective Blackthorn reduction strategies."

Dr. Albert Boehm, Directorate of Public Works, Environmental Branch of USAG Bavaria-Hohenfels.

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