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A comparison of two different mapping methods for identifying the current distribution of the invasive vine (*Antigonon leptopus*, Hook & Arn.) on the Caribbean island of St. Eustatius

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Introduction

- Current distribution maps can be powerful tools to help manage invasive plant species; however, the usefulness of such maps depends on their purpose and the methods used to build them.
- With a distribution map of an invasive species, managers can plan where to perform eradication measures and estimate resources needed to manage the invasive species based on the area it occupies.
- The aim of this study is to compare two methods of mapping the current distribution of *Antigonon leptopus* (Coralita) on the small Caribbean island of St. Eustatius.
- Coralita is a vine originating from Mexico that is spreading in the Caribbean and other tropical habitats throughout the world, and therefore is a concern for conservation efforts of natural areas (Burke & DiTommaso 2011).

Research Aim

We compared the following two methods for creating a map of the current distribution of Coralita:

1) Observer/Expert-based ground survey map, and
2) Semi-automated vegetation classification using satellite imagery.

Methods

Observer/Expert map

Data collection

- The primary and secondary roads of St. Eustatius were walked or driven to check for Coralita presence (Berkowitz 2014)

Map creation

- Coralita presence was extrapolated from the areas visited through expert deduction

Semi-automated map

Image acquisition

- A WorldView-2 satellite image was acquired

Groundtruth point collection

- 192 groundtruthing points were collected and assembled encompassing a range of land cover types

Variable compilation and testing

- 92 variables derived from the spectral bands in the image were tested for the classification:
  - 8 reflectance bands
  - 20 vegetation indices
  - 64 grey-level co-occurrence matrix texture variables (with window size = 3 pixels)

Support Vector Machines (SVM) classification

- An SVM classification is a non-parametric machine learning algorithm that tries to find the optimum separation between classes of data (Mountrakis et al. 2011)
- SVM feature weights were calculated for all variables (Üstun *et al.* 2007)
- The 8 highest-weighted, uncorrelated (Pearson's correlation coefficient < 0.7) variables were chosen for the classification
- A map with the probability of Coralita presence was created

Compiling maps and threshold determination

- 30 SVM models were built using a random selection of the groundtruth data
- The resulting 30 probability maps were compiled and the average pixel value calculated
- A probability threshold of 0.85 was used as a cut-off for defining a pixel as a Coralita pixel

The morphology and ecology of Coralita
a) Detail of flowers: Coralita produces flowers in panicles, with each flower having 5 tepals, 8 stamens, and 3 carpels. **b)** Leaf morphology: Leaves are heart-shaped and alternate, with prominent veins. **c)** Tubers are present and can be found at depths of up to 2 meters. **d)** Tepals enlarge to surround developing fruit, eventually turning brown when fruit is ripe. **e)** Coralita can spread vigorously and produce monoculture carpets over invaded areas. **f)** Coralita produces large quantities of nectar and is very attractive to native and non-native pollinators. **g)** If left unattended, Coralita can overgrow almost anything, such as this abandoned car.

Results

The results are summarized in the table below:

	Observer/Expert map	Semi-automated map
Area covered by Coralita (ha)	770	30
% Island covered by Coralita	37	1.5
Overall accuracy (%)	79	90
Percent false negatives	6.5	10
Percent false positives	14	0

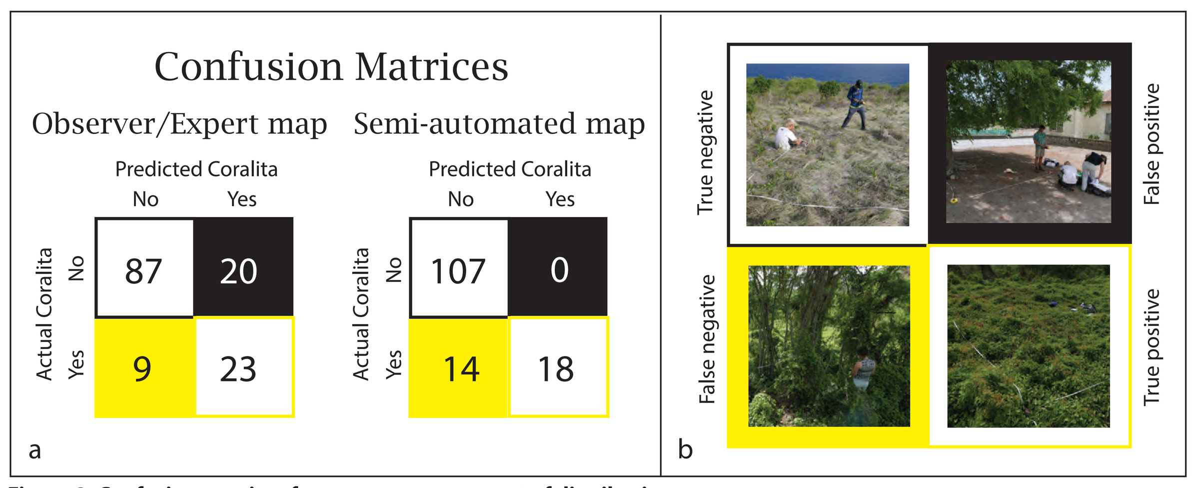

Figure 2: Confusion matrices for accuracy assessment of distribution maps.
a) Confusion matrices showing the accuracies of each distribution map. The color scheme follows that of figure 1b, with a black outline being true negative, solid black being false positive, solid yellow being false negative, and yellow outline being true positive.
b) Photos from groundtruthing points illustrating each accuracy state.

- The Observer/Expert map predicted 25x more area covered by Coralita than did the Semi-automated map.
- Overall accuracy was higher in the Semi-automated map.
- The proportion of false negatives was higher in the Semi-automated map; however, the proportion of false positives was higher in the Observer/Expert map.
- If groundtruthing points where Coralita was found in the understory were included, the overall accuracy for the Observer/Expert map remains the same at 79%, while the overall accuracy for the Semi-automated map decreases to 77%.

Conclusions & Applications

Managers must weigh multiple criteria when deciding which mapping method to use.

	Observer/Expert map	Semi-automated map
Resources needed	Handheld GPS receiver, GIS software	GNSS receiver, GIS and statistical software
Repeatability	Not repeatable	Quickly and easily repeatable
Most conspicuous error	Overestimate of cover	Underestimate of cover
Methodological limitation	Relies on human deduction for extrapolating cover from visited areas	Cannot identify areas where plant is growing in understory, has sparse cover

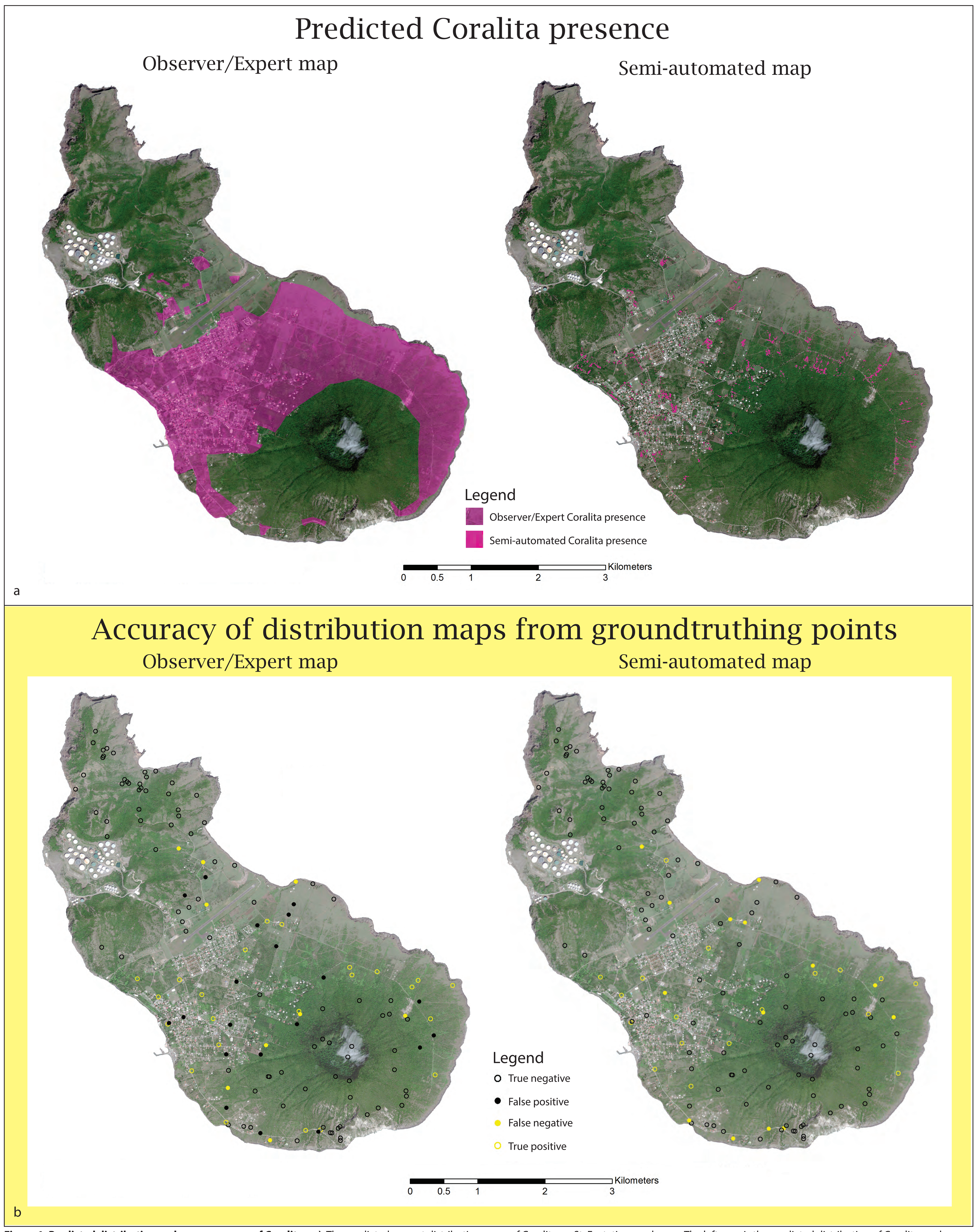

Figure 1: Predicted distribution and accuracy maps of Coralita. a) The predicted current distribution maps of Coralita on St. Eustatius are shown. The left map is the predicted distribution of Coralita made using the Observer/Expert method. The map on the right is the predicted distribution of Coralita made with the Semi-automated method. **b)** Maps displaying the accuracy of the distribution maps from GPS groundtruthing points are shown. 139 groundtruthing points where there was one dominant land cover type and no Coralita in the understory present were selected. The true negative points are where the distribution map predicted no Coralita and no Coralita was found at the groundtruthing point. The false positive points are where the distribution map predicted Coralita to be present, but no Coralita was found at the groundtruthing point. The false negative points are where the distribution map predicted no Coralita, but Coralita was found at the groundtruthing point. Finally, the true positive points are where Coralita was predicted to be present and it was found at the groundtruthing point.

Literature:
Berkowitz, B. 2014. The State of *Antigonon leptopus* (Corallita) on St. Eustatius in 2014. Final report to St. Eustatius National Parks (STENAPA).
Burke, J.M. & A. DiTommaso. 2011. Corallita (*Antigonon leptopus*): Intentional Introduction of a Plant with Documented Invasive Capability. *Invasive Plant Science and Management*, 4(3): 265-273.
Mountrakis, G., J. Im, C. Ogole. 2011. Support vector machines in remote sensing: A review. *ISPRS Journal of Photogrammetry and Remote Sensing*, 66: 247-259.
Üstun, B., W.J. Melssen, L.M.C. Buydens. 2007. Visualisation and interpretation of Support Vector Regression models. *Analytica Chimica Acta*, 595: 299-309.

Acknowledgements: Gratitude is given to R. Zilber, T. de Sciciolo, J. Bekema, W. Jesse, B. Bernik, and J. Ellers for helping to collect the groundtruthing points, and to J. Vaas for re-visiting some groundtruthing points, as well as thoughtful discussions and encouragement.

Van Eeden fonds

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