

# Maximizing image resolution to solve the problem of species identification

Cooperative research between  
TNC, USGS BRD, and Resource  
Mapping Hawaii

# A short history of remote sensing products for vegetation mapping in Hawaii

- Black and white aerial photography
- Analog color and infrared aerial photography
- Satellite based imagery
  - MODIS
  - Landsat
  - Quickbird / IKONOS
  - Hyperion
- Aerial based digital multi-spectral data
- Aerial based hyperspectral and LIDAR data

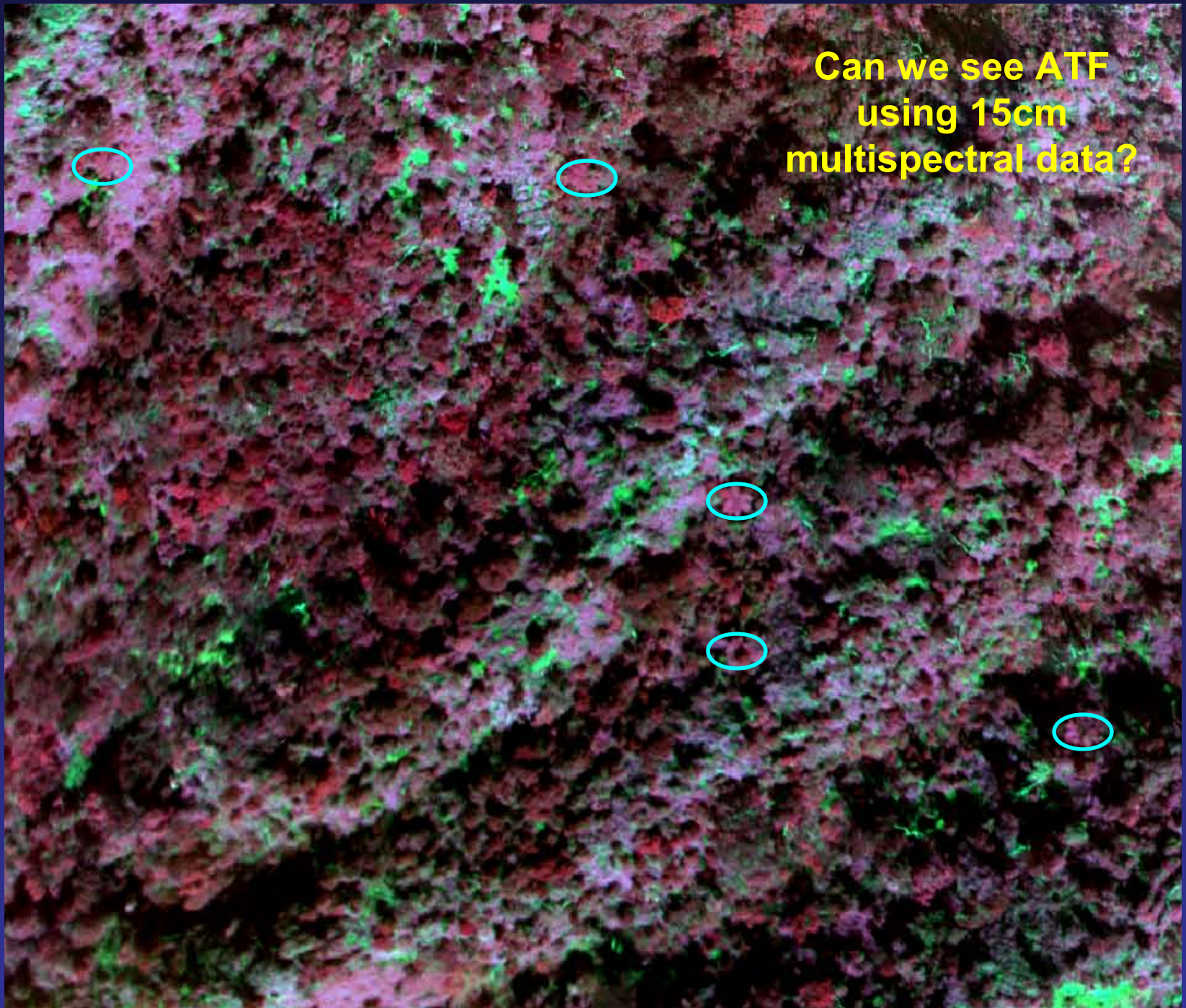
# Problems associated with plant species mapping in Hawaii

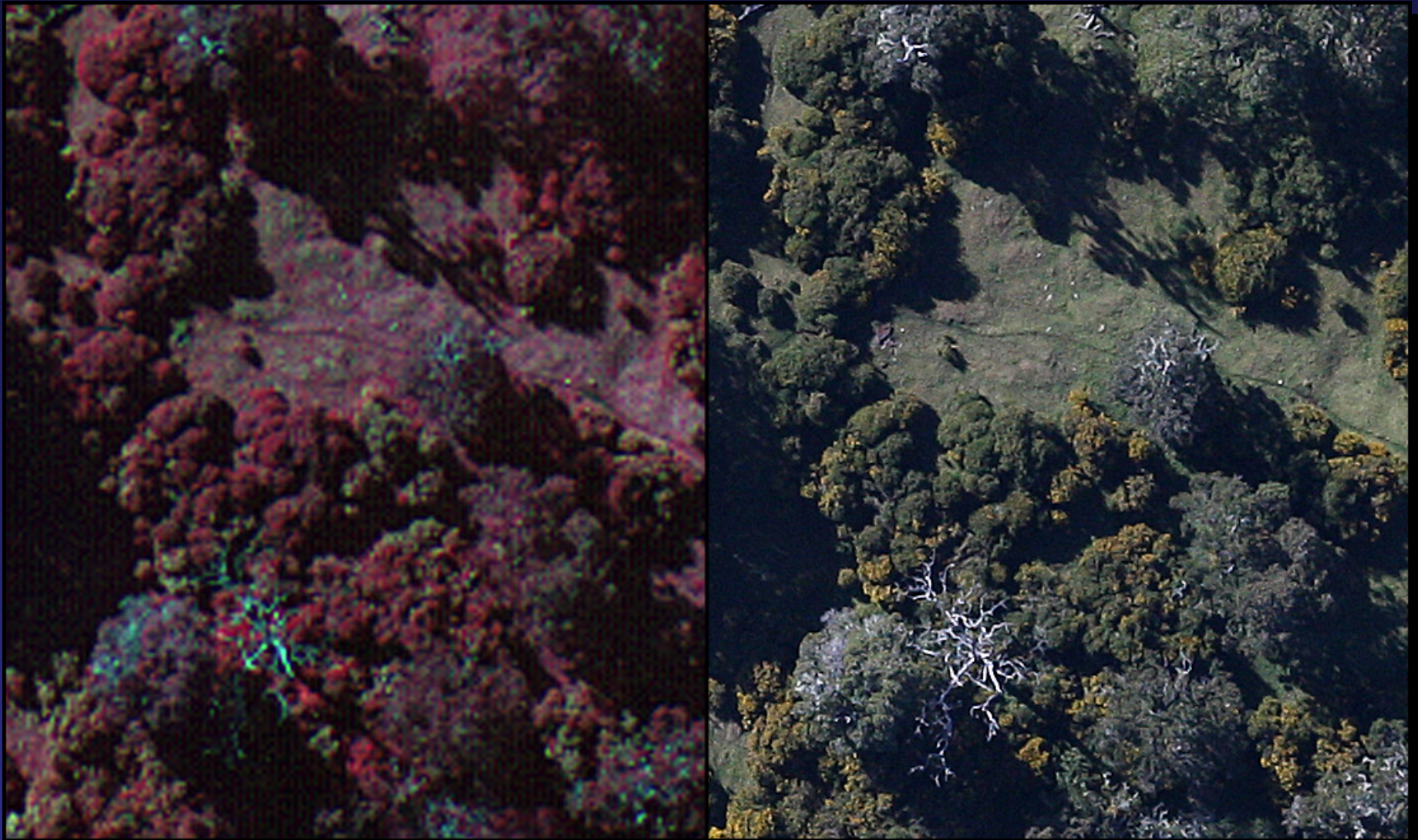
- Intense native species diversity
- Numerous invasive species
- Remote areas difficult to access on ground
- Cloud cover often confounding
- Many cases of extreme topographic relief
- Availability of data products that are both current and applicable.
- Costs of data products and related analysis

# Evolution of Resource Mapping Hawaii LLC

- Preliminary pilot project through USGS with support from TNC, Army, and Forest Service
- Follow up project again through USGS to collect imagery for TNC Kauai specifically for Australian tree fern and Hakalau National Wildlife Refuge
- New system development resulting from limitations discovered from earlier projects.
- Permanent system now based in Kauai with a mandate to serve the goals of conservation within the Pacific

Can we see ATF  
using 15cm  
multispectral data?



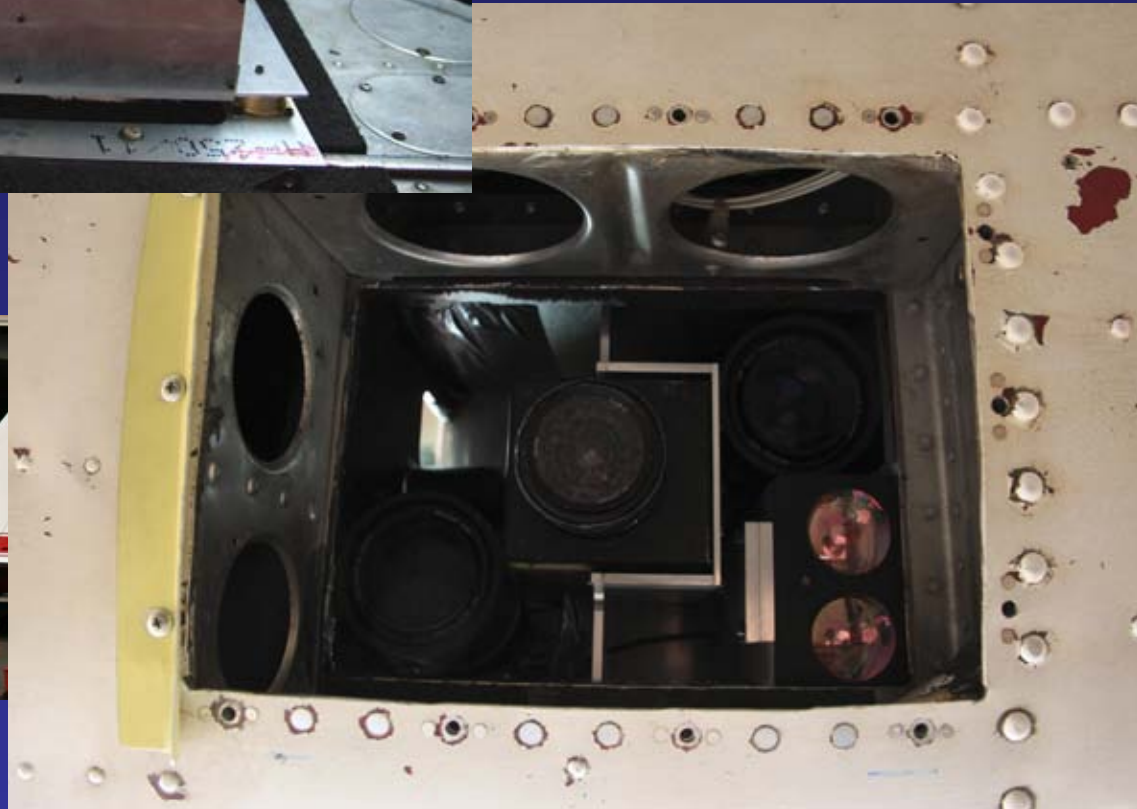


A subsection of the natural color with it's corresponding multispectral. The multispectral shows better spectral discrimination between trees while the natural color has more detail. A three times increase in spatial resolution in the natural color was sufficient to visually distinguish many tree species in Hakalau National Wildlife Reserve but not all.

# Duel scale system components

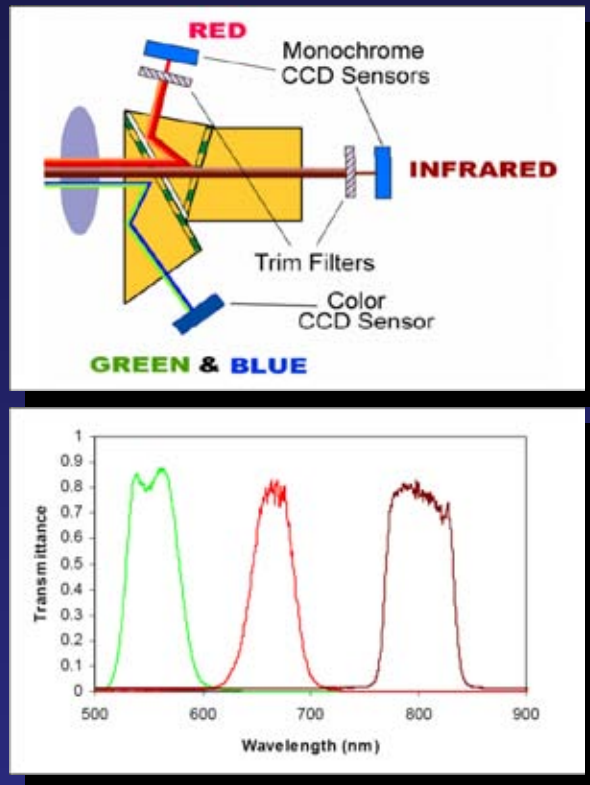
- 4 band multi-spectral Duncantech camera
- 2 x medium format Mamiya natural color cameras
- INS (internal navigation system)
- GPS (with Omnistar license) RMS 5m
- Radiometer (conversion to percent reflection)
- Gimbal stabilizing system
- Profiling laser
- Computing cluster and storage array

Cessna 182 with permanent belly port and system components mounted



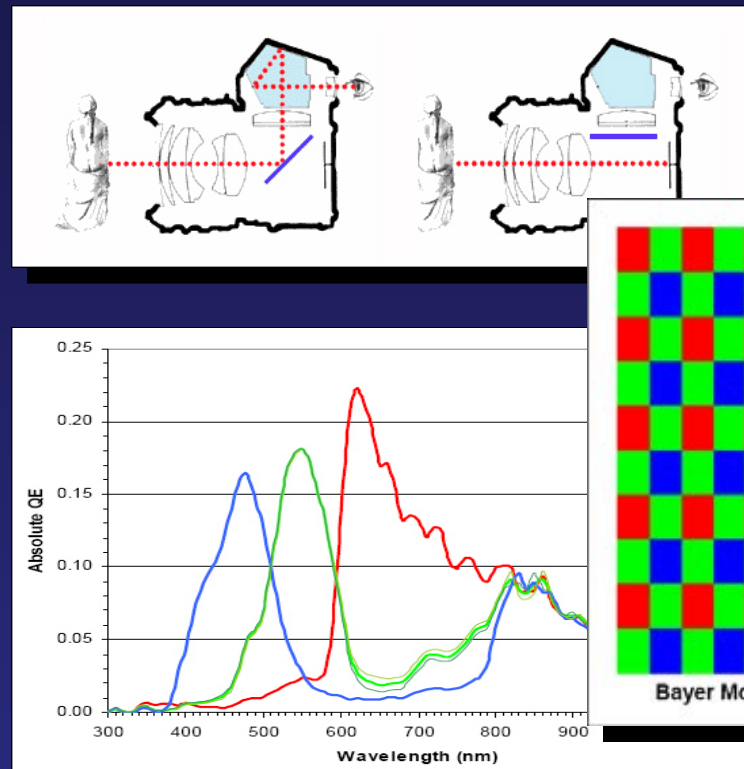


# Technical Differences Between the Multispectral and Natural Color Camera Systems



The MS-4100 multispectral camera uses three 1,916 by 1,078 pixel sensors with a beam splitting prism and dichotic trim filters to extract precise separate bands of the spectrum.

This use of separate sharp-cut filters provides the consistent radiometric response of the system.



RM natural color camera uses a single large sensor (5,616 by 3,744 pixels) with small dye patches over each pixel in a Bayer pattern of red, green and blue.

The monochrome image recorded by the camera is converted to RGB 3-band color by interpolating each pixel's missing colors from its neighbors.

The results approximate normal color and can be interpreted visually, but lack the spectral separation for sophisticated radiometric analysis.

# Data products and some applications

- 4 band multi spectral imagery at 20 cm resolution
- 3 band natural color imagery at 2 cm resolution
- Visible surface digital elevation model (DEM)
  
- Very high resolution data maximizes visual interpretability
- A number of plant species do not have unique spectral signatures that can be used to identify them using automated analysis techniques
- Not limited to plant species identification but anything that can be seen from above
  - Animal surveys under open to semi open conditions
  - Near shore reconnaissance
  - Land use mapping
  - Individual tree tracking over time
  - Photogrametric measurement of features or vegetation

# Difference between image analysis and interpretation

## Image analysis

- An automated approach to image classification
- Generally requires specialized classification software
- Minimizes observer error by applying rules across entire data set

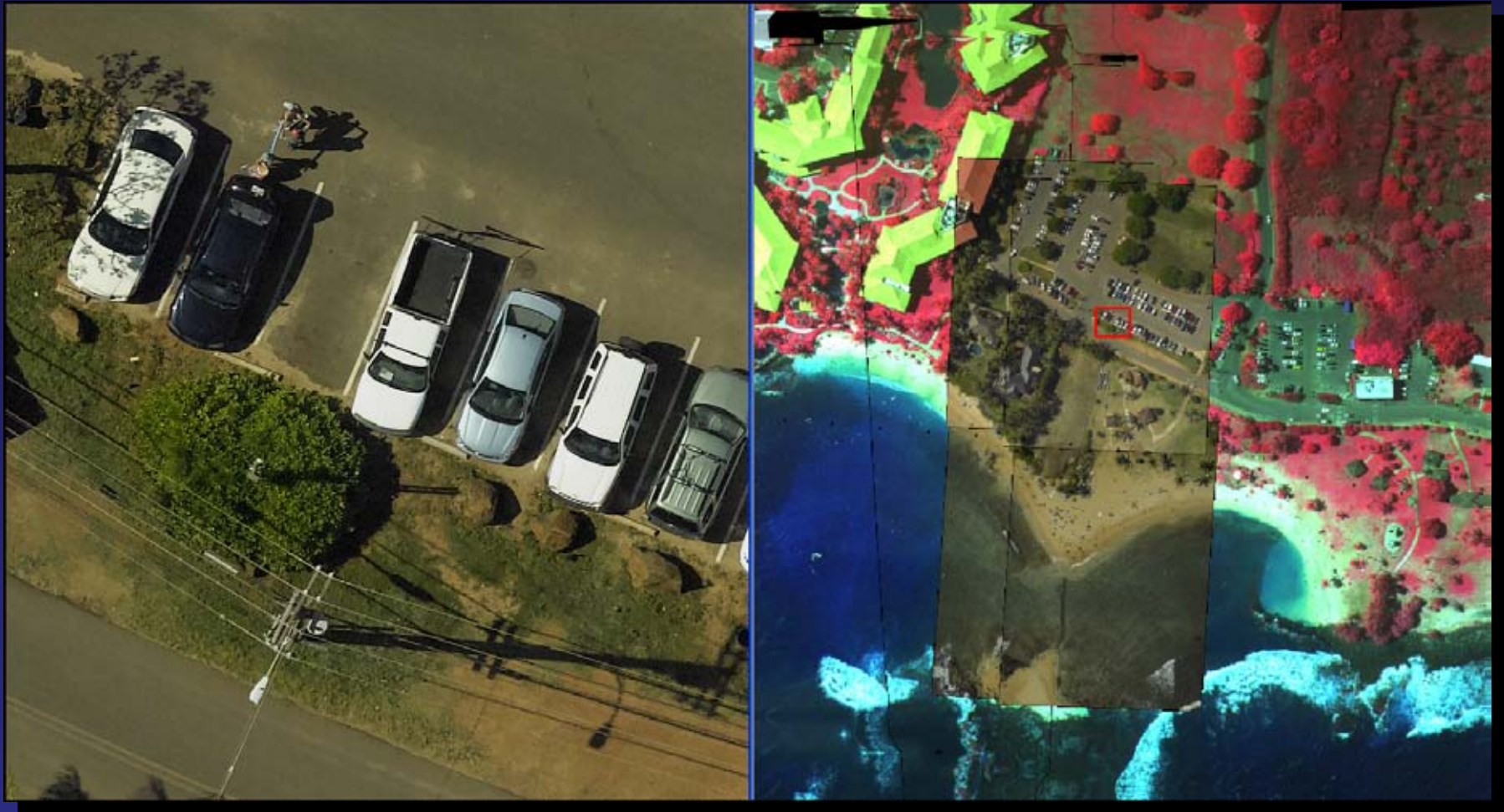
## Image interpretation

- Relies on the skills of an expert interpreter
- Does not require any specialized software but can incorporate it.
- Takes advantage of our best recognition tool, i.e. human brain.

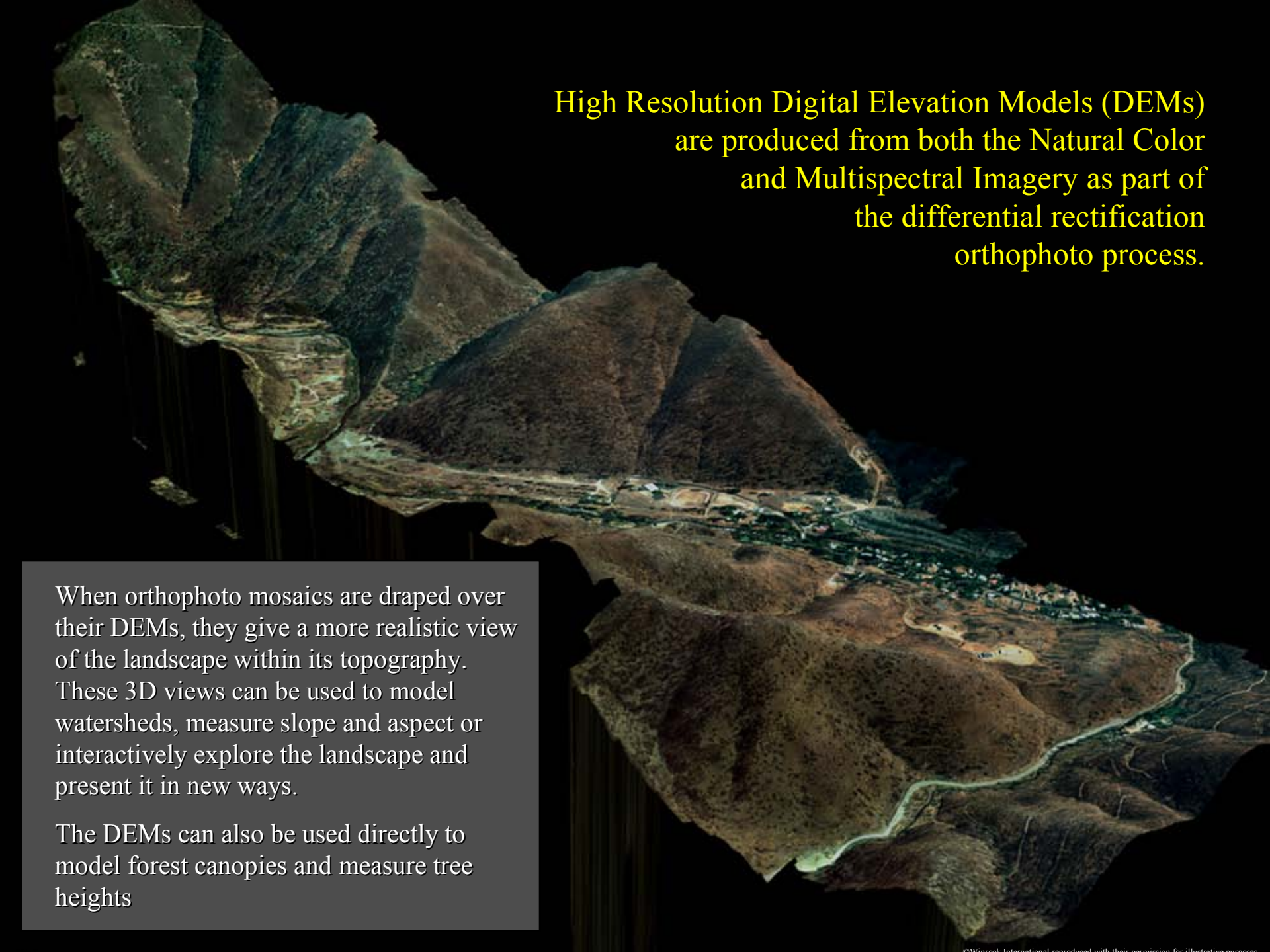
# Example swath, coastal Kauai

15cm multi-spectral 2cm natural color





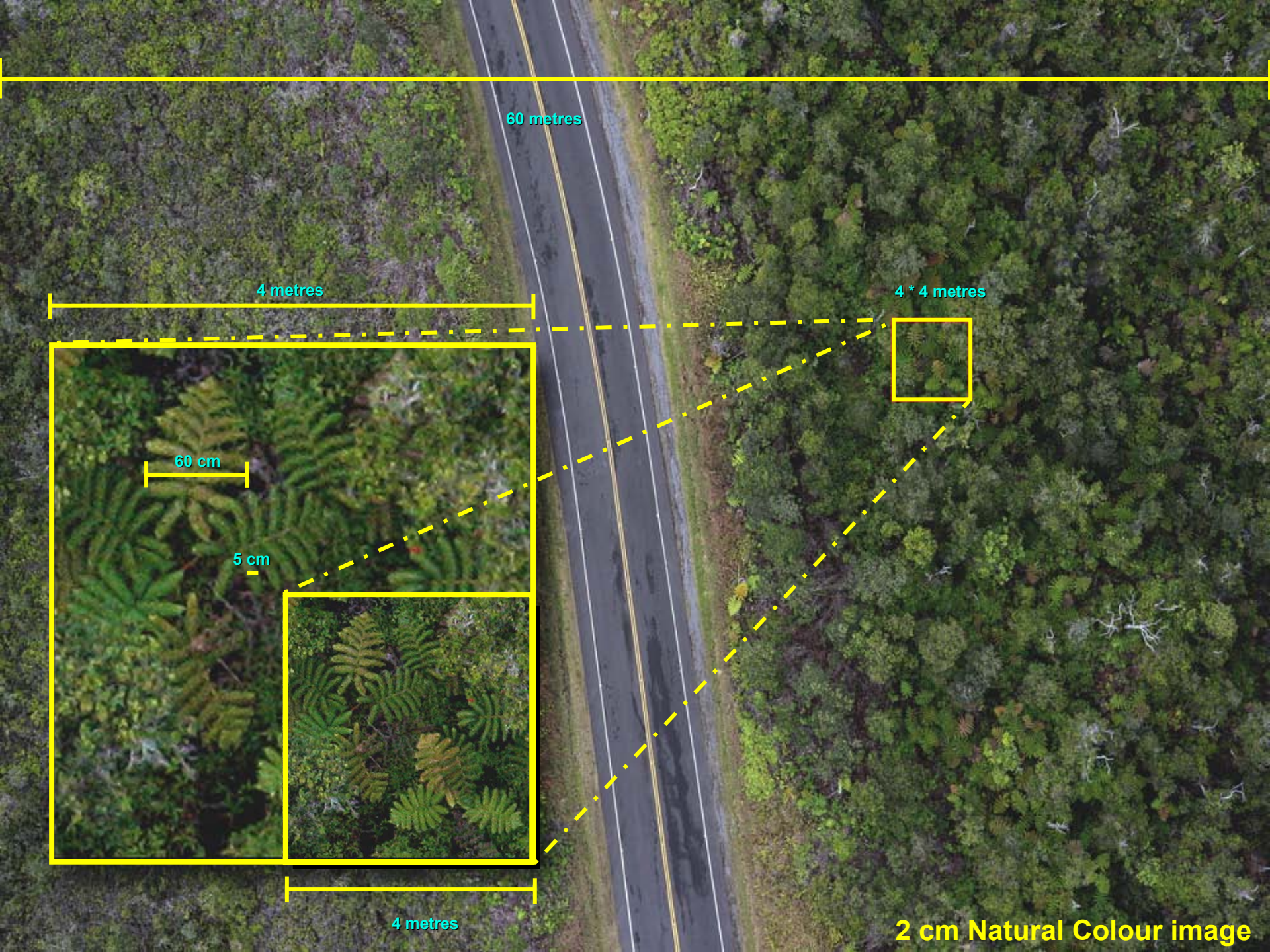
The natural color images overlap each other 60% to provide good stereo, and the two sets of imagery from the right and left looking cameras overlap each other 10%, providing a 12,000 pixel swath at 10 times the resolution of the multispectral imagery.



High Resolution Digital Elevation Models (DEMs)  
are produced from both the Natural Color  
and Multispectral Imagery as part of  
the differential rectification  
orthophoto process.

When orthophoto mosaics are draped over their DEMs, they give a more realistic view of the landscape within its topography. These 3D views can be used to model watersheds, measure slope and aspect or interactively explore the landscape and present it in new ways.

The DEMs can also be used directly to model forest canopies and measure tree heights



60 metres

4 metres

4 \* 4 metres

60 cm

5 cm

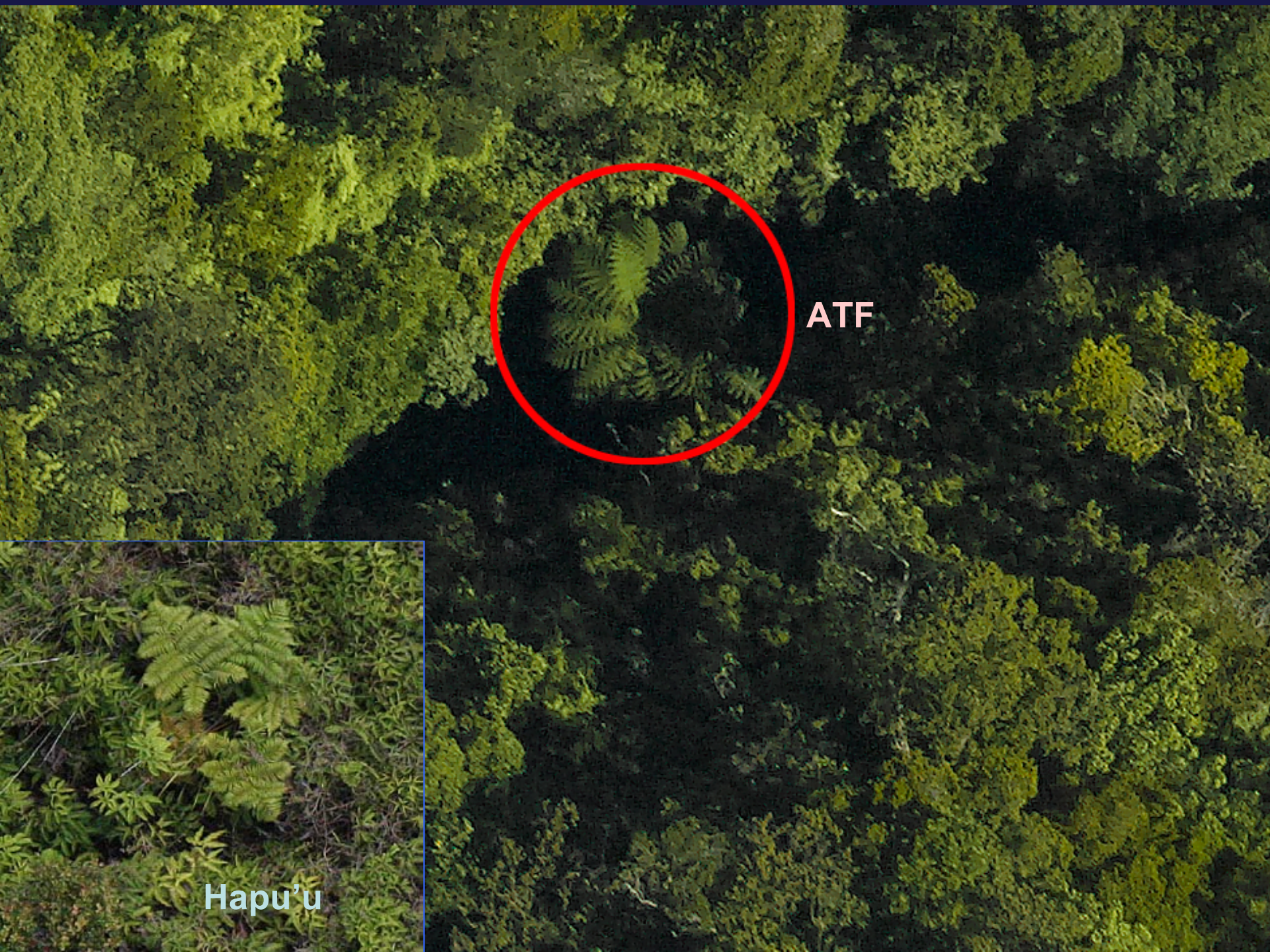
4 metres

2 cm Natural Colour image



Tree Fern at  
approximately  
2.2 cm per pixel in  
Hanalei Valley, Kauai





ATF



Hapu'u



Psidium  
cattelianum

Pandanus  
tectorius

Psidium  
cattelianum

Melastoma  
candidum

Schefflera  
actinophylla

Metrosideros  
polymorpha

Macaranga  
mappa

Cecropia  
obtusifolia

Melochia  
umbellata

Trema  
orientalis

Nephrolepis  
multiflora



At full resolution (above) or 200% (left), the natural color imagery can capture fine detail of the shallow reef structure.

# Acknowledgements

## The Nature Conservancy Hawaii

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## Resource Mapping Hawaii

Dana Slaymaker, Jim Hoffert

## Fly Kauai

Ray Smith

*Resource Mapping*  
*Remote Sensing and GIS for Conservation*

The Nature  
Conservancy   
Protecting nature. Preserving life.™

# Questions of cost and availability

Please refer all questions of this nature to  
Resource Mapping Hawaii representatives  
Dana Slaymaker and Jim Hoffert

There is a table in the vendors section of the  
conference hall

Web site: [HTTP://resourcemappinggis.com](http://resourcemappinggis.com)