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Progress and Plans for Processing Airborne Data

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Primary Objectives

1. Provide consistent, calibrated, and undistorted multispectral image and DSM databases for the Colorado River corridor from Lake Powell to Pierce Ferry every 4 years. Image data at 20-cm resolution, DSM data at 1-m resolution, and both with 30-cm positional accuracy.

2. Analyze these periodic databases to examine periodic changes in sandbars, campsites, vegetation, geomorphology, and near-shore aquatic habitats as a function of dam operations.

Status: We are now collecting the best data possible. Although we got behind schedule in providing the final databases for various scientific analyses, we are rapidly catching up and will complete all databases before the 2013 data are delivered this year.

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Historical Perspective

Before 2002, we collected aerial photography annually at a cost of about $45,000/annum, but the data were not rectified or calibrated, few people used the film, and rectification was estimated to cost $500,000/annum in 2002.

We started using digital cameras in 2002 every 4 years with the contractor rectifying and mosaicking the imagery in 2002 and 2005 at a cost of $250,000-$300,000/annum, but the contractors' image products had several flaws, which caused serious problems and time in analyzing the imagery.

In 2009 (and 2013) we employed a new sensor ($433,000) and the contractor delivered just the rectified flightlines, which we then select the best flightline segment, calibrate the flightlines for consistency, and create the image mosaics. The resulting imagery has been significantly easier and faster to process by a time factor of 7. The final 2009 image database is the best in existence for the corridor.

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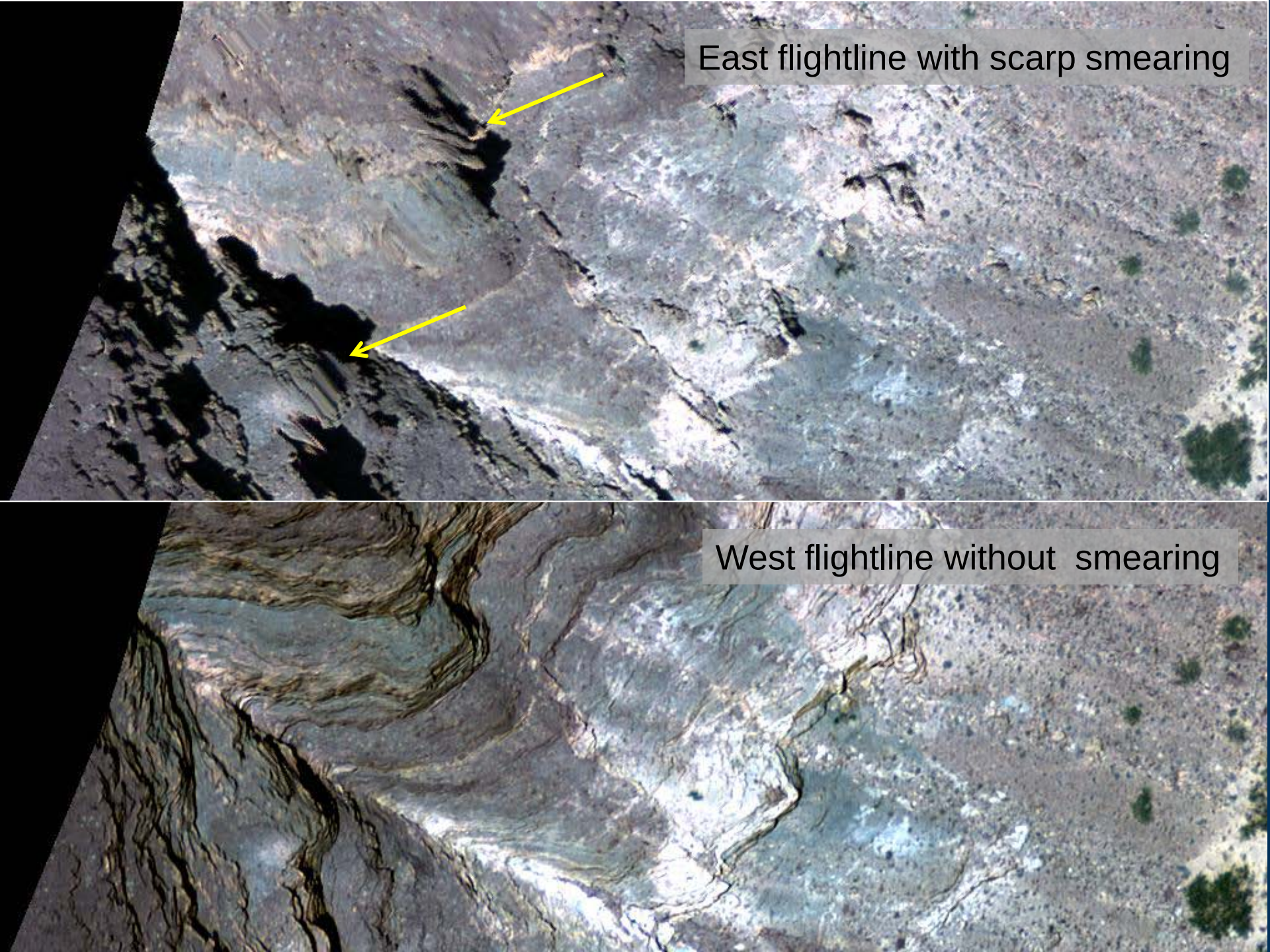
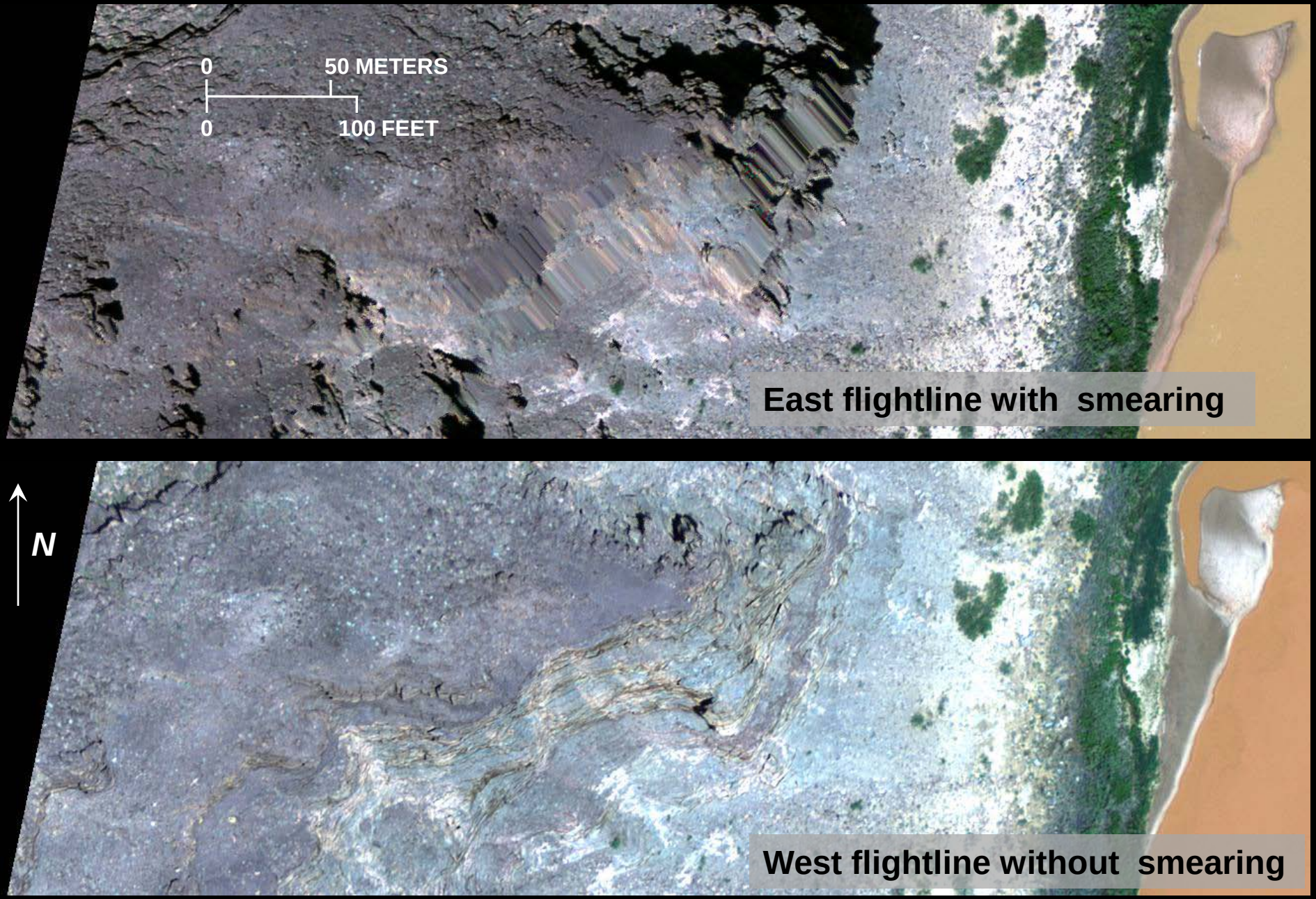

East flightline with scarp smearing
West flightline without smearing

Prevalent Surface Smear Effect



The 2009 imagery are far superior to 2002 or 2005 for all canyon resource mapping and assessment - sandbar example shown by the next sequence of slides.

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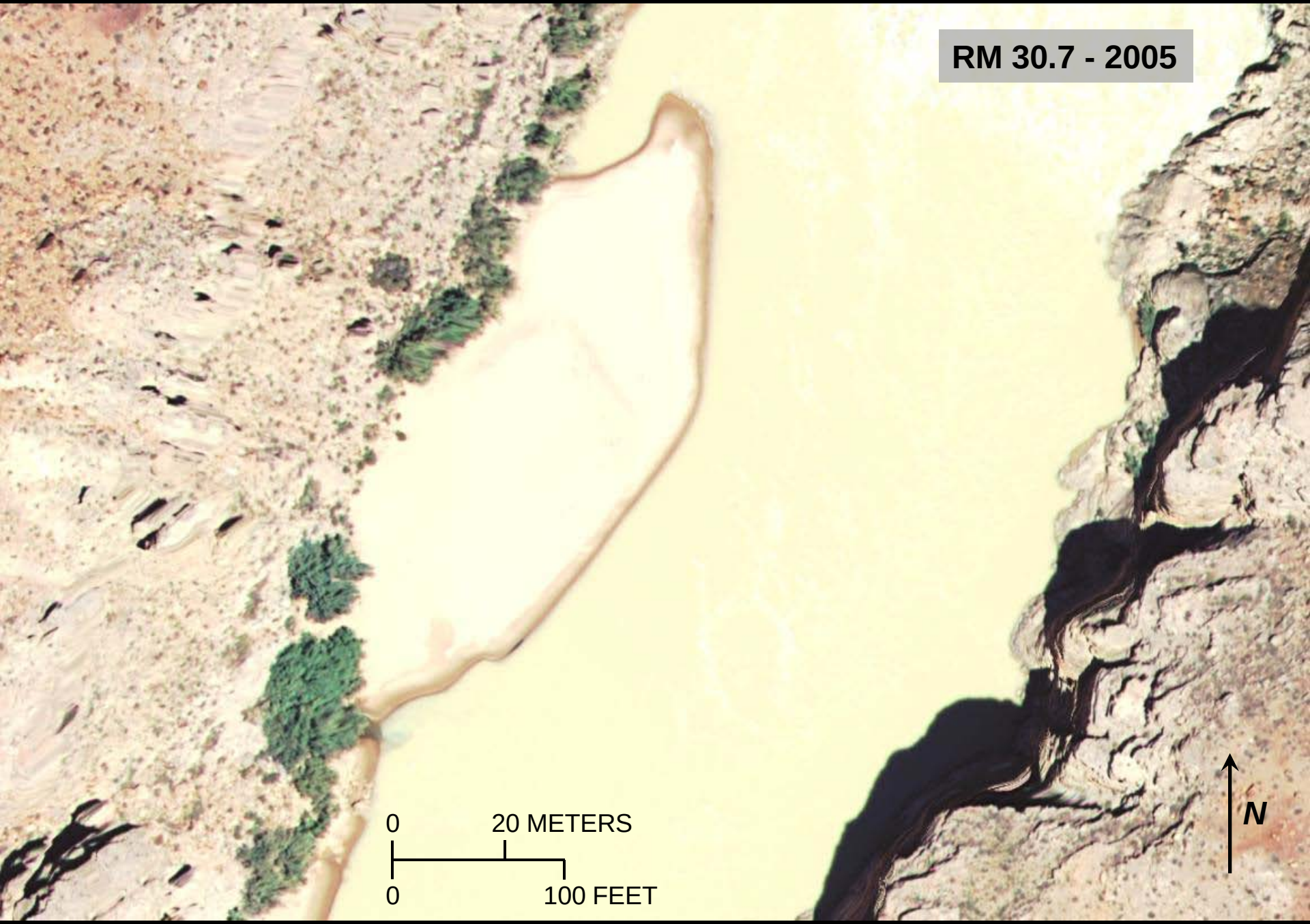
RM 30.7 - 2002
0
20 METERS
0
100 FEET
N


RM 30.7 - 2005
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20 METERS
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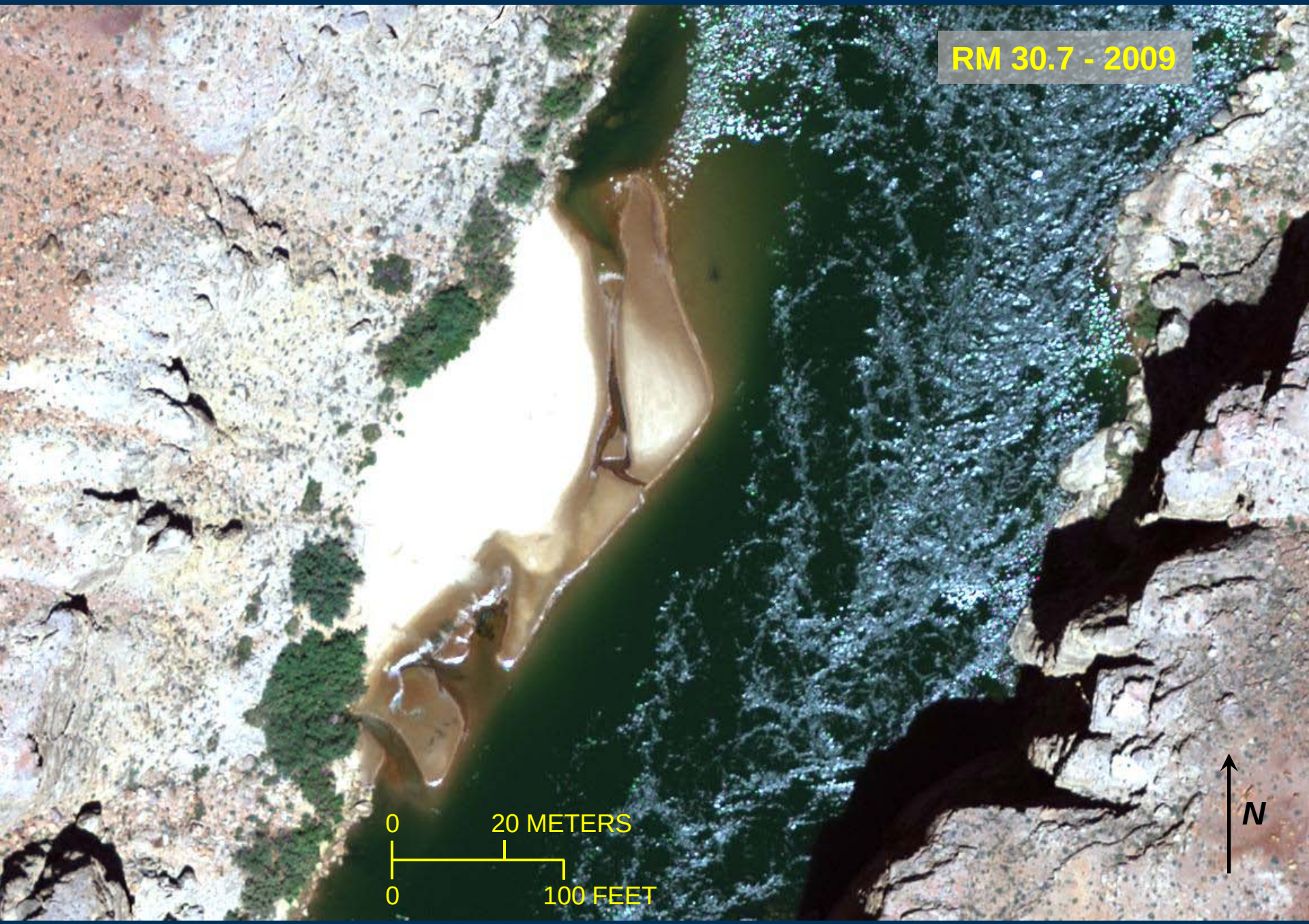
RM 30.7 - 2009
0
20 METERS
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100 FEET
N

The 2009 imagery are also superior to 2002 or 2005 for detailed vegetation mapping and assessment

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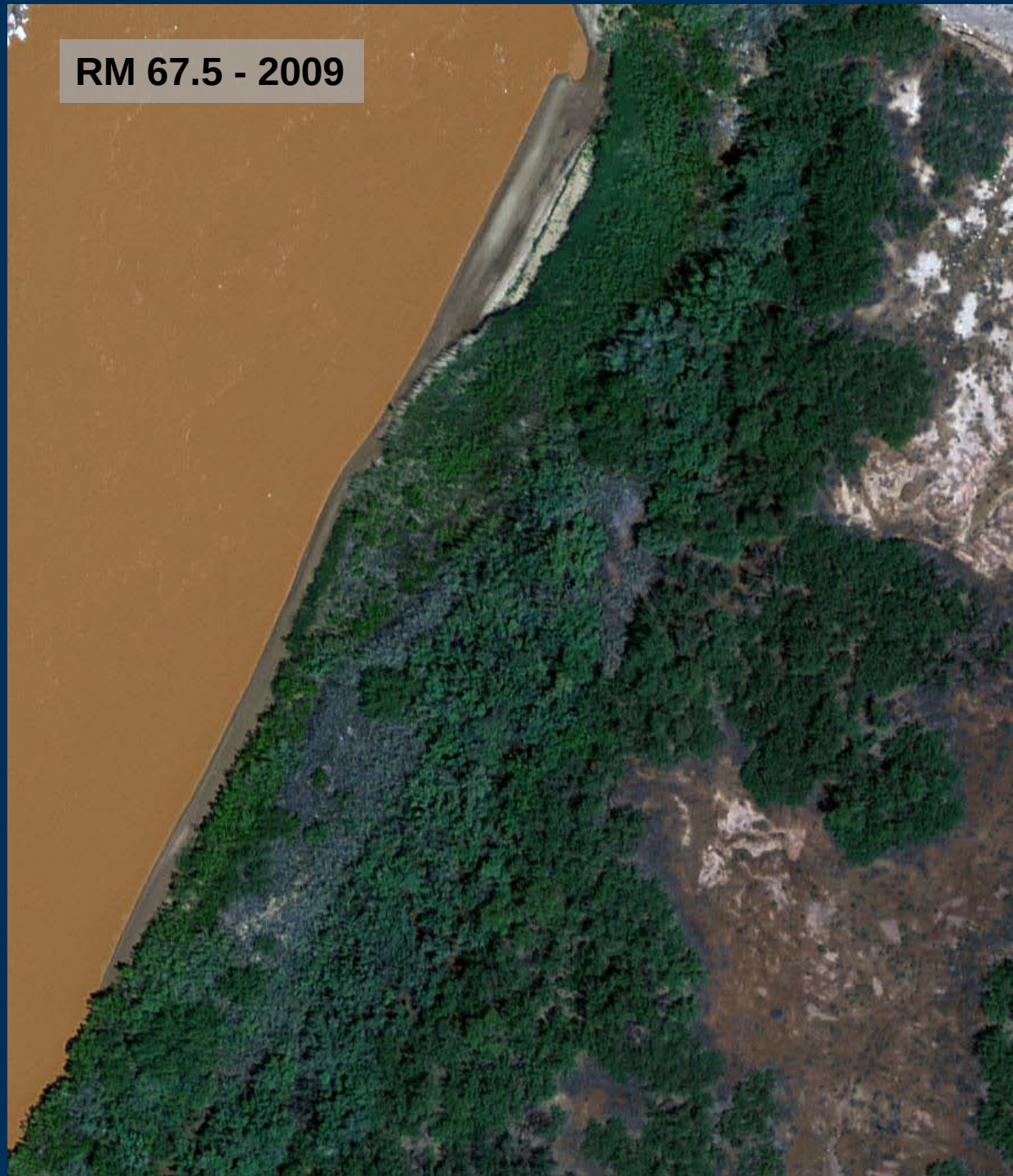
Common canyon vegetation species are quite distinct on the 2009 imagery, not so bad on the 2002 imagery, and less so for 2005.



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So have the data been used that were acquired in 2002, 2005, and 2009?

I have provided a document from Tom Gushue (our GIS guy) outlining the uses that have been made, to his knowledge, of the airborne data since 2002 (Justification for Remote Sensing Overflight Data.docx).

Granted, not all of the uses are scientifically tangible in that the use alone does not directly address AMWG issues, but most of the uses of the data have greatly assisted and improved scientific data collection and/or analyses.

In the spreadsheet that I provided is a list of the conference presentations or publications that have used the airborne data in their analysis and/or interpretations, but I do not always know when the data are used and by whom, since it can be obtained directly from our data servers.

"Yes, Phil, but how has the data been used to address the systemwide issues that can only be approached with such data?"

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Systemwide Data Analysis Update

There are 3 systemwide tasks for the remote sensing data.

1. Provide gross vegetation cover and a classified vegetation databases.

2. Provide landcover for 1,200 sandbar and campsite areas that consist of water, gross vegetation, sand, other smooth material, and rough material (some of these units could be also used by aeolian studies).

3. Number 2, but for entire surface up to 250,000 cfs for possible stage-discharge, climate, and mass-movement effects. This database would also include aspects related to fish habitat that is not considered in item 2, such as backwater areas, cobble bars, and debris flows.

No. 3 presents more ambiguity in the results and difficulty in the approach than does no. 2, due to the larger variety of surface materials upslope, thus The final approach for no. 2 will be made more rigorous for no. 3.

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Vegetation

The gross vegetation databases for 2002, 2005, and 2009 are completed.

The 2002 vegetation has been classified; the 2009 vegetation is being classified by a UA PhD student as part of her thesis.

The 2005 imagery has some serious surface smearing, which obscures vegetation in places. We need to create exclusion areas for that database so that its analysis does not consider these “voids.”

Once 2005 exclusion areas are established (before June), the gross vegetation changes can be easily analyzed, but we currently lack a botanist with canyon experience to interpret the results.

The following is an example of some analyses taking place.

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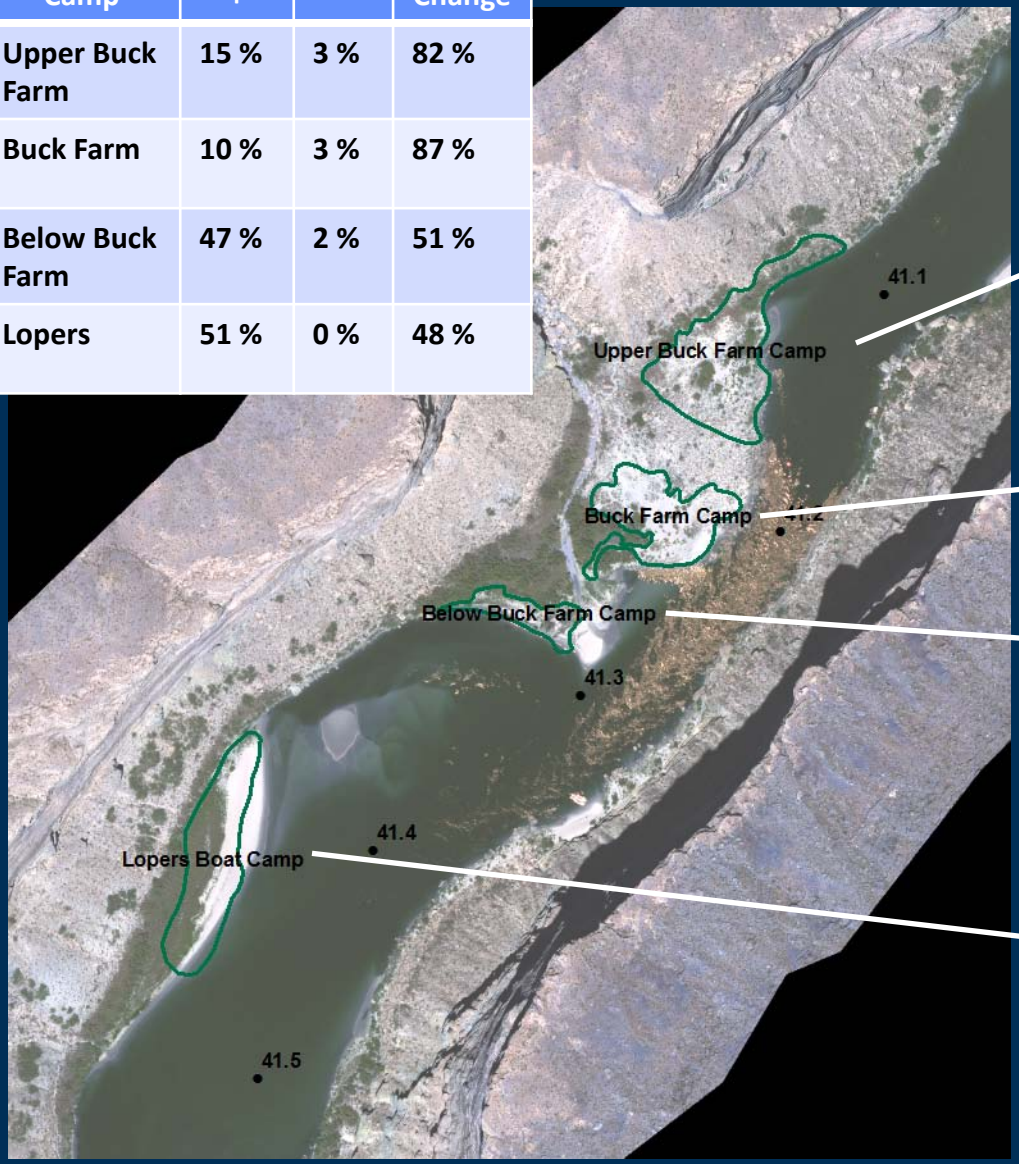
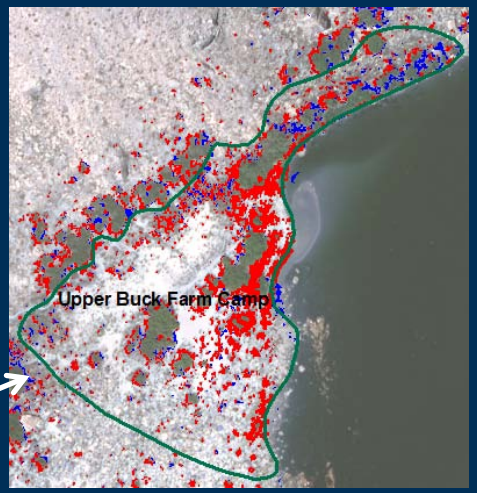
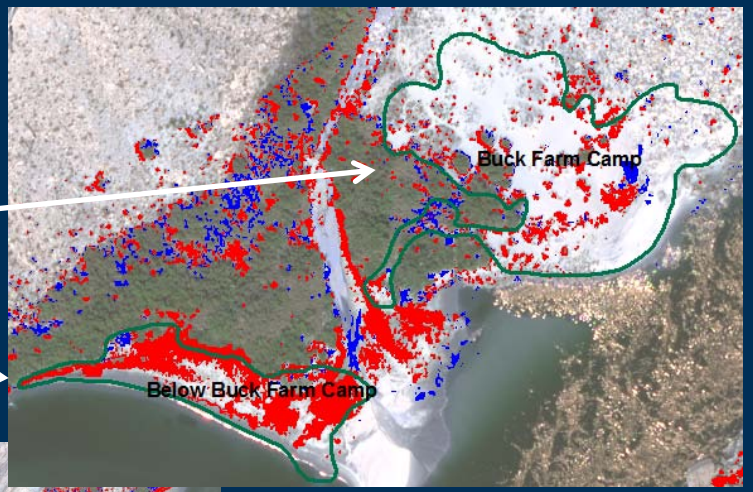
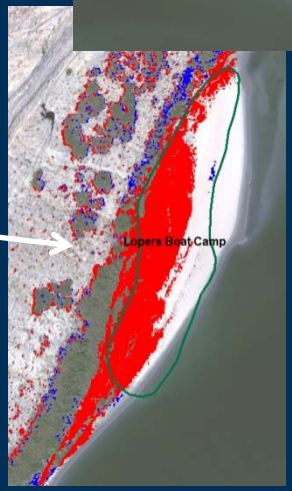
RM 41 Campsite Vegetation Change 2009-2002

Camp	+	-	No Change
Upper Buck Farm	15 %	3 %	82 %
Buck Farm	10 %	3 %	87 %
Below Buck Farm	47 %	2 %	51 %
Lopers	51 %	0 %	48 %









Change 2002-2009

Increase

Decrease

Sandbar and Campsite Analyses

The analysis for this task is conducted in 2 stages.

The first stage takes the water, vegetation, and bare-ground mask, further Refines water and sparse vegetation units, segments the remaining bare-ground unit into four brightness levels based on image statistics, filters the image data to reduce local noise, forms surface texture, and several other steps. This stage is completed for 2002 and 2009.

The second stage employs a spectral, textural, and spatial contextual analysis on the two brightest bare-ground units (and may go down one more unit if wet sand exists in the darker unit). At this point, the last step in the analysis for wet sand needs to be designed and tested (it is the most difficult). The complete analysis for 2002 and 2009 will be completed before June. When the stage 2 algorithm Works at 90% or better accuracy, each of the 1,200 areas requires 1 minute to process.

The following slides show an example at RM 195. The sand and vegetation units will be vectorized and provided to the scientists for spatiotemporal analyses.

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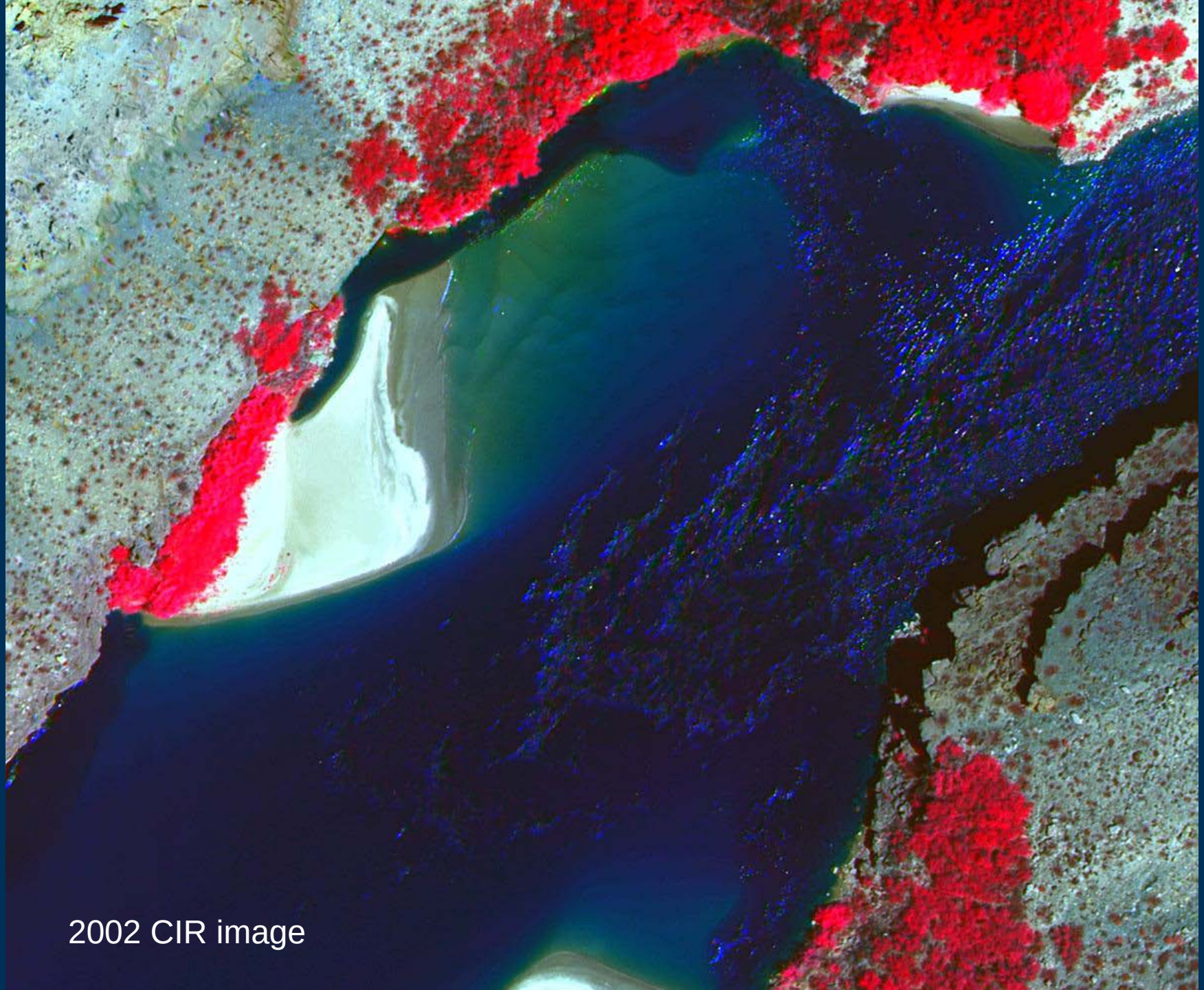
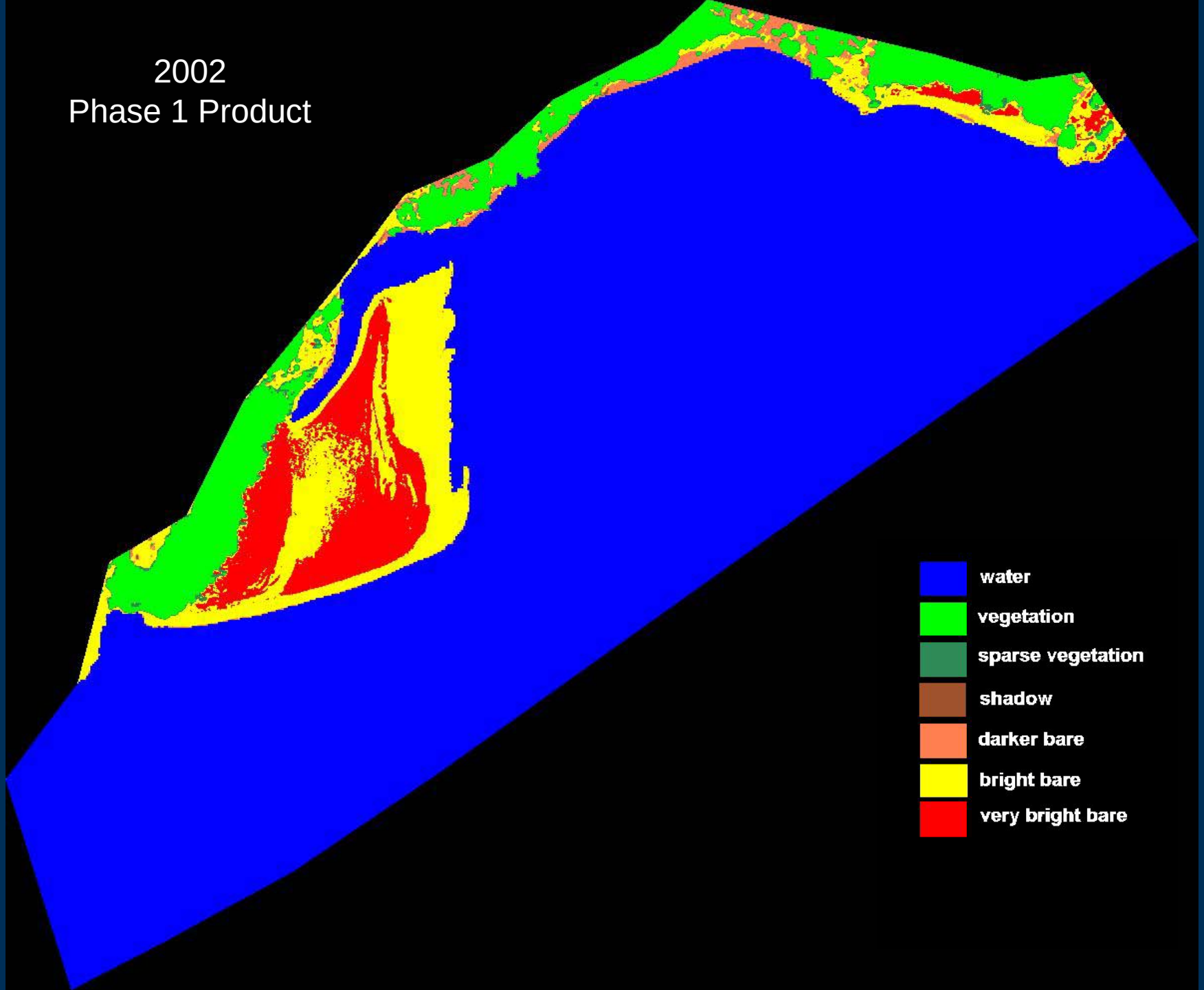


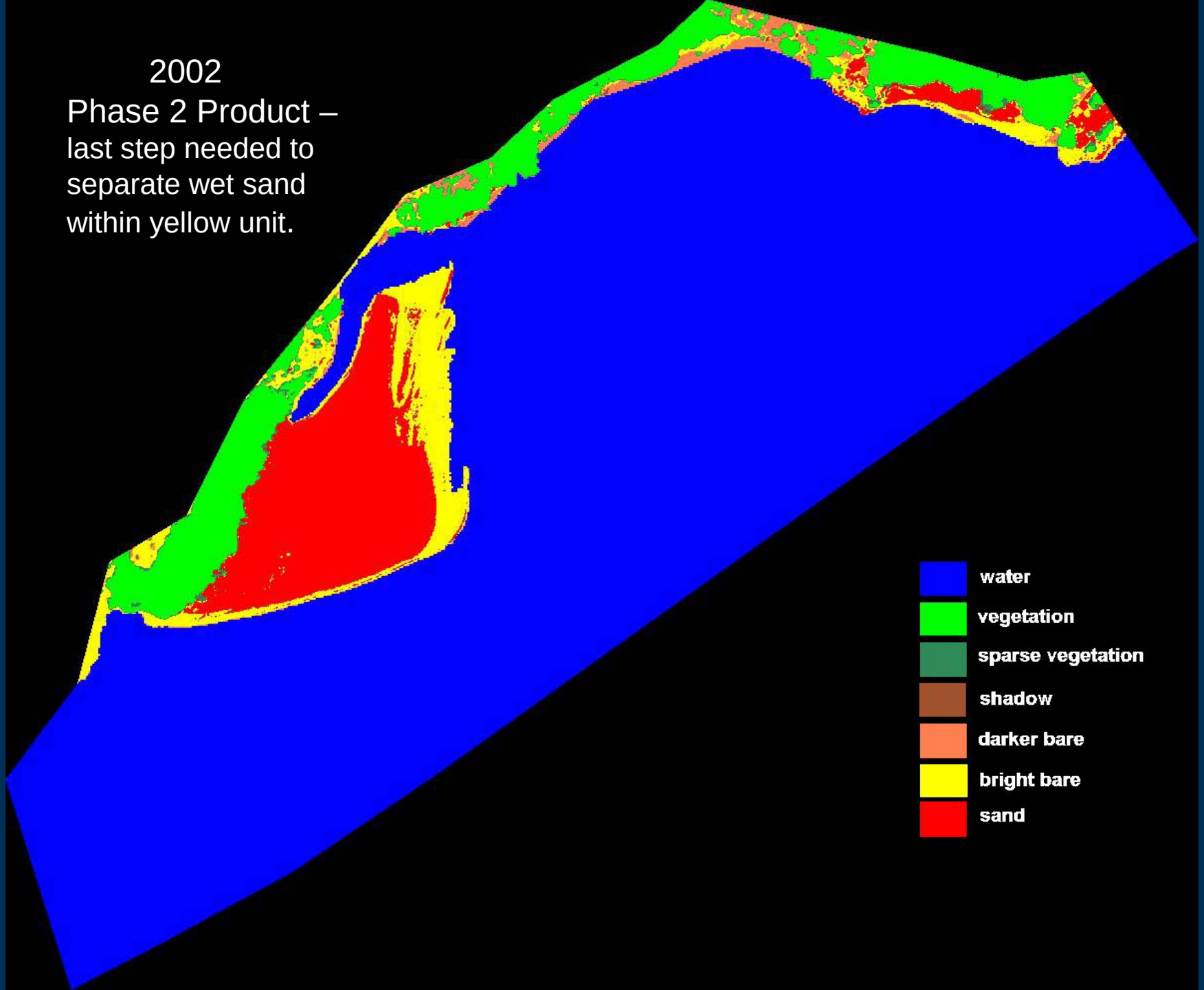
2002 CIR image

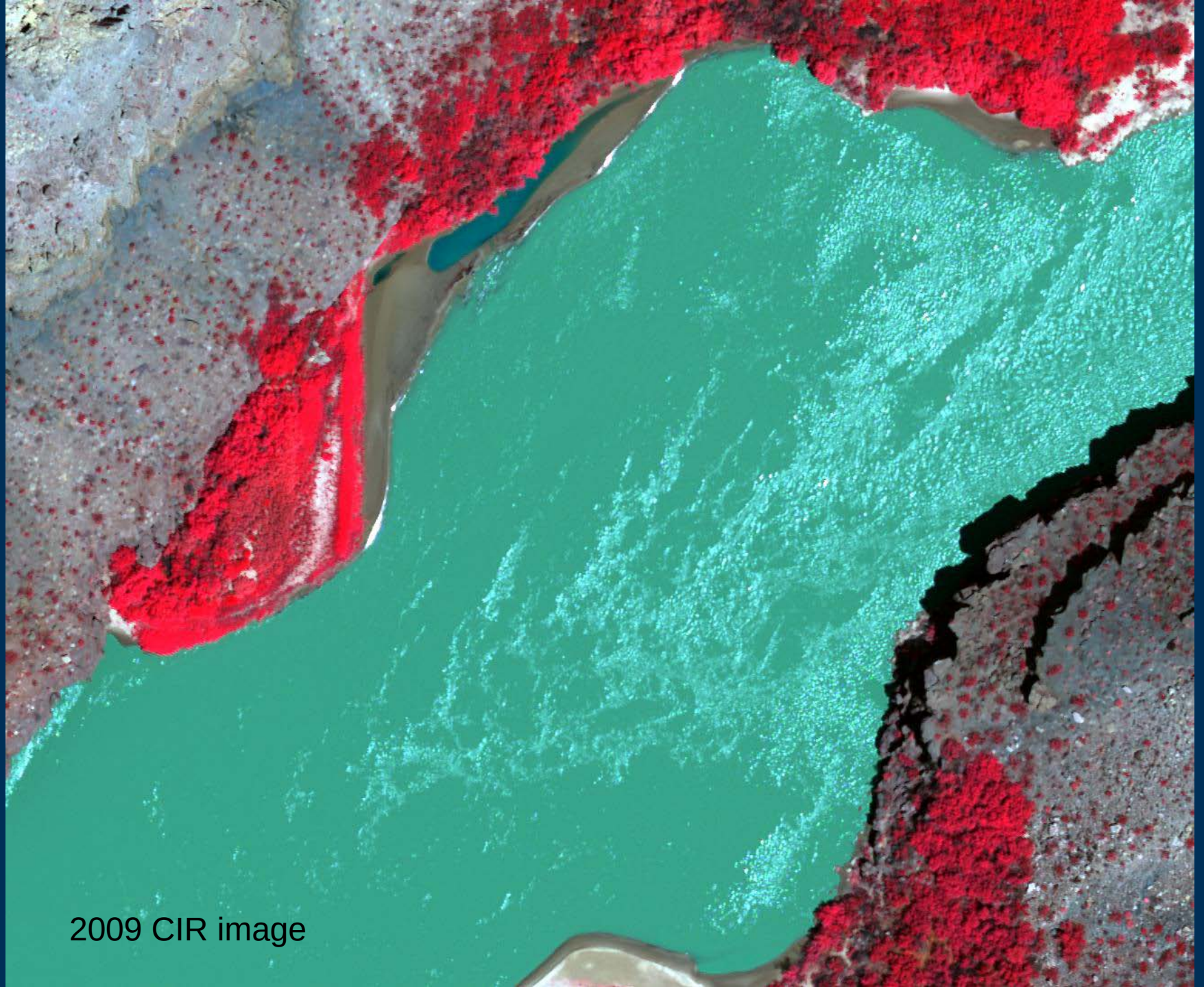
2002
Phase 1 Product



2002

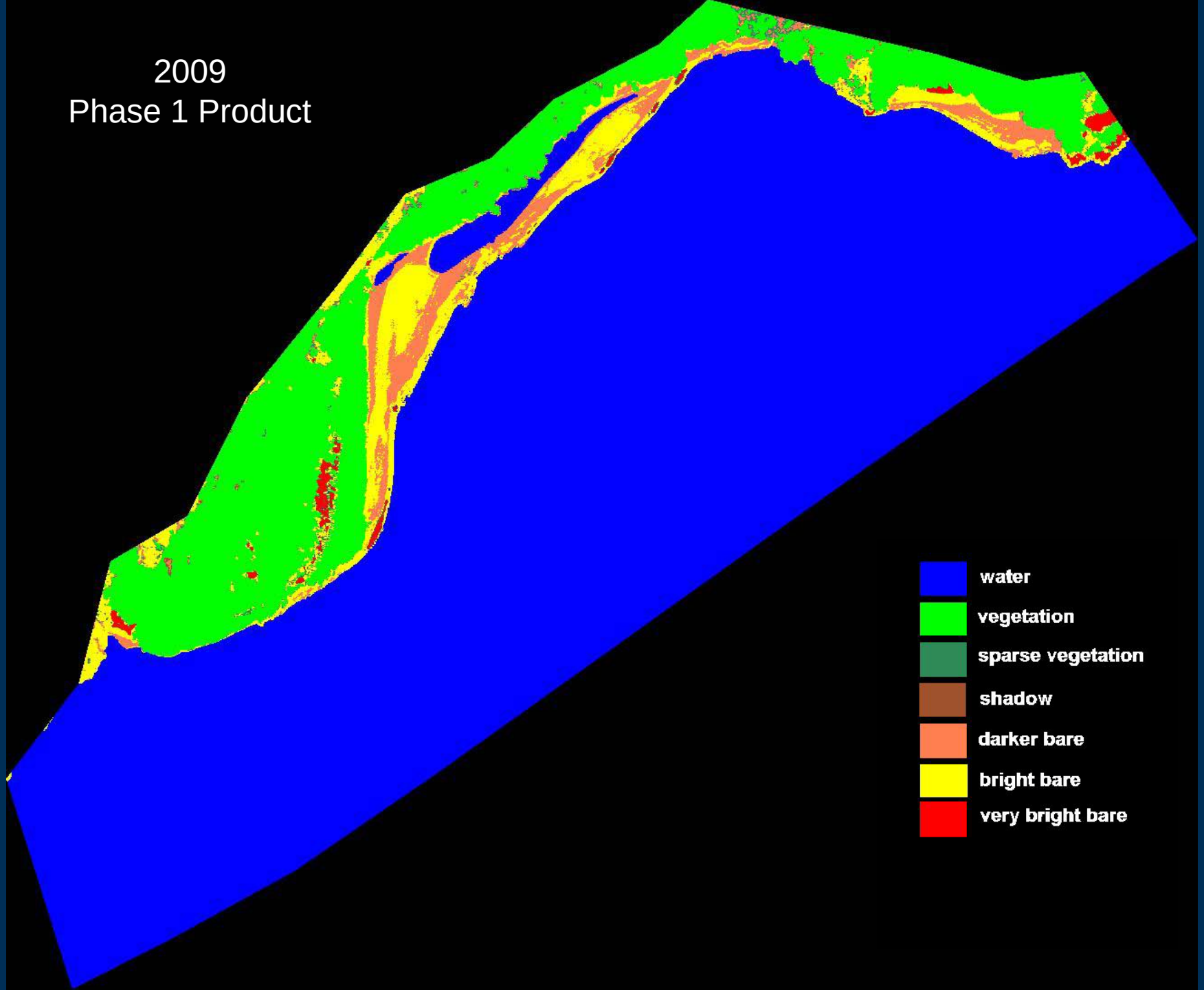
Phase 2 Product – last step needed to separate wet sand within yellow unit.





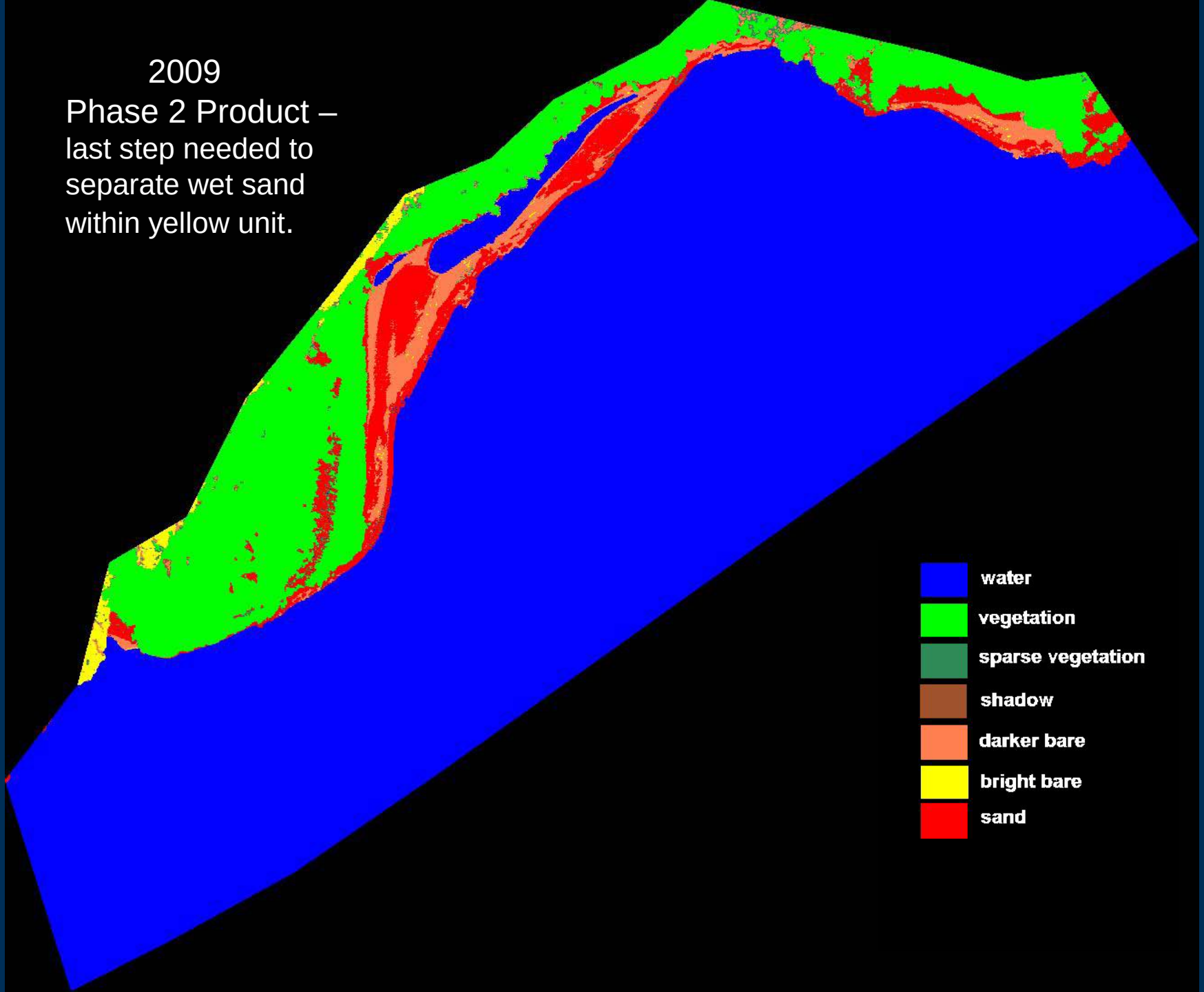
2009 CIR image

2009
Phase 1 Product



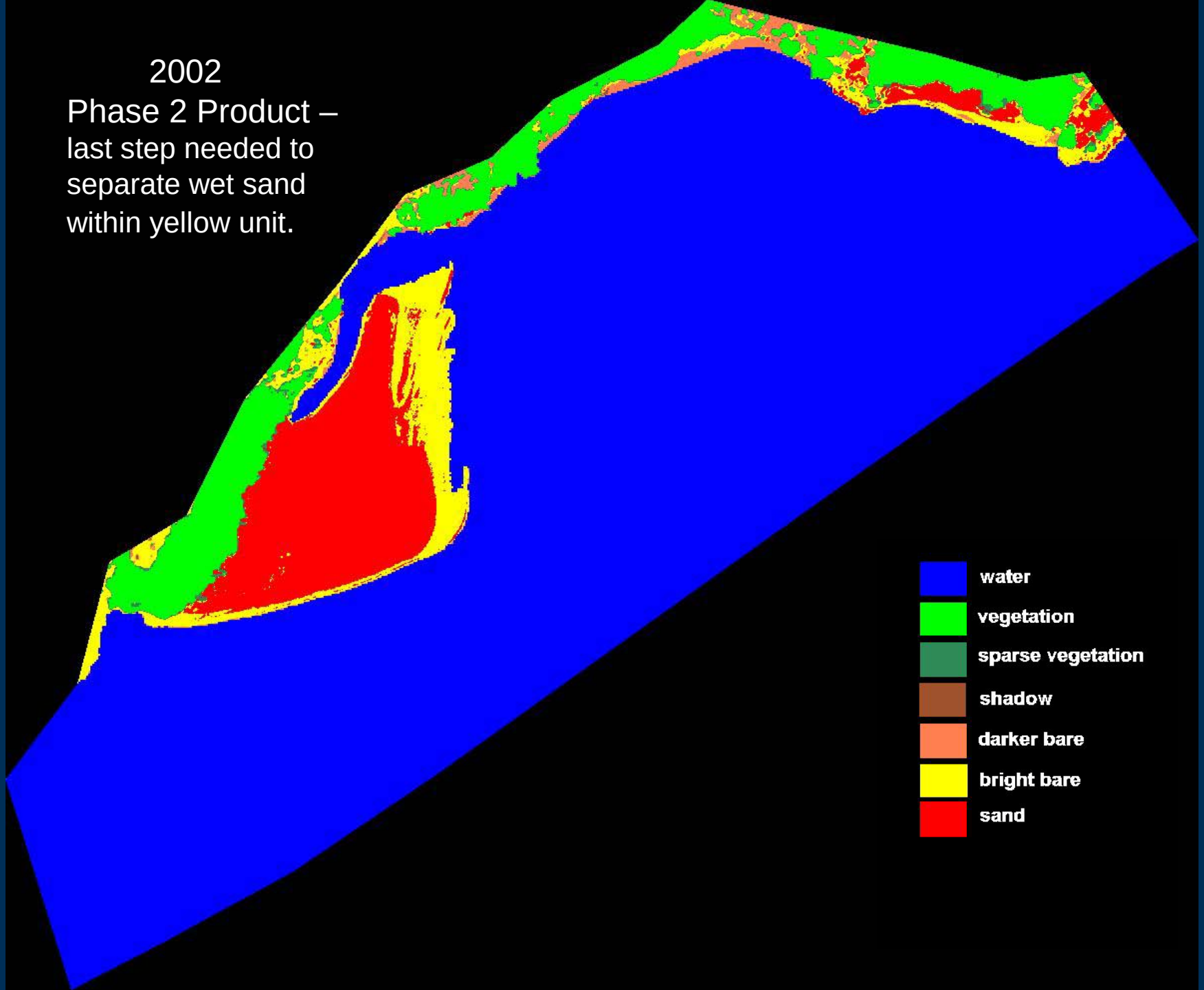
2009

Phase 2 Product – last step needed to separate wet sand within yellow unit.



2002

Phase 2 Product – last step needed to separate wet sand within yellow unit.



Full Canyon Geomorphic Analysis

The computer-generated surface units will be completed and published as a Data Series before the 2013 data are delivered. I need to interface with fish scientists to ensure they get what they need. Parts of the database require visual geomorphic mapping using the 2009 imagery and altering the units for the 2002 imagery where change has occurred. Once mapped, geomorphic unit alteration for subsequent years is rapid, just has not been done canyonwide.

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2002 and 2009 DSM Data

I have fully assessed the accuracy and precision of these systemwide topographic databases. Summary of observations:

1. Vertical accuracy for 2002 = 28 cm, 2009 = 26 cm
2. Vertical precision between 2002 and 2009 = 13 cm
3. Each dataset has vertical offsets and these do vary throughout the corridor, which I can correct.
4. There is some co-registration issues, which I will also correct, to make change detection for accurate.
5. Once calibrated the data will be sufficiently precise for examining canyonwide changes for certain resources (maybe not for cultural features) and will be very easy to detect mass movements, which I have observed between the data sets (which in the past we only detected by visual examination of 2,500 air photos).

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2013 Schedule

by June	Working on final step in two-phase image analysis to provide landcover databases for sandbar and campsite analyses using 2002 and 2009 data.	Will have the 2002 and 2009 data required for corridor-wide sandbar and campsite change detection within 1,200 sites.	
	Will have published natural-color and color-infrared imagery from 2009 as a Data Series so it is available on the USGS publications site.		USGS Data Series
by August	Will have the 2002 and 2009 DSM data calibrated and will start determine its use for coarse- and fine-grained sediment studies.		USGS Data Series
by Oct	Will have above data for entire corridor augmented with manual geomorphic units (debris fans, bedrock, cobble bars, etc.) and publish databases as Data Series		USGS Data Series for 2002 and 2009

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