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Update on Analysis of 2005 Imagery

Presentation to the Glen Canyon Dam Adaptive Management Program, Technical Work Group.
April 8, 2008
3:00 PM

U.S. Department of the Interior
U.S. Geological Survey

FY2007-2008 REMOTE SENSING PROJECTS

DASA 12.D6.08

Integrated Analysis and Modeling-Mapping Shoreline Habitat Changes

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FY2007-2008 REMOTE SENSING PROJECTS

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Integrated Analysis and Modeling-Mapping Shoreline Habitat Changes

PROJECT GOALS

GOAL 1: Develop automated shoreline-habitat data across stage-discharge ranges for the entire Grand Canyon Ecosystem Corridor from remotely-sensed data sources.

- **Classify whole surfaces by selected habitat characteristics such as: geomorphology, texture (roughness), vegetation, and ultimately, velocity and temperature from models.**

- **Develop automated techniques for extracting habitat data from these surfaces for individual stage lines or depth zones bracketing stage lines.**

GOAL 2: Conduct change detection on fine-grained sediment (sand) deposits, vegetation and sand-bounded backwaters.

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Integrated Analysis and Modeling-Mapping Shoreline Habitat Changes

SCIENCE QUESTIONS

- SSQ 3-9. How do varying flows positively or negatively affect campsite attributes that are important to visitor experience?
- SSQ 1-4. Is there a “Flow-Only” (non-sediment augmentation) operation that will restore and maintain sandbar habitats over decadal time scales?
- SSQ 4-2. How important are backwaters and vegetated shoreline habitats to the overall growth and survival of YoY and juvenile native fish? Does the long-term benefit of increasing these habitats outweigh short-term potential costs (displacement and possibly mortality of young humpback chub) associated with high flows?

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Integrated Analysis and Modeling-Mapping Shoreline Habitat Changes

OTHER SCIENCE QUESTIONS

- What is the rate of change in eddy storage (erosion) during time intervals between BHBFs?
- What are the most appropriate methods for detecting change in shoreline habitat along the entire CRE given the available data sets collected using different technologies (scanned-analog vs. digital), different platforms (Leica ADS-40/ISTAR vs. DMC/3001, Inc.), and different image resolutions (30cm vs. 22cm vs. 18cm)?
- What level of change can be detected in shoreline habitat using remotely sensed data collected in the past 5 years? What changes have occurred to the shoreline habitat across the CRE in the past 5 years?
- Where have the most significant changes taken place in shoreline habitat along the CRE in the past 5 years, and within which shoreline habitat classes are the most noticeable changes? How does the shoreline habitat relate to backwater environments/habitats? What have been the changes in backwater abundance/size/shape over the past 5 years?
- As historical analog over flights become available in digital format, can the timeline be extended back to previous years?

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Integrated Analysis and Modeling-Mapping Shoreline Habitat Changes

Work Plan Products

- Surface texture classifications for entire river corridor.
- Vegetation classification for entire river corridor.
- Surficial geomorphic classifications (cliff, talus, debris fan, and cobble Bar) for entire river corridor.
- Final composite shoreline classification scheme and computer programs for extracting shoreline habitat attributes.

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Integrated Analysis and Modeling-Mapping Shoreline Habitat Changes

Additional Products (if time permits)

- **Update and extend USU backwater time series through year 2005.**
- **Near-shore habitat statistical summaries for selected flow regimes in the CRE between Lees Ferry and Diamond Creek.**

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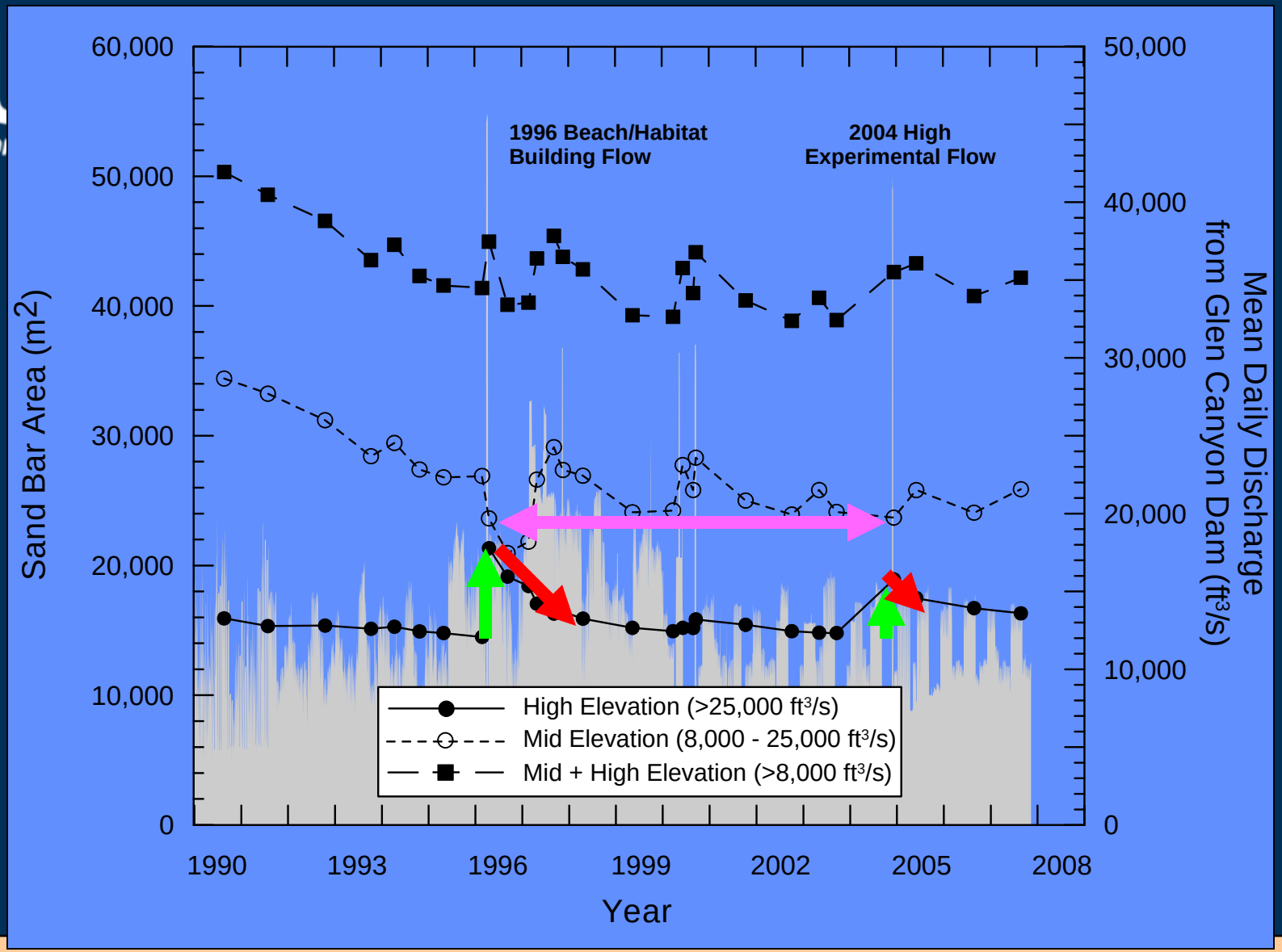

Three components that we must understand to rebuild average size of bars: gains by floods, rates of erosion, spacing of floods

Habitat and Sub Adult Humpback Chub

Converse, Y.K., Hawkins, C.P. and Valdez, R.A. 1998.

Sub adult humpback chub samples using electro-fishing.

- Vegetation, talus and debris fan shorelines have more cover and greater fish densities than bedrock, cobble and sand shorelines.

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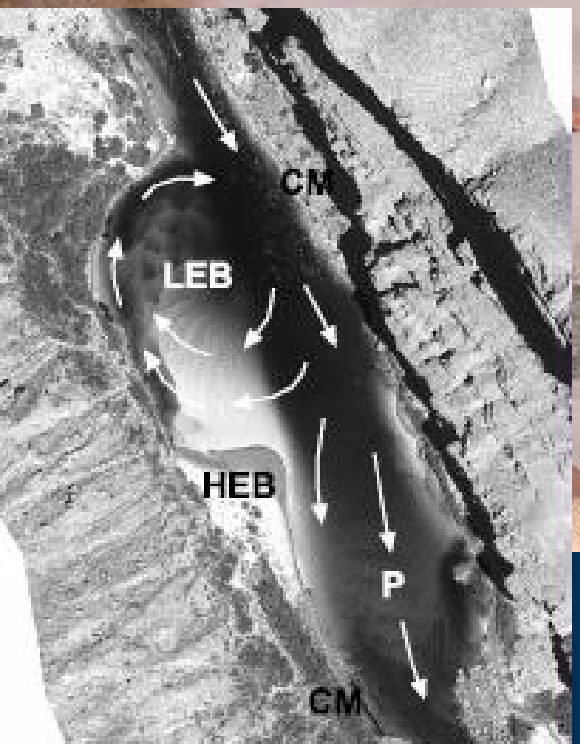
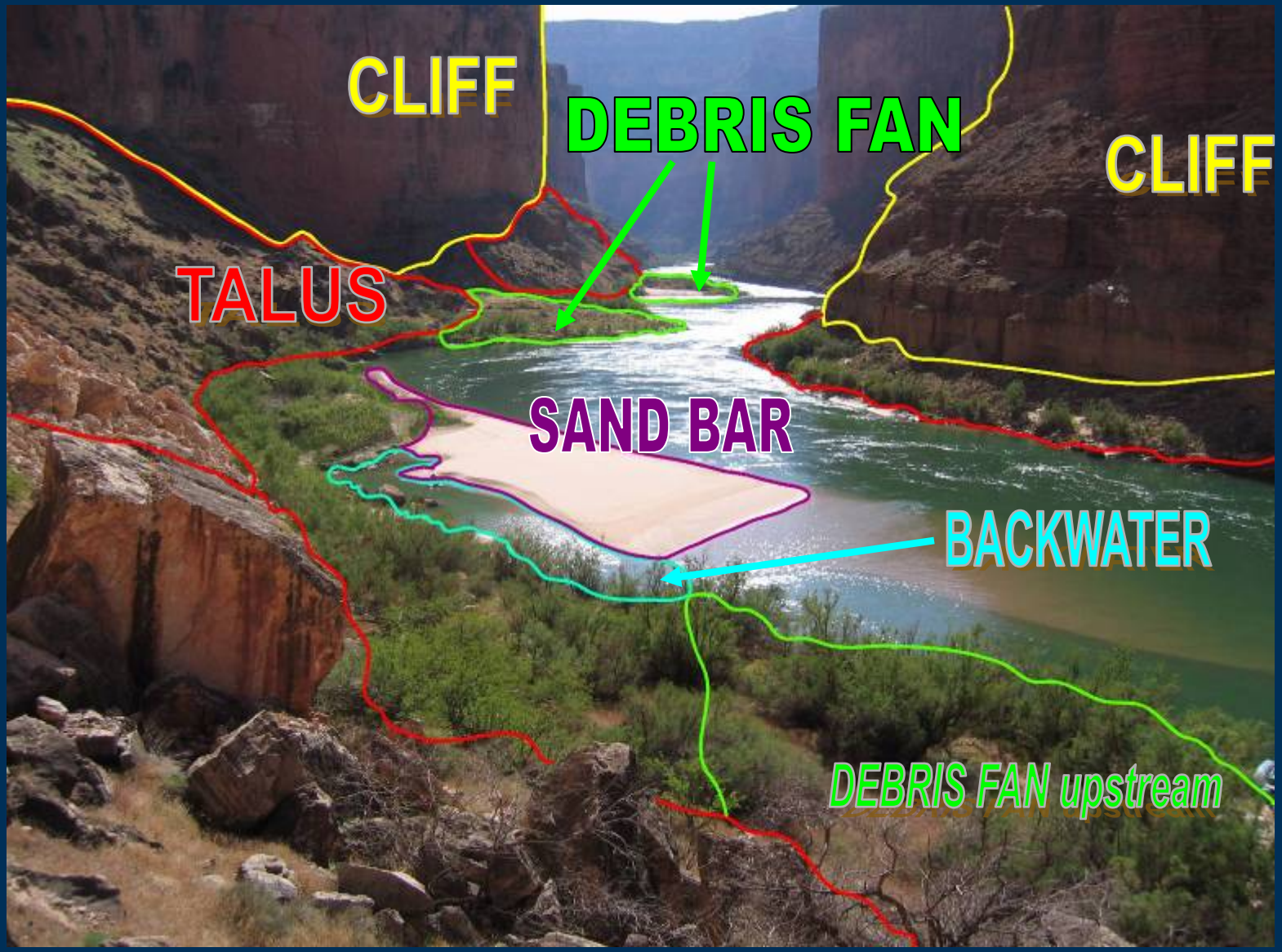
Mainstem backwaters MAY benefit humpback chub

- Warming in low-velocity, backwater areas.
  Cover along excavated shorelines.

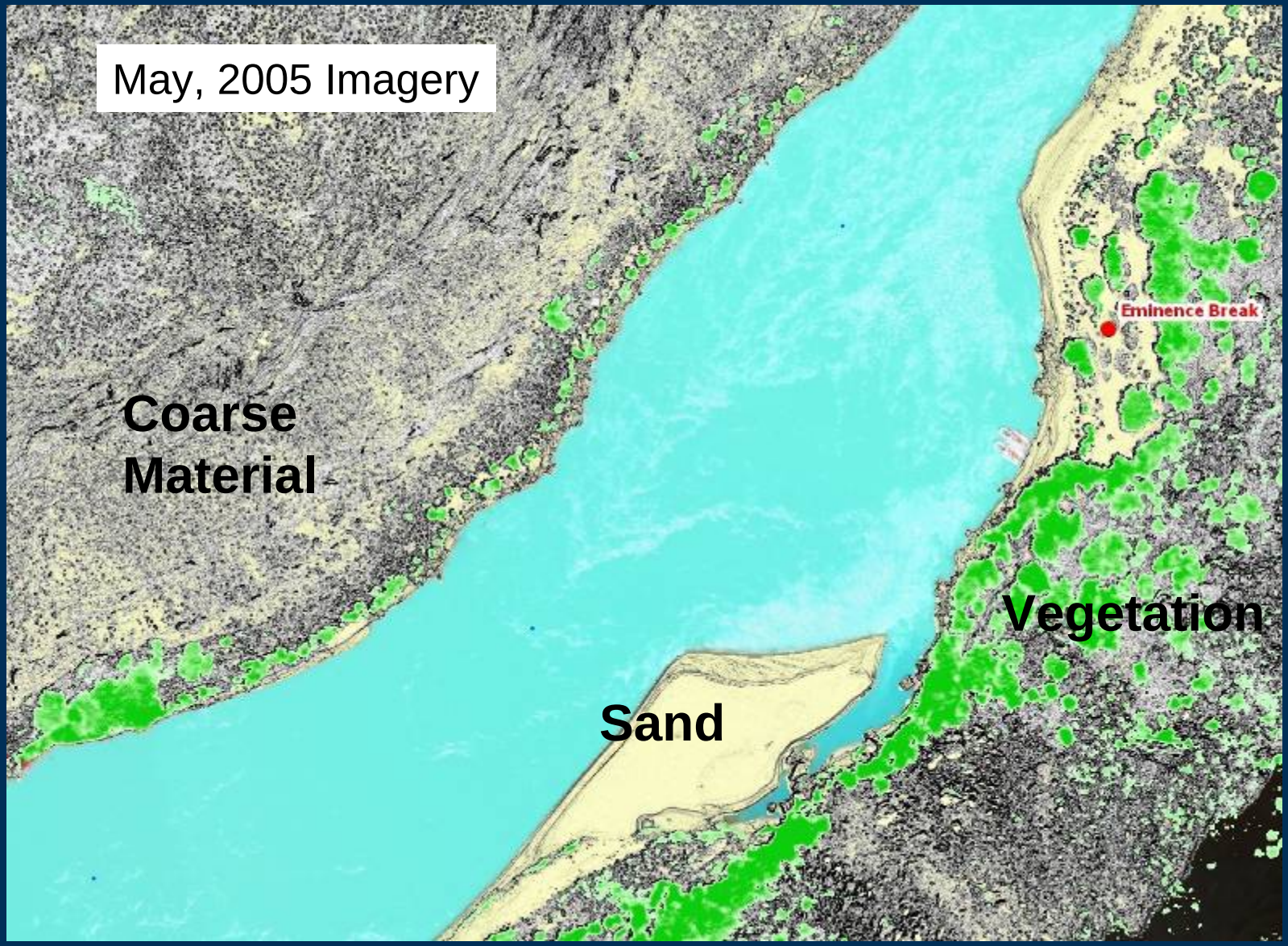
- Seining trips find many juvenile Chub in backwaters, but…
- Seining results are not comparable to electro-fishing, which is not always possible in backwaters.



Geomorphic features are being delineated as polygons for the entire river corridor. These will be complete by the end of FY08.

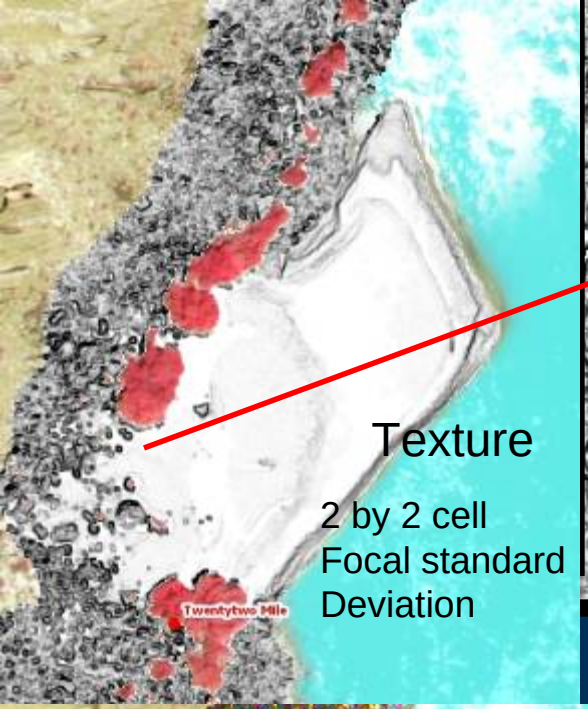


Texture (roughness), sand & vegetation are complete from Lees Ferry to Diamond Creek for May, 2002 and May, 2005 Imagery.



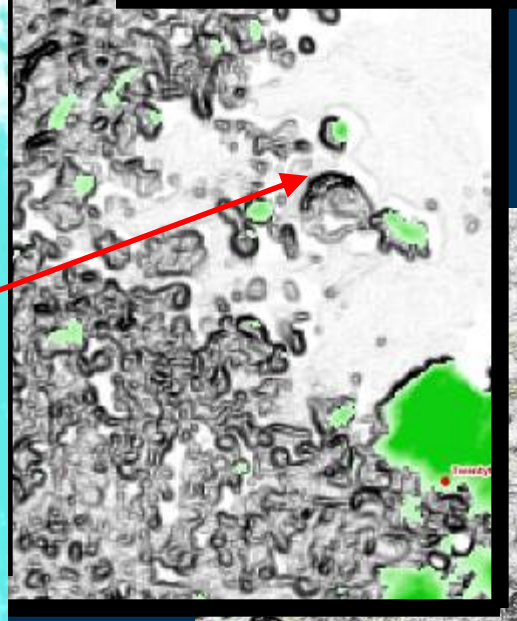
Preliminary data: subject to review and revision.

SAND CLASSIFICATION



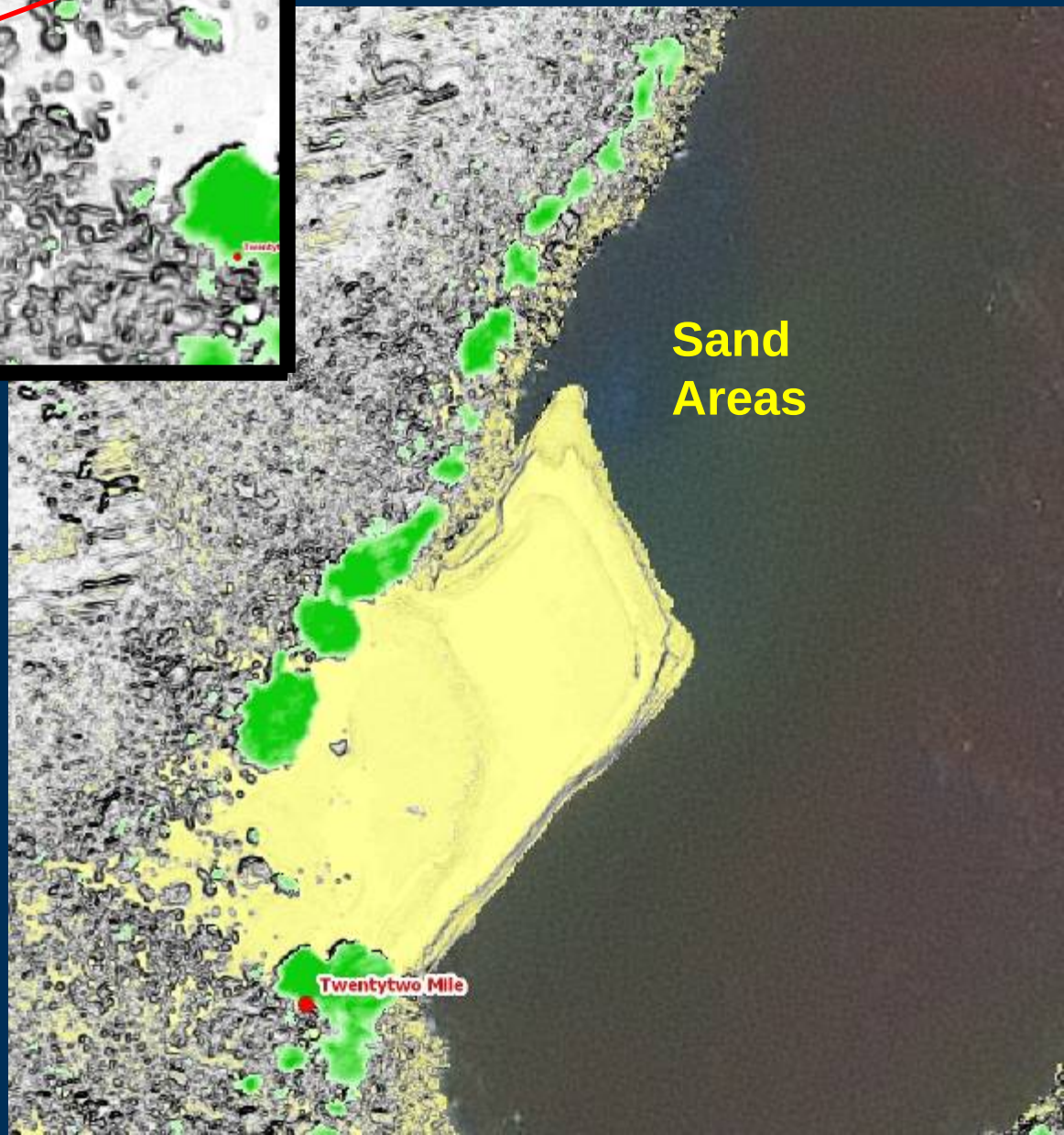
Texture

2 by 2 cell
Focal standard
Deviation



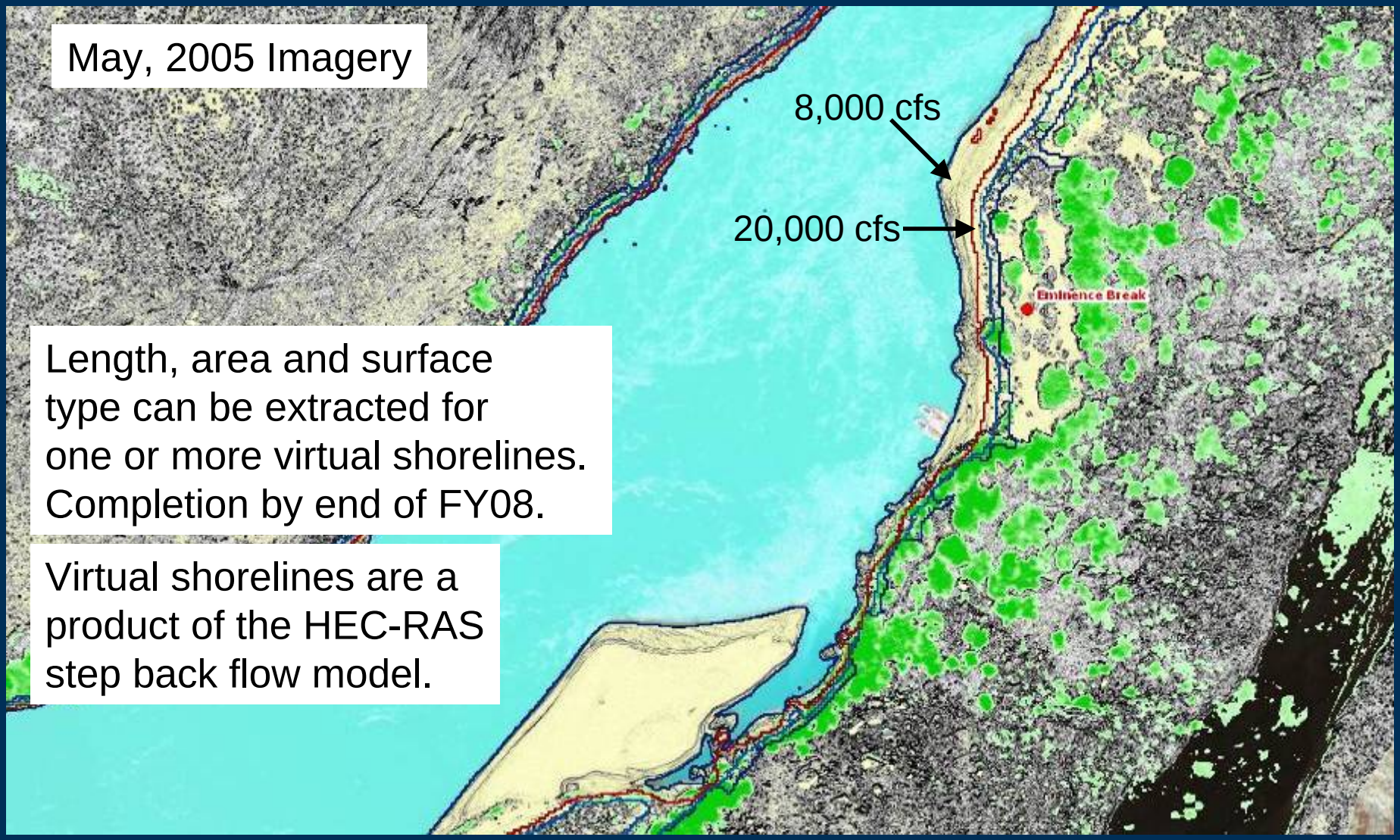
Brightness

30 Unsupervised
Classes



Sand
Areas

Automated programs for extracting habitat data from these surfaces for individual stage lines or depth zones will be completed by the end of FY08.



Length, area and surface type can be extracted for one or more virtual shorelines. Completion by end of FY08.

Virtual shorelines are a product of the HEC-RAS step back flow model.

Preliminary data: subject to review and revision.

Virtual Shorelines

One-Dimensional Step-Backwater Model (HEC-RAS)

GIS Virtual Shoreline Program

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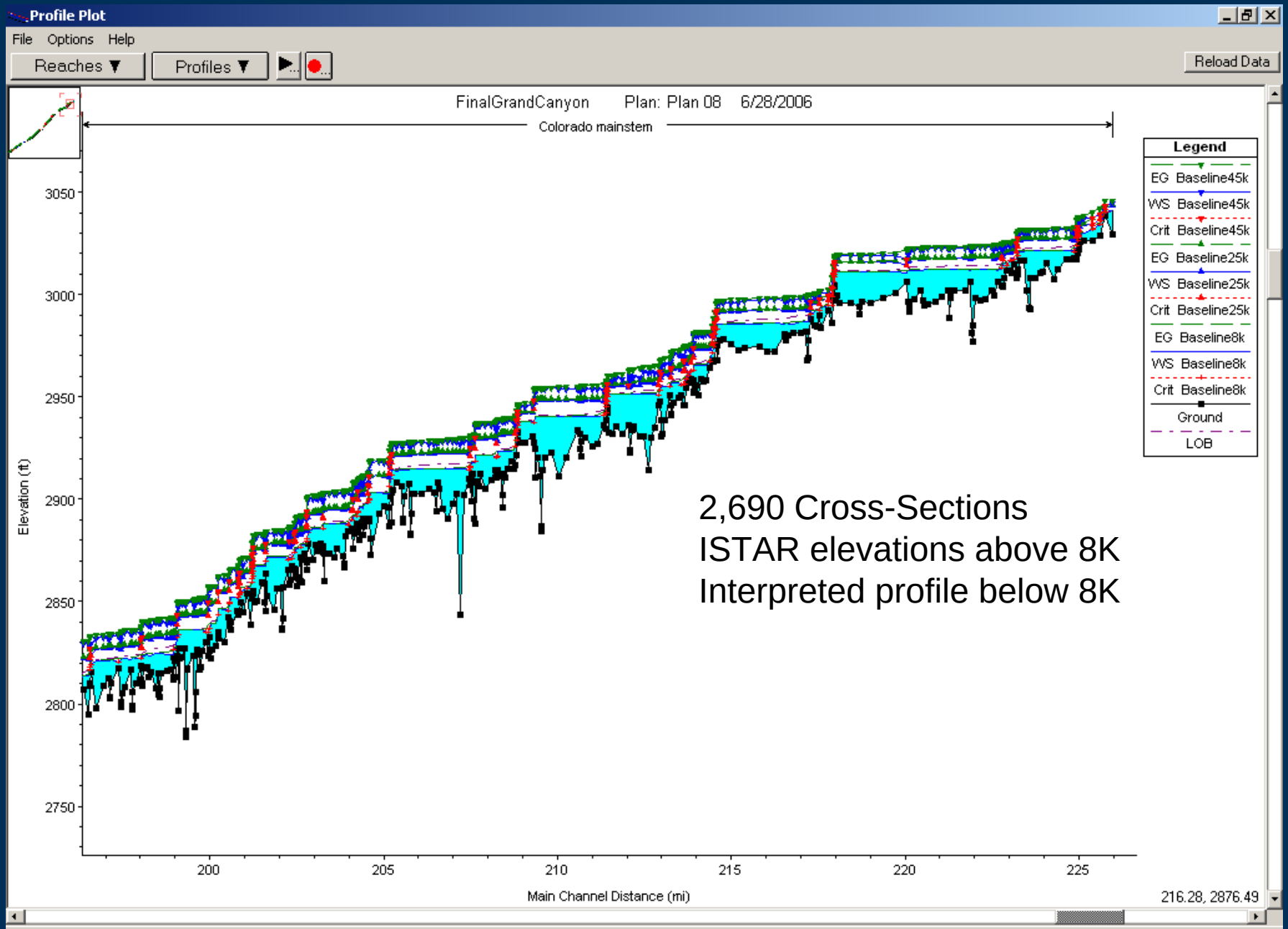
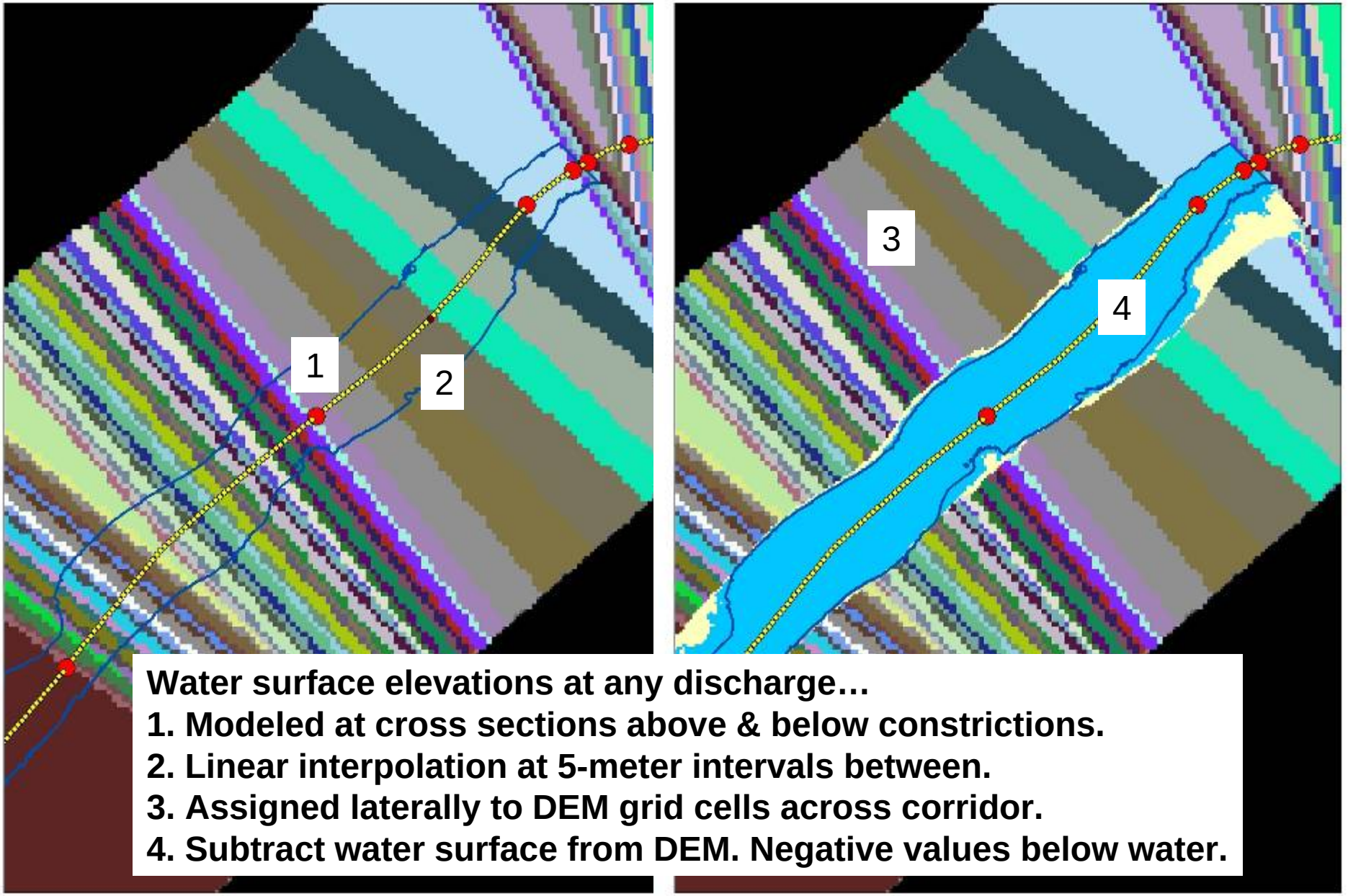
Surface Profile Hec-Ras

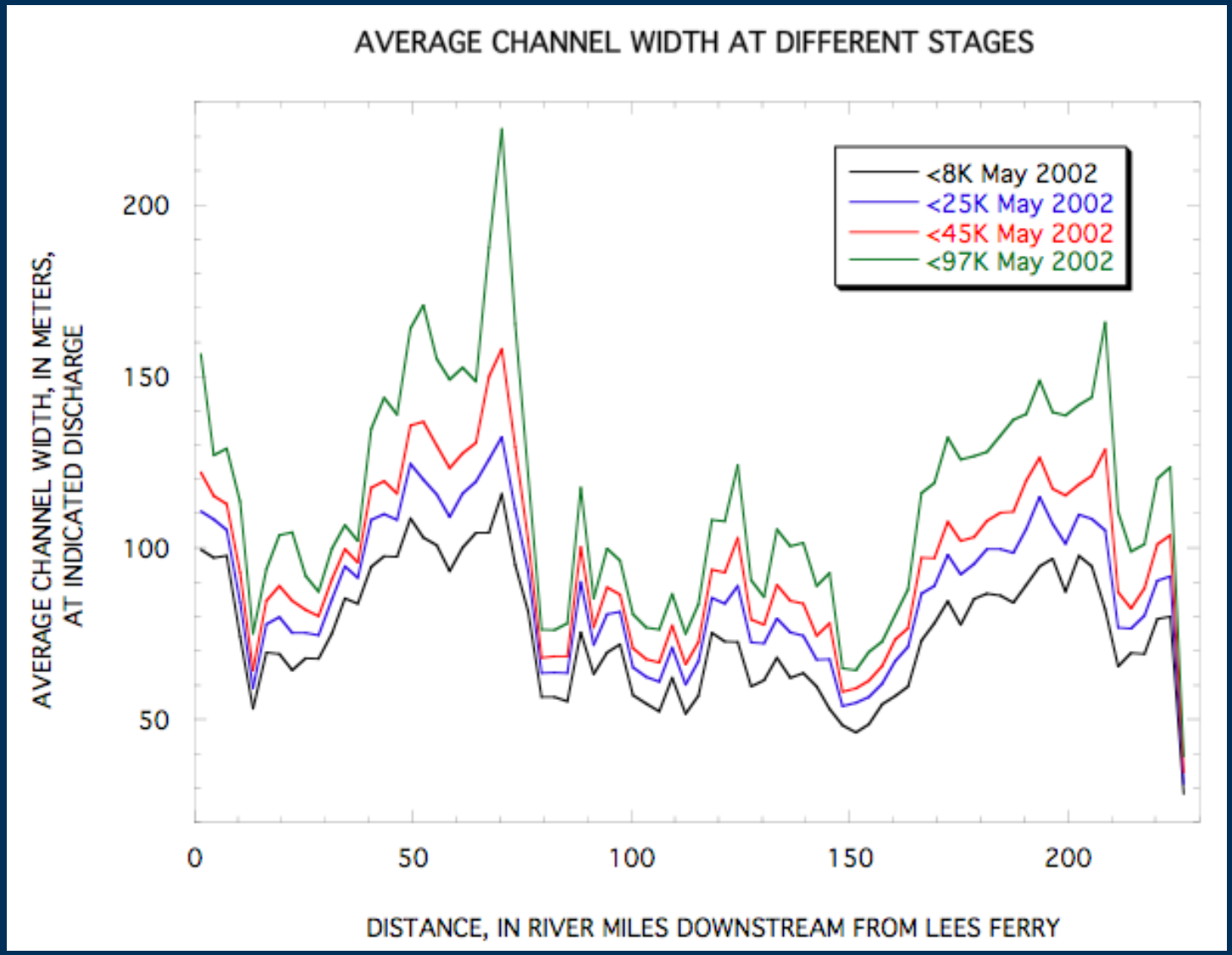


Virtual Shoreline Construction: Grandma's Quilt



Water surface elevations at any discharge…

1. Modeled at cross sections above & below constrictions.
2. Linear interpolation at 5-meter intervals between.
3. Assigned laterally to DEM grid cells across corridor.
4. Subtract water surface from DEM. Negative values below water.


AVERAGE CHANNEL WIDTH AT DIFFERENT STAGES
<8K May 2002
<25K May 2002
<45K May 2002
<97K May 2002
AVERAGE CHANNEL WIDTH, IN METERS, AT INDICATED DISCHARGE
200
150
100
50
0
50
100
150
200
DISTANCE, IN RIVER MILES DOWNSTREAM FROM LEES FERRY

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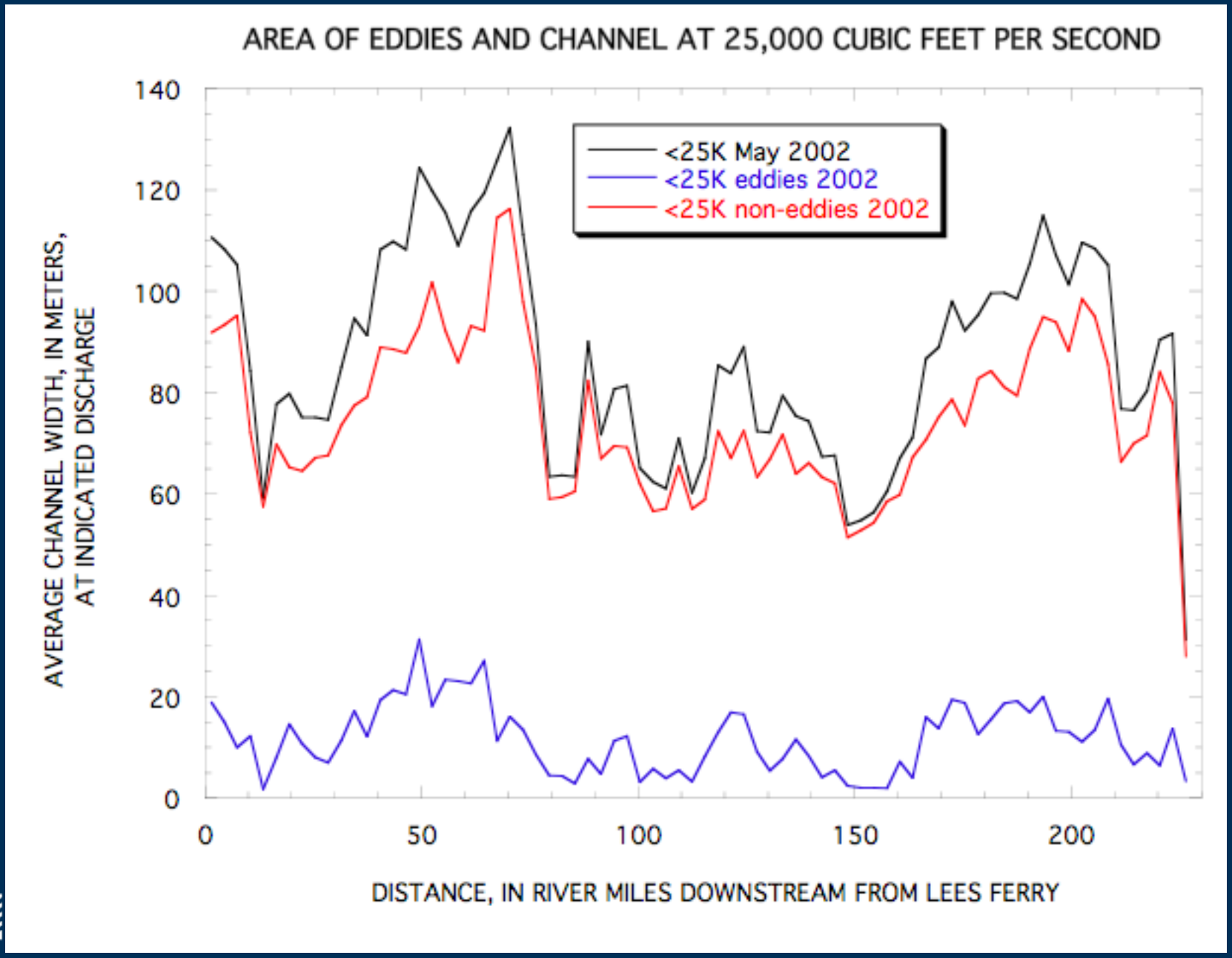
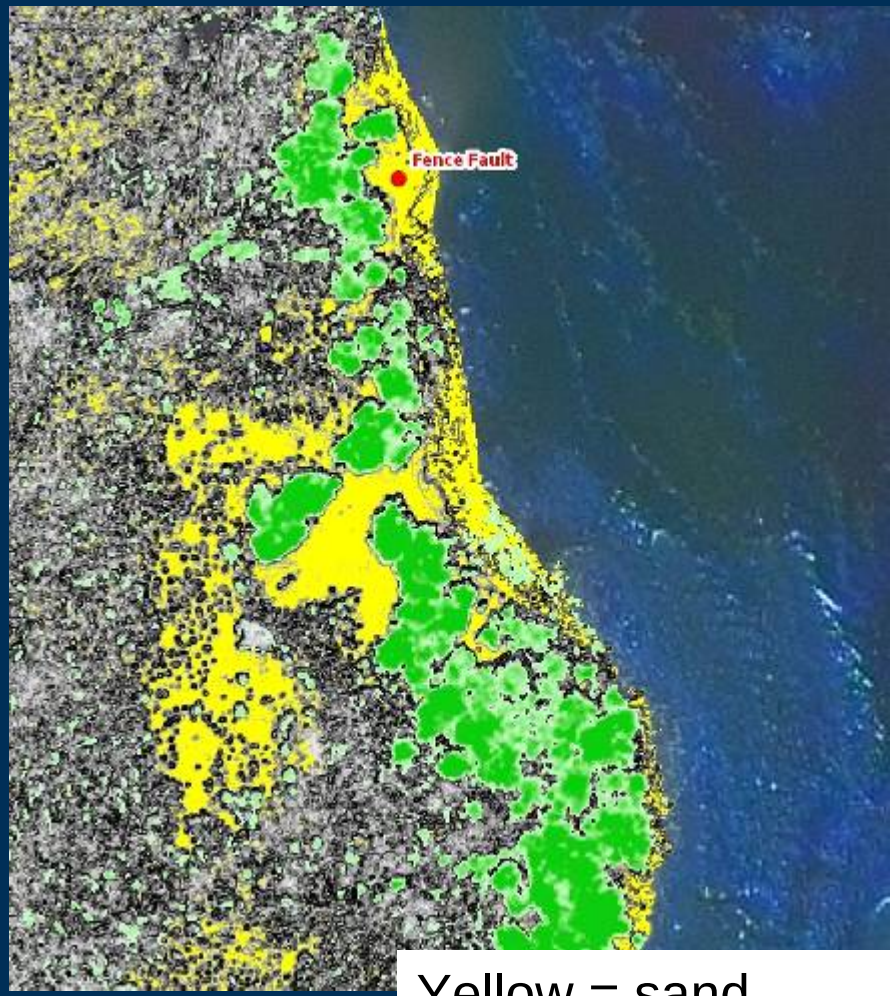

AREA OF EDDIES AND CHANNEL AT 25,000 CUBIC FEET PER SECOND
AVERAGE CHANNEL WIDTH, IN METERS, AT INDICATED DISCHARGE
140
120
100
80
60
40
20
0
0
50
100
150
200
DISTANCE, IN RIVER MILES DOWNSTREAM FROM LEES FERRY
<25K May 2002
<25K eddies 2002
<25K non-eddies 2002

Sand & Vegetation Have Been Classified from Lees Ferry to Diamond Creek for May, 2002 and May, 2005.

Fence Fault
River Mile 30



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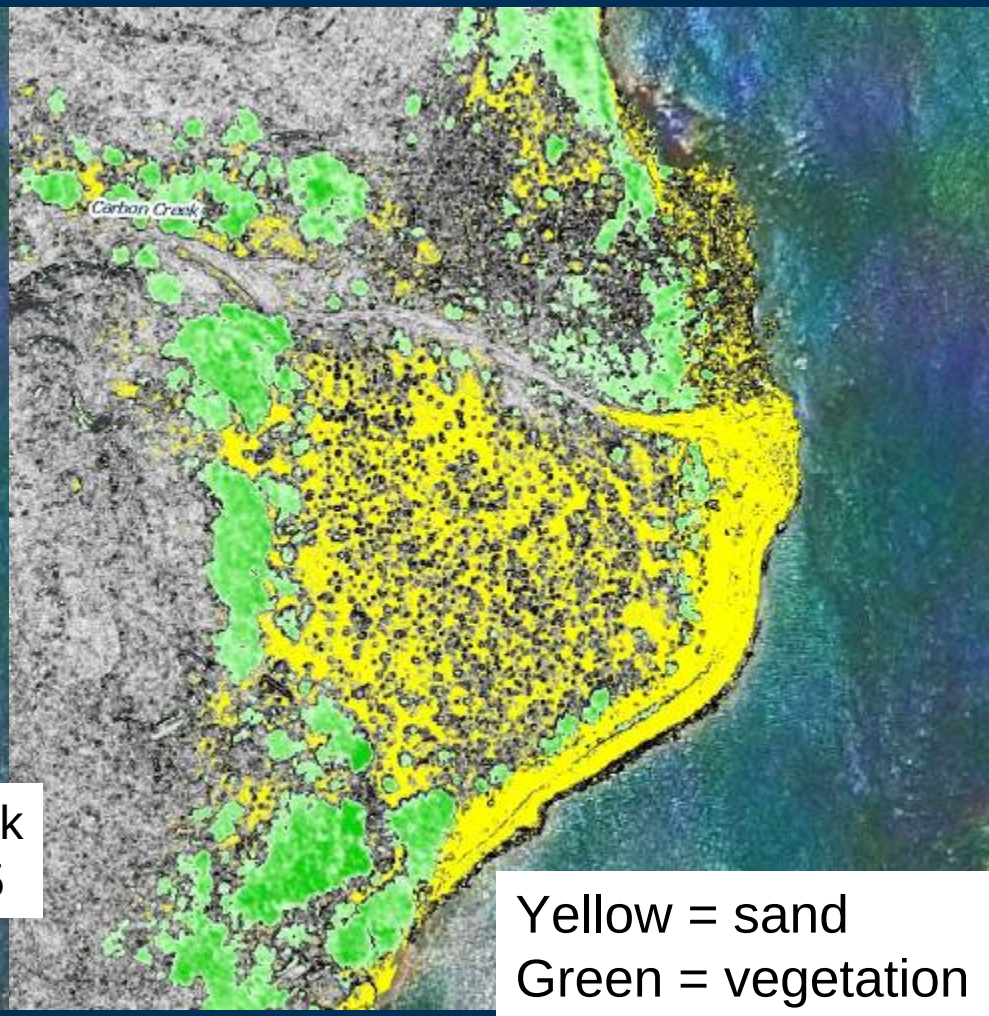
May, 2002 Image

Classified Image

Yellow = sand
Green = vegetation

Preliminary data: subject to review and revision.

Sand & Vegetation Have Been Classified from Lees Ferry to Diamond Creek for May, 2002 and May, 2005.



Carbon Creek
River Mile 65

Yellow = sand
Green = vegetation

USGS

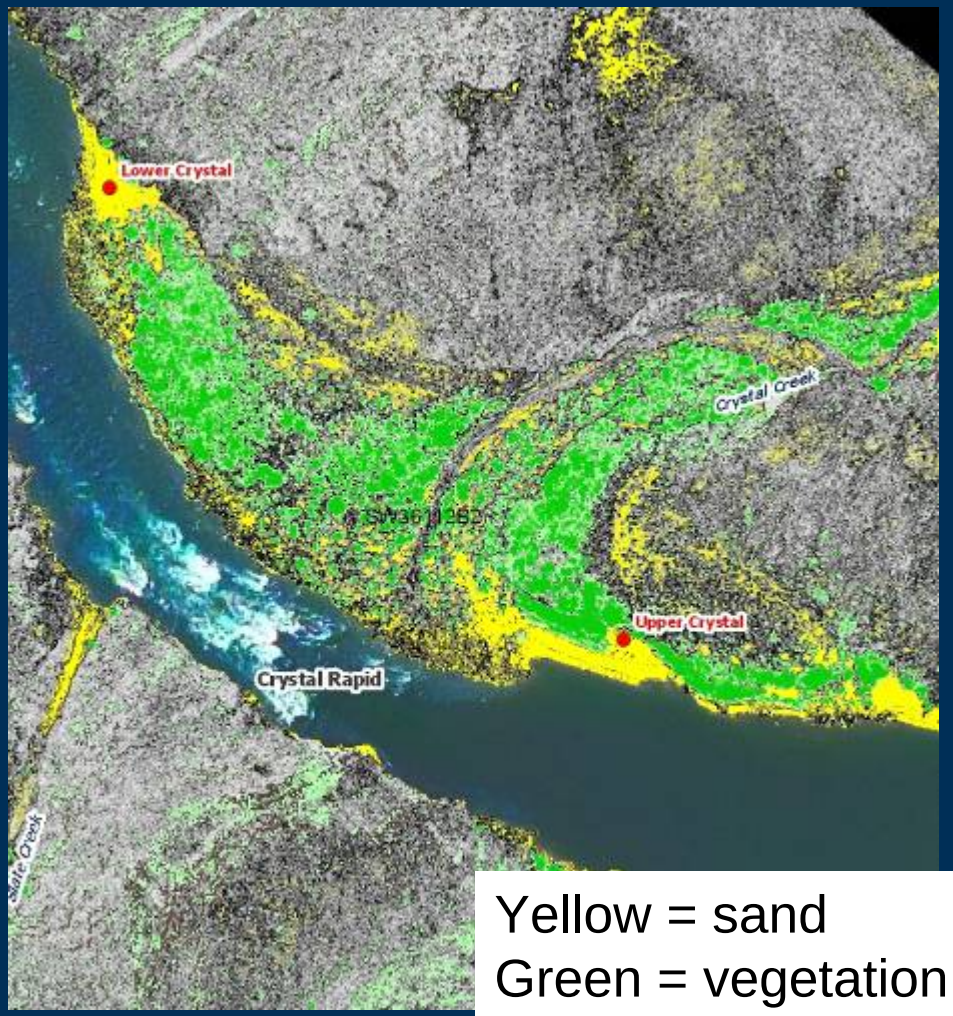
May, 2002 Image

Classified Image

Preliminary data: subject to review and revision.

Sand & Vegetation Have Been Classified from Lees Ferry to Diamond Creek for May, 2002 and May, 2005.

Crystal Creek
River Mile 99



Yellow = sand
Green = vegetation

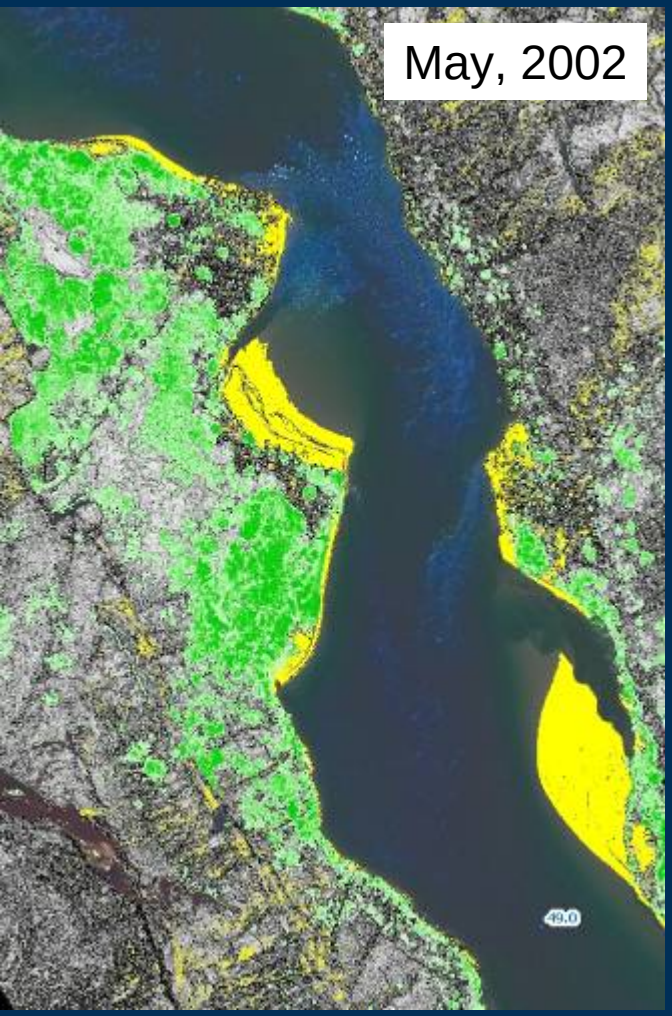
USGS

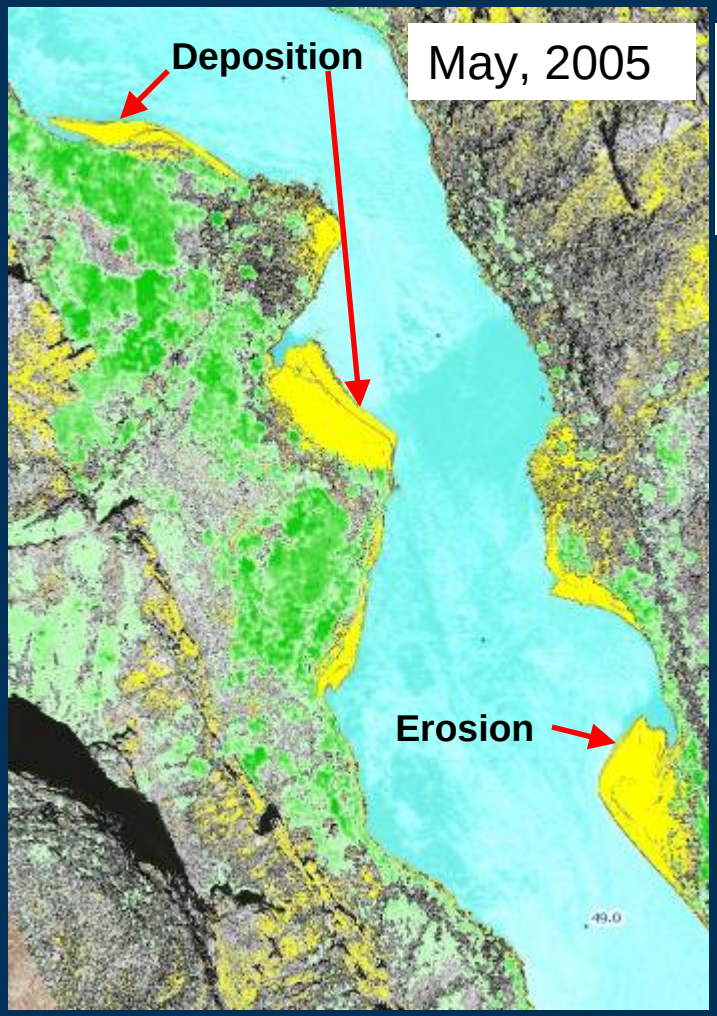
May, 2002 Image

Classified Image

Preliminary data: subject to review and revision.

RIVER MILE 49: COMPARISON OF MAY, 2002 AND MAY, 2005 SAND & VEGETATION AREA





Classified Images
Yellow = sand
Green = vegetation

Change in Sand Deposits Between River Miles 48 & 50

Fluctuating zone (8-25K) sand area increased by 19%

25-45K stage zone sand area increased by 17%.

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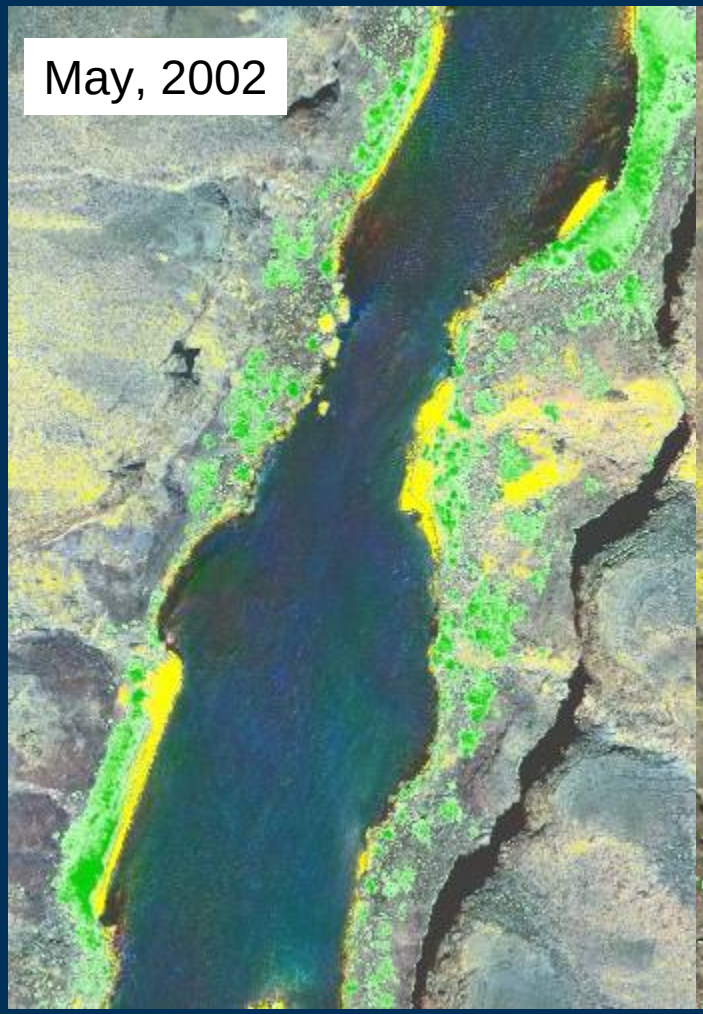
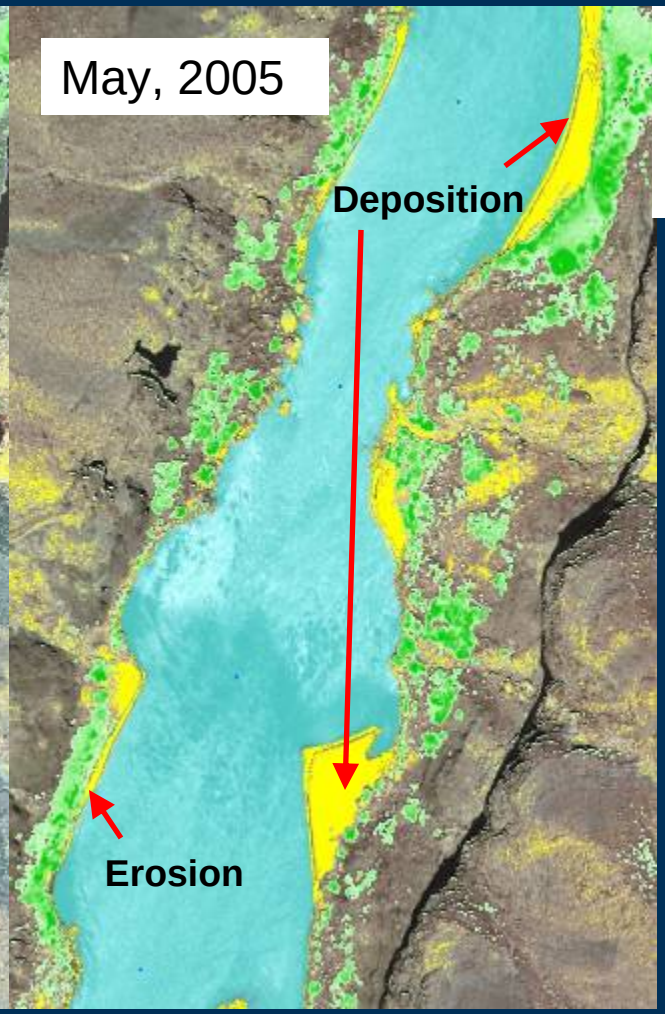
Preliminary system-wide analysis complete. Review initiated.

Preliminary data: subject to review and revision.

RIVER MILE 64: COMPARISON OF MAY, 2002 AND MAY, 2005 SAND & VEGETATION AREA





Classified Images
Yellow = sand
Green = vegetation

Change in Sand Deposits Between River Miles 63 & 65

Fluctuating zone (8-25K) sand area increased by 53%

25-45K stage zone sand area increased by 2%.

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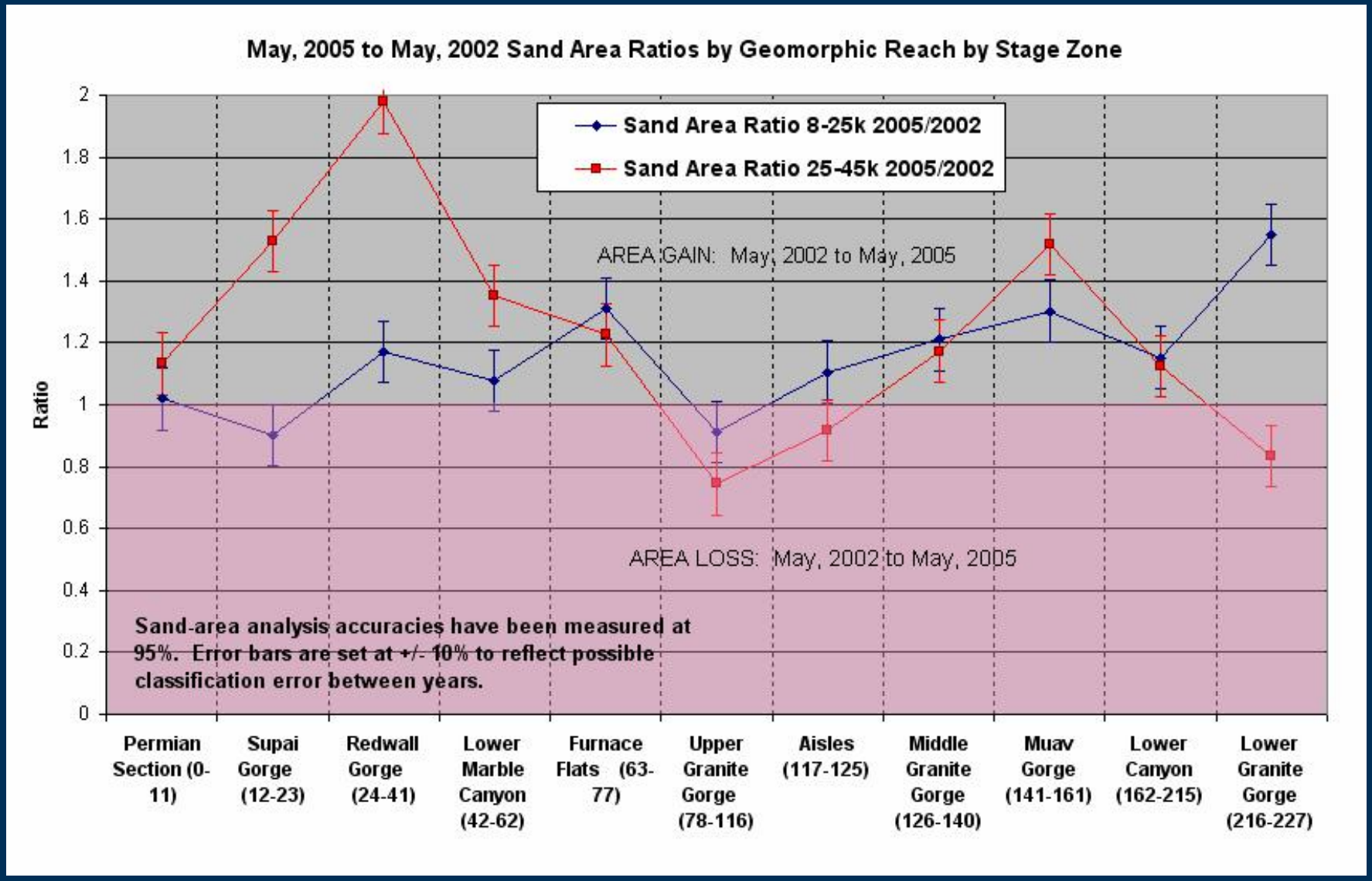
Preliminary system-wide analysis complete. Review initiated.

Preliminary data: subject to review and revision.

PRELIMINARY SYSTEM-WIDE CHANGE IN SAND AREA ABOVE 8,000 CFS: MAY, 2002 TO MAY, 2005



Preliminary data: subject to review and revision.

Shoreline Habitat Polygons.

Embayments with differing hydraulic, textural thermal and biotic characteristics.

Completed for the entire river corridor from May, 2002 and May, 2005 imagery.

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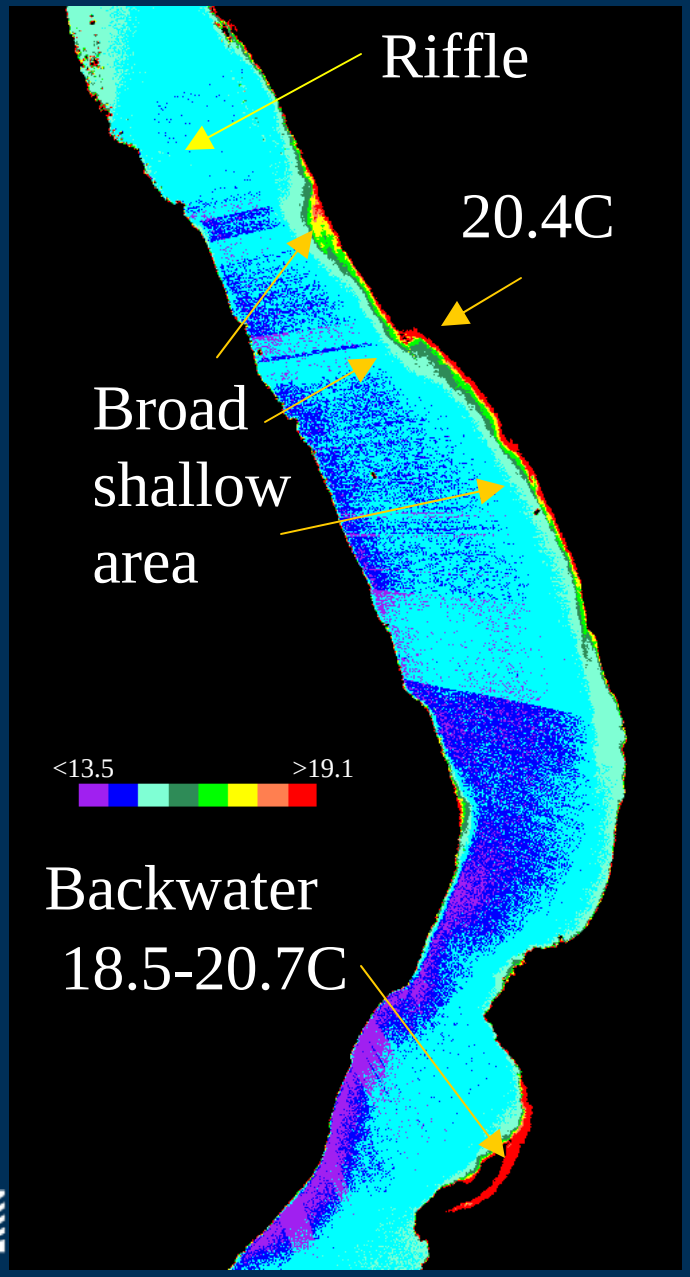
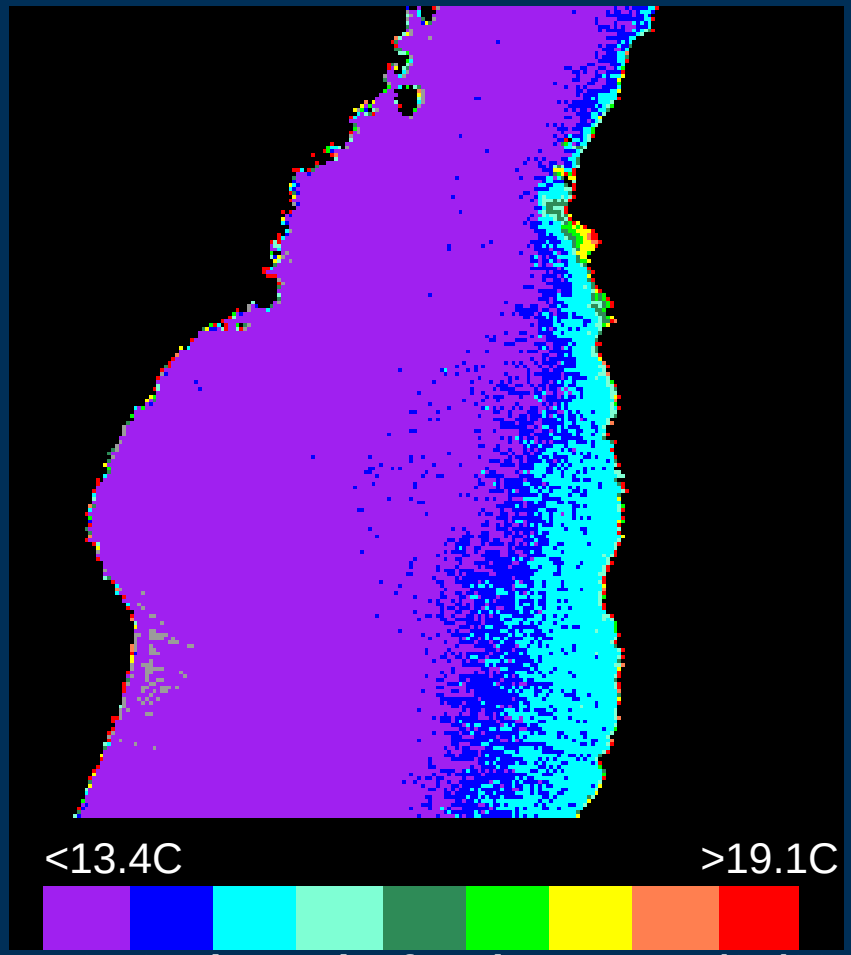
2000 Low Summer Steady Flow test: shoreline temperatures



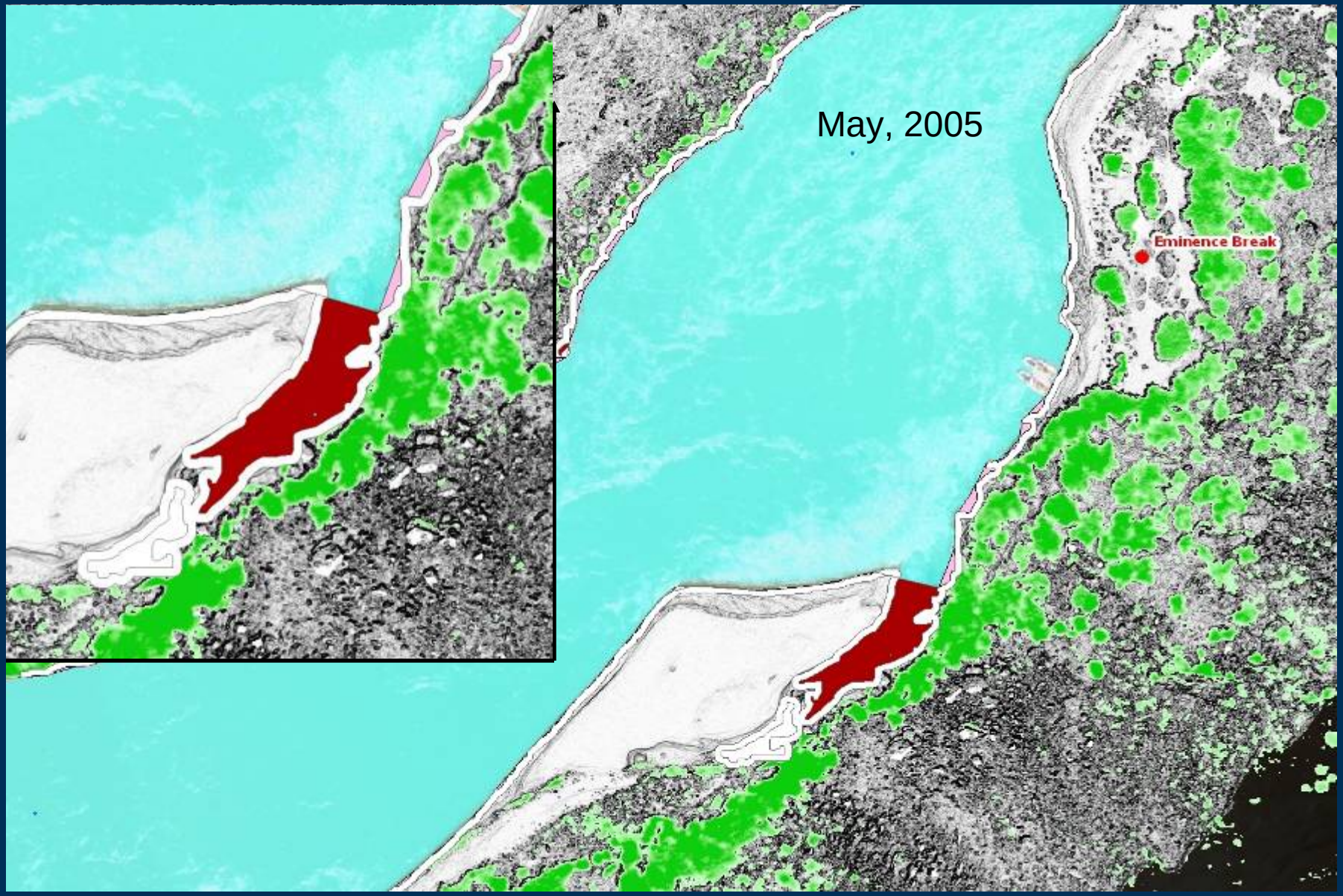
RM 68 Thermal infared image 7/25/00



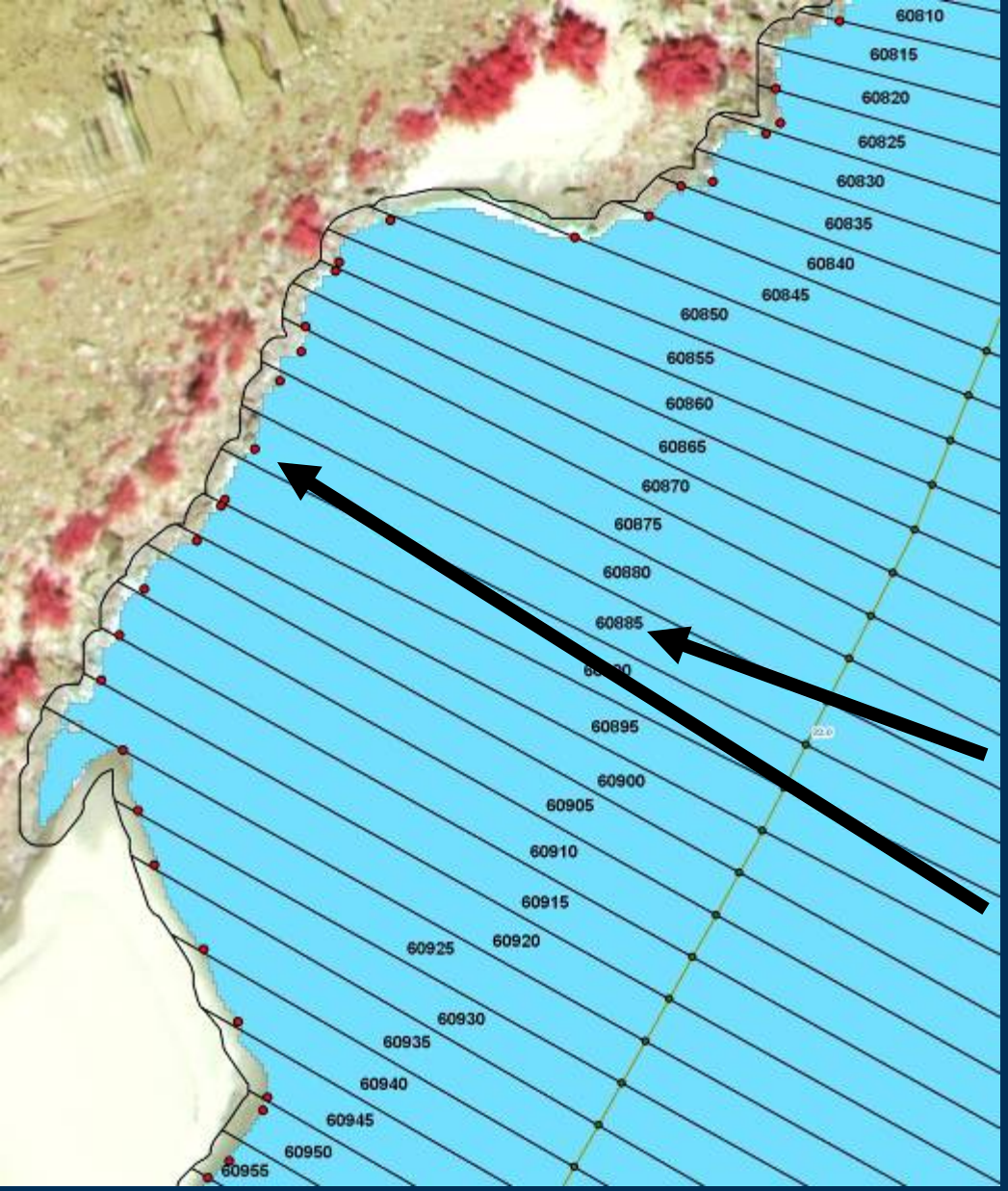
RM 64.6LThermal Infared Imagery 7/25/00

Shoreline Habitat Polygons RM 44

Produced from an Automated Procedure for Closing Off Shoreline Area



Preliminary data: subject to review and revision.



Shoreline Habitat Polygons (RM22)

An automated procedure for delineating backwaters and other shoreline habitats from imagery and historical shorelines.

- For every 5 meters of downstream distance…
- Select the closest shoreline point (promontory).

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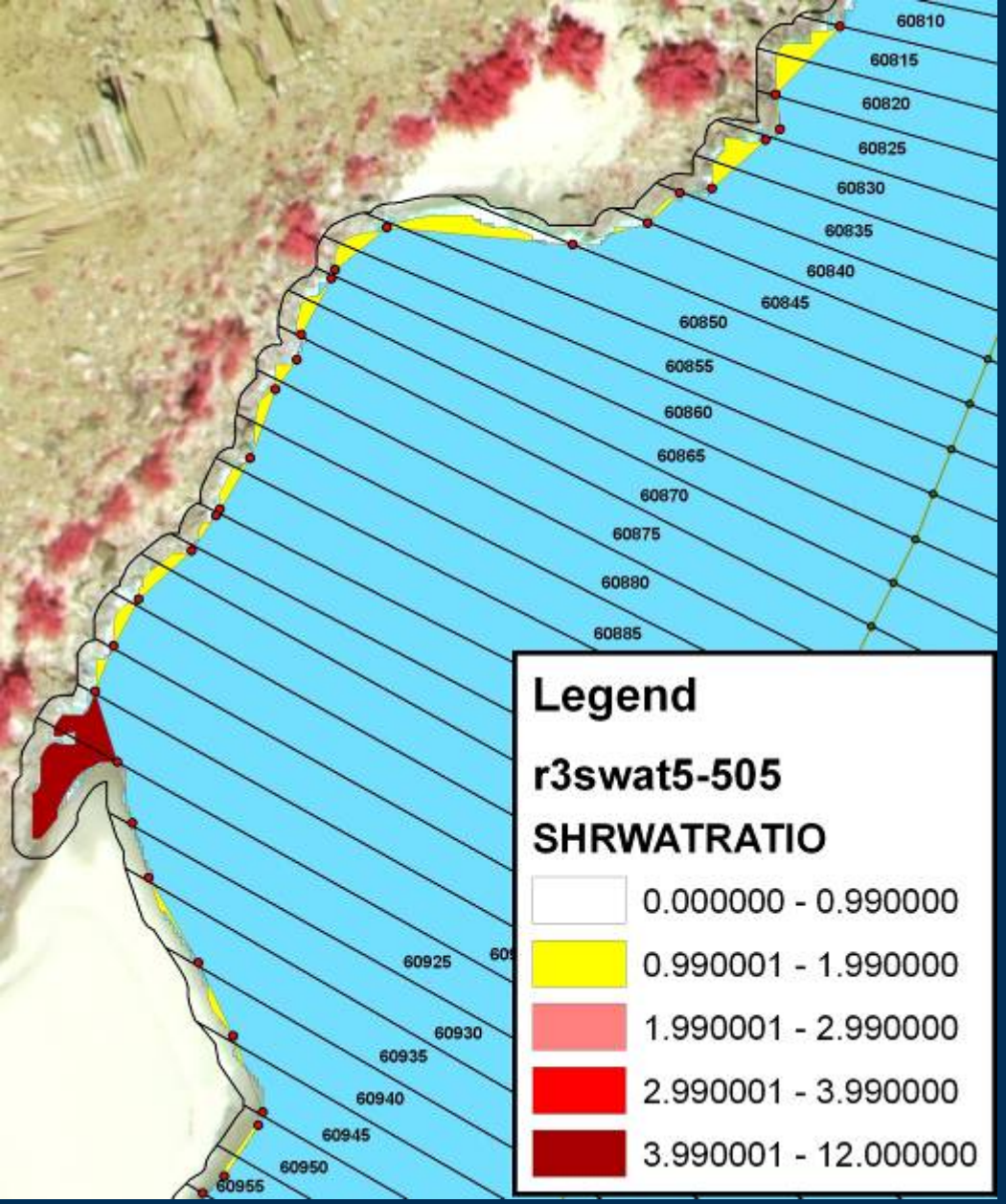

Shoreline Habitat Polygons (RM22)

- Connect each point and merge with the shoreline.
- Resulting polygons enclose embayments and headlands of various size, physical shoreline characteristics and thermal properties.
- Ratios of shoreline length to closure length are one measurement of complexity (rugosity).

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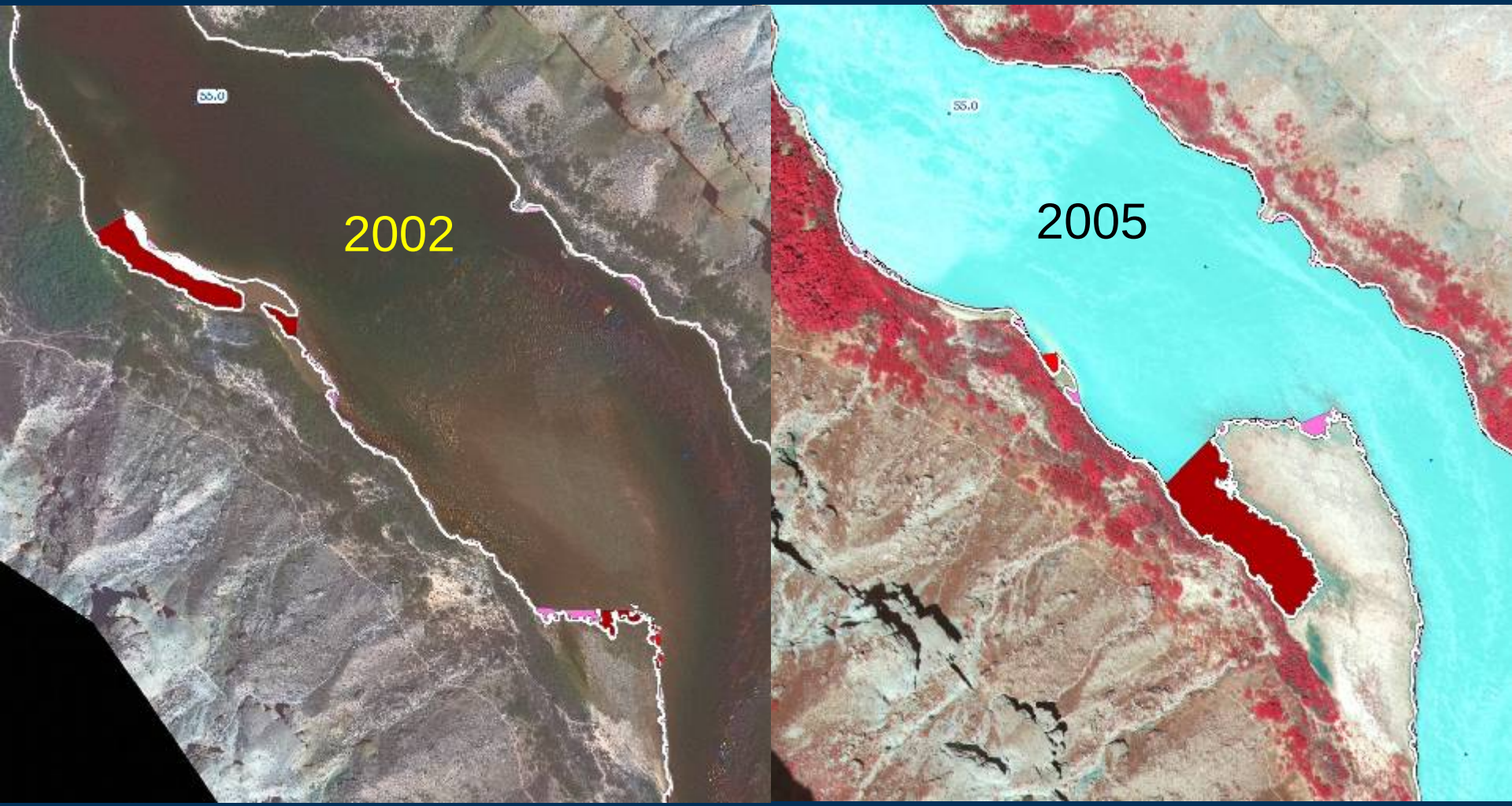
Shoreline Habitat Polygons RM 29

Produced from an Automated Procedure for Closing Off Shoreline Area

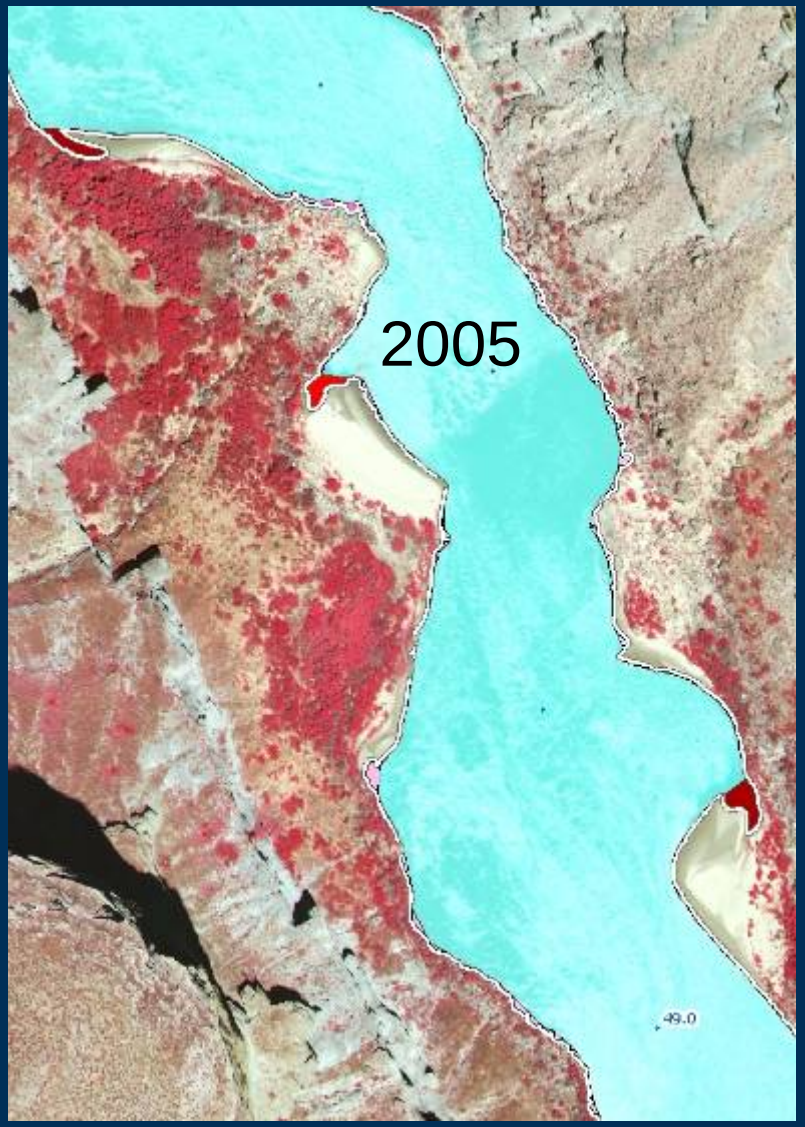
Preliminary data: subject to review and revision.

Habitat Polygon Change (RM 55) Between May, 2002 & May, 2005



Preliminary data: subject to review and revision.

Habitat Polygon Change (RM 49) Between May, 2002 & May, 2005

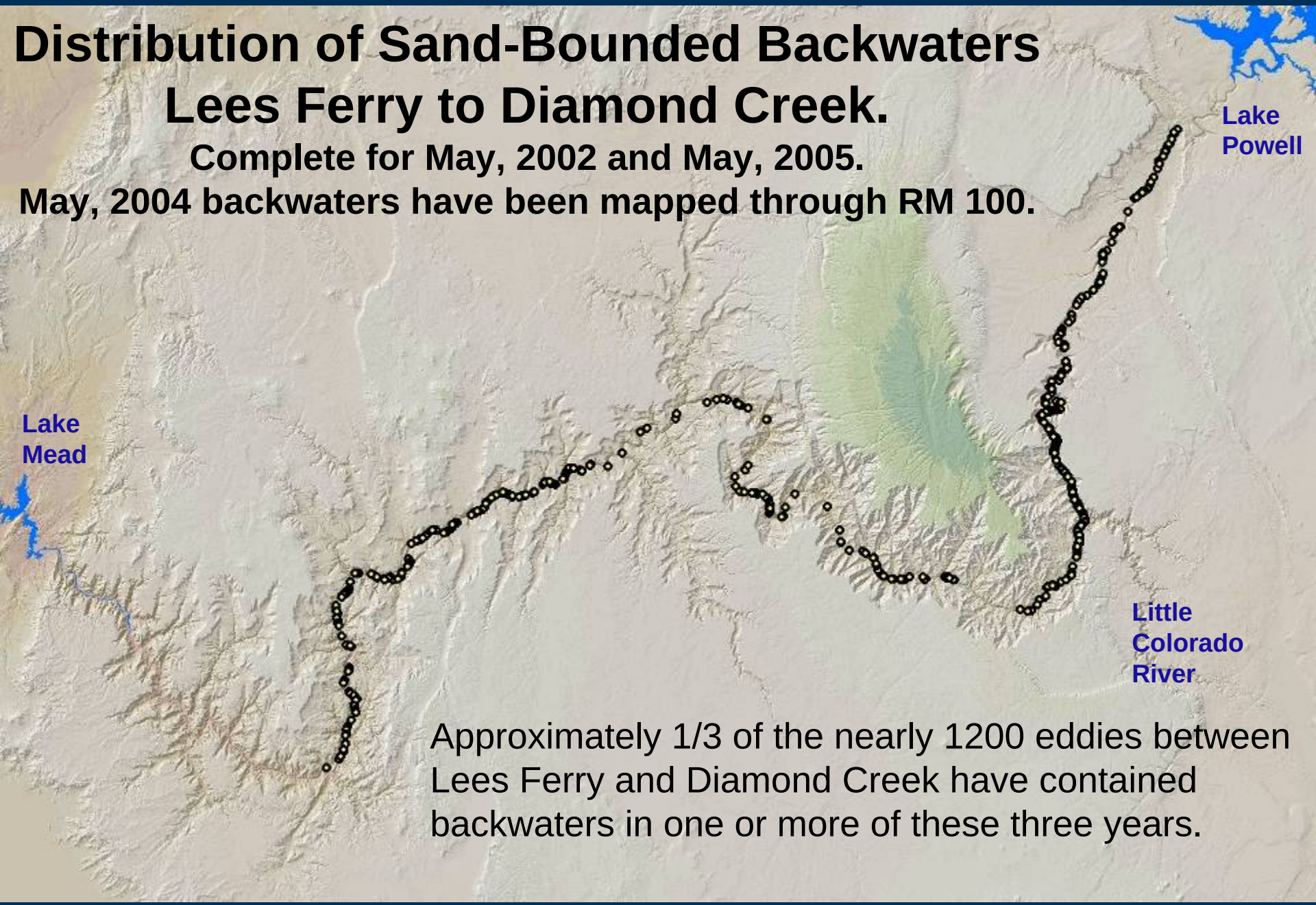


Preliminary data: subject to review and revision.

Distribution of Sand-Bounded Backwaters Lees Ferry to Diamond Creek.

Complete for May, 2002 and May, 2005.

May, 2004 backwaters have been mapped through RM 100.

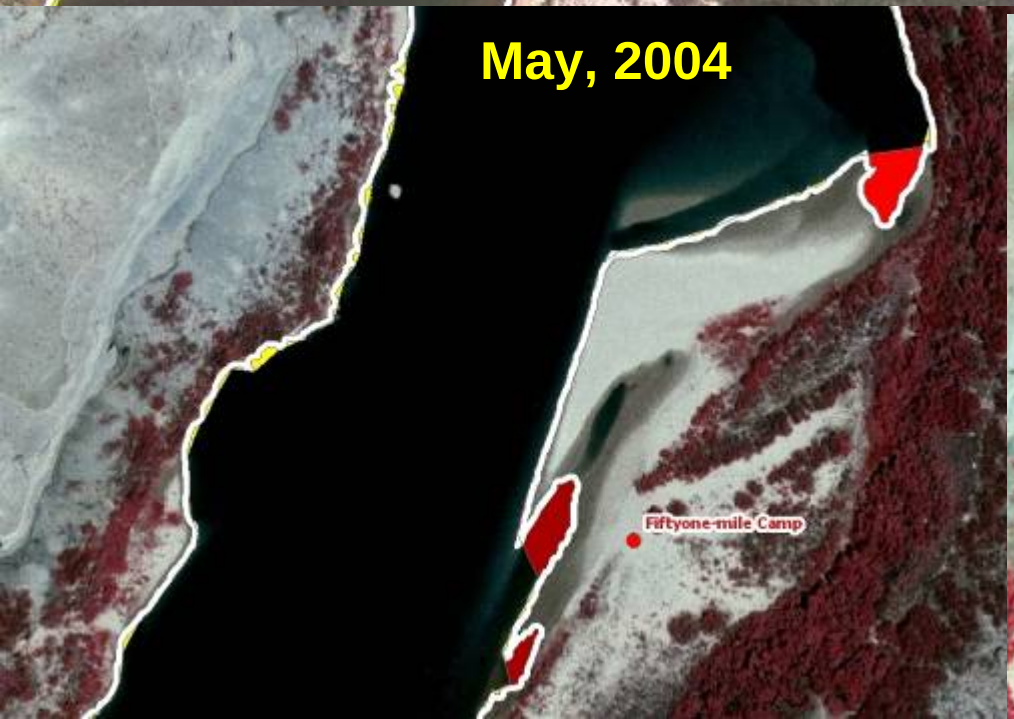


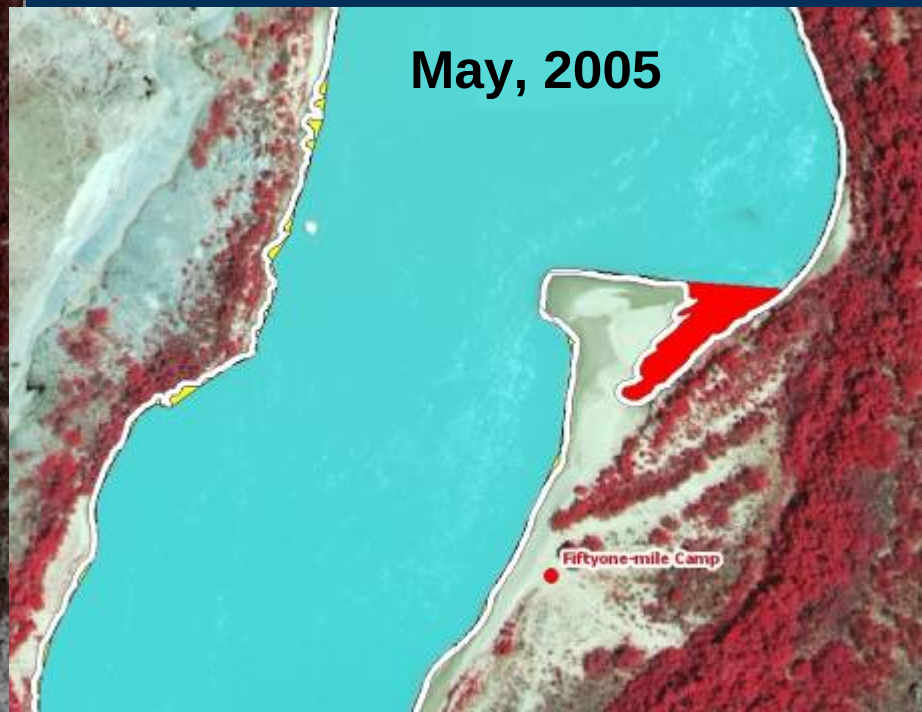
Approximately 1/3 of the nearly 1200 eddies between Lees Ferry and Diamond Creek have contained backwaters in one or more of these three years.

Backwaters at River Mile 51

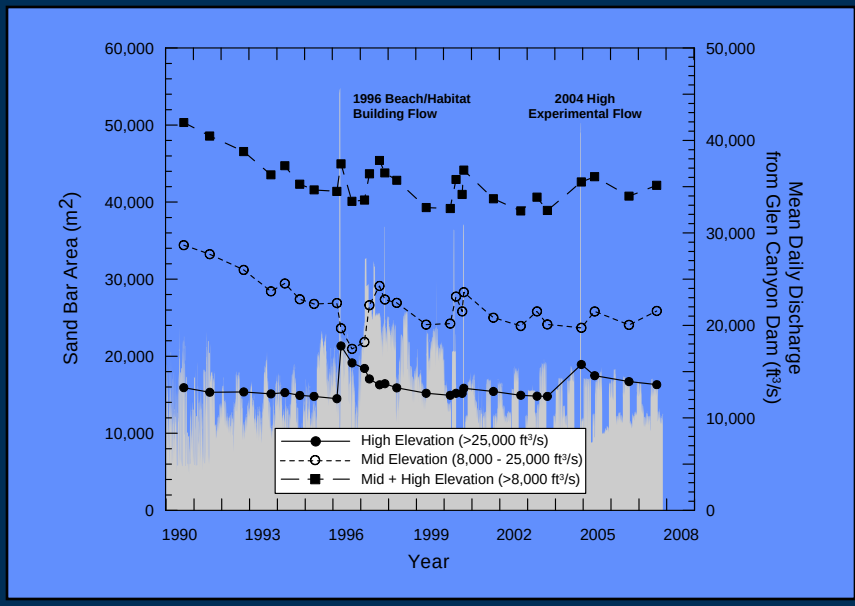
Produced from an Automated Procedure for Closing Off Shoreline Area

Preliminary data: subject to review and revision.





QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.



QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

USGS

(Schmidt et al., 2007)

Backwater area depends on water stage and bar topography

Automated classification of CRE surface materials, shoreline types and backwater areas from remotely-sensed imagery is precise, objective and fast.

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