

# Alternative Indicators of BMP effectiveness: **Analysis of Changes in the Riparian Zone**

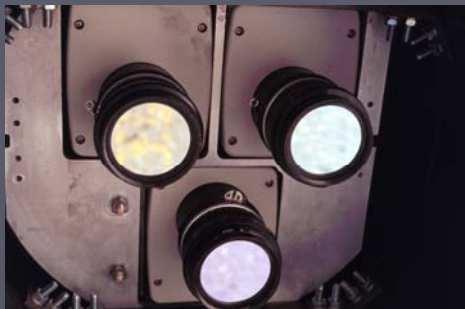
Doug Jackson-Smith  
Christopher Neale  
USU

## Overview

- ▶ Limitations to WQ monitoring data in 1990s suggested need to search for alternative indicators of change
- ▶ Search led to discovery of October 1992 aerial videography for LBR
  - Provided basis for MS thesis in 1990s
- ▶ Discussion with Dr. Christopher Neale led to proposal to re-fly the same area in October 2007

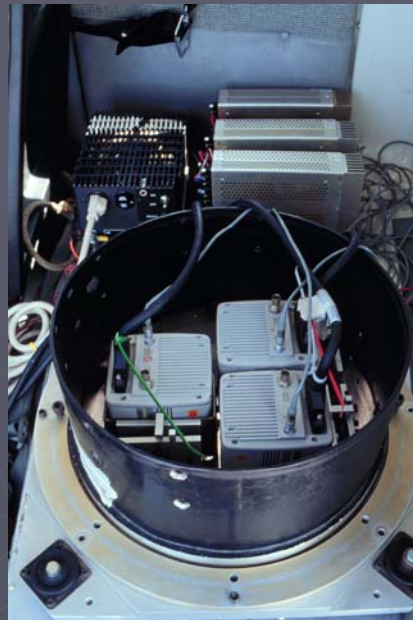
## Image Acquisition and Processing Methodology

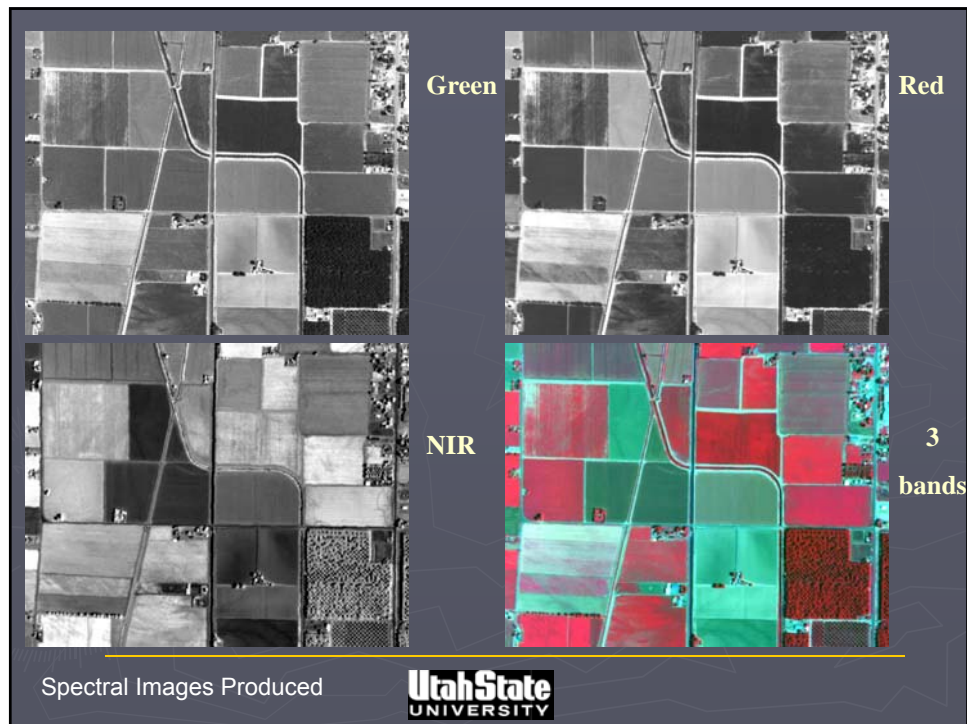
- ▶ Multispectral Imagery were acquired using the USU airborne system
- ▶ In 1992, the first version of the system was used which was based around video cameras
- ▶ In 2007, the imagery were acquired using the latest version of the system, based on digital cameras
- ▶ Both systems were flown on USU's remote sensing aircraft



**Kodak 4.2i digital cameras with interference filters forming spectral bands.**

**The cameras are mounted on carbon composite and high-grade aluminum mount**





## Image Acquisition Campaigns

- ▶ September 10<sup>th</sup>, 1992
- ▶ September 7<sup>th</sup>, 2007
- ▶ Clear sky conditions

## Methods

- ▶ Obtain new imagery September 2007
- ▶ Process old imagery
  - Video → digital still images
  - Identify location of images
  - Rectify images
- ▶ Very Labor Intensive
- ▶ Need to select critical areas to examine
- ▶ Used BMP data (from post-interviews) to locate treatment & control sites

## 1992 Image Processing

- ▶ Optical Imagery from 1992 System:
  - Imagery was stored on S-VHS tapes and later digitized using a frame grabber system into Tiff format
  - Line shift (V-shift/H-shift) correction, to remove effects of aircraft movement on the interlaced images
  - Correction for lens vignetting and radiance non-uniformities
  - Geo-rectification of individual images to a base map, using the rectified and calibrated shortwave image mosaic as a base image
  - Calibration of image strips to obtain reflectance using system calibration

## 2007 Airborne Image Processing

- ▶ Optical imagery from 2007 System:
  - Correction for geometric and radial distortions
  - Correction for lens vignetting and radiance non-uniformities
  - Registration into individual 3-band images
  - Geo-registration (rectification) to digital orthophoto quadrangle base map
  - Formation of image mosaic strips along the flight lines (image stitching)
  - Absolute radiometric calibration of the image strips using the system calibration and standard reflectance panel data acquired on the day of each flight

### Image Rectification

Individual 3-band images are rectified to a digital ortho map base using common, well defined control points visible in both sets of images and a polynomial transformation

Digital Orthophoto Map Base



3 Band Multispectral Imagery



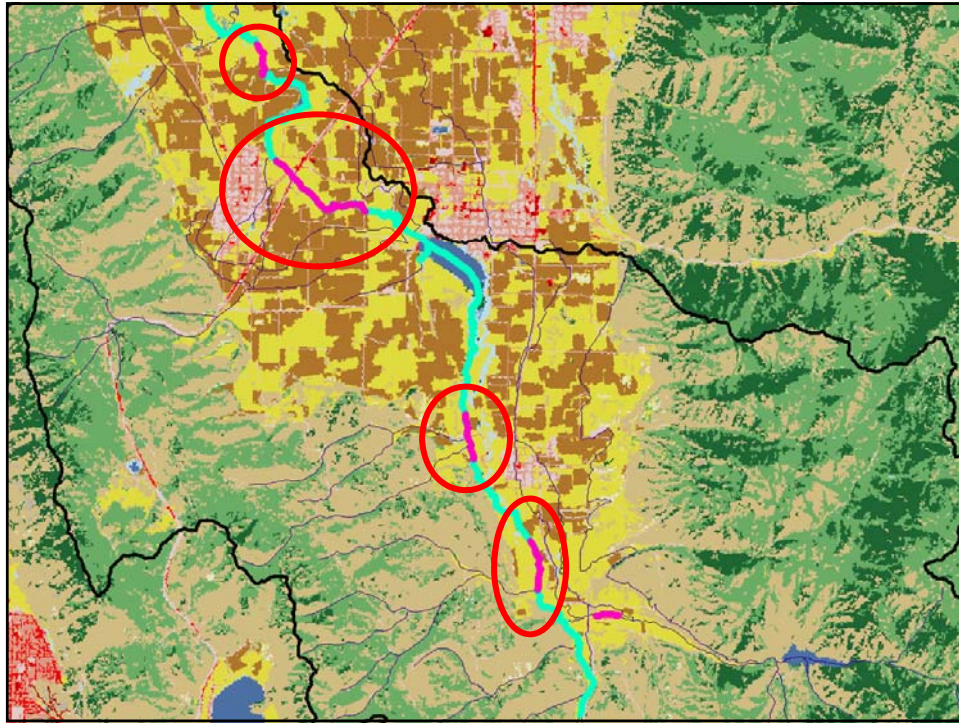
Thermal Imagery is rectified to 3-band mosaic acquired during the same flight

## Locating 'Riparian Area' Impact BMPs

- ▶ Focus on 30 meter buffer from stream
- ▶ Stream channel structural BMPs
  - Clearing & snagging (326)
  - Streambank and shoreline protection (580)
  - Stream channel stabilization (584)
- ▶ Stream access controls for livestock
  - Riparian fencing (5383) – subset of 382
  - Stream crossing (578)
- ▶ Riparian vegetation
  - Channel vegetation (322)
  - Critical area planting (342)
  - Tree/Shrub establishment (612)

## Treatment & Control Sites

- ▶ Identified stretches of the river where
  - there are many 'riparian area relevant' BMPs clustered
  - There is a similar stretch of river immediately upstream without BMPs
- ▶ Focus is on post-interview BMPs
  - Also included 'contracted' BMPs for farms where we were unable to conduct interviews



1992 Multispectral Mosaic

2007 Multispectral Mosaic

**Site: Upstream from Hyrum Dam**

Two vertical strips of multispectral mosaic imagery showing the same river reach in 1992 and 2007. The left strip is labeled '1992 Multispectral Mosaic' and the right strip is labeled '2007 Multispectral Mosaic'. The imagery shows changes in vegetation and land cover over time. The background is dark gray with a faint grid pattern.

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**Site: Upstream from Hyrum Dam**

1992 Multispectral Mosaic      2007 Multispectral Mosaic

Detail 1

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This slide shows a comparison of two multispectral mosaics for a specific site upstream from Hyrum Dam. On the left, the 1992 mosaic shows a narrow, winding channel with a dark, textured bed. On the right, the 2007 mosaic shows a wider, more defined channel with a smoother bed and more surrounding vegetation. The text 'Detail 1' is centered below the images, and the Utah State University logo is in the bottom right corner.

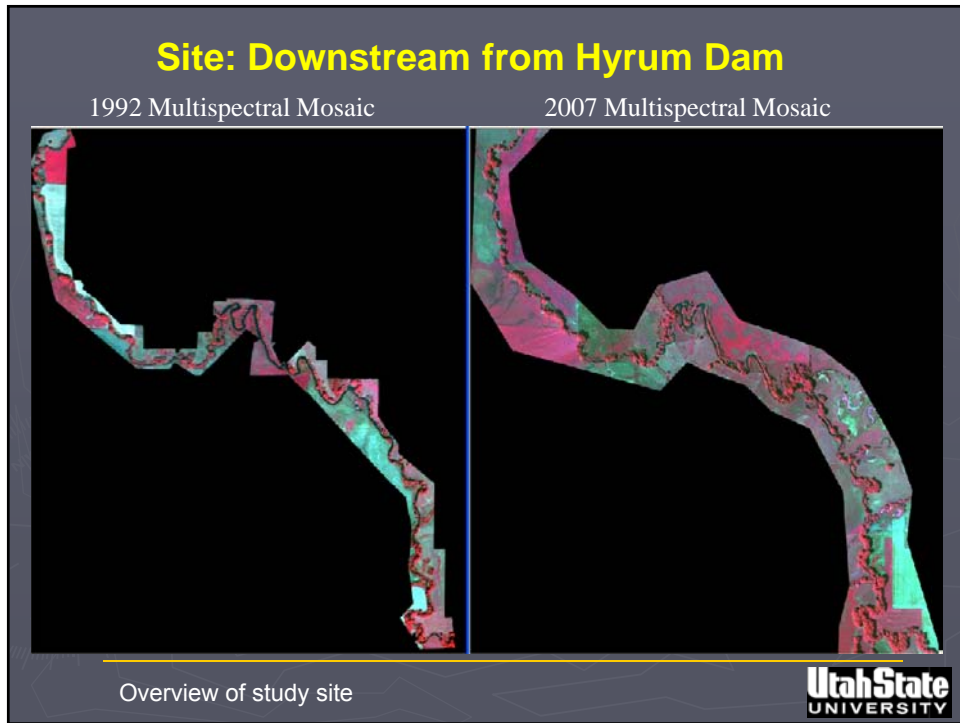
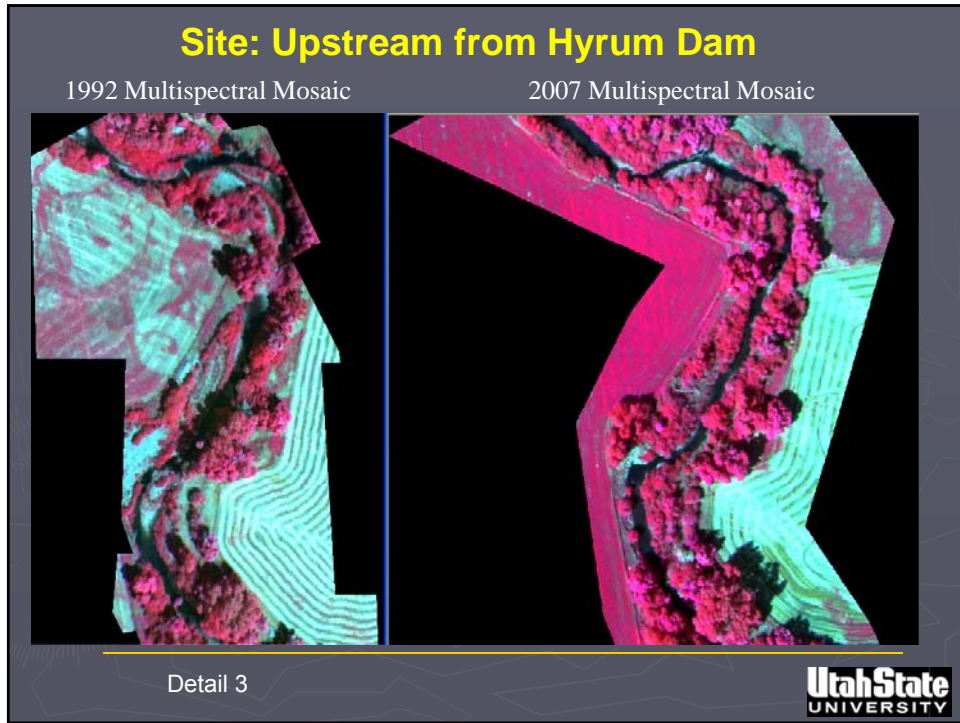
1992 Multispectral Mosaic      2007 Multispectral Mosaic

**Site: Upstream from Hyrum Dam**

Detail 2

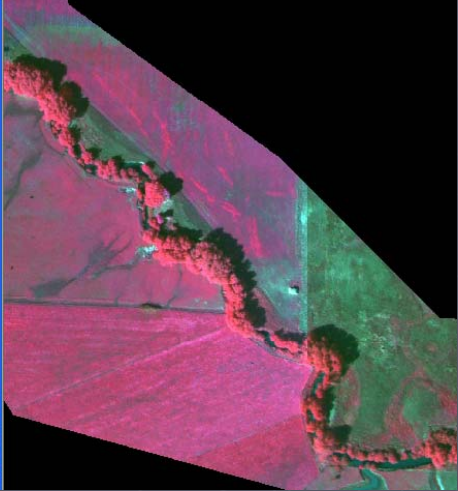
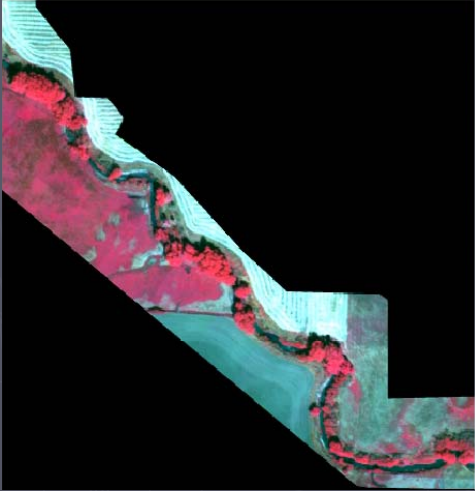
Utah State UNIVERSITY

This slide shows a comparison of two multispectral mosaics for another site upstream from Hyrum Dam. On the left, the 1992 mosaic shows a channel with a dark, textured bed and some surrounding vegetation. On the right, the 2007 mosaic shows a wider, more defined channel with a smoother bed and more surrounding vegetation. The text 'Detail 2' is centered below the images, and the Utah State University logo is in the bottom right corner.




### Site: Downstream from Hyrum Dam

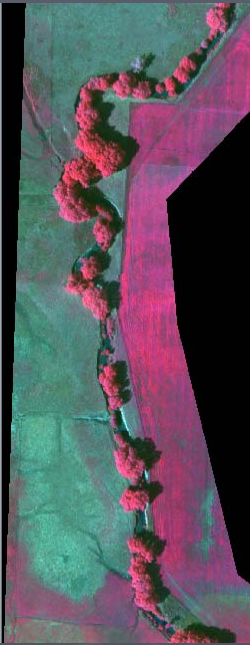
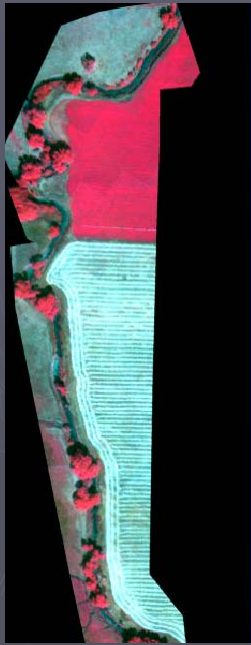
1992 Multispectral Mosaic	2007 Multispectral Mosaic
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Detail 1



1992 Multispectral Mosaic	2007 Multispectral Mosaic	<h3 style="text-align: center;">Site: Downstream from Hyrum Dam</h3>
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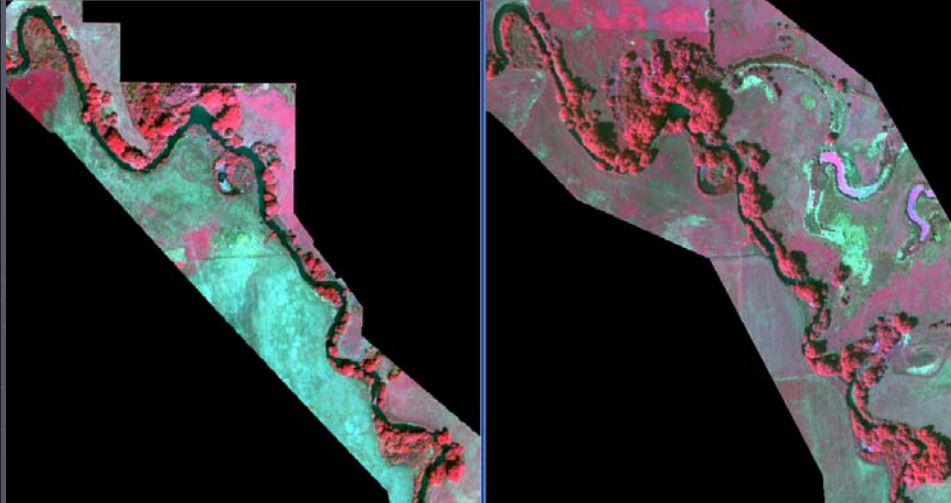
Detail 2



### Site: Downstream from Hyrum Dam

1992 Multispectral Mosaic

2007 Multispectral Mosaic



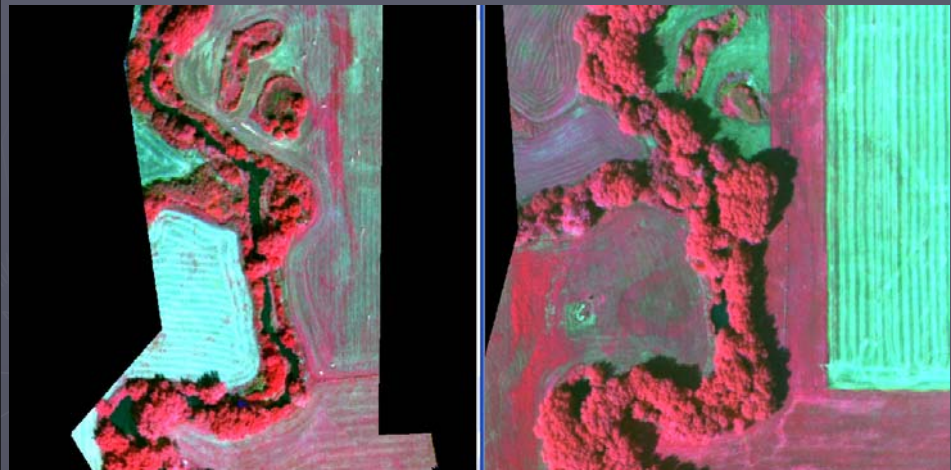
Detail 3



### Site: Downstream from Hyrum Dam

1992 Multispectral Mosaic

2007 Multispectral Mosaic



Detail 4





## Progress

- ▶ All 1992 images have been “grabbed” from the S-VHS videotapes
- ▶ Approximately 80 images from 1992 and 20 images from 2007 are being processed to complete mosaics for all study areas

## Remaining Work

- ▶ Finish processing 1992 imagery that matches areas of interest
- ▶ Develop metrics to quantify changes in riparian & river conditions 1992-2007
  - Vegetative cover
  - Stream channel shape, width, sinuosity
  - Others?
- ▶ Compare treatment & control sites

## Observations on Initial Results

- ▶ Significant vegetation growth
  - Trees significantly larger throughout watershed
- ▶ Significant geomorphologic changes in main stream channel path
  - New 'islands'
  - Major bank cuts & erosion
- ▶ Need to ascertain what are
  - BMP effects vs. storm events, natural dynamic river changes, etc.