(one-quarter of 21.2 percent), and its doubling time is therefore almost fourteen years, not a little over three. The mistake is reproduced ritually for every state. That's first-year statistics, folks... and a howler. Fix it, please, for the next printing.

This is a kind of atlas that should be coming out more often: fine thematic mapping with sensible accompanying text and photographs, charts and tables. All the hallmarks of an inescapable volume are on hand—no one who works in the West, or writes or teaches or lives here—should go without. If there are individual details that can be picked on, that's the sort of discussion that such a book should inspire. And, overall, the symphony is sonorous and striking.

cartographic techniques

Low Altitude Videography as a GIS Data Source

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Overview

Low-altitude, visible spectrum videography provides a relatively low-cost opportunity to detect detailed surface features, and may be a practical media choice for monitoring such surface feature changes over time. However, this type of imagery has not been widely used as a resource for developing thematic data in Geographic Information Systems (GIS). This article describes a process for converting the video frames into composite still images and for georeferencing these images to an existing set of base GIS themes.

Interest in exploring this process arose in 1997 when resource managers at the South Slough National Estuarine Research Reserve (NERR) in Coos Bay, Oregon, wanted to evaluate the change in the distribution of eel grass beds (*Zostera marina* and *Z. japonica*) in the slough. The eel grass beds provide shelter for a wide variety of fish and invertebrates and are an important component in the slough ecosystem. Field observations conducted in 1991 and 1992 were used to develop GIS data layers showing the approximate distribution of the beds at that time. Base themes for the GIS, such as the channel location and shoreline, were developed using 1991 aerial photos (1" = 1,000') and 7.5 minute USGS maps (1" = 2,000') (Figure 1).

Video Characteristics

In 1996, visible spectrum Hi-8 video was filmed by Charles Rosenfeld, Department of Geosciences, Oregon State University, for a major portion of the slough. The camera altitude varied from approximately 1,000' to 1,500', and the scale of the resultant digitally converted images was approximately 1" = 100'. At 72 DPI, this corresponds to a resolution of about 1.4' per pixel. By comparison, shuttle radar and SPOT resolution is typically 10 m, and Landsat thematic mapper (TM) and multispectral scanner (MSS) images range from 30 m to 120 m resolution.

Each frame of the video contained locational coordinates obtained from a GPS. However, the sensitivity of the GPS equipment recording the latitude and longitude was such that the values did not keep pace with the movement of the aircraft. At several points, the coordinate values are lost completely for a period of a few seconds to over a minute. Consequently, the latitude and longitude values were useful only for very general placement of
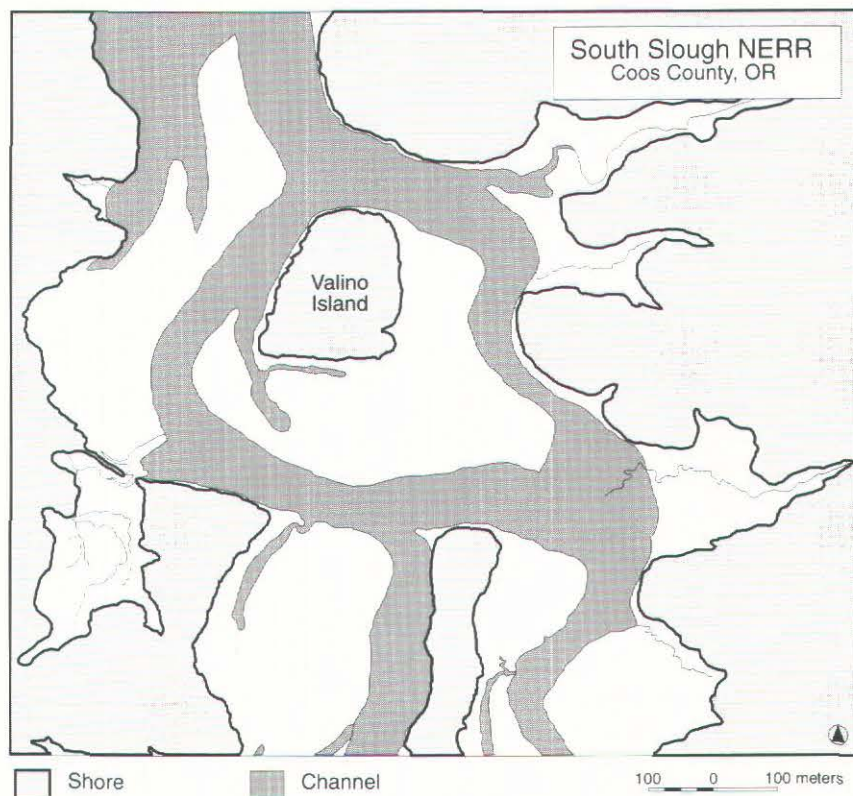

Figure 1. South Slough Base GIS Data from 1991 Aerial Photography

geographic location, such as identifying the approximate beginning and ending range of footage for the study area. No flight plan was provided with the video.

Georeferencing of the videography is further complicated by the differences in distortion between the 12 mm lens for the videography and the 152 mm lens used for the aerial photography. The misalignment is primarily longitudinal, as the video imagery coincides reasonably well in the north-south direction.

Software and Hardware

MacIntosh System 8.0:
    Adobe Photoshop 4.0
    Adobe Premiere
    Macromedia Freehand 7.0
    Kandu CADMover 4.0
Windows NT:
    ESRI ArcView 3.0a

Process Description

The four major parts of this process are 1) the conversion of the video frames to still imagery, 2) compositing the individual stills, 3) delineating the new surface feature vector information, and 4) importing the new surface feature vector data to the GIS.

Video Conversion to Still Imagery

Adobe Premiere video editing software was used throughout this part of the process, with full screen settings (640 x 480 pixels), to view and capture video data.

    1. Capture two sample frames for start and two sample frames for end positions each time plane began and ended a pass to determine total number of passes, orientation of each pass and geographic extent.
    2. Use the rough latitude and longitude coordinate values on the video and USGS quad map to determine which sections covered the study area. Of the eight identified passes, only the first seven covered the study area.

3. Capture frames of the study area as PICT images. In order to have sufficient overlap between frames, capture approximately 1 frame per second, or every 30th frame. Each frame image is about 8" x 6.5" and at 72 DPI is approximately 900 KB. For our project, the number of images per pass varied from 30 to 40. Thus, about 220 MB of disk space was required to store all the individual frame images.

Creating the Composite Images

The challenge in the compositing process is to place the individual frames so that features in the resultant image are in their proper geographic location with respect to some set of base features. Since the GPS locations provided on the video were not precise and there were no other comprehensive set of control points available as reference, the existing GIS vector data representing shorelines and the

channel were used as the base for georeferencing.

The software tools used in this compositing process were ESRI's ArcView 3.0a for GIS data manipulation, and Macromedia Freehand 7.0 , which was selected because it uses both vector and raster data, and allows linking to the individual image files without actually storing them as part of the composite file. This helps to reduce the amount of disk space required and the processing time. Adobe Photoshop 4.0 was also used to preprocess the PICT images and convert them to TIFF.

    1. Display the base data in an ArcView View window, using distinct symbology for shore and channel features. Export the View as an Adobe Illustrator format vector file, and open with Freehand 7.0 .
    2. Rescale the vector features in Freehand to approximate the size of the anticipated finished
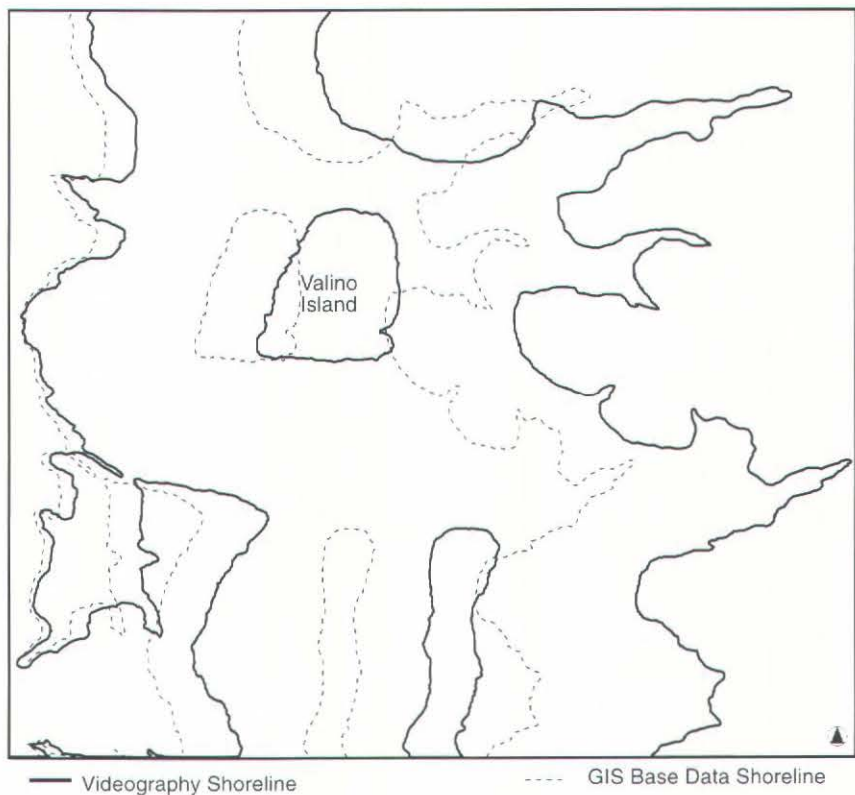

Figure 2. Comparison of Camera Lens Distortion Effect on Shoreline

——— Videography Shoreline   - - - - GIS Base Data Shoreline

composite image. The rescaling percentage may be estimated based on a preliminary joining of several adjacent images from each pass to determine the final size of the total image. In this project, a 2000% overall enlargement was applied, then a 72% horizontal resizing was used to compensate for the difference in lens distortion between the video camera and still aerial camera that provided the 1991 images for the base GIS data (Figure 2). It is important to note the rescaling percentages because once features are delineated from the composite image, the resultant vectors will be scaled inversely (in this case, increased horizontally by approximately 139%) to create data consistent with the original base data and the other existing data in the GIS.

3. Using Photoshop 4.0, open each PICT and clip out only the central portion of the image, plus a minimal overlap, and paste it into a new file to be saved as a compressed TIFF. This reduces the individual image file size typically by 70 - 80%, and allows the linking function in Freehand. PICT files, when imported into Freehand, are automatically embedded in the working file regardless of the preference setting that controls linking.

4. Open the Freehand 7.0 base file, and import the individual TIFF images as links, working on one pass at a time. Create a separate layer for each pass, and position / scale the images to fit the base data. In this project, scale adjustments were made uniformly for all the images in a single pass, although the percentage adjustment varied from pass to pass depending on variations in the video camera altitude between passes. Adjustments were made to each pass based on the inclusion of

adjacent passes, distributing the perceived error throughout the area to achieve the best fit with the boundaries of the base data.

Delineating New Feature Data

Now that the TIFF images have been composited, capture the desired surface features as vector data in Freehand.

1. With the spatially referenced TIFF images as background layers, create a new layer for the new surface feature data. It is

possible to work at the scale of the original videography by zooming in on the image, and full-size plots may be used as an additional source of information.

2. The new feature data will be scaled to the size of the video images. Apply the inverse scaling described above to the new feature data and the base data to set it back to the original dimensions of the base data.
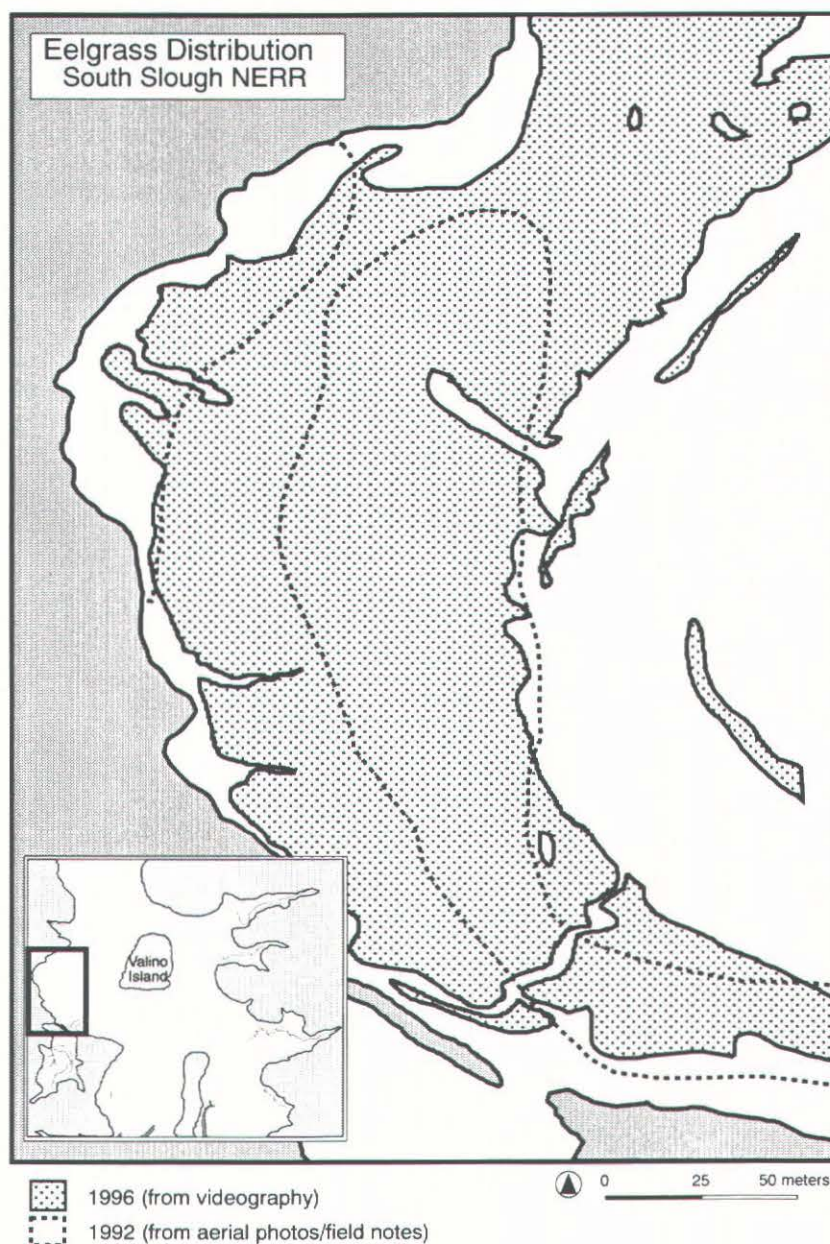

Eelgrass Distribution
South Slough NERR

Valino Island

1996 (from videography)
1992 (from aerial photos/field notes)

0   25   50 meters

Figure 3. Eelgrass Distribution at South Slough NERR

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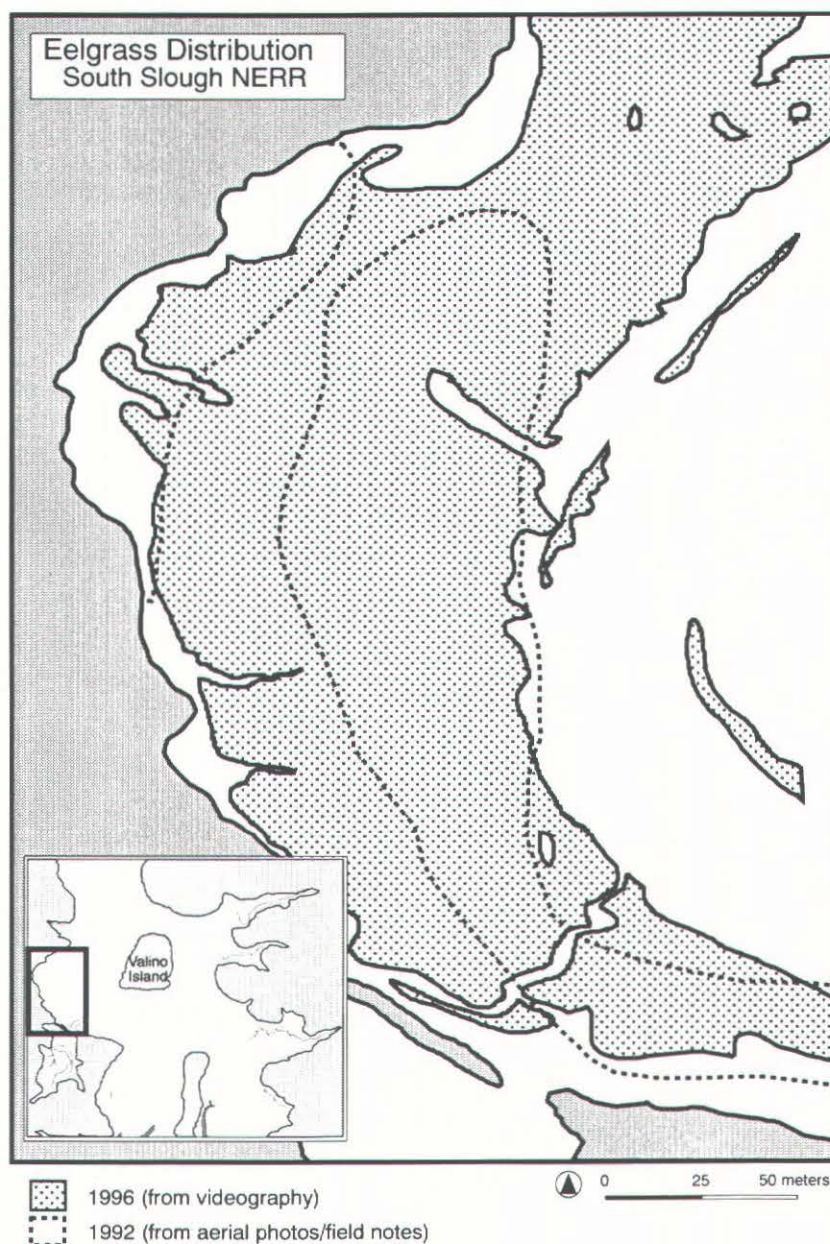

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