Manual Mapping
A Tutorial for the Beverly, MA, Image

The following tutorial is provided as an example of how a manual land cover map is made for the Beverly, MA Landsat image. After completing this tutorial as a training exercise, each step presented should also be done by your students, using the image of your own GLOBE Study Site (your 15 km x 15 km area.) Figure BIO-MM-1 shows a false-color infrared image of the Beverly, MA image, and will be used to illustrate the process of performing a manual land cover mapping. Note that water and vegetation types are more readily distinguished if the false-color infrared image is used. However, you also want to keep your "true-color" image handy, because it is useful for distinguishing developed areas.

The following steps are used in the manual mapping method.

1. Select the Landsat satellite image to be mapped. In the false-color infrared image, actively growing green vegetation will appear red (hardwoods and fields are bright red to pink, evergreens are dark red to black), water is black, while urban areas and bare soils are blue.

2. Overlay an 8.5 x 11 inch sheet of clear plastic on top of the colored print of the image, using tape to hold it firmly in place. Once the overlay is in place, mark the location of the image edges or corners on the overlay so that it can be placed in exactly the same position if it is removed. This will also allow you to place the overlay on either the true color or false-color infrared image to take advantage of the discrimination capabilities of each type of image.

3. The mapping process involves carefully outlining the different land cover types seen on the image, using either colored crayons or felt-tip marking pens. Use different colors to represent different land cover classes if possible. Assign each the appropriate number for its specific MUC class. Be certain to identify each area with the most detailed MUC value for its class.

The illustrations accompanying this tutorial illustrate the steps in developing a manual land cover map. For clarity, the individual steps are shown on separate illustrations, then assembled to show the final map. In practice, each step is done on the same sheet, gradually building a complete map.

- Step 1: outline water bodies. Here we see Marine Open Water, MUC 72, and Fresh Open Water, MUC 71. Note that for Open Water, the MUC scheme only contains two levels.
- Step 2: outlline barren areas. In the illustration "Barren" areas, labeled MUC 52 (Sandy) and 53 (Bare Rock) are outlined. The Urban Residential (91) and Commercial (92) areas are also differentiated.
- Step 3: the remaining major features are developed, including:
  MUC 63 — Estuarine
  MUC 93 — Urban Transportation
  MUC 811 — Row Crops/Pasture
  MUC 822 — Golf Courses
  MUC 823 — Cemeteries
  Also added are the vegetated areas:
  MUC 0192 — Evergreen Temperate Closed Forest
  MUC 0222 — Deciduous Closed Forest with Evergreens and Shrubs
- Step 4: the final product, a labeled land cover type map of the Beverly area. Your students should decide on the final format of your own map.

Since the land cover types in your local area may be very different from those in Beverly, MA, you may certainly want to proceed with a different order to outlining MUC classes. Remember to take advantage of both the true-color and false-color infrared images provided to your school.

If there are areas on your image for which your students are not sure of the specific MUC class, have students decide how they can verify what is in that location. This activity is likely to take several class periods to complete. Have your students be as careful and specific as possible in outlining and assigning classes to the various land cover areas in their image.
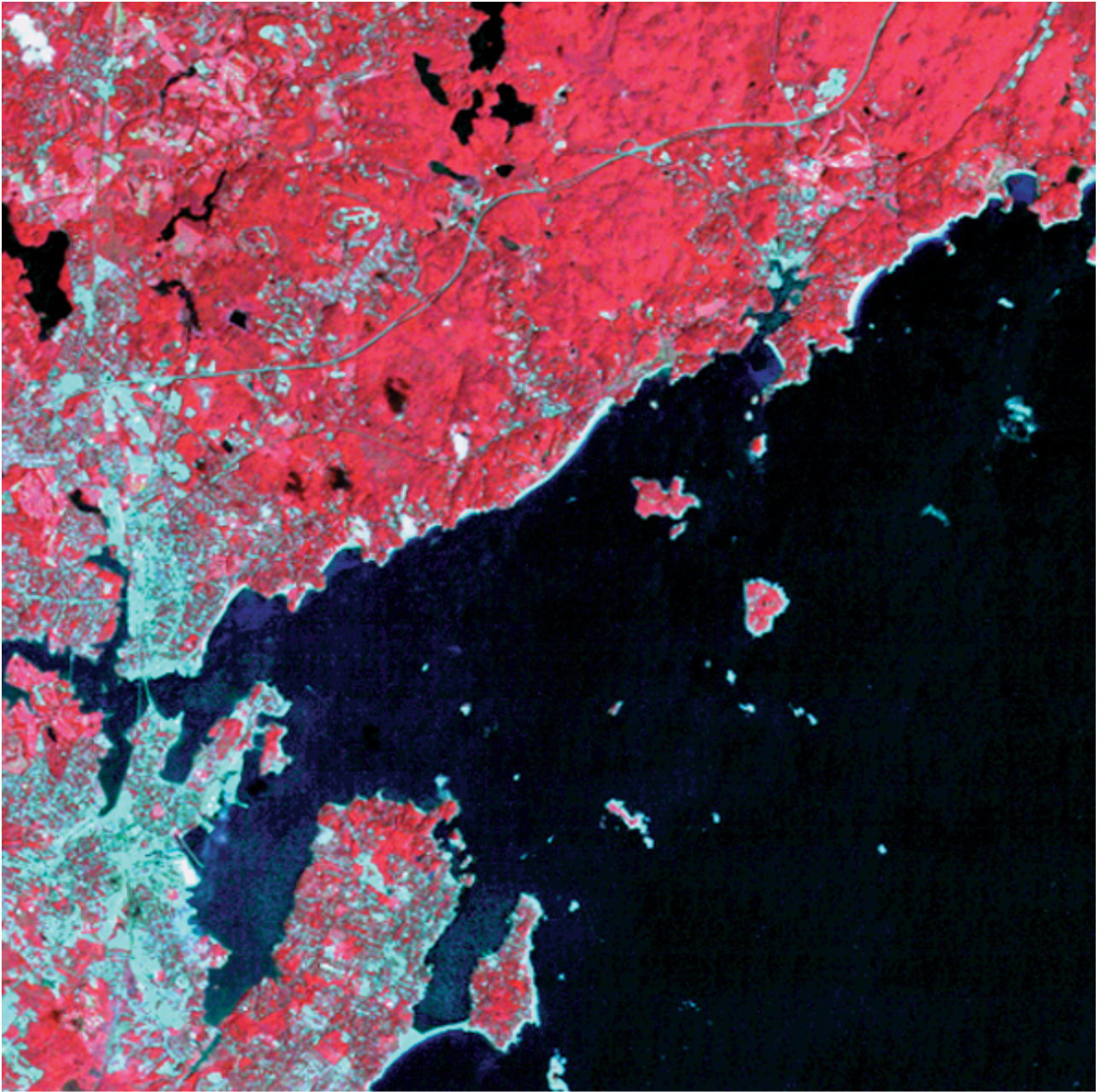
Once your Land Cover Map is completed, you will need to determine its accuracy. This is called "Accuracy Assessment," and is described in the *Accuracy Assessment Tutorial*.
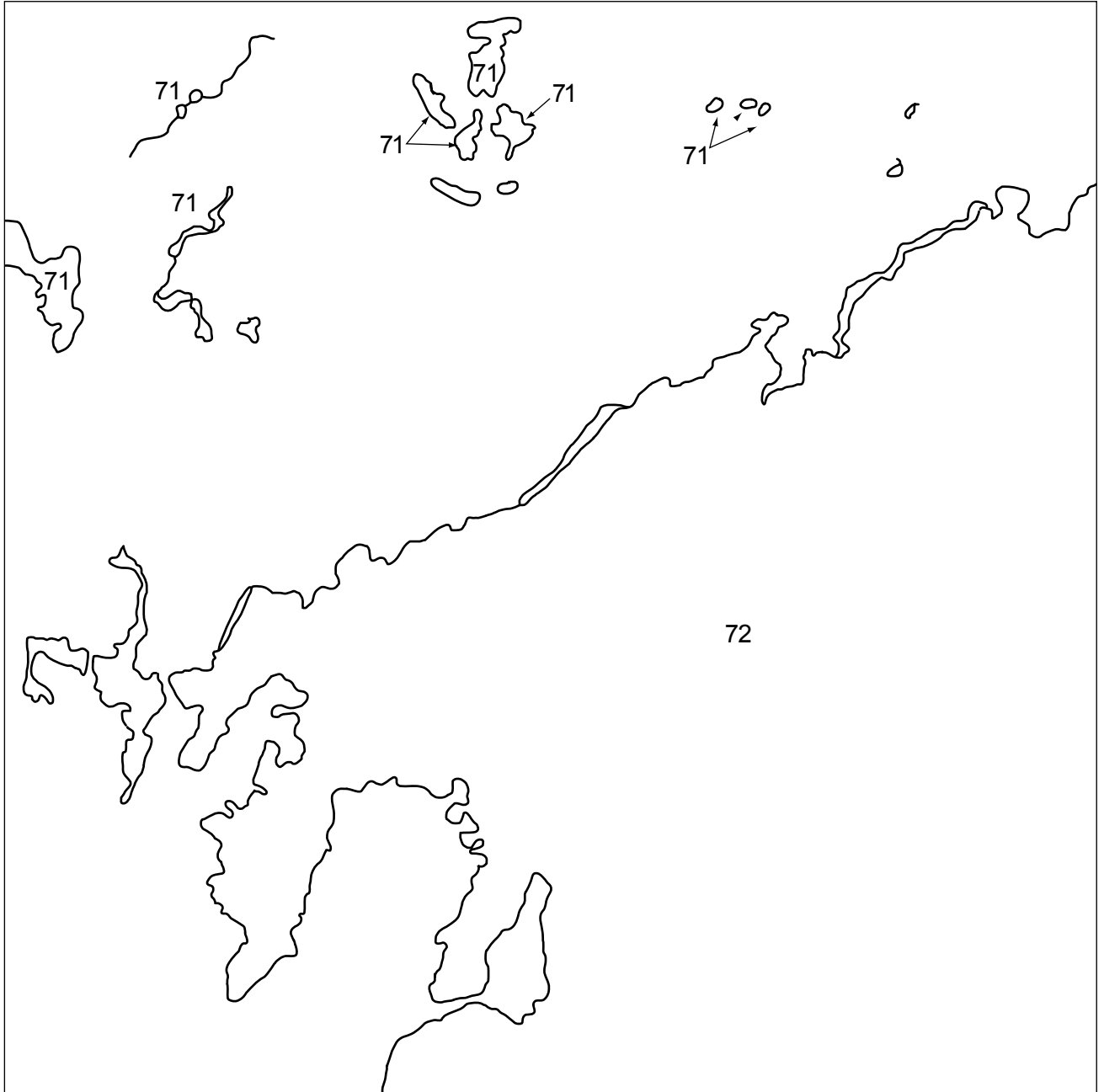
During the validation process, you will report your validation data as Land Cover Sample Sites. Once your map is validated, a copy, along with your validation data, can be uploaded to your school website, shared with local govenment, and shared with collaborating GLOBE schools.
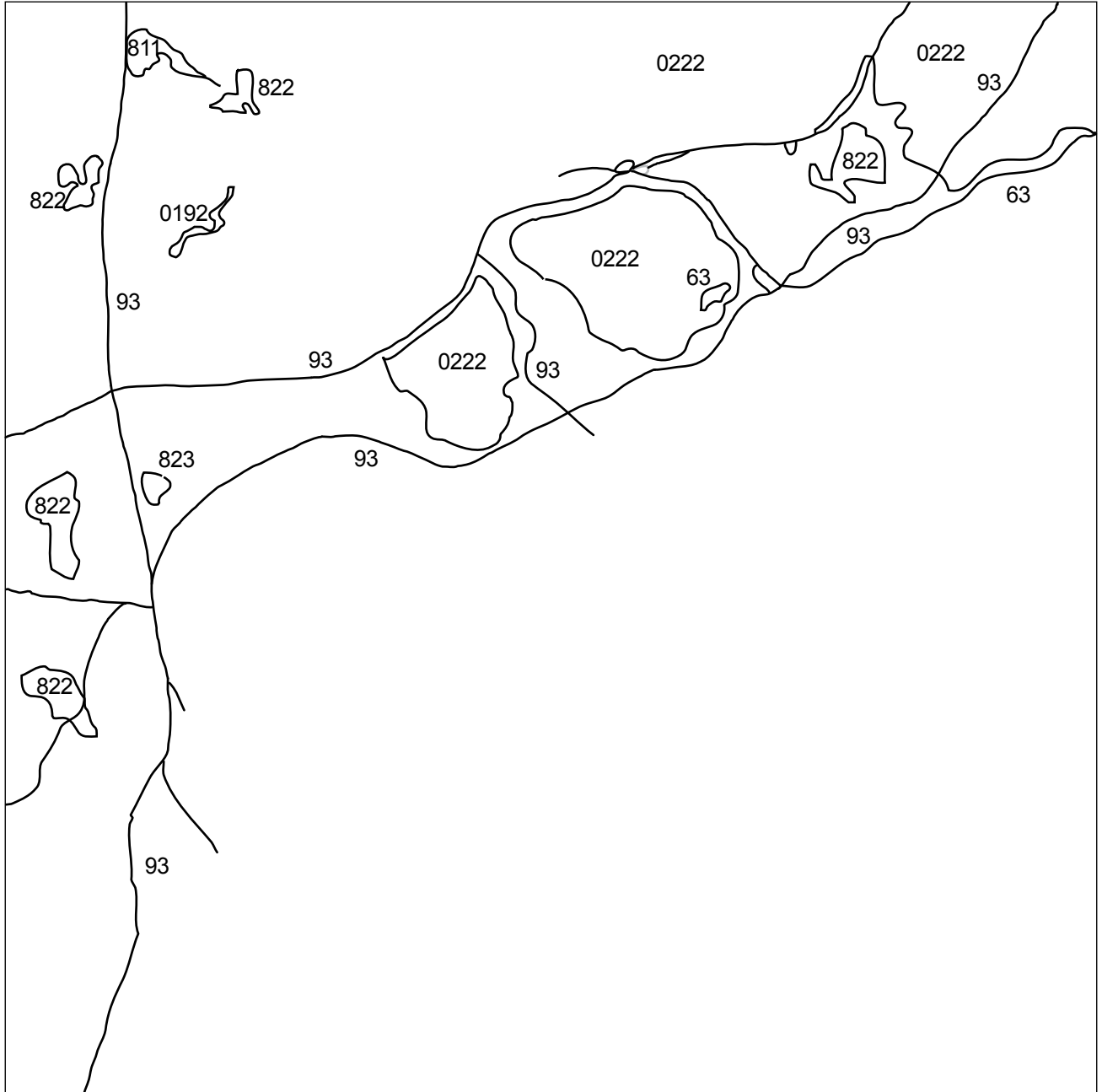
Figure BIO-MM-1: Beverly Landsat Scene

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