

ELECTROMAGNETIC SAMPLING ANALYSIS AND PREDICTION (ESAP V. 2.35)

FOR SIGNAL PROCESSING DATA COLLECTED WITH EMI INSTRUMENTATION

OVERVIEW

How to import and edit survey data generated from an EM38 survey into ESAP for analysis



How to use ESAP to generate sampling designs from field measurements



How to create a map of various soil characteristics

WHAT IS ESAP?



ECe (or Salinity) Sampling, Assessment, and Prediction



A statistical software package for estimating field-scale, spatial soil property patterns from EMI signal data.



Developed at the USDA-ARS US Salinity Laboratory in Riverside, CA and specifically designed to facilitate cost-effective, technically sound, soil salinity assessment and data interpretation techniques.



Available for download free of charge online at:

<https://www.ars.usda.gov/pacific-west-area/riverside-ca/us-salinity-laboratory/docs/esap-model/>

CORE MODULES OF ESAP



ESAP-RSSD (Response Surface Sampling Design)

Examine, analyze, & summarize EC_a survey data
Generates optimal soil sampling designs from sensor data



ESAP-Calibrate

Converts survey data into predicted soil salinity (a/o other soil properties)
Diagnose & identify primary soil properties influencing survey data
Generates multiple field summary statistics
Generates prediction data (used for making spatial maps)



ESAP-SaltMapper

I-D transect plots and 2-D raster maps
Tile line maps, calculate tile line locations, diagnose potential tile line problems

SUPPORT MODULES OF ESAP



ESAP-SigDPA (Signal Data Pre- processing Algorithm)

Tool to pre-process signal data into format used and recognized by core Modules.

Perform signal data QA/QC and validity checks, scale conversion, and row (transect) identification & assignment.

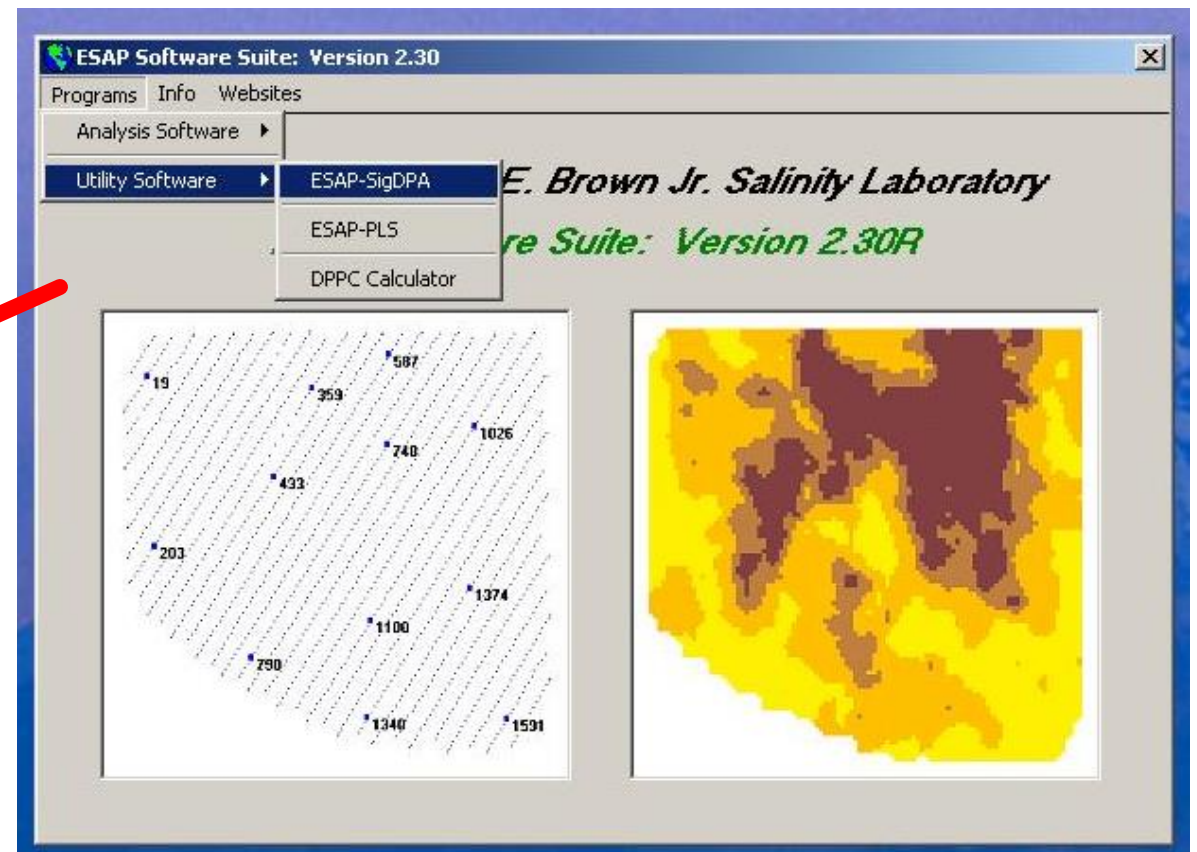
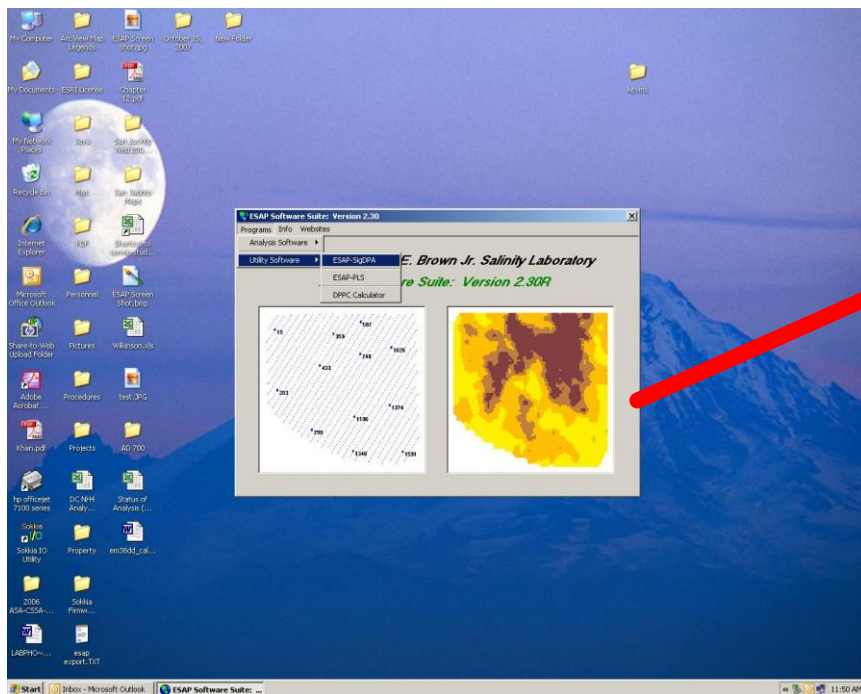


ESAP-DPPC (Dual Parallel Pathway Conductance) Calculator

Convenient to use calculator version of the 1989 Rhoades DPPC model
Used for direct prediction of salinity from spot 4-probe or EM survey data given soil temperature, texture, and moisture measurements (or estimates)

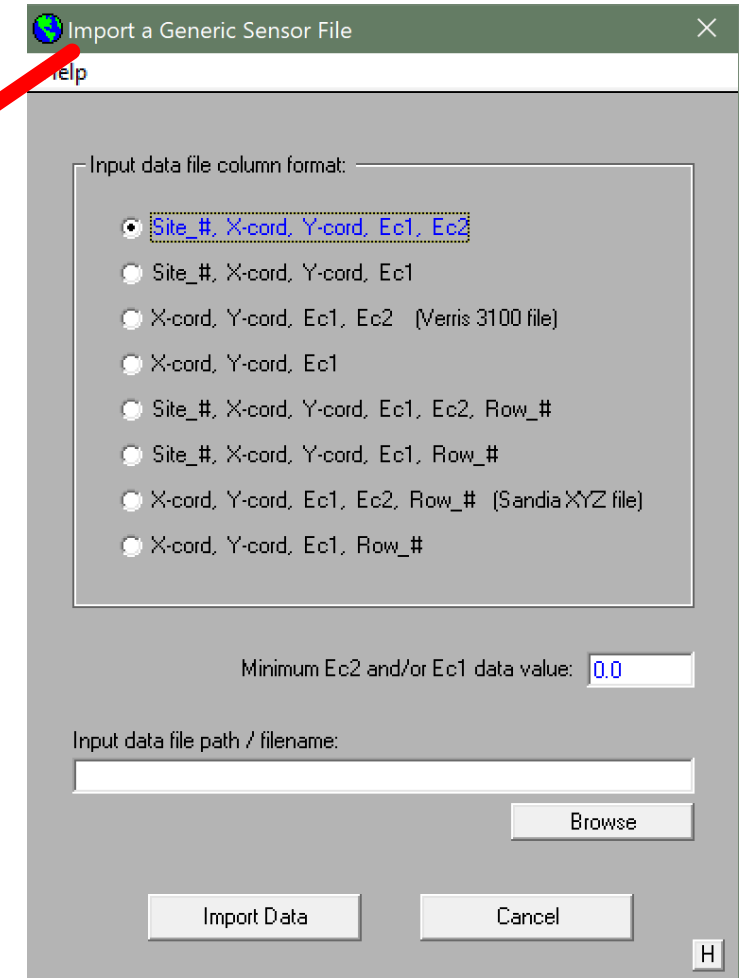
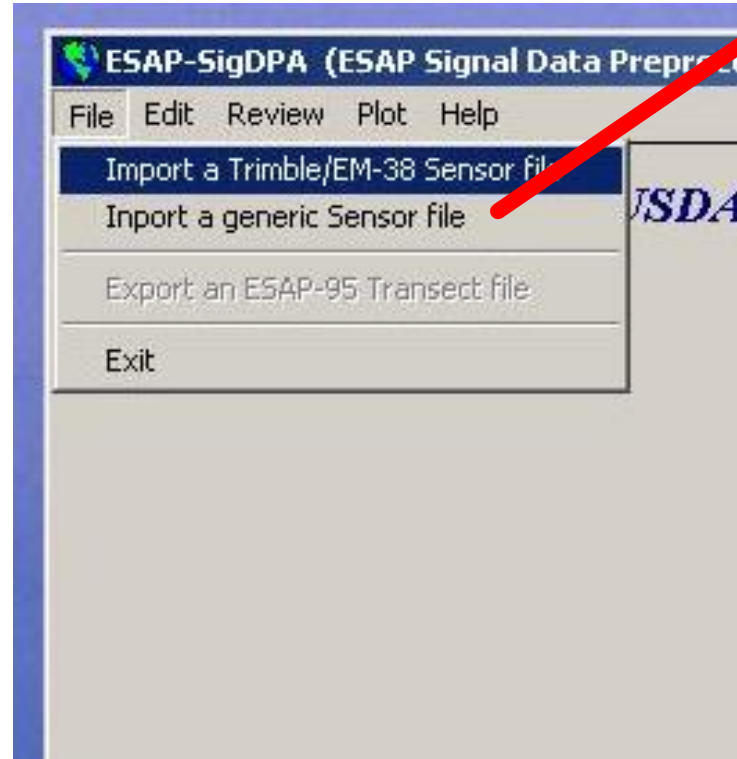
USING SIGDPA TO EDIT EM DATA FOR SAMPLE DESIGN

- Open ESAP and under “Programs” select “Utility Software” and then select “ESAP Sig-DPA”



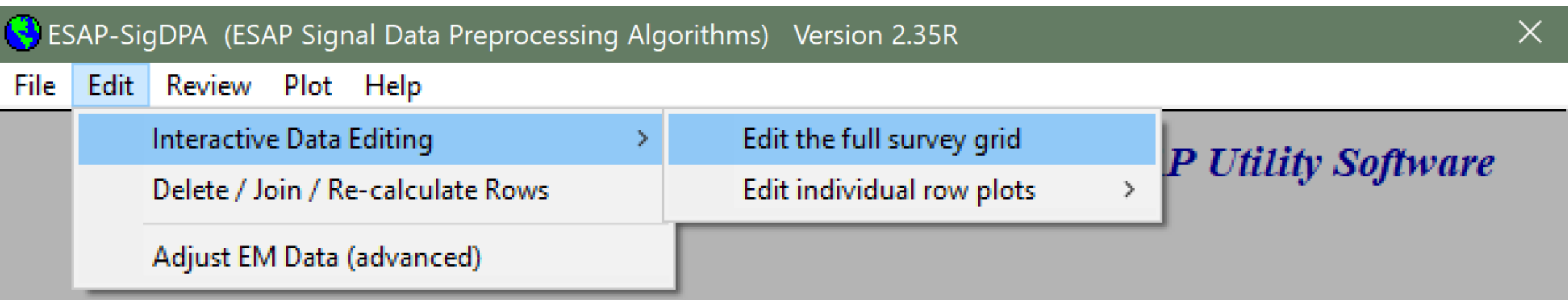
IMPORTING DATA INTO SIGDPA

- Under “File” select to Import a generic Sensor file
- Select the appropriate file format
 - Usually Site #, X,Y, Ec 1, Ec 2
- Browse for the EM38 .csv generated from DAT38MK2 but **MAKE SURE TO DELETE** the column headers



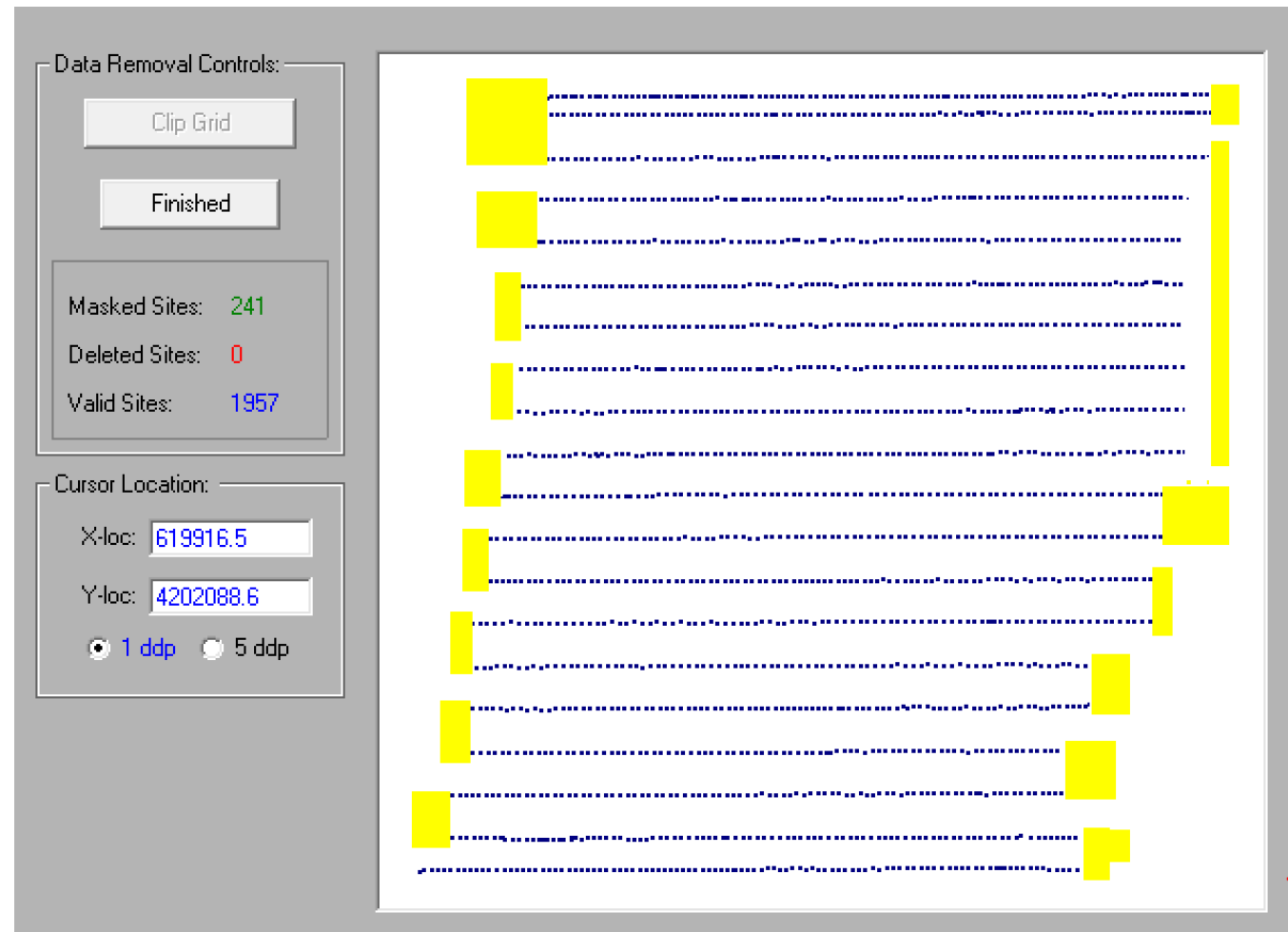
REMOVING EDGES TO GENERATE TRANSECT DATA

- Under “Edit” Select “Interactive Data Editing” and then “Edit the full survey grid”

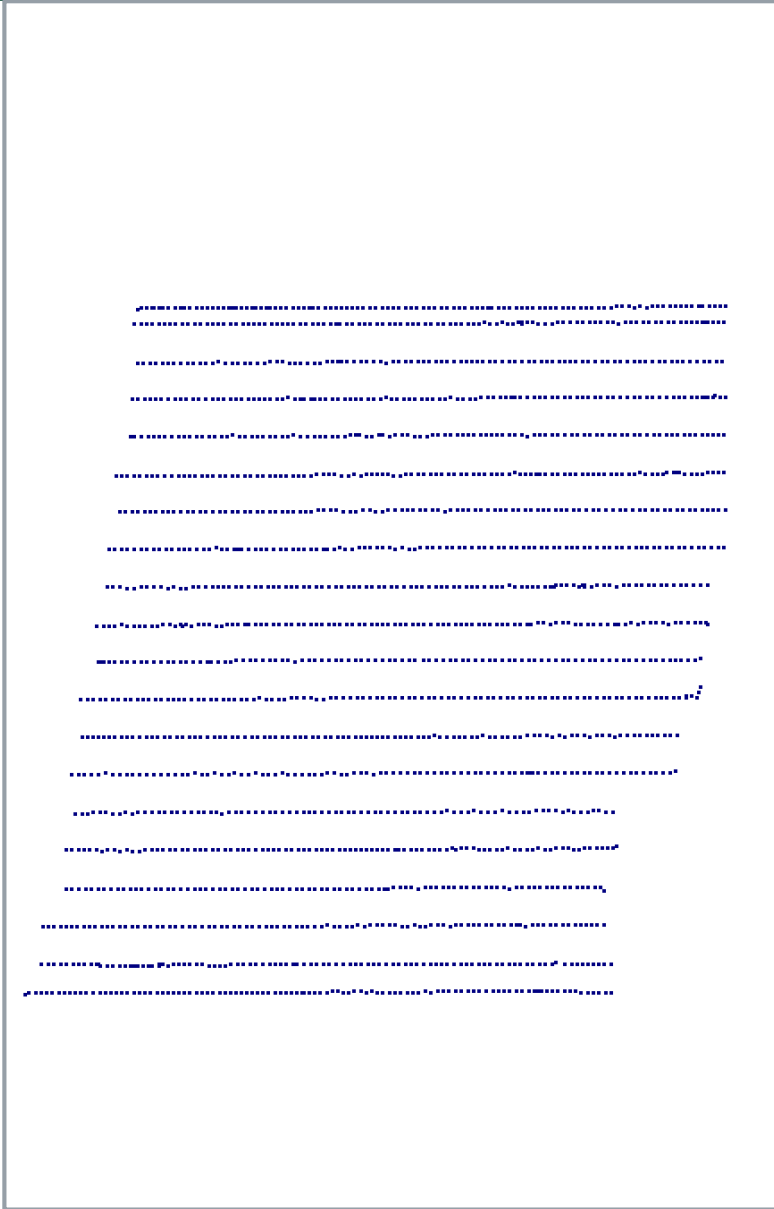
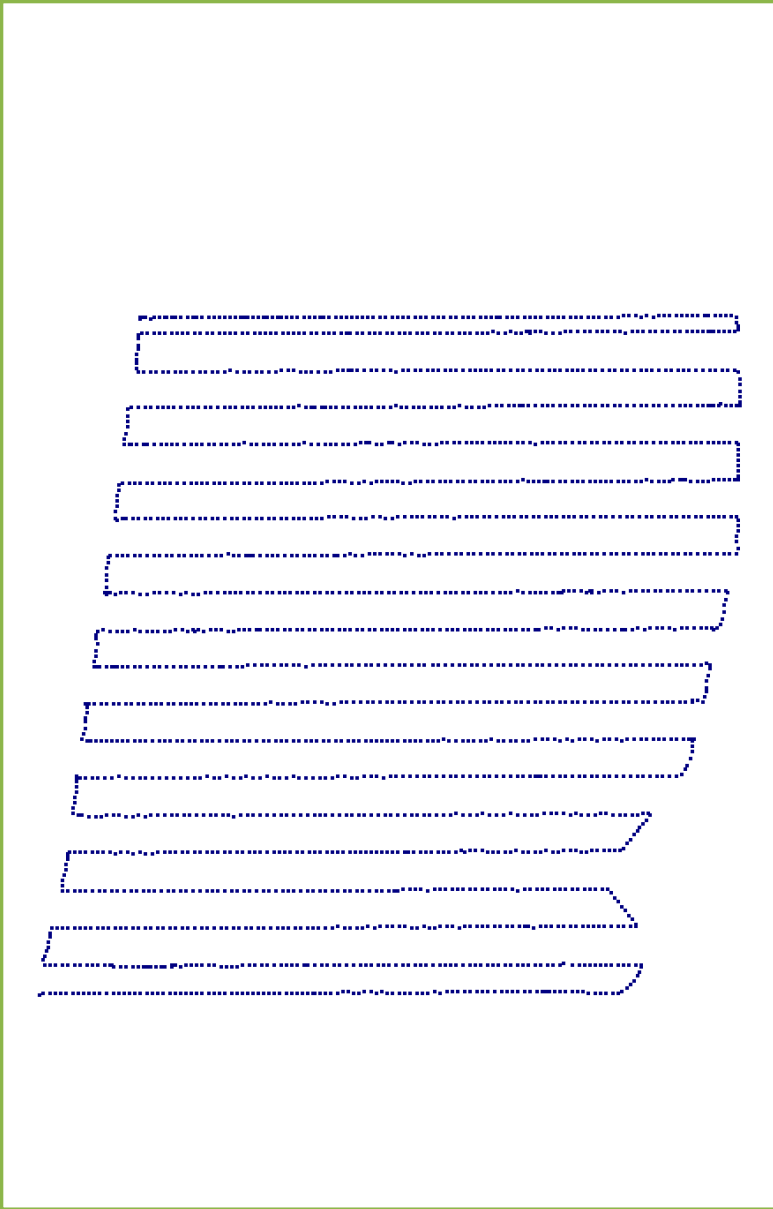


REMOVING EDGES TO GENERATE TRANSECT DATA

- Under “View” select “Display full map (max resolution)”
- Click the “Clip Grid” Button and highlight the areas of the map you want clipped
 - The areas you remove will be highlighted in yellow
- Click “Finished” and then mask and delete the clipped portion with the button that appears at the bottom of the screen

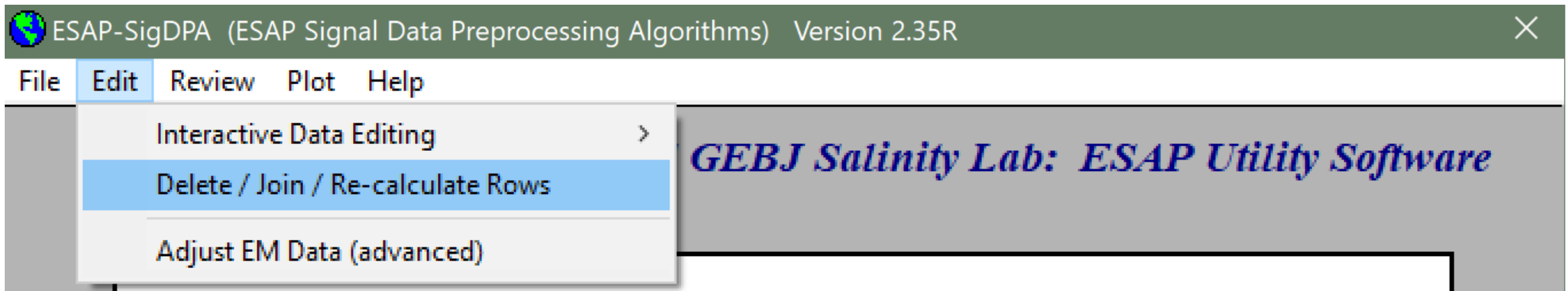


BEFORE AND AFTER CLIPPING



NUMBERING ROWS FOR TRANSECT DATA

- Under “Edit” Select “Delete/Join/Re-Calculate Rows



ADDING NUMBERS TO ROWS

- Check the “Specify Y distance value” (or X distance value if the transects run north and south)
 - Input the distance between transect passes (note: it is better to underestimate than overestimate here)
- Press “OK”

Row Editing / Re-numbering

Row Editing / Row Re-numbering Options

☐ Joint two rows

☐ Delete a row

Recalculate row numbering using a new distance value:

☐ Specify true distance value

☐ Specify X distance value (for N-S runs)

☒ Specify Y distance value (for E-W runs)

Enter the new Y distance value: 10

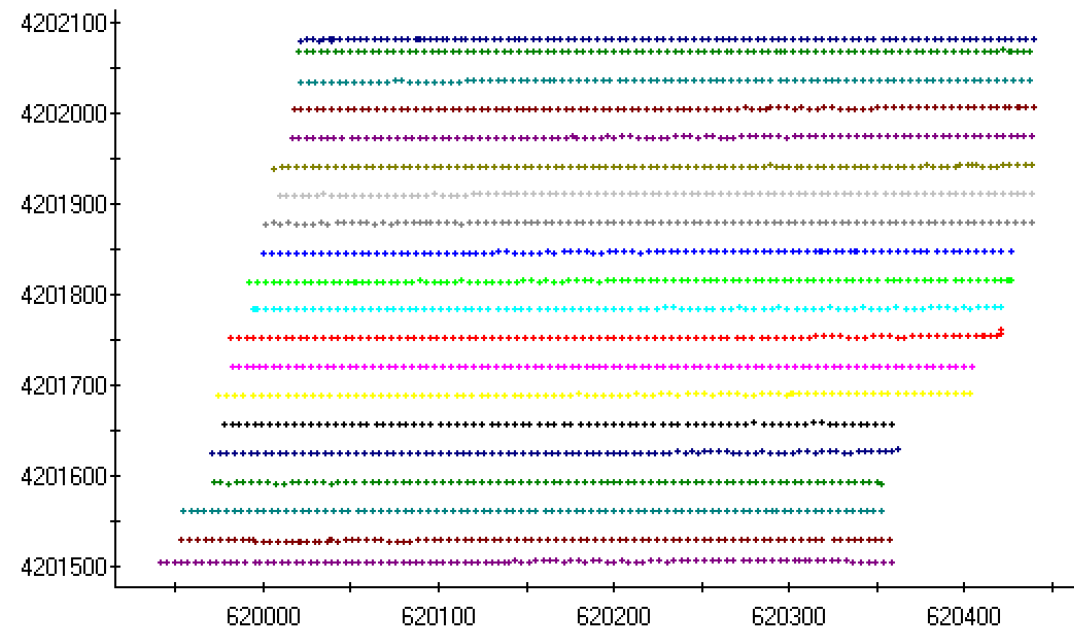
OK Cancel

H

- Select “Survey Grid” under “Plot” to check that each transect has a distinct color in the correct location

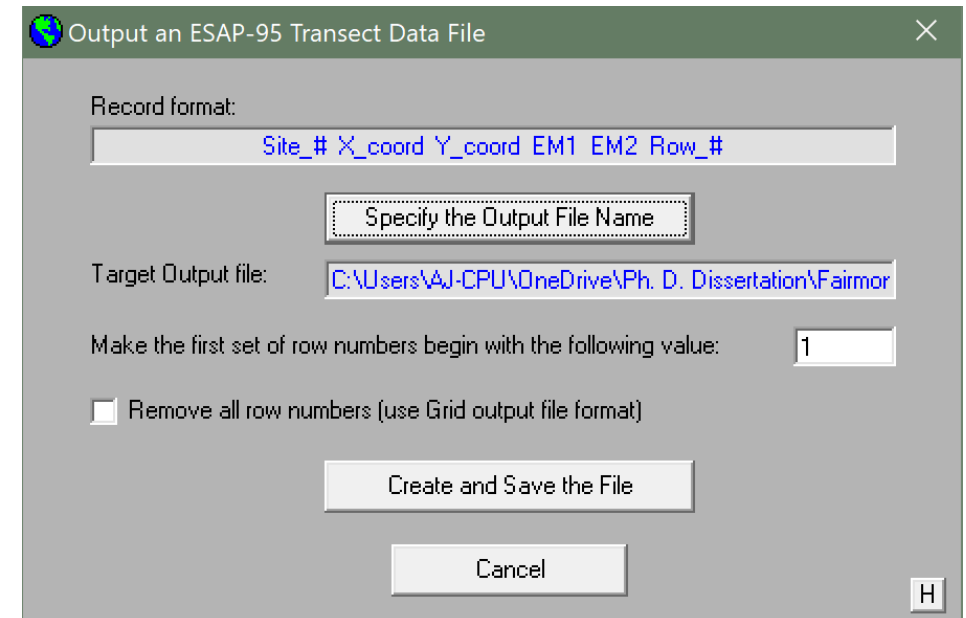
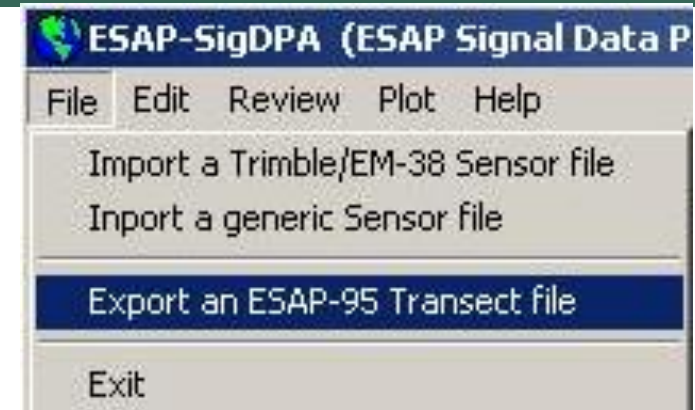


Sample Grid Plot



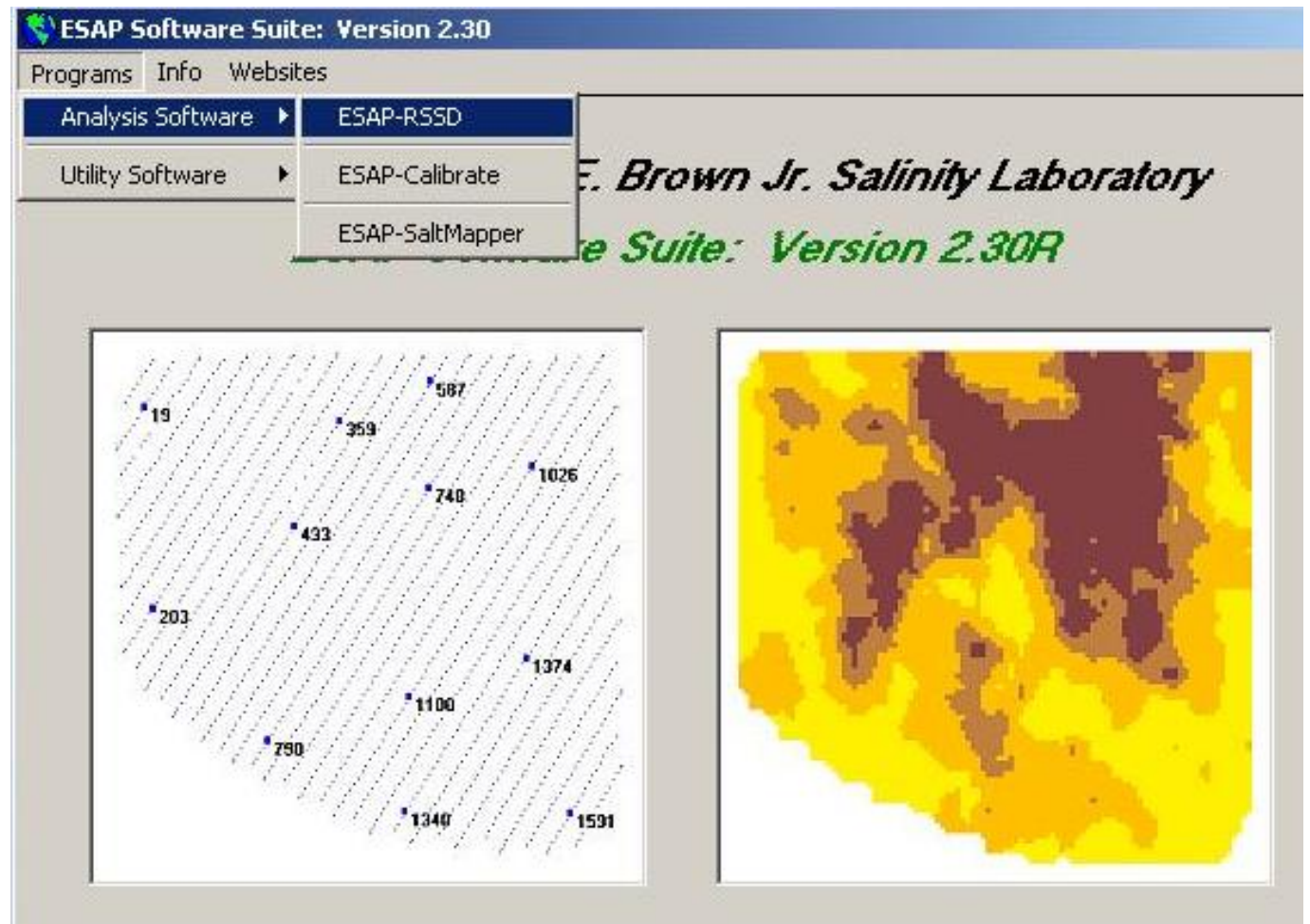
EXPORTING TRANSECT DATA TO USE IN ESAP-RSSD

- Once the transects are labelled correctly:
 - Under “File” select “Export an ESAP-95 Transect file”
 - Specify the name and location of your output file
 - “Create and Save the File”
- You may now exit Sig-DPA



GENERATING A SAMPLING DESIGN

- ESAP-RSSD will take EM38 Transect data to statistically locate the best sampling locations for correlating soil characteristics to EM38 readings
- Open ESAP-RSSD from the ESAP main menu under “Programs” and “Analysis Software”



CREATING NEW PROJECTS

- Select Set/Create Project and Field ID under “File” menu.



CREATING NEW PROJECTS

- Create Project in “Create/Set Project” window.

The screenshot shows a Windows-style dialog box titled "Create / Set Project and Define Field ID Code". It is divided into several sections:

- Set Current Project Directory:** A list box containing the following items: Buttonwillow91 (selected), Buttonwillow93, LasVegas2005, SanJacinto2005, Training1, Training2, and Training3.
- Project / Field ID Information:** A section with two labels: "Project:" followed by the text "Buttonwillow91" and "Field ID:" followed by the text "exp1". Below these are "OK" and "Cancel" buttons.
- create project and field ID specified above:** A button located below the Project / Field ID Information section.
- Create a New Project Directory:** A large empty text box with a "New" button to its right.
- Field Description:** A text input field.
- Please enter a unique 4 character alpha-numeric field ID code:** A text input field containing the text "exp1".

There is also a small "H" button located to the right of the "create project and field ID specified above" button.

IMPORTING DATA

- Select Import a Transect Survey File under the “File” and “Import Survey Data File.”



IMPORTING DATA

- Browse to locate file we created in Sig-DPA, click on it, then click “OK” in the “File Structure and Import” window.

File Structure and Import

The site identification and/or s2 signal columns represent optional data columns which can be included in an import grid or transect data file. Please indicate if either or both of these columns are present in your file by checking the appropriate boxes.

☐ numeric site identification code

REQUIRED: x-coordinate

REQUIRED: y-coordinate

REQUIRED: s1 (1st signal column)

☒ s2: (2nd signal column)

REQUIRED: row number

Perform natural log transform on input signal data? ☐ Yes ☒ No

(Note: select Yes if you are performing a soil salinity survey, and you expect that at least 10% of the field exceeds 4 dS/m.)

Required Record Order: site-ID*, x-cord, y-cord, s1, s2*, row-num (* if present)

Please enter the appropriate labels and units for your signal data column(s).

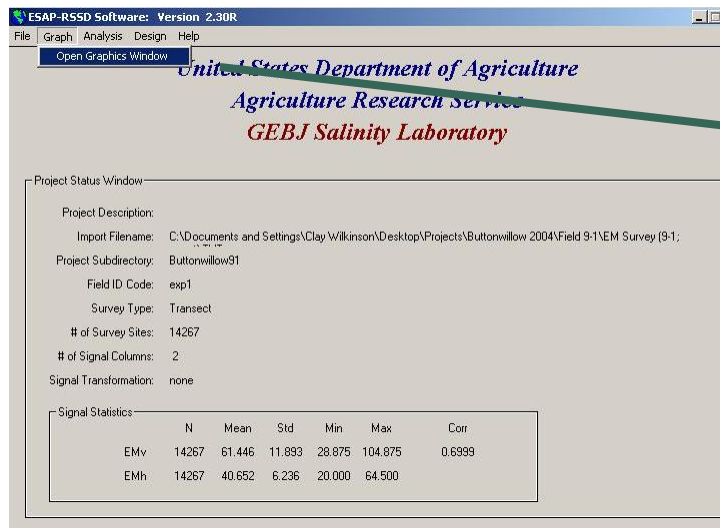
s1 Label: s2 Label: ☒ mS/m ☐ dS/m

Path \ Filename:

H

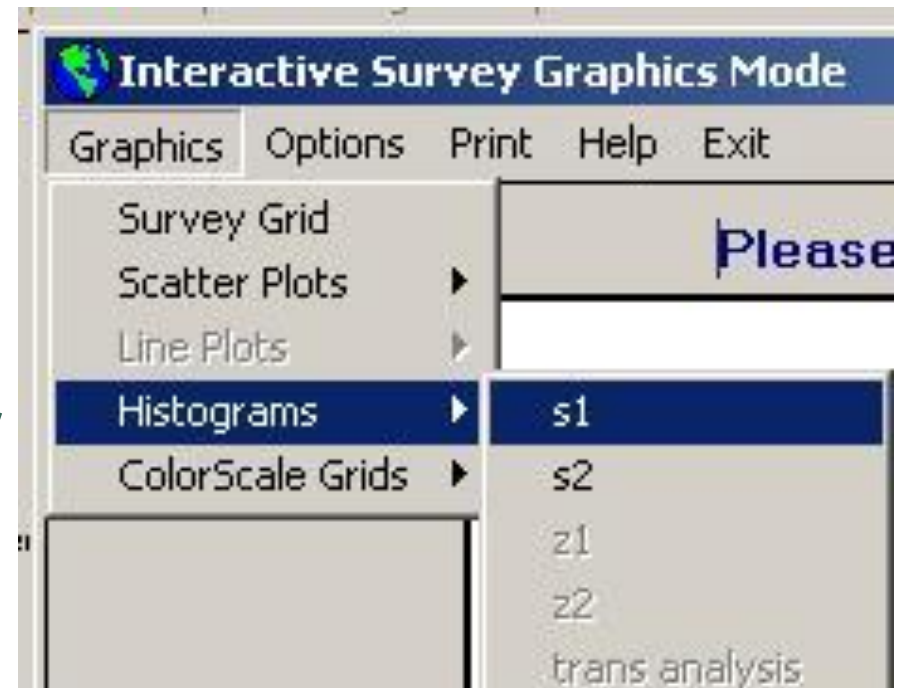
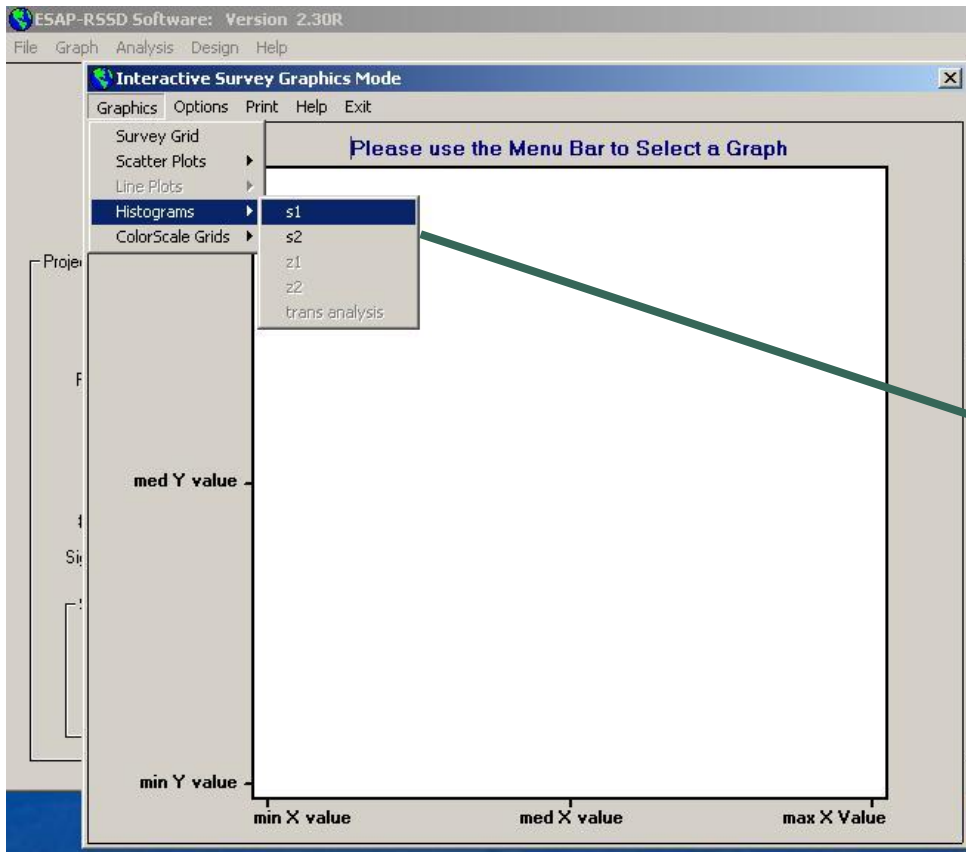
CHECKING ASSUMPTIONS

- Select Open Graphics Window under “Graph” menu.



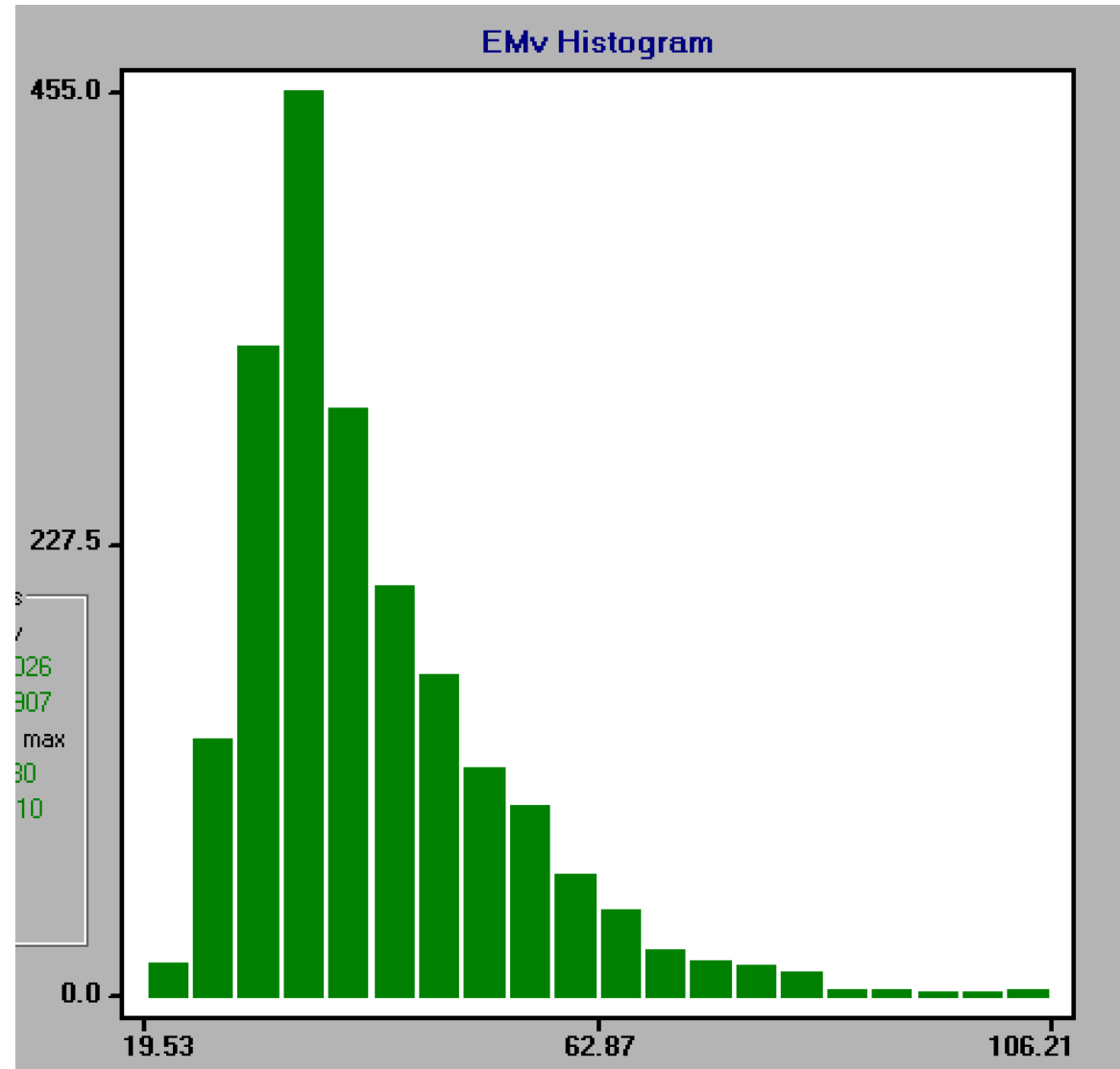
CHECKING FOR NORMALITY

- RSSD sampling designs require that the EM values are normally distributed to satisfy statistical assumptions
- To check we must look at histograms of both EM signals (Graphics → Histograms → s1/s2



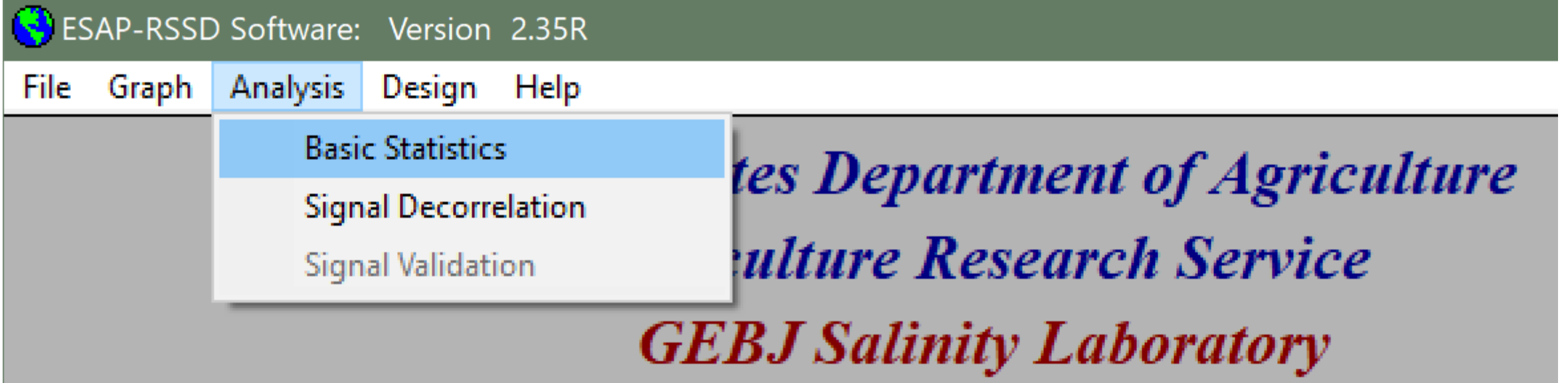
NON-NORMAL DATA AND LOG TRANSFORMATION

- Often EM data is non-normally distributed.
- This is because most fields only have small areas of high salinity, and not the entire field
- To correct for this, we must log-transform the data



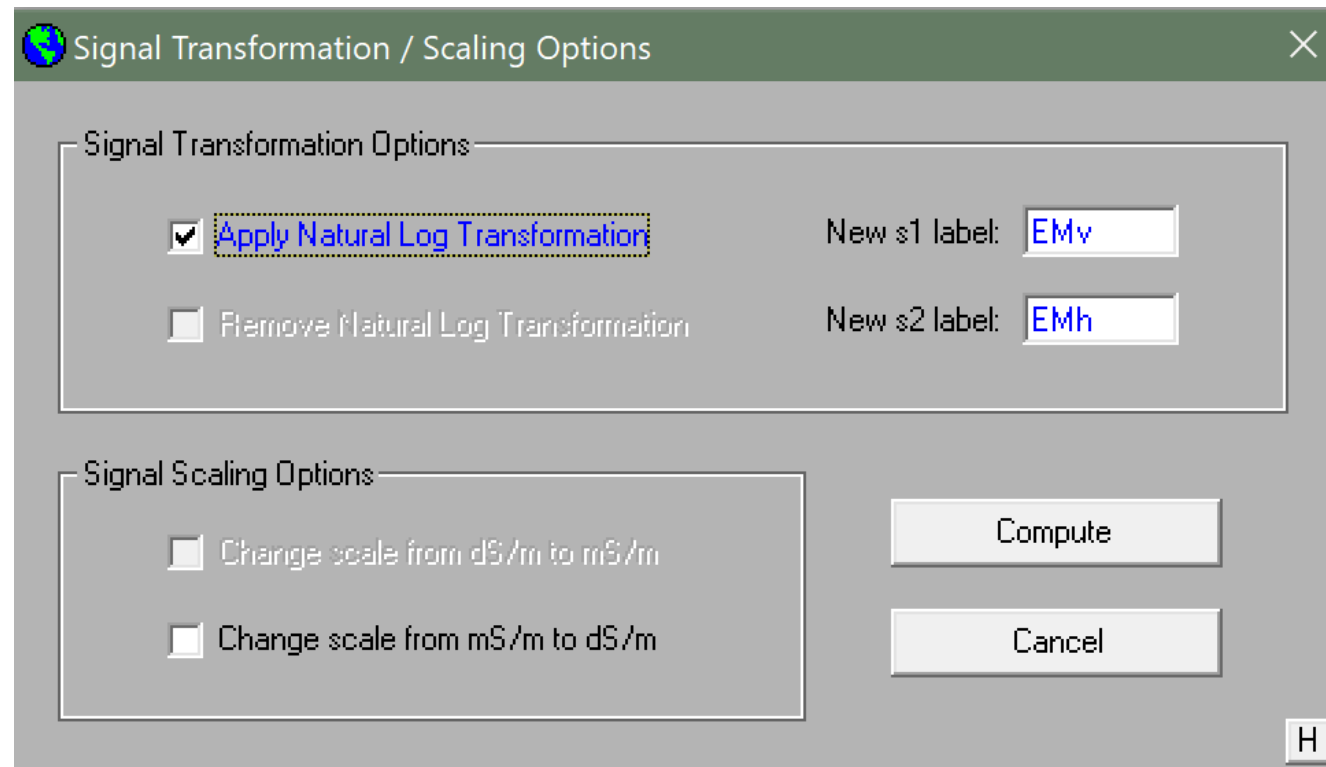
LOG TRANSFORMING DATA

- To log transform the data, under “Analysis” select “Basic Statistics”



LOG TRANSFORMING DATA

- Check “Apply Natural Log Transformation” and press “Compute”



The image shows a software dialog box titled "Signal Transformation / Scaling Options". It contains two main sections: "Signal Transformation Options" and "Signal Scaling Options". In the first section, the checkbox "Apply Natural Log Transformation" is checked and highlighted with a dashed yellow border, while "Remove Natural Log Transformation" is unchecked. To the right, "New s1 label" is set to "EMv" and "New s2 label" is set to "EMh". The second section has two unchecked checkboxes for changing scales. At the bottom right are "Compute" and "Cancel" buttons, and a small "H" button in the bottom right corner.

Signal Transformation / Scaling Options

Signal Transformation Options

☒ Apply Natural Log Transformation

☐ Remove Natural Log Transformation

New s1 label: EMv

New s2 label: EMh

Signal Scaling Options

☐ Change scale from dS/m to mS/m

☐ Change scale from mS/m to dS/m

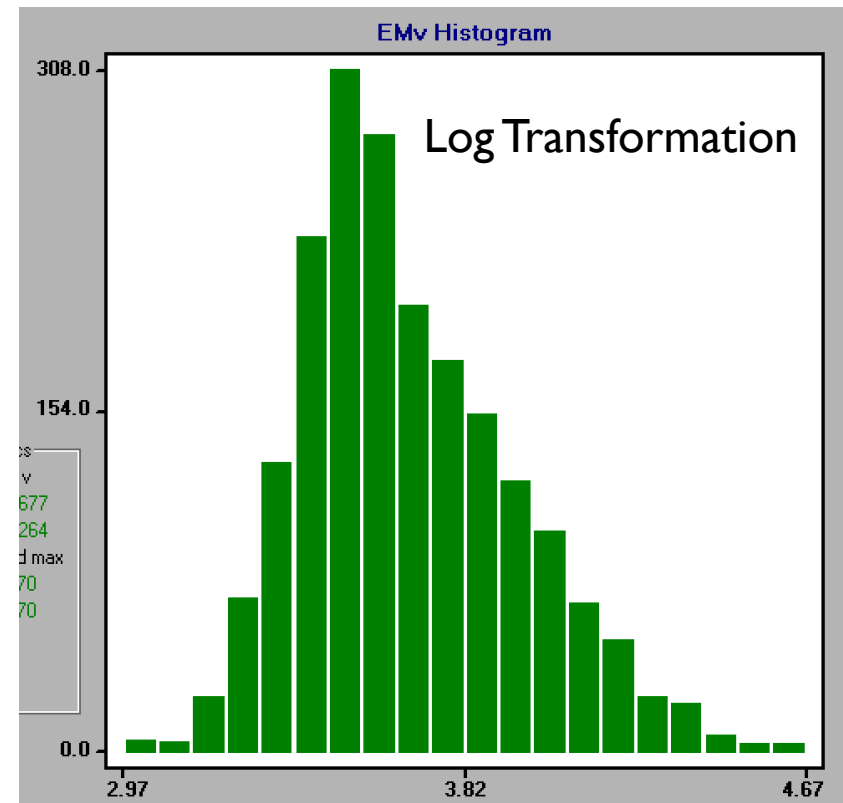
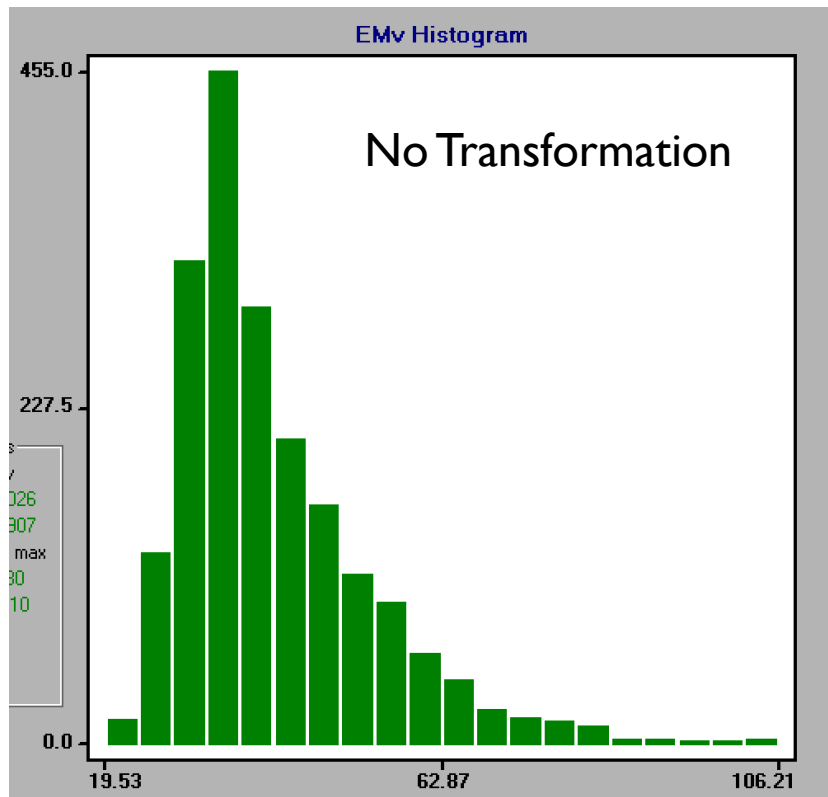
Compute

Cancel

H

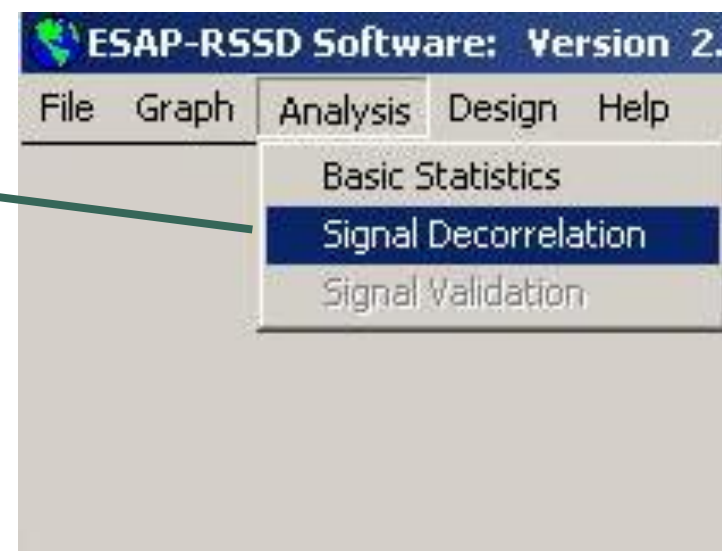
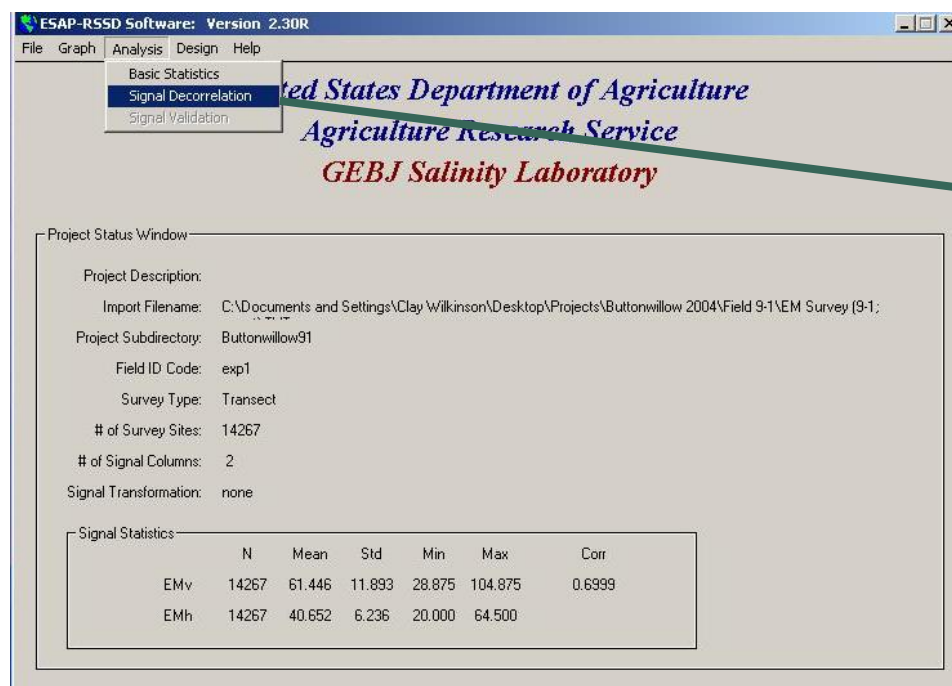
CHECKING NEW DISTRIBUTION

- Check to see that your log transformed data is more normally distributed in the graphics menu again.



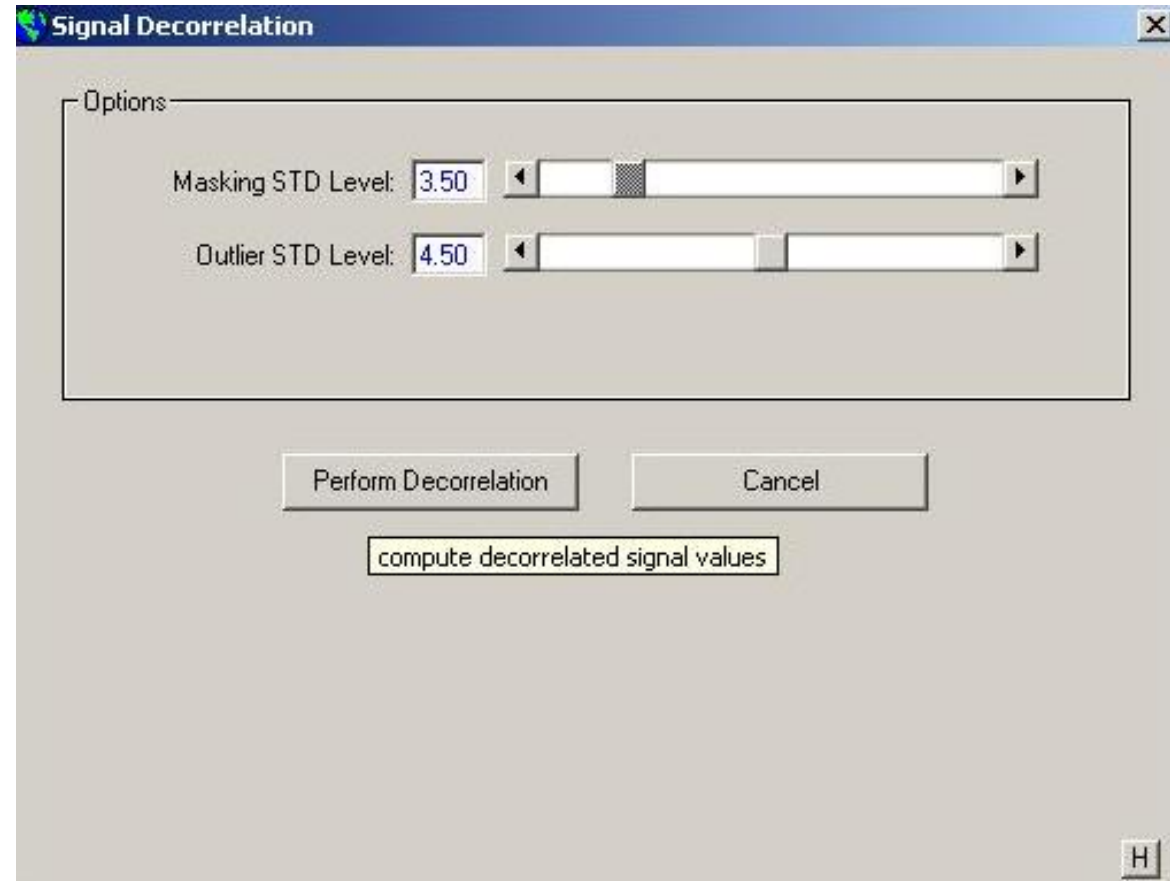
SIGNAL DECORRELATION

- Select Signal Decorrelation under the “Analysis” menu.



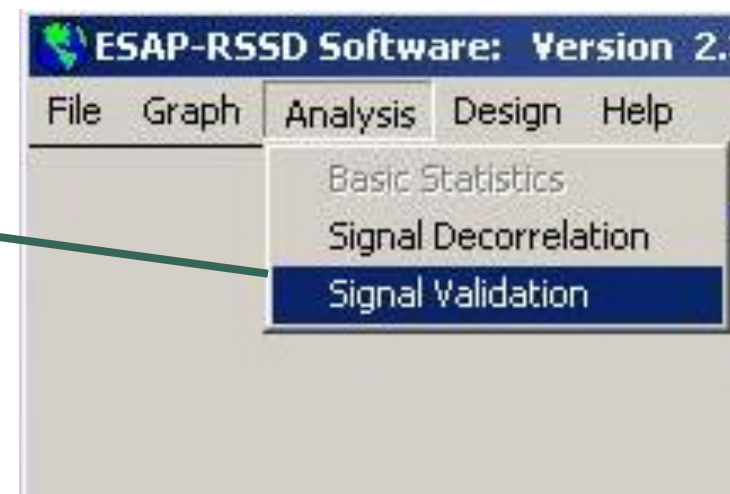
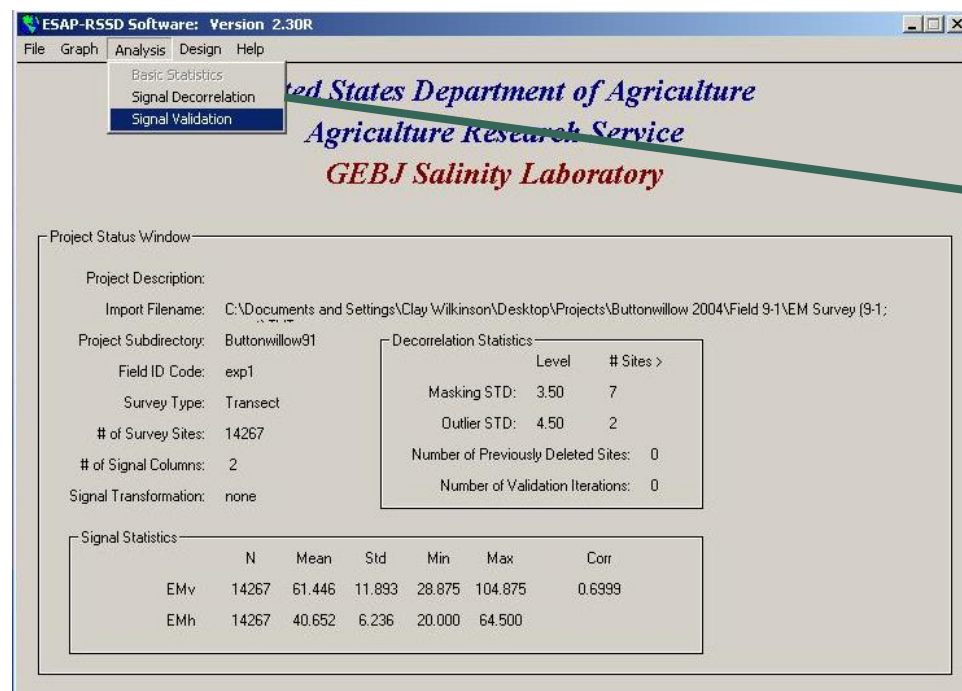
SIGNAL DECORRELATION

- Click “Perform Decorrelation” button.



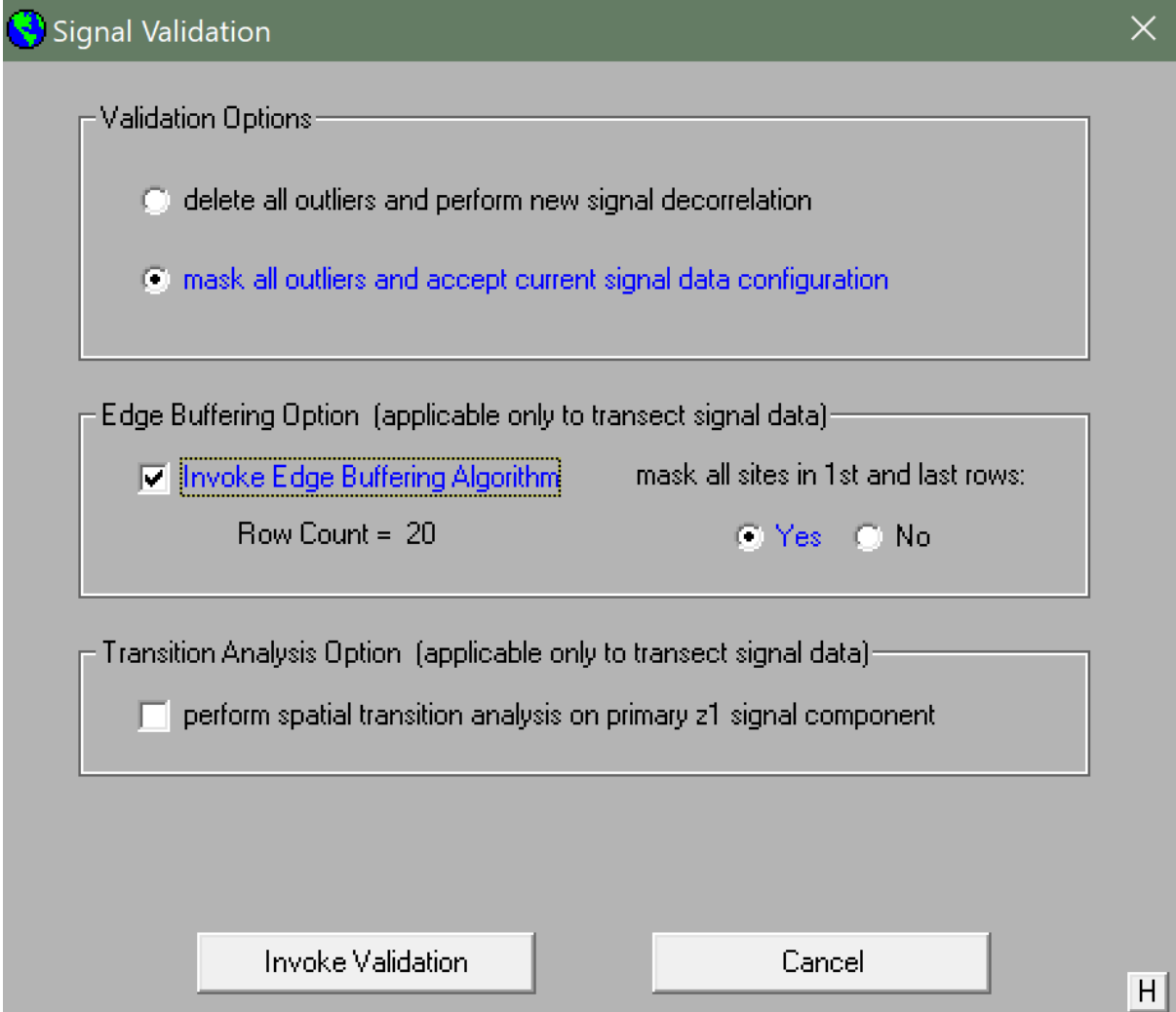
SIGNAL VALIDATION

- Select Signal Validation from the “Analysis” tab



SIGNAL VALIDATION

- “Mask all outliers and accept current signal data configuration”
- Invoke edge buffering algorithm (optional)
- “Invoke Validation”



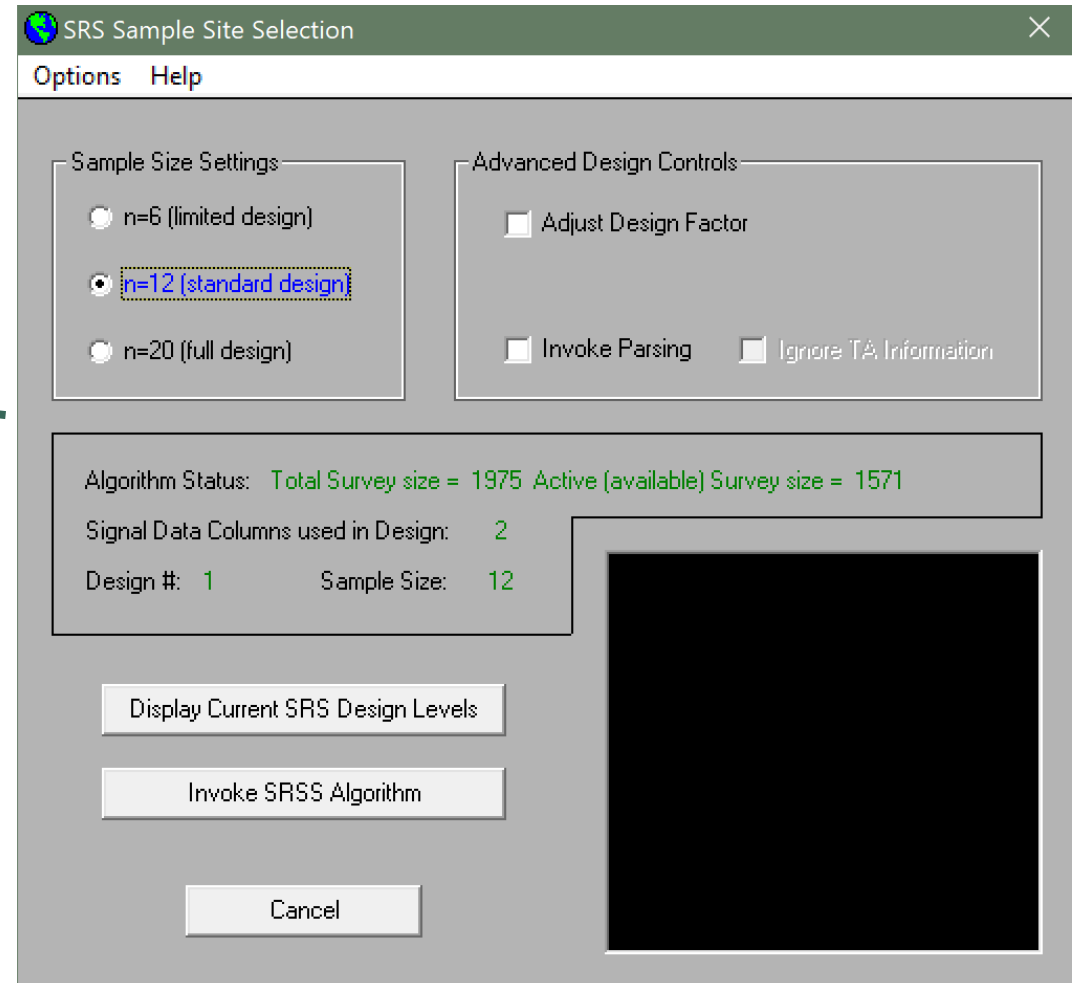
The image shows a 'Signal Validation' dialog box with a green title bar and a close button (X) in the top right corner. The dialog is divided into three main sections, each with a title and a group box border:

- Validation Options**: Contains two radio button options. The first is 'delete all outliers and perform new signal decorrelation'. The second is 'mask all outliers and accept current signal data configuration', which is selected and highlighted in blue.
- Edge Buffering Option (applicable only to transect signal data)**: Contains a checked checkbox for 'Invoke Edge Buffering Algorithm' (highlighted with a dashed yellow border). Below this checkbox, it says 'Row Count = 20'. To the right, there is a label 'mask all sites in 1st and last rows:' followed by two radio buttons: 'Yes' (selected and highlighted in blue) and 'No'.
- Transition Analysis Option (applicable only to transect signal data)**: Contains an unchecked checkbox for 'perform spatial transition analysis on primary z1 signal component'.

At the bottom of the dialog, there are two buttons: 'Invoke Validation' and 'Cancel'. In the bottom right corner, there is a small button labeled 'H'.

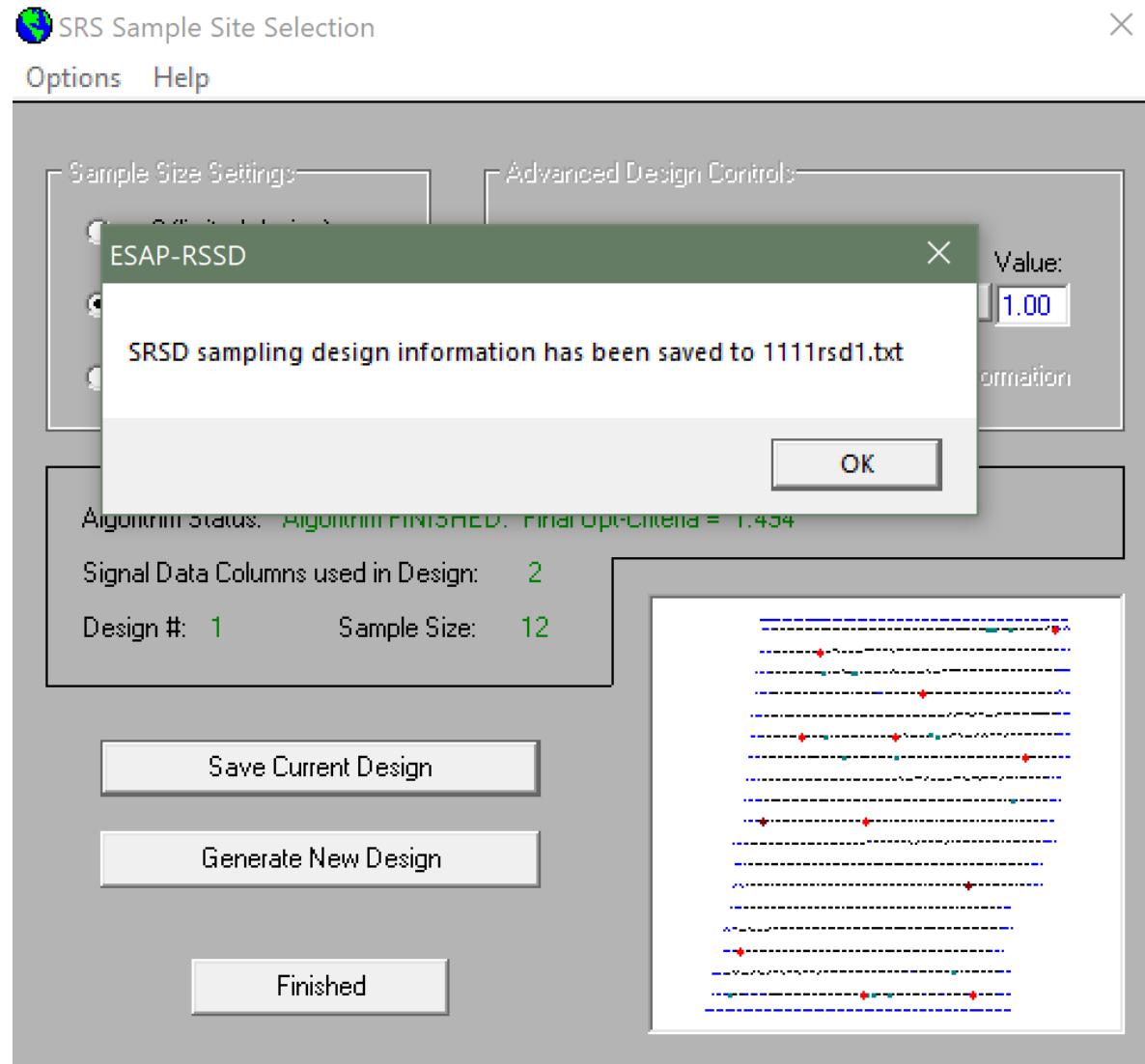
SAMPLE DESIGN

- Select Signal Validation from the “Analysis” tab
- “Invoke SRSS Algorithm”



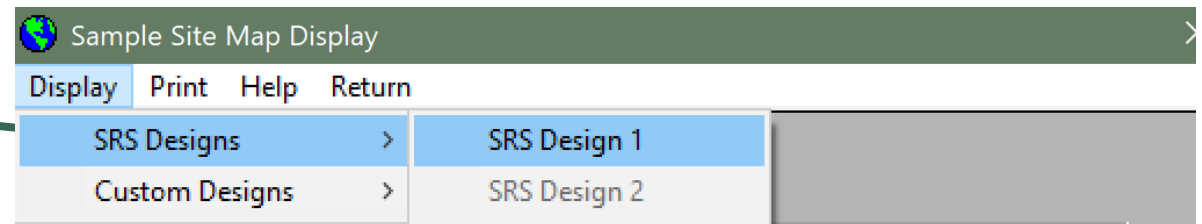
SAMPLE DESIGN

- “Save Current Design”
- Try to have Opt-Criteria 1.30 or less
 - Change design factor and/or invoke parsing to obtain best results
- Generate as many designs as needed to pick best result



SAMPLE DESIGN

- After clicking “Finished”, from the main menu, open the sample site map



SAMPLE DESIGN

- You may now view and print your sample map
- To view gps coordinates and statistical results, open the project folder on the desktop and go to the “rsd1” and “gps1” files

ESAP SRS Sample Design #1

