

# **Shoreline Change from a Storm Event Procedure using the Digital Shoreline Analysis System**

**Brian Madore**

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The Digital Shoreline Analysis System (DSAS) is an ArcMap extension created by the U.S. Geological Survey (USGS). The tool is publicly available for download and can be obtained at <http://woodshole.er.usgs.gov/project-pages/dsas/>.

Note: The PDF guide which will be downloaded shortly provides specific information on how to use the DSAS tool. This workflow uses information obtained from the DSAS PDF manual and if any additional information is required about the DSAS tool outside of this workflow, it is recommended to check the PDF guide/manual.

Using the DSAS tool for the analyzing of storm event changes may work best over smaller regions, looking at specific damaged locations. It would be recommended that if a large area (100s of km) being examined that this workflow may work best by looking at several smaller sections (10s of km) than one large area.

## A. Installing the Digital Shoreline Analysis System for ArcMap 10

A.1. The DSAS tool and required documentation was downloaded from <http://woodshole.er.usgs.gov/project-pages/dsas/version4/index.html>. The website contains four files which are necessary in order to set up and run the DSAS tool.

A.1.1. Download the MCRinstaller, DSASv4.3 zip, DSASv4.3 pdf, and the DSASv4.3 sample data.

**USGS**  
science for a changing world  
U.S. Geological Survey Open-File Report 2008-1278

**The Digital Shoreline Analysis System (DSAS) version 4.0—An ArcGIS Extension for Calculating Shoreline Change**

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**Abstract**

The Digital Shoreline Analysis System (DSAS) version 4.3 is a software extension to ESRI ArcGIS v.10 that enables a user to calculate shoreline rate-of-change statistics from multiple historic shoreline positions. A user-friendly interface of simple buttons and menus guides the user through the major steps of shoreline change analysis. Components of the extension and user guide include (1) instruction on the proper way to define a reference baseline for measurements, (2) automated and manual generation of measurement transects and metadata based on user-specified parameters, and (3) output of calculated rates of shoreline change and other statistical information. DSAS computes shoreline rates of change using four different methods: (1) endpoint rate, (2) simple linear regression, (3) weighted linear regression, and (4) least median of squares. The standard error, correlation coefficient, and confidence interval are also computed for the simple and weighted linear-regression methods. The results of all rate calculations are output to a table that can be linked to the transect file by a common attribute field. DSAS is intended to facilitate the shoreline change-calculation process and to provide rate-of-change information and the statistical data necessary to establish the reliability of the calculated results. The software is also suitable for any generic application that calculates positional change over time, such as assessing rates of change of glacier limits in sequential aerial photos, river edge boundaries, land-cover changes, and so on.

A public bulletin board for DSAS support is available at <https://woodshole.er.usgs.gov/cgi-bin/discuss/show.cgi?ID=2> to report bugs as well as to exchange tips and techniques with the authors and other DSAS users.

Historic shorelines for a portion of southwestern Nantucket Island, Massachusetts.

The following files are available for download:

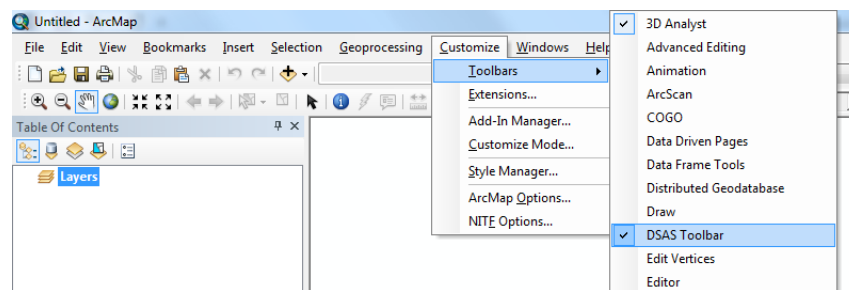
- required MCRinstaller.zip (228 Mb) - MATLAB Component Runtime Utility installer (please see DSAS user guide for more information)
- DSASv4.3.4730.zip (2.1 Mb) - the DSAS installer package, compressed zip file
- DSASv4.3.pdf (9.3 Mb) - Adobe PDF user guide (includes installation instructions).
- DSASv4.3\_sample\_data.zip (276 kb) - Sample ArcGIS 10 geodatabase, compressed zip file.

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A.2. The PDF downloaded contains detailed steps for how to use all DSAS tool functions and information on its installation. If this workflow cannot provide all answers or if more information is needed, check the DSAS PDF.

A.3. Check to make sure Microsoft .NET Framework 3.5 is downloaded on the computer by checking A. Start>Control Panel>Administrative Tools or Start>Control Panel>Add/Remove Programs.

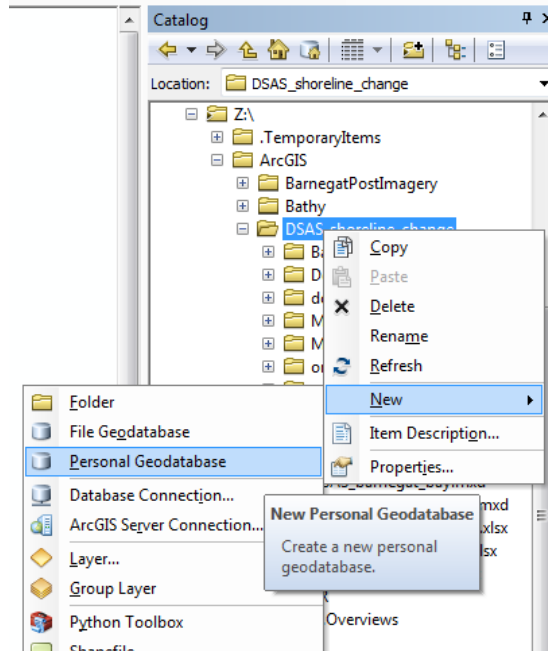
- A.3.1. If Microsoft .NET Framework 3.5 is not installed on the computer go to <http://www.microsoft.com/en-us/download/details.aspx?id=21> or if the link does not work use Google.com to search for Microsoft .NET Framework 3.5 (make sure the download is from Microsoft).
- A.3.2. Install the Microsoft .NET Framework 3.5 once downloaded.
- A.4. Install the MATLAB Component Runtime utility by executing the MCRInstaller.exe, which was downloaded from the DSAS website in step A.1.1.
- A.5. Once the Microsoft .NET Framework 3.5 and MATLAB Component Runtime utility have been installed the DSAS tool can be installed.
- A.5.1. First, close all ArcGIS software running on the computer.
- A.5.2. Extract the DSASv4.3 zip file to a preferred location to be saved.
- A.5.3. Launch the setup.exe application.
- A.5.4. Choose an installation folder.
- A.5.5. The program will confirm the installation of the tool, click close to exit.
- A.5.6. The tool is now installed and can be accessed in ArcMap.
- A.6. The DSAS toolbar can be opened in ArcMap by selecting **Customize** then **Toolbars** and selecting the **DSAS Toolbar**.



## B. Obtaining and Creating Shorelines

- B.1. The DSAS system requires multiple shorelines from different dates to obtain data and results. The shorelines used can be imported from existing shapefiles, created from aerial imagery, or created from other various techniques. **Important Note:** Each shoreline will need information regarding the date of the shoreline and the uncertainty of the shoreline. When downloading shorelines keep track of this information if it is given, check the metadata if necessary to also determine this information. For the uncertainty, if the that information is not provided, section C will go over how to determine the uncertainty of an individual shoreline.
- B.2. **An important note:** DSAS requires data to be in meter units in a projected coordinate system. It is recommended to use a UTM projection and to use the same projection for all shorelines.
- B.3. All data that will be used with the DSAS tool must be stored in a personal geodatabase. This includes shorelines and baselines (which will be discussed later).
- B.3.1. To create a personal geodatabase open the Catalog tool in ArcMap and select the folder to where the database will be saved. Right-click the folder and select **New**

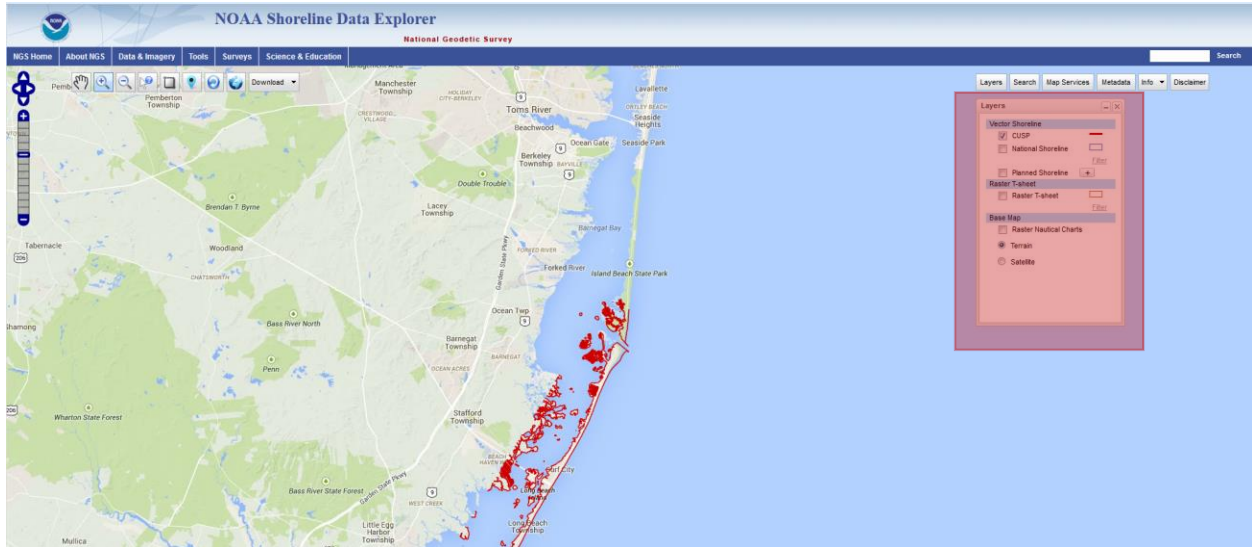
then **Personal Geodatabase**. Name the database an appropriate title (for this workflow it will be referenced as DSAS\_database).



B.4. Any existing shoreline shapefiles that will be used must be imported into the DSAS\_database. This can be achieved by right-clicking the DSAS\_database and selecting **import** then **feature class (single)**. The import tool will open, requiring the input file as well as the name for the output file into the DSAS\_database.

B.5. Any shoreline that is to be analyzed by DSAS must be imported as stated in step B.4. To obtain shorelines there are a couple places to start. The first to be discussed is the NOAA Shoreline Data Explorer. This website contains shorelines for U.S. states and territories. These shorelines can be downloaded as vector shapefiles which can then be directly added to the DSAS\_database.

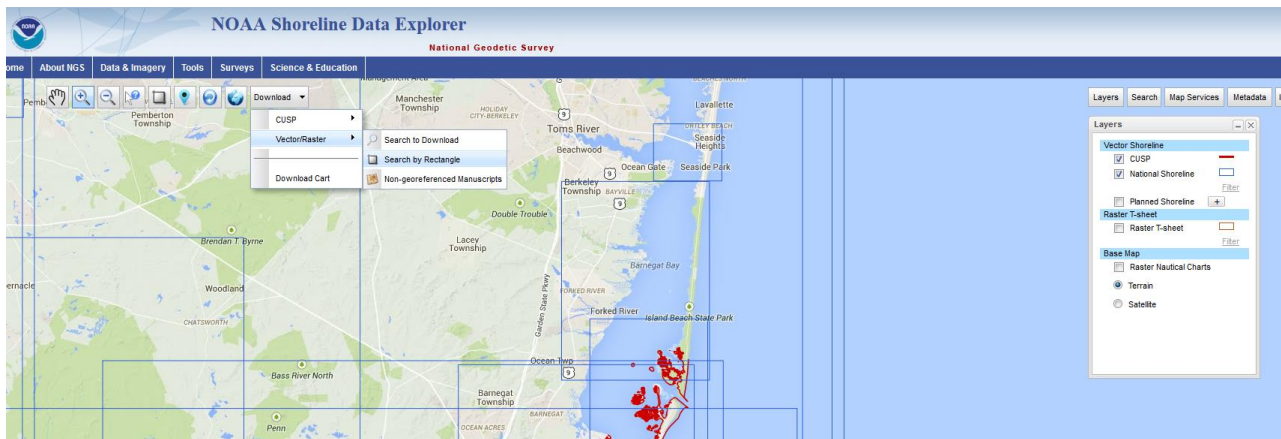
B.5.1. To use the website first zoom into the region being examined. There are several data sources which can be selected and they are displayed in the layers window.



B.5.2. The CUSP, National Shoreline, and Raster T-sheet shorelines are all usable shorelines however based on work conducted the National Shoreline appears to have the best quality shorelines and contains more recent shorelines. For these reasons this workflow will show how to download and use National Shoreline shorelines, however the other shorelines may be used as well.

B.5.3. Select the check box in the layers window next to National Shoreline.

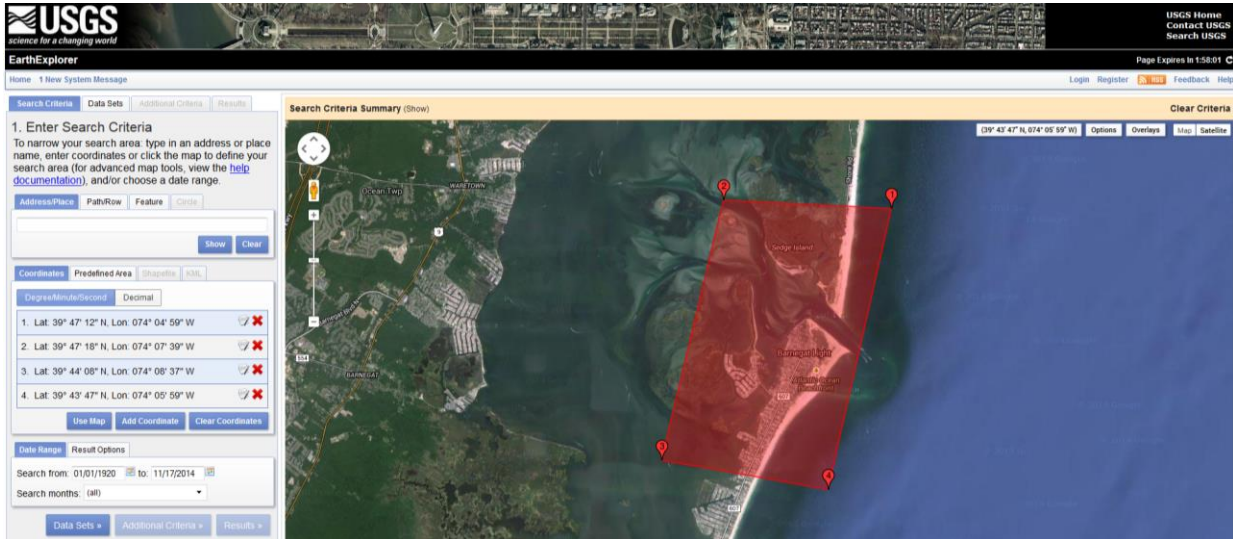
B.5.4. Select **Download** then **Vector/Raster** then **Search by Rectangle**. Draw an outline over the region where shoreline data is requested. A window will display with shorelines available for the selected region. Note: the regions covered by the National Shorelines vary in size, some may be over only small regions, while others may cover a larger area.



B.5.5. In the Information window displaying the available shorelines, select the desired shoreline and then select **Add to Download Cart**. Add all desired shorelines, then proceed to the download cart which can be found under **Download** then **Download Cart**.

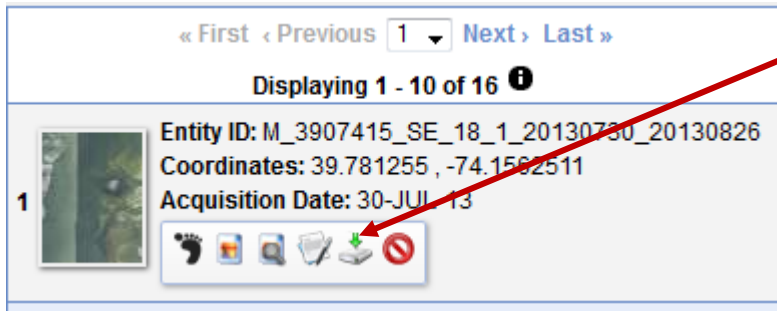
- B.5.6. In the Download Cart select each shoreline and download the data.
- B.5.6.1. It may take several minutes for the download to start.
- B.5.7. Once downloaded extract the data for each download. Save the extracted data to a designated folder. It is recommended to save the folders based on the date of the shoreline.
- B.5.8. Depending on how the data was downloaded sometimes the shapefiles downloaded will all share a common name, such as softcopy. This generic name should be changed in ArcMap under the Catalog window as soon as possible to avoid confusion between the different dataset shorelines. Renaming the files to shoreline\_\*date\* (such as shoreline\_2013\_july\_30) is recommended.
- B.5.8.1. It is important to keep the coordinate systems of the downloaded files consistent and to make sure the units are in a projected coordinate system with meter units. If a downloaded shorelines coordinate system needs to be changed go to the ArcToolbox and select **Data Management Tools > Projections and Transformations > Project**. This tool allows for the input of the shoreline shapefile and will output a new shoreline with a new designated coordinate system.
- B.5.8.2. These downloaded shoreline shapefiles may also require some editing, which can be done by selecting edit features in ArcMap.
- B.5.9. The downloaded vector shorelines will need to be input into the personal geodatabase. Right-click the database in the catalog window and select **Import > Feature Class (single)**. Select the shoreline to be input, and choose a name to call the output feature (this name can be the same as the input, but should contain at least the date designation of the shoreline).
- B.5.10. Repeat steps B.5 for any vector shoreline that is desired from the NOAA Shoreline Data Explorer.
- B.6. The other technique for obtaining shorelines is to use aerial imagery to digitize the shoreline from.
- B.6.1. This technique may be important for the post storm shoreline as major storm events will have aerial imagery collected soon after a storm event. Digitizing this response imagery will provide the most accurate depiction of the damage caused by the storm.
- B.6.1.1. For obtaining response imagery check the Emergency Response Imagery website provided by NOAA and the National Geodetic Survey at [http://storms.ngs.noaa.gov/eri\\_page/index.html](http://storms.ngs.noaa.gov/eri_page/index.html) .
- B.6.2. The <http://earthexplorer.usgs.gov/> website provides a useful tool for obtaining imagery over small specific areas. **Note:** a login is required to download imagery from EarthExplorer. Registration is free and can be done at the time of download.

B.6.2.1. To use the EarthExplorer website for downloading imagery, first zoom into the study area and then create a polygon around the study area by clicking the outside vertices of the polygon.



B.6.2.2. Next navigate to the **Data Sets** tab. Select the **Aerial Imagery** tab and select the data sources desired. The NAIP JPG2000 and High Resolution Orthoimagery are two recommended sources, however any aerial imagery will suffice.

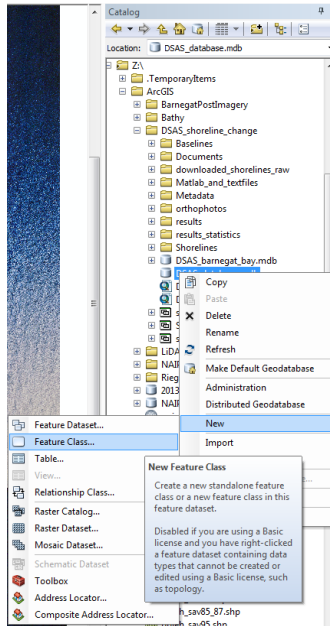
B.6.2.3. Next navigate to the **Results** tab. Any image from the selected Data Set which is covered under the polygon created in B.6.2.1 will be displayed. Select an image to be downloaded by selecting the download button for each image desired.



B.6.2.4. Once downloaded the image and its associated data will need to be extracted and then saved to a designated location. It is recommended to save the imagery based on the date and data source of the image (for example, a NAIP image from July 30<sup>th</sup> 2013 should be saved in a folder 30\_july\_2013 (or the date format required) under a NAIP folder). It is important to keep the raw data organized and the metadata with it.

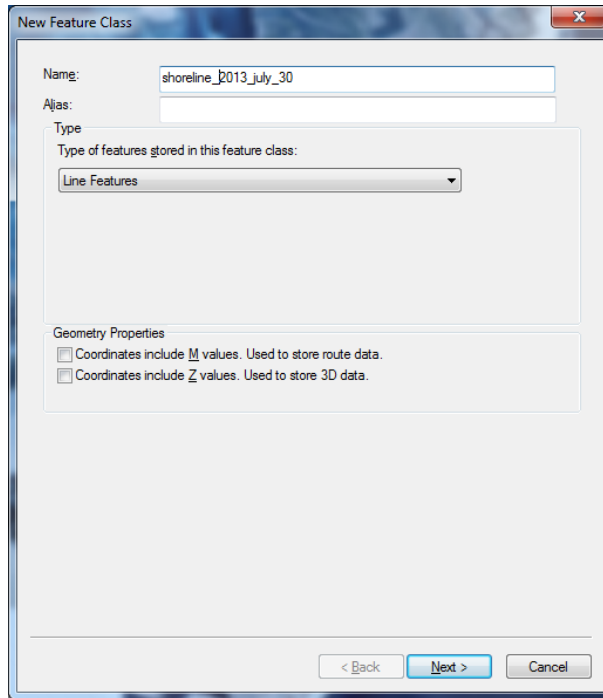
B.6.2.5. For each date of downloaded imagery there is likely to be multiple images. In ArcMap the shoreline for each shoreline date will be created. Open ArcMap and select **Add Data**. Add all images from one date data set. For example, add all imagery corresponding to the July 30<sup>th</sup> 2013 dataset.

B.6.2.6. To create the shoreline from the imagery, in the Catalog in ArcMap, select the DSAS\_database, right-click the database and select **New** then **Feature Class**.

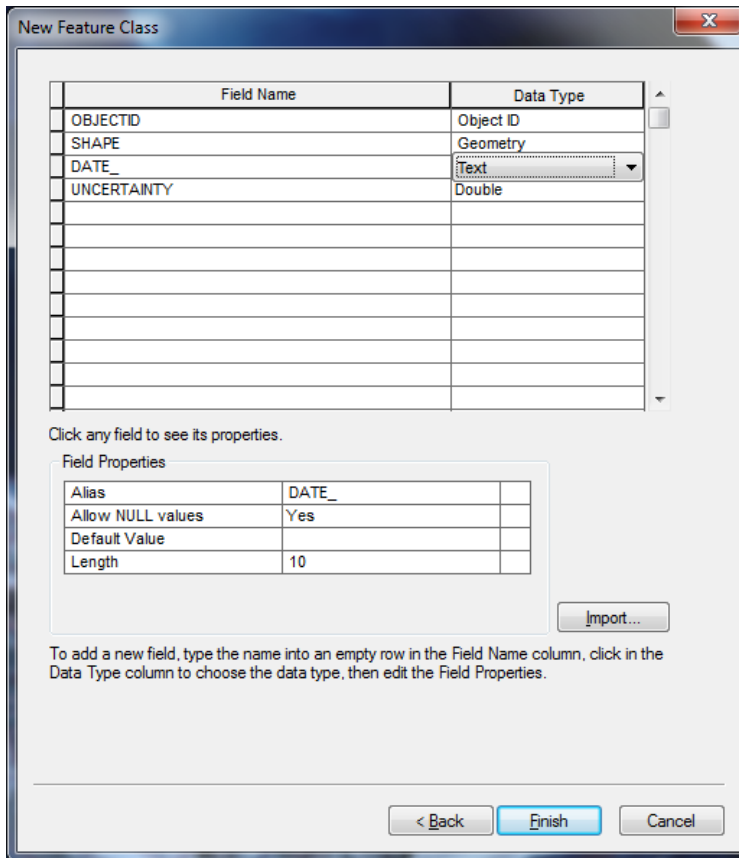


B.6.2.7. Name the feature class based on the date of the aerial imagery (for example shoreline\_2013\_july\_30). Select **Line Features** for the type, and select next.

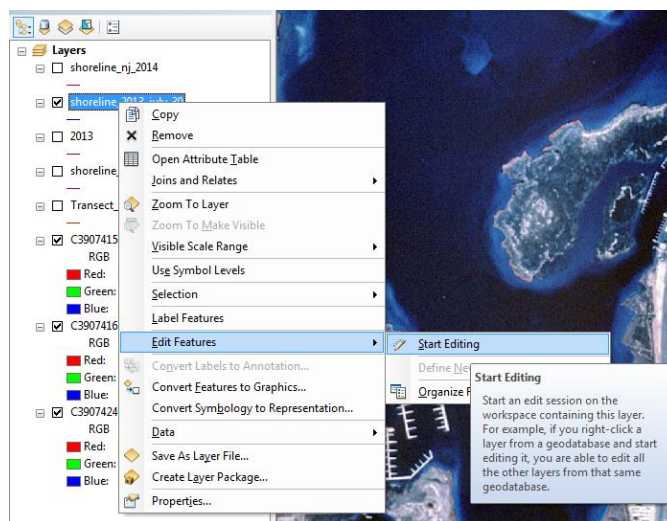




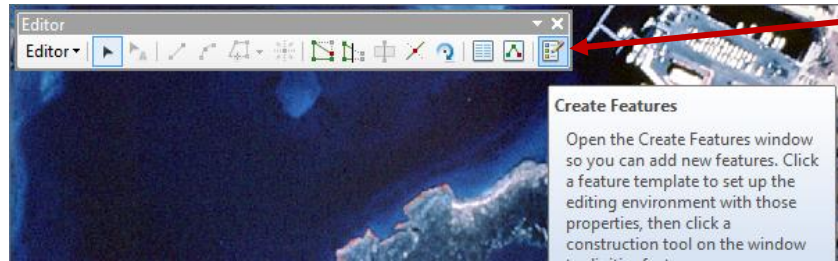
- B.6.2.8. Selecting the appropriate and correct feature class is important! It is required to be in a projected coordinate system with meter units (such as UTM) and is strongly recommended that the coordinate systems for all of the shorelines be the same (for this workflow NAD\_1983\_UTM\_Zone\_18N is the projected coordinate system).
- B.6.2.9. Keep the tolerance at .001 meters.
- B.6.2.10. Two new fields will be added to the feature class being created, **IMPORTANT:** these new fields must be input exactly as stated for each created feature class and shoreline. The first field is DATE\_ which has data type Text and Length 10. The second field is UNCERTAINTY and has data type Double.



B.6.2.11. Once created, the feature class can now be edited. Right-click the newly created feature class in the layers window and select **Edit Features > Start Editing**.



B.6.2.12. In the **Editor** toolbar which appears select the **Create Features** button to open the Create Features window.



B.6.2.13. Select the shoreline feature class to be created for the appropriate imagery added. Create a line feature for the shoreline for the study area being examined.

B.6.2.13.1. To create an appropriate shoreline from the imagery it will require patience and time to digitize a line feature throughout the imagery. The shoreline should be created at the high water line, which is not always the easiest to determine. The best distinction over low relief sandy areas is to look for the mark from the highest tide line (where the sand changes color from being wet at the last highest tide). In some areas where there is higher relief or vegetation at the land/water interface it may be easier to digitize. This step can be time consuming and saving periodically is recommended. When mistakes are made it is easier to use the editor toolbar to edit the created line features than to start each segment over. Once the shoreline feature is finished select **Editor** in the Editor toolbar and select **Save Edits**. Then select **Editor** and choose **Stop Editing**.

B.7. Repeat step B.6 and all of its components for each dataset of aerial imagery downloaded.

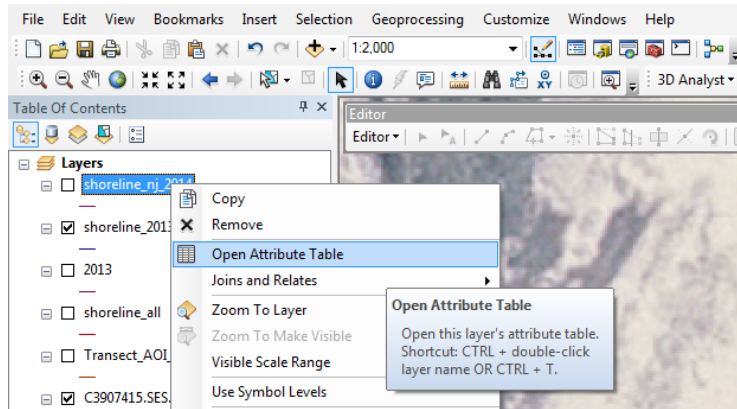
## C. Creation of Shoreline For DSAS Input

C.1. In order for the DSAS tool to run, all the multiple shorelines each with distinct dates must be added to one feature class. Before all the shorelines are composed into one feature class a few requirements need to be checked.

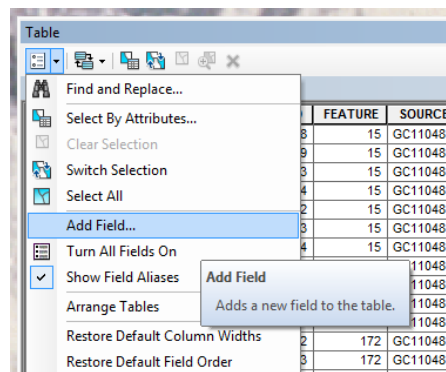
C.2. All of the shoreline feature classes must be in the personal geodatabase created. The hand digitized shorelines should have been created within the database with the same appropriate projected coordinate system. Shorelines that are obtained from the NOAA Shoreline Data Explorer or from other outside sources must be imported into the database as described in step B.5.9.

C.3. After all the individual shorelines are in the personal geodatabase, several unique attribute fields must be created. These fields are DATE\_ and UNCERTAINTY. For the digitized shorelines from imagery this step was completed during the creation of the feature class, however it is important to verify these fields exist.

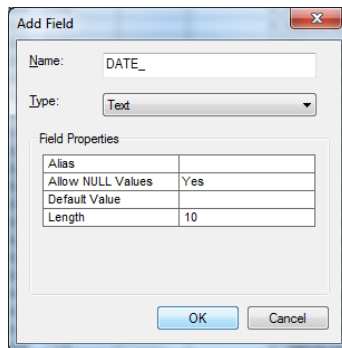
C.3.1. For the feature classes missing the DATE\_ and UNCERTAINTY fields do the following: To create the new fields select the feature class in the layers window, right-click the feature and select **Open Attribute Table**.



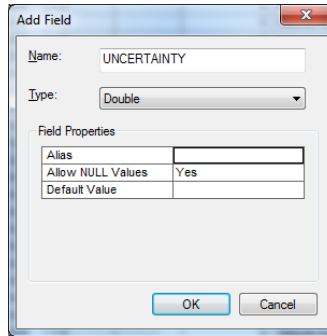
C.3.2. In the attribute table select **Table Options** then **Add Field**.



C.3.3. Input DATE\_ as the name, Text as the type, and **IMPORTANTLY** set the length to 10.



C.3.4. Add another field and this time set the name as UNCERTAINTY and type as Double.



C.3.5. The two new fields will have been added to the table.

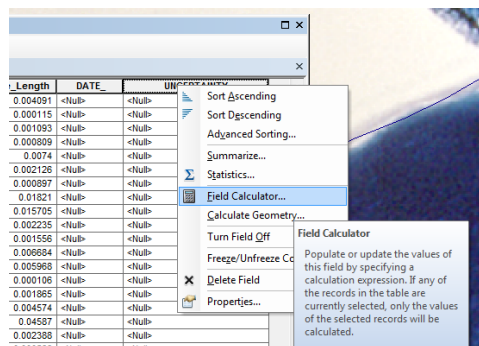
C.4. Now that all of the feature classes contain the DATE\_ and UNCERTAINTY fields, the data in each of those tables must be populated. This requires entering a specific date format for each date and the uncertainty value associated with horizontal accuracy/uncertainty for each feature class.

C.5. In order to edit the DATE\_ field first open the attribute table for a feature class.

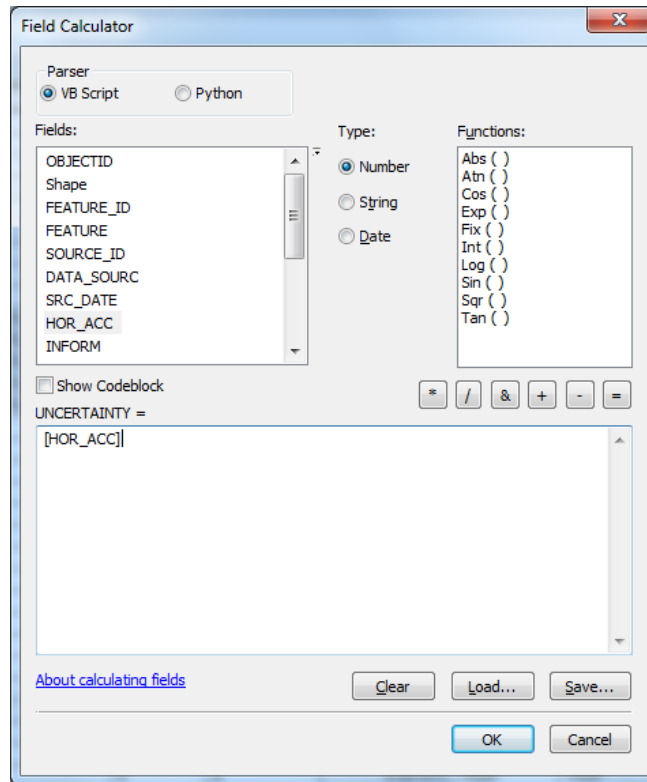
C.6. Open the **Editor** toolbar and select **Editor > Start Editing**. Select the feature class if prompted.

C.7. Once editing has been turned on it is possible to edit the fields in the attribute table. For each feature add the appropriate date of the shoreline in the following format mm/dd/yyyy.

C.8. The uncertainty values can now be implemented as well. Some vector shorelines downloaded from the NOAA Shoreline Data Explorer may contain a horizontal accuracy field. These values should be used if available. In order to copy those values to the UNCERTAINTY field right-click the UNCERTAINTY field and select **Field Calculator**.



C.9. Set the equation to UNCERTAINTY = HOR\_ACC (or the name of the horizontal accuracy or uncertainty that is already present). Select OK.



C.10. If there was no predetermined uncertainty/horizontal accuracy or the shoreline was manually hand digitized the values for the appropriate uncertainty were taken from *National Assessment of Shoreline Change: Historical Shoreline Change along the New England and Mid-Atlantic Coasts* report. This report provides a table for average uncertainties for the New England and Mid-Atlantic shorelines (if the area of study is outside this region it may be suggested to search for alternate reports which may suggest an appropriate uncertainty value to use). These uncertainty values are based on the type of data the shorelines are derived from and the date of that data.

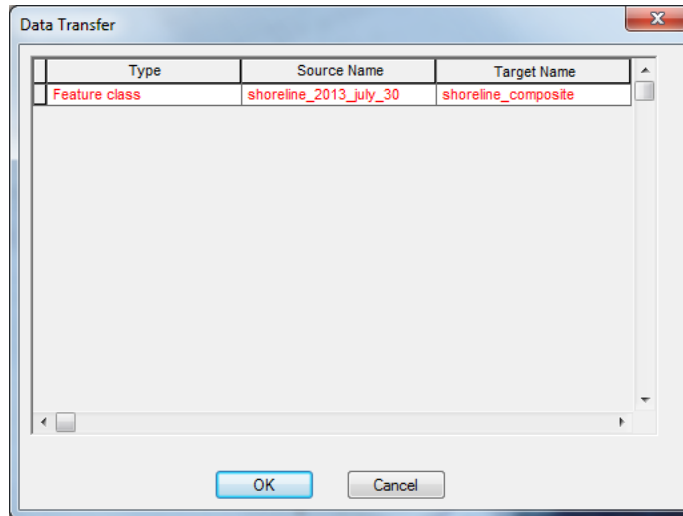
**Table 5.** Average uncertainties for the New England and Mid-Atlantic shorelines.  
[-, not applicable; m, meters]

Measurement Uncertainty (meters)	T-sheets (1800-1950s)	T-sheets (1960-1980s)	Air photos (1970-2000s)	Lidar (1997-2000)
Georeferencing ( $U_g$ )	4	4	-	-
Digitizing ( $U_d$ )	1	1	1	-
T-sheet survey ( $U_t$ )	10	3	-	-
Air photo ( $U_a$ )	-	-	3	-
Uncertainty of the High Water Line ( $U_{pd}$ )	4.5	4.5	4.5	-
Lidar total position uncertainty ( $U_p$ )	-	-	-	2.3
<b>Total shoreline position uncertainty (<math>U_p</math>) (m)</b>	<b>11.7</b>	<b>6.8</b>	<b>5.5</b>	<b>2.3</b>

This table is from:

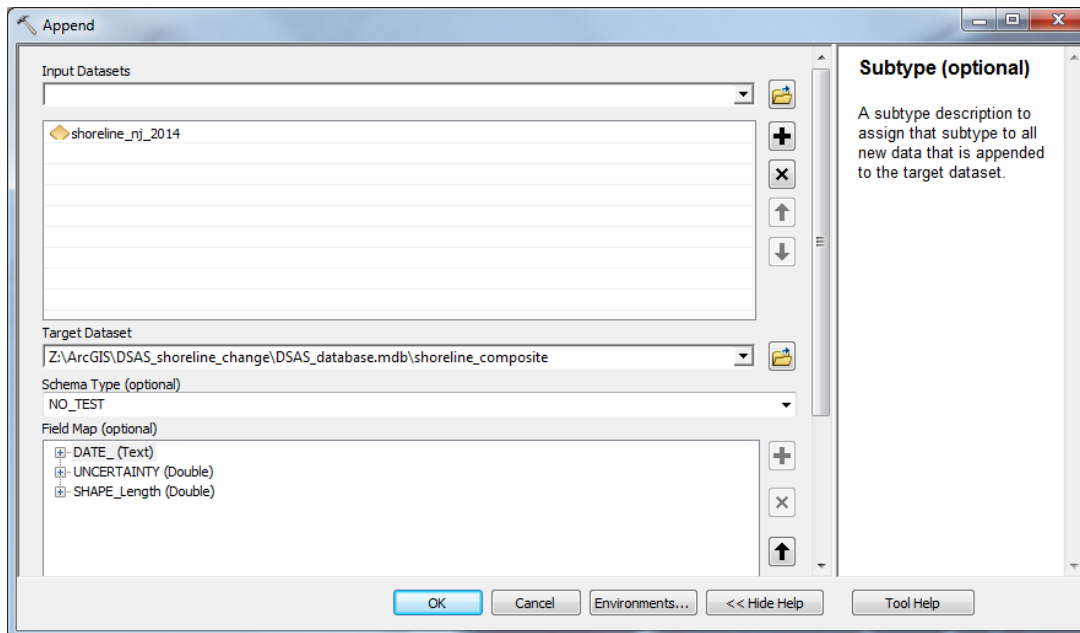
Hapke, C.J., Himmelstoss, E.A., Kratzmann, M., List, J.H., and Thieler, E.R., 2010, National assessment of shoreline change: Historical shoreline change along the New England and Mid-Atlantic coasts: U.S. Geological Survey Open-File Report 2010-1118, 57p.

- C.11. Repeat steps C.4 to C.10 for each shoreline feature class.
- C.12. Before continuing it is important to check the projection for each feature class. Each feature class should be in a projected coordinate system with meter units, typically UTM. Each feature class should also use the same projection. If a projection needs to be changed see step B.5.8.1.
- C.13. Once all shoreline files have the DATE\_ and UNCERTAINTY fields complete, and have the correct projection, the following can be complete. All of the shorelines must be combined to an existing shoreline. It is recommended to make a copy of the oldest shoreline to provide as the shoreline which the others will be added to.
- C.13.1. Select the oldest shoreline in the personal geodatabase in ArcMap in the Catalog window. Right-click and select copy, then right-click and select paste in the database. Since the file name will be the same the following window will appear. Change the Target Name to Shoreline\_composite (or some variation).



C.13.2. Select the ArcToolbox and go to **Data Management Tools > General > Append**.

C.13.3. In order from oldest to most recent shoreline, add the shorelines into **Input Datasets**. (**DO NOT INPUT** the oldest shoreline for which a copy was made (step C.13.1.)). Select the target dataset as shoreline\_composite. For Schema Test select NO\_TEST. Select OK. **Important note:** add the most recent (or post storm event shoreline last).



C.13.4. The completed shoreline has now been created and is ready to be used in the DSAS tool once the baselines have been created.

C.13.5. In order to better visualize the composite shoreline file, right-click the shoreline\_composite in the layers window and select properties. Go to the symbology tab and select Categories for **Show**. Select DATE\_ for the **Value Field**, then select **Add All Values**. Select OK.



## D. Baseline Creation

D.1. Baselines are line shapefiles created parallel to the shoreline pattern for the area of study.

The DSAS tool uses the baselines to create perpendicular transects that cut across all shorelines. The requirements for the baselines are as follows (obtained from DSAS PDF). Note: This workflow describes the overall and basic creation of baselines. For further in depth knowledge and utilities of the baselines consult the DSASv4.3 PDF.

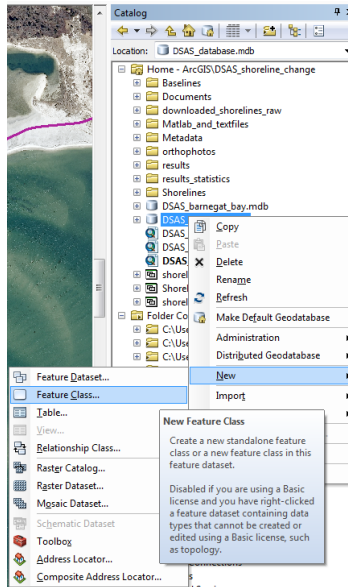
Checklist of baseline requirements:

- D.1.1. Must be a feature class within a personal geodatabase.
- D.1.2. Must be in a projected coordinate system in meter units.
- D.1.3. May consist of a single line or be a collection of segments.
- D.1.4. Each baseline segment must be placed entirely onshore or offshore with respect to the shorelines.
- D.1.5. Must meet the attribute field requirements described below.

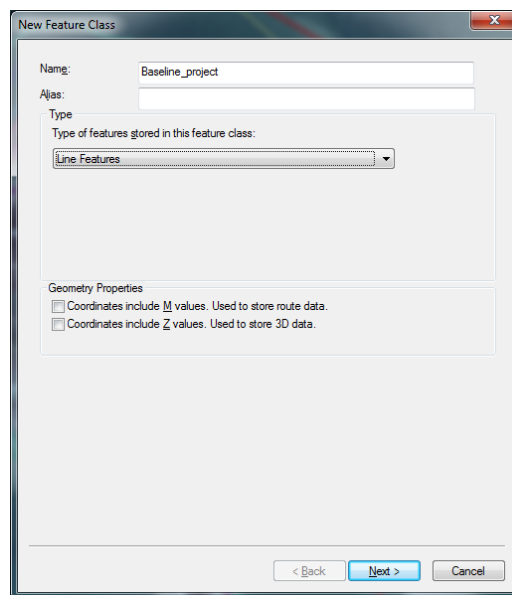
D.2. Images showing results of shorelines (from B and C, image 2) and the baselines created for the shorelines. Baselines are shown in image 3 as red lines.



D.3. To start the creation of a baseline open the catalog window in ArcMap and navigate to the personal geodatabase used from the previous sections. Right-click the database and select **New > Feature Class**.

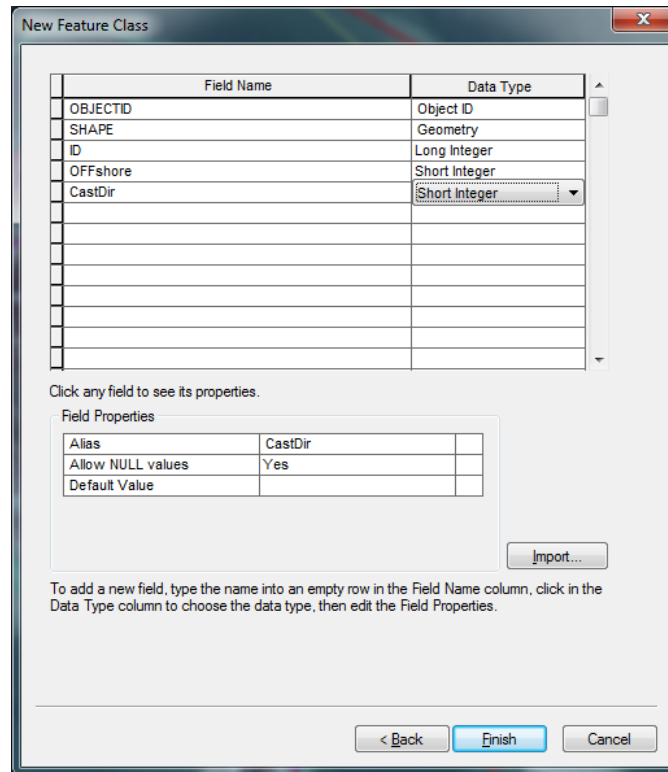


D.4. Name the file, such as `baseline_project`, and choose Line Feature for the type.

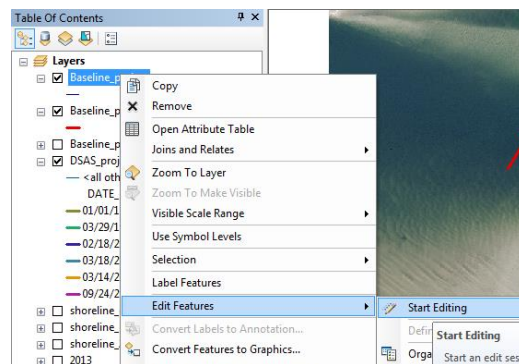


D.5. Select the coordinate system for the baseline. It is required that the coordinate system be projected and with meter units, it would also be recommended to use the same coordinate that has been used for the shorelines in steps B and C. Select next. Keep the tolerance as .001 meters and select next.

D.6. A few fields will be added before finishing the creation of the baseline. The first field to add is called ID and will have data type long integer. The next field to add is OFFshore which will have data type short integer. The final field to add is CastDir with data type short integer. Note: some of the fields are case sensitive, so make sure to correctly input the field name. Select finish to create the baseline feature class.



D.7. Now that the baseline feature class has been created the baseline features can be constructed and edited. To start editing the baselines, right-click the baseline in the layers window and select **Edit Features > Start Editing**.



D.8. On the Editor toolbar select the **Create Features** button on the far right.

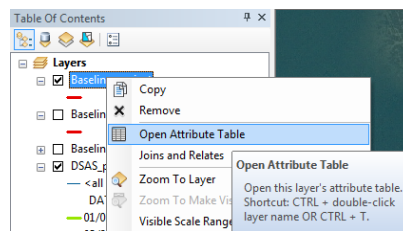


D.9. Choose the baseline in the Create Features window. Baselines can now be created parallel to the shorelines created in steps B and C. The baselines can be created in segments, and should follow the overall shape of the shoreline as best as possible. Baselines can be placed entirely offshore of shorelines or entirely onshore of shorelines, however a baseline cannot be placed between shorelines. The image on the left shows

baselines (in red) and shorelines (other colors). The southward baseline is entirely offshore and the northern baseline is entirely onshore of all the shorelines. These baselines are appropriate and would work correctly. The middle image has both baselines offshore, this is also appropriate and would work correctly. The image on the right has a baseline in between shorelines and would not work correctly. It is recommended that when possible it is easier and more convenient to have all baselines either offshore or all baselines onshore, however this might not be the optimal situation so a mix of baselines onshore and offshore may be the best approach. After creating the baselines select **Editor > Save Edits**. Then select **Editor > Stop Editing** in the Editor toolbar.



D.10. Once all baselines have been created the fields added in step D.6 need to have values added. To edit the values in these fields right-click the baseline in the layers window and select **Open Attribute Table**.



D.11. The first field to edit is the ID field. The ID field is used to determine the ordering of the segments of the baseline. Each segment of the baseline will need to be given a unique integer value starting with 1. If a segment does not have an integer value then the DSAS tool will not cast transects from that baseline. In order to input values right-click the baseline in the layers window and select **Edit Features > Start Editing**. In the attribute table input integer values starting with 1 for each segment of the baseline.

OBJECTID *	SHAPE *	ID	OFFshore	CastDir	SHAPE_Length
1	Polyline	1	<Null>	<Null>	119.311778
5	Polyline	2	<Null>	<Null>	156.010266
6	Polyline	3	<Null>	<Null>	102.390872

D.12. The next field to edit in the table is the OFFshore field. This field is used to indicate whether a segment of the baselines is onshore (landward of all shorelines) or offshore (seaward of all shorelines). A segment onshore will have a value of 0 and a segment offshore will have a value of 1. For the example shown below the first segment (southernmost) is offshore, the second segment (middle segment) is onshore, and the third segment (northernmost) is offshore. Therefore the OFFshore values for segments with ID 1 and 3 is 1. And the segment with ID 2 will have an OFFshore value of 0.

OBJECTID *	SHAPE *	ID	OFFshore	CastDir	SHAPE_Length
1	Polyline	1	1	<Null>	119.311778
5	Polyline	2	0	<Null>	156.010266
6	Polyline	3	1	<Null>	102.390872

D.13. The final field CastDir is used to determine the direction the transects will be created when the DSAS tool is run. A value of 0 will result in transects being cast to the left of the flow of the segment, and a value of 1 will create transects to the right of the flow of the segment. In order to use this appropriately the direction of flow is required to be known. The flow is determined by how the segment for each part of the baseline was created. When the first point of a line is made that is the starting point of the flow and it will flow toward the end point (last point of the segment created). **Important note:** Having a mix up in the flow directions is a common/easy mistake to be made. When creating transects if all or some of the transects are going the wrong direction check the CastDir field and the flow of the segments.

D.14. For this example the flow of all the segments is to the north. Therefore for the southernmost and northernmost segment the transects will need to be cast to the left in order to cross the shorelines. The middle segment will need to have transects cast to the right. Therefore the resulting table will have the following values.

OBJECTID *	SHAPE *	ID	OFFshore	CastDir	SHAPE_Length
1	Polyline	1	1	0	119.311778
5	Polyline	2	0	1	156.010266
6	Polyline	3	1	0	102.390872

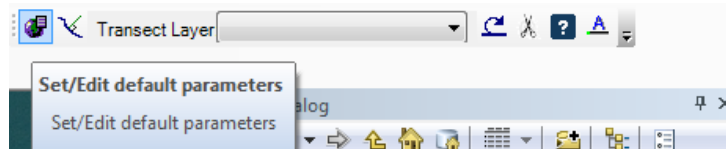
D.15. Once all the fields in the attribute table have been filled out, select **Editor > Save Edits** then select **Editor > Stop Editing** in the Editor toolbar.

D.16. Note: if a combination of onshore and offshore baselines is not being used the OFFshore and CastDir fields are not required and their creation in step D.6 can be skipped, however ID is still necessary. Read the DSASv4.3 PDF for more information.

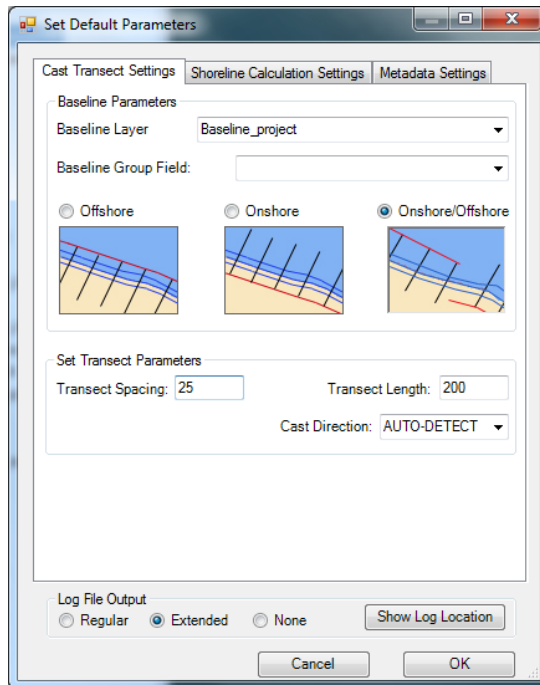
## E. Casting Transects

E.1. The DSAS tool can now be used to create transects. If the DSAS toolbar is not open go to **Customize > Toolbars** and select DSAS Toolbar.

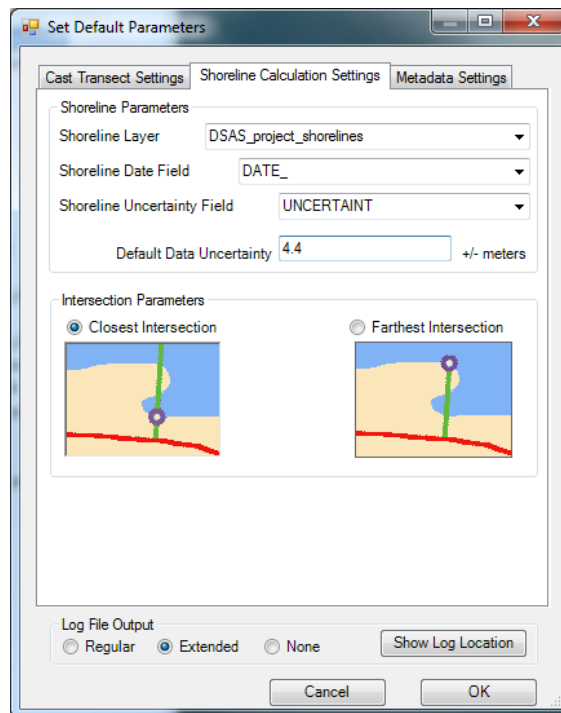
E.2. On the DSAS Toolbar go to Set/Edit default parameters.



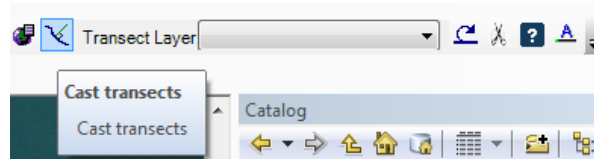
E.3. Select the baseline for the **Baseline Layer**. The **Baseline Group Field** should be left empty. Select the offshore, onshore, or onshore/offshore variation depending on how the baselines created in section D are placed. Set values for the transect spacing and transect length fields. These values are in meters. The transect spacing is the distance on the baseline between each transect that will be created. This value can vary greatly depending on the size of the area being studied, however the value should be small enough to cover variations in the shoreline. The transect length is how far each transect will propagate from the baseline. It is important that this value is large enough so that all transects will cross all shorelines at some point.



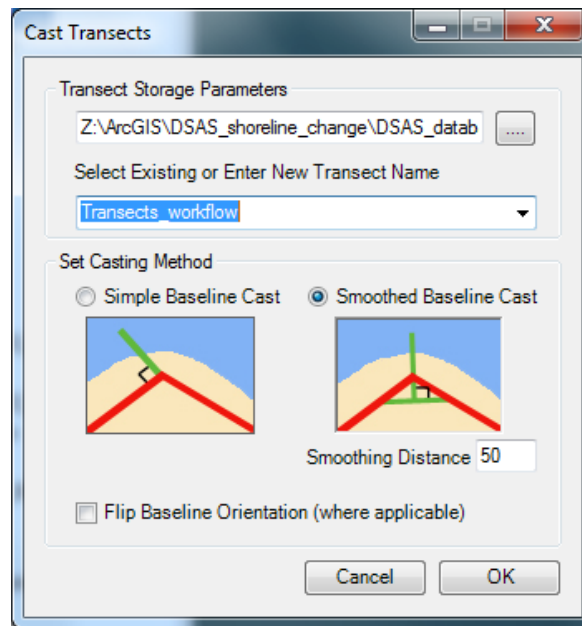
E.4. Switch to the **Shoreline Calculation Settings** tab. Specify the shoreline composite file which contains all shorelines in the single feature class (created in step C.13.3) for the Shoreline Layer. Specify DATE\_ for the Shoreline Date Field. Specify UNCERTAINTY for the Shoreline Uncertainty Field. Select either Closest Intersection or Farthest Intersection (this decision is a personal choice, but would recommend closest intersection when using primarily offshore baselines).



- E.5. Switch to the **Metadata Settings** tab. Fill out the metadata information.
- E.6. Select OK.
- E.7. On the DSAS Toolbar select Cast Transects.



- E.8. The **Transect Storage Parameters** should automatically be set to the personal geodatabase created for the project, if not specify the database. Input a transect name for the transects which will be created. Select either simple or smoothed baseline cast. Select OK.



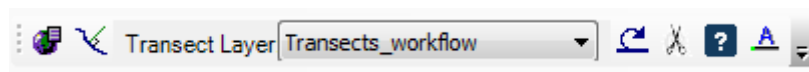
- E.9. The tool will now cast transects from the baselines. If the resulting transects are cast incorrectly, check steps D.12 and D.13 as well as step E.3. Consult the DSASv4.3 PDF if there are any other issues noticed. An example of the shorelines (multi-colored), baselines (red color), and transects (yellow color) can be seen below. The DSASv4.3 PDF also explains other modifications that can be applied to the transects and baselines after the transects are created, see the PDF if any more information or possible features are required.



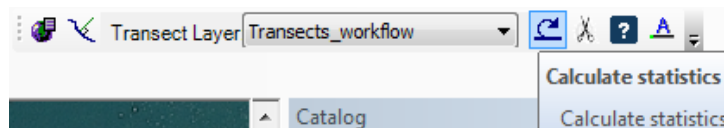


## F. Calculating Statistics

F.1. Select the **Transect Layer** in the DSAS Toolbar.



F.2. Select the **Calculate Statistics** button on the DSAS Toolbar.

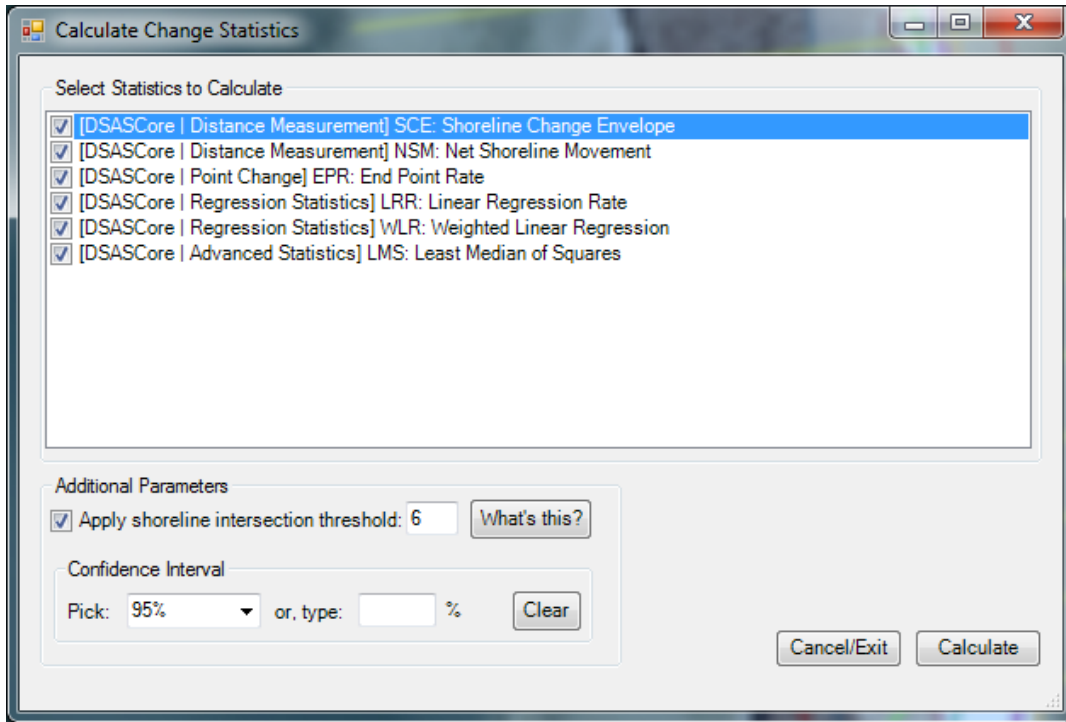


F.3. Select the statistics to be calculated internally with the DSAS toolbar. Each of the statistical calculations has a detailed description in the DSASv4.3 PDF. It is recommended if the exact statistics required are not known then all statistics should be chosen.

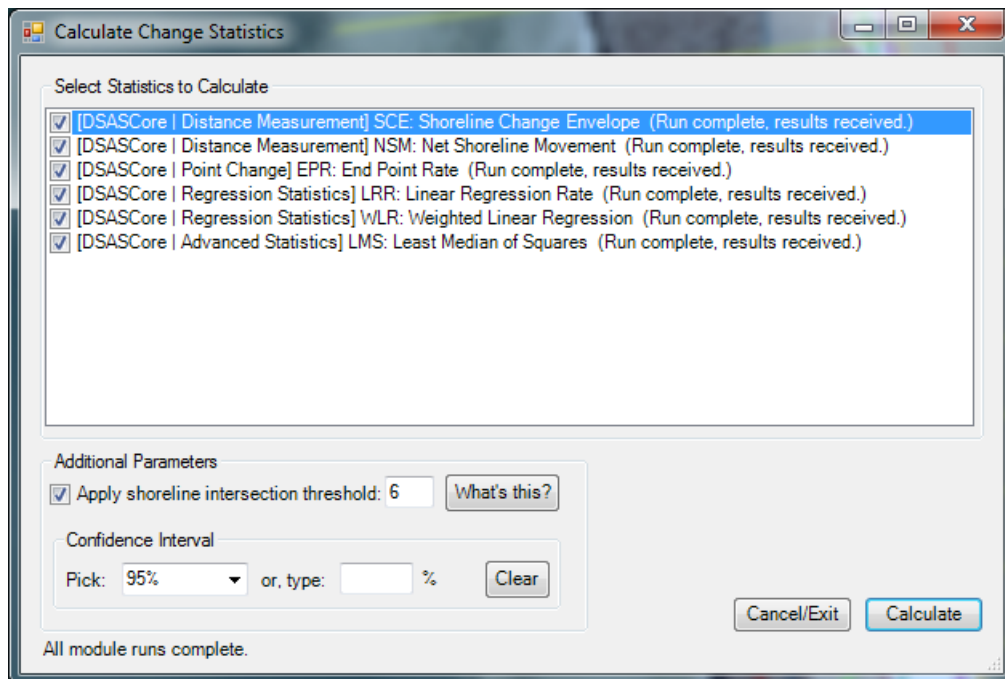
F.4. For the Additional Parameters, the shoreline intersection threshold sets a minimum number of shorelines a transect must cross in order for it to be included in the statistics. It is recommended that if the historical shorelines and the post-storm shorelines used cover mostly all of the same areas that the threshold be set at the total number of shorelines. This will make it so the statistics for an individual transect that does not cross all shorelines will be excluded in the statistic calculations. This example has 6 shorelines and therefore the intersection threshold will be set at 6 to insure only transects crossing every shoreline are used for statistical purposes.

F.5. Set the **Confidence Interval** to a desired percent, 95% is recommended.

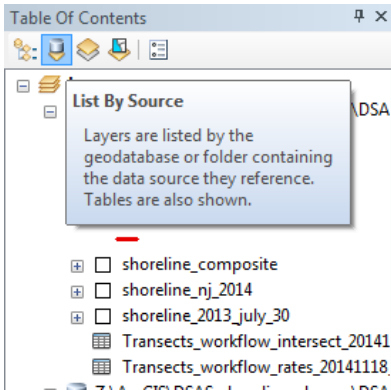
F.6. Select **Calculate** to calculate the statistics of the shoreline transects.



F.7. When the tool has finished running it will say run complete, results received after each statistic. Click Cancel/Exit.



F.8. The resulting statistics will be saved in the geodatabase and can be viewed in ArcMap by switching to List by Source in the Table of Contents.



F.9. The statistics are saved as two different tables with the name of the transect used for calculating statistics. One file is transects\_intersect which contains information for every transect and where it specifically crosses each different shoreline. The TransectId is the value of a transect (each transect is given an integer value starting with 1). BaselineId refers to the baseline the transect is associated with. ShorelineId refers to the date of the shoreline the transect crosses. Distance is the value of the distance from the baseline to the intersection point of the specific transect and shoreline. The X and Y values are the UTM coordinates of the intersection point (if UTM is the projection). The transects\_rates table provides the resulting statistics for each transect. For further descriptions of the statistics, information on the two tables, and other information consult the DSASv4.3 PDF.

object identifier *	TransectId	BaselineId	ShorelineId	Distance	IntersectX	IntersectY
1	1	1	01/01/1951	-26.773663	575439.044823	4401396.373643
2	1	1	03/29/1995	-24.844275	575440.876055	4401395.766084
3	1	1	02/18/2002	-39.731954	575426.745773	4401400.454167
4	1	1	03/18/2007	-30.598431	575435.414636	4401397.57805
5	1	1	03/14/2012	-25.42698	575440.322994	4401395.949576
6	1	1	09/24/2013	-21.973735	575443.600559	4401394.86216
7	2	1	01/01/1951	-36.68208	575437.512909	4401423.221918
8	2	1	03/29/1995	-24.988449	575448.611637	4401419.53963
9	2	1	02/18/2002	-44.06017	575430.510173	4401425.545255
10	2	1	03/18/2007	-19.779888	575453.555217	4401417.899471
11	2	1	03/14/2012	-17.754586	575455.477484	4401417.26171
12	2	1	09/24/2013	-22.294675	575451.168368	4401418.691369
13	3	1	01/01/1951	-45.617826	575436.904182	4401449.763905
14	3	1	03/29/1995	-26.277788	575455.260313	4401443.673788

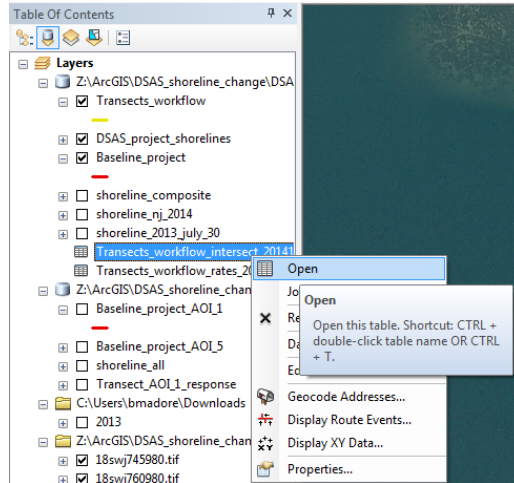
object identifier *	Transectid *	TCD	EPR	ECI	SCE	NSM	LMS	WLR	WR2	WSE	WC195	LRR	LR2	LSE	LC195
1	1	0	0.08	0.18	17.7	4.8	0	0.32	0.25	1.85	0.763	0	0	7.04	0.372
2	2	25	0.23	0.18	26.3	14.3	0.25	0.42	0.3	2.18	0.898	0.23	0.28	9.94	0.525
3	3	50	0.38	0.18	23.6	23.6	0.37	0.55	0.51	1.8	0.741	0.29	0.54	6.99	0.369
4	4	75	0.57	0.18	35.8	35.6	0.4	0.68	0.47	2.41	0.993	0.47	0.58	10.4	0.552
5	5	100	0.73	0.18	45.5	45.5	0.58	0.88	0.62	2.32	0.954	0.63	0.75	9.63	0.509
6	6	190.43	0.99	0.18	62.3	62.3	0.9	1.64	0.68	3.76	1.546	0.83	0.69	14.4	0.763
7	7	215.43	1.01	0.18	63.1	63.1	0.93	1.53	0.73	3.18	1.308	0.87	0.78	12.0	0.637
8	8	240.43	1	0.18	62.6	62.6	0.9	1.42	0.75	2.79	1.15	0.87	0.83	10.3	0.547
9	9	265.43	0.94	0.18	58.8	58.8	0.75	1.18	0.77	2.15	0.886	0.82	0.87	8.3	0.438
10	10	290.43	0.9	0.18	56.4	56.4	0.87	1.28	0.81	2.09	0.861	0.8	0.88	7.83	0.414
11	11	315.43	0.9	0.18	56.6	56.6	0.87	1.09	0.89	1.26	0.52	0.83	0.96	4.45	0.235
12	12	340.43	0.88	0.18	55.4	55.4	0.84	0.81	0.84	1.2	0.494	0.83	0.92	6.49	0.343
13	13	425.41	0.83	0.18	52.2	52.2	0.78	0.8	0.95	0.63	0.26	0.8	0.98	3.22	0.17
14	14	450.41	0.78	0.18	48.6	48.6	0.73	0.73	0.91	0.76	0.313	0.74	0.96	4.1	0.217
15	15	475.41	0.72	0.18	45.2	45.2	0.67	0.84	0.95	0.65	0.269	0.68	0.98	2.42	0.128
16	16	500.41	0.69	0.18	43.3	43.3	1.15	0.92	0.89	1.09	0.45	0.64	0.93	4.53	0.239
17	17	525.41	0.7	0.18	43.7	43.7	1.23	0.95	0.87	1.22	0.502	0.63	0.93	4.69	0.248

F.10. The DSASv4.3 PDF provides more information on statistics and visualizations that can be processed within ArcMap.

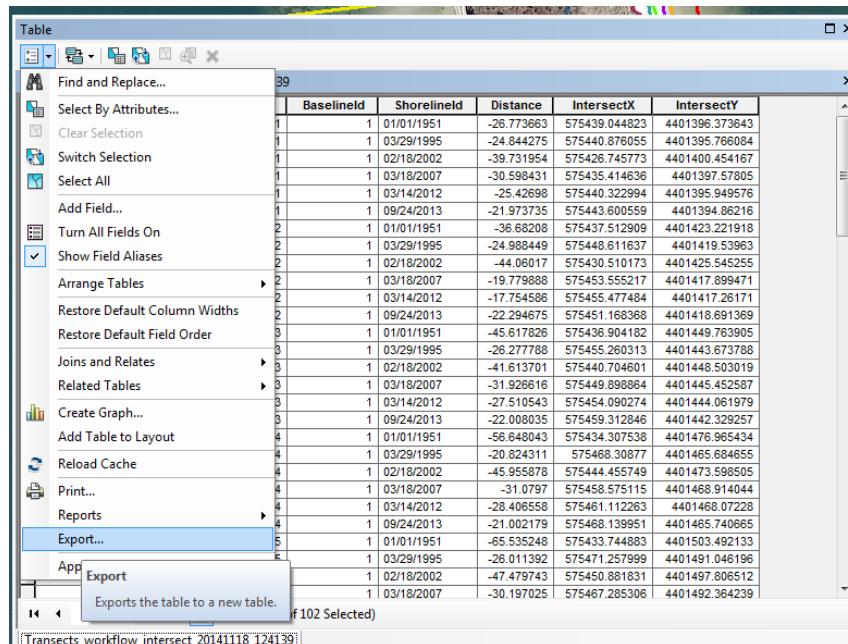
**G. Exporting statistics for MATLAB statistical calculations**

G.1. The DSAS tool provides useful information for the rates of change and progression of shorelines over time. In order to better understand the impact of a storm event other statistics need to be calculated. These statistics will use the shorelines prior to the major storm event to create an analysis of the natural background state of the shoreline. The background state will then be extrapolated to the time of the storm event (and beyond if there are any long term recovery shorelines obtained) and the extrapolated/predicted shoreline will be compared to the actual shoreline following the storm event. This comparison of predicted shoreline to actual shoreline after a storm event provides useful information on any major changes in the shoreline caused by the storm which deviate from the background state. Shorelines taken months or years after the storm event can also be used to calculate how the shorelines are recovering, if the system is going back to the natural state before the storm, or if/what permanent damage has been caused.

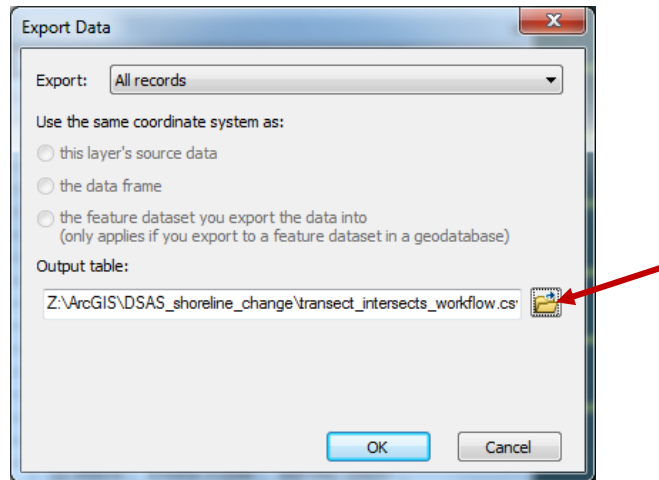
G.2. The information required for the MATLAB statistics is located in the transect\_intersect table created in step F.8. In the Table of Contents window right-click on the transect\_intersect table and select Open.



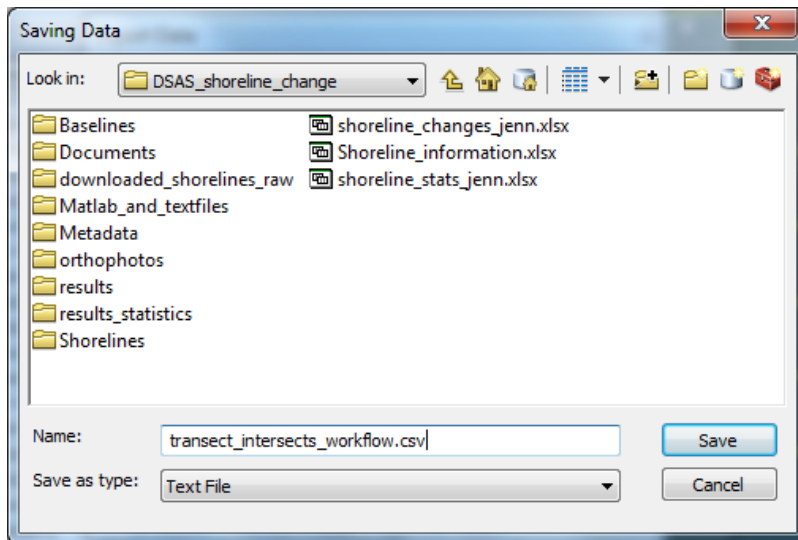
G.3. Go to **Table Options > Export**.



G.4. Select All Records for **Export**. Select the folder to browse for the location to save the exported table.



G.5. When in the desired location to save the table change the **Save as type** to Text File. Name the table and end the name with a .csv extension (as shown below). Select Save.



G.6. Select OK to export the data and when prompted about adding the new to the current map, select no.

G.7. The file is now ready to be uploaded into MATLAB where a separate workflow will describe how to run the code and the results it provides.

## References

Hapke, C.J., Himmelstoss, E.A., Kratzmann, M., List, J.H., and Thieler, E.R., 2010, National assessment of shoreline change: Historical shoreline change along the New England and Mid-Atlantic coasts: U.S. Geological Survey Open-File Report 2010-1118, 57p.

Himmelstoss, E.A. 2009. "DSAS 4.0 Installation Instructions and User Guide" in: Thieler, E.R., Himmelstoss, E.A., Zichichi, J.L., and Ergul, Ayhan. 2009 Digital Shoreline Analysis System (DSAS) version 4.0 — An ArcGIS extension for calculating shoreline change: U.S. Geological Survey Open-File Report 2008-1278.