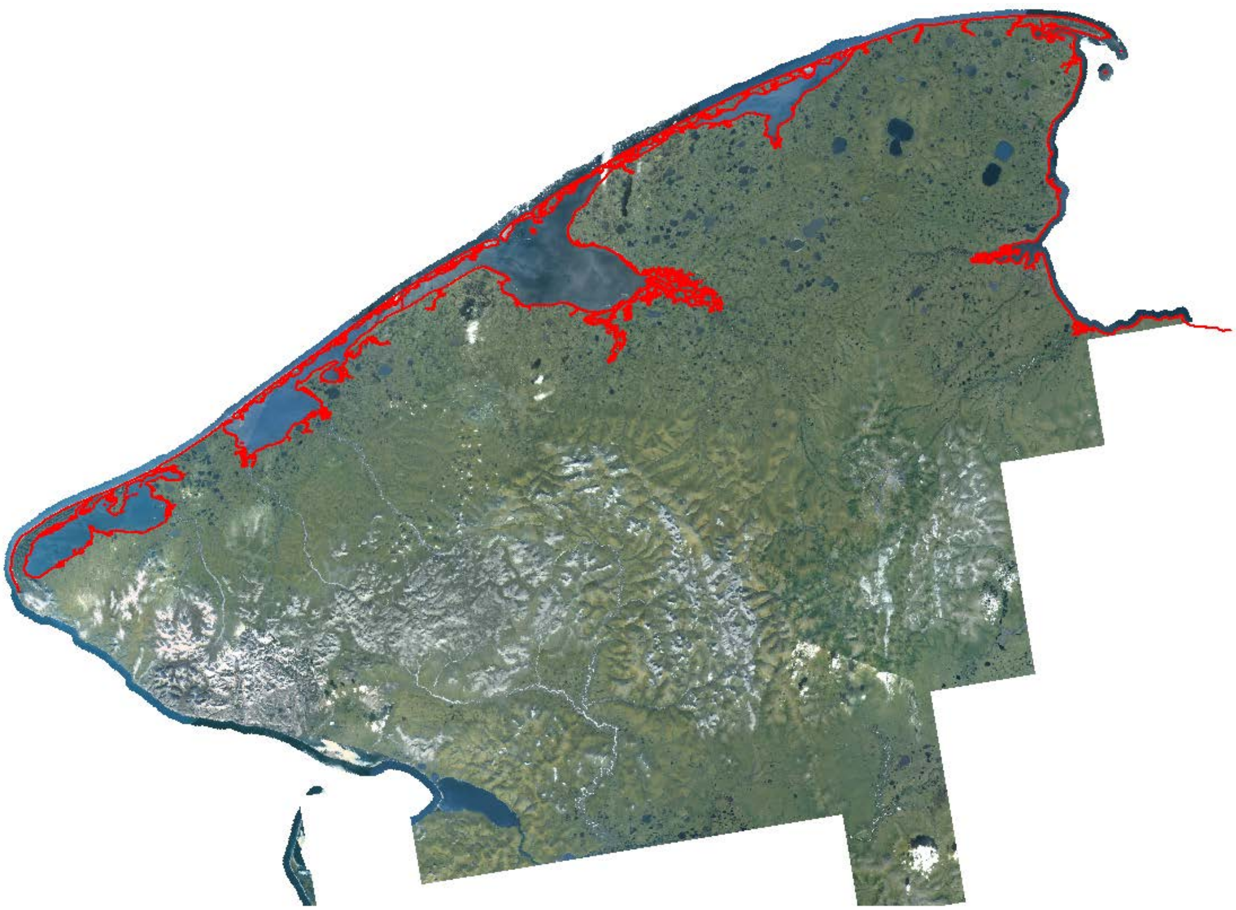
Compilation of an NHD Compliant Shoreline from Cape Prince of Wales to Cape Espenberg Using NOAA Extracted Vector Shoreline



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Prepared for Western Alaska Landscape Conservation Cooperative

Under Cooperative Agreement #F12AC01540, Against CESU #10170-BJ-001

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About the Cover: Revised NHD compliant shoreline shown (in red) overlayed upon more recently acquired SPOT 5 true-color orthoimagery. Image courtesy of K. R. Good. ©2013. Saint Mary's University of Minnesota, GeoSpatial Services.

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List of Acronyms

BELA – Bearing Land Bridge National Preserve

GIS – Geographic Information Systems

GNIS – Geographic Names Information System

EVS – NOAA Extracted Vectorized Shoreline

ENC – NOAA Electronic Navigational Chart Shoreline

FGDC – Federal Geographic Data Committee

MHW – Mean High Water Level

NHD – National Hydrography Dataset

NOAA – National Oceanic and Atmospheric Administration

NPS – United States National Park Service

NWI – National Wetland Inventory Program

SPOT 5 – SPOT 5 Satellite

USGS – United States Geological Survey

USFWS – United States Fish and Wildlife Service

WALCC – Western Alaska Landscape Conservation Cooperative

Abstract

The compilation of an accurate and contemporary digital shoreline for Alaska is an important step in understanding coastal processes and measuring changes in coastal storm characteristics. Consistent with efforts by the United States National Park Service (NPS) at Bering Land Bridge National Preserve (BELA) and Cape Krusenstern National Monument, high quality, defensible digital shoreline datasets are under development for select coastal parks in the State of Alaska. Near BELA, for the area from Cape Prince of Wales to Cape Espenberg, extended revised shoreline coverage can be produced using true color coastal shoreline imagery to update the boundary demarking the mean high water (MHW) shoreline, which represents the boundary between state owned tidal lands and lands in private ownership. In this process, National Oceanic and Atmospheric Administration (NOAA) Office of Coast Survey Cartographic and Geospatial Technology Program electronic vector shoreline (EVS) revisions demarking MHW coupled with aerial photographic interpretation are used to revise present United States Geological Survey (USGS) topographic shoreline data currently represented in the National Hydrography Dataset (NHD). This is a cooperative project by the Western Alaska Land Conservation Cooperative (WALCC), United States Fish and Wildlife Service (USFWS), the NPS, and Saint Mary's University of Minnesota (SMUMN). NHD compliant MHW shoreline datasets developed within this project are publically available from the USGS National Map for ongoing scientific work and investigations into coastal processes along the Seward Peninsula in Western Alaska.

Acknowledgements

The authors would like to acknowledge the following individuals for their technical consultation, guidance and support on this project: Joel Cusick, NPS; Jerry Tande, USFWS; and Jeffery Knopf, Senior GIS Analyst, SMUMN.

Introduction

The National Hydrography Dataset (NHD) provides the single most comprehensive coverage of hydrographic data across the United States. The robust nature of the data model continues to support third party stewardship and partner based updating while implementing a stringent quality assurance and quality control model to support multi-resolution data. Throughout Alaska and particularly in western portions of the State, much of the currently available shoreline data from NHD remains imprecise and ambiguous. The majority of this data was interpreted and compiled from high altitude; small scale aerial imagery and represents drift lines, vegetation boundaries, high water marks, and other visible features. This data is available in digital form through the NHD layer of the National Map and, for much of coastal Alaska; it remains the best available representation of shoreline features.

As new image data is acquired with improved resolution and higher spatial accuracy, however, agencies such as the National Oceanic and Atmospheric Administration (NOAA) are updating and enhancing the existing shoreline datasets for use in coastal mapping applications. One such application is NOAA's extracted vector shoreline (EVS), which best represents the location of the Mean High Water (MHW) tidal datum. When derived from tidally referenced, high resolution aerial imagery, EVS data can be used as a starting point to develop a new NHD compliant shoreline that can be registered and distributed via the National Map.

The MHW shoreline is a tidal datum, which represents the boundary separating state-owned tidelands from uplands subject to private ownership. Delineation of this shoreline for the area extending from Cape Prince of Wales to Cape Espenberg is important from a variety of perspectives including: having an accurately defined tidally referenced shoreline for scientific study; identifying various areas of management responsibility; and providing publically available, standardized interagency accepted baseline for assessment of coastal processes. An accurate and more contemporary shoreline also benefits region-wide shoreline mapping efforts (i.e., ShoreZone) to ensure geomorphological and biological parameters are linked to the best digital version of shoreline available.

Hydrography is a fundamental spatial data layer for the United States Fish and Wildlife Service (USFWS) and the National Park Service (NPS). The NHD program is the baseline data set for the USFWS and serves to assist with: 1) refuge boundary delineation; 2) assessing coastal change; 3) assessing storm surge impact and damage including shoreline erosion; 4) subsidence; 5) infrastructure development; 6) support for the National Wetlands Inventory (NWI) program; and 6) habitat management. For the NPS the NHD remains an integral consideration in park management for: 1) boundary definition and coastline assessment; 2) assessing visitor use; 3) resource protection and management; 4) assessing impacts of global climate change; 5) examining the impact of subsidence; 6) infrastructure development; and 7) wildfire fuel regime identification and management.

In 2010 the Western Alaska Landscape Conservation Cooperative (WALCC) was established as a consortium allowing regional partners to increasingly coordinate, share, and develop scientific information and findings to develop an increasingly informed conservation community (WALCC, 2013). The consortium serves to address conservation challenges impacting multiple ownership boundaries that can be most effectively resolved by pooled knowledge, resources, and ideas (WALCC, 2013). In 2012, the WALCC directed its scientific focus towards investigations of sea/ocean shoreline and the coastal zone. As part of this focus, the WALCC and its partners expressed interest in assisting the efforts of other federal entities to develop a current accurate and representative digital spatial datum demarking mean high water along the Western Alaska coastline extending from Cape Prince of Wales to Cape Espenberg. Original efforts by NPS and USFWS were focused on shoreline updates for Bering Land Bridge National Preserve (BELA), which represents approximately sixty percent of the coast from Cape Prince of Wales to Cape Espenberg (see Figure-1). Additional funding provided by the WALCC extended the shoreline update to include one hundred percent of this shoreline (see Figure-1).

NHD compliant shoreline revisions are a vital source of scientific data that is frequently consulted for ongoing coastal work and compilation of numerous other spatial datasets. The MHW shoreline is also important for continued refinement of available information on wetland and aquatic habitats and vegetation throughout Western Alaska. Examples of uses of NHD and MHW shoreline revisions include: 1) new acquisition and updates to the National Wetland Inventory (NWI); 2) Shore Zone implementation; 3) United States Geological Survey US Topo updates; 4) park administrative unit boundary refinement; 5) and coastal research initiatives focused on both natural and anthropogenic resources.

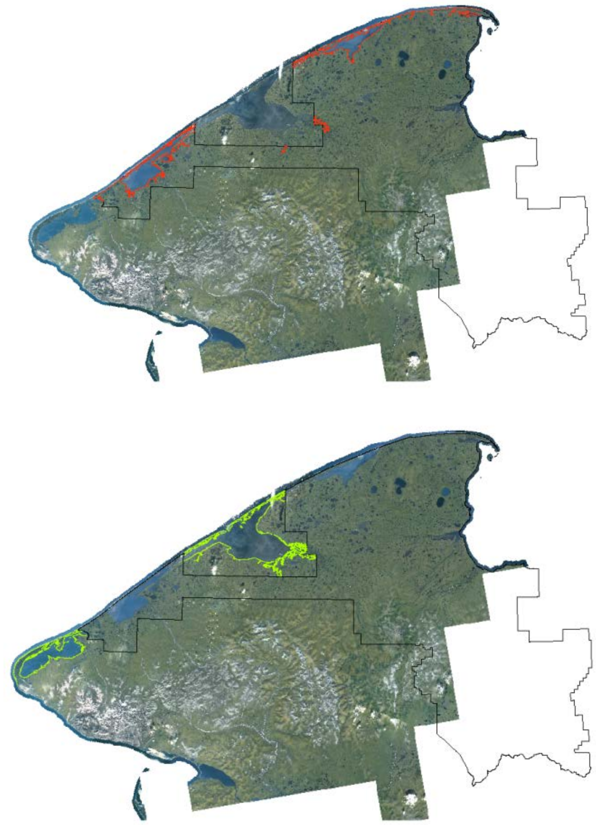


Figure 1. Top: NPS contributions (red) to NHD update and extension contributions by WALCC (green) overlayed upon true-color recently acquired SPOT5 imagery. Note, BELA administrative unit boundary (black).

Purpose

The National Hydrography Dataset (NHD) is the surface water component of The National Map. The NHD is a digital vector dataset maintained by the United States Geological Survey (USGS) used by geographic information systems (GIS). It contains features such as lakes, ponds, streams, rivers, canals, dams and streamgauges. These data are designed to be used in general mapping and in the analysis of surface-water systems.

NHD serves as the single most comprehensive record of hydrologic features for the nation. In many parts of the United States and particularly Alaska, however, shorelines features in the NHD are both ambiguous and imprecise. The Alaska shoreline features present in much of the current NHD database were developed from the original 1950's era topographic mapping of the state using traditional, small scale aerial photography and photo interpretation techniques. These demarcations are often indicative of: drift lines; vegetation edges; visible tidal lines; and other visible features. Since the initial compilation of shoreline features occurred in Western Alaska, scientific investigations have substantially increased understanding of the tidal datum and natural coastal processes affecting the region. Greater scientific understanding coupled with new: techniques and improved technology; as well as a collection of newer imagery revisions can now be combined to update the NHD shoreline.

Throughout Alaska the most accurate digital representation of the MHW shoreline is NOAA's extracted vector shoreline (EVS) and electronic navigational chart (ENC) data. Where EVS and ENC data are unavailable, shoreline data from NHD remains the best historical representation of MHW shoreline. By integrating EVS, ENC, NHD and traditional aerial photographic interpretation using newly acquired imagery bases (both aerial and space-based), revisions to and updates of the NHD shoreline are possible. These revisions serve to enhance current and future research and understanding of coastal shoreline processes throughout Western Alaska and other coastal portions of the state. The purpose of this project is to revise the current NHD shoreline in the National Map using original NHD as the starting point and incorporating NOAA EVS data and aerial image interpretation techniques for updates.

Methodology

Updates to the National Hydrography Dataset (NHD) are conducted using several data edit phases including: data acquisition and preparation; registration; development and processing; and, data model validation using USGS ArcGIS NHD GeoEdit tools. This process effectively moves compiled coastline data (including NOAA EVS, existing NHD data, and image interpreted coastline) to the NHD data schema for use as target data in the NHD GeoEdit Tools. To prepare shoreline features for use as target data and future registration through the NHD GeoEdit Tools, a ArcGIS template line feature class is developed within a template hydrography feature dataset alongside a newly developed shoreline update feature class. The NHD template contains a newly created draft feature class and the ‘raw’ shoreline update features can subsequently be imported and used for review and modification.

Development and processing of new updates for NHD is completed through a standardized procedure. NHD coastline reaches are cut and merged to a selected study area. Polygons created from the line feature class are required to be closed by an editor prior to creating a polygon feature class from the lines feature class as any gaps in the lines will prohibit creation of polygons. The newly revised NHD draft data contains both updates for lines and polygon feature class (see Figure 2). At this stage a new field is required for both created line and polygon feature classes, declared ‘NHD_FC’, which incorporates a coded value domain structure (see Figure 3). The ‘NHD_FC’ field is subsequently populated and unnecessary polygons are removed by the editor. The editor reviewing the “NHD_FC” field additionally checks for gaps in lines and removes unwanted island polygons. Object level feature based information from the lines and polygons feature classes can be loaded to a designated NHD feature class through the ESRI load tool. The editor then can populate the NHD FC’s feature class fields “Ftype” and “Fcode”. These fields are populated with defined values identified in the data model. Common ‘Ftype’ codes in coastal areas include: coastline, ‘Ftype’ 566; sea ocean, ‘Ftype’ 445; and estuary ‘Ftype’, 493. The editor can, at this time, specify whether a feature is a coastline, bay, lake, pond, etc. A second population for the fields “GNIS_ID” and “GNIS_NAME” is executed to define Geographic Names Information System (GNIS) data for named features. Those features without defined GNIS Names can be left blank.

The final stage of development and processing for target data requires the verification and resolution of outstanding topology errors as well as the removal of original lines and

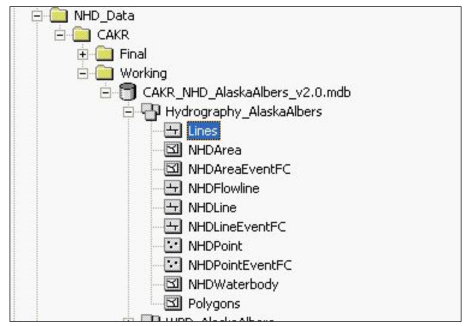


Figure 2. Sample NHD hydrography feature dataset with lines and polygons feature class added.

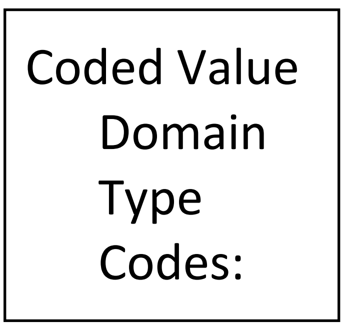


Figure 3. Coded value domain structure for line and polygon feature classes.

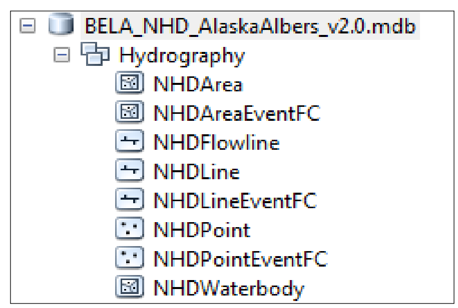


Figure 4. Sample of a finalized NHD migrated dataset.

polygon feature classes. A compacted database, which can be used to reduce both dataset size and increase performance, can be implemented containing final versions for the feature classes: NHDLine; NHDFlowline; NHDArea; and NHDWaterbody (see Figure 4).

Once the NHD compliant target data has been created it is necessary to run it through the NHD GeoEdit Tools (version 5.0.1) so that the data can be uploaded into the USGS National Map dataset. Updated NHD data can be checked for compliance with NHD standards and protocols using these tools. This serves two purposes: first, it provides an additional quality assurance and quality control review; and second, it determines whether any conflicts exist within the dataset prior to registration with master NHD database. The first, and most significant step in this process, is the development of a metadata record. Metadata, commonly referred to as "data about data", provides a record of pertinent information about the data author, data quality, and source/base data used to update the NHD layers. For this project, the metadata prepared for the shoreline update from Cape Prince of Wales to Cape Espenberg meets Federal Geographic Data Committee (FGDC) standard #FGDC-STD-001-1998.

Using the NHD GeoEdit Tools, previously created target data can be loaded into a checkout geodatabase. The most commonly used processes for this are replace and import. In some cases additional ArcGIS editor tools are needed, for example, delete, modify, reshape, and merge. Once all the target data for each feature has been moved to the appropriate feature class (i.e. NHDLine; NHDFlowline; NHDArea; and NHDWaterbody) the QC Checks within the NHD GeoEdit Tools can be run.

Quality control Checks require any geometric errors to be repaired according to established topological standards. Following the repair of any geometric issues, a series of individual QC Checks are conducted to further repair the dataset. When all issues have been addressed, a final quality control check is executed. Figure 5 includes several common errors that may be present after a successful run of NHD GeoEdit Tool functions.

2546	15674436	ArtificialPath	Feature Record	NHDFlowline FLOW_CHECK_VALIDATION_ERROR	NHDFlowline	Flow Checks - Final QC(Flow Check Error Validation):NHDFlowline Flow Check Validation Error (See Status Description)	1	A Branched or Gapped Flow Error was found with a GNIS_ID value = 1409877 (this may be due to an attribute OR geometry error)		Thursday, June 20, 2013 4:34:37 PM	Friday, June 21, 2013 9:41:32 AM	Resolved
3376	22430924	ArtificialPath	Feature Record	NHDFlowline RC_MAINTENANCE_GNIS_ID	NHDFlowline	Database Integrity Checks - Final QC(RC Maintenance GNISID):Feature has no matching Reachcode, GNIS_ID record in ReachcodeMaintenance table	1	REACHCODE = 19030401014565 not exist in NHDReachCodeMaintenance table		Friday, June 21, 2013 9:18:23 AM	Friday, June 21, 2013 9:41:36 AM	Resolved

Figure 5. Sample selection of common feature specific NHD GeoEditTool function identified errors.

Results

Revisions to coastal shoreline are critical for improving scientific understanding of coastal processes throughout the United States and in Western Alaska. As the level of regional understanding of coastal processes improves along with advances in techniques and imagery acquisition the representation of shoreline presented as follows can serve as an important point-in-time snapshot of the environment. Through the integration of aerial photographic interpretation of newly acquired 2003 NPS true-color coastal imagery, NOAA EVS, and historical NHD, records revisions can successfully be performed to represent the most current shoreline MHW. These revisions meet National Map standards of +/- 32-meters in horizontal accuracy and scalability requirements for the State of Alaska at 1:63,360. Spatial data prepared throughout the course of this cooperative effort by SMUMN is presented via the following map products. Subsequently, revisions to the shoreline feature in NHD predominantly promotes continued informed decision making and the knowledgeable development of continued natural resource management practices in coastal regions throughout Western Alaska.

This Space Is Intentionally Left Blank

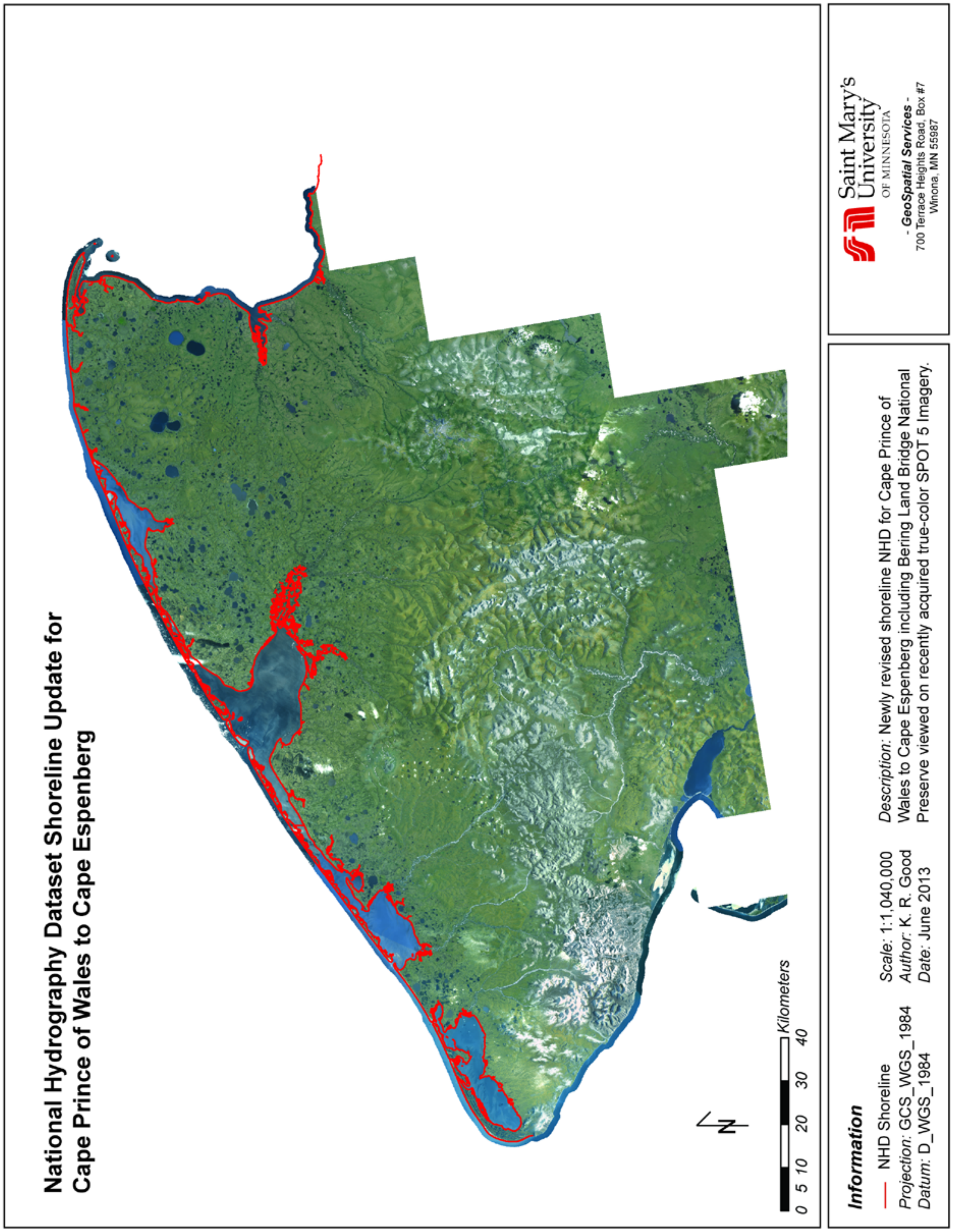


Plate 1. Map of final comprehensive shoreline NHD update for Cape Prince of Wales to Cape Espenberg

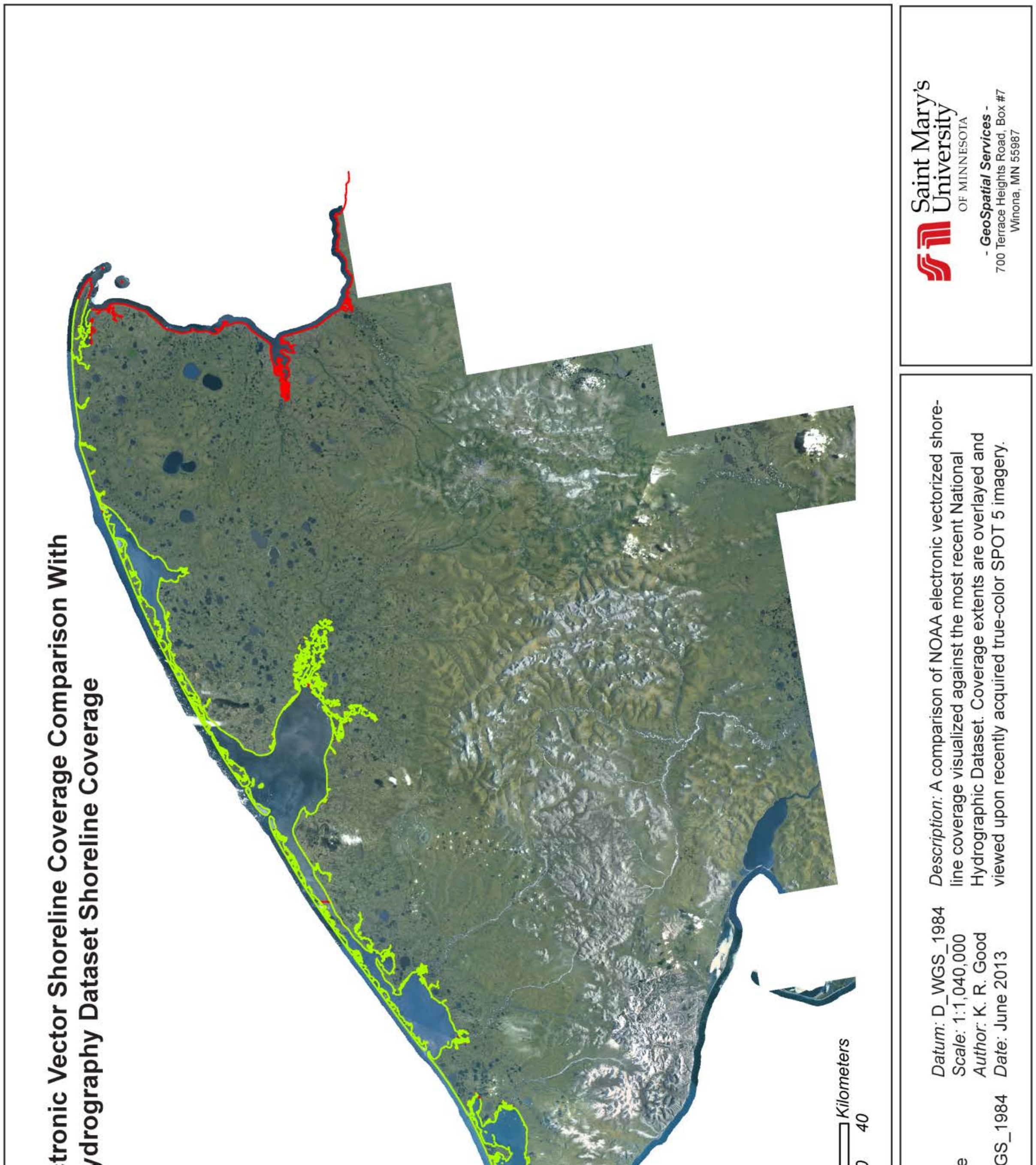


Plate 2. Revised shoreline NHD coverage.

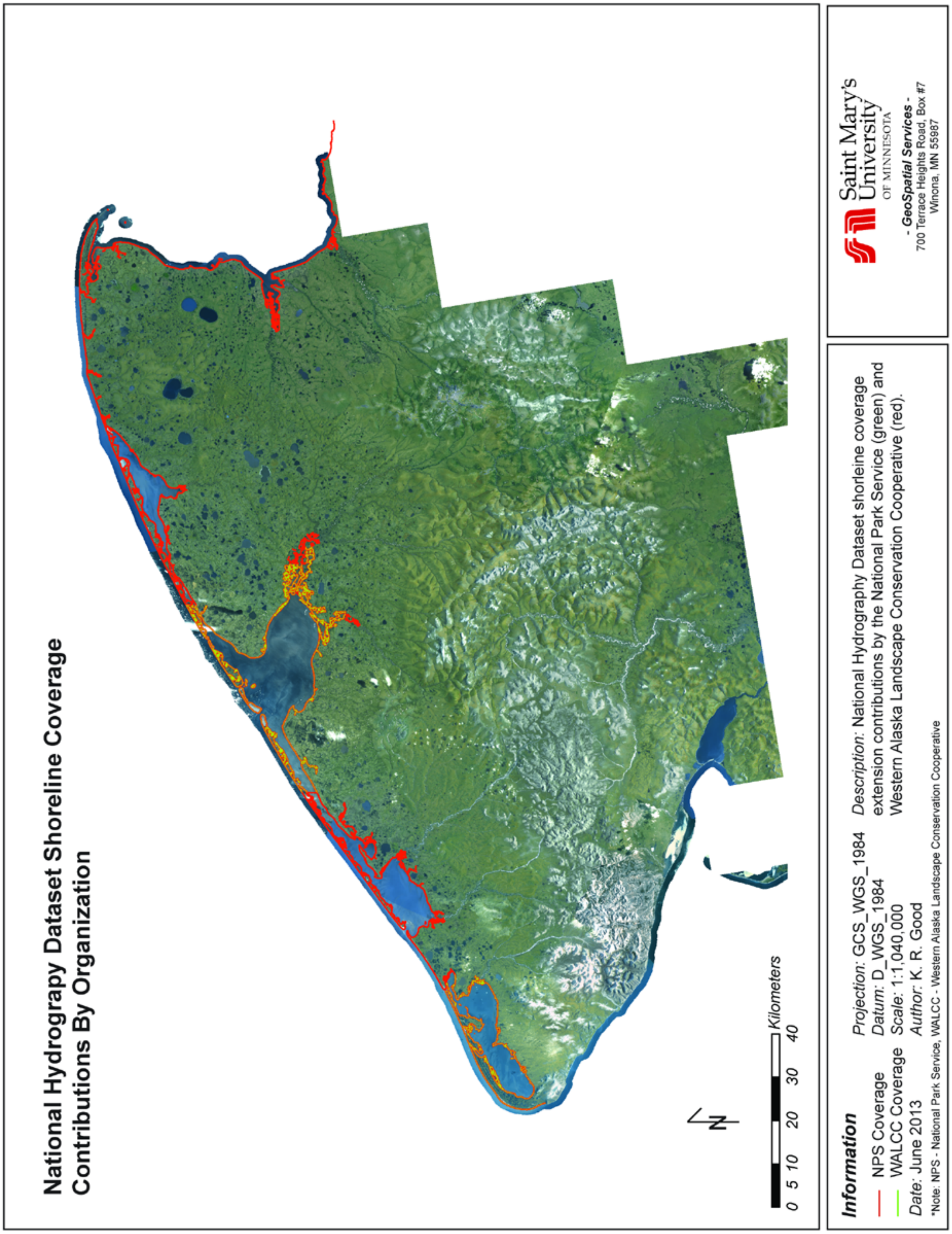


Plate 3. Contributions to revised shoreline NHD coverage by organization.

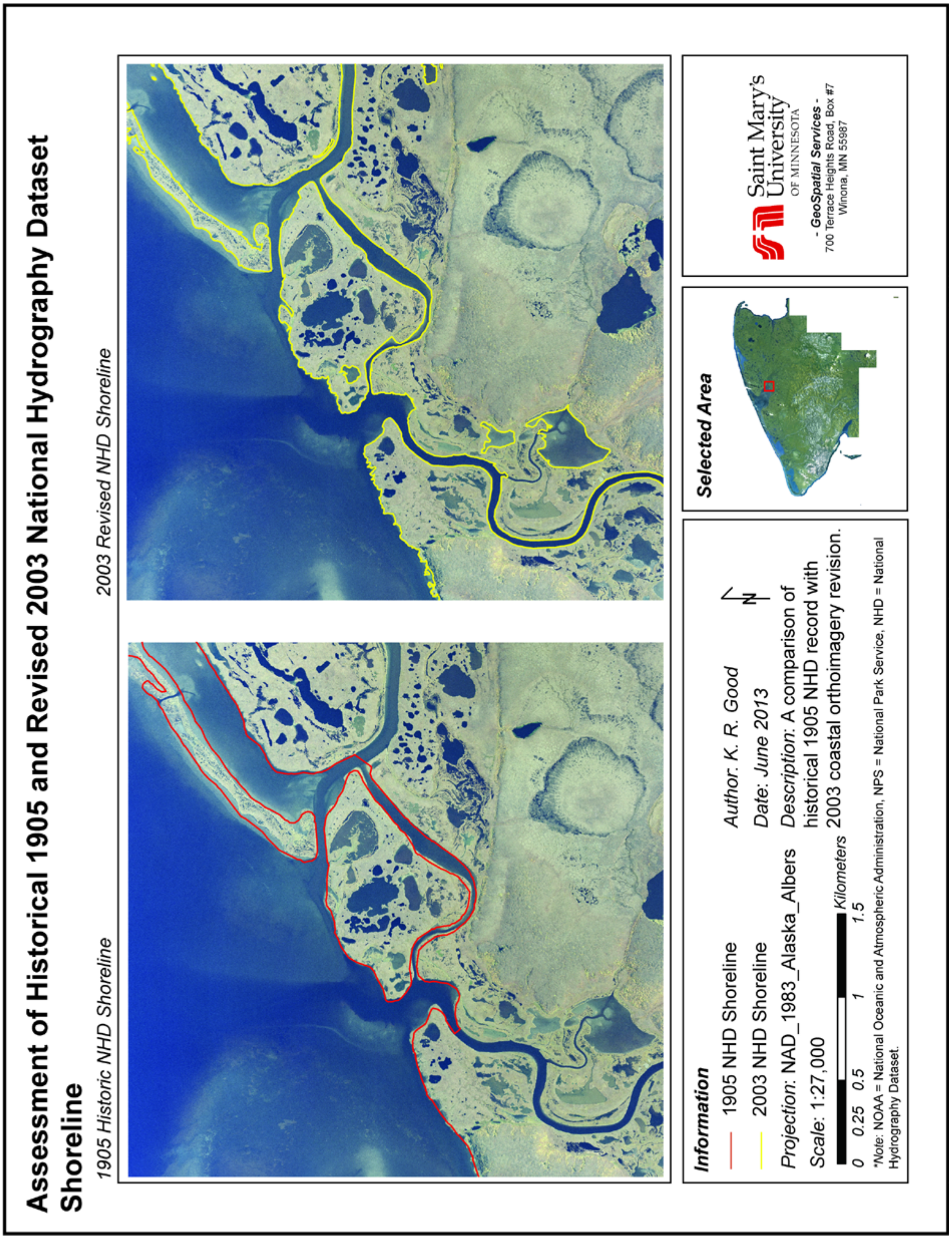


Plate 4. Historical comparison of 1905 and 2003 National Hydrologic Dataset quality comparison.

Discussion

Throughout Western Alaska, historical shoreline records demarking the extent of the mean high water level remain imprecise as a result of original mapping efforts using small scale aerial photographic imagery bases. As a result, previous versions of shoreline features might represent; drift lines, vegetation boundaries, high water marks, and other visibly identifiable lines. Revisions to the demarcation of MHW shoreline can be successfully developed using more recently acquired high resolution imagery and revisions to coastal NHD information where appropriate base data, such as NOAA EVS, is available for use.

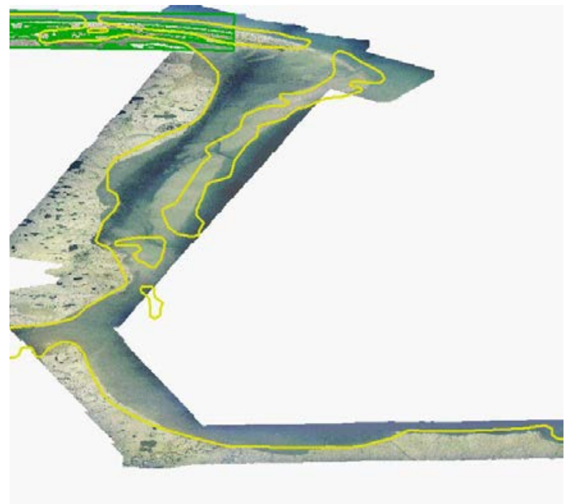


Figure 6. NOAA EVS (Green), NOAA ENC (Yellow) coverage for study area. ENC not adequate for mapping.

On this project, for the area extending from Cape Prince of Wales to Cape Espenberg and an area adjacent to Deering, Alaska, NOAA EVS was present for seventy percent of the study. For the remaining thirty percent there were three choices for completion of the updated NHD data: retain the original NHD; develop a new shoreline from the NOAA ENC database; or, photo interpret a new shoreline dataset using 2003 aerial imagery (tidally referenced to Mean High Water) from the NPS (see Figure-6). Given that the shoreline for the rest of the study area was derived from the NOAA EVS data based on the 2003 aerial imagery, it was a simple decision to use that same imagery to complete the shoreline from Cape Espenberg to Deering. These revisions and updates were completed through the application of traditional aerial photo interpretation techniques in a heads-up, on-screen environment in ArcGIS.

Aerial photographic interpretation of MHW was completed by an interpreter at a mapping scale of 1:3,500. This scale provided sufficient amount of detail in the 2003 coastal imagery in order to identify specific features across the visible landscape. In several circumstances defining the MHW shoreline required consideration of natural geomorphic factors such as wave action. Determining if sandbars were part of the coastal shoreline required a decision whether or not they were caused primarily by wave action. In these circumstances the shape and orientation of sandbars provided some indication of whether the sandbar was driven by wave action and flooded less frequently than daily. Additionally, a second scenario requiring further interpretation became evident where an understanding of hydrology was used to estimate the demarcation of the MHW boundary immediately adjacent to coastal estuaries and river outlets. Given these scenarios, where an estuary and or river were present, the MHW was delineated to the maximum extent of lateral channels.

Revisions to NHD MHW shoreline were performed according to editing protocols (see Appendix B) and validated using the NHD GeoEdit Tools and NHD data conflation process are largely recognized as valid. However, GIS analysts need to be aware that, in some circumstances, unacceptable errors may not be immediately fixed by the standard NHD GeoEdit Tools and may require an iterative use of the tools for identification. Where these issues arise, the dataset requires further review and validation by the analyst(s) prior to submission of the update. It is necessary to recognize the tool is not “fool proof”. Continued error checking using the NHD GeoEdit Tool requires an additional allowance of time as the quality assurance and quality control check is run at the HUC feature level. These errors can be reduced by imposing several standard map topology rules.

To ensure consistent representation across the entire area of coastline from Cape Prince of Wales to Cape Espenberg standard ESRI topology tools can be applied to identify some of the issues the NHD GeoEdit Tool may miss. A topology assessment can be applied prior to geometry verification in the NHD GeoEdit Tool and in this scenario applies the following rules to linear features, such as the shoreline: 1) must not overlap; 2) must not self-overlap; 3) must not self-intersect; and 4) must not have dangles. Topology, in the application of coastline NHD revisions, can be used to ensure a consistent representative dataset describing high quality coastline extent at a point-in time for further scientific study of coastal processes.

Literature Cited

Western Alaska Landscape Conservation Cooperative.2013. Overview. Retrieved from https://westernalaskalcc.org/about/sitepages/about.aspx

Appendix-A: Sample of NHD Revision Metadata

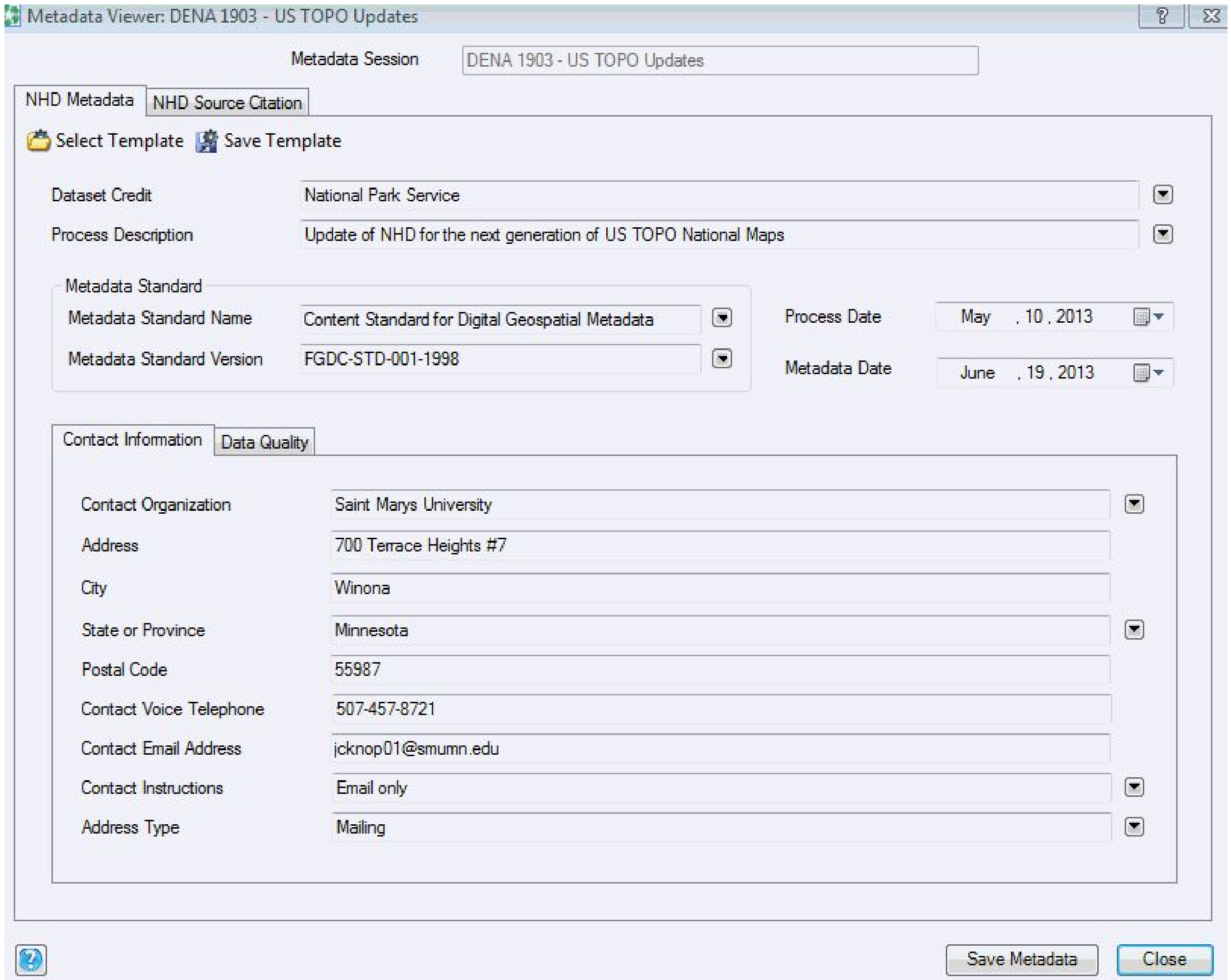


Figure A-1. Sample view of revised shoreline NHD metadata entered through the automated USGS NHD Edit tool process.

Appendix-B: Draft NPS NHD Update Protocol

Draft Shoreline Selection Protocol

Compilation of an Accurate and Contemporary Digital Shoreline for Alaska Coastal Parks (PMIS #156638)

The Compilation of an Accurate and Contemporary Digital Shoreline for Alaska Coastal Parks project was initiated with the purpose of creating a high quality defensible digital shoreline dataset for most coastal parks in the National Park Service (NPS) Alaska Region that would replace existing U.S. Geological Survey (USGS) topographic shoreline data represented in the National Hydrographic Dataset (NHD) using the best available National Oceanic and Atmospheric Administration (NOAA) delineations of high water line (HWL) or mean high water (MHW) shorelines. For Alaska, the best available NOAA delineations of MHW shoreline are provided via two data sources, extracted vector shoreline data (EVS) and electronic navigational chart (ENC) shoreline data. This Shoreline Selection Protocol outlines the rationale or decision process to be used for best available shoreline selection and documentation. This protocol is a working document based largely on scenarios encountered during the compilation of a revised digital shoreline for Kenai Fjords National Park (KEFJ). The information provided in this protocol is intended to be used when applicable. However, unique scenarios may exist on a park-by-park basis that warrant deviation from the content of, or revision to this protocol. When such scenarios are encountered NPS Alaska Region and Saint Mary's University of Minnesota Geospatial Services (SMUMN) project staff shall work together in determining and properly documenting the most approach resolution for the issue. This includes modifications or revisions to the protocol as necessary.

SELECTION AND PROCESSING OF NOAA SHORELINE DATA

I. DOWNLOADING NOAA SHORELINE DATA

i. Extracted Vector Shoreline (EVS) Data

NOAA's Extracted Vector Shoreline (EVS) data represents shoreline data extracted from raster nautical charts using a process and software developed by the NOAA Office of Coast Survey (OCS) Cartographic and Geospatial Technology Program (CGTP). Though the EVS data is not currently maintained and may not reflect the shoreline on the latest edition paper marine chart, these data for Alaska coastal parks remain the largest spatially scaled dataset from original NOAA surveys and represent, in many cases, the highest quality tidally-referenced mean high water (MHW) line for this project. EVS data can be downloaded through the National Geodetic Survey (NGS) NOAA Shoreline Data Explorer web viewer at http://www.ngs.noaa.gov/newsys_ims/shoreline/index.cfm. Only high resolution data should be selected since these represent the largest spatial scale data available (Figure 1).

The decision to exclude medium resolution EVS data for the five coastal parks covered in this project was made after high and medium resolution datasets were compared for scale and currentness (Figures 1 and 2). NOAA marine charts for Alaska, especially in northwest and southwest Alaska, have extremely small scales (i.e. 1:200,000 or larger) and though linework and navigational aids may be updated on a marine chart from recent surveys, the stated publication scale of the chart will compromise the quality of the shoreline GIS layers due to generalization following extraction methods of binary raster marine chart files used in nautical chart production. This was found evident in all parks including ANIA, BELA, CAKR, KEFJ and LACL.

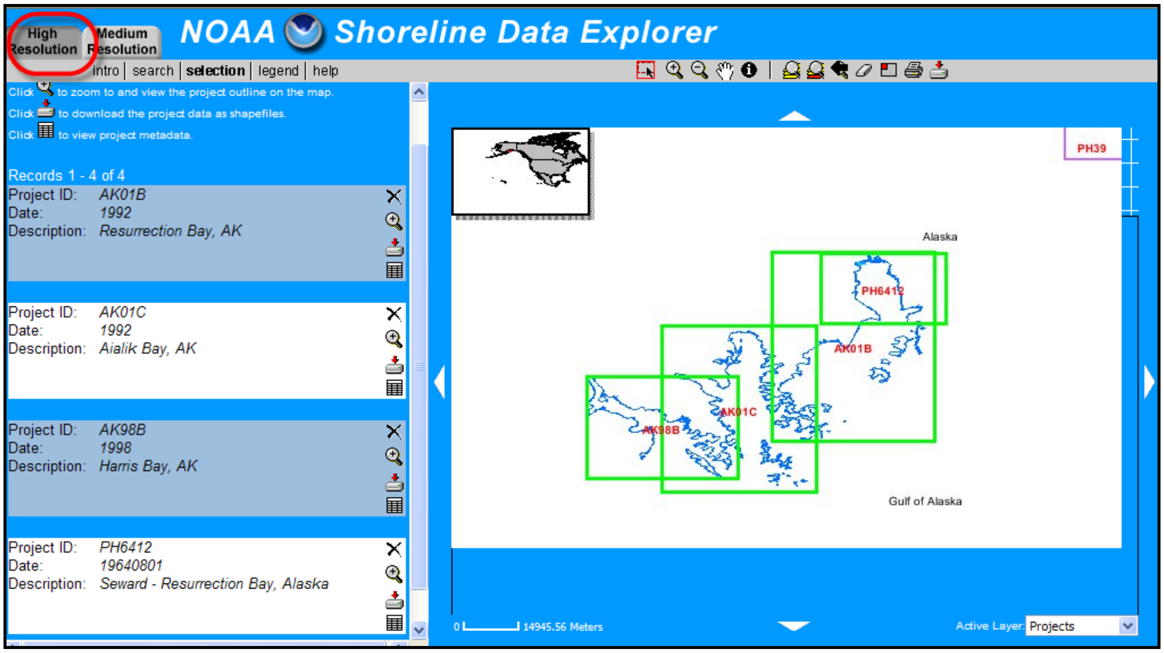


Figure 1. The NOAA Shoreline Data Explorer website and the high resolution EVS project boundary areas of interest for Kenai Fjords National Park (KEFJ).

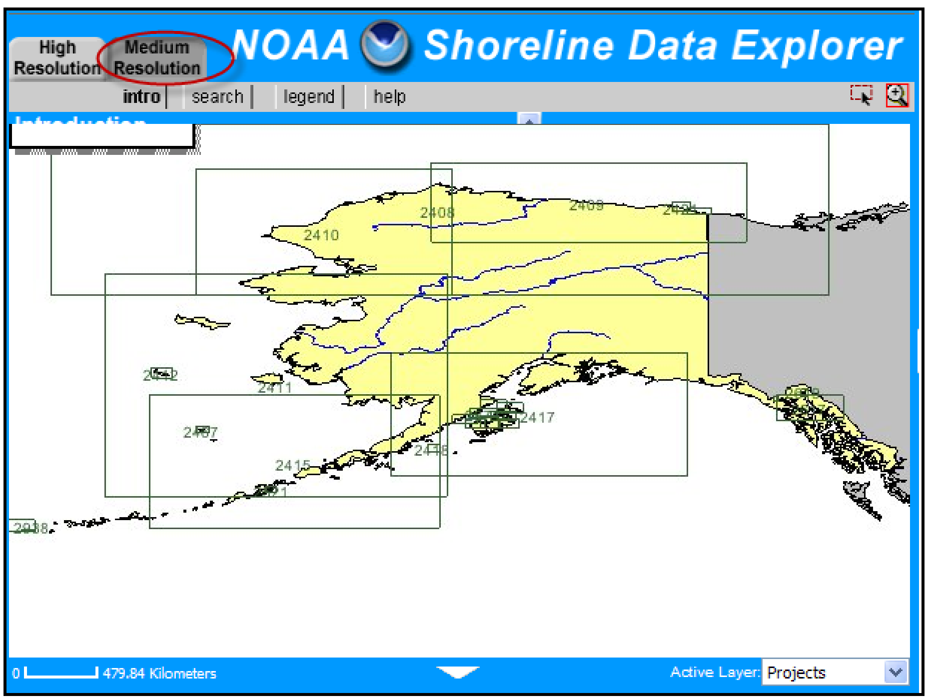


Figure 2. Medium resolution EVS project boundaries for Alaska, the size of which depicts the coarse scale of these products.

High resolution EVS data is extracted on a project boundary basis, which in some cases includes areas outside park boundaries (Figure 1). During the extraction process, no attempt should be made to exclude shoreline data outside of National Park Service (NPS) boundaries. Individual project boundary datasets (identified by Project ID) as well as their associated metadata.html documents should be extracted in compressed file format such as WINZIP and stored in a directory tree structured by the NPS park code, NOAA data type, and NOAA ProjectID and publication date (e.g. KEFJ\EVS\AK01B_1992) (Figure 3). During the download process, the default download options "Include entire project area" and "Include all project layers" should be selected to ensure the most complete EVS data is captured. In addition to line shapefiles, certain EVS project boundary downloads will include point shapefiles. Point data represents landmarks, obstructions, aids to navigations, and rock features, and were not used in this project for shoreline delineation. The metadata.htm document associated with the EVS project boundary dataset must be downloaded separately. Hyperlinks are embedded in the Source Section of a metadata.html document through which descriptive reports can be accessed. These descriptive reports describe the photogrammetric processes including horizontal control associated with the project, and are internally referenced on the NOAA Index of Descriptive Reports website at http://www.ngs.noaa.gov/desc_reports/. In some cases multiple descriptive reports are available for an EVS project boundary, each representing a different field survey date or geographic cell of coverage. Descriptive reports should be saved into the project directory structure in PDF format alongside the appropriate EVS shapefiles and metadata.htm document.

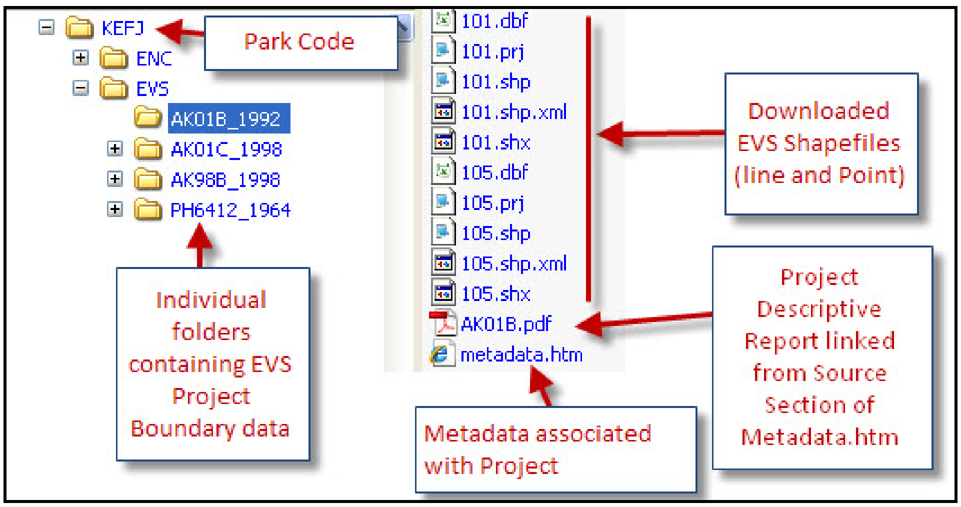


Figure 3. Example of the preferred folder structure and file naming convention for EVS data storage. Typical files within this structure include the EVS project boundary shapfile(s), the metadata associated with the project, and any descriptive report(s) referenced in the metadata.

Table 1 outlines the NOAA high-resolution EVS project boundaries pertinent to the five coastal parks associated with this project.

Table 1. NOAA high resolution EVS project boundaries, survey dates and scales.

Park	EVS Project Boundary	Survey Date of Publication[1] (# Reports)	Scale[2]
Aniakchak National Monument and Preserve (ANIA)	CM-8200	19870701(4)	1:20,000
Bering Land Bridge National Preserve (BELA)	AK301	20030723(1)	1:12,000
Cape Krusenstern National Monument (CAKR)	AK302	20030723(1)	1:12,000
Kenai Fjords National Park (KEFJ)	AK01B AK01C AK98B	19920101(1) 19980101(1) 19980101(1)	8m horizontal 95% CI 24.4m horizontal 95%CI 7m horizontal 95% CI
Lake Clark National Park and Preserve (LACL)	PH6301B	19700701 (12)	1:20,000

[1] Publication date is the published date of the project obtained from the temporal keyword in the project's metadata.htm document. This may

not reflect the on-water survey date – see the descriptive reports for source date of survey. # of Reports reflect the number the descriptive reports for the project.

[2] Scale is defined per the descriptive report. Nominal scales were used for ANIA, BELA, CAKR and LACL project boundary areas, while horizontal accuracies at 95% CI were used for KEFJ project boundary areas.

ii. Electronic Navigational Chart (ENC) Shoreline Data

NOAA's Electronic Navigational Chart (ENC) data represent vectorized shoreline data from official NOAA marine charts. ENC data is represented in geodatabase feature classes using ESRI's S-57 protocols and are a combination of charted information as well as original source information from surveys in the area. The ENC shoreline corresponds to the black line (approximate MHW) seen on official NOAA marine charts, which are now downloadable from the web and represent the most current form of officially recognized MHW coastline at charted map scales. ENC datasets should be downloaded using the Graphical Catalog available on the NOAA OCS ENC Chart Downloader website at http://www.charts.noaa.gov/?Disclaimer=noaa%21nos@ocs%23mcd&Submit=Proceed+to+Chart+Downloader. ENC data is extractable through the Graphic Catalog on an ENC cell name basis (Figure 4). Individual ENC datasets are extractable in compressed file format. ENC data is intended to be stored in a directory tree structured by the NPS park code, NOAA data type, and NOAA ENC cell name (e.g. KEFJ\ENC\US4AK2FM) (Figure 5). Within this directory structure, a folder must be established for each ENC dataset downloaded, its title reflecting the assigned ENC cell name. This folder shall serve as a storage location for the ENC data once it is uncompressed. Once downloaded, the ENC dataset shall be uncompressed exposing a folder titled "ENC_ROOT". This ENC_ROOT folder contains the raw ENC data and must be stored within the appropriately titled ENC cell name folder. Further processing of raw ENC data is necessary before the ENC data is compatible within an ESRI environment. These processing steps are outlined in Section III (ii) of this protocol, *ENC Data Processing.*

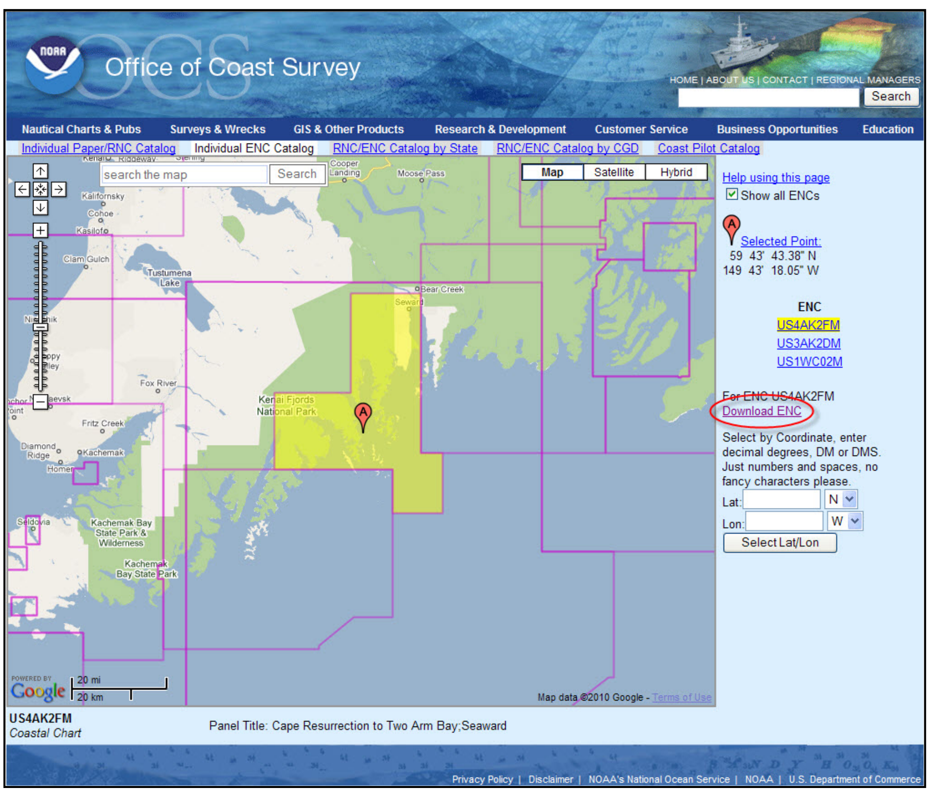


Figure 4. The Graphical Catalog NOAA OCS ENC Chart Downloader website and an ENC dataset of interest for KEFJ identified by ENC cell name.

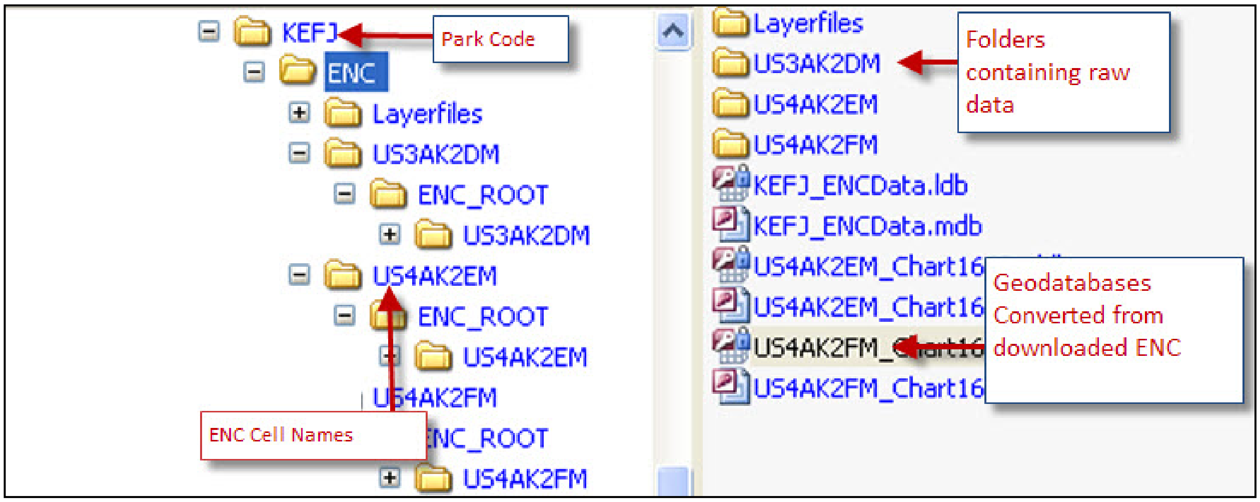


Figure 5. Example of the preferred folder structure and file naming convention for ENC data storage.

Table 2 outlines the NOAA ENC cell name boundaries pertinent to the five coastal parks associated with this project.

Table 2. Largest scale charts available in ENC format from NOAA's Graphic ENC Catalog map server.

Park	ENC Cell Name	Marine Chart Number/Name	Charting Survey Dates[1]	Scale[2]
ANIA	US2AK5FM US4AK5HE[3] US4AK5IE[3]	16011/Alaska Peninsula and Aleutian Islands to Seguam Pass 16566/Chignik and Kujulik Bays, Alaska Pen 16568/Wide Bay to Cape Kumlik, Alaska Pen.	1950 - 1970	1:1,023,188 1:77,477 1:106,600
BELA	US1BS03M US3AK80M	514/Bering Sea Northern Part 16200/Norton Sound; Golovnin Bay	1950 - 2003	1:3,500,000 1:400,000
CAKR	US1BS03M US2AK92M	514/Bering Sea Northern Part 16005/Cape Prince of Wales to Point Barrow	1950 - 2003	1:3,500,000 1:700,000
KEFJ	US4AK2DM US4AK2EM US4AK2FM	16680/Point Elrington to East Chugach Island 16681/Seal rocks to Gore Point 16682/Cape Resurrection to Two Arm Bay; Seward	1927 - 2001	1:200,000 1:83,074 1:81,847
LACL	US4AK13M	16661/Cook Inlet, Anchor Point to Kalgin Island	1935 - 1975	1:100,000

[1]Charting survey dates were determined in part by information provided through the NOAA NOS Hydrographic Survey Data web viewer.

[2]Scale is defined from scale noted on chart.

[3]This data was provided directly to the NPS Alaska Region from James Hawks at NOAA OCS and is not currently available on the NOAA NOS Hydrographic Survey Data web viewer.

II. PROJECT GEODATABASE DEVELOPMENT

Using ArcCatalog a file geodatabase titled "Shoreline_PMIS_156683" shall be created. This geodatabase shall serve as the project's primary data repository, in which raw and processed data is stored. Within the file geodatabase a feature dataset for each coastal park unit shall be established to accommodate the storage of park-specific spatial data (Figure 6). Each feature dataset shall be named in accordance with the four-digit NPS park code (e.g. KEFJ for Kenai Fjords National Park), and assigned the Alaska Albers Equal Area Conic projected coordinate system using the North American Datum of 1983 (NAD83). The Alaska Albers Equal Area Conic NAD83 projected coordinate system is the preferred projection for use during interim linework preparation. However, prior to integration into the USGS National Hydrographic Dataset (NHD) finalized data will need to be reprojected to the coordinate system supported by the USGS NHD.

Figure 6. Project geodatabase structure.

III. PROCESSING NOAA SHORELINE DATA

i. EVS Data Processing

EVS data downloaded from the NGS NOAA Shoreline Data Explorer internet map server is defined in a geographic coordinate system using NAD83. Before this raw data may be incorporated into the project geodatabase it must be reprojected to the Alaska Albers Equal Area Conic projected coordinate system. This can be accomplished using the Project tool available in the Feature toolset of ArcToolbox's Projection and Transformations toolbox. However, no datum transformation is required. The reprojected EVS file should be saved as a feature class in the appropriate feature dataset of the geodatabase. The output name assigned to the feature class shall first reflect the NOAA data type (i.e. EVS) followed by the NOAA project boundary (Figure 7).

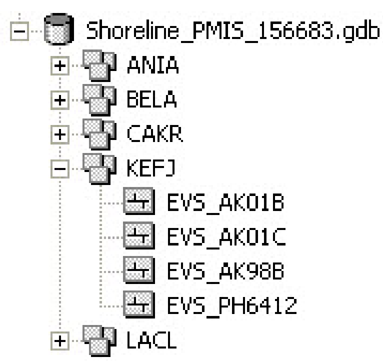


Figure 7. Example of the approach for raw EVS data storage in the project geodatabase structure.

Each raw EVS dataset may now be loaded into ArcMap for further processing. Raw EVS datasets likely contain linework extraneous to this project, such as transportation linework depicting inland runways, and/or natural feature linework depicting bluffs or cliffs, etc. For this project, efforts shall focus on evaluating EVS data coded as SHORELINE and ALONGSHORE FEATURE in the attribute field "CLASS". Shoreline and alongshore feature line segments can be extracted from raw EVS data by performing a Select By Attribute query on the data using the definition query: SELECT *FROM [feature class name] WHERE: "CLASS" = "SHORELINE" OR "CLASS" = "ALONGSHORE FEATURE". Once shoreline and/or alongshore features have been extracted, the selected records should be exported as a new feature class representing processed EVS data. The naming convention for the processed dataset shall first reflect the data type followed by the NOAA project boundary followed by the type or types of CLASS feature values now contained in the dataset (Figure 8).

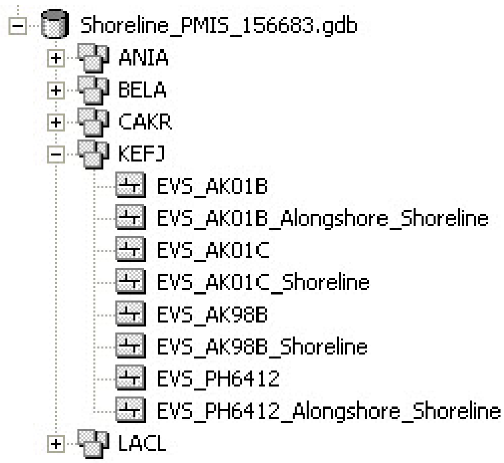


Figure 8. Example of the approach for processed EVS data storage in the project geodatabase structure.

Replicate features have been identified in certain EVS datasets (e.g. the KEFJ dataset EVS_AK98B contains triplicate features). A replicate feature scenario is one in which a single line segment is mistakenly repeated appearing as multiple records that are spatially coincident and identical in the attribute table (i.e. in terms of attribution, excluding unique Object ID values). The existence of replicate features does not diminish the quality of the EVS data provided, it simply adds needlessly to its volume. Therefore, all processed EVS datasets should be examined for the presence of replicate features. Replicate features can be exposed via an ascending sort of the data's Shape_Length attribute field values. The Shape_Length attribute field provides the length of each line segment to six decimal places. Records with repeating Shape_Length values are likely replicate features and should be evaluated. Replicate features can be manually removed from a processed EVS dataset by loading the dataset into ArcMap, entering an edit session, and selecting and deleting the replicate records from the dataset's attribute table. When replicate features exist, the eldest record for each feature as determined by the Object ID value should be the record that is retained in the attribute table.

ii. ENC Data Processing

Raw ENC data downloaded using the Graphical Catalog available on the NOAA OCS ENC Chart Downloader website requires certain processing before it is ESRI-compatible. Each raw ENC is a complex vector database containing approximately 180 possible data layers. Because of this, NOAA OCS developed extensions to simplify the use of ENCs in an ESRI environment. The ENC Data Handler extension for ArcGIS should be downloaded at http://www.csc.noaa.gov/products/enc/arcgis9x.html. This extension imports ENC data into a defined geodatabase structure based on ESRI's S-57 data model, assigns nautical chart symbology to each feature class, and removes extraneous data layers that do not contain data. Once the extension is downloaded, the necessary steps for processing the ENC dataset from its raw format into an ArcGIS geodatabase should be followed. These steps are provided in the tutorial document "Tutorial for Using the ENC Data Handler Extension for ArcGIS 9.0" packaged with the extension. The tutorial document can be found at C:\Program Files\ENC_DATA\ENC_Docs.

Once the raw ENC data is downloaded and processed for ESRI compatibility, it may be reviewed in ArcCatalog. ENC datasets are composed of multiple point, line, and polygon-type feature classes. The line-type feature class "CoastlineFeature" shall be the feature class of interest for the purpose of this project. The ENC CoastlineFeature linework downloaded from NOAA's Graphic Catalog is defined in a geographic coordinate system using the World Geodetic System 1984 (WGS84) datum. Before this

CoastlineFeature data may be incorporated into the project geodatabase it must be reprojected to the Alaska Albers Equal Area Conic NAD83 projected coordinate system. This can be accomplished using the Project tool available in the Feature toolset of ArcToolbox's Projection and Transformations toolbox. During the reprojection process, the geographic datum transformation "NAD_1983_To_WGS_1984_1" should be applied. The "NAD_1983_To_WGS_1984_1" datum transformation "does nothing" to the data since the datum shift parameters for the transformation are 0, 0, and 0. Per communication between NPS project staff and NGS NOAA in July 2010, this particular transformation should be applied to all ENC data tagged or assigned the WGS84 datum as the data is already in the latest realization of NAD83. Therefore, projecting ENC data using the "NAD_1983_To_WGS_1984_5" datum transformation would needlessly transform the data. NOAA expresses all marine chart data in WGS84/NAD83 as these datums are considered the same for navigation at charted scales.

The reprojected ENC CoastlineFeature linework should be saved as a feature class in the appropriate feature dataset of the project geodatabase. The CoastlineFeature feature class shall be renamed so that the output name assigned to the feature class reflects the NOAA data type (i.e. ENC) followed by the NOAA ENC cell name (Figure 9).

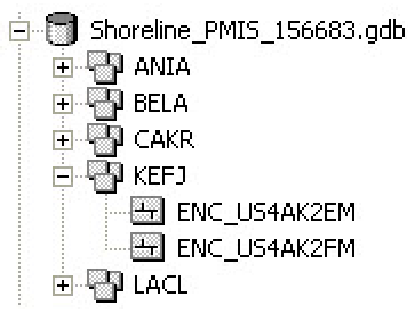


Figure 9. Example of the approach for processed ENC data storage in the project geodatabase structure.

IV. DATA SOURCE PREFERENCES

When available, EVS linework provided by NGS NOAA shall serve as the primary data source for updates to the National Map NHD digital shoreline. The EVS data pertinent to this project is based on survey-work postdating USGS National Map efforts, is well documented with FGDC-compliant metadata, and offers highly accurate large-scale depictions of mean high water (MHW) resulting from the application of modern survey technologies. EVS linework should be validated against the highest quality verifiable digital orthorectified imagery available (i.e. 1:24,000 or higher) and the most current, large scale NOAA marine chart prior to acceptance. Marine charts may be accessed and downloaded from the NOAA OCS Online Chart Viewer website at http://www.nauticalcharts.noaa.gov/mcd/OnLineViewer.html. In cases where multiple marine charts exist for the same area, the largest scale chart should be selected.

High resolution imagery shall serve as a more current validation dataset to compare EVS linework. The NPS Alaska Region has an excellent compilation of various satellite and aerial imagery. Table 3 outlines the highest quality imagery datasets available for the five coastal parks associated with this project. Unique characteristics of these imagery datasets include:

- orthorectified imagery based on high quality DEM (including LIDAR and SRTM 30 meter);
- tidally-coordinated photography allowing for exposure of the tidal areas below high water;
- acquisition dates that are more current than DLG-based 1950s survey data;
- FGDC compliant metadata; and,

- in some cases, GPS-collected ground control point data for verification.

Since the late 1990s various NPS Alaska Region coastal field crews have used global positioning systems ranging from ± 8 meter precision lightweight GPS (PLGRs) and Trimble mapping grade GPS systems to collect point features on visible identifiable objects (VIO) scattered along coastal ranges. Due to these unique characteristics, especially independent ground control verification with GPS, the NPS Alaska Region is confident in the use of this imagery as a reference for EVS data validation, minor digitizing for the establishment of connecting arcs, and minor digitizing efforts as needed along glacial extents (Digital Shoreline data Assembly and Verification, Sections III and VI, respectively).

Table 3. Select metadata for the high quality imagery dataset available for this project.

Park	Imagery	Acquisition Date(s)	Type(s)	Scale(s)	NMAS[1] Accuracy (m)	GPS Accuracy (m)	GPS Accuracy Source(s)	Pixel Size (m)	Notes
ANIA	Coastal Imagery ANIA	July – August 1994	True Color, Pan	1:24,000	± 12	± 10 – 20 (est.)	1999 PLGR GPS (NPS); 2009 Building Survey	1.0	Tidally coordinated (see index for est. tides). Aerial photos rectified to Govt. Use Only DOQQs; GPS control pts.
	IKONOS OrthoImage Mosaic (NRCS)	2004 - 2005	True Color, Near IR	1:24,000	± 12	± 10 – 20 (est.)	1999 PLGR GPS (NPS); 2009 Building Survey	1.0	GPS control pts. for on-ground verification.
	IKONOS OrthoImage Mosaic	2005, 2007	True Color, Near IR	1:24,000	± 12	± 10 – 20 (est.)	1999 PLGR GPS (NPS); 2009 Building survey	1.0	GPS control pts. for on-ground verification.
BELA	Aircraft GMU and LIDAR Controlled Aerial photography[2]	2002	True Color	1:5,000	± 5	± 5	See Source Project AK0301	0.3	LIDAR controlled. Local tidal datum provides high quality imagery interpretive shoreline.
CAKR	Aircraft GMU and LIDAR Controlled Aerial photography[3]	2002	True Color	1:5,000	± 5	±5	See Source Project AK0302	0.3	LIDAR controlled. Local tidal datum provides high quality imagery interpretive shoreline.
KEFJ	IKONOS OrthoImage	2005	True Color	1:24,000	± 12	± 8	1998 GPS survey (NPS)	1.0	
	Coastal Pan OrthoPhotos	1993 -1994	Pan	1:24,000	± 12	± 8	1998 GPS survey (NPS)	0.3	Tidally coordinated (see index for est. tides). Co-referenced to IKONOS imagery and DEMs.
	CIR Orthophotos	2003 - 2004	Color IR	1:36,000, 1:40,000	± 12	± 8	1998 GPS survey (NPS)	0.5	Co-referenced to IKONOS imagery and DEMS.
	Seward OrthoImage IKONOS	June 2005	True Color	1:24,000	± 12	Unknown		1.0	
LACL	IKONOS OrthoImage	2005	True Color	1:24,000	± 12	Unknown		1.0	
	Coastal Imagery LACL	1992 -1994	Pan	1:24,000	± 40	Unknown		1.0	Low quality rectification. Tidally coordinated. Wait on use until Coastal OrthoPhoto is in place.
	Coastal OrthoPhoto[4]	July 2010	Color IR	1:24,000	NTE 1.5m RMSE	Unknown		0.6	Tidally coordinated. See Index for est. tides.

[1] National Mapping Accuracy Standards – horizontal accuracy. See the website http://rmmcweb.cr.usgs.gov/nmpstds/nmas.html

[2] Detailed metadata, including estimated horizontal accuracies, can be found at http://www.ngs.noaa.gov/desc_reports/AK0301.PDF

[3] Detailed metadata including estimated horizontal accuracies of imagery can be found at http://www.ngs.noaa.gov/desc_reports/AK0302.PDF

[4] Imagery acquired in July 2010. Processing is due Fall 2010 and is expected to be available Winter 2010/2011.

This validation effort shall serve as a means to identify potential errors contained in the linework. For this project, a potential error is defined as a section of linework that significantly deviates from the imagery and/or NOAA marine chart (Figures 10 and 11). When a potential error is identified, other NOAA data may prove more appropriate for shoreline revisions and should be evaluated. Potential errors in EVS linework are not expected to be common and should be brought to the attention of NPS Alaska Region project staff so the approach for shoreline revision in the affected area can be jointly discussed (Conceptual Model 1). In areas where potential EVS errors exist best efforts shall be put forth to determine the most reasonable approach for shoreline revision. This may include, but is not limited to, evaluation of NOAA ENC shoreline data and existing National Map NHD shoreline data, solicitation of shoreline/terrain characteristics from professionals with expert knowledge of the area, and/or the solicitation of supplemental information that could assist project staff in evaluating the reasonableness of the available shoreline linework (e.g. GPS data).

Figure 10. A potential EVS dataset error associated with the Pony Cove area at KEFJ. At this location the EVS MHW linework (pink) deviates from the coastlines depicted in the 2005 IKONOS and the 1993 coastal panchromatic imagery as well as the NOAA marine chart black line by distances greater than 350 meters in areas.

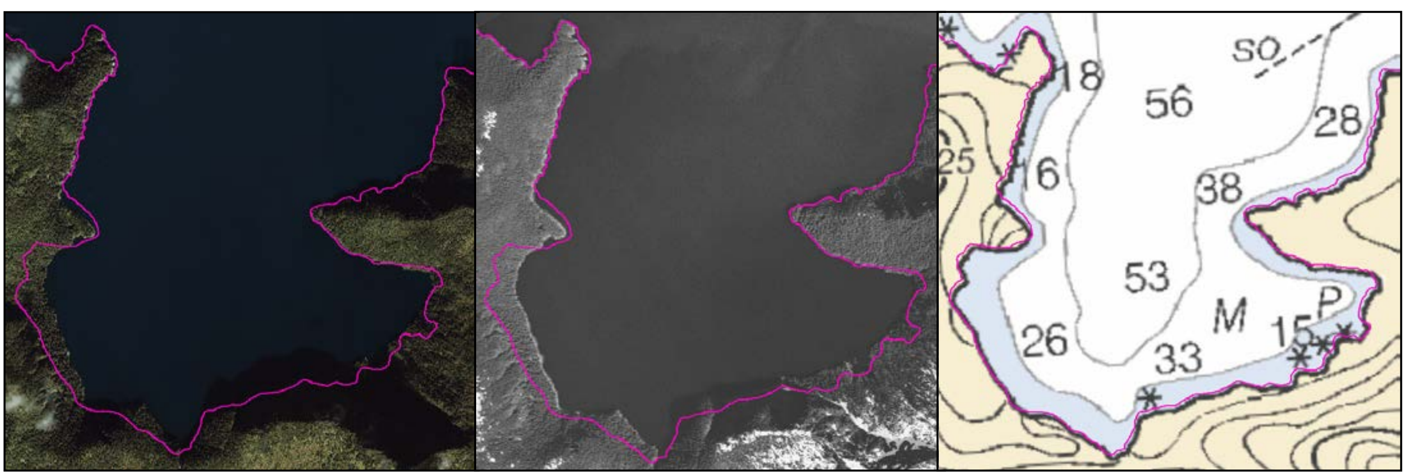


Figure 11. A potential EVS dataset error associated with the Agnes Cove area at KEFJ. At this location the EVS MHW linework deviates from the coastline depicted in the 2005 IKONOS and the 1993 coastal panchromatic imagery by distances greater than 70 meters in areas, but appears to agree with the NOAA marine chart black line.

During the KEFJ shoreline revision process two potential errors in the EVS dataset AK01B were identified along the Aialik Peninsula, one at Pony Cove and one at Agnes Cove. The most significant of these was exhibited at Pony Cove, where the EVS MHW linework deviated from the coastlines depicted in the available imagery (i.e. 2005 true color IKONOS satellite imagery and the 1993 coastal panchromatic aerial imagery) as well as from the black line MHW notation in the NOAA marine chart #16682 by distances greater than 350 meters in some areas (Figure 10). Per protocol, the NOAA ENC US4AK2FM dataset was then examined. The latest MHW linework available in the ENC US4AK2FM dataset for the Pony Cove area was derived from hydrographic survey work performed by NOAA in August and September 2001 as described in NOAA's H-Cell descriptive reports H-11074 and H-11075. During these 2001 hydrographic survey efforts NOAA conducted verification on their vector shoreline data from geographic cell 10494 (i.e. the EVS AK01B data from 1992). Shoreline revision recommendations based on this verification were subsequently captured by the ENC US4AK2FM dataset as identified in the descriptive reports. Validation of the ENC US4AK2FM data against the available imagery illustrates a correction in the shoreline for the Pony Cove area (Figure 12). For this reason, the ENC data was incorporated into the shoreline revision for this area of KEFJ[1] .

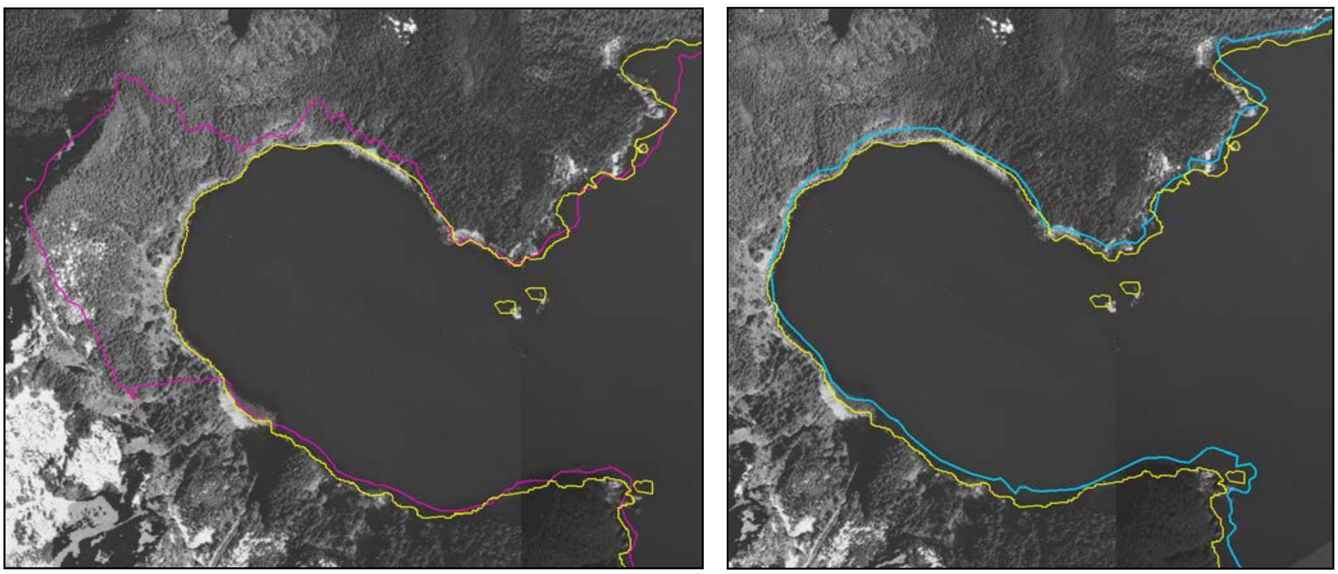


Figure 12. The image series above compares the quality of the ENC data available for the Pony Cove area of KEFJ (yellow) against the available EVS shoreline data (pink) and the existing National Map NHD linework (blue).

In the area of Agnes Cove where the other potential error at KEFJ was identified, EVS MHW linework deviated from the coastline depicted in the 2005 true color IKONOS satellite imagery and the 1993 panchromatic aerial imagery by distances greater than 70 meters in some areas, but appeared consistent with the black line MHW notation as seen in the NOAA marine chart #16682 (Figure 11). The ENC linework for the Agnes Cove area which was based on the same survey efforts as the linework at Pony Cove was evaluated. The ENC linework in the area was generally consistent with the EVS linework, expect for a minor correction to a small southern cove that had been disproved. Based on expert knowledge from the KEFJ Natural Resource Program the Agnes Cove shoreline is a very steep, stable rock shoreline. MHW is in this area is therefore not expected to fluctuate greatly over time nor extend as far landward as depicted by the NOAA data into the interior's spruce, hemlock, and alder vegetation.

[1] Prior to of NOAA's ENC dataset acceptance US4AK2FM into the shoreline revision for KEFJ, linework derived from the 2001 survey efforts described in NOAA's H-Cell descriptive reports H-11074 and H-11075 required generalization. The reasons for generalization as well as the approach applied are outlined in Section XII, *Generalizing Line Segments*.

For this reason, the existing National Map NHD digital shoreline data was conservatively retained in the southern portion of Agnes Cove where the potential error was seen (Figure 14).

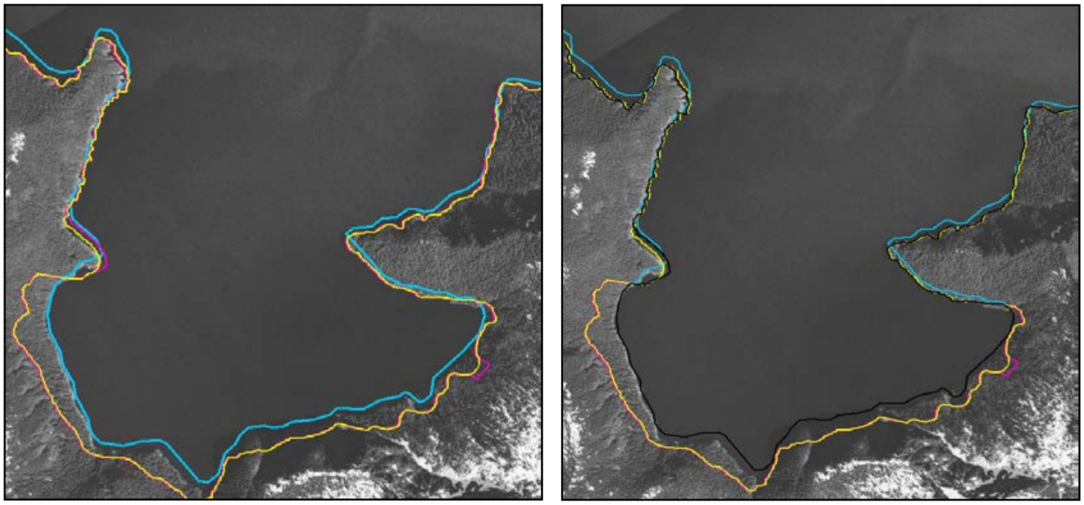


Figure 13. The image series above compares the quality of the ENC data available for the Agnes Cove area of KEFJ (yellow) against the available EVS shoreline data (pink) and the existing National Map NHD linework (blue). The right-hand image depicts the linework selections adopted in the Shoreline_Updates feature class in black for Agnes Cove.

The validation effort shall also serve as a means to identify potentially outdated linework in areas such as harbors where changes in shoreline occur more frequently due to the modification or construction of man-made waterfront structures and alongshore features such as breakwaters, wharfs, etc (Figure 14). In cases where EVS data appears outdated, other NOAA data may prove more appropriate for shoreline revision and should be evaluated. The best available NOAA shoreline data should be accepted, given the data postdates that of the National Map NHD line segment (Conceptual Model 1).

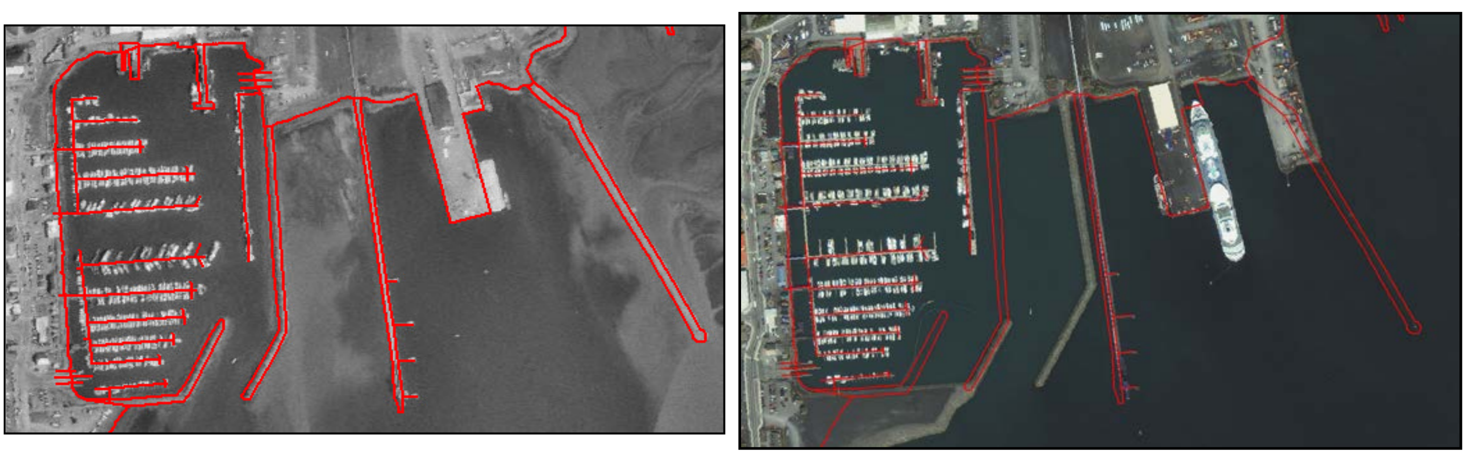


Figure 14. Example of outdated EVS data at the Seward Harbor near KEFJ. The EVS data for this area (red) is derived from survey work conducted in 1992. The linework is consistent with the appearance of the Seward Harbor as seen in the USGS digital orthophoto quadrangle (DOQ) from June 1997 (left), but does not reflect the more recent changes in breakwater or wharf configuration as seen in the 2005 IKONOS satellite imagery (right).

When imagery of sufficient quality is unavailable to validate the available EVS linework National Map NHD digital shoreline data shall be conservatively retained. Table 3 outlines the suitable imagery sources currently available for the five coastal parks associated with this project. However, over the course of this project additional imagery sources may become available for use in data validation.

When EVS linework is unavailable, ENC shoreline data provided by NOAA OCS shall serve as the secondary source for updates to the National Map NHD digital shoreline. ENC linework should be validated against the highest quality verifiable digital orthorectified imagery available (i.e. 1:24,000 or higher) and the most current, large scale NOAA marine chart prior to acceptance. This validation effort shall serve the same purpose as described for the NOAA EVS data. Conceptual Model 1 outlines the protocols established for the use of ENC data. Certain ENC linework provided by NOAA OCS is derived from survey work predating the USGS National Map NHD digital shoreline efforts of the 1940s and 1950s. Source inset maps available on the NOAA marine charts as well as the information provided by the NOAA NOS Hydrographic Survey Data ArcIMS site available at http://map.ngdc.noaa.gov/website/mgg/nos_hydro/viewer.htm can be of assistance in making these determinations. In such cases, the retention of existing National Map NHD digital shoreline is likely preferred. However, this will need to be determined by NPS and SMUMN project staff on a park by park basis (Conceptual Model 1). Along the western half of the KEFJ shoreline from Sandy Bay to Nuka Passage, for example, National Map NHD digital shoreline data was retained over the available NOAA ENC data. For the above mentioned stretch of shoreline the ENC dataset US4AK2EM was available. Excluding island linework, the shoreline data in this ENC dataset references the NOAA marine chart 16681 Seal Rocks to Gore Point as its source. The source inset map for marine chart 16681 indicates that much of ENC data in the area is based on survey work performed between 1900 and 1939 (Figure 15). Information provided through the NOAA NOS Hydrographic Survey Data ArcIMS site confirmed that the majority of the NOAA survey work in the area was conducted between 1927 and 1930 (Figure 16).

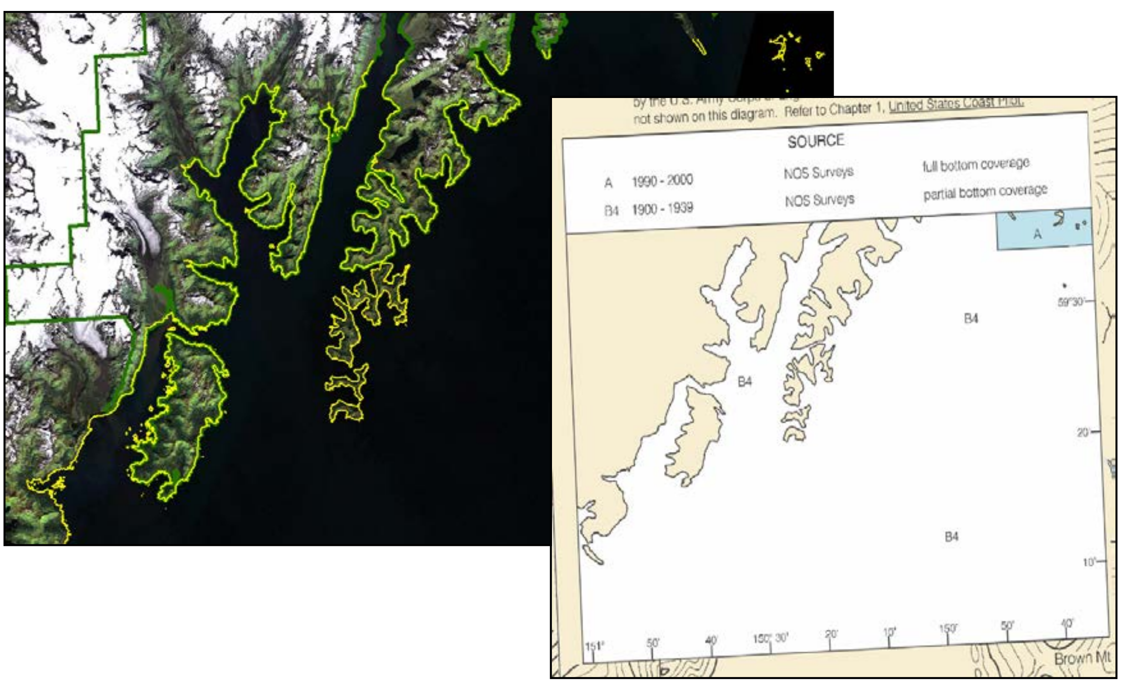


Figure 15. The NOAA ENC dataset US4AK2EM covers the western side of KEFJ as shown by the yellow linework in the left-hand image. The right-hand image depicts the source inset for NOAA marine chart #16681. Within this inset areas depicted in blue pertain to survey work conducted between 1990 and 2000, while areas depicted in white pertain to survey work conducted in 1939 or earlier.

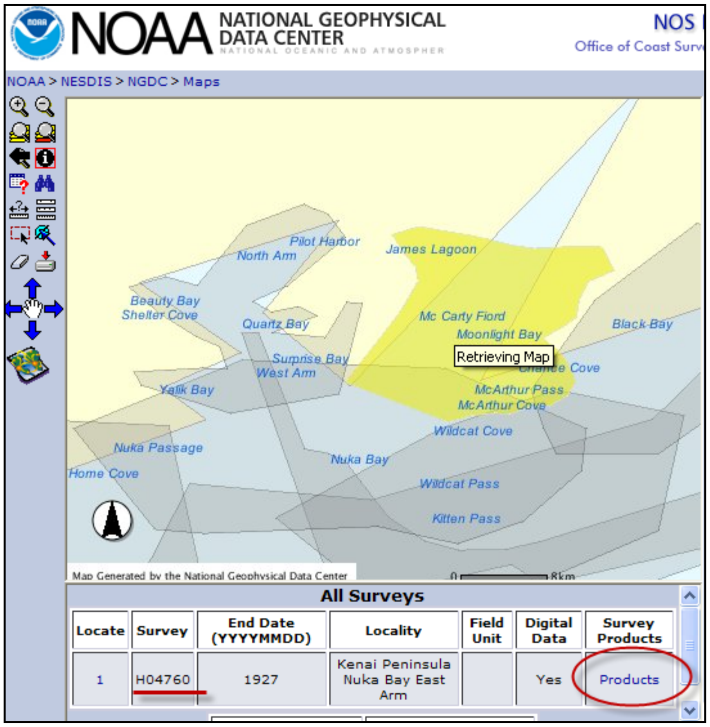
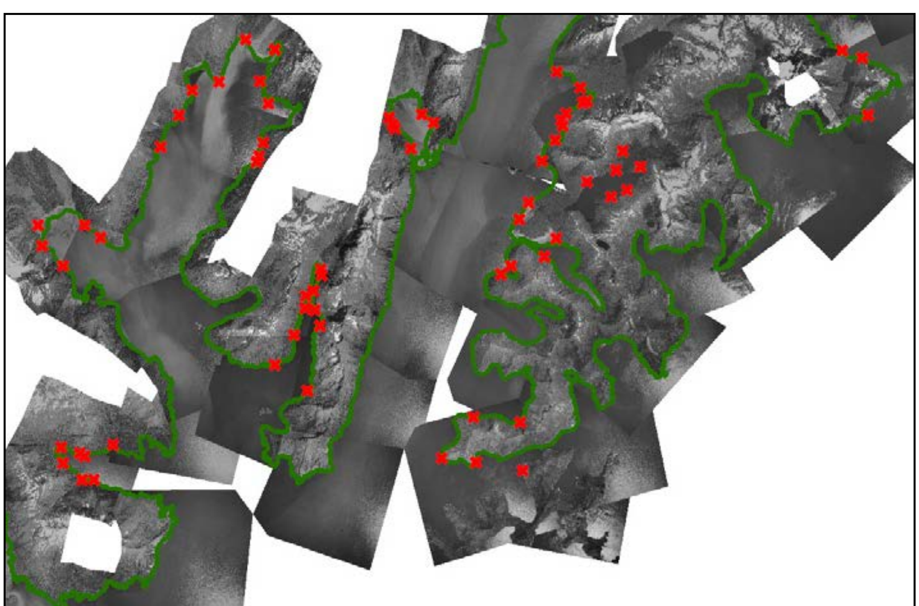


Figure 16. Screenshot from the NOAA NOS Hydrographic Survey Data web viewer showing the selection of a hydrographic survey conducted in McCarty Fjord (KEFJ). The descriptive report for the survey H-04760 can be accessed via the Products link. The end date for this survey is listed as 1927.

In this area of KEFJ a large number of dispersed GPS-collected ground control points were captured in 1998 for the purpose of registering imagery referenced in Table 3 (Figure 17). As a result this imagery has an implied accuracy of ± 8 meters. The NOAA shoreline data in the ENC US4AK2EM dataset does not agree well when compared against the imagery. Discrepancies ranging from approximately 50 meters to over 100 meters between the ENC shoreline linework and the 2005 IKONOS satellite imagery appeared frequently across the ENC dataset (Figure 19). As the available ENC data fails to provide an improved consistent representation of MHW, the decision was made in this instance to retain the existing National Map NHD digital shoreline data for this western stretch of KEFJ shoreline.

Figure 17. Location of GPS-collected ground control points (red crosses) captured in 1998 in the western half of KEFJ for the purpose of registering the aerial imagery of the Coastal Pan OrthoPhotos dataset. Additional control points were collected for this effort; however, this image focuses on presenting those that are spatially relatable to the NOAA ENC US4AK2EM dataset.



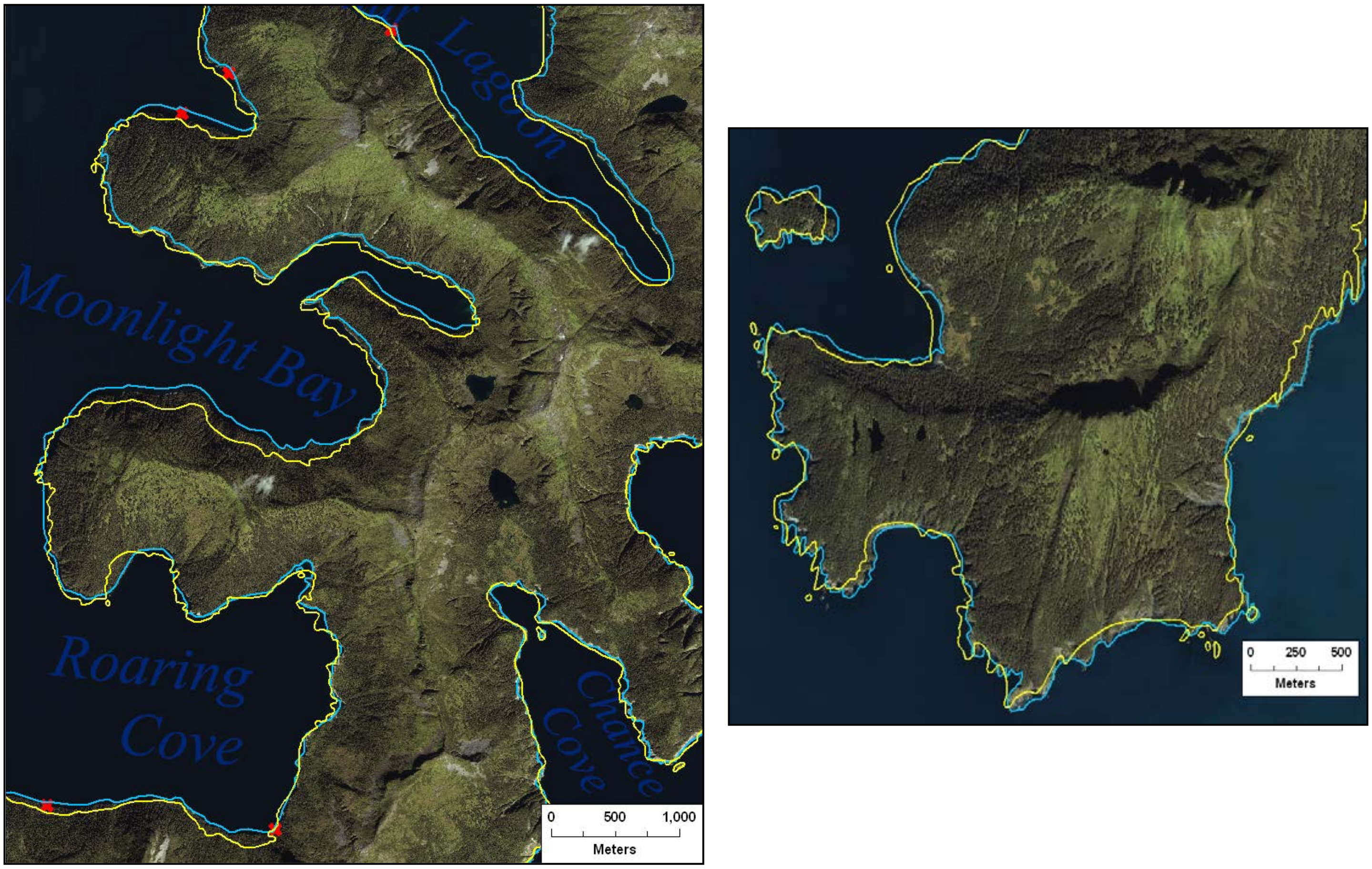


Figure 18. The image series above compares the quality of the ENC data available along the western half of KEFJ (yellow) against the available the existing National Map NHD linework (blue). Frequent discrepancies ranging from approximately 50 meters to over 100 meters between the ENC shoreline linework and the 2005 IKONOS satellite imagery are exemplified in the above images.

DIGITAL SHORELINE DATA ASSEMBLY AND VERIFICATION

I. COMPILING THE UPDATED DIGITAL SHORELINE

A new line-type feature class titled "Shoreline_Updates" should be developed in each park feature dataset of the project geodatabase (Figure 19). All line segments involved in the shoreline revision process for a park shall be stored as separate data records in the Shoreline_Updates feature class established for that park. The attribute structure for each Shoreline_Updates feature class should adopt the schema outlined in Table 4. The attribute structure of the Shoreline_Updates feature class was designed to facilitate documenting the linework decisions made for each park's shoreline revisions. The attribute fields "ObjectID", "Shape", and "Shape_Length" are mandatory fields assigned to the feature class by ESRI. Values for these fields will be automatically generated as data records are loaded into the Shoreline_Updates feature class.

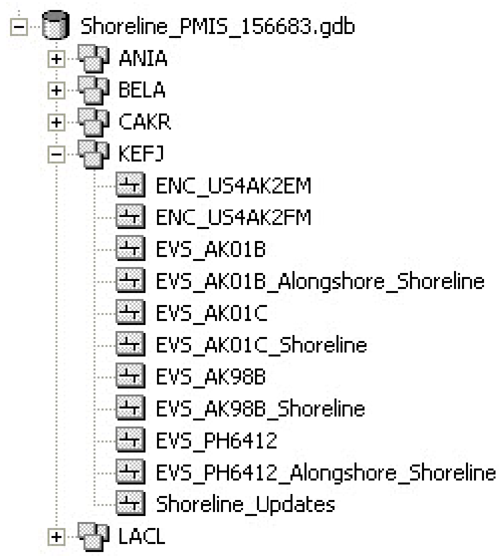


Figure 19. Example of the Shoreline_Updates feature class for KEFJ in the project geodatabase structure.

The attribute fields "Source_ID", "Source_Date", "Hor_Acc", "Attribute", and "Class" were included in the schema to capture information pertaining to the source and quality of the NOAA data used in the update process. These attribute fields are taken from the existing EVS data structure, as the extracted vector shoreline data is expected to be the primary source for revisions to the National Map NHD digital shoreline. When loading EVS data into a Shoreline_Updates feature class, values for these fields will be automatically generated given the attribute field mapping defined in Table 4 is followed. When loading ENC data into a Shoreline_Updates feature class, values for the attribute fields "Source_ID" and "Source_Date" will be automatically generated given the attribute field mapping defined in Table 4 is followed. However for ENC datasets, information related to the attribute fields "Hor_Acc", "Attribute", or "Class" is either not available or not attributed as a text field. Therefore, the population of these fields in the Shoreline_Updates feature class is not mandatory to ENC line segments.

The attribute fields "Update_Data_Reference", Update_Agency", and "Update_Method" were added to the schema to capture important reference information. Values for these attribute fields must be manually populated for all data records loaded in the Shoreline_Updates feature class. Largely, the values assigned to these attribute fields serve to assist project staff in tracking 1.) the source dataset from which the line segment originated, 2.) the agency providing the source dataset for the line segment, and 3.) whether the line segment is an existing line segment, was manually created through head-ups digitization, or was developed based on an outlined generalization approach. The information provided in these three attribute fields is expected to facilitate any review process that shall take place prior to linework finalization for NHD incorporation. Table 5 outlines the approach to be taken for entering notations into the "Update_Data_Reference" attribute field.

Table 4. Schema model for the Shoreline_Updates feature class.

Attribute Name	Data Type (Width)	Description	Domain	Mapping EVS	Mapping ENC	Mapping Other Segments
ObjectID	OID	Internal feature number.	-	Automatic	Automatic	Automatic
Shape	Geometry	Specifies the geometry of the record.	-	Automatic	Automatic	Automatic
Source_ID	Text (50)	Raw data source reference[1].	-	SOURCE_ID	SORIND	-
Source_Date	Text (8)	Date assigned to raw data source[2].	-	SRC_DATE	SORDAT	-
Hor_Acc	Text (6)	Specifies the implied horizontal accuracy of the raw EVS data.	-	HOR_ACC	-	-
Attribute	Text (50)	Indicates the feature type of the raw EVS data based on NGS C-Coast definitions[3].	-	ATTRIBUTE	-	-
Class	Text (32)	Specifies the class type of the raw EVS data based on NGS C-Coast definitions[3].	-	CLASS	-	-
Update_Data_Reference	Text (50)	Dataset reference for the record.	-	Manual	Manual	Manual
Update_Agency	Text (10)	Specifies the agency that provided the dataset referenced for the record.	NOAA NPS SMUMN USGS	Manual	Manual	Manual
Update_Method	Text (50)	Specifies whether the record is based on existing linework or digitizing efforts.	Existing Digitized Generalized	Manual	Manual	Manual
Shape_Length	Double	Specifies the length of the record.	-	Automatic	Automatic	Automatic

[1] EVS data source notations reference a survey's geographic cell or the survey's descriptive report code. ENC data source notations do not reference a raw data source. Instead they reference the NOAA-specific code assigned to the raw data source (e.g. the source indication "US,US,graph,BP-1884460" references the NOAA H-Cell Survey #11074). Inquiries regarding the meaning of ENC source values can be fielded by NOAA Office of Coast Survey (OCS). Once the meaning of the source value is obtained, further information on the raw data source may be accessible through the products offered online at the NOAA NOS Hydrographic Survey Data Viewer website (http://map.ngdc.noaa.gov/website/mgg/nos_hydro/viewer.htm).

[2] EVS source date notations reference the source survey date. ENC source date notations either reference the source survey date or the date of paper marine chart publication.

[3] The NGS's Coastal Cartographic Object Attribute Source Table (C-COAST) Index and Glossary is available online at http://www.ngs.noaa.gov/newsys_ims/misc/c_coast_def.htm.

Table 5. Notation protocol for the Update_Data_Reference attribute field in the Shoreline_Updates feature class.

Source Type	Update_Data_Reference Notation	Example(s)
NOAA EVS line segment	Data type followed by the NOAA project boundary.	EVS_AK01B; EVS_AK01C; EVS_AK98B
NOAA ENC line segment	Data type followed by the NOAA ENC cell name.	ENC_US4AK2EM; ENC_US4AK2FM; US4AK2GM

USGS NHD line segment	Source dataset title reference	NHD Flow Network- Region 19 Alaska
Digitized line segment – imagery based	Source dataset title reference	IKONOS OrthoImage True Color- KEFJ; Seward OrthoImage IKONOS 20050603
Digitized line segment – connect arc	Connecting Arc	Connecting Arc
Generalized NOAA line segment	Data type followed by the NOAA project boundary or cell name	EVS_AK01B; ENC_US4AK2EM

II. CLIPPING

The NOAA coastline data, whether EVS or ENC, covers the entire coast of Alaska irrespective of National Park boundaries. Since the focus of this project is NPS lands, it is necessary to limit the extent of the data to be updated. The park boundary provided in NPS Theme Manager can be used to extract the required data through a clipping operation. However, as is often the case there are inconsistencies between the park boundary and the coastline data which may lead to exclusion of data that should be included. This is normal and typically occurs because of projection, temporal, and scale differences between the data sets involved. These inconsistencies vary from park to park. An example for Cape Krusenstern (CAKR) is shown in Figure 20. The heavy green line is the park boundary, and the red line is the EVS data. An effective strategy for dealing with the inconsistencies between the park boundary and coastline data is to buffer the park boundary. An appropriate buffer size is determined by measuring the offset between the park boundary provided in NPS Theme Manager and the coastline data. Essentially, take the largest offset measured and double it. In the case of CAKR the buffer was 500 meters based on the largest measured offset of approximately 230 meters. The NPS Theme Manger park boundary is then buffered with the resulting layer used to clip the coastline data. The idea is to include all of the data that should be included while limiting the amount of extraneous data.

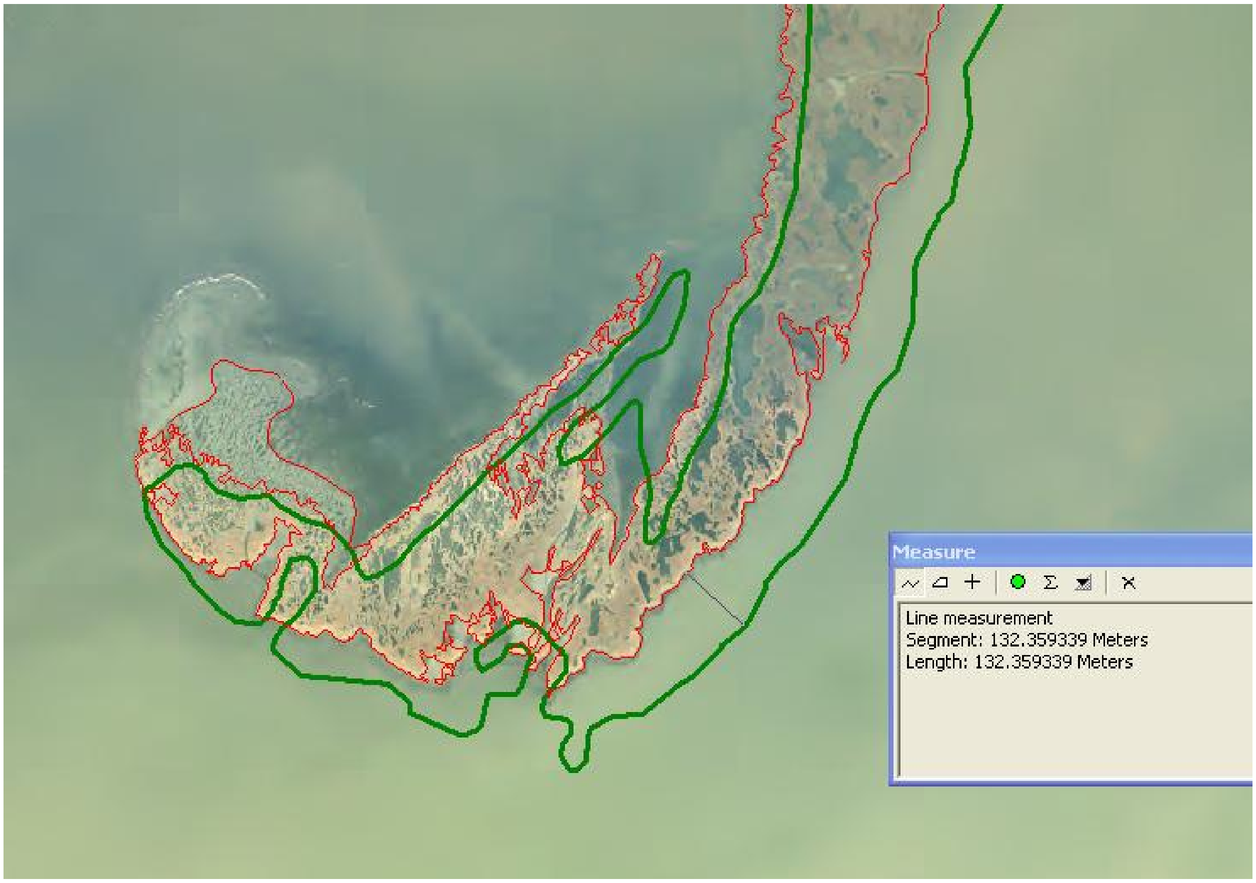


Figure 20. Inconsistency between park boundary and coastline data in eastern Cape Krusenstern National Monument (CAKR). Red is EVS coastline data and green is the CAKR boundary provided in the NPS Theme Manager.

III. JOINING LINE SEGMENTS

This project aims to replace the 1940-1950s era topographical National Map NHD digital shoreline with the best available NOAA delineations of high water line or MHW for five coastal parks in the Alaska Region NPS. Accomplishing this requires the joining or splicing of line segments together, whether to connect existing National Map NHD data with NOAA shoreline data or to connect various NOAA shoreline data sources together. The following text outlines preferred approaches for line segment joining.

i. Joining Dangling Line Segments

If the linework to be joined dangles and does not intersect at or near the point of the desired join, a connecting arc should be developed. The connecting arc should connect to existing nodes in each dataset when a snapping environment is applied, and promote a short transition between the two line segments, with as much of the original linework as possible preserved. The use of background imagery may be of assistance in determining an appropriate location for the placement of a connecting arc. Before developing a connecting arc the line records to be joined should be examined. The average distance between nodes should be determined for each line record. This can be accomplished generally through the use of the measurement tool, or more precisely through the application of the Split at Vertices tool available in the Features toolset of ArcToolbox's Data Management Tools toolbox. The distance between nodes in a connecting arc should be comparable to the smaller of the average node distances exhibited in the two original lineworks (Figure 21). For longer connecting arcs, this may require the placement of multiple nodes. Imagery should serve as a reference for the appropriate placement of multiple nodes when required (Figure 22).

In the scenario where two datasets of comparable quality (e.g. two NOAA EVS datasets) overlap in coverage but do not intersect, both datasets should be evaluated to determine a suitable join approach. Attribute values for fields such as "SRC_DATE", "HOR_ACC", and "ATTRIBUTE" should be examined and the linework compared against high quality verifiable digital orthorectified imagery (i.e. 1:24,000 or higher). When no such imagery is available for comparison, the dataset with the highest horizontal accuracy should be followed until an appropriate connecting arc between the two datasets can be established. When the distance between the two datasets (given their stated horizontal accuracies) implies either provides a reasonable representation of MHW and imagery is available for comparison, the linework that best fits the imagery may be followed until an appropriate connecting arc between the two datasets can be established (Figure 22). Additionally, the protocol outlined in the above paragraph shall further govern the development of the connecting arc.

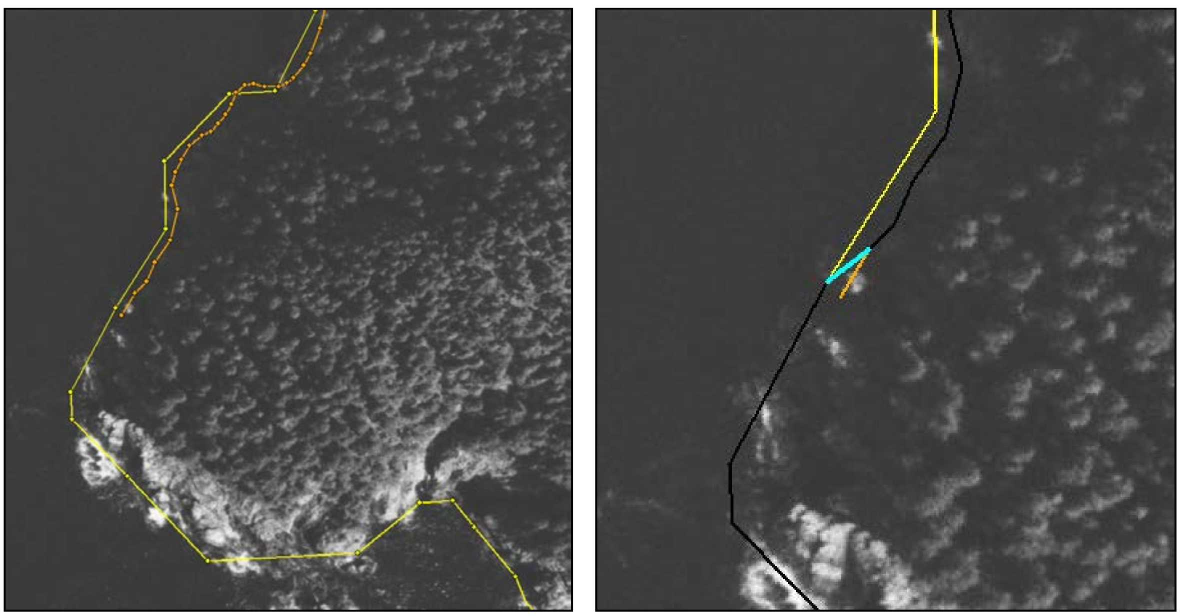


Figure 21. The image series above illustrates the join of an NOAA ENC dataset (yellow) to a NOAA EVS dataset (orange) for the KEFJ shoreline revision through the development of a connecting arc. The datasets to be joined provide an example of a dangle, as they do not intersect at the point of the desired join. The EVS dataset depicted in orange has a listed horizontal accuracy of 24.4 meters. Connecting the datasets at their existing intersection was not preferred as that would account for a loss of over 100 meters of high-quality EVS data. Instead a short connecting arc was established. The left-hand image presents the nodes that occur in each dataset. The average node distance for the ENC linework (yellow) was determined to be approximately 31 meters while the average node distance for the EVS linework (orange) was determined to be approximately 8 meters. Based on this information and the prerequisite that a connecting arc snap to existing nodes within the original data, the connecting arc depicted in blue in the right-hand image was established. The length of the connecting arc established (i.e. approximately 11 meters) is comparable to the average node distance seen in the EVS dataset.

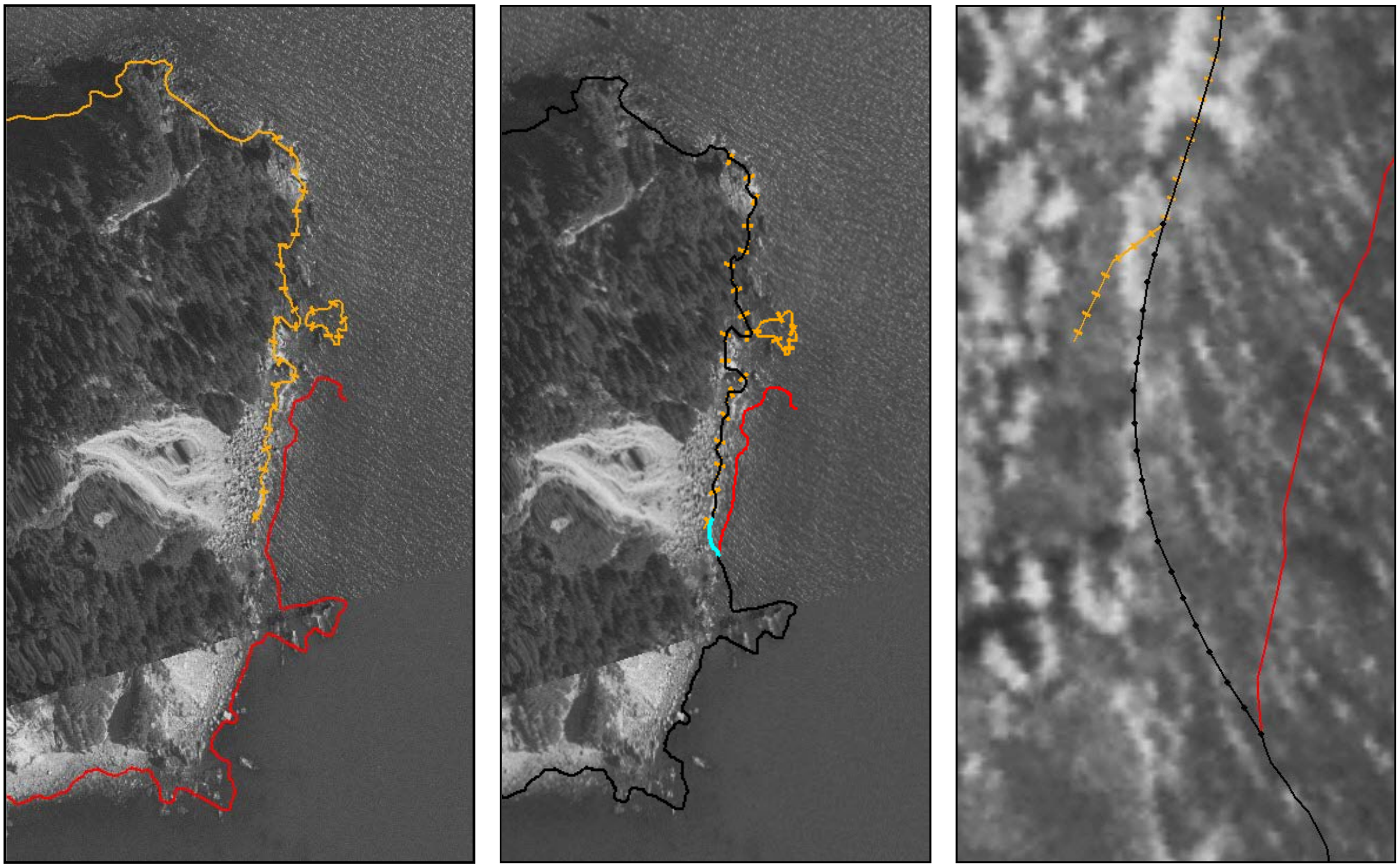


Figure 22. The above image series illustrates the join of two NOAA EVS datasets from 1998 for the KEFJ shoreline revision through the establishment of a connecting arc. The original linework for the two datasets is shown in the left-hand image. The orange hatched linework represents EVS data coded as Natural.Mean High Water.Approximate. Per the NGS C-Coast definition approximate NMHW linework is considered to be within 100 feet (30.5 meters) of its correct geographic location, and is used to denote shoreline obscured by shadows or line-of-sight blockage. The solid red linework represents EVS data coded as Natural.Mean High Water with a horizontal accuracy of 7.0 meters. The distance between the two datasets averages 15 meters or less (implies the actual MHW line could reasonably fall in the middle of the two sets of linework). As shown in the middle image the decision was made to use the orange EVS data over the red EVS data in the area of overlap given the imagery available. The connecting arc established for the join is presented in both the middle and right-hand images. In the right-hand image, the nodes of the connecting arc are visible.

Once the connecting arc is established in the Shoreline_Updates feature class proper attribution should be assigned to the data record as follows:

- Update_Data_Reference = Connecting Arc
- Update_Agency = NPS, SMUMN, etc.
- Update_Method = Digitized

After the connecting arc is documented, the line segments adjoining the arc should be edited as appropriate to its end nodes.

ii. Joining Line Segments at a Point of Intersection

If the linework to be joined intersects at or near the point of the desired join, then the linework should be spliced together at the point of intersection (Figures 23). This approach does not necessitate the development of a connecting arc. Instead both participating line segments should be loaded into the Shoreline_Updates feature class and appropriately edited to the point of intersection using editing properties and/or advanced editing options such as the Trim tool. Changes in shape length imparted to the line segments through editing should be automatically captured by the ESRI ArcGIS software once editing is complete.

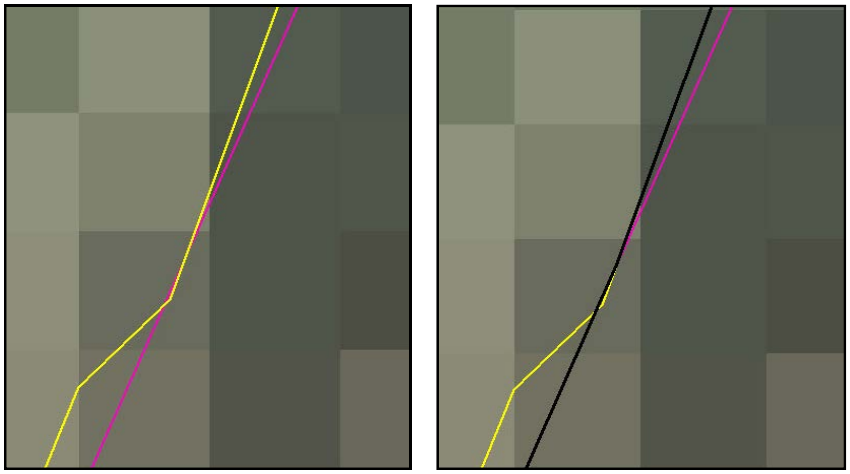


Figure 23. The image series on the left illustrates the join of NOAA EVS data (pink) to NOAA ENC data (yellow) at a point of intersection. The original linework for the two NOAA datasets is shown in the left-hand image. The right-hand image depicts the final Shoreline_Updates linework resulting from the join (black).

IV. HANDLING UPDATES ACROSS GLACIAL EXTENTS

i. EVS Line Segments

Certain EVS datasets will contain shoreline segments attributed as Natural.Glacier. NGS C-COAST defines natural as "composed of naturally occurring materials, or created, or appearing to have been created, by natural processes," and glacier as "a mass of snow and ice continuously moving from higher to lower ground or, if afloat, continuously spreading"[2]. EVS linework coded as Natural.Glacier may not match a glacial edge depicted in the available imagery. Furthermore, EVS linework coded as Natural.Mean High Water may appear to cross sections of glacial ice (Figure 24).

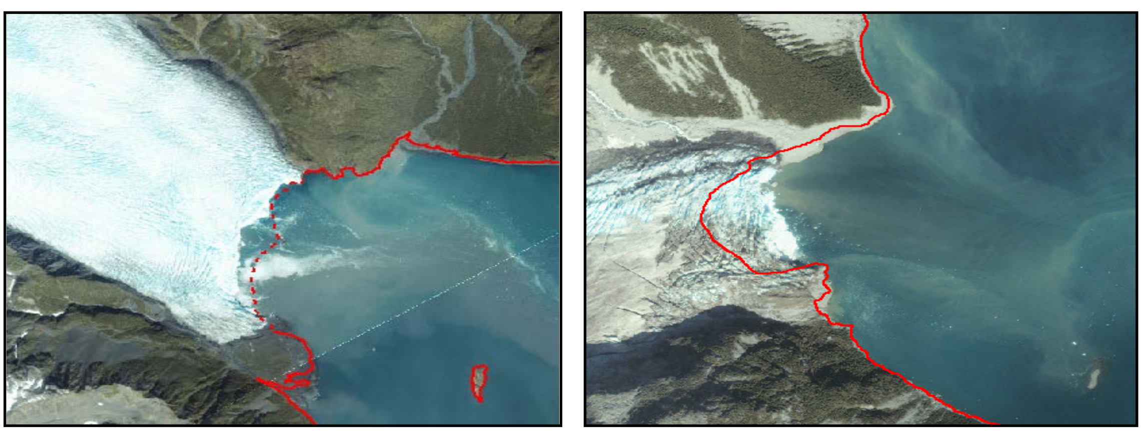


Figure 24. Differences in glacial edge depictions between NOAA EVS linework from 1998 and IKONOS satellite imagery from 2005 for KEFJ. In both images EVS linework is depicted in red, with solid line segments representing MHW and dashed line segments representing natural glacier.

These variations may be explained by the process of glacial retreat or advance, and temporal differences between the date of the NOAA coastal survey and the date of image acquisition. When such scenarios

[2] The NGS C-COAST index/glossary is available at http://www.ngs.noaa.gov/newsys_ims/misc/c_coast_def.htm.

are encountered the protocol outlined in Conceptual Model 2 (Digital Shoreline Data Assembly and Verification, Section XI) should be followed. When the protocol outlined in the conceptual model calls for the heads-up digitization of a line segment, digitizing shall be conducted in a controlled manner. All digitizing shall be conducted in stream mode at a scale of 1:5,000 or larger using the highest quality verifiable orthorectified imagery (i.e. 1:24,000 or higher) available for reference. During stream mode digitizing vertices are recorded automatically at preset intervals of either distance or time as the cursor is moved. The minimum interval between vertices is defined by the streaming tolerance assigned. For this project, a streaming tolerance of 10 meters shall be used. A snapping environment should be applied to ensure the ends of the digitized line segment reconnect to existing nodes in the MHW linework of the EVS data.

Digitizing efforts to update glacial linework are only appropriate if EVS data representing MHW (i.e. Natural.Mean High Water or Natural.Mean High Water. Approximate, etc.) abuts either side of the glacial edge. In this situation, the digitized segment should immediately reconnect to an existing node in the EVS MHW data. It is inappropriate to digitize across a glacial edge if the digitized segment cannot immediately reconnect to EVS MHW data, therefore requiring the extrapolation of MHW (Figure 25). One exception to this rule was made for updates to the KEFJ shoreline in the location of Pederson Glacier (Figure 26). At this location existing linework following a visual approximation of high water line using 2005 IKONOS true-color satellite imagery was available from the NPS Alaska Region Land Resources Program Center. This linework is not tied to a vertical tidal datum, nor is intended to be the definable NOAA MHW line. However extrapolation of MHW between EVS data at this location accounts only for about 1 km of shoreline (excluding the glacial edge), vastly improves upon the existing linework depicted by the National Map NHD, and offers a more current representation of the glacier's edge compared to the EVS from 1998. This linework originated from the most current version of the Alaska National Park Boundaries dataset managed by the NPS Alaska Region (i.e. May 2010), which is intended to provide a statewide summary of all park, preserve, monument, and current wilderness boundaries.

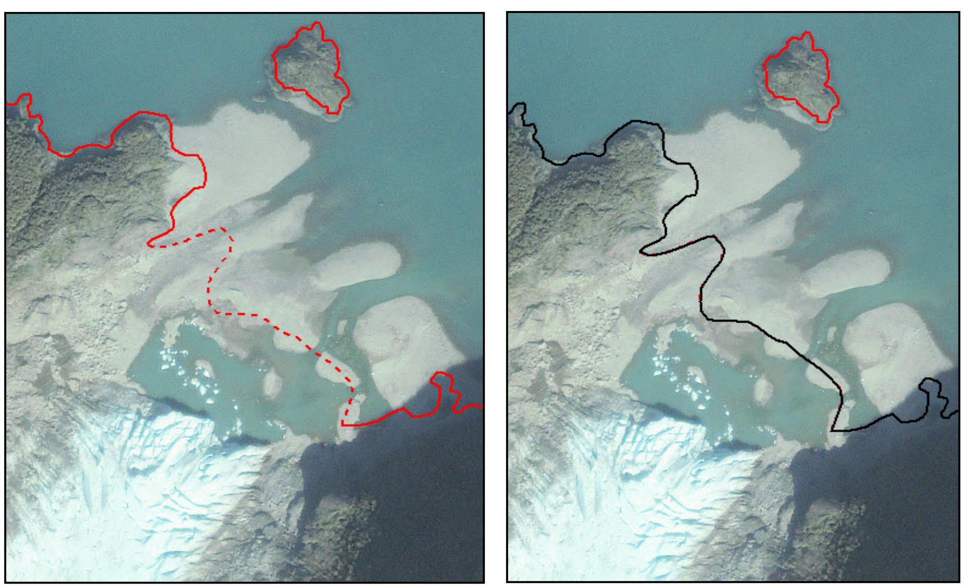


Figure 25. The image series above illustrates a scenario in KEFJ where digitizing a line segment across a glacial edge was inappropriate as the EVS data available did not abut the glacial edge and would therefore require the extrapolation of MHW. The left-hand image depicts the EVS data from 1998 in red, with solid line segments representing MHW and dashed line segments representing natural glacier. Despite disagreement with the 2005 IKONOS satellite imagery, the EVS data was directly accepted per protocol into the Shoreline_Updates feature class linework depicted in black in the right-hand image.

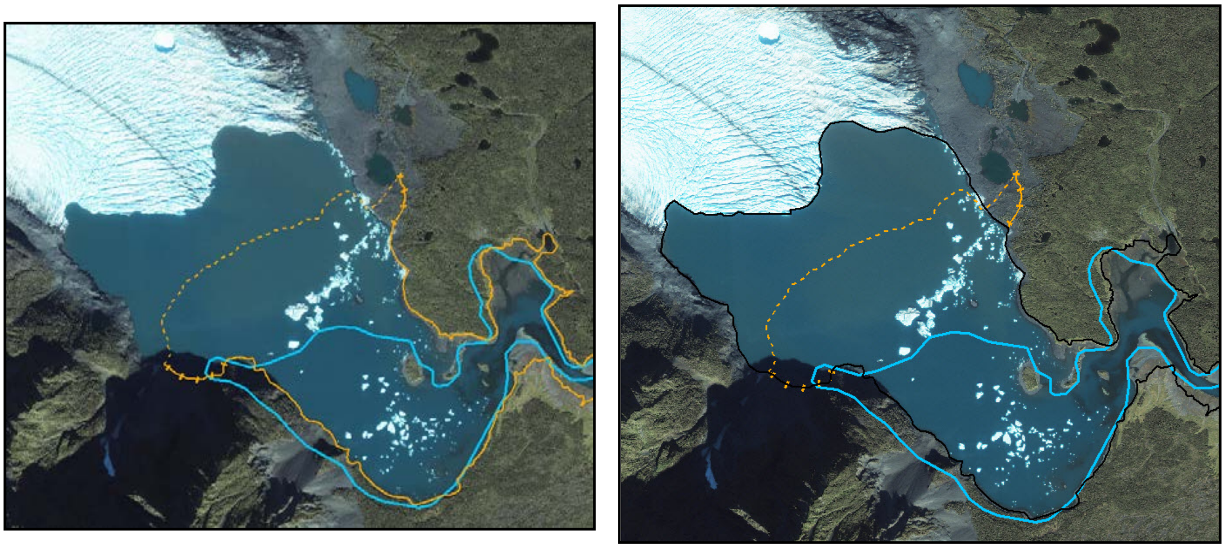


Figure 26. The left-hand image compares the EVS data available in the area of Pederson Glacier (KEFJ) (orange) against the existing National Map NHD digital shoreline data (blue). Solid orange linework represents MHW; hatched orange linework represents approximate MHW; and, dashed orange linework represents segments of natural glacier. The right-hand image depicts in black the shoreline linework that was accepted, as an exception to this protocol, into the Shoreline_Updates feature class for KEFJ.

Once established, digitized line segments should be appropriately attributed in the Shoreline_Updates feature class as follows:

- Update_Data_Reference = Imagery source used for the digitizing process
- Update_Agency = NPS, SMUMN, etc.
- Update_Method = Digitized

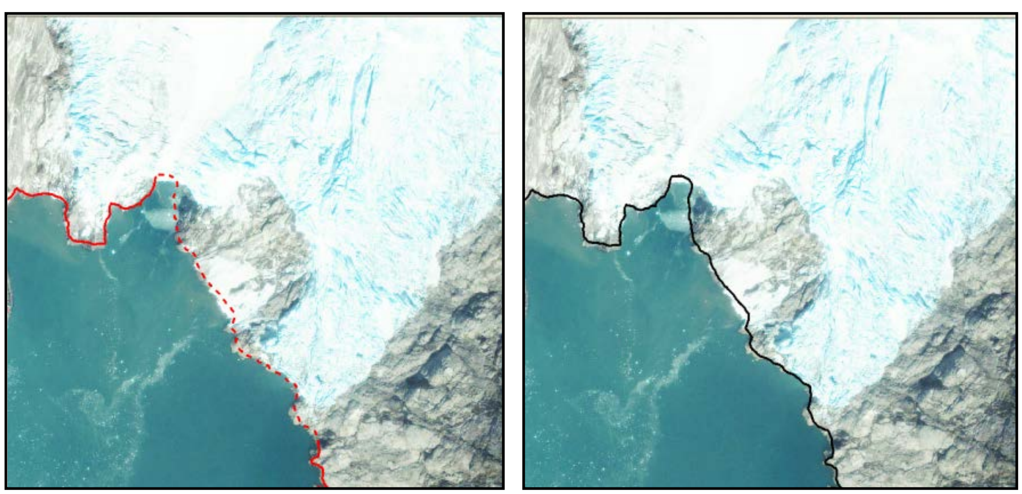


Figure 27. The image series above illustrates slight differences in glacial edge representation between the NOAA EVS data from 1998 and IKONOS satellite imagery from 2005 for the eastern portion of Northwestern Glacier in KEFJ. The left-hand image depicts the EVS data from 1998 in red, with solid line segments representing MHW and dashed line segments representing natural glacier. In this instance, EVS line segments deviate less than 20 meters from the glacial edge seen in the IKONOS satellite imagery. Based on the protocol outlined in Conceptual Model 2 these line segments were directly accepted into the Shoreline_Updates feature class linework depicted in black in the right-hand image.

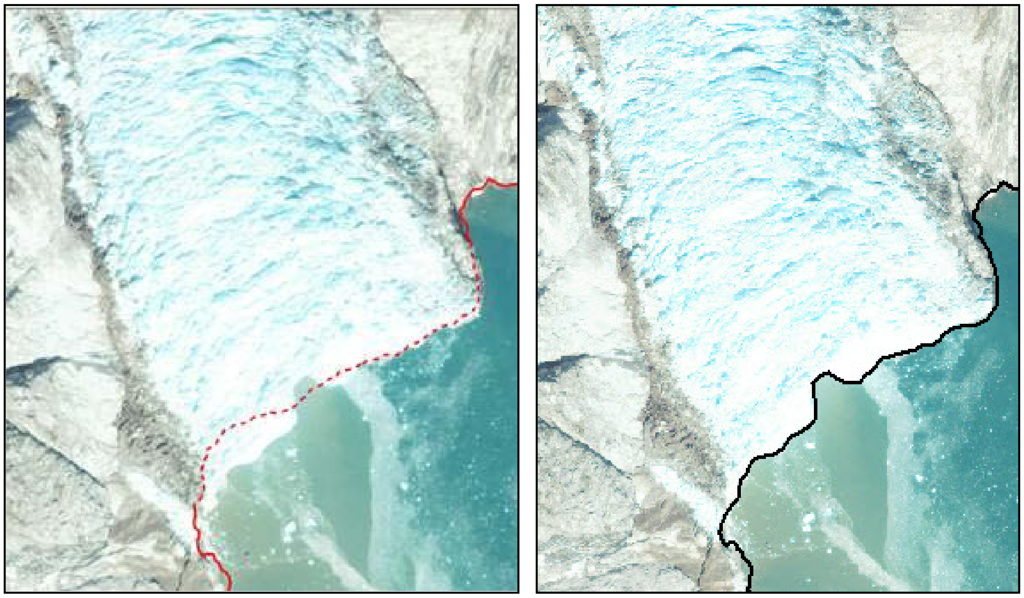


Figure 28. The image series above illustrates varying degrees of differences in glacial edge representation between the NOAA EVS data from 1998 and IKONOS satellite imagery from 2005 for the western portion of Northwestern Glacier in KEFJ. The left-hand image depicts the EVS data from 1998 in red, with solid line segments representing MHW and dashed line segments representing natural glacier. In this instance, the EVS natural glacier line segment deviates in some areas less than 20 meters from the glacial edge seen in the IKONOS satellite imagery and more than 20 meters in others. Based on the protocol outlined in Conceptual Model 2 the natural glacier line segment was replaced with the digitized line segment depicted in back in the right-hand image.

ii. ENC Line Segments

Certain ENC datasets will contain coastline segments valued as glacier (seaward end) in the "Category of Coastline" attribute field. ENC linework coded as glacier (seaward end) may not necessarily match a glacial edge depicted in the available imagery. Furthermore, certain ENC line segments not coded as glacier (seaward end) may appear to cross sections of glacial ice. As described in Digital Shoreline Data Assembly and Verification, Section IV, these variations may be explained by the process of glacial retreat or advance, and temporal differences between the date of the ENC data and the date of the image acquisition. When such scenarios are encountered the same general protocol referenced and outlined in Digital Shoreline Data Assembly and Verification, Section IV applies.

iii. National Map NHD Line Segments

When neither NOAA EVS nor ENC linework is available for use existing National Map NHD digital shoreline data shall be retained. Due to the era of the National Map NHD data, the linework contained is unlikely to match glacial edges depicted in the available imagery. However, digitizing efforts should be avoided in these scenarios to eliminate extrapolations of MHW (Figure 29).

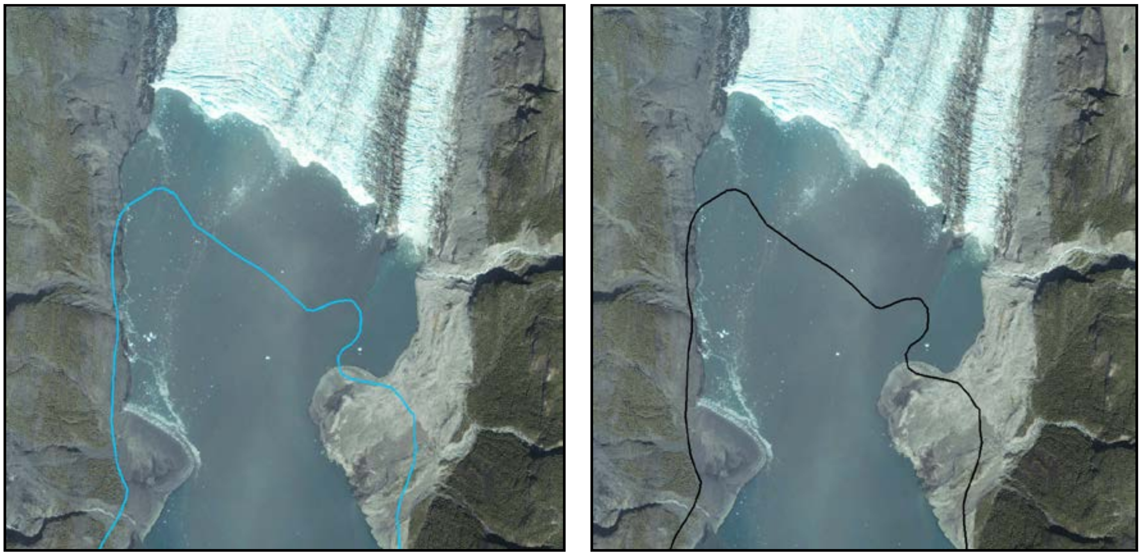


Figure 29. The image series above illustrates the decision to accept National Map NHD digital shoreline depictions of glacial extents in areas where neither NOAA EVS nor ENC data is available. In this scenario digitizing is inappropriate as it would require the extrapolation of MHW for distances between the National Map NHD data and the glacier's edge.

V. HANDLING UPDATES OF MAN-MADE WATERFRONT STRUCTURES & ALONGSHORE FEATURES

i. EVS Line Segments

As described in Selection and Processing of NOAA Data, Section III (i), project efforts shall focus on evaluating EVS line segments valued in the "CLASS" attribute field as SHORELINE and ALONGSHORE FEATURE. NGS C-COAST defines SHORELINE as "the intersection of the land, including man-made waterfront structures, with the water surface," and ALONGSHORE FEATURE as "an object that intersects, abuts, or is adjacent to and seaward of the shoreline." In the EVS data, the "ATTRIBUTE" attribute field provides more descriptive information on the type of SHORELINE or ALONGSHORE FEATURE depicted by a record (e.g. Man-made.Wharf or Quay, Breakwater.Bare, Pier, etc.). Linework related to man-made waterfront structures and alongshore features are currently contained in the National Map NHD digital shoreline. Largely, this includes linework related to breakwaters and wharfs or quays (Figure 30). For this reason, coastal linework in areas where man-made waterfront structures exist should be evaluated and updated if more current, higher-quality NOAA data is available. In such cases where EVS data will be used to update the digital shoreline the protocol outlined in Conceptual Model 3 (Digital Shoreline Data Assembly and Verification, Section XI) should be followed.

Figure 30. National Map NHD digital shoreline linework for the Seward Harbor (KEFJ). The left-hand image depicts the National Map NHD digital shoreline data against a USGS DOQ from June 1997. The right-hand image depicts the National Map NHD digital shoreline data against IKONOS satellite imagery from 2005. The breakwater and wharf/quay linework contained in the National Map NHD dataset generally appears to have been last processed between the 1980s and early 2000s, but is outdated compared to the IKONOS satellite imagery from 2005.

ii. ENC Line Segments

Per Selection and Processing of NOAA shoreline Data, Section III, the line-type feature class “CoastlineFeatures” shall be the ENC feature class of interest for the purpose of this project. Within the “COAST_TYPE” attribute field of this feature class line segments are valued as either Coastline or Shoreline records. Shoreline records relate to man-made waterfront structures and alongshore features. The “Category of shoreline construction” attribute field may provide more descriptive information on the type of ENC Shoreline feature depicted by a record (e.g. breakwater, pier [jetty], wharf [quay], rip rap, sea wall, ramp, etc.), while the “Condition” attribute field may provide more descriptive information regarding the feature’s condition. As described in Digital Shoreline Data Assembly and Verification, Section VI (i), the National Map NHD digital shoreline contains linework related to man-made waterfront structures and alongshore features, which are eligible for revision. In such cases where ENC data will be used to update the digital shoreline the protocol outlined in Conceptual Model 4 (Digital Shoreline Data Assembly and Verification, Section XI) should be followed.

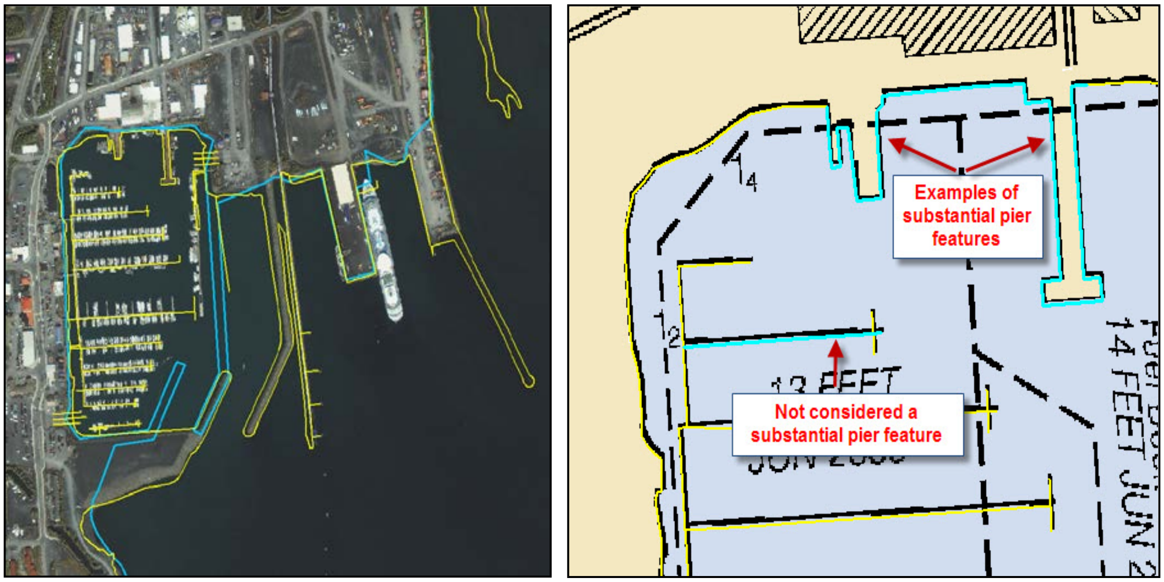


Figure 31. The left-hand image compares NOAA ENC linework for the Seward Harbor near KEFJ (yellow) against National Map NHD data (blue). The ENC linework is derived from August 2006 survey blueprints provided by the US Army Corps of Engineers, Alaska District. The left hand image compares the ENC data against the most current large-scale NOAA marine chart (i.e. 1:10,000), and assists in outlining what is described in Conceptual Model 4 as a substantial pier feature.

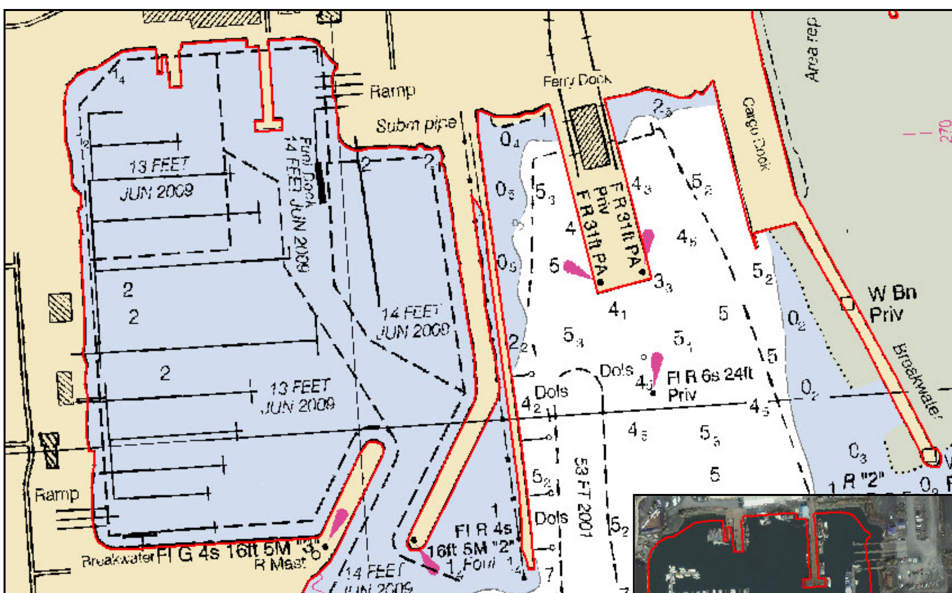


Figure 32 . This group of images illustrates the preferred approach for shoreline revisions at the Seward Harbor near KEFJ based on the protocol outlined in Conceptual Model 4. In these images NOAA ENC data is depicted in red. This linework was provided to illustrate the protocol outlined in Conceptual Model 4 only. The linework was not adopted into the shoreline revision for KEFJ at this time as despite available NOAA data and high-quality imagery, this area falls outside the management of the NPS.

VI. HANDLING INTERIOR DEPICTIONS OF MEAN HIGH WATER PRESENT IN NOAA DATA

Shoreline data provided by NOAA is likely to contain representations of MHW that when compared to the existing National Map NHD shoreline linework extend further landward, covering greater interior reaches (Figure 33). NOAA data may also contain MHW SHORELINE records that represent hydrographic features completely internal to the coast (Figure 34). In such cases, the NOAA data expected to replace the existing National Map NHD data shall be accepted in the interim into the Shoreline_Updates feature class as is, without modification. However, these areas shall subsequently be brought to the attention of the NPS Alaska Region project staff, so further information regarding the tidal influence of these features can be solicited from the suitable subject authorities. MHW linework is expected to be incorporated into the National Map NHD shoreline update where the feature in question is determined to be a tidally influenced saltwater feature. As a result of the determinations made the interim NOAA data accepted into the Shoreline_Updates feature class may require modification prior to finalization and NHD incorporation.

Figure 33. The above image series illustrates how EVS (red) and ENC (yellow) shoreline data provided by NOAA contains representations of MHW that when compared to existing National Map NHD linework (blue) extend further landward, covering greater interior reaches.

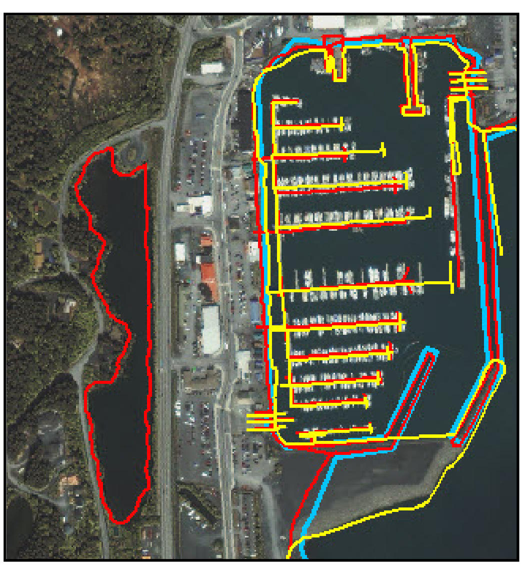


Figure 34. The images series to the left illustrates how EVS data provided by NGS NOAA (red) depicts the MHW level of features that are completely internal to the coast.

VII. HANDLING UPDATES OF OFFSHORE ISLANDS OR ROCKS (ISLETS)

Shoreline data provided by NOAA in EVS and ENC form depicts offshore islands, rocks (islets), shoals obstructions and other pertinent navigational hazard and features. A complete list of standard chart symbols can be found in the reference publication U.S. Chart 1: Nautical Chart Symbols, Abbreviations and Terms which can be freely downloaded at http://www.nauticalcharts.noaa.gov/mcd/chartno1.htm. In NOAA data offshore islands or islets represent areal extents that are separate and seaward of the mainland coastline and surrounded by a solid back line delineating MHW (Figures 35 and 36). Some nautical charts may also associate a number with an island, which represents the height in meters above the height datum. In the NOAA EVS and ENC datasets, islands and islets are represented by a single or a set or line records.

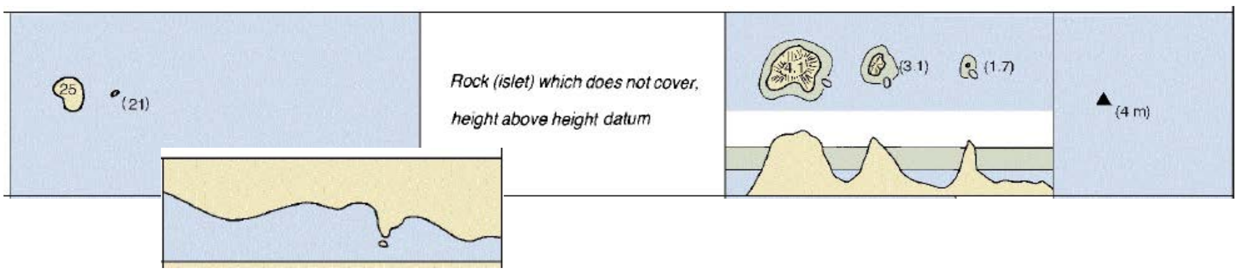


Figure 35. NOAA marine chart depiction of a rock (islet) and an island.

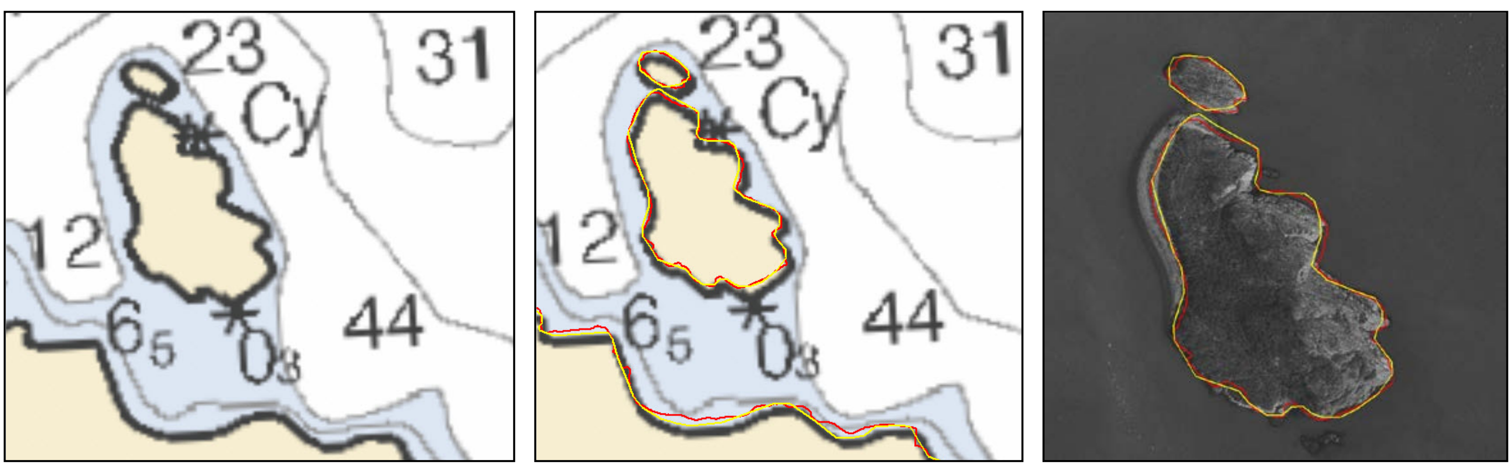


Figure 36. The left-hand illustrates the NOAA depiction of an island and/or islet group in Northwestern Lagoon of KEFJ as seen on a nautical chart. The middle image illustrates the EVS (red) and ENC (yellow) representations of those features against the chart. In the right-hand image the same EVS and ENC linework is compared the available panchromatic coastal imagery for KEFJ.

The National Map NHD also contains data related to islands and islets. However, islands and islets are handled as holes in the NHD Area dataset or as coastline reaches in the NHD Flowline dataset detached or seaward of the mainland coastline (Figure 37). No minimum mapping unit is currently assigned to islands and islets contained in the National Map NHD. Information regarding the minimum mapping unit for NOAA EVS and NOAA ENC datasets is still being solicited from NOAA OCS. Island and islet features are not represented consistently between National Map NHD, NOAA EVS, and NOAA ENC datasets. That is, an island or islet feature appearing in one dataset may be present in a second dataset but shaped differently, or may be absent from that second dataset altogether (Figure 38).

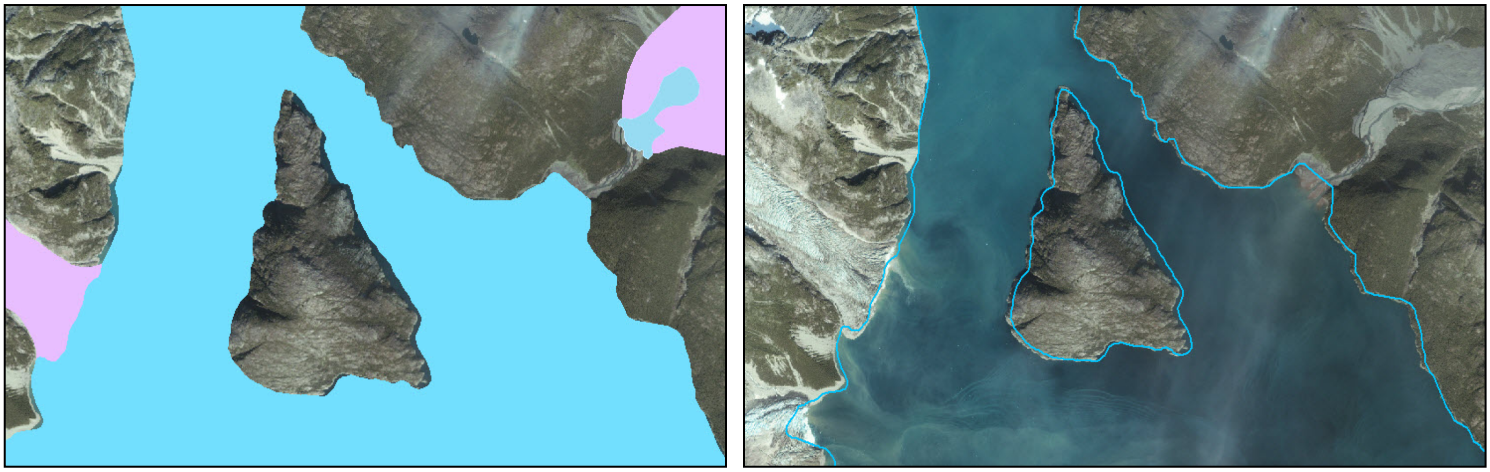


Figure 37. The image series above illustrates how island and islet features are handled in the National Map NHD. Within the NHD Area dataset as seen in the left-hand image island and islet features appear as holes in data classified as SeaOcean. Island or islet features in the NHD Flowline dataset are represented as linear features as seen in the right-hand image.

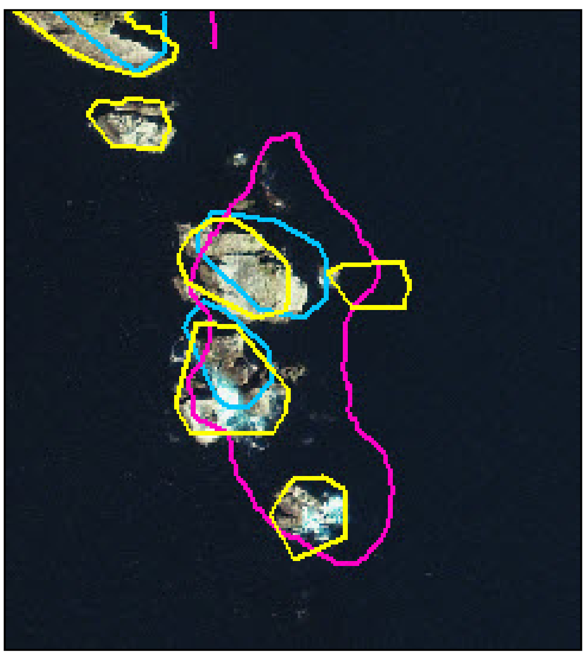


Figure 38. Example of how the representation of island/islet features vary between National Map NHD data (blue), NOAA EVS data (pink), and NOAA ENC data (yellow) for an area off of Aialik Cape at KEFJ.

With the exception of Nuka Island at Kenai Fjords National Park, the legislated park boundaries for the parklands associated with this project do not currently include offshore islands or islets[3]. For this reason, offshore island/islet feature representation as it currently exists in the National Map NHD data shall be maintained. That is, efforts shall not be put forth to replace the existing NHD island/islet data with island/islet data from NOAA EVS or NOAA ENC sources. Even though Nuka Island at KEFJ is a known

[3] The jurisdiction of offshore islands/islets is pending legislation for Lake Clark National Park and Preserve (LACL).

exception, the choice to retain National Map NHD linework for the island was made as no NOAA EVS data was available, and the NOAA ENC shoreline data that was available failed to provide an improved consistent representation of MHW.

As NOAA EVS and/or ENC linework is adopted into the shoreline revision process situations where NOAA data intersects or encompasses a National Map NHD island/islet feature are likely to occur (Figure 39). In these scenarios, the NOAA data expected to replace the existing National Map NHD data shall be accepted in the interim into the Shoreline_Updates feature class as is, without modification. However, these areas shall subsequently be brought to the attention of the NPS Alaska Region project staff so consultation with land managers at the appropriate agency or agencies can be initiated. The NPS Alaska Region wishes to avoid making changes to the National Map NHD dataset that would affect other agency boundaries without their notice or participation. Through discussions, it is hoped that the preferred approach for shoreline updates using NOAA data will be determined acceptable. In such cases the interim data contained in the Shoreline_Updates feature class can be finalized. This would require the removal of the National Map NHD island or islet feature, as island or islet feature cannot not topologically exist landward of the mainland coastline. If no consensus can be made following consultation, modification of the interim data would be necessary. This may require the retention of a section of existing National Map NHD linework.

Figure 39. The image series above illustrates how the acceptance of NOAA shoreline data may impact National Map NHD island/islet feature data. In the left-hand image, NOAA EVS data (red) intersects a National Map NHD island feature (blue) near Tooth Cove at KEFJ. In the right-hand image NOAA EVS data encompasses a National Map NHD island feature.

If the scope of this project is expanded to include other NPS Alaska Region parklands such as Katmai National Park and Preserve (KATM) or Glacier Bay National Park and Preserve (GLBA), whose legislated boundaries include offshore islands/islets a set distance off the coastline, the protocol for handling updates of offshore islands and islet must be revised. A reasonable minimum mapping unit for island and islet features would need to be determined, as well as a conceptual model developed outlining how the available linework will be evaluated to determine the best and most comprehensive island/islet feature updates.

VIII. MERGING

There are many instances in the NOAA coastline data of connected features having identical attributes. In Figure 40, the 6 features highlighted in light blue have identical attributes as shown in the table. In some cases these linear features are extremely small (<50 meters long). Often there are as many as 8-10 or more adjacent features with identical attributes.

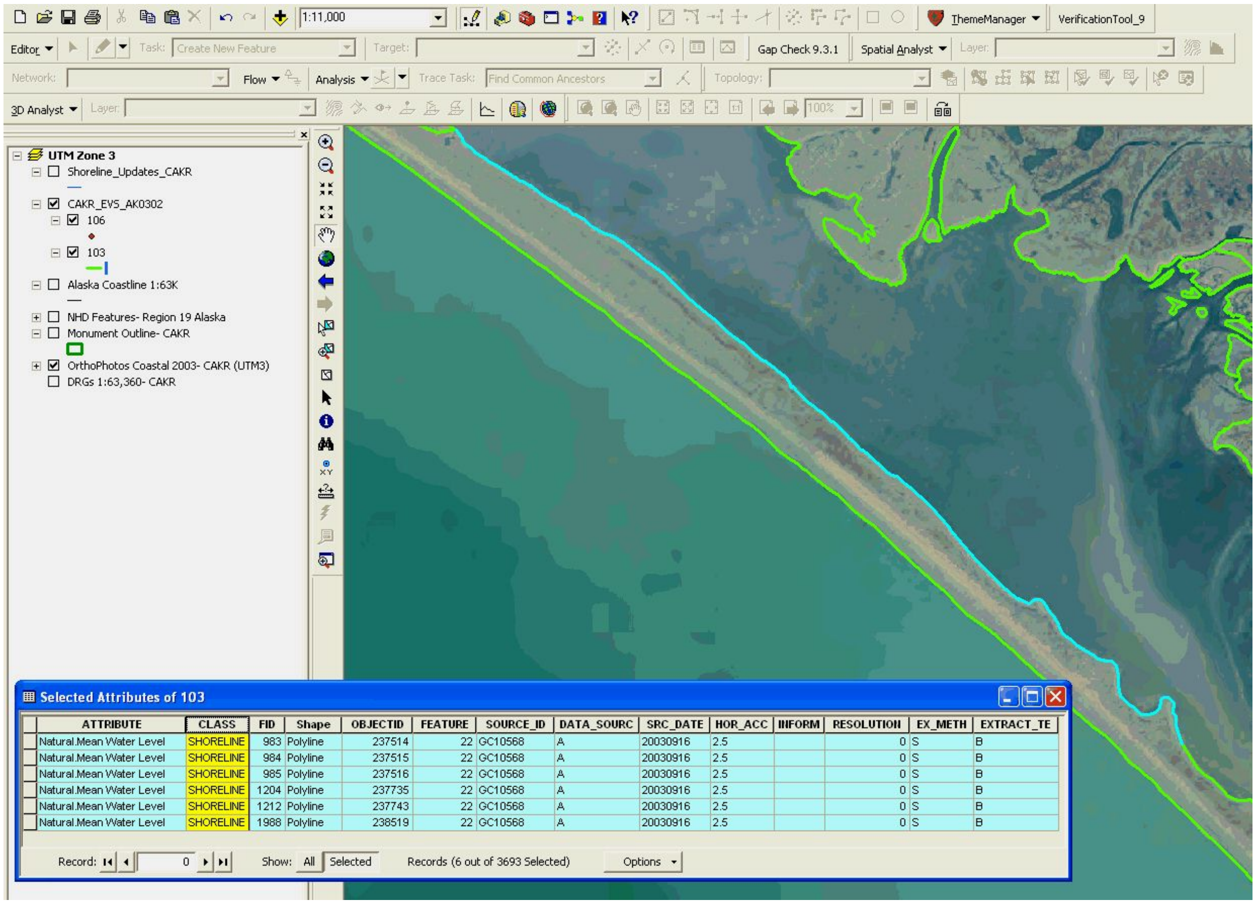


Figure 40. Features that should be merged. The selected (blue) line is actually 6 separate adjoining features with identical atributes.

The purpose of merging at this point is mainly to minimize the size of the database, making it less susceptible to data corruption. If there are any different attributes between adjoining features they are not merged. The data may be aggregated further before it is loaded into the NHD template, mainly because the ENC and EVS data have many more classes than the NHD for attributing a line. This is explained further below in <u>Migration to the National Hydrograhy Dataset, Section II (iii-A)</u>.

IX. GENERALIZING LINE SEGMENTS

Over the course of the project it may be necessary, under special circumstances, to generalize shoreline data provided by NOAA. One such circumstance warranting data generalization occurred during the KEFJ shoreline revision process for a section of ENC data extending along the eastern side of Aialik Peninsula. The ENC dataset US4AK2FM contained a subset of 48 line records with a rasterized appearance for a stretch of coastline south of Bulldog Cove to the Aialik Cape area (Figure 41). This linework was derived from hydrographic survey work performed by NOAA in August and September 2001. During these 2001 survey efforts shoreline verification was conducted against the existing shoreline vector data from NOAA's project geographic cell 10494 (GC10494) (i.e. the EVS data AK01B from 1992). Shoreline verification was done in part as errors in the EVS dataset AK01B were known to exist at certain areas (Figures 10 and 11). The resulting ENC data are based on shoreline revision recommendations outlined in NOAA's H-Cell descriptive reports H-11074 and H-11075[4]. As a result, the ENC linework was preferred in certain areas over the available EVS data. Generalization of this ENC data subset was necessary as the rasterized nature of the original linework would have inhibited its incorporation into the National Map NHD digital shoreline.

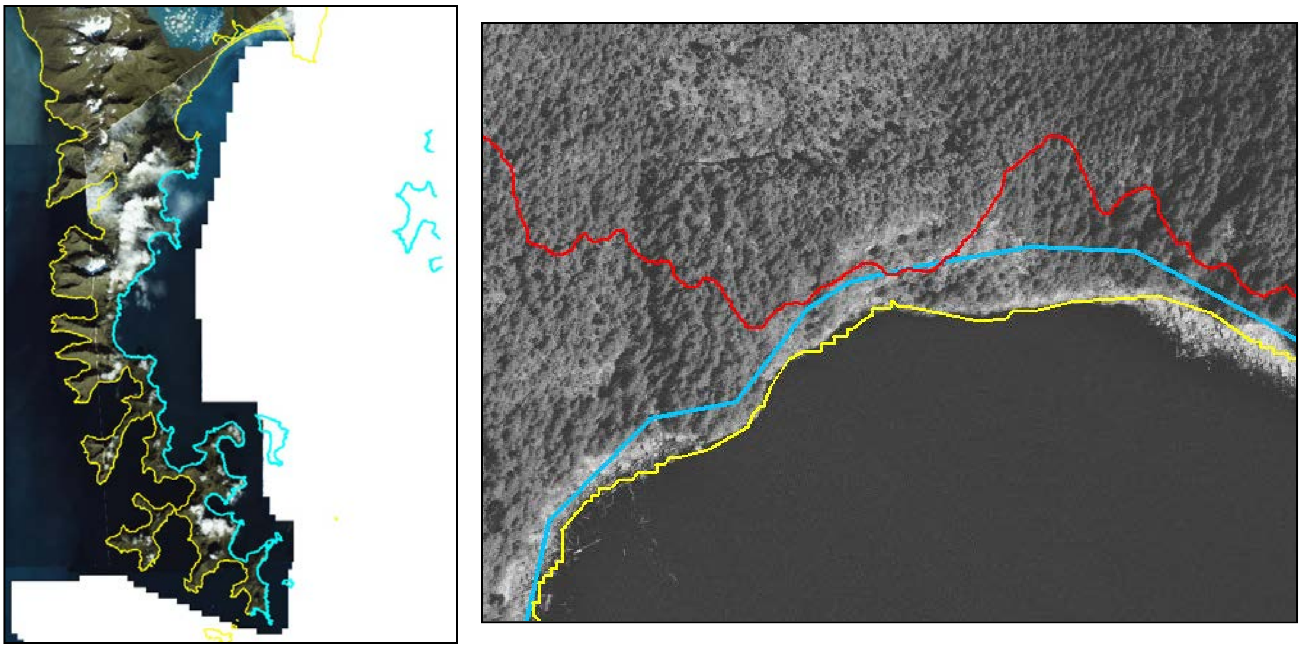


Figure 41. The image series above depicts a subset of shoreline linework within the ENC US4AK2FM dataset provided by NOAA. The extent of the ENC subset (blue) appears in the left-hand image. In the right-hand image a section of the potential EVS error identified at Pony Cove is depicted (red) against the ENC data (yellow) and National Map NHD data (blue). This image provides an example of suitability of this ENC data for areas along the Aialik Peninsula at KEFJ, but also portrays its rasterized character.

For generalization the 48 line record subset of the ENC US4AK2FM dataset was first extracted. The Split Line at Vertices tool available in the Feature toolset of ArcToolbox's Data Management Tools toolbox was then applied to break the line records into their most fundamental arc lengths. This created a dataset consisting of 13,036 records. Next, all records with a Shape_Length value greater than zero were selected (i.e. 12,978 records) using a Select by Attribute Query, and a text file was exported. The text file was opened in Microsoft Excel and the arc length mode, or value that occurs most frequently, was then determined for the dataset. For this subset of ENC data, the arc length mode was calculated

[4] The 48 line records that required generalization within the ENC dataset US4AK2FM were coded either "US, US, graph, BP-188460" or "US, US, graph, BP-188619" in the Source Indication attribute field. Per NOAA OCS the source code BP-188460 corresponds with the H-Cell survey H-11074 and the source code BP-188619 corresponds with H-Cell survey H-11075. NOAA's H-Cell descriptive reports H-11074 and H-11075 can be accessed through the NOS Hydrographic Survey Data website at http://map.ngdc.noaa.gov/website/mgg/nos_hydro/viewer.htm.

to be 4.1 meters. A new line-type feature class with an assigned XY tolerance of 4 meters (i.e. arc length mode) was then established in an interim file geodatabase titled ENC_US4AK2FM_Generalization[5]. During the development of this feature class the ENC attribute schema was imported from the raw ENC dataset within the project geodatabase. The 48 record subset of ENC data was then loaded into the established feature class and the Smooth Line tool available in the Generalization toolset of ArcToolbox's Data Management Tool toolbox applied. In the Smooth Line tool's dialog box, the Output Feature Class to be saved within the interim file geodatabase was titled ENC_US4AK2FM_Subset_4mPAEK; the PAEK smoothing algorithm was applied; a smoothing tolerance of 4 meters (i.e. arc length mode) was assigned; the option to preserve endpoint for closed lines was selected; and the "No Check" option for handling topological errors was chosen. PAEK, which stands for polynomial approximation with exponential kernel, was the algorithm type selected for the smoothing as it calculates a smoothed line that will not pass through input line vertices. Generalization results are presented in Figure 42. The resulting feature class was then loaded into the KEFJ feature dataset of the project geodatabase[6], loaded into an ArcMap session, and incorporated as needed into the Shoreline_Updates feature class for KEFJ.

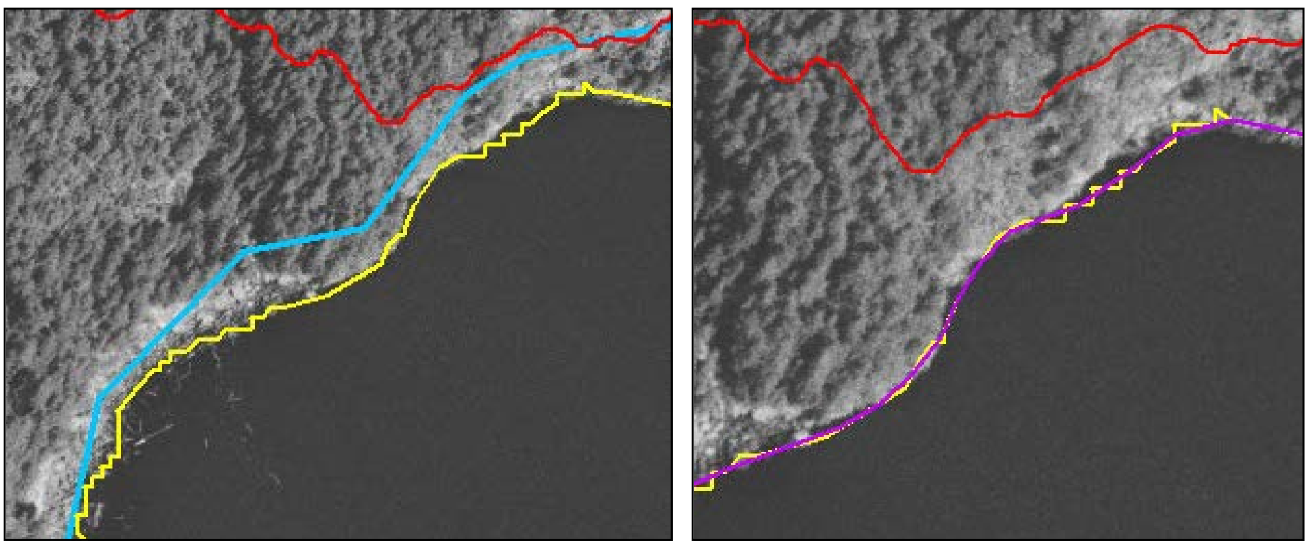


Figure 42. The image series above presents a snapshot of the results from linework generalization on a subset of ENC data from the dataset US4AK2FM for KEFJ. The original ENC data is presented in the left-hand image (yellow) along with EVS data (red) and National Map NHD shoreline data (blue). The right-hand image depicts how the generalized ENC shoreline data (purple) compares with the original linework.

If generalization of NOAA data is necessary, generalization shall follow the procedure outlined above. When submitting data to the NPS Alaska Region for review, all interim file geodatabases created for generalization purposes shall be submitted along with the project geodatabase for examination. Using this approach, it is expected that linework generalization should be representative of the original data as well as repeatable.

[5] The creation of an interim file geodatabase for data generalization was necessary as the feature class XY tolerance required for generalizing the ENC linework (i.e. 4 meters) differed from the default XY tolerance assigned to the feature classes within the project geodatabase (i.e. 0.001 meters). A feature class for generalization within the KEFJ feature dataset of the project geodatabase would not have permitted this change in XY tolerance.

[6] When loading the feature class into feature dataset the XY tolerance is reassigned from 4 meters to 0.001 meters. This change allows for the feature class to be adopted into the feature dataset, but does not actually adjust the data itself. This can be verified by comparing the ENC_US4AK2FM_Subset_4mPAEK feature class from the interim database to the ENC_US4AK2FM_Subset_4mPAEK feature class from the project geodatabase.

X. SHORELINE UPDATES – FINAL VERIFICATION

After the data has been prepared as explained in the previous sections, topology is built and validated to find any errors that might be present. Errors that might be present in the coastline linear data include:

1. Lines that overlap another line
2. Lines that self-overlap by looping back upon themselves.
3. Lines that cross another line.
4. Lines that loop back upon themselves and cross.
5. Lines with multiple vertices at the same location.
6. Lines that have gaps between them, but should be connected.

Topology is used to find these errors and ensure data quality. Topology rules are set to look for specific types of errors. The following rules are set for the coastline data:

1. Must not Overlap
2. Must not Self-Overlap
3. Must not Intersect
4. Must not Self-Intersect
5. Must not have Dangles

Rules 1-4 find instances where lines overlap or cross. Rule 5 finds the ends of lines that do not connect to another line. For example a connecting arc that was not properly snapped to the existing linework. Rule 5 will produce false positives along the edges of the data extent. All of the "must not have dangles" errors are inspected on a case by case basis. The false positives are marked as exceptions to the topology rules and the true errors are fixed.

Compacting the Shoreline_Updates geodatabase is the final step before submitting the data to the NPS for review. This is accomplished through ArcCatalog. For a little background, there is a group of tables in the database called delta tables. The delta tables keep track of every operation performed on the data and can get extremely large. Compacting reduces the size of the database by purging any unneeded records from the delta tables. This also helps promote stability of the database making it less susceptible to data corruption.

XI. CONCEPTUAL MODELS

The conceptual models outlined in this protocol were developed in Microsoft PowerPoint. The following hyperlinks can be selected to access each individual conceptual model.

- Conceptual Model 1 – Data Source Preferences
- Conceptual Model 2 – Updates Across Glacial Extents
- Conceptual Model 3 – Updates of Man-Made Waterfront Structures and Alongshore Features For EVS Data
- Conceptual Model 4 – Updates of Man-Made Waterfront Structures and Alongshore Features For ENC Data

MIGRATION TO THE NATIONAL HYDROGRPAHY DATASET

I. NATIONAL HYDROGRAPHY DATASET OVERVIEW

The National Hydrography Dataset (NHD) is the portion of the National Map that deals with hydrologic features. NHD contains information on both naturally occurring and constructed bodies of water. The information uses a coded classification system to identify features by type. Hydrologic flow networks are also part of the NHD. Information on related entities such as dams, bridges, or any other related features can be included as well. Each feature in the NHD is assigned a unique identifier that can be used to link additional data to the feature.

i. NHD Data Model Overview

The current NHD data model can be found at:
http://nhd.usgs.gov/NHDv2.0_poster_6_2_2010.pdf
This data model represents the current model for NHD data. It consists of a number of feature classes. There is some overlap between the types of features that can be added to each feature class. The core feature classes for the purposes of migrating the Shoreline Updates to the NHD template are:

- NHDLine – contains linear landmark features. This feature class contains landmark features that typically are not part of the drainage network and are included for cartographic purposes. In some cases, features in NHDLine can overlay features in NHDFlowline.
- NHDFlowline – contains the linear features that make up the hydrologic drainage network. This feature class is the basis for the geometric network that defines the flow relationships between the NHD features. The majority of these features are StreamRivers that are too narrow to be delineated as a polygon. NHDFlowline is probably the most important of all the NHD feature classes.
- NHDArea – contains polygon features. There is some overlap between the features in the NHD Area and NHD Waterbodies feature class. Generally the features in NHD Area are included for cartographic purposes. Areal StreamRivers and SeaOcean polygons fit into this feature class.
- NHDWaterbody – contains hydrographic features that are represented by polygons. Lakes, ponds, and estuaries fall within this category.

All of the feature classes use subtypes to describe each feature type. The subtypes are populated using a variety of coded value domains. The FType and FCode fields contain the coded values. The FType contains a 3 digit code while the FCode contains a 5 digit code that includes the FType + 2 digits which provide more detail about the nature of the feature. Examples of valid FTypes are 460 for StreamRiver, 558 for Artificial Path, and 390 for LakePond. 39004 is an example of an FCode for a LakePond – Perennial. All of the domains are described in the data model diagram.
There are some unique conventions concerning how features fit into each of the four feature classes. For instance, a river that is delineated as an area is not in the NHDWaterbody feature class but the NHDArea feature class. However, a LakePond areal feature is part of the NHDWaterbody feature class. In order to maintain the integrity of the drainage network the approximate center line of an areal river is represented as an artificial path in the NHDFlowline feature class. Similarly, SeaOcean is a subtype of the NHDArea feature class while Estuary is part of the NHDWaterbody feature class.

ii. Reaches

For the purposes of the NHD, a reach is a segment of surface water with similar hydrologic characteristics. NHD contains three types of reaches: transport, coastline, and waterbody. Transport reaches represent paths that water takes through a drainage network. Coastline reaches represent a section of coastline along the following bodies of water:

- Atlantic Ocean
- Pacific Ocean
- Arctic Ocean
- Great Lakes
- Gulf of Mexico
- Caribbean Sea

Both transport and coastline reaches are delineated using linear features. It should be noted that coastline reaches end where a transport reach discharges into the sea or a Great Lake.
A waterbody reach is a hydrologic feature delineated using polygons. LakePonds make up the majority of waterbody reaches, although in Alaska ice masses (glaciers), and estuaries are more common than in the lower 48 states.

iii. Geographic Names

The NHD uses the Federal government's Geographic Names Information System (GNIS) to name features. The GNIS name is stored in the GNIS_Name field. GNIS_ID contains the eight digit identifier for the feature in GNIS. If a feature does not have a GNIS name, the GNIS_ID and GNIS_Name fields are left blank.

iv. NHD Stewardship

The concept of the NHD program is to have a nationwide database of hydrologic features which are included in the National Map and are continuously revised based on the most current information and local knowledge. The United States Geological Survey (USGS) maintains the database, while updates are performed at the local level by public and private entities. All updates have to be reviewed by a data steward before being submitted to USGS for inclusion on the nationwide database. In most cases the data steward is an employee of a state agency who assumes responsibilities for NHD stewardship in addition to their normal duties. The core of the NHD Stewardship process is the idea that local level updates will lead to a more accurate and comprehensive dataset that can be utilized by end users nationwide.

II. THE NHD EDIT PROCESS

USGS has created several tools to process data for inclusion in the NHD. The NHD GeoEdit Tools are used for small scale edits of the data while the NHD GeoConflation Tool is used for editing large areas of data. Since the areas of interest are isolated to a relatively narrow band along the coast, USGS has recommended that the GeoEdit Tools be used for this project. USGS is currently in the process of rebuilding and improving the GeoEdit Tools. They are writing the tools to work in ArcGIS 9.3.1. Beta versions are expected to be released in late summer 2011. As an interim step, however, data will be migrated into the NHD data model using a template provided by USGS, thus ensuring that it will be ready for the GeoEdit process when the tools become available. The process described below is not the actual GeoEdit process, but it prepares the data for when the new GeoEdit tools become available.

i. Data Template Preparation

The data templates are downloaded from the NHD Stewardship page:
http://webhosts.cr.usgs.gov/steward/scripts/st2_software.pl
There are two templates that need to be downloaded:
NHD_AlbersEqArea_L48_93_v2.0_05262010.mdb
NHD_Geo_dd_93_v2.0_05262010.mdb
These are saved to a folder called NHD_Templates. Since there is no Albers template for Alaska, the Albers Equal Area template for the lower 48 is projected to Alaska Albers and named:
NHD_AlaskaAlbers_93_v2.0.mdb
The Alaska Albers template will be used for all of the NHD data in the Alaska parks. The Geographic coordinate system template is only used during the final stages of the NHD edit process. The final NHD_Templates folder should look like this:

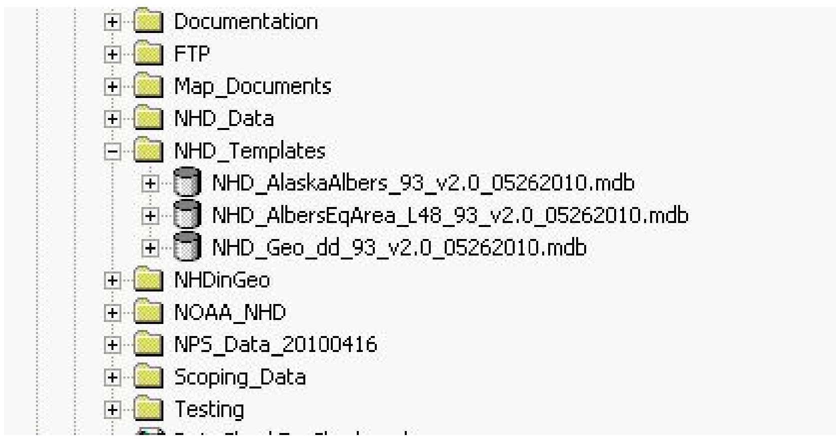


Figure 43. Final NHD_Templates folder showing all four templates required for the complete NHD edit process.

ii. Workspace Preparation

Create a folder called NHD Data as shown on the graphic. Under NHD create a folder with the four letter NPS park code for the park to be migrated (CAKR in this example). In this folder create two folders, one named Working and one named Final. As the names imply, Working is the location in which all processing will occur while Final is the location where the completed data will be stored (Figure 44).

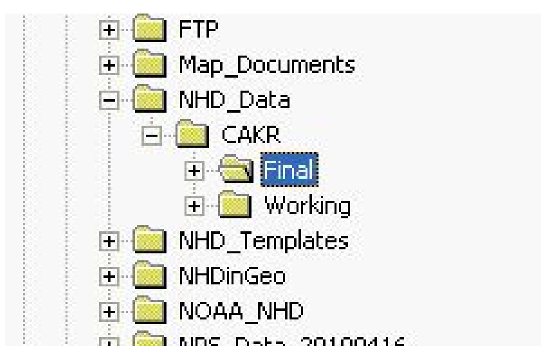


Figure 44. Working schema, showing a subfolder for each park in the NHD_Data folder.

iii. Data Preparation for Migration of Shoreline Data to the NHD Template

The starting point for migration is the Shoreline_Updates feature class for the particular park to be updated. Before proceeding with NHD migration, the Shoreline_Updates should have final NPS approval and be free of topology errors.

A. Linear to Polygon Conversion

Copy the NHD Alaska Albers template into the Working folder associated with the park to be migrated. Rename it with the park code at the beginning. For example, CAKR_NHD_AlaskaAlbers_v2.0.mdb.

1. Create a linear feature class called Lines as shown below (Figure 45).

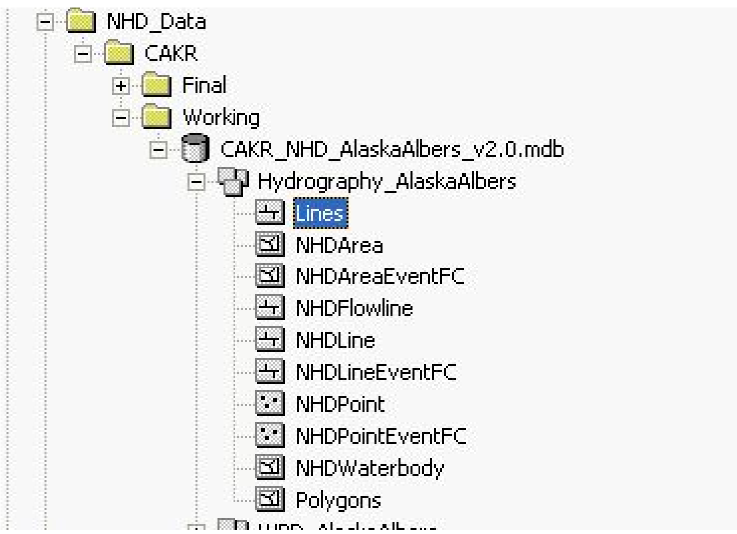


Figure 45. Working folder structure. Note the presence of all of the NHD feature classes. The Lines and Polygons feature classes are interim feature classes created by the editor. The lines are created in step 1, and the Polygons are created during step 4.

2. Import the linear features from the Shoreline_Updates feature class into the Lines feature class created in step 2.
3. Converting the linear feature class into a polygon feature class requires “closing” the lines. Edit the lines to close off any lines that do not form enclosed areas. The polygon conversion process will only convert enclosed areas to polygons. This is also a good time to add any lines that are needed, such as where areal rivers meet a coastline reach as shown in Figure 46 below.

Figure 46. Editing examples. Closing the estuary polygon was necessary because clipping the data to the park boundary, "opened" what would have been a closed polygon. Separation of the StreamRiver from the Estuary is required because once converted to polygon data, the areal StreamRiver will be migrated to the NHDArea feature class while the Estuary will be migrated to the NHDWaterbody feature class. The Artificial Paths are added for inclusion in the NHDFlowline feature class.

These are just a few examples of edits that may need to be performed for the linear to polygon conversion. It may be necessary to merge adjacent sections of coastline as well. For example the Shoreline_Updates data might have a section coast delineated by a series of line attributed some attributed as "Natural Mean High Water", and others as "Apparent Swamp or Marsh." NHD requires these are all attributed as "Coastline." According to the NHD standard, each coastline reach will be assigned a unique identifier. A coastline reach is the section of coast between the points where transport reaches discharge into the SeaOcean or Estuary. In either case, merging should only occur at junctions where only two features meet. When lines are merged in this situation the coincident nodes of each line become a vertex on the merged line. If there are three or more features meeting at a single junction, as is the case where a transport reach discharges, the features will not be merged. Merge coastline sections where there are two coastline sections abutting each other with no transport reach intersecting. NHD requires the entire coastline between transport reaches (StreamRiver or Artificial Path) be one feature for the purposes of assigning reach codes. The coastline feature should begin and end where transport reaches intersect. This means coastline features may need to be cut where they meet transport reaches. This includes any artificial paths that have been added to represent areal rivers. The end result should be one unique coastline reach between the points where any transport reaches meet the coastline. Lines should only be added to close off polygons, create artificial paths or to cut polygons into their proper classification (i.e. StreamRiver from LakePond or Estuary from SeaOcean). **At no time should the geometry of the NOAA data be changed regardless of whether it is based on the EVS or ENC.**

4. The next step is to convert the Lines feature class to a polygon feature class. To do this open ArcCatalog and navigate to the NHD layer containing the Lines feature class as shown in Figure 47. Right-click on the feature dataset containing the Lines feature class, click New (not Import as shown), then Polygon Feature Class from Lines.

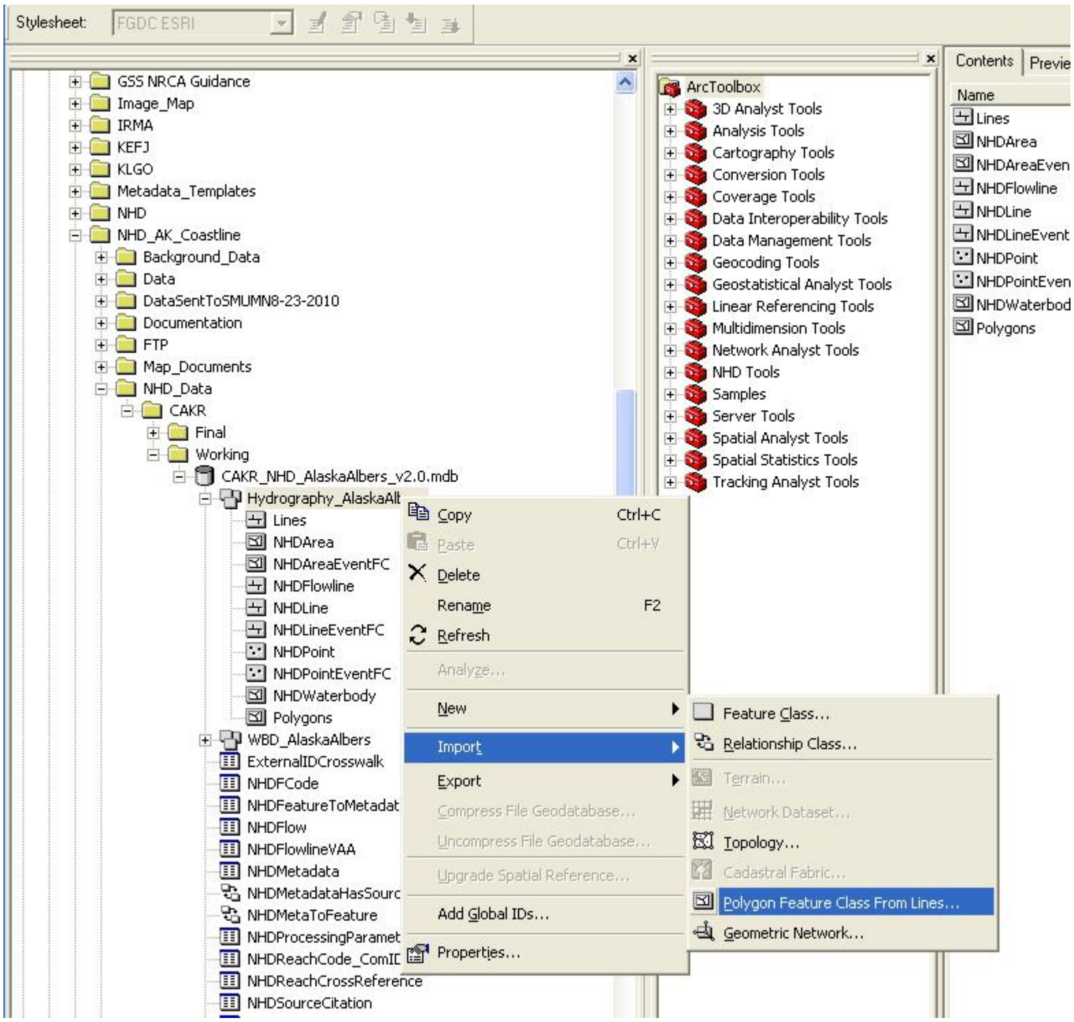


Figure 47. Invoking the Polygon Feature Class form Lines command.

5. Clicking on Polygon Feature Class From Lines brings up the following dialog box. Name the feature class polygons, accept the default Cluster tolerance, check the Lines feature class in the list, and then click OK.

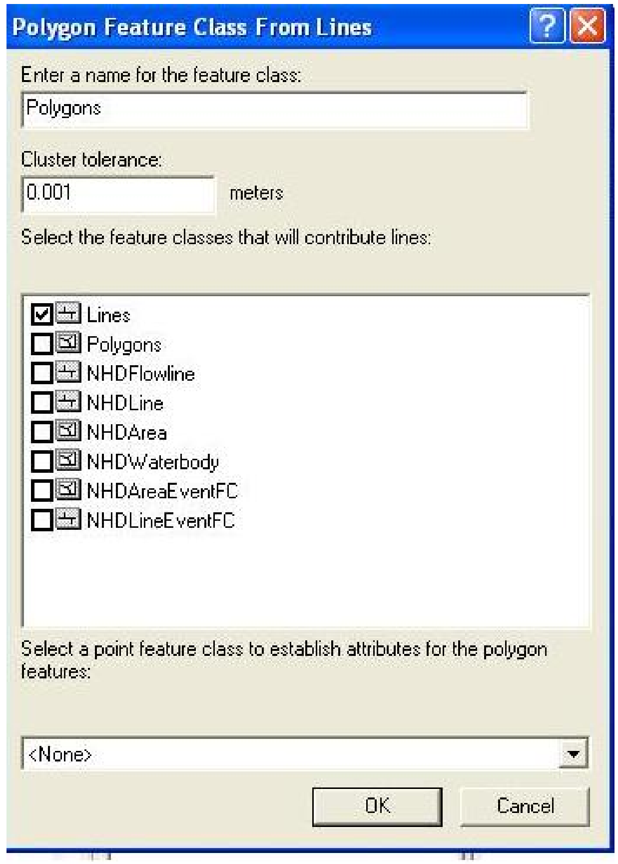


Figure 48. Polygon feature Class from Lines interface.

B. Migration

Migration involves not only moving the features from the Lines and Polygons feature classes to the NHD Data Model, but also populating the NHD feature classes with the appropriate FType, FCode, GNIS_ID and GNIS Name. The best approach is to move the features into the NHD template and then populate it with the correct attributes.

1. Since the features to be migrated reside in two feature classes which will be moved into four feature classes, it is necessary to review the data and specify to which NHD feature class(es) the feature belongs. First, create a coded value domain containing values that will specify to which NHD feature class(es) the feature belongs. Also, create a short integer field called NHD_FC in both the Lines and Polygons feature classes that uses this domain. This field will be populated during the next step to specify the NHD feature class to which the feature will be migrated and then queried during the actual data migration. Include the following values:

   A. NHDWaterbody, NHD_FC = 1
   B. NHDArea, NHD_FC = 2
   C. NHDLine, NHD_FC = 3

D. NHDFlowline, NHD_FC = 4

E. Both NHDLine and NHDFlowline, NHD_FC = 5

F. Not Included in NHD, NHD_FC = 999

2. Open ArcMap and add the Polygons feature class with an appropriate imagery layer in the background. Start editing and pan through the data removing any polygons that are land. These will be mainly islands. A Before & After example is shown in Figure 49. Polygons are symbolized in blue with 50% transparency.

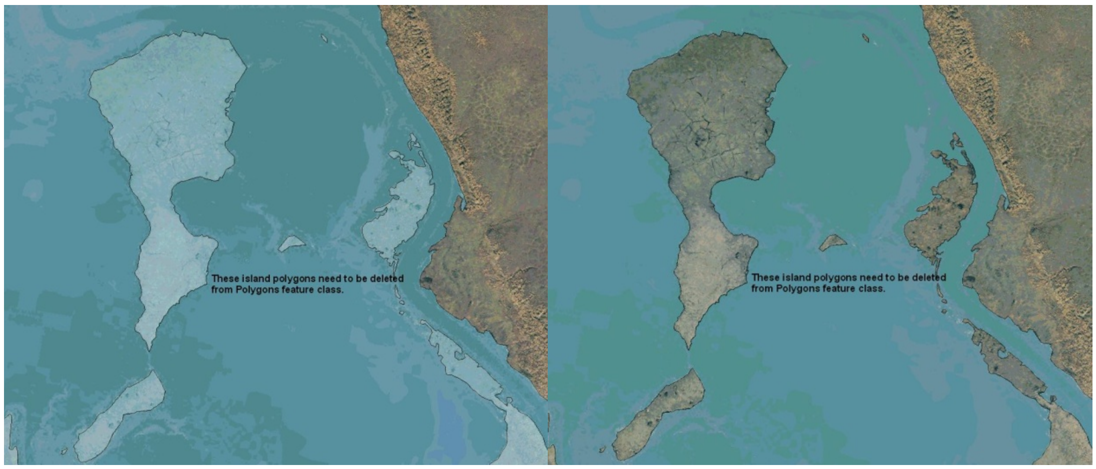


Figure 49. Polygon removal example. Left graphic shows data before the island polygons are removed. Right hand side shows the result after the islands polygons are deleted. Polygons are symbolized in blue with 50% transparency.

While looking for islands that need to be deleted, populate the NHD_FC field for all of polygon features. In most cases it will be NHDWaterbody, but in a few instances such as the areal rivers and SeaOcean areas it will be NHDArea. Follow the same procedure to populate the NHD_FC field for the Lines feature class. It is best to not have both the Polygons and Lines feature class in the project at the same time due to the fact it is easy to select a line and unknowingly delete it while editing the polygons.

3. Use the Simple Data Loader to load data from the Lines and Polygons feature classes into the appropriate NHD feature classes. Start the Simple Data Loader by right clicking on the destination feature class. In the example shown in Figure 50, the destination feature class is NHDArea.

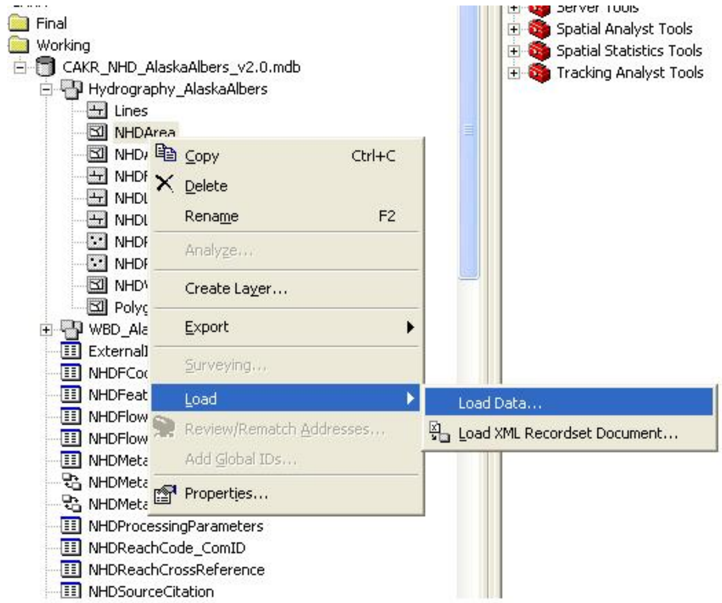


Figure 50. Starting the simple data loader. In this example, data will load into the NHDArea feature class.

Click next, which will bring up the dialog box shown below. Click on the folder button and Navigate to the feature class (Lines or Polygons) containing the data to be loaded. Then click Add and the dialog box will look as shown in Figure 51. Then click Next.

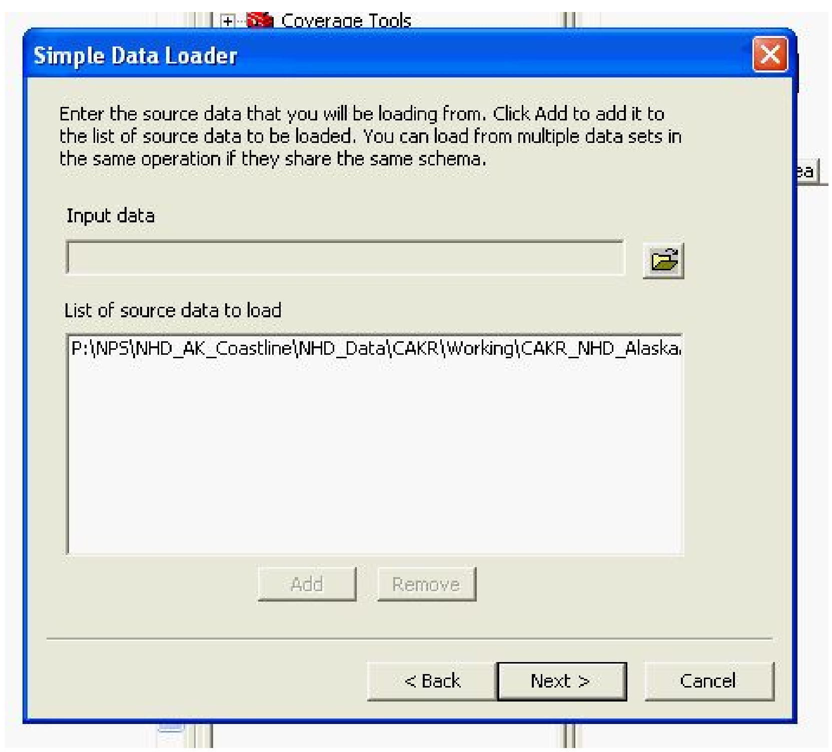


Figure 51. Simple Data Loader Interface.

Click through the next dialog boxes accepting the default values until the dialog box shown below appears. This dialog box allows the use of a query to select the data that will be loaded. Click on the Query Builder button and query the NHD_FC field with the value corresponding to the destination feature class (in this case, NHD_FC =2) as shown in Figure below

.

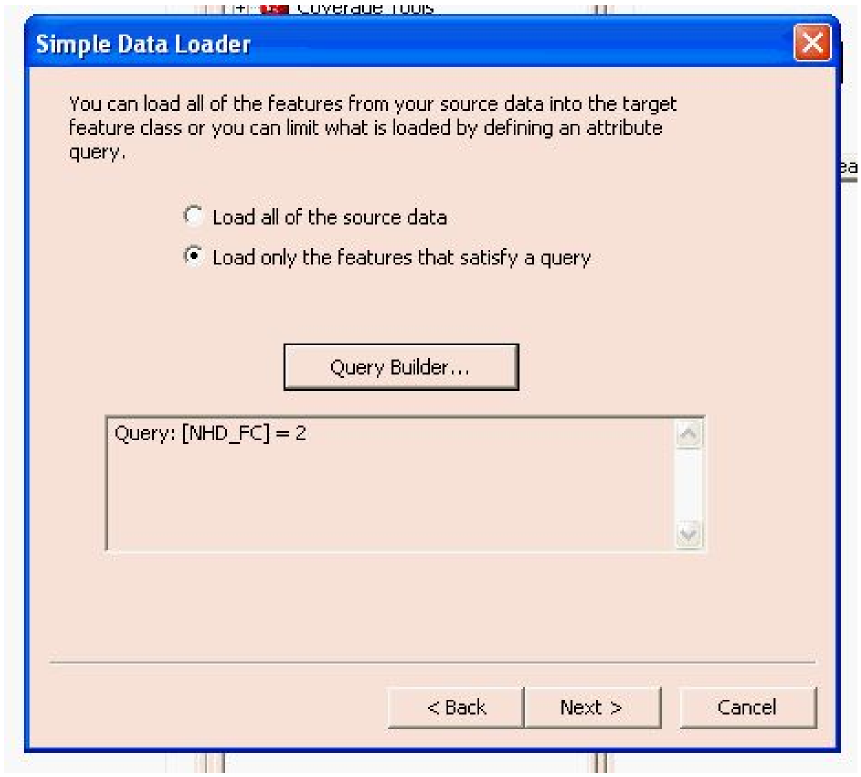


Figure 52. Data Load Selection Query. In this example the data is to be loaded into the NHD Area feature class (NHD_FC=2) therefore those features with an NHD_FC values equal to 2 are queried. See page 44, Section B-1 for further information.

Click OK. Verify the source and target datasets are correct in the next window. If they are correct, click Finish. Repeat the process for all four NHD feature classes.

4. Open ArcMap and add all four NHD feature classes and the appropriate background imagery to the map document. Pan through the data and populate the FType and FCode field of each feature class with the appropriate values as defined by the NHD Data Model. Groups of features with identical attributes can be attributed at the same time using the field calculator. Fix any errors that might still be present in the data.

5. Populate the GNIS_ID and GNIS_Name field of each NHD feature class. To do this, first, add the GNIS Region 19 point shapefile. However, DO NOT populate the GNIS fields of the NHD Line and Flowline feature classes with the adjacent waterbody as specified in the documentation. Per Hank Nelson at USGS, this is no longer valid (7/10/2012) and if these are populated will generate errors when the NHD QC Tools are applied. The GNIS data can be downloaded from the following location:

http://webhosts.cr.usgs.gov/steward/scripts/st2_software.pl

6. Spatially join the GNIS shapefile to the NHD feature classes. This creates an output table that is added to the map.

7. Table join the output table to the NHD feature class on OBJECTID. Calculate the GNIS_ID = FEATURE_ID and GNIS_Name=FEATURE_NA. After calculating, both the table join and spatial join can be removed and the output feature class can be removed from the project. If there are only a few features with GNIS Names, this step can be performed manually without doing the join.

8. Review the data again to make sure the GNIS_ID and GNIS_Name fields are correct. There may be a significant amount of manual editing that will need to be done to insure these are correct. Use the DRG and GNIS shapefiles as background information. Not every feature will have a GNIS name associated with it. Those that do not have a GNIS Name will be left blank.

9. Create a topology for the linear feature classes using the following rules:

    a. Must not Overlap
    b. Must not Self-Overlap
    c. Must not Intersect
    d. Must not Self-Intersect.

10. Verify and topology and fix errors, repeat until clean.

11. Similarly, create a topology for the polygon feature classes using the following rules:

    a. NHDArea – Must not overlap
    b. NHDWaterbody – Must not overlap

12. Verify and topology and fix errors, repeat until clean.

13. Copy the data to the Final folder. Delete the Lines and Polygons feature classes. Compact the database one last time and it is considered complete and ready to be used as a Target dataset for the NHD editing process.

USING THE NHD GeoEdit TOOLS

The ultimate goal is to submit the updated coastline to the NHD master geodataset. This requires the data passing the NHD quality assurance and verification process. The NHD GeoEdit tools are the main tools used in the process. The latest GeoEdit tools were released in March of 2012. The GeoEdit Tools documentation explains the USGS process in detail. The following sections will give a summary of the USGS process as it relates to the NPS coastal parks.

I. Requesting a Check Out From the Master Geodatabase

To obtain data from the master geodatabase, a user must have a username and password for the stewardship website. The username and password is obtained from the NHD regional point of contact. The stewardship website is the vehicle for requesting the data. Data is checked out by Subbasin (8-digit HUC). In cases where the coastline forms the boundary between two subbasins both subbasins need to be checked out in one piece. This is accomplished by selecting one of the subbasins for checkout and then checking the box for the appropriate subbasin in the window. It is critical that both subbabsins are obtained in one check out. This does not mean the entire subbasin needs to be edited. Edits are documented through the use of metadata sessions as explained in the next section. The subbasins are requested from the master NHD dataset and an email notification is sent to the requester when the data is ready. The checkout is referenced with a unique Job ID. The Job is then opened through the NHD Update toolbar in an ArcMap session.

II. Metadata in the GeoEdit Process

The GeoEdit tools track edits to the NHD through metadata sessions. Before any changes to geometry or attribution can be made metadata must be created. Metadata in the NHD is to the feature level, therefore each type of edit or source data must have its own metadata session. For example, if an updated section of coastline is made up of source data from multiple sources such as NOAA EVS data as well as ENC data, two metadata sessions would be required. Connecting arc additions also require their own metadata. If existing NHD is being retained it is not required that a separate metadata session be created, because these features will not be changed. In this case, the only edits that might possibly be required would be splitting an existing NHD feature and deleting the portion that overlaps the updated NOAA data. The connecting arc metadata can be used for this situation provided it is clearly explained in the metadata. Similarly, datasets of the same type, but with different dates of acquisition require separate metadata sessions. When performing the NHD edits, it is critical that the correct metadata session is selected in the NHD Editor window.

III. Performing Edits Using the NHD GeoEdit Tools

The NHD GeoEdit Tools User Guide provides documentation in both text and video form. These provide the starting point for using the GeoEdit tools. They provide a basic understanding of the NHD edit process, and reviewing the process in detail here would be redundant. However there are some concepts of the process that are not obvious from the USGS documentation:

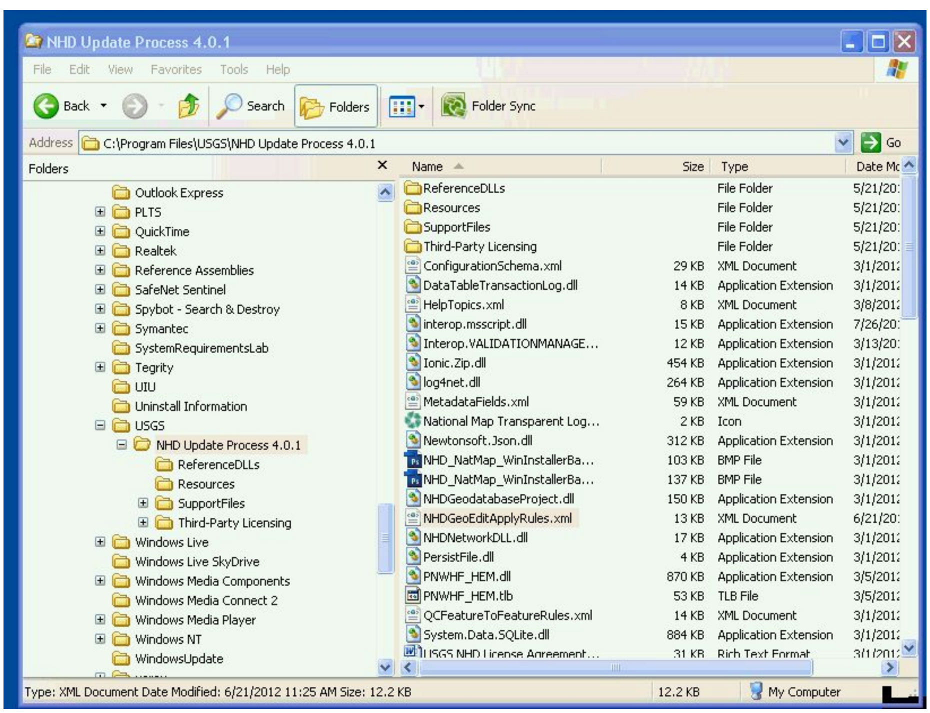
The target edit layer can be changed within the tool without applying rules and saving edits. This is valuable knowledge for performing edits, especially since the NHD GeoEdit Tools documentation makes no mention of this fact. It allows one to work around the “chicken or the egg” type of scenario when fixing errors requires edits to multiple layers. For example, a coastline feature that does not exactly match the boundary of its adjacent SeaOcean polygon will generate an error. This error likely occurred because the coastline was updated prior to the SeaOcean polygon or vice versa. In either case, it is impossible to apply rules and save either layer individually. The target edit layer must be switched before trying to apply rule in order to make edits to both layers which allows one to apply rules without generating errors and therefore save the changes.

Whenever possible use the replace geometry tool, rather than deleting the old data and importing the new data. Deleting a feature retires its reach code from use. Replacing the geometry preserves the current reach code and therefore maintains the relationships with any HEM events that might be tied to the flow network. As a best practice, replace geometry should be used wherever possible in order to maintain HEM event relationships, and help limit the number of reach codes that are removed from service. The HEM event issue is probably not as critical for Alaska as it is for the lower 48 states, but with the sheer density of features in Alaska, limiting the number of reach codes that are retired is a good idea.

In cases where there are BayInlet features that are also part of the SeaOcean it is permissible to "stack" a BayInlet feature on top of the SeaOcean feature, in the NHD Area feature class. The caveat is that their boundaries must exactly match. This prevents the tools from flagging coastline on ocean bays and inlets as errors, because the coastline does not fall on the SeaOcean.

The NHD tools limit the options available to an editor. Plus, there is no real clear direction as to which tools or processes must be invoked from within the NHD tools. It appears tools such as the select tool can be safely selected from outside of the NHD tools. Any operation that involves a change to the NHD feature classes that will be saved requires use of the NHD tools. Trying to make edits in a regular ArcGIS edit session will generate an error. Also, when editing outside of the NHD editor, which is required to import features into the Import_Lines or Import_Polygons feature classes, be aware that the NHD tools will change the selectable layers settings. In these cases it will most likely be necessary to set/reset the selectable layers settings. When switching between editing within the NHD and Import feature classes be very careful to save edits and close one edit session before attempting to open the other.

In discussions with the USGS point of contact, Henry Nelson, concerning the sheer number of errors associated with existing transport reaches not properly connecting to the updated coastline reaches, he recommended removing some of the rules from consideration as an interim step. This is accomplished by commenting out lines of code in the .xml file that contains the rules. These rules will be applied by the QA tools during the final QA checks. The graphics below show the location of the GeoEdit rules .xml, and a portion of the text of the file. Obsolete with GeoEdit Tools Version 4.0.3



```xml
<?xml version="1.0" ?>
<!-- XML for storing the configuration for NHD Geoedit Apply Rules version="2.0"  -->
- <Layers>
 - <ApLayer Tag="NHDFLOWLINE" Name="NHDFlowline">
    <Topology SubType="CanalDitch" Relation="CanNotCross" With="NHDFLOWLINE:Coastline" />
    <Topology SubType="CanalDitch" Relation="WhenWithinMustWithin" Within="NHDWATERBODY:Ice Mass,LakePond,Reservoir,Estuary"
      With="NHDLINE:Bridge,Tunnel,Flume;NHDAREA:Bridge,Tunnel,Flume" />
    <Topology SubType="CanalDitch" Relation="WhenWithinMustWithin" Within="NHDAREA:StreamRiver,CanalDitch,Spillway,Rapids,SeaOcean,Submerged
      Stream,Area of Complex Channels" With="NHDLINE:Bridge,Tunnel,Flume;NHDAREA:Bridge,Tunnel,Flume" />
    <Topology SubType="CanalDitch" Relation="WhenCrossMustWithin" Cross="NHDWATERBODY:Ice Mass,LakePond,Reservoir,Estuary"
      With="NHDLINE:Bridge,Tunnel,Flume;NHDAREA:Bridge,Tunnel,Flume" />
    <Topology SubType="CanalDitch" Relation="WhenCrossMustWithin" Cross="NHDAREA:StreamRiver,CanalDitch,Spillway,Rapids,SeaOcean,Submerged
      Stream,Area of Complex Channels" With="NHDLINE:Bridge,Tunnel,Flume;NHDAREA:Bridge,Tunnel,Flume" />
    <!-- <Topology SubType="Coastline" Relation="MustIntersect" With="NHDAREA:SeaOcean;NHDWATERBODY:Estuary" />  -->
    <Topology SubType="StreamRiver" Relation="WhenCrossMustWithin" Cross="NHDAREA:CanalDitch"
      With="NHDLINE:Bridge,Tunnel,Flume;NHDAREA:Bridge,Tunnel,Flume" />
    <Topology SubType="StreamRiver" Relation="CanNotCross" With="NHDFLOWLINE:Coastline" />
    <Topology SubType="Pipeline" Relation="CanNotCross" With="NHDFLOWLINE:Coastline" />
    <Topology SubType="Pipeline" Relation="CanNotOverlap" With="NHDFLOWLINE:AnySubTypes" />
    <Topology SubType="Underground Conduit" Relation="MustIntersect" With="NHDPOINT:SinkRise,SpringSeep;NHDFLOWLINE:AnySubTypes" />
    <Geometry SubType="StreamRiver" Relation="FLWithFLSplit" With="NHDFLOWLINE:Connector,StreamRiver,Coastline" />
    <Geometry SubType="StreamRiver" Relation="FLWithFLSplitTouches" With="NHDFLOWLINE:StreamRiver,Coastline,CanalDitch" />
    <Geometry SubType="StreamRiver" Relation="FLWithFLSplitBase" With="NHDFLOWLINE:AnySubTypes" />
    <Geometry SubType="StreamRiver" Relation="FLWithWBSplit" With="NHDWATERBODY:LakePond,Estuary,Ice Mass,Playa,Reservoir,SwampMarsh" />
    <Geometry SubType="StreamRiver" Relation="FLWithAreaSplit" With="NHDAREA:StreamRiver,CanalDitch,Area of Complex Channels" />
    <Geometry SubType="ArtificialPath" Relation="FLWithFLSplit" With="NHDFLOWLINE:ArtificialPath,Connector,StreamRiver,Coastline" />
    <Geometry SubType="ArtificialPath" Relation="FLWithFLSplitBase" With="NHDFLOWLINE:AnySubTypes" />
    <Geometry SubType="ArtificialPath" Relation="FLWithWBSplit" With="NHDWATERBODY:AnySubTypes" />
    <Geometry SubType="ArtificialPath" Relation="FLWithAreaSplit" With="NHDAREA:StreamRiver,CanalDitch,Area of Complex Channels" />
    <Geometry SubType="Connector" Relation="FLWithFLSplit" With="NHDFLOWLINE:ArtificialPath,Connector,StreamRiver,Coastline" />
    <Geometry SubType="Connector" Relation="FLWithFLSplitBase" With="NHDFLOWLINE:AnySubTypes" />
    <Geometry SubType="Connector" Relation="FLWithWBSplit" With="NHDWATERBODY:LakePond,Estuary,Ice Mass,Playa,Reservoir" />
    <Geometry SubType="Connector" Relation="FLWithAreaSplit" With="NHDAREA:AnySubTypes" />
    <Geometry SubType="CanalDitch" Relation="FLWithFLSplitTouches" With="NHDFLOWLINE:StreamRiver,Coastline,CanalDitch" />
    <Geometry SubType="CanalDitch" Relation="FLWithFLSplitBase" With="NHDFLOWLINE:AnySubTypes" />
    <Geometry SubType="Pipeline" Relation="FLWithFLSplitBase" With="NHDFLOWLINE:AnySubTypes" />
    <Geometry SubType="Underground Conduit" Relation="FLWithFLSplitBase" With="NHDFLOWLINE:AnySubTypes" />
    <Geometry SubType="Coastline" Relation="FLWithFLSplitBase" With="NHDFLOWLINE:AnySubTypes" />
    <Geometry SubType="Coastline" Relation="FLWithFLSplitTouches" With="NHDFLOWLINE:AnySubTypes" />
```


The lines beginning with “<! - - “, and ending with “ - - > “ are the commented out lines. By removing these rules from consideration one is able to save in interim steps. If these rules are applied all of the errors generated must be addressed before the changes can be saved. In which case there may be days of work required to fix all the errors required in order to save. After edits connecting the transport reaches to the updated coastline are complete these rules can again be used during the QA checks.

NHD QC Checks

GNIS Names

NHD Flowlines with an FTYPE of coastline should not have any

Draft Shoreline Selection Protocol

Compilation of an Accurate and Contemporary Digital Shoreline for Alaska Coastal Parks (PMIS #156638)

Appendix A: Notes Specific to Each Park

Cape Krusenstern National Monument (CAKR)

Source Data (data highlighted as **BOLD** was selected for inclusion):
EVS – AK0302, 2003
ENC – US1BS03M, 1991; US3AK92M, 1992

Boundary:
CAKR Preserve Boundary, NPS Theme Manager, March 2010, buffered to 500 meters

Background Imagery:
IKONOS Orthoimage True Color – BELA, NPS Theme Manager, 2005

Summary:
There are approximately 70 miles of coastline in CAKR. EVS data covers 100% of the coastline. Per the protocol EVS was chosen because it was not only the most current data, but it more closely matched the imagery. There are no connecting arcs in the data. The boundary was buffered to 500 meters in order to insure all of the islands in the southeastern portion of the preserve were captured. There were a surprising number of very short adjacent line segment with identical attributes. These were merged as appropriate in order to reduce the size of the dataset. There were also a large number of line features with the “apparent marsh” attribute versus the “mean high water” attribute. Features attributed as “apparent marsh” were treated in the same manner as “mean high water” in order to have a continuous coastline. There are also a number of man-made features in the northern portion of the park. These features are permanent piers associated with a mining operation and are therefore included as coastline.

Bering Land Bridge National Preserve (BELA)

Source Data (data highlighted as **BOLD** was selected for inclusion):
EVS – AK0301, 2003
ENC – US1BS03M, 1991; US3AK80M, 1995
NHD – 1905 Subregion, 2005, 2010
Photointerpreteted Coastline, SMU, 2011 based on 2003 Orthophoto

Boundary:
BELA Preserve Boundary, NPS Theme Manager, March 2010, buffered to 175 meters

Background Imagery:
IKONOS Orthoimage True Color – BELA, NPS Theme Manager, 2005
Aerial Orthophoto Mosaic – 2003, 0.6 meter resolution

Summary:
There are approximately 340 miles of coastline in BELA. EVS data covers approximately 70% of the coastline. The eastern 30% of the park coastline is covered by NHD data. Per the protocol EVS was chosen if available, because overall it more closely matched the imagery. Originally, NHD was chosen over the ENC for the remainder of the park because it more closely matched the imagery. After consultation with NPS and internal discussions within NPS, it was decided that SMU would use photo interpretation methods to delineate the coastline for the eastern portion of BELA based on a 2003 aerial orthophoto mosaic, created specifically for studying coastline issues in BELA. The photo-mosaic has a

relatively high resolution of 0.6 meters with a horizontal accuracy of +/-1.1 m RMS. The boundary was buffered to 175 meters. To summarize there are 766 features in the data, approximately 2/3 from the EVS data. 1/3 delineated by SMU, and just a handful of connecting arcs generated by SMU.

Anaikchak National Monument and Preserve

Source Data (data listed in **BOLD** selected for inclusion):
EVS – CM-8200, July 1982
ENC – US4AK5HE, February 2006
NHD – 1902 Subregion, January 2007 to July 2008

Boundary:
ANIA Preserve Boundary, NPS Theme Manager, March 2010, buffered to 150 meters

Background Imagery:
IKONOS Orthoimage True Color – ANIA, NPS Theme Manager, 2005

Summary:
There are approximately 60 miles of coastline in ANIA. EVS data covers approximately 80% of the coastline. The western 20% of the park coastline has coverage by both ENC and NHD data. Per the protocol EVS was chosen if available, because overall it more closely matched the imagery. The NHD was chosen over the ENC for the remainder of the park because it more closely matched the imagery, and post dated the ENC data. One connecting arc of approximately 40 meters long was generated to connect the NHD portion of the data to the EVS data. The connecting arc was generated preserving as much of the EVS as possible. Topology found 26 dangles within the data. Most of these were errors in the NHD data where end points of lines that should have been coincident were not. In all cases the points were less than 5 meters apart, in some cases much less, and fixed by snapping together. In one case a gap was present in the NHD data. It appears the line segment was misclassified as "CARTOGRAPHIC LIMIT" rather than "SHORELINE", and therefore was not extracted. The missing segment was added back into the data and classified as shoreline. There are 115 features in the data, 21 from the NHD, 1 connecting arc generated by SMU and the balance from the EVS.

Lake Clark National Park and Preserve

Lake Clark National Park and Preserve (LACL)
Source Data (data listed in **BOLD** selected for inclusion in Shoreline_Updates):
EVS – PH6301B, July 1970
ENC – US4AK13M, February 2001
NHD – 1902 Subregion, 2006-2010 within park

Boundary:
LACL Park Boundary, NPS Theme Manager, March 2010, buffered to 1250 meters

Background Imagery:
IKONOS Orthoimage True Color – LACL, NPS Theme Manager, 2005-2008

Summary:
There are approximately 85 miles of coastline in LACL. EVS data covers 100% of the coastline. Approximately 40% of the coastline falls within ANSCA holdings inside of the park boundary. Per the protocol EVS was chosen because it was available. It should be noted that the EVS data was the oldest of the data sets. It actually appears that much of the NHD for this park has been up dated within the last year or two. If the decision is made to abandon the EVS in favor of the NHD, it will require a minimum of rework to load the NHD into the feature class. Overall, both the EVS and NHD correlated with the imagery. River mouths were the main areas where the imagery and the data were not in agreement. This was true of both the EVS and the NHD. The boundary was buffered to 1250 meters. Buffering to this distance included a small piece of a USFWS offshore island which can be deleted at the request of NPS. Any smaller buffer created data holes in the Tuxedni River estuary. It was not necessary to generate any connecting arcs for this park since the data came from a single source. There were 16 locations where it appears line segments were misclassified as “CARTOGRAPHIC LIMIT” rather than “SHORELINE”, and therefore not extracted. The missing segments were added back into the data and reclassified as “SHORELINE”. Identical adjacent line segments did not appear to be an issue with this data set. There was one replicate feature. To summarize there are 456 features in the data, all of which came from the EVS.