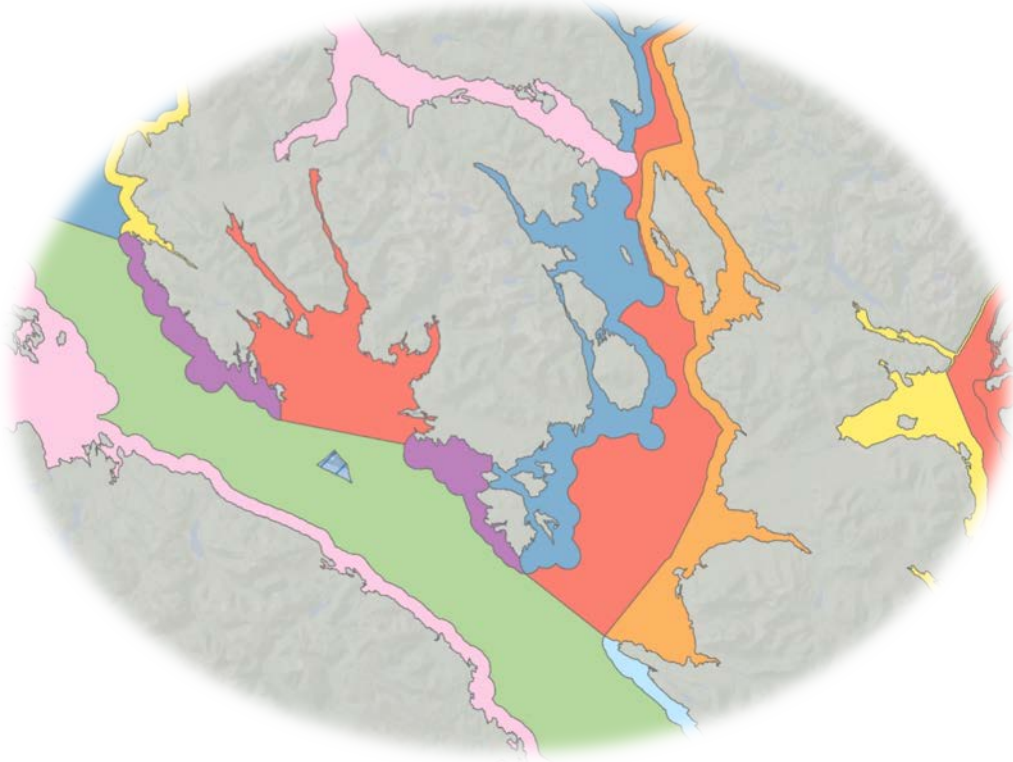# ALASKA'S MARINE ASSESSMENT UNITS

Report and Data Prepared by Marcus Geist and Anjanette Steer with the University of Alaska Anchorage's Alaska Center for Conservation Science Project support from Alaska Department of Environmental Conservation, Division of Water

June 30, 2023

Introduction

This document summarizes an effort by the Alaska Department of Environmental Conservation (ADEC) in collaboration with the University of Alaska Anchorage's Alaska Center for Conservation Science (ACCS) to develop a statewide, continuous, geospatial dataset of Alaska's marine waters.

Purpose and Need

As part of its responsibilities under the federal Clean Water Act, ADEC must produce a biennial integrated report of water quality that includes both freshwater and saltwater resources managed by the State of Alaska. Through national guidance from the US Environmental Protection Agency (USEPA), each waterbody is defined as an assessment unit (AU) that can be delineated by each individual state. These waterbodies are maintained by ADEC as well as uploaded to a national USEPA database known as ATTAINS (Assessment and Total Maximum Daily Load Tracking and Implementation System).

The United States Geological Survey (USGS) produces national geospatial datasets inventorying and mapping freshwater waterbodies such as rivers, streams, lakes, and ponds through the National Hydrographic Dataset (NHD) which is excellent foundational dataset for freshwater assessment units.

While the federal National Oceanic and Atmospheric Administration (NOAA) has created nautical charts of nearshore marine areas for over a century, unfortunately there are no seamless, consistently scaled, geospatial datasets delineating marine waterbodies such as harbors, bays, coves, channels, straits or lagoons. With this data gap, ADEC and ACCS embarked on a process to develop a dataset that covered all state marine waters in simple format,

Project Priorities:

- Include previously delineated impaired waters as well as areas with some monitoring history that were also mapped previously (n ~130)

- Delineate new community based marine assessment units for 18 Alaskan communities encompassing community facilities and extending one half mile offshore (Appendix A)

- Map the remainder of Alaska's marine waters with a seamless fabric of assessment units based upon NHD watershed boundaries

Methods

This section details the steps taken to create the state of Alaska's marine waterbody base layer

Assemble Datasets

All of the component datasets, or building blocks, for the marine water delineation effort can be found and downloaded from public, online data sources. Appendix B (ADEC Marine 2023 Data Sources) includes detailed descriptions of these component datasets as well basic metadata regarding source agencies, download year, and hyperlinks (current as of report publication June 2023).

Alaska Generalized Coastline

This dataset is simple outline of mainland Alaska (connected to North American continental land mass) as well as approximately 1000 large islands in Alaskan waters that has been generated by the Alaska Department of Natural Resources. It is of suitable scale and accuracy to select the watersheds that are deemed "coastal or marine" to mask out terrestrial portions of those watersheds. The dataset's total summarized coastline is 42,395 miles.
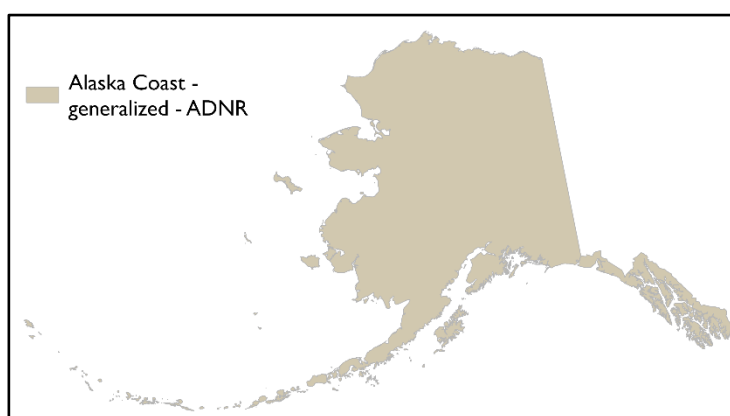

Alaska Detailed Coastline

This dataset includes many smaller islands that were not in the generalized coastline dataset. There are over 37,000 islands versus the 1,000 islands and the total coastline length is 49,000 miles. This dataset was used to manually delineate community coastal assessment units. The map inset shows these smaller included islands near Sitka.
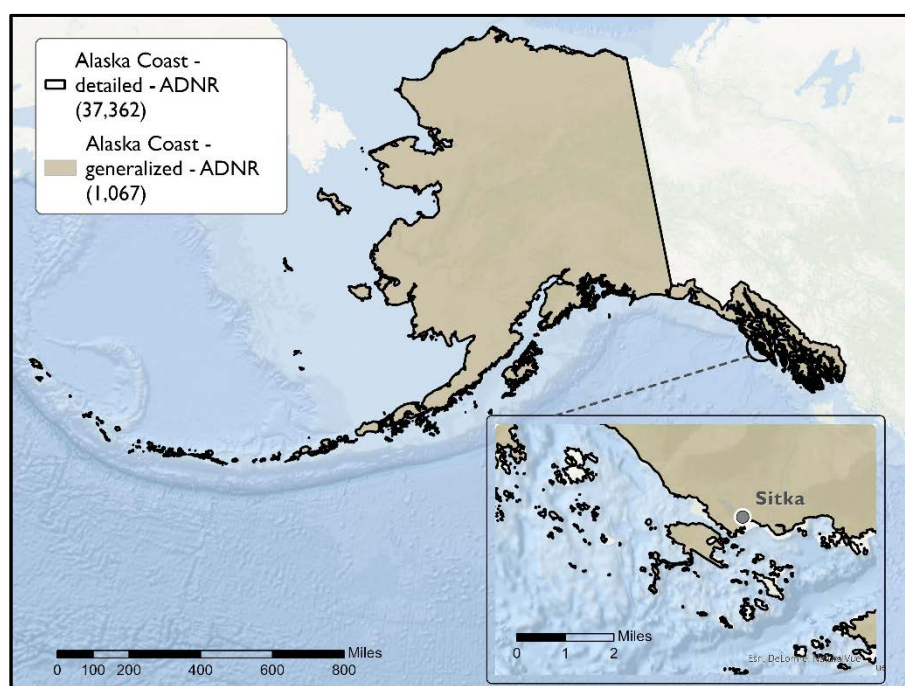
Watershed Boundary Dataset – HUC10 Watersheds

This a national generated dataset representing freshwater drainages that are protracted approximately 3 miles offshore into marine waters. There are 2,549 ten-digit Hydrologic Unit Code (HUC10) watersheds across Alaskan drainages. Selecting those watersheds that intersect the general coastline boundary yields an initial total of 563 HUC10s with a potential marine component. These are the building blocks for the new marine assessment units.
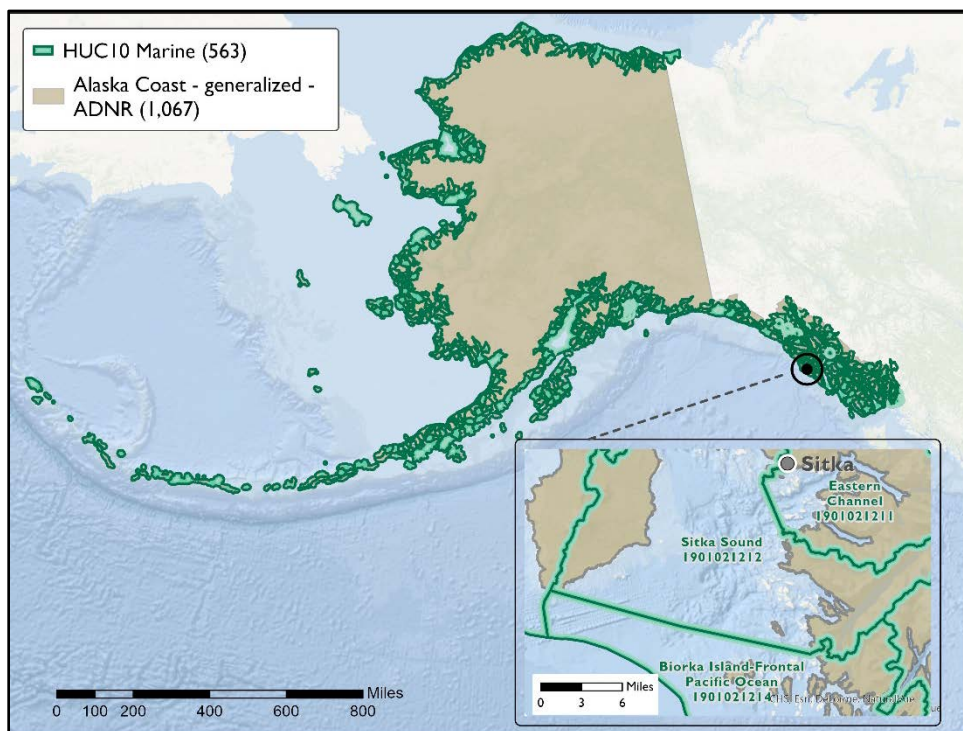
Federal and State Waters

The National Oceanic and Atmospheric Administration (NOAA) created this dataset to distinguish jurisdiction based upon the Submerged Lands Act. There are portions of Southeast Alaska (see inset map) where in which "enclaves" of federal waters are surrounded by state waters. Certain marine waters have been designated state waters by special amendments to the Act including Prince William Sound, Cook Inlet, and Kachemak Bay.
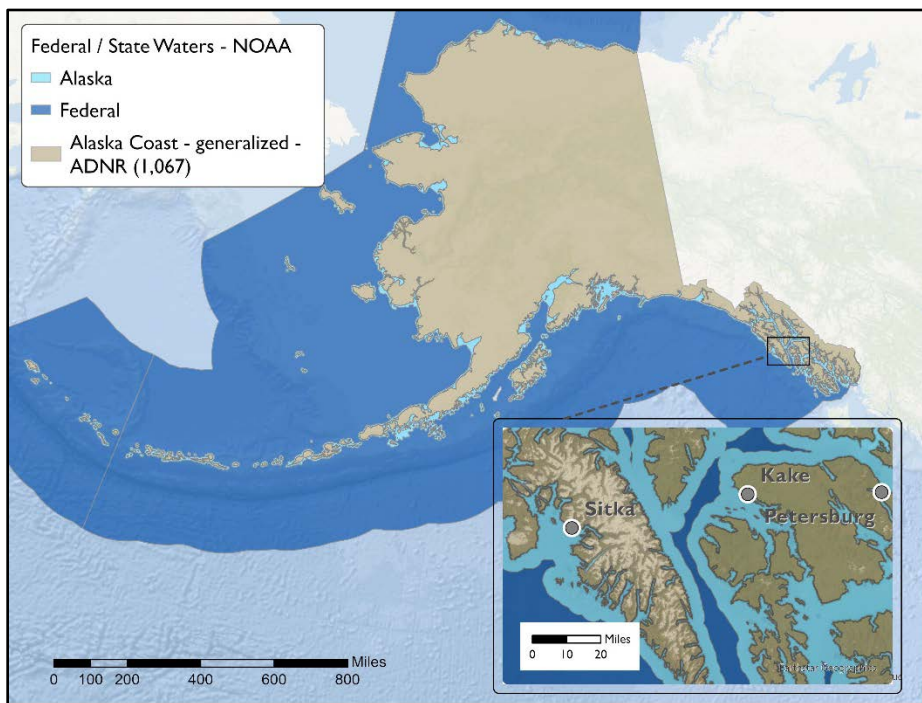
Maritime Boundaries

These lines delineate various limits of United States waters including territorial seas, contiguous zones, the exclusive economic zone and the international boundaries between the US and Canada and the US and the Russian Federation (Bering Sea). These boundaries were used to exclude the watershed portions extending beyond US waters.
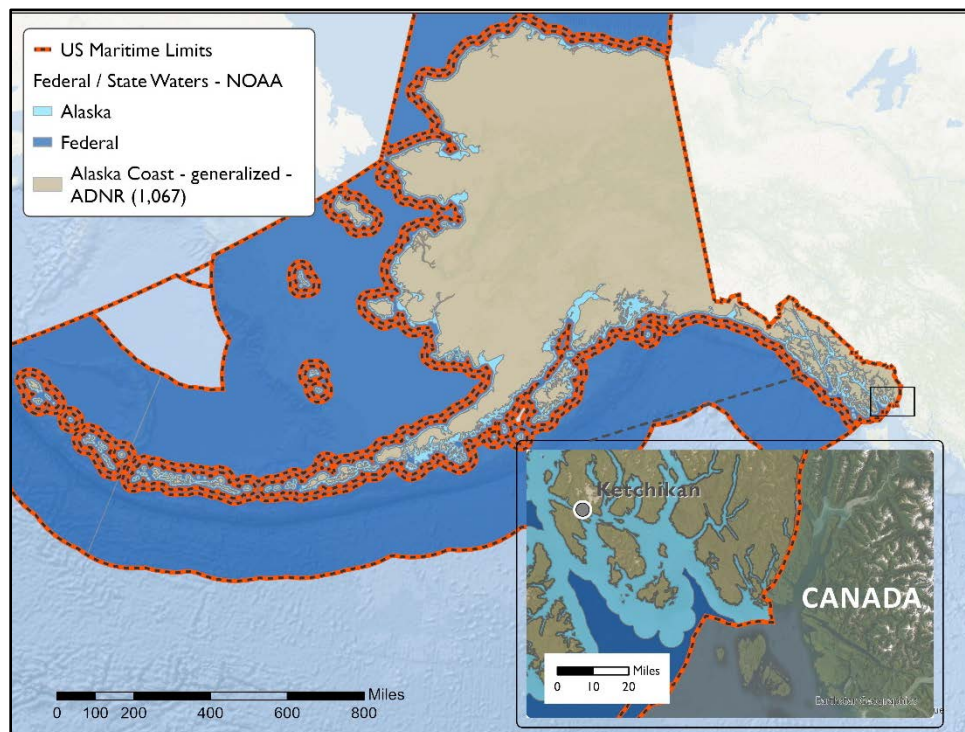
Continually Updated Shoreline Product (CUSP)

This data set was created to deliver continuous shoreline with frequent updates to support various GIS applications including coastal and marine spatial planning, tsunami and storm surge modeling, hazard delineation and mitigation, environmental studies and may assist in nautical chart updates. The CUSP is incomplete across Alaska; however, it was used to manually delineate the shoreline boundary for many of the coastal community marine assessment units.
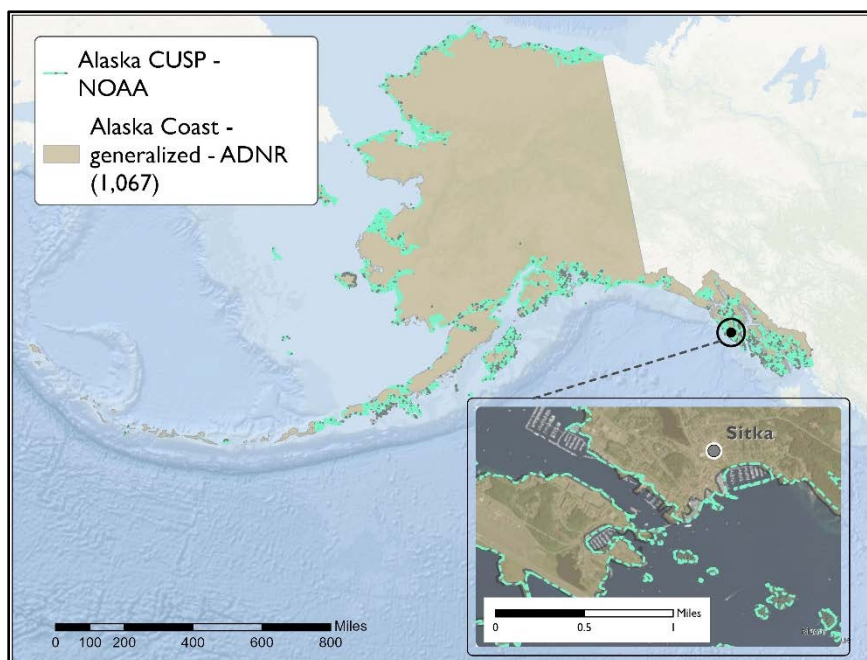
Existing Marine Assessment Units designated by ADEC (pre-2022)

These marine waters were previously delineated by ADEC due to impairment or assessment status and are to be incorporated into the newly created statewide marine assessment unit dataset as is or with modification based upon ADEC staff input.
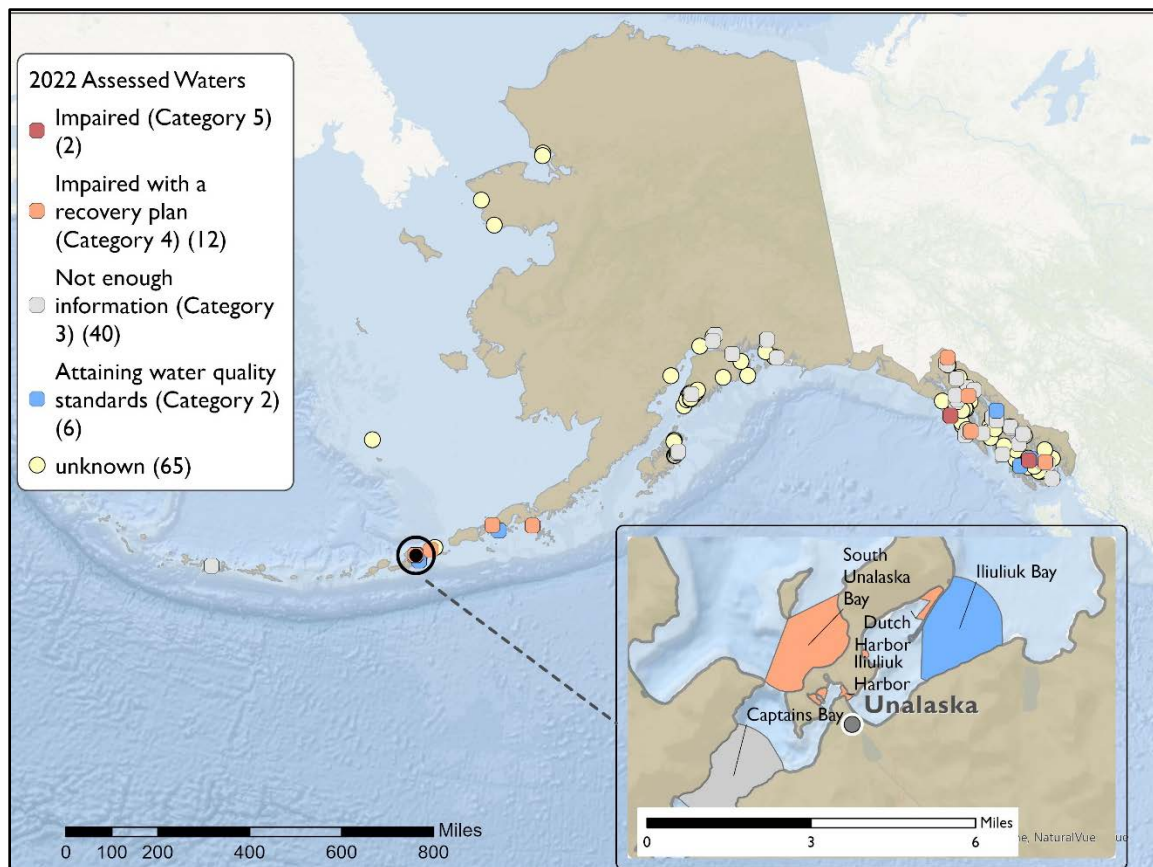
Create initial base Marine Assessment Units

1) Begin with the HUC10 watershed boundaries 2022, select HUC10s that intersect with Alaska Coastline datasets, export Coastal HUC10s (n=563). This creates the base Marine Assessment Units (MAUs)

2) Generate an Assessment Unit Identifier for each MAU, using the following field calculator code in ArcGIS "AK_M_"+Mid(HUC10, 3,7)+"_000" this generates the AU ID by starting with the prefix "AK_M" and then starting with the fourth position in the HUC10 string (note computer sequences the positions 0,1,2,3, …), then adding the last 7 digits of the HUC10 watershed, and finally adding an underscore and the suffix '000' creating a single "parent" MAU feature for each HUC10. NOTE: This creates a single feature for each marine HUC10, but in some cases the features can be multi-part (see Appendix C: Delineation Examples)

Modify Base HUC10 MAUs

1) Remove terrestrial (land) portion of the Coastal HUC10s: Use "Erase" function in ArcGIS Pro: Input Features – Coastal HUC10s, Erase Features – Generalized Alaska 1:63,360

2) Remove Canadian and Russian Waters from dataset, use the Maritime Boundaries line dataset and Split command in ArcGIS to divide HUC10 MAUs that straddle international boundaries. This occurs in only three locations: the US -Canada border in the Beaufort Sea, US-Russia border between Big and Little Diomede Islands, and the USA-British Columbia border in Southeast Alaska. After splitting the boundary HUC10s, delete the Canadian and Russian portions of the draft MAUs.

3) Remove Federal Waters using the NOAA Federal/State waters dataset by selecting the federal waters and using the Erase function to remove the portions of the draft MAUs in federal waters. Note: the process step creates gaps in larger channels and straits.

4) Remove sliver polygons resulting from very small overlaps between base HUC10 and coastline. There are numerous cases in which a HUC10 watershed extends only to the shoreline, but not offshore (e.g. Arctic and Western Alaska watersheds that terminate at intracoastal lagoons). Throughout Alaska there are riverine watersheds that terminate at the shoreline barely overlapping the coastline boundary. Additional cases include southcentral and southeast tidewater glacier HUC10 watersheds with little or no open water at the glacier face. ACCS project staff visually reviewed the individual coastal HUC10 watersheds with very small sliver polygons determining their status as marine or "not marine" using current satellite imagery for discernment. This step removed 128 HUC10 watersheds.
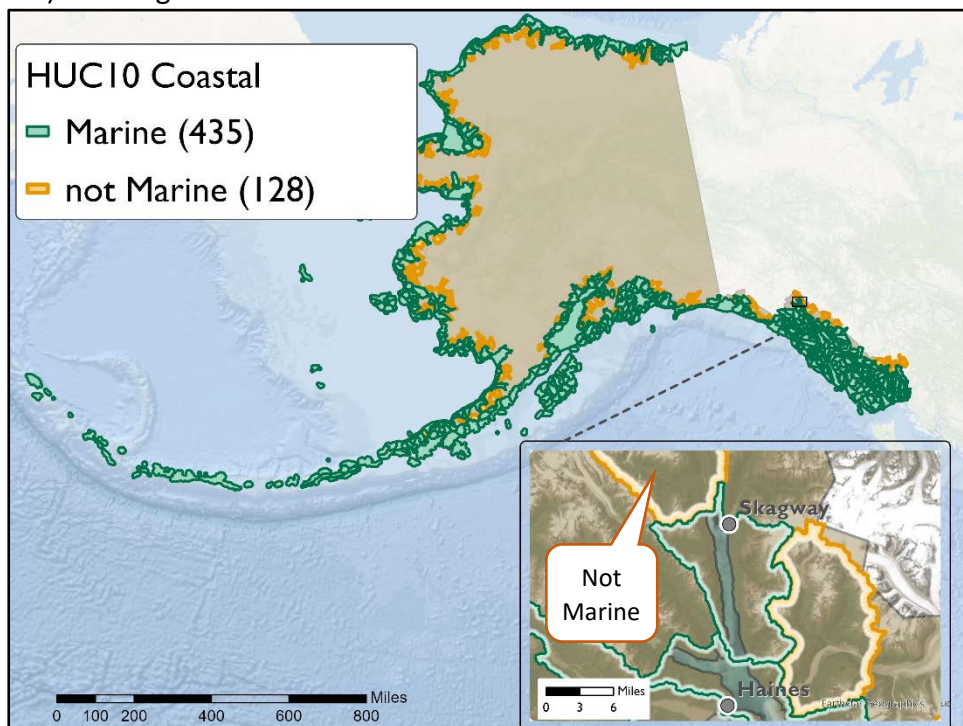
Generate the Coastal Community Marine Assessment Units

1) Begin with the list of ADEC designated priority communities (Appendix A), select Detailed Alaska Coastline or CUSP segments based upon input from ADEC delineating the upper and lower geographic boundaries of each Community Marine Assessment Unit. ACCS project staff used their professional judgement in each of the 18 cases determining which of the two available datasets best represents the shoreline.

2) Buffer the selected coastline segments one half mile offshore to create the new Community Marine Assessment Units

3) Assign Assessment Unit Identifier (AU ID) code based upon on host HUC10 and accounting for any existing Assessment Units in the HUC10 (e.g. previous MAUs)

4) Insert these newly created coastal community marine assessment units into the existing collection of MAUs based on the marine HUC10s: Create a space in the existing MAUs by using the Erase tool with the community MAUs erasing their footprints in the existing MAUs, then copy and paste the community MAUs into the composite MAU dataset. See Nome Harbor example using CUSP shoreline for half mile buffer, then carve the community MAU out of parent MAU (Safety Sound – Frontal Norton Sound MAU)
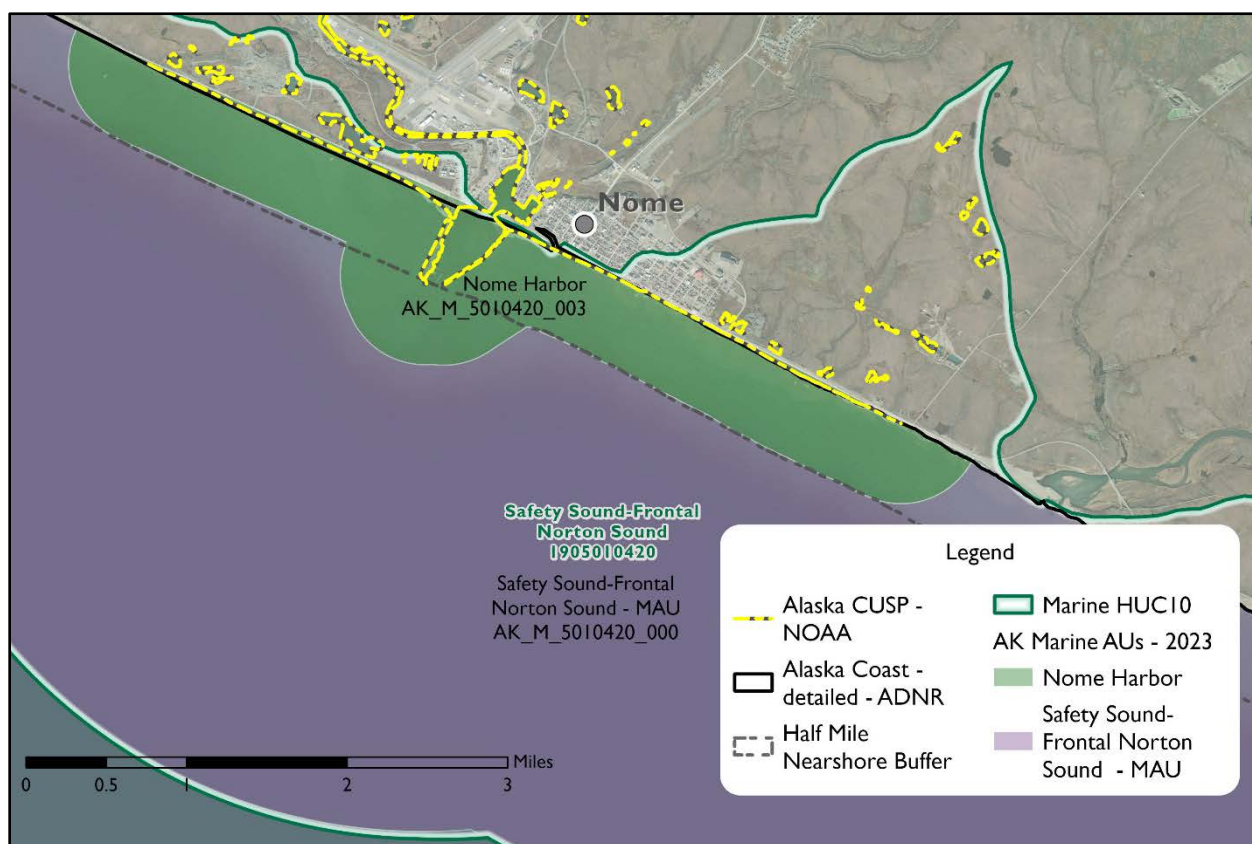
Insert Existing Marine Assessment Units and Retire former non-attaining AUs

1) Insert previously delineated Marine AUs including existing impaired waters and those waterbodies recently (2021-22) digitized as geospatial data, but not yet categorized regarding water quality attainment status.

2) Using previously delineate MAU polygons, create a space in the growing Marine AU composite layer by using the Erase tool. Then copy and paste old MAUs into the modified composite layer.

3) During the project period, ADEC staff noted a total of 14 formerly non-attaining Assessment Units that should no longer be mapped or regarded as separate AUs. The retired areas have been incorporated into new Assessment Units. These MAUs are listed in Appendix C and included a separate feature class in the data package.
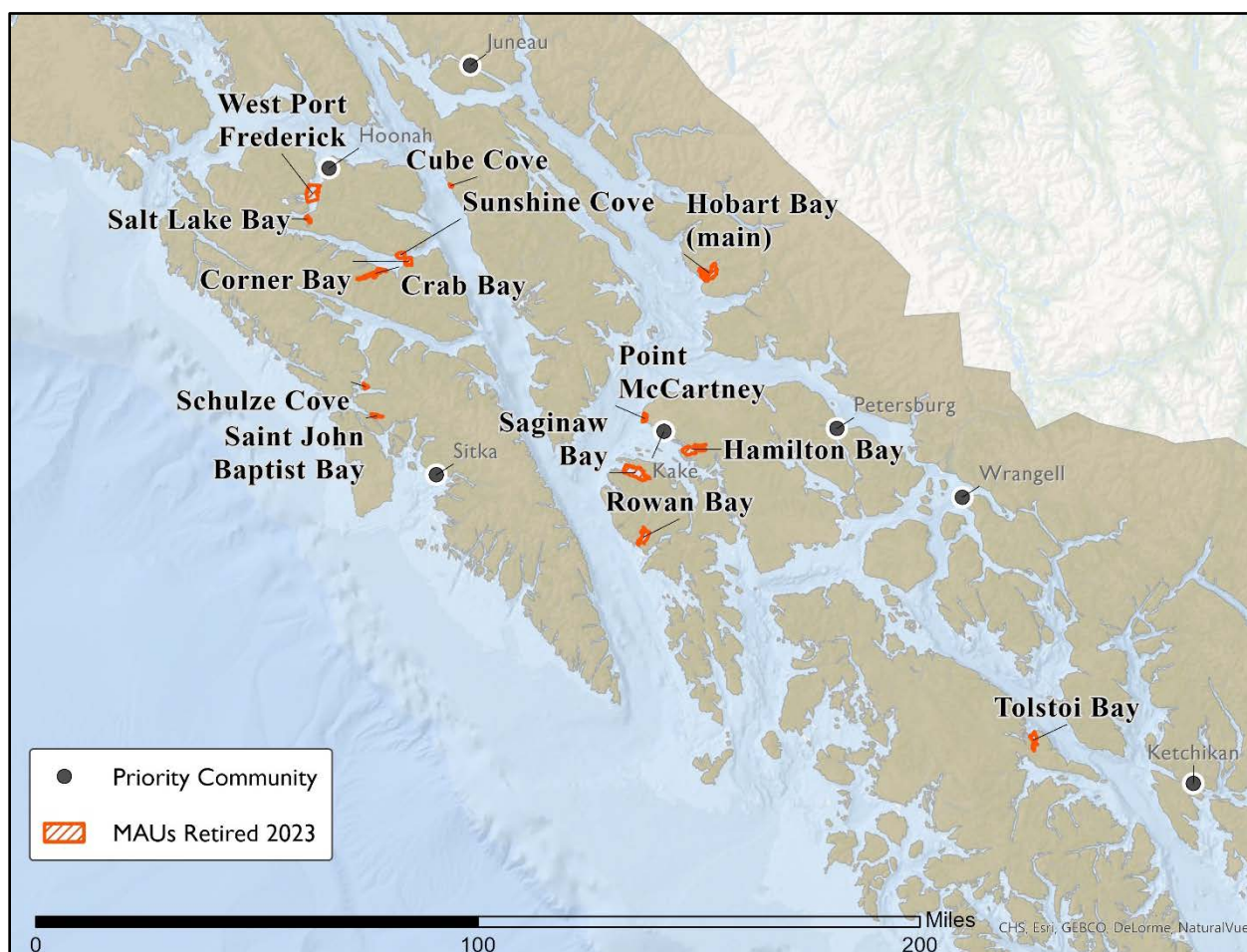
Create Topology to enforce Topological Rules

1) In the project geodatabase, create a feature dataset, copy the composite MAU polygon file into the new feature dataset

2) Create a Topology in ArcGIS, create a rule that features in the MAU composite "Cannot Overlap". The MAU polygons should be adjacent to each other without overlapping

Topology Properties: MAUs_Topology

	Feature Class 1	Subtype 1	Rule
General			
Feature Class			
Rules	AKMAUs_June19g4		Must Not Overlap (Area)
Errors	AKMAUs_June2023_FInal		Must Not Overlap (Area) ▾
Manage			

3) Validate Topology, this function enforces the topological rules and generates errors.

4) Use the Topology Error Inspector to review any cases in which polygons overlap, this best accomplished on a case by case basis visually to inspect and correct errors that resulted from offsets between the various datasets (HUC10 watersheds, coastlines, and previously delineated MAUs)

5) After applying topology and correcting any identified errors, resulting dataset is seamless without overlaps or gaps

Results

A grand total of 507 unique marine assessment unit have been created for Alaska. This composite Marine Assessment Unit inventory includes 18 community-based units as well existing impaired marine waters and other previously mapped waterbodies. The inset map in shows the seamless nature of adjacent marine assessment units as well as demonstrating the white gaps resulting from federal waters within some of the larger waterbodies (e.g. Stephens Passage and Chatham Strait on either side of Admiralty Island south of Juneau),
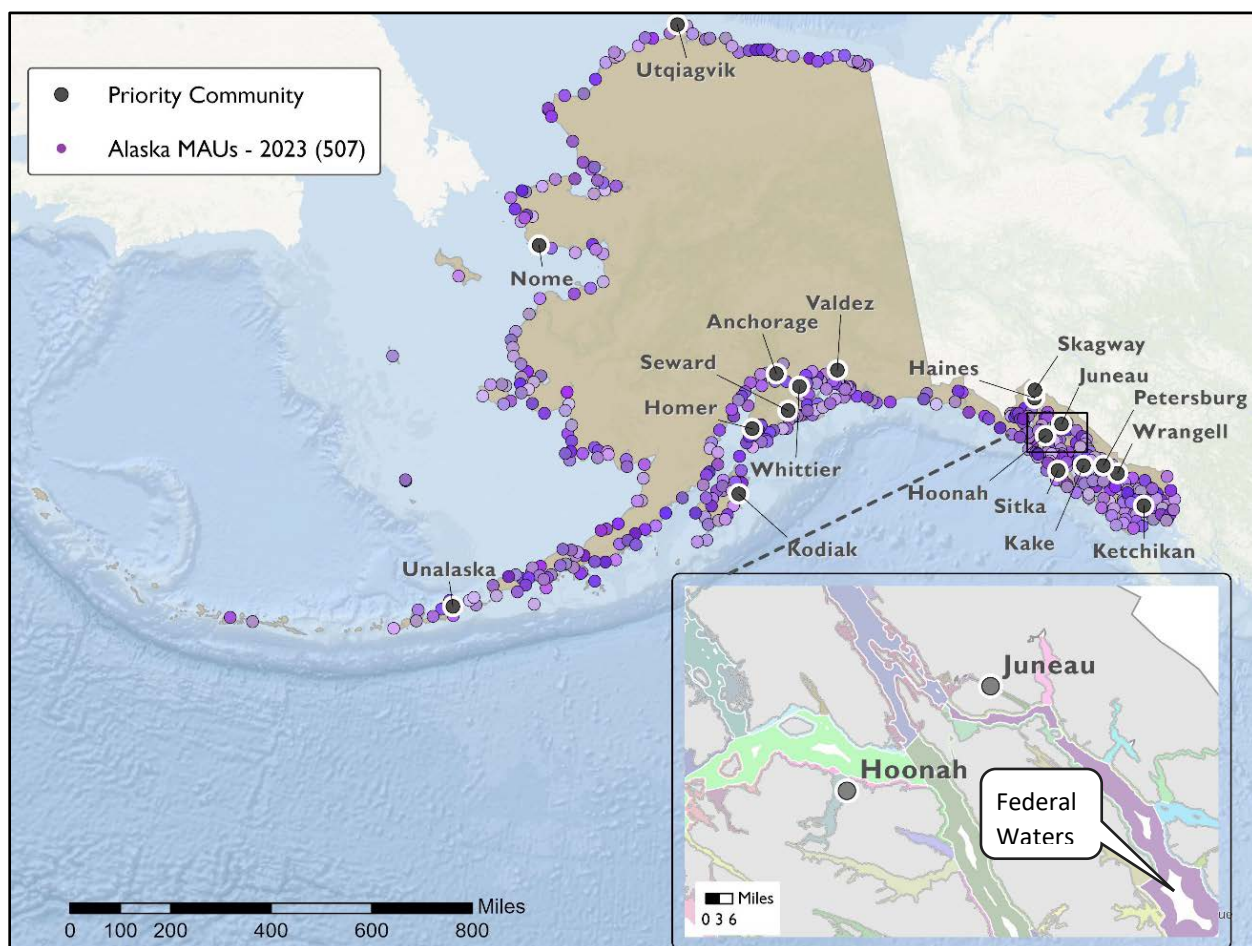
Discussion

Throughout the marine assessment unit process, project members have sought to create a system that is simple, and can be modified moving into the future as new, more spatially specific waterbodies are delineated.

Multi-part Assessment Units – Discontiguous Sections

Some HUC10 watersheds in the national Watershed Boundary Dataset particularly those drainages noted as "Frontal" exist as multi-part features in multiple, discontiguous sections that can be separated by other HUC10s (see Dry Bay Frontal - Stephens Passage example with four discrete sections). Other multi-part MAUs exist on either side of channels (east and west or

north and south) and there are multi-part MAUs among multiple islands (Aleutians, Prince William Sound, and Southeast Alaska).
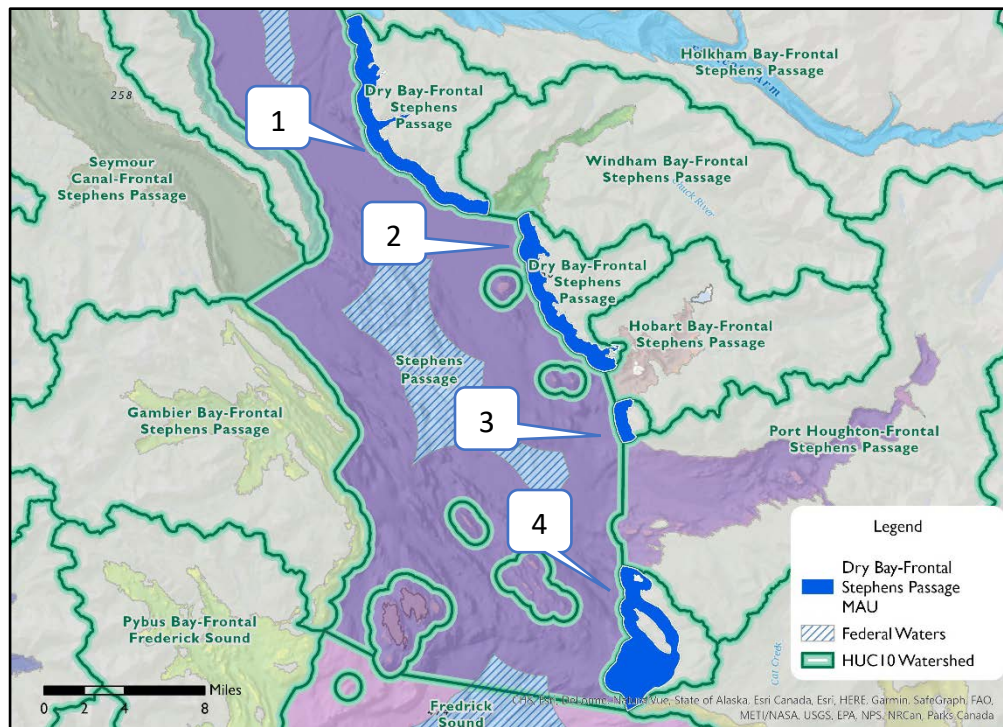
There a few multi-part marine units that are listed as impaired and exist as small, discretely delineated areas (see example for Iliuliuk Harbor/Dutch Harbor area).

The dataset includes 57 multi-part marine assessment units. They have been maintained as separate polygons with common attributes in an effort to facilitate any future modifications. A summary version of the dataset in which there is only one feature per marine assessment unit is also included in the data package.
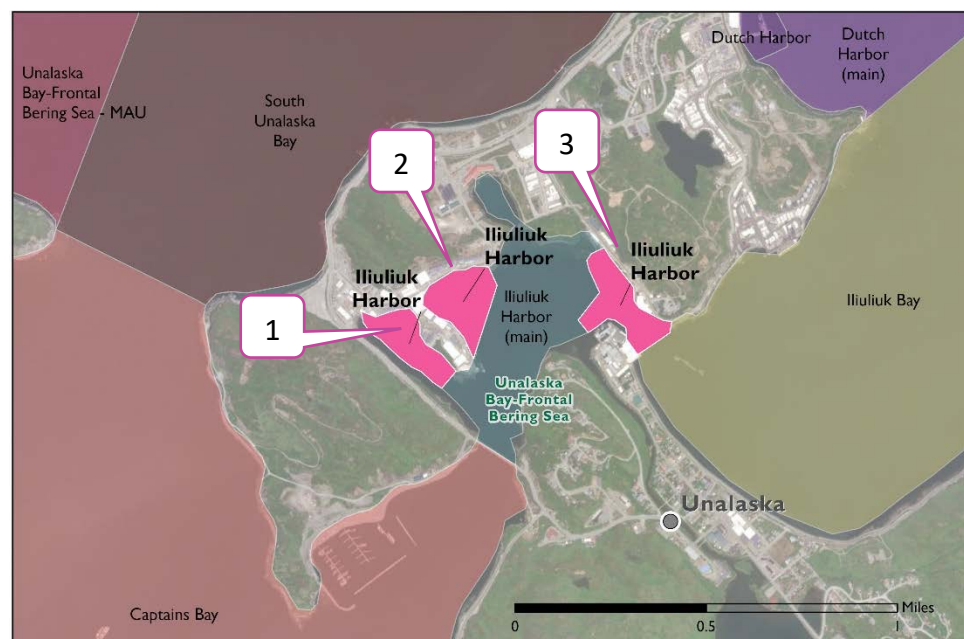
Enclaves

The base watershed layer from the national Watershed Boundary Dataset classifies large marine waterbodies such as Cook Inlet in Southcentral and the many larger channels, straits, passages, and sounds of Southeast Alaska as entirely water and excludes even the smallest of islets and rocks (less than 0.1 acre) from the HUC10 watershed boundary. These isolated bits of land in the middle of the much larger watersheds create exclaves that are neither hydrologically correct nor visually appealing. The default base HUC10 dataset includes a one-kilometer buffer around these small islands and rocks. For the sake of visual continuity, mapping simplicity, and the realities of marine waters; these exclaves have been dissolved and incorporated in the much larger surrounding waterbody. The mapped example shows two separate exclaves within the Ernest Sound MAU. The exclaves were dissolved rather than associate the two circular buffered areas with the distant and disconnected shore portions of the Frontal MAUs on both the east and west sides of Ernest Sound.
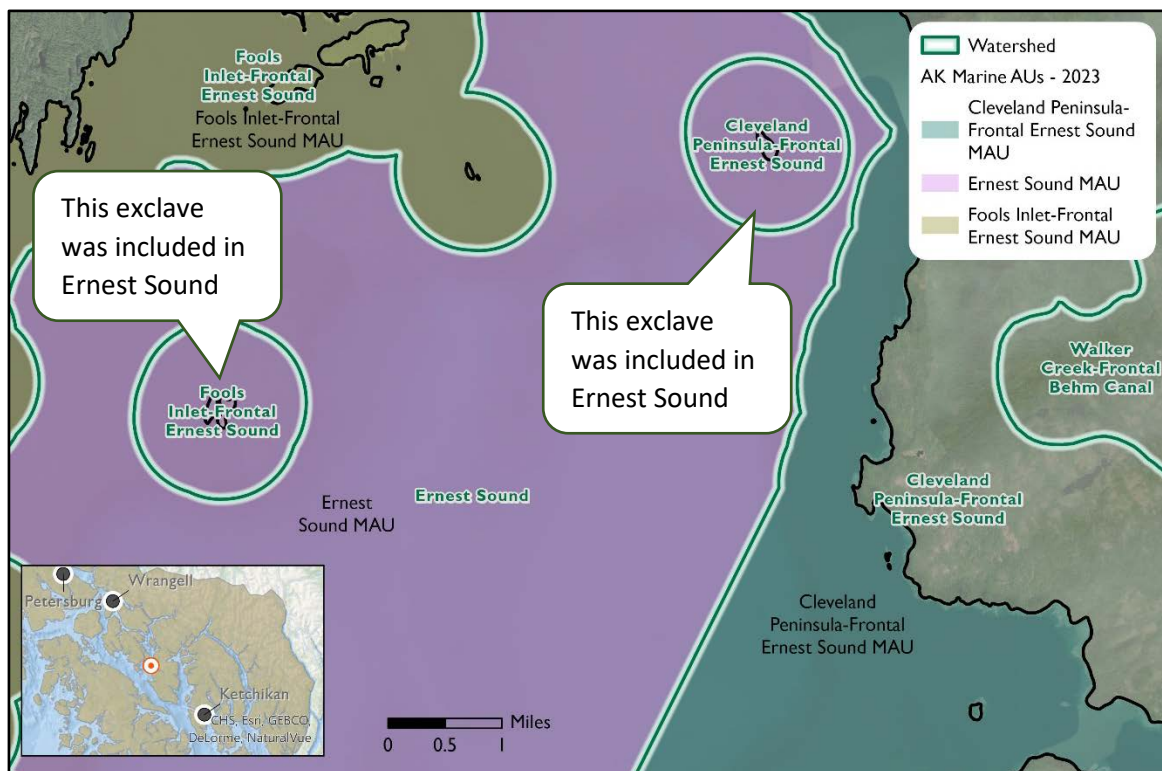
Constricted Channels

The base watershed layer from the national Watershed Boundary Dataset was designed to delineate freshwater drainages at varying scales, however, in the marine environment there are some mapping peculiarities. The previously mentioned larger waterbodies such as channels, passages, sounds, and straits typically cover the main, central area of a waterway with "frontal" watersheds flanking on either side. In some cases where a channel of strait narrows, the central HUC10 watershed is constricted to very, very small dimensions (< 200 meters wide). These can result in some very unusually shaped marine assessment units as shown in the mapped example.
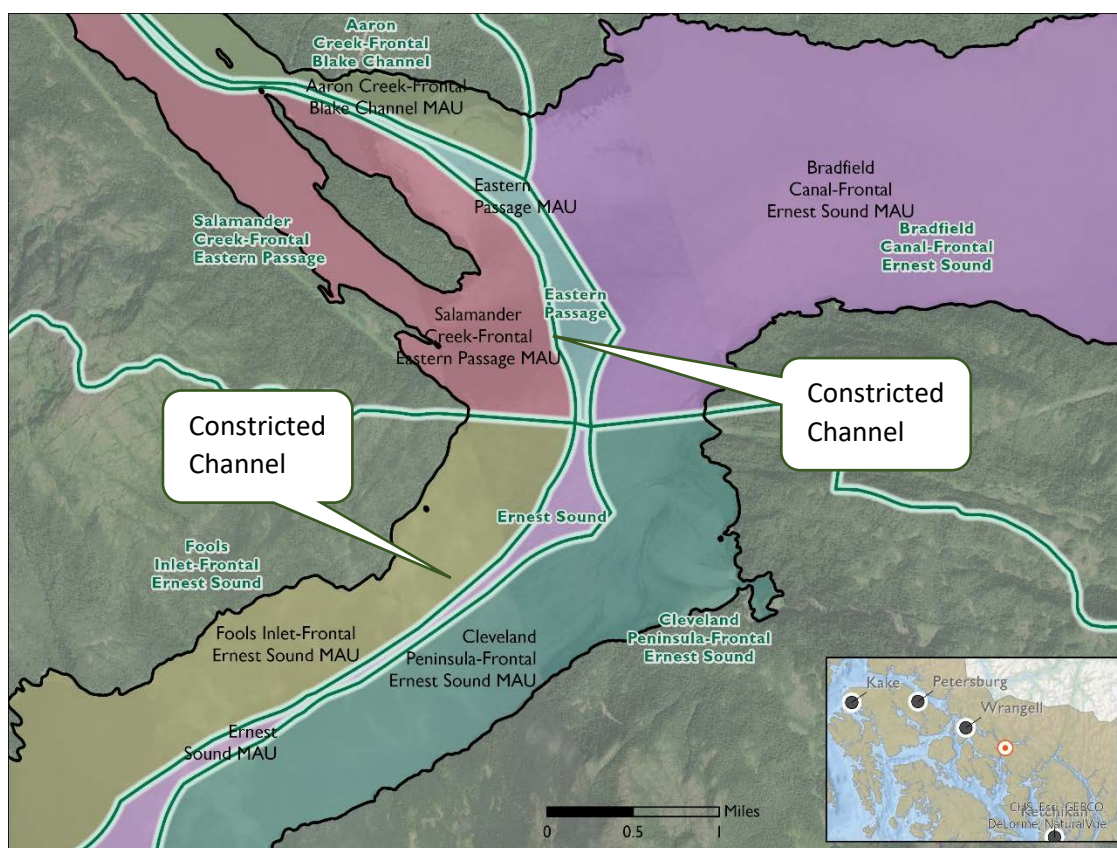
Future Edits

With the seamless marine assessment unit dataset covering Alaska's entire coastline, ADEC staff will be able to subdivide existing marine assessment units into smaller, more geographically discrete areas as needed while maintaining the basic data structure of HUC10 watershed boundaries and assessment unit identifier schema. Assigning a newly created assessment unit identifier will require the consulting the existing MAU inventory for that particular host HUC10 watershed to be sure that the new assessment unit identifier is not currently in use. Additionally, the list of retired assessment units should also be consulted to verify that the new AU ID was not previously used.

Data Delivery

The project package includes all of the component datasets used to create and modify this marine assessment unit inventory.   Additionally, the Marine Assessment Units are delivered in multiple formats.

1) MAUs_FINAL_singlepart – 509 polygon features, one for each marine assessment unit attributed with AU ID, host HUC10 watershed, host HUC8 subbasin, existing water quality attainment categorization if known, and notes regarding MAU creation. In this dataset, each MAU is represented by a single feature or single row in the attribute table. Area attributes (acres, square kilometers, and square miles) are summarized for each MAU.

2) MAU_FINAL_centroids – 509 point features, one for each marine assessment unit

3) MAU_FINAL_multipart – 626 polygon features representing the same 509 unique MAUs, but keeping separate polygons and separate features for each of the discontiguous polygons in effort to facilitate any future edits. Area attributes (acres, square kilometers, and square miles) are calculated for that individual feature (polygon) rather than the entire MAU unless the marine assessment unit is a single polygon.

APPENDIX A: Alaska Coastal Communities prioritized for Marine Assessment Units

	Name	Region
1	Anchorage	Southcentral
2	Dutch Harbor / Unalaska	Southwest / Aleutians
3	Haines	Southeast
4	Homer	Southcentral
5	Hoonah	Southeast
6	Juneau / Auke Bay	Southeast
7	Kake	Southeast
8	Ketchikan / Ward Cove	Southeast
9	Kodiak	Southwest / Aleutians
10	Nome	Northwest
11	Petersburg	Southeast
12	Seward	Southcentral
13	Sitka	Southeast
14	Skagway	Southeast
15	Utqiagvik	Arctic
16	Valdez	Southcentral
17	Whittier	Southcentral
18	Wrangell	Southeast

APPENDIX B: ADEC Marine 2023 Data Sources				
Name	**Agency**	**Date**	**Description**	**Link**
Alaska Detailed Coastline (Alaska 1:63,360)	ADNR	download 2022, data vintage 1998 or older topographic maps	This coverage was generalized from the cst63xsi, which is similar to coast63 without the small islands. The Abstract from the coast63 coverage is as follows: This is a first cut at a statewide 1:63,360 coastline. The entire coastline, however, is not 1:63.360; only where data was available as of January 1998. It is a mixture of sources ranging from the Department of Natural Resources, Land Records Information Section hydrography database to the Exxon Valdez Oil Spill Environmentally Sensitive Index coastline (no ESI attributes included) to the US Geologic Survey hydrography to US Forest Service (in Prince William Sound). Where the 1:63,360 data was unavailable the 1:250,000 coastline was used to fill in.	https://gis.data.alaska.gov/datasets/SOA-DNR::alaska-coastline/about?layer=4
Alaska Generalized 1:63,360 (Alaska_Coastline.shp)	ADNR	2023 (pub date 1998)	This dataset traces the Alaskan coastline and excludes all small islands and offshore rocks.	https://gis.data.alaska.gov/datasets/SOA-DNR::alaska-generalized-163360/about
Continually Updated Shoreline Product (CUSP)	NOAA	2023	This data set was created to deliver continuous shoreline with frequent updates to support various GIS applications including coastal and marine spatial planning, tsunami and storm surge modeling, hazard delineation and mitigation, environmental studies and may assist in nautical chart updates.	https://shoreline.noaa.gov/data/datasheets/cusp.html

APPENDIX B: ADEC Marine 2023 Data Sources

Name	Agency	Date	Description	Link
Federal and State Waters	NOAA	2023	These data show the geographic representation of Federal and State Waters for the purpose of display in the MarineCadastre.gov OceanReports application. The boundary between state and federal waters was determined by consulting The Submerged Lands Act (43 U.S.C. §§ 1301 et seq.), 48 U.S.C. §§ 1705 and The Abandoned Shipwreck Act (43 U.S.C. §§ 2101). Some boundary delineations based on the SLA were approximated in this data set, including areas in Hawaii, Alaska, and Washington State. Although state borders do not extend over water, it was necessary to approximate these borders to produce this data set.	https://www.fisheries.noaa.gov/inport/item/54383
Maritime Boundary	NOAA	2022	Maritime limits and boundaries for the United States are measured from the official U.S. baseline, recognized as the low-water line along the coast as marked on the NOAA nautical charts in accordance with the articles of the Law of the Sea. The Office of Coast Survey depicts on its nautical charts the territorial sea (12 nautical miles), contiguous zone (24nm), and exclusive economic zone (200nm, plus maritime boundaries with adjacent/opposite countries)	https://nauticalcharts.noaa.gov/data/us-maritime-limits-and-boundaries.html
Watershed Boundary Dataset (WBD); (HUC10 Watershed)	USGS	2022	Boundaries for HUC10 Watersheds for Alaska (HU2=19). These drainage boundaries are typically projected 3 miles offshore into marine waters.	https://prd-tnm.s3.amazonaws.com/index.html?prefix=StagedProducts/Hydrography/WBD/HU2/

APPENDIX C: Retired Marine Assessment Units

	AU Name	AU ID	HUC10 Name	HUC8 Name	ADEC Notes	ACCS Notes
1	**Tolstoi Bay**	AK_M_1010303_015	Kashevarof Passage-Frontal Clarence Strait	Prince of Wales	Not map correctly, formerly impaired (residues), 2023 merged into larger Kashevarof Passage MAU	Create new AU for larger area, merge this AU into that one. Need new AU ID.
2	**Saint John Baptist Bay**	AK_M_1021208_004	Neva Strait-Frontal Peril Strait	Baranof Island	Formerly impaired (toxics), 2023 retired	Create new AU for larger area, merge this AU into that one. Need new AU ID.
3	**Schulze Cove**	AK_M_1021207_002	Fish Bay-Frontal Peril Strait	Baranof Island	Formerly impaired (toxics), Cat 2, 2023 retired	Create new AU for larger area, merge this AU into that one. Need new AU ID.
4	**Cube Cove**	AK_M_1020408_005	Fishery Creek-Frontal Chatham Strait	Admiralty Island	Formerly impaired, 2023 retired merged into larger MAU Fishery Creek - Frontal Chatham Strait	Create new AU for larger area, merge this AU into that one. Need new AU ID.
5	**Corner Bay**	AK_M_1021103_001	Tenakee Inlet-Frontal Chatham Strait	Chichagof Island	Formerly impaired (residues), 2023 retired, merged into larger Tenakee Inlet MAU	Create new AU for larger area, merge this AU into that one. Need new AU ID.
6	**Sunshine Cove**	AK_M_1021103_008	Tenakee Inlet-Frontal Chatham Strait	Chichagof Island	2023 retired, merged into larger Tenakee Inlet MAU	Can be changed as needed, keep AU ID for ATTAINS. Multiple AUs can be merged together if needed (Crab Bay, Corner Bay), must retire "extra" AU IDs
7	**Salt Lake Bay**	AK_M_1021109_007	Port Fredrick-Frontal Icy Strait	Chichagof Island	Formerly impaired (residues), 2023 retired merged into larger MAU	Create new AU for larger area, merge this AU into that one. Need new AU ID.

APPENDIX C: Retired Marine Assessment Units

	AU Name	AU ID	HUC10 Name	HUC8 Name	ADEC Notes	ACCS Notes
8	**West Port Frederick**	AK_M_1021109_011	Port Fredrick-Frontal Icy Strait	Chichagof Island	Formerly impaired (residues); has parameters for harbor monitoring, 2023 retired, merged into Port Fredrick MAU	Create new AU for larger area, merge this AU into that one. Need new AU ID.
9	**Point McCartney**	AK_M_1021005_005	Keku Strait-Frontal Frederick Sound	Kuiu-Kupreanof-Mitkof Islands	2023 - merged in general Portage Bay MAU	Create new AU for larger area, merge this AU into that one. Need new AU ID.
10	**Crab Bay**	AK_M_1021103_002	Tenakee Inlet-Frontal Chatham Strait	Chichagof Island	2023 retired, merged into larger Tenakee Inlet MAU	Can be changed as needed, keep AU ID for ATTAINS
11	**Saginaw Bay**	AK_M_1021006_004	Saginaw Bay-Frontal Frederick Sound	Kuiu-Kupreanof-Mitkof Islands	Formerly impaired (residues), 2023 retired	Create new AU for larger area, merge this AU into that one. Need new AU ID.
12	**Rowan Bay**	AK_M_1021007_002	Bay of Pillars-Frontal Chatham Strait	Kuiu-Kupreanof-Mitkof Islands	Formerly impaired (residues), 2023 retired merged into larger MAU	Create new AU for larger area, merge this AU into that one. Need new AU ID.
13	**Hamilton Bay**	AK_M_1021005_006	Keku Strait-Frontal Frederick Sound	Kuiu-Kupreanof-Mitkof Islands	Formerly impaired (residues), 2023 retired	Create new AU for larger area, merge this AU into that one. Need new AU ID.
14	**Hobart Bay (main)**	AK_M_1020614_003	Hobart Bay-Frontal Stephens Passage	Holkham Bay	Formerly impaired, 2023 created expanded AU includes formerly impaired polygon plus remainder of the Bay, assigned a new AU ID	Create new AU for larger area, merge this AU into that one. Need new AU ID.