Inlet Atlas 2.0

Accessing Geomorphic Analysis Products with Enterprise Services

Charlene Sylvester, Dr. Kaitlyn McPherran, Matheus de Assis Bose, Loderay Bracero Marrero, and Dr. Justin Shawler

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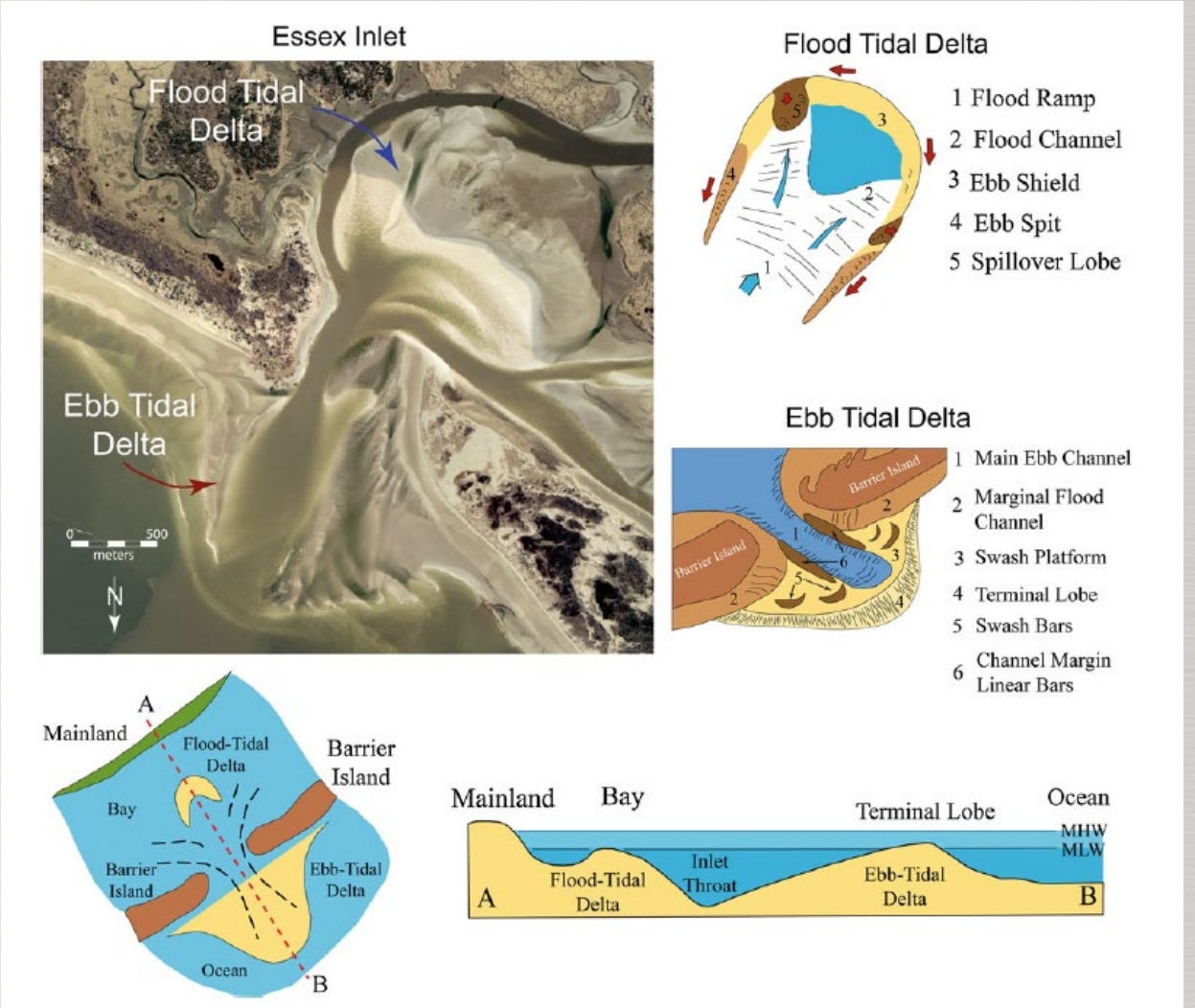
Coastal Inlets

- Common feature on sandy barrier coasts
- Complex, rapidly changing geomorphology
- May quickly scour, infill, and migrate
- Drive regional sediment variability



Example tidal inlet morphologic features from Essex Inlet MA (Figure by FitzGerald and Buynevich (2021) in: Encyclopedia of Coastal Science)

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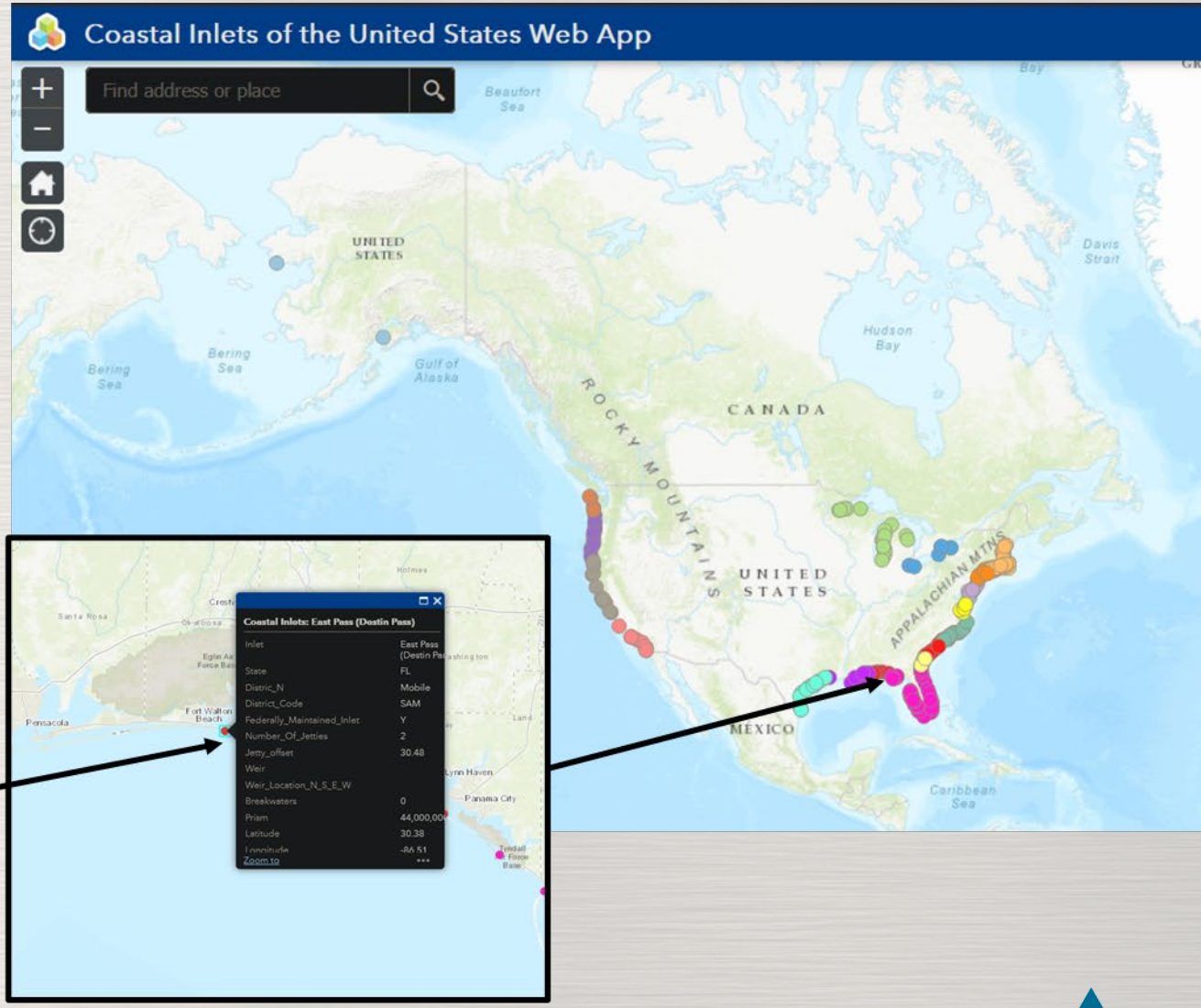
Coastal Inlets, cont.

- USACE maintains nearly 200 coastal inlets (USACE CIRP, 2025a)
- Provide millions of jobs and trillions of dollars in value to the nation (IWR, 2025)
- Dredges 223 Mcy/yr at cost of $1.7B (total, including inlets) (USACE HQ, 2025)

Severe shoaling in the navigation channel of Manasquan Inlet NJ

CIRP US Coastal Inlet Atlas

- Database of info on federally maintained inlets
- Lacks ready made bathymetric datasets and geomorphometric data products
- Hosted on CHL's ArcGIS® Online Subscription
- Manual update and maintenance



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Expanding the Atlas

- High-resolution, repeat bathymetric maps
- Results from four geomorphometric analysis methods
  - Relative Relief (Wernette et al., 2016)
  - Geomorphons landform classification (Jasiewicz and Stepinski, 2013)
  - Chronstratigraphic analysis (Pearson et al., 2022)
  - Conformal Mapping analysis (Pearson et al., 2022)
- Enterprise Postgres Geodatabase hosted on RDE
- ESRI ArcGIS® Enterprise Portal web services, public maps and apps
- Spatio-Temporal Access Catalog (STAC)

Modern data storage and dissemination architecture for efficient discovery, access, use, and maintenance of R&D products for field practitioners and researchers

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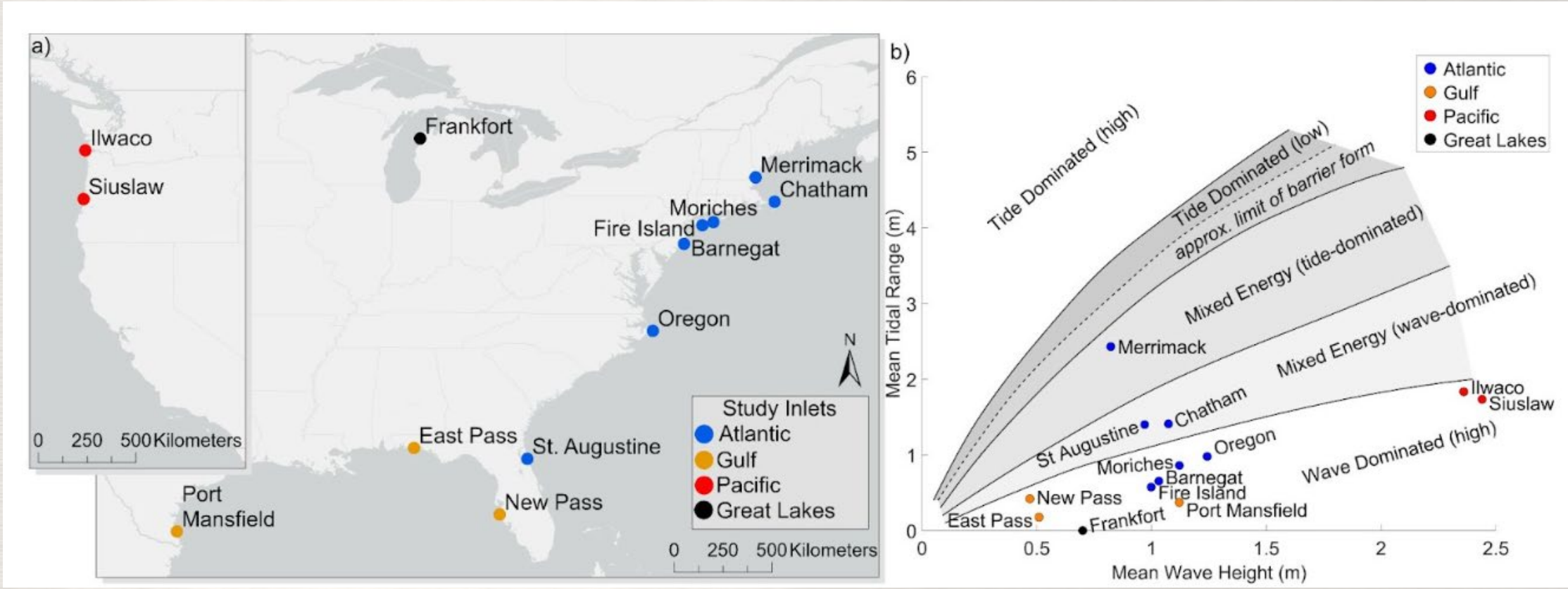
Study Sites



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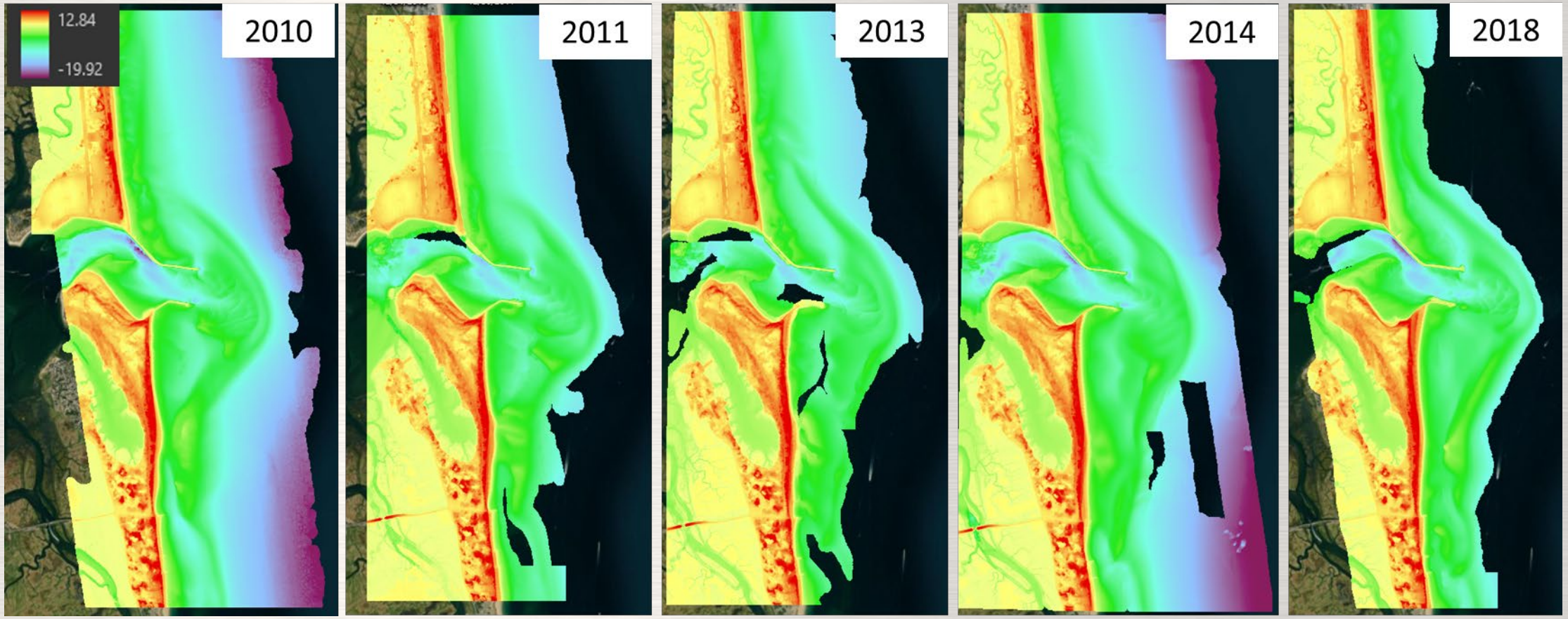
US Tidal Inlet Atlas 2.0



Merrimack MA topobathymetric lidar elevation data (m) (NCMP).

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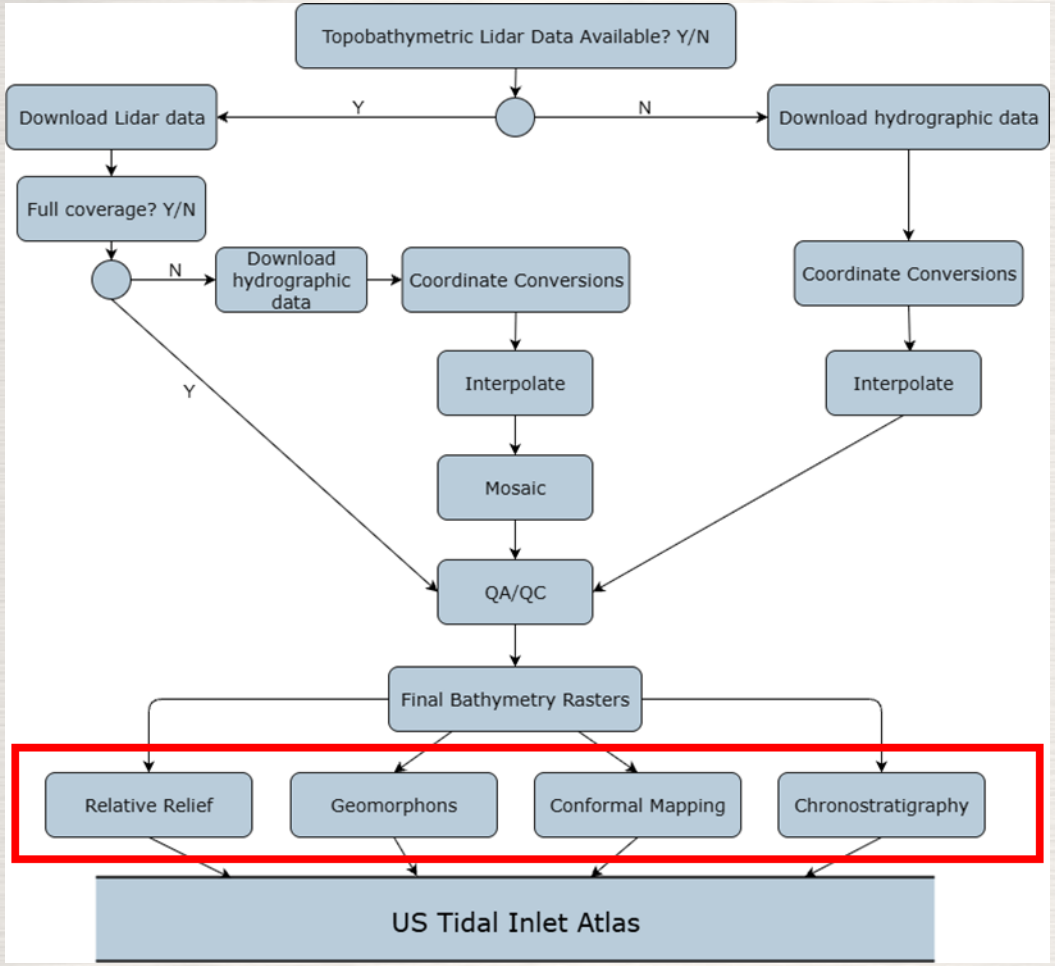
Geomorphic Analyses



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ERDC/CHL CHETN-IV-132
APRIL 2025

Tools for Inlet Geomorphic Mapping: An Overview and Application at East Pass, Florida and Fire Island Inlet, New York

by Justin L. Shawler, Charlene S. Sylvester, Kaitlyn A. McPherran, Matheus de Assis Bose, and Rekea Williams

Jasiewicz, Jarosław, and Tomasz F. Stepinski. 2013. "Geomorphons—A Pattern Recognition Approach to Classification and Mapping of Landforms." *Geomorphology* 182: 147–56. https://doi.org/10.1016/j.geomorph.2012.11.005.

Pearson, S. G., E. P. L. Elias, B. C. van Prooijen, H. van der Vegt, A. J. F. van der Spek, and Z. B. Wang. 2022. "A Novel Approach to Mapping Ebb-Tidal Delta Morphodynamics and Stratigraphy." *Geomorphology* 405: 108185. https://doi.org/10.1016/j.geomorph.2022.108185.

Wernette, Phillipe, Chris Houser, and Michael P. Bishop. 2016. "An Automated Approach for Extracting Barrier Island Morphology from Digital Elevation Models." *Geomorphology* 262: 1–7. https://doi.org/10.1016/j.geomorph.2016.02.024.

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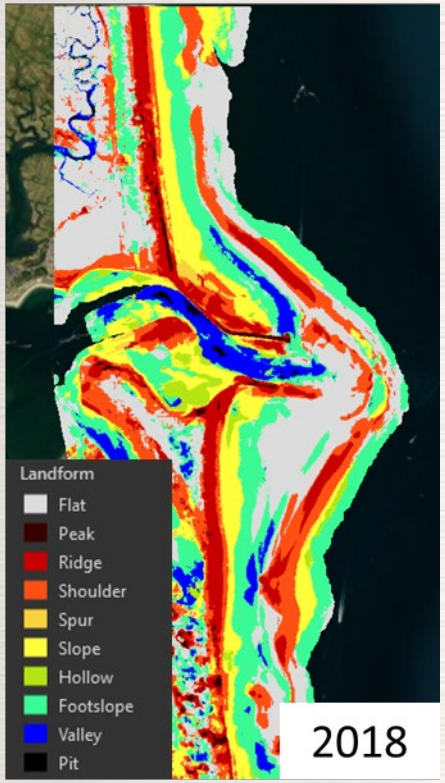
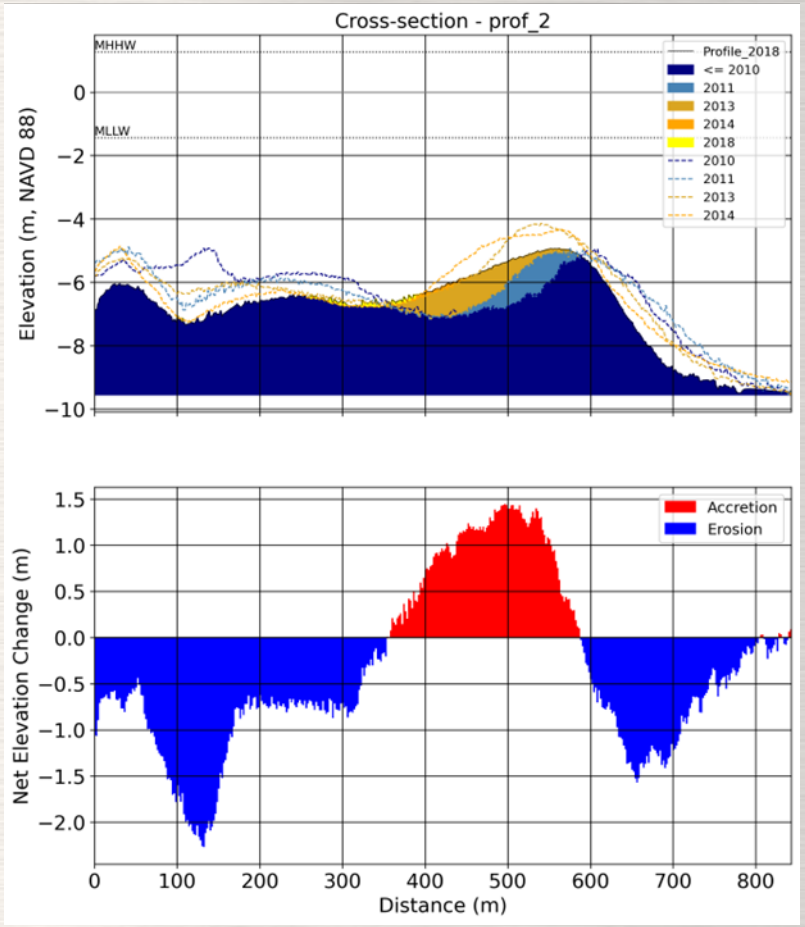
Data Products

Geomorphon Landform Classification

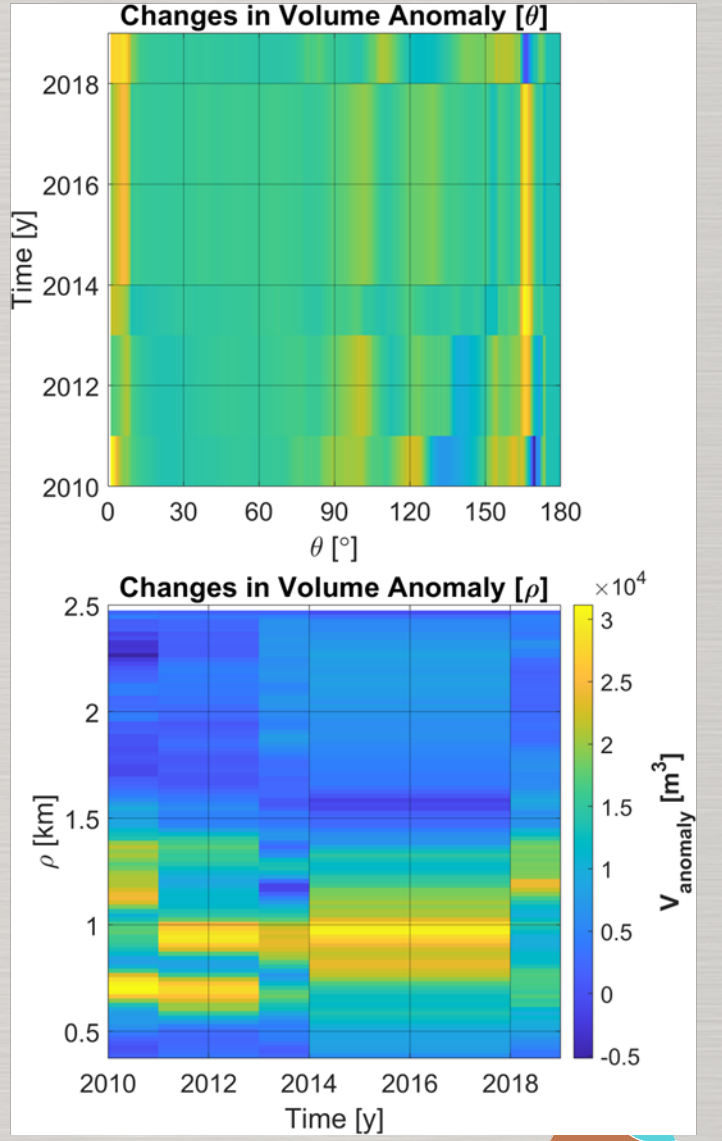


Relative Relief Analysis

Chronostratigraphic Analysis



Conformal Mapping Analysis



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Potential Management Applications

- Identify sediment borrow and placement areas for BUDM.
- Track shoal migration for targeted mapping efforts.
- Provide data and information for hydrodynamic and sediment transport models to improve numerical modeling efforts.
- Identify areas of problematic shoaling outside the narrow bounds of the federal navigation channel which still affect navigation.
- Estimate post-dredge recharge rates to optimize dredging strategies.
- Aid in the siting and scoping stages of coastal engineering projects.
- Identify bypassing directions and rates to incorporate inlet-scale processes into regional sediment management practices.
- Inclusion into other ready-made USACE tools such as the Sediment Budget Analysis System (USACE CIRP, 2025b).

Existing Inlets Atlas

- Storage – Hosted feature layer in ArcGIS® Online, consuming minor amount of ESRI credits
- One primary point feature class with all attributes
- Data is disconnected from authoritative data sources, requiring manual update and maintenance of feature layer.
- Backup - Copies of data exist across MS Teams and local machines. Which source is authoritative? Current?

Field

Name	Alias	Type
OBJECTID	OBJECTID	OID
Shape		Geometry
Inlet_Name	Inlet	String
State	State	String
District_Name	Distric_N	Rep_Average_QNet_CM_Per_Year	Rep_Average_QNet_CM_Per_Year	Double
District_Code	District_Co	QNet_Direction_Degrees	QNet_Direction_Degrees	Long Integer
Federally_Maintained_Inlet	Federally_M	QNet_Direction_N_S_E_W	QNet_Direction_N_S_E_W	String
Number_Of_Jetties	Number_Of	Spring_Discharge_CM_Per_Second	Spring_Discharge_CM_Per_Second	Double
Jetty_offset	Jetty_offse	Avg_River_Discharge_CM_Per_Sec	Avg_River_Discharge_CM_Per_Sec	Double
Weir	Weir	Max_River_Discharge_CM_Per_Sec	Max_River_Discharge_CM_Per_Sec	Double
Weir_Location_N_S_E_W	Weir_Locat	Median_Grain_Size_D50_MM	Median_Grain_Size_D50_MM	Double
Breakwaters	Breakwater	Channel_Cross_Sectional_Area	Channel_Cross_Sectional_Area	Double
Prism	Prism	Minimum_Cross_Sectional_Width	Minimum_Cross_Sectional_Width	Double
Latitude	Latitude	Distance_Offshore_KM	Distance_Offshore_KM	Double
Longitude	Longitude	Distance_Downdraft_Attachment	Distance_Downdraft_Attachment	Double
Ebb_Tidal_Delta_Volume_CM	Ebb_Tidal_I	Distance_Updraft_Attachment	Distance_Updraft_Attachment	Double
Flood_Tidal_Delta_Volume_CM	Flood_Tidal	Avg_Annual_Entrance_Dredging	Avg_Annual_Entrance_Dredging	Double
Minimum_Width_Meters	Minimum_W	Min_Annual_Entrance_Dredging	Min_Annual_Entrance_Dredging	Double
WIS_Station_Number	WIS_Station	Max_Annual_Entrance_Dredging	Max_Annual_Entrance_Dredging	Double
WIS_Station_Latitude	WIS_Station	Maint_Dredge_Depth_OverBar	Maint_Dredge_Depth_OverBar	Double
WIS_Station_Longitude	WIS_Station	Maint_Dredge_Width_OverBar	Maint_Dredge_Width_OverBar	Double
WIS_Station_Depth_Meters	WIS_Station	Advance_Dredge_Depth_OverBar	Advance_Dredge_Depth_OverBar	Double
Mean_Wave_Height_Hmo_Meters	Mean_Wav	Maint_Entrance_Channel_Depth	Maint_Entrance_Channel_Depth	Double
Mean_Peak_Period_Tp_Seconds	Mean_Peak	Maint_Entrance_Channel_Width	Maint_Entrance_Channel_Width	Double
Wave_Energy_Ef_N_MperS_M	Wave_Ener	Advance_Entrance_Dredging	Advance_Entrance_Dredging	Double
		Referenced_Wave_Height	Referenced_Wave_Height	Double
		Rep_Wave_Period	Rep_Wave_Period	Double
		Rep_Minimum_QNET	Rep_Minimum_QNET	Double
		Rep_Maximum_QNET	Rep_Maximum_QNET	Double
		Rep_Average_QGross	Rep_Average_QGross	Double
		Rep_Minimum_QGross	Rep_Minimum_QGross	Double

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Inlets Atlas 2.0

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- Storage – Hosted feature layer in ArcGIS® Online, consuming minor amount of ESRI credits
- One primary point feature class with all attributes
- Data is disconnected from authoritative data sources, requiring manual update and maintenance of feature layer.
- Backup - Copies of data exist across MS Teams and local machines. Which source is authoritative? Current?

Inlets Atlas 2.0

- Storage – Enterprise geodatabase hosted on ERDC RDE network in partnership with USACE CorpsCam
- SDSFIE-compliant feature classes, tables, relationship classes, and metadata
- Authoritative data in the Enterprise geodatabase stays in sync with web services and applications.
- Backup - Routine backups of the geodatabase are accomplished by system admin.

Modern data storage and dissemination architecture for efficient discovery, access, use, and maintenance of R&D products for field practitioners and researchers

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Inlets Atlas 2.0 Enterprise Architecture

- Postgres geodatabase paired with ArcGIS® Enterprise on ERDC RDE network
  - Admin by Mike Forte
- SDSFIE-compliant when possible
  - Geospatial data – vector and raster datasets
  - Tabular data – business tables for metadata, related data, etc.
  - Relationship classes – establishes connections between geospatial and tabular data
- CHL THREDDS server and Spatio-Temporal Access Catalogs (STAC)
  - Support from Mitch Brown

PostgreSQL database paired with ArcGIS® Enterprise 11.3 Portal and Server

Image Source: Esri

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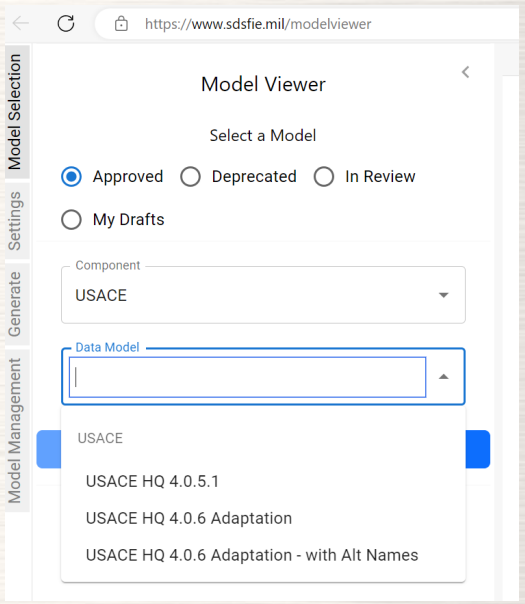
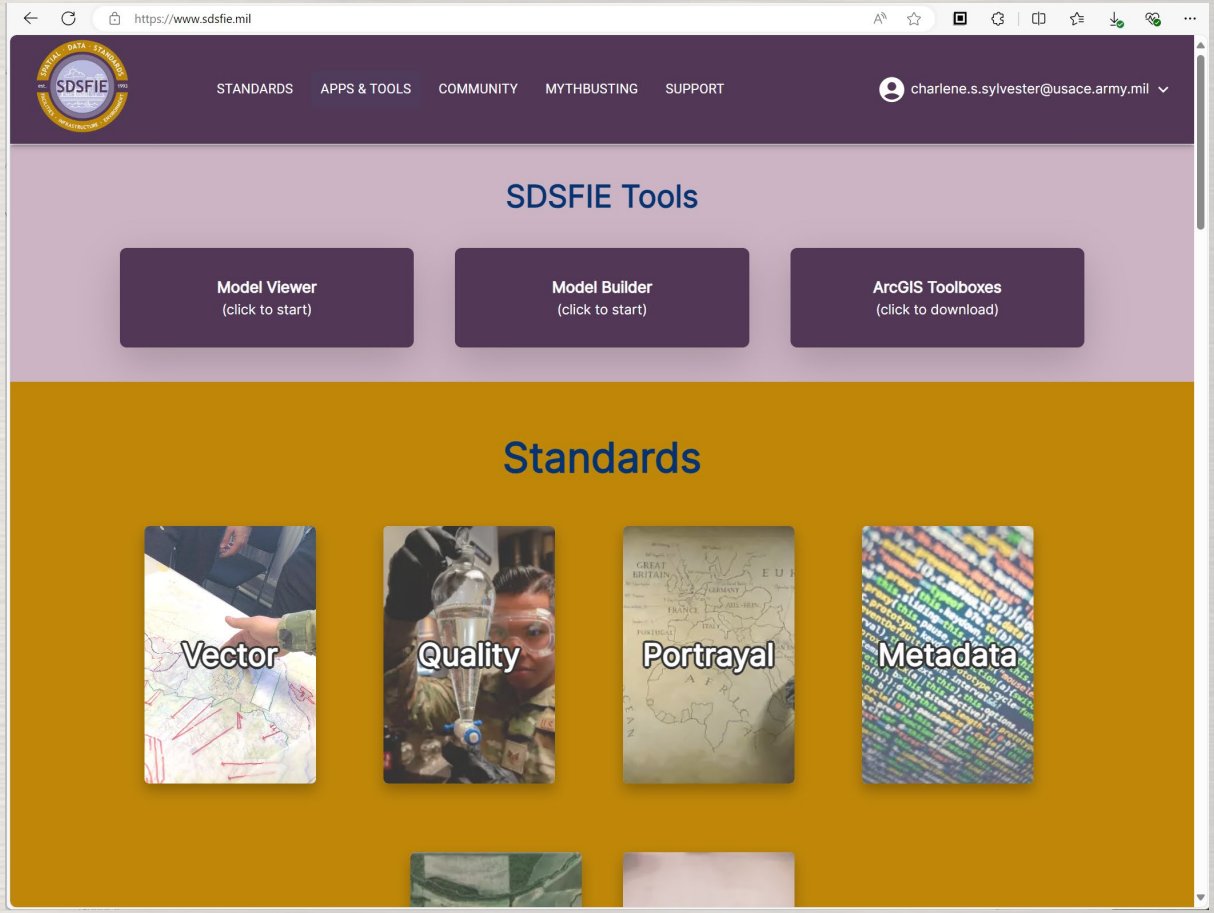
SDSFIE Introduction

- **S**patial **D**ata **S**tandards for **F**acilities, **I**nfrastructure, and **E**nvironment (SDSFIE)
- Family of standards and data models to promote **F**indable, **A**ccessible, **I**nteroperable, and **R**eusable (FAIR) data
- DODI 8130.01 Installation Geospatial Information and Services
- Installation and Civil Works geospatial data



USACE data models



Reference for more information Microsoft PowerPoint - 1.2 SDSFIE Use and Governance 20230908.pptx and SDSFIE Website

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SDSFIE Example

Entity

FIND IN TREE

USACE HQ 4.0.5.1

(point) Inlet Infor

Standardizes featu

Names

Model Name	Alias Name
ProjectReferencePoint	Project Reference, Point

Justification

Definition

The location of or area delineating a specific project expressed in point form. This is the ve

Note

The entity specifically supports the following USACE programs and/or functional areas: CP

Other Properties

Default Geometry	Permissible Geometry	Gold
P	P	No

Superclass

ProjectReference

From SDSFIE M

*CAC Log-in

Attributes:

Standardizes attribution

COLUMNS FILTERS DENSITY EXPORT

Model Name	Alias Name	Definition	Data Type
archiveIndicat...	Archive Indica...	Indicates whether a project is historic or active.	YesOrNo
districtCode	District Code	A 2 digit code that refers to the district.	String
			String(MAX)
			String
		Project Notebook) polygons - Found...	Integer
		onal Id/Projects.	String(MAX)
			Integer
		timedia records that reference data.	String
		netadata.	String
		erations and Maintenance Business ...	String
		a project in P2(Primavera). This cod...	Integer
		(Army Management Structure Code...	String
		the associated project identifier rec...	String
			String(MAX)
		ifier for each record or instance of a...	String
			String
			String
		ly and uniquely identify a DoD real p...	Integer
sdsId	Globally Uniq...	The unique identifier for all entities in the SDSFIE.	GUID

https://www.sdsfie.mil/modelbuilder

Model Selection | Settings | Generate | Model Management

Model Generation

No model selected, please return to the Model Selection tab to select a model and entities to generate.

Generate Physical Model

Generate Logical Model

Generate ASW from Model

Download ArcGIS Toolboxes

From SDSFIE Model Builder*

*CAC Log-in

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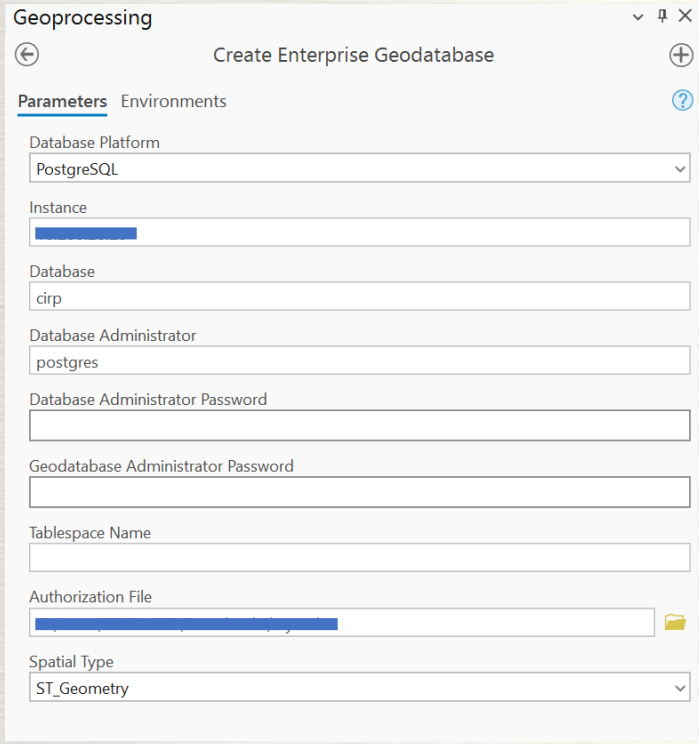
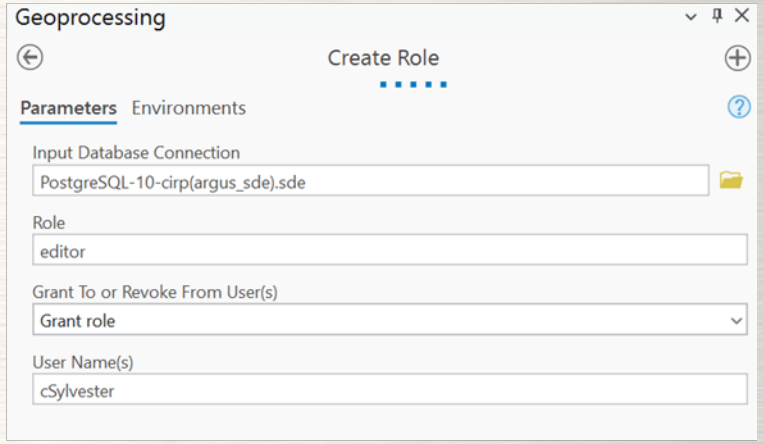
Inlets Atlas 2.0 Enterprise Geodatabase

‘CIRP’ geodatabase instance

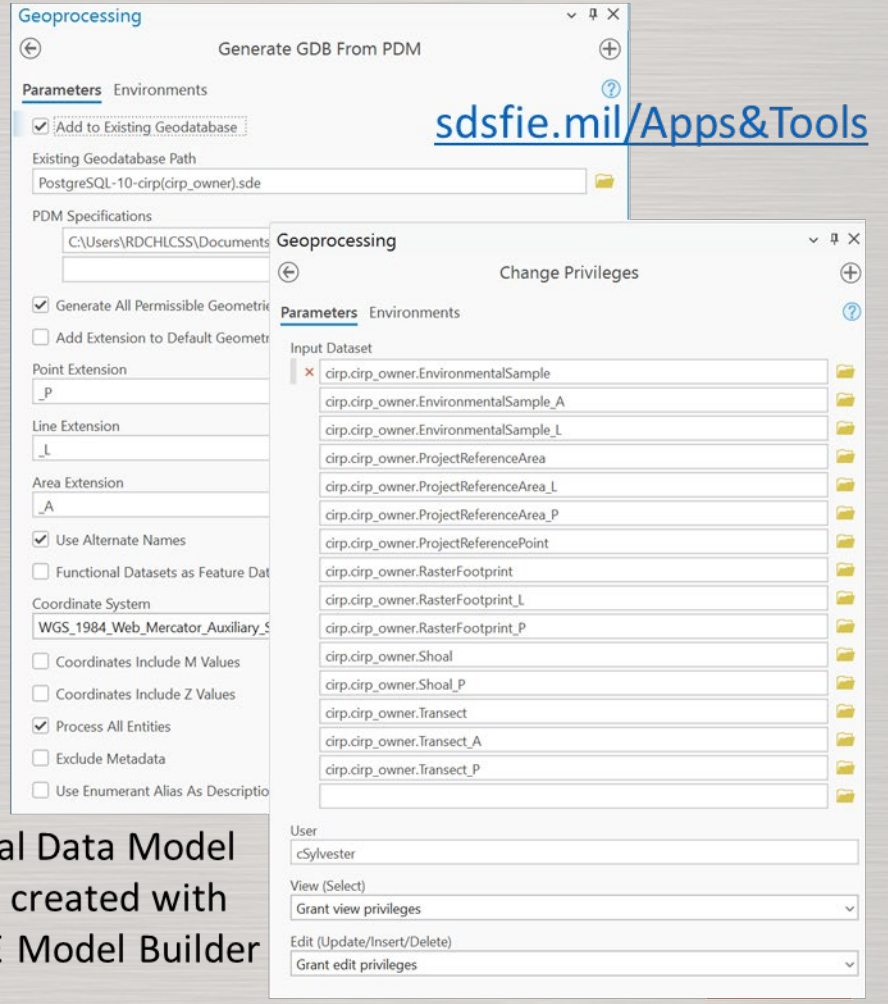


User Roles



Controls who can view, edit (insert, update, or delete), and create datasets in the geodatabase

Feature Classes and Business Tables



sdsfie.mil/Apps&Tools

Physical Data Model (PDM) created with SDSFIE Model Builder Tool

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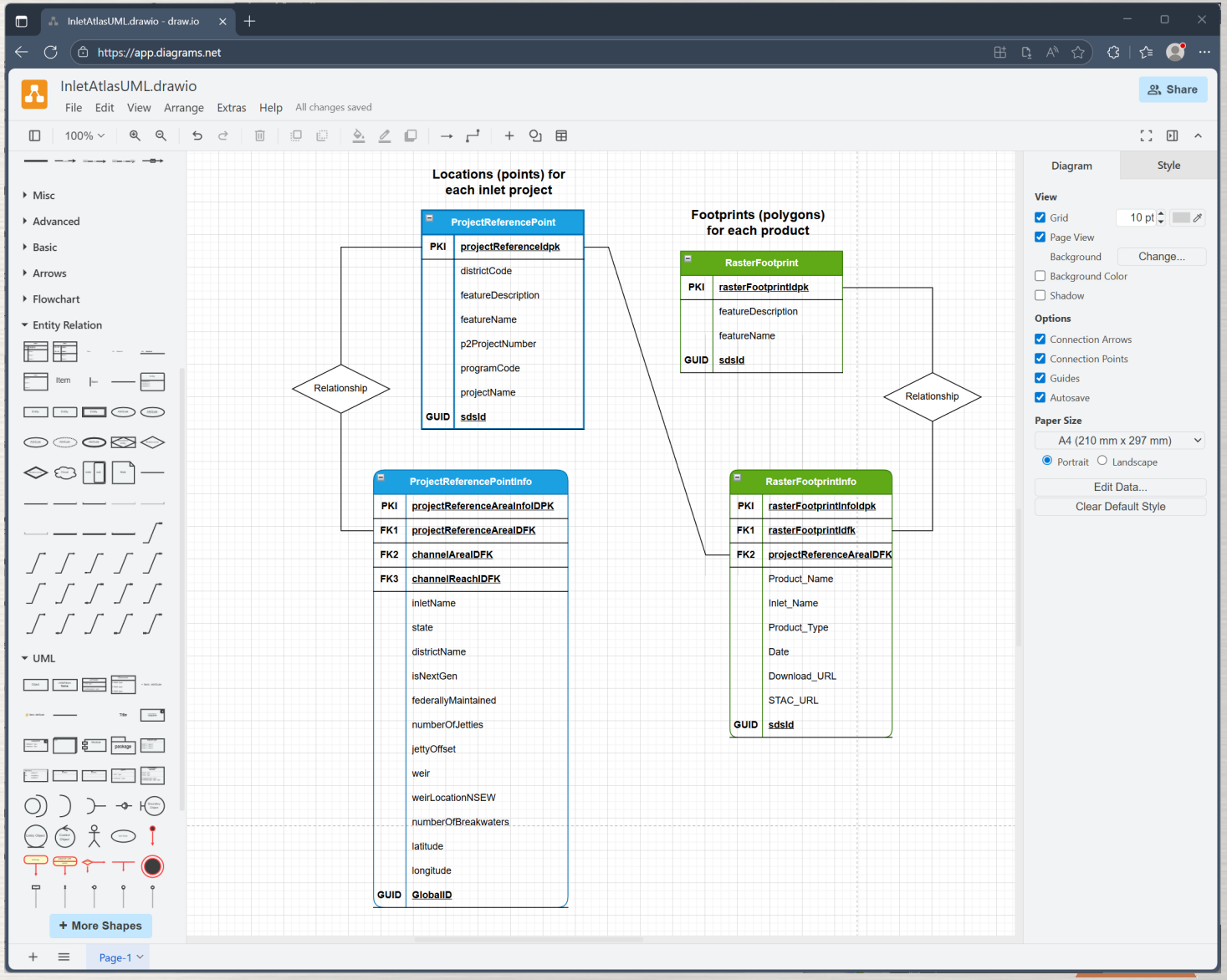
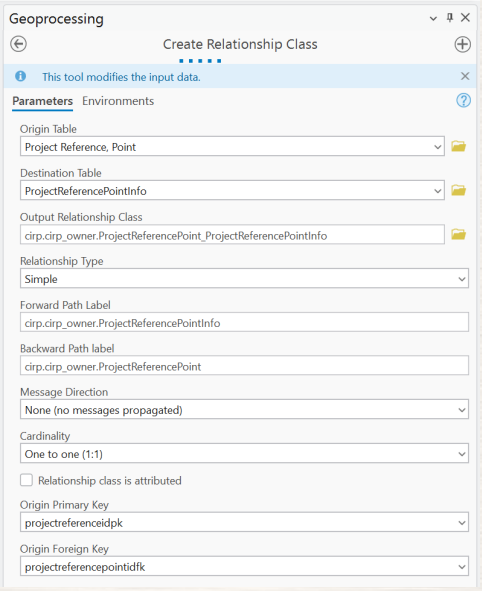
Inlets Atlas 2.0 Enterprise Geodatabase

Enablers of open, linked, interoperable data

- Relationship classes used to extend attribution of SDSFIE feature classes and link datasets
- One-to-one
  - Inlet location to inlet information
- One-to-many
  - Inlet location to product footprints
- Globally-unique identifiers are used for primary keys and foreign keys





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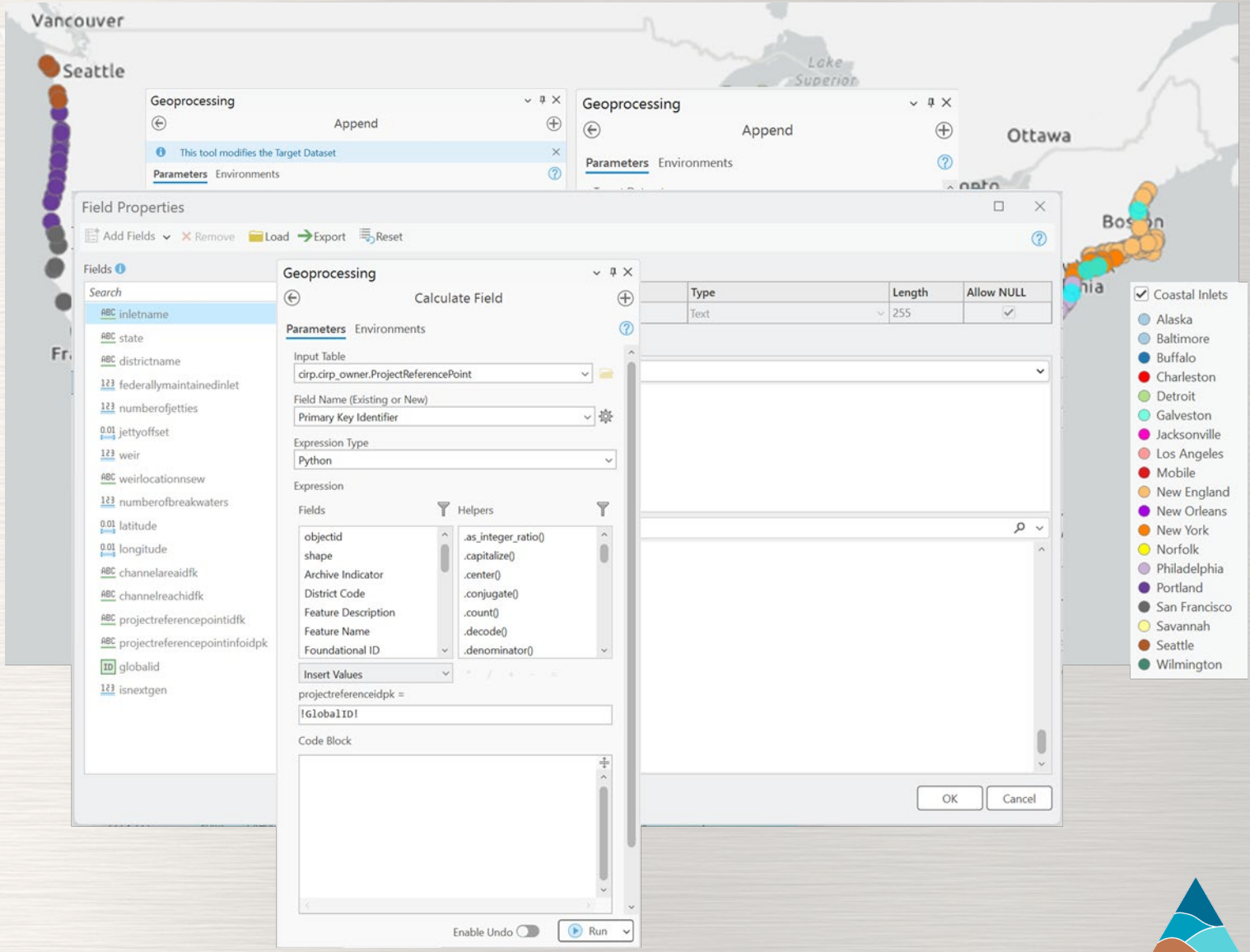
Populating the Geodatabase

Vector and Tabular Data

- Append inlet locations (points) from existing atlas to feature class *ProjectReferencePoint* and table *ProjectReferencePointInfo*
- Use a field map to populate SDSFIE attributes and extended attributes
- Calculate primary and foreign keys
- Verify relationship between points and table



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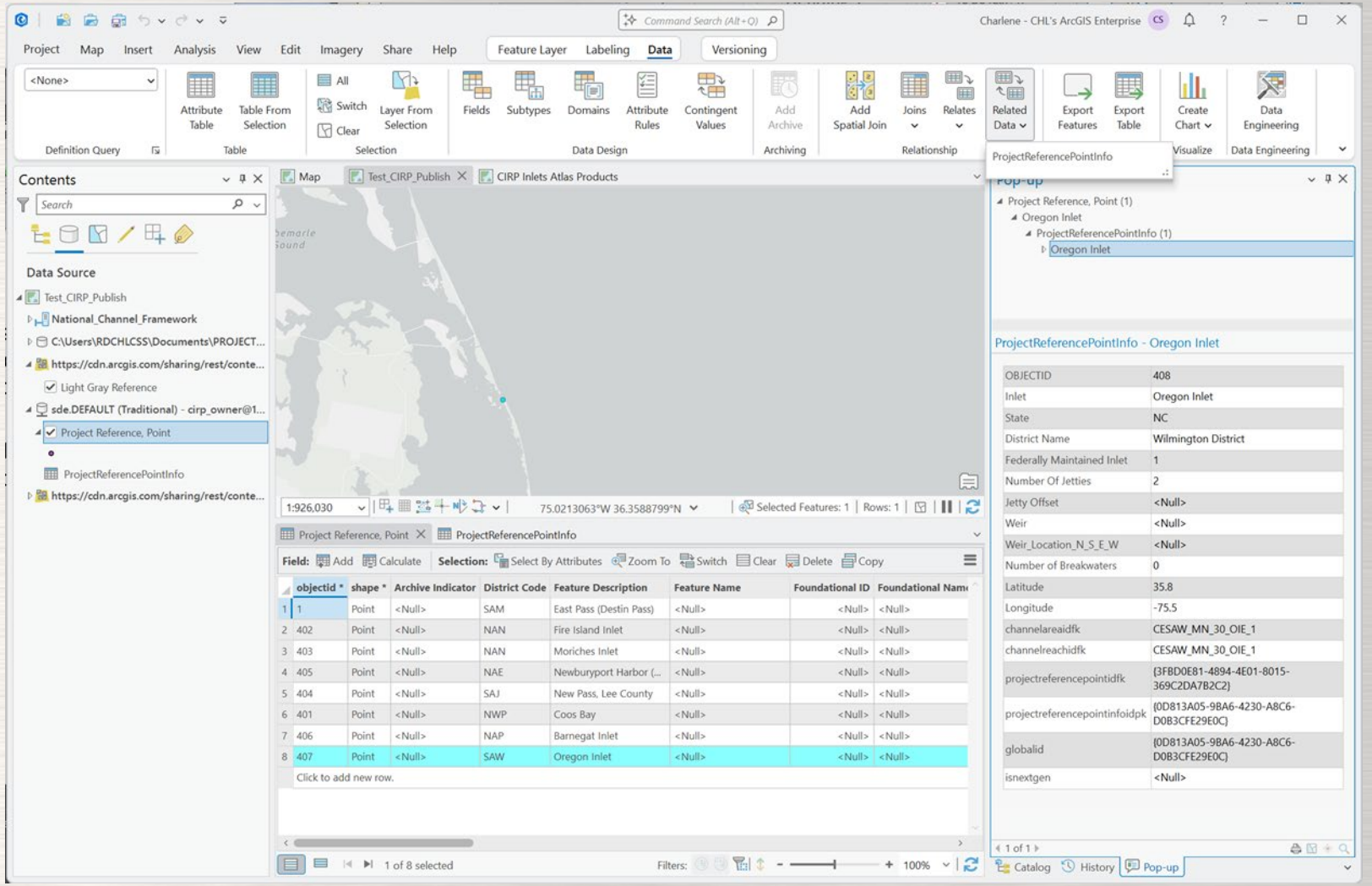

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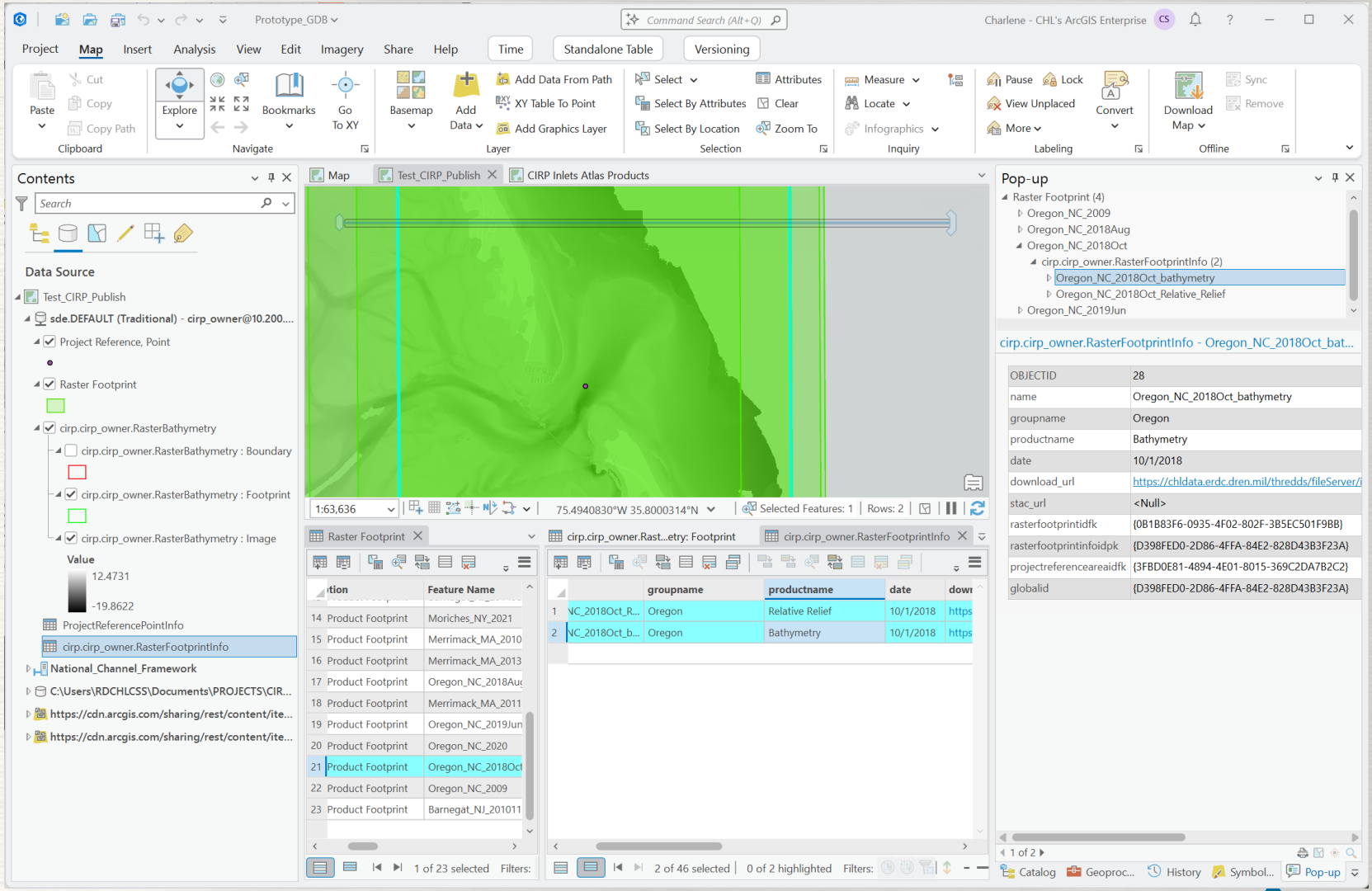
Populating the Geodatabase

Raster Data

- Load raster products into geodatabase
- Build and configure a mosaic dataset
- Append footprints to feature class *RasterFootprint* and table *RasterFootprintInfo*
- Calculate primary and foreign keys and other attributes
- Verify relationship between points and table



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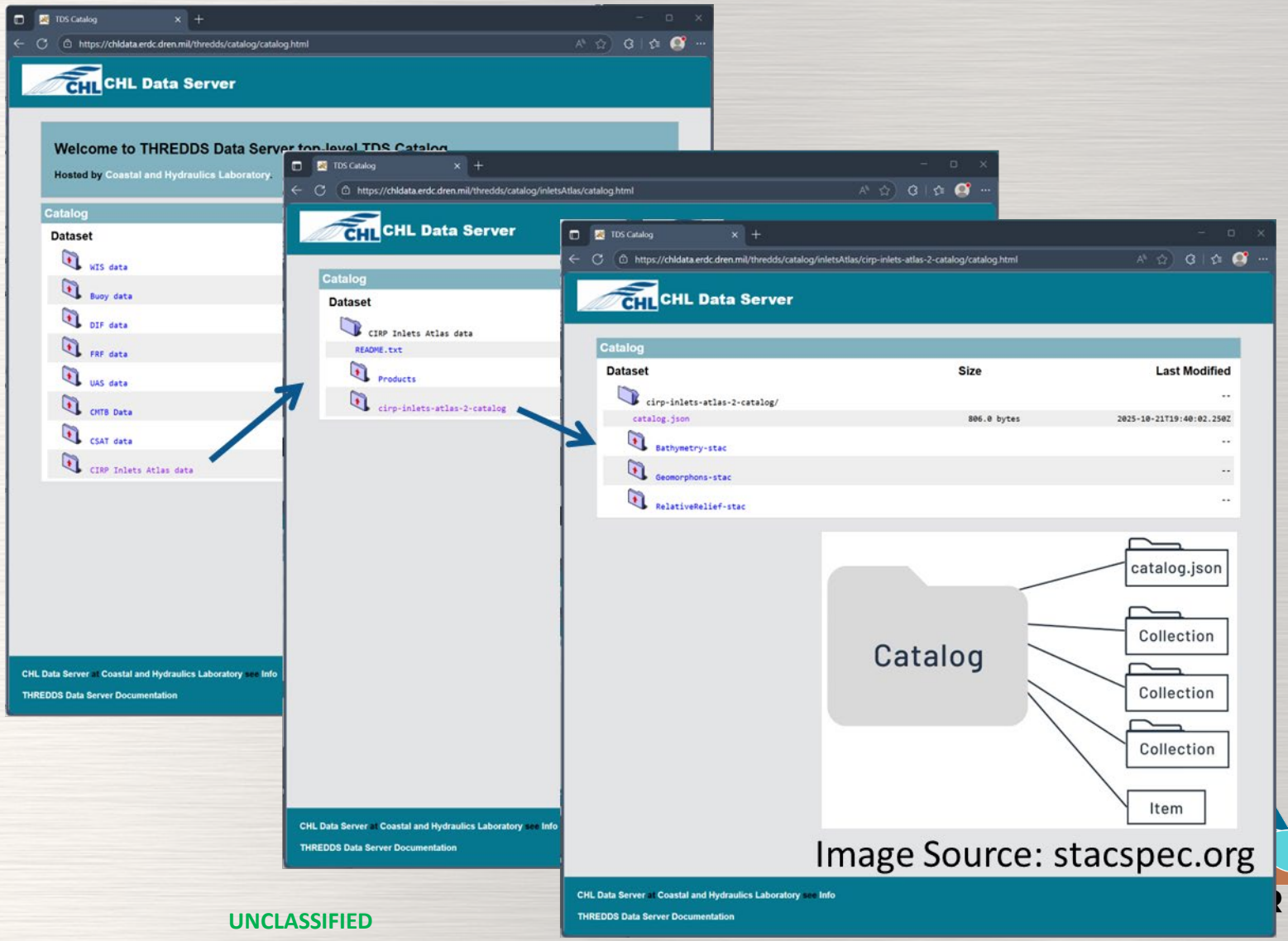
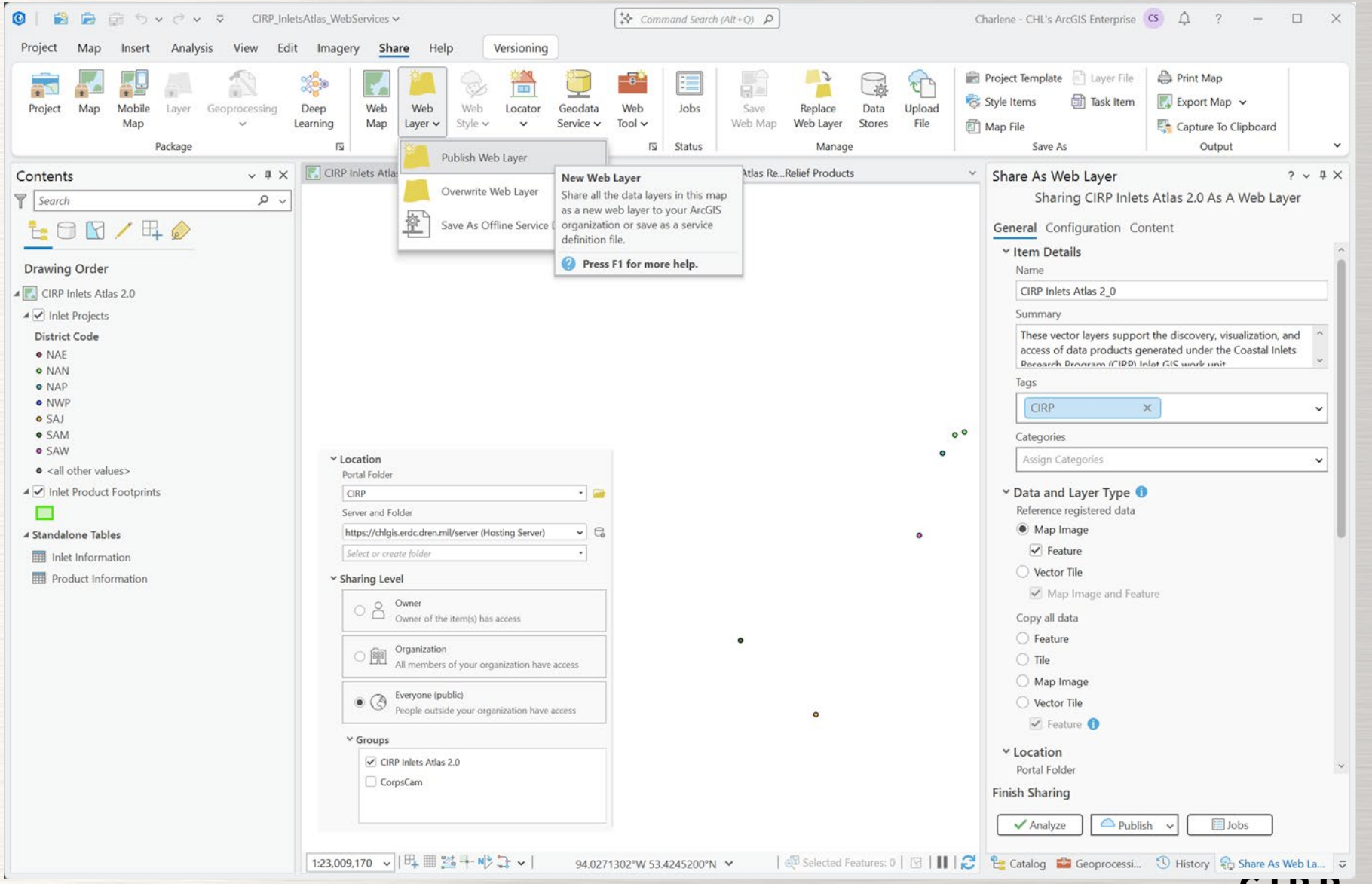
Building a Spatio-Temporal Access Catalog (STAC)

- Migrate Inlets Atlas 2.0 Final_Products folder to CHL THREDDS Server
- Python script to build a STAC locally
  - URLs to products and thumbnails
  - Collection and Item metadata
- Migration of STAC to CHL THREDDS Server
- Populate STAC_URL attribute in Enterprise table *RasterFootprintInfo*



Publishing Web Feature Services

- Configure ArcGIS® Pro map with Enterprise vector feature classes and business tables
- Register geodatabase as a Data Store
- Share map as a Web Layer
  - *Add summary and tags*
  - *Reference registered data, feature access*
  - *Set Portal folder and server URL*
  - *Set sharing levels*



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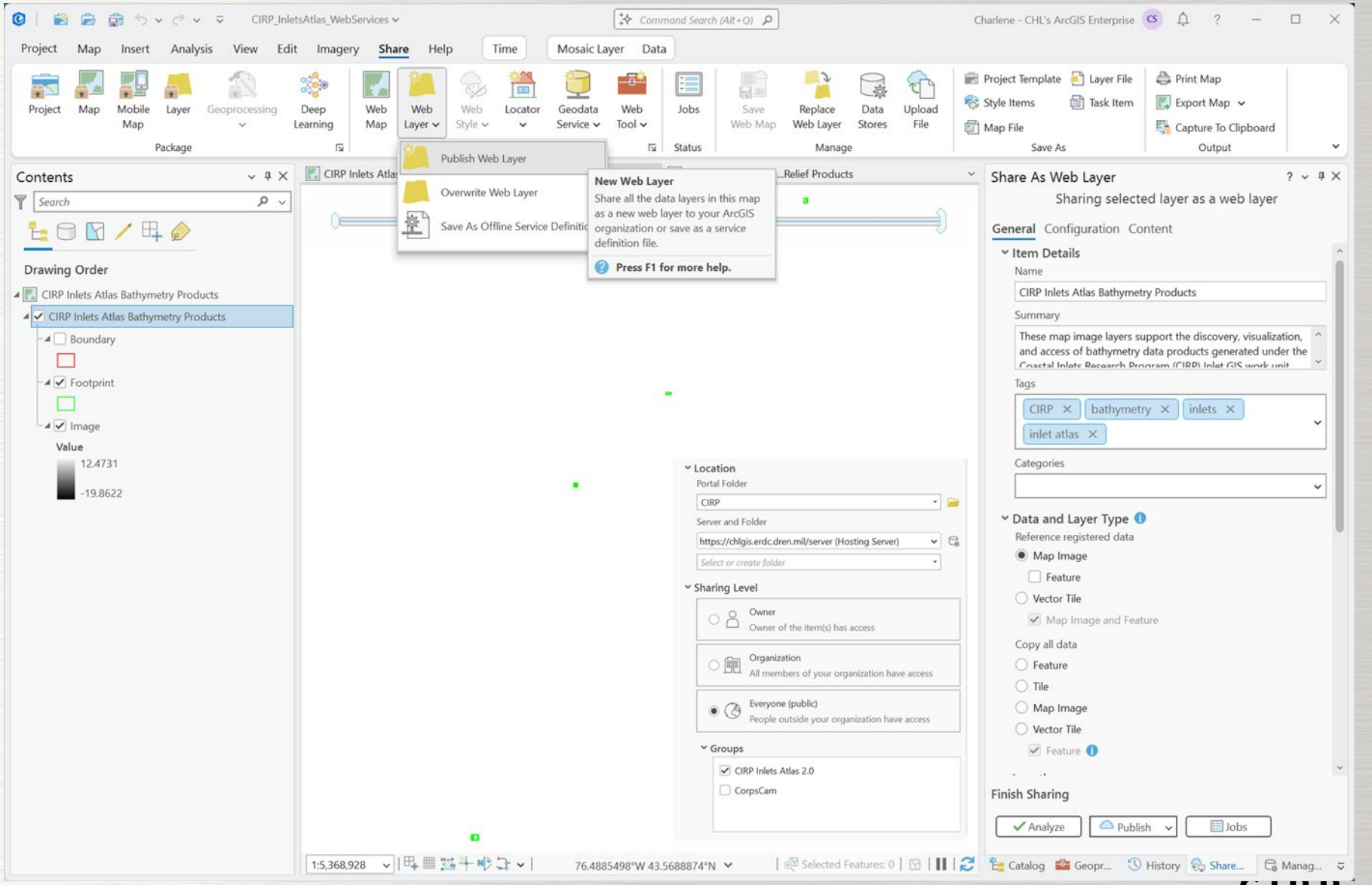
Publishing Map Image Layers

- Configure ArcGIS® Pro map for each mosaic dataset
  - Bathymetry
  - Relative Relief
  - Geomorphons
- Share maps as Map Image Layers
  - *Add summary and tags*
  - *Reference registered data as Map Image*
  - *Set Portal folder and server URL*
  - *Set sharing levels*



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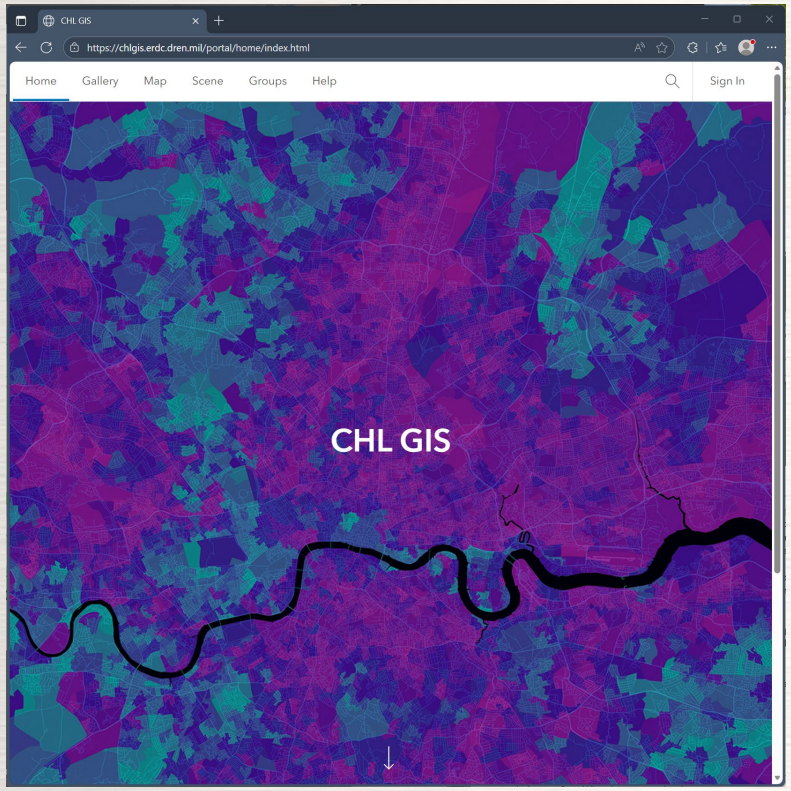
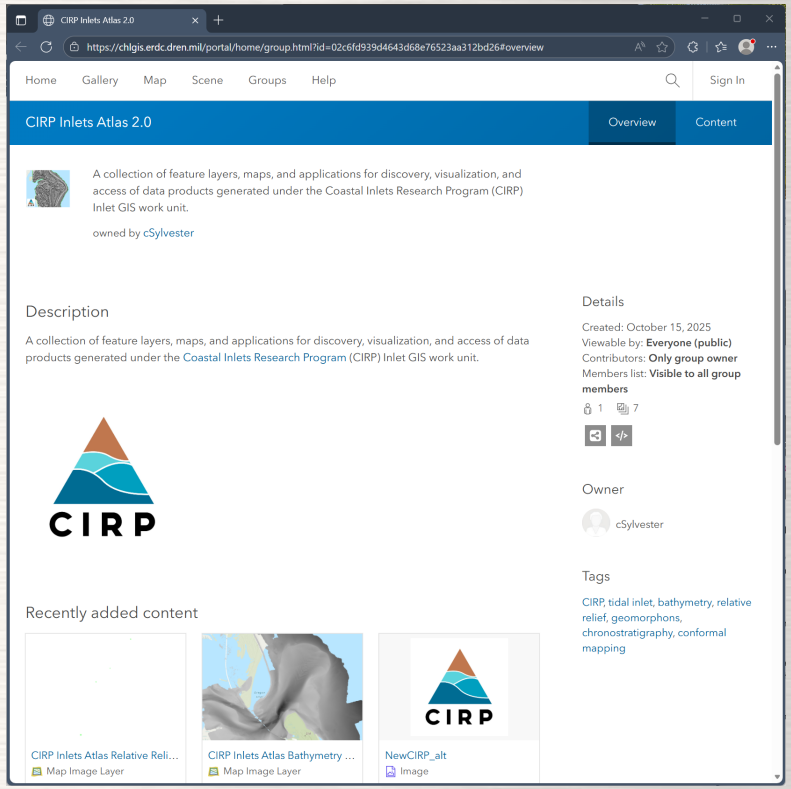
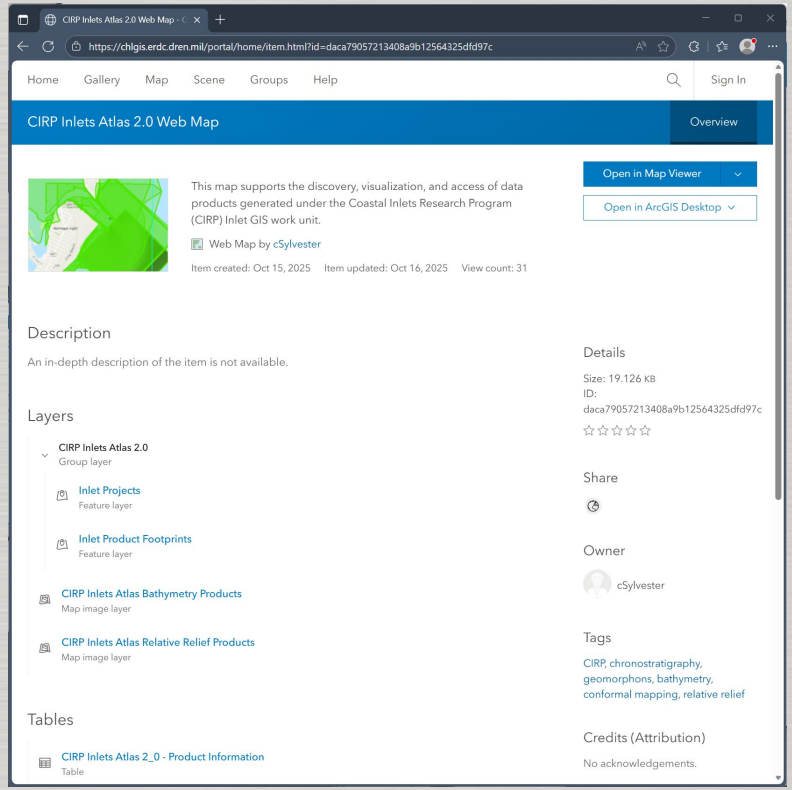
Discovery and Access



[CHL GIS Portal](#) content management system for layers, maps, apps



Inlet Atlas 2.0 Group to organize content



Inlet Atlas 2.0 Item (e.g., web map)

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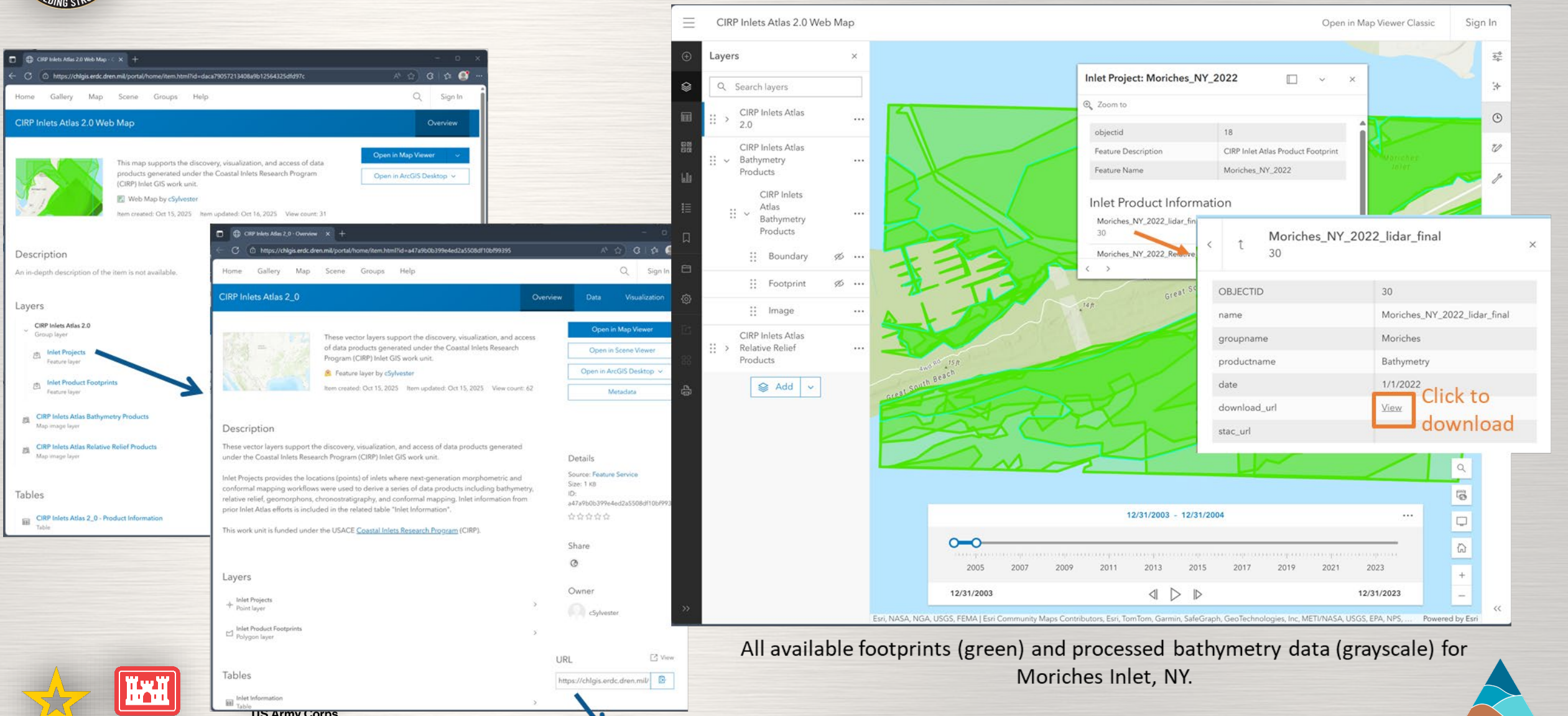
Discovery and Access, cont.



All available footprints (green) and processed bathymetry data (grayscale) for Moriches Inlet, NY.

URL to RESTful feature service to use in ArcGIS® Pro or access programmatically

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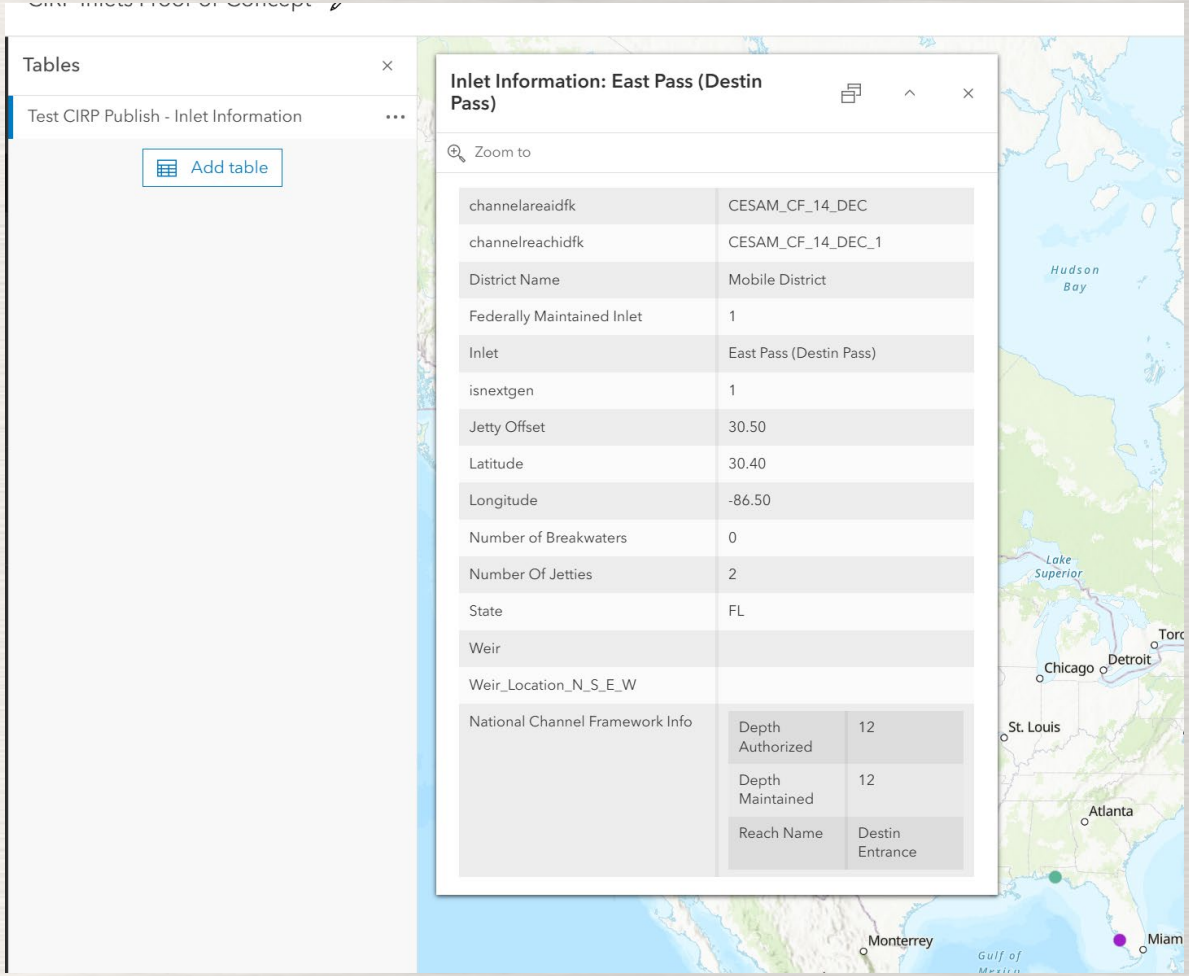
Discovery and Access, cont. again

- Interoperability with USACE National Channel Framework (NCF)
- NCF information was manually populated in the prior Atlas
- Use of NCF foreign keys (e.g. *channelreachidfk*) with custom Arcade to link inlet information table to NCF information in a web map pop up

Enabling open, linked, interoperable data



Proof-of-concept for linking USACE NCF web services to Inlets Atlas 2.0 services

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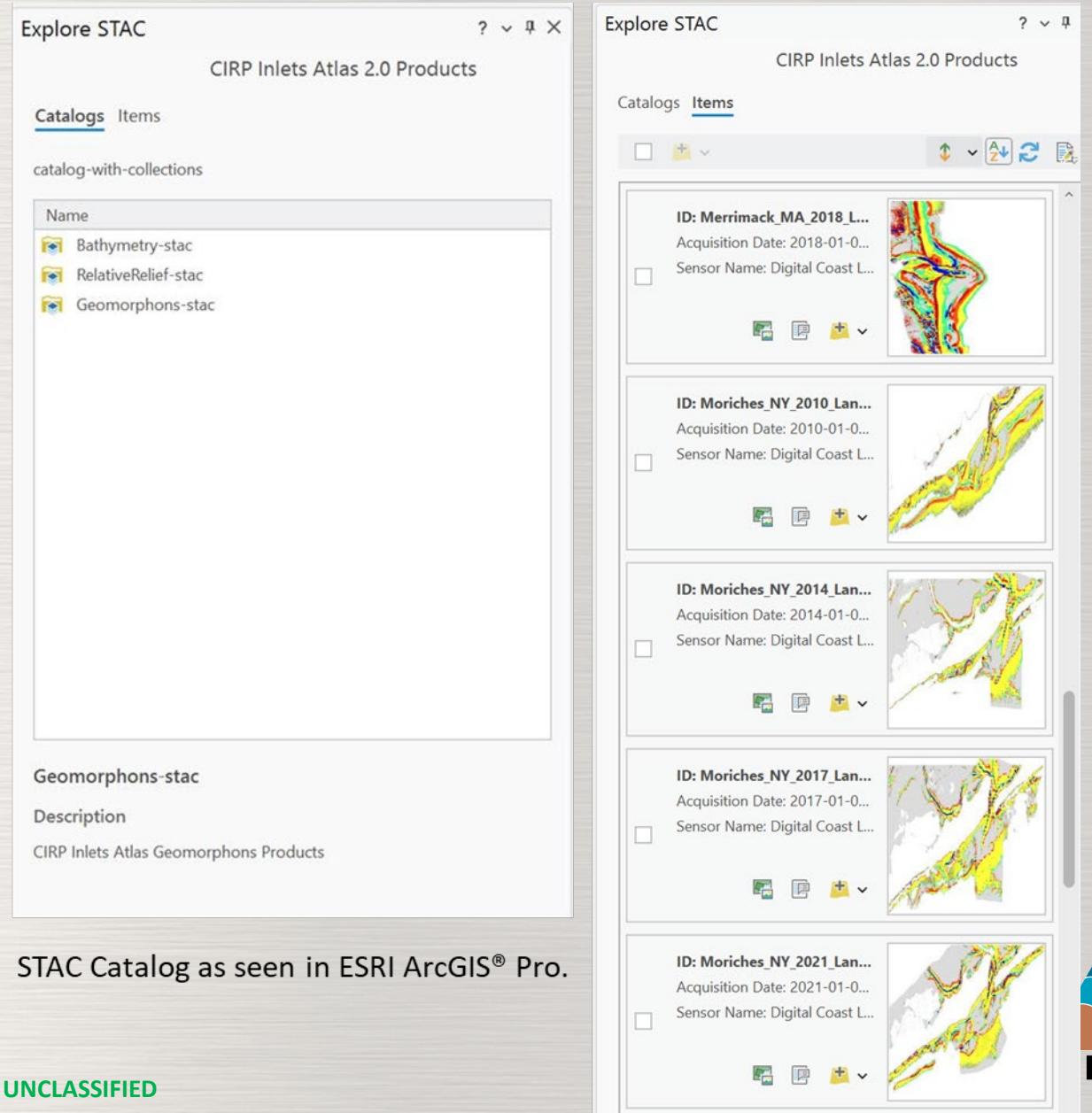
Discovery and Access via STAC

- Products are also available in a STAC at https://chldata.erdc.dren.mil/thredds/fileServer/inletsAtlas/cirp-inlets-atlas-2-catalog/catalog.json
- Direct access in ArcGIS Pro
  - Insert > Connections > STAC Connection
- Programmatic access via PySTAC and other Python libraries



STAC Catalog as seen in ESRI ArcGIS® Pro.

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Next Steps

- Incorporate feedback on Inlet Atlas 2.0 products and services from PDT members, CIRP geospatial products team members, and others
  - Ease of access and use
  - Interpretability of products and services
  - Sufficiency of attribution and ideas for expansion
- *Scientific Data* paper submission (McPherran et al.) and Zenodo database
- Complete the ingestion of products into the Inlet Atlas 2.0 products
  - Chronostratigraphy and conformal mapping products
  - Chatham, St. Augustine, New Pass, East Pass, Port Mansfield, IIwaco, and Siuslaw
- Creation of an Inlets Atlas 2.0 web experience
- Further automation of workflows to ingest products into Enterprise services
- Provide raster products as image services vs. map image layers
  - FAQ: When to Publish a Raster Dataset as a Map Image Service vs. an Image Service?

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Questions?

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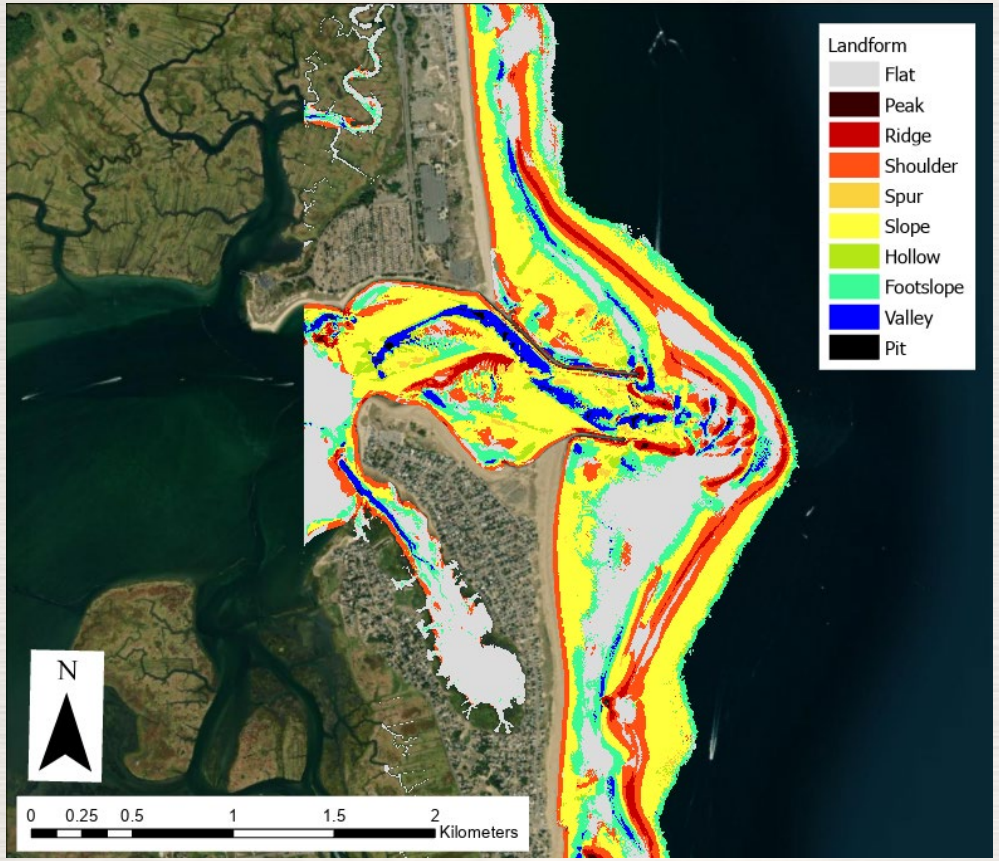
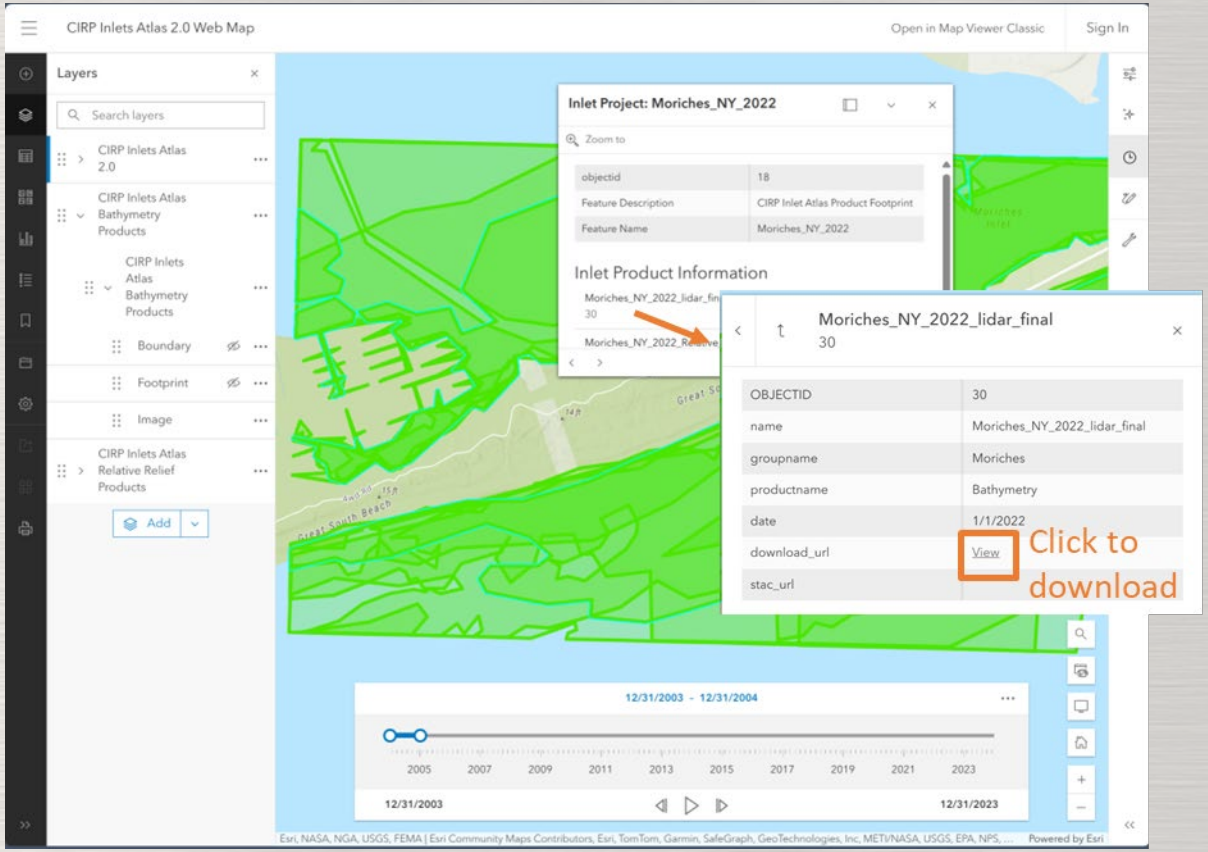


Merrimack MA 2018 (NCMP) geomorphon landform classification.



Inlets Atlas 2.0 Web Map

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