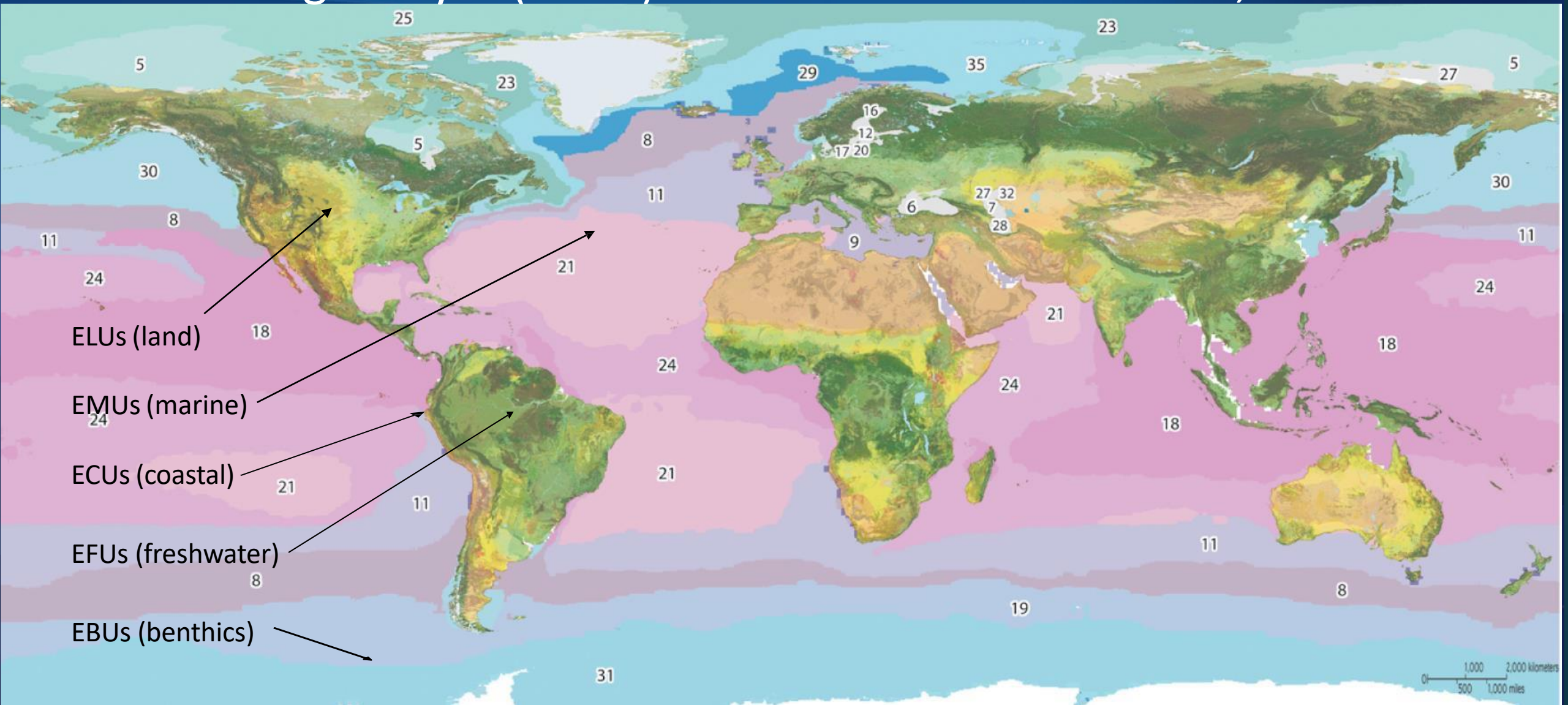
USGS/Esri Ecological Marine Units (EMUs) and Ecological Coastal Units (ECUs) as Standardized Spatial Units for Marine Ecosystem Accounting

Roger Sayre (USGS) 27 JUN 2019 Glen Cove, NY



UN Sustainable Development Goals

The need to conserve global ecosystems is mandated in three UN SDGs (below). To conserve them requires knowing where they are on the landscape and in the oceans, and thus the need for global ecosystem mapping.

Terrestrial: By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands. By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.

Freshwater: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.

Marine: By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information.

GEO ECOSYSTEMS Initiative: Global Ecosystem Mapping

Develop a standardized, robust, and practical global ecosystems classification and map for the planet's *terrestrial, freshwater,* and *marine* ecosystems.

USGS/Esri Highest Order Ecosystem Complexes (20)

- *Terrestrial Domain (6)*

  Forests, Shrublands, Grasslands, Croplands, Barrenlands (sparsely or non-vegetated), Built Environment

- *Freshwater Domain (3)*

  Lakes and Ponds, Rivers and Streams, Wetlands

- *Coastal Domain (5)*

  Coastal Lands, Nearshore Waters, Nearshore Seafloor, Offshore Waters, Offshore Seafloor

- *Oceanic Domain (6)*

  Sunlit Waters, Twilight Waters, Deep Waters, Slope Seafloor, Abyssal Seafloor, and Hadal Seafloor

Rolling Up the Global Ecological Units

- *Terrestrial Domain (6)*

  Forests, Shrublands, Grasslands, Croplands, Barrenlands (sparsely or non-vegetated), Built Environment

  ELUs

- *Freshwater Domain (3)*

  Lakes and Ponds, Rivers and Streams, Wetlands

  EFUs

- *Coastal Domain (5)*

  Coastal Lands, Nearshore Waters, Nearshore Seafloor, Offshore Waters, Offshore Seafloor

  ECUs

  EBUs

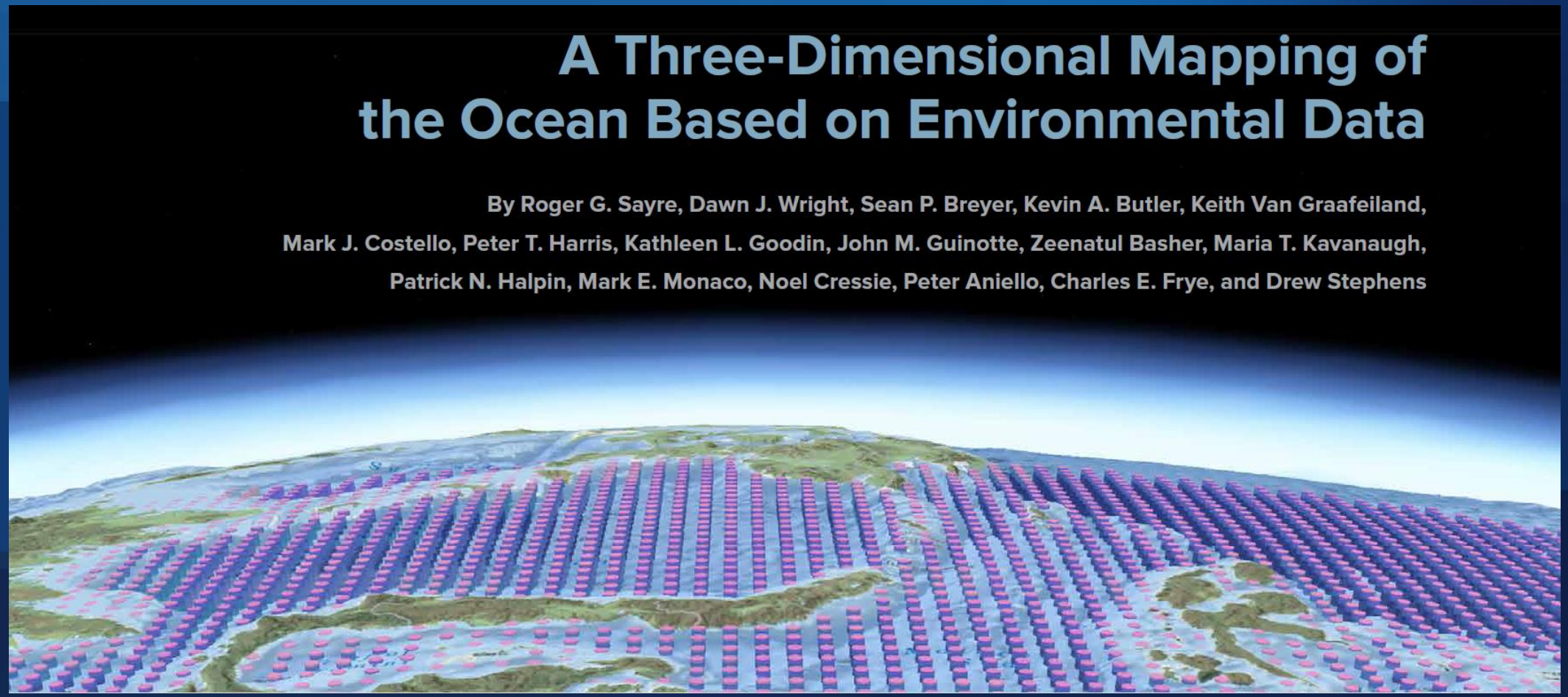
- *Oceanic Domain (6)*

  Sunlit Waters, Twilight Waters, Deep Waters, Slope Seafloor, Abyssal Seafloor, and Hadal Seafloor

  EMUs

  EBUs

Ecological Marine Units (EMUs)



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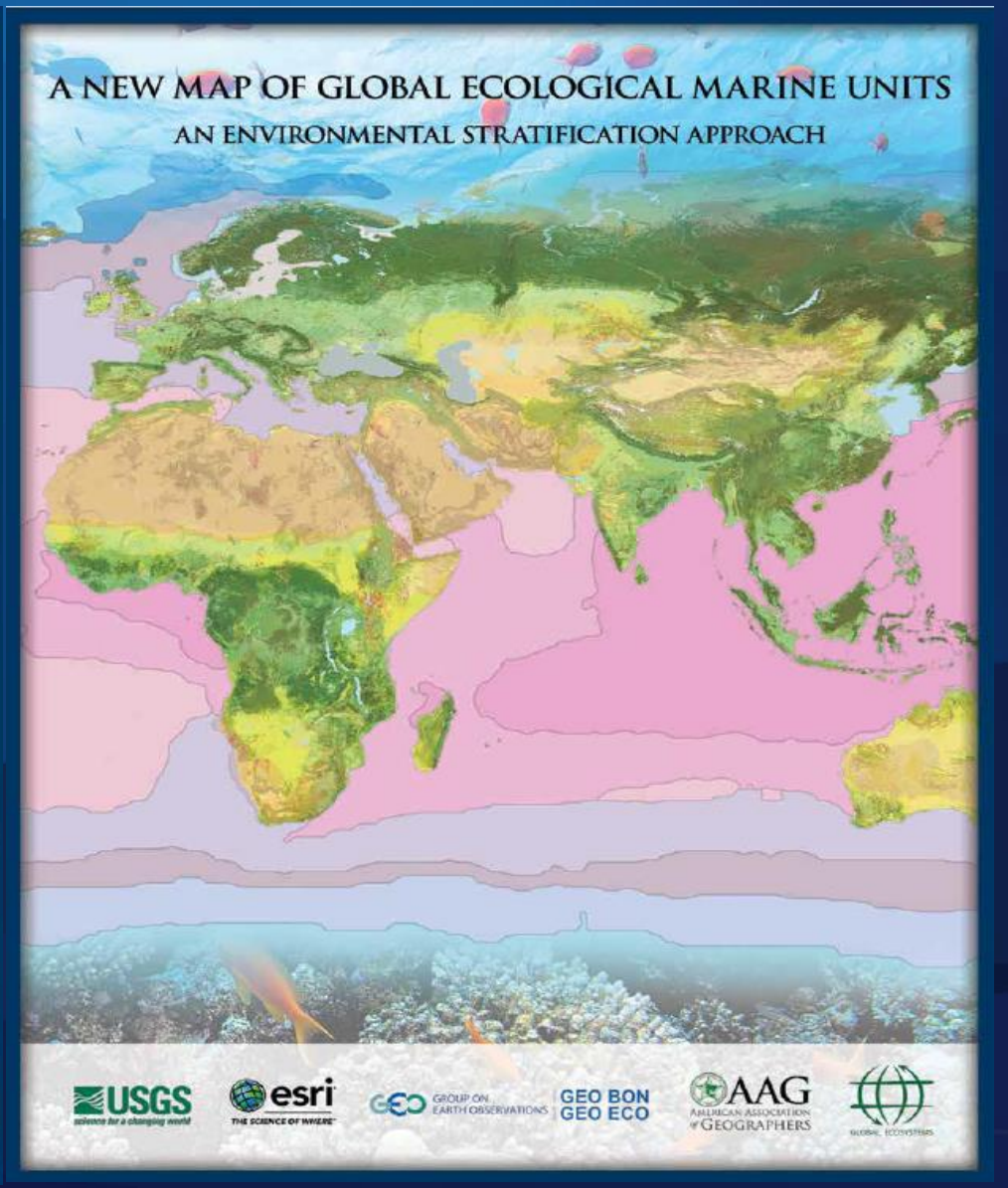
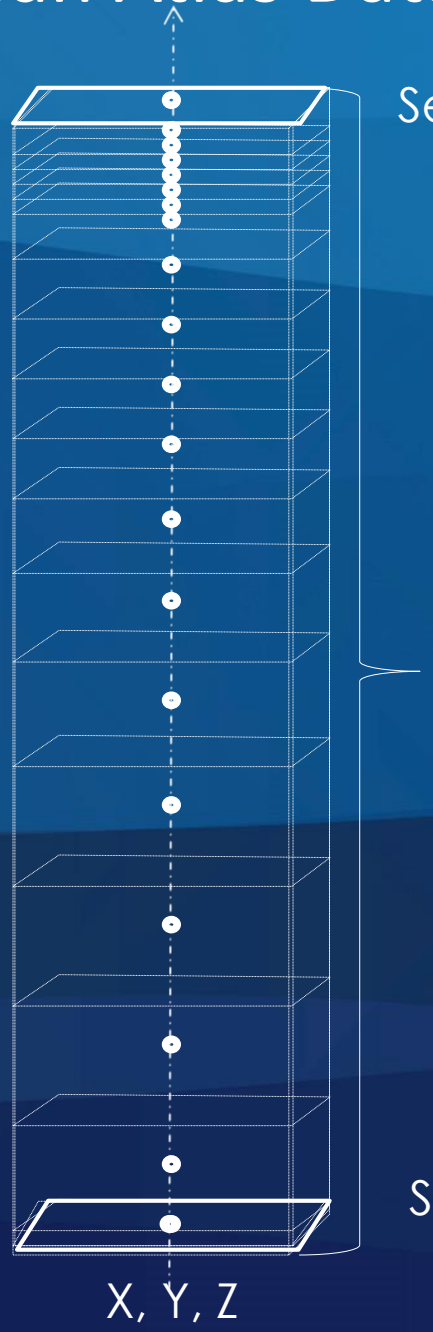
Oceanography

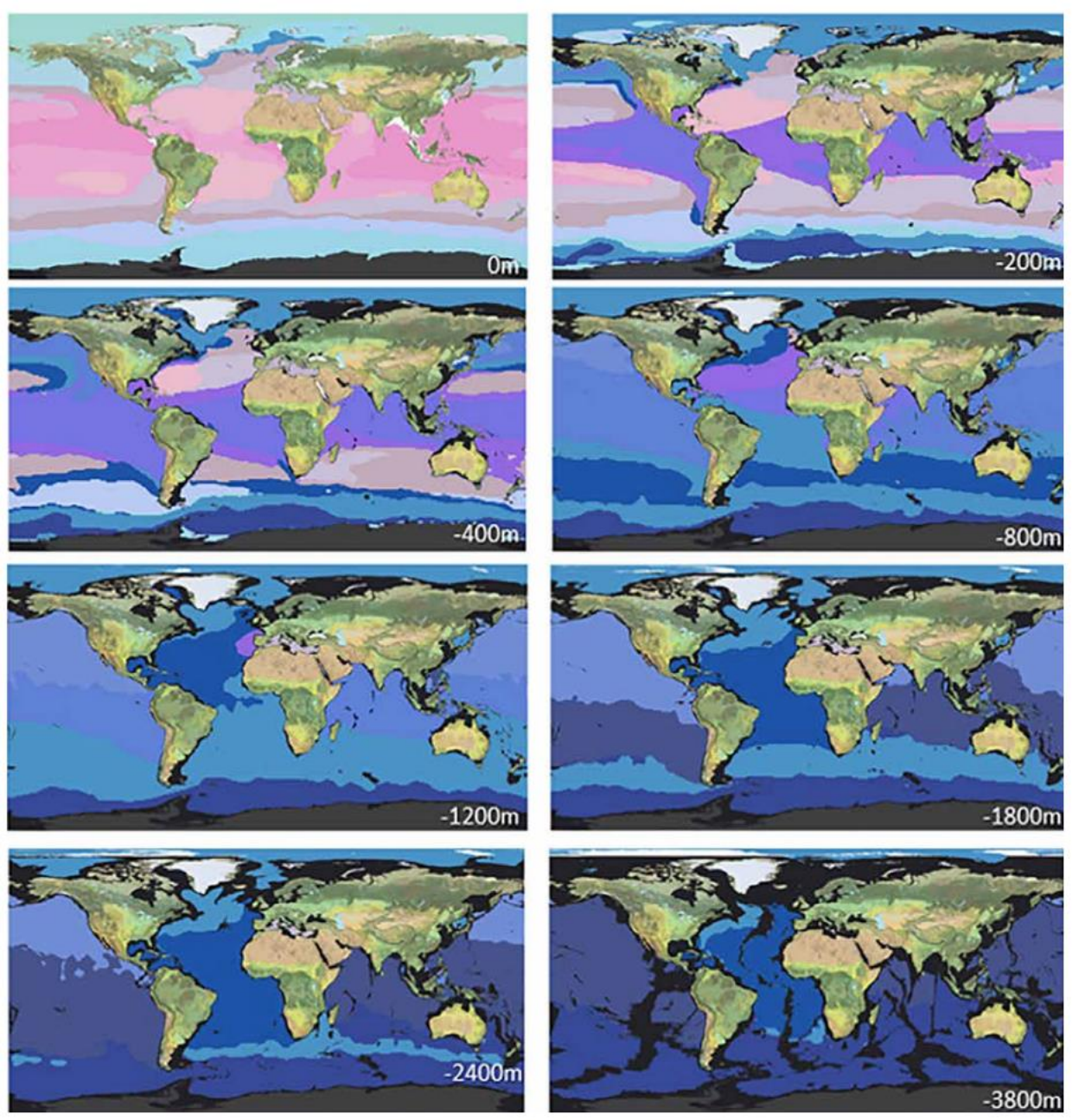
Global Ecological Marine Units (EMUs)



NOAA World Ocean Atlas Data (52 million points)

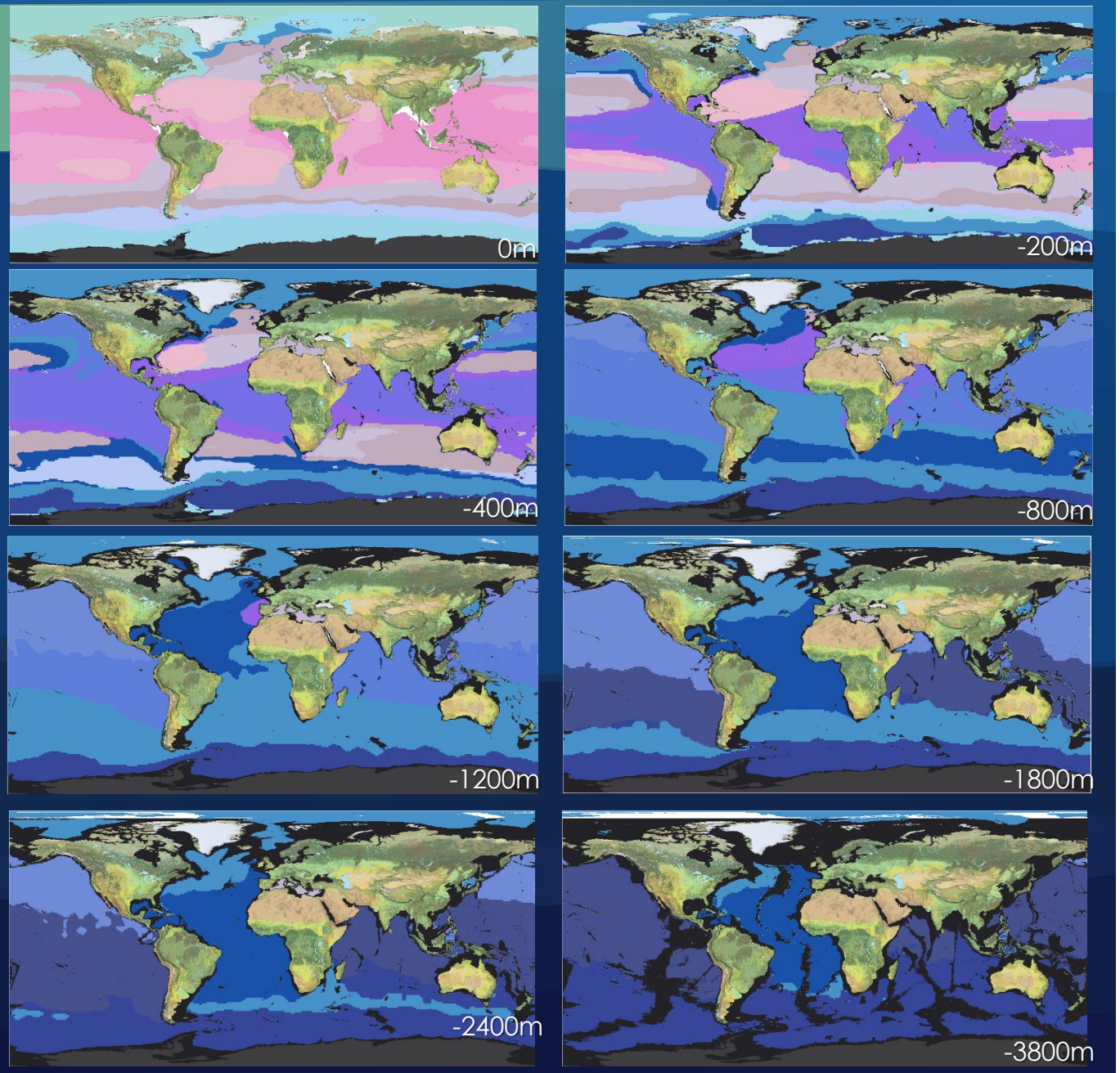


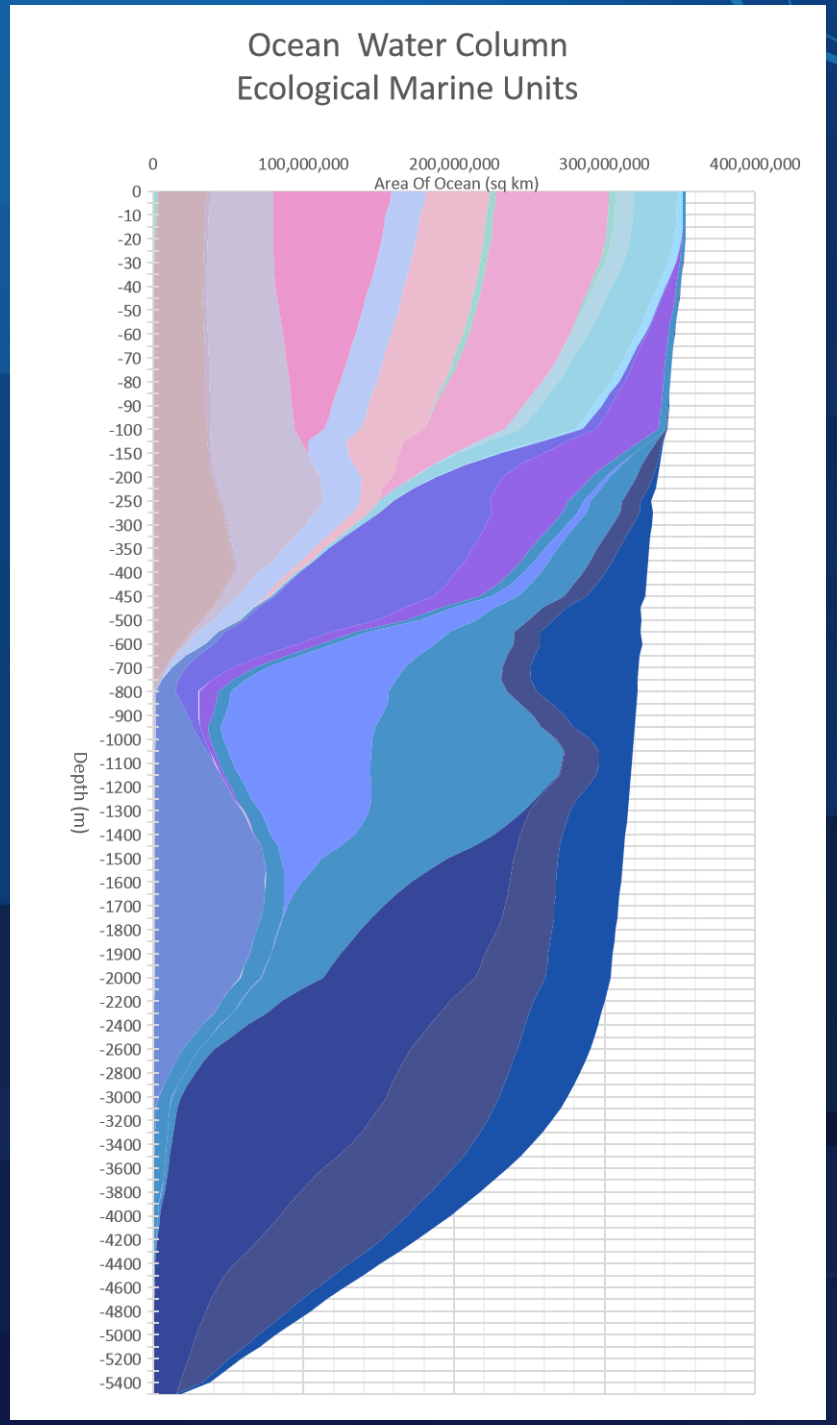
EMUs (Ecological Marine Units)



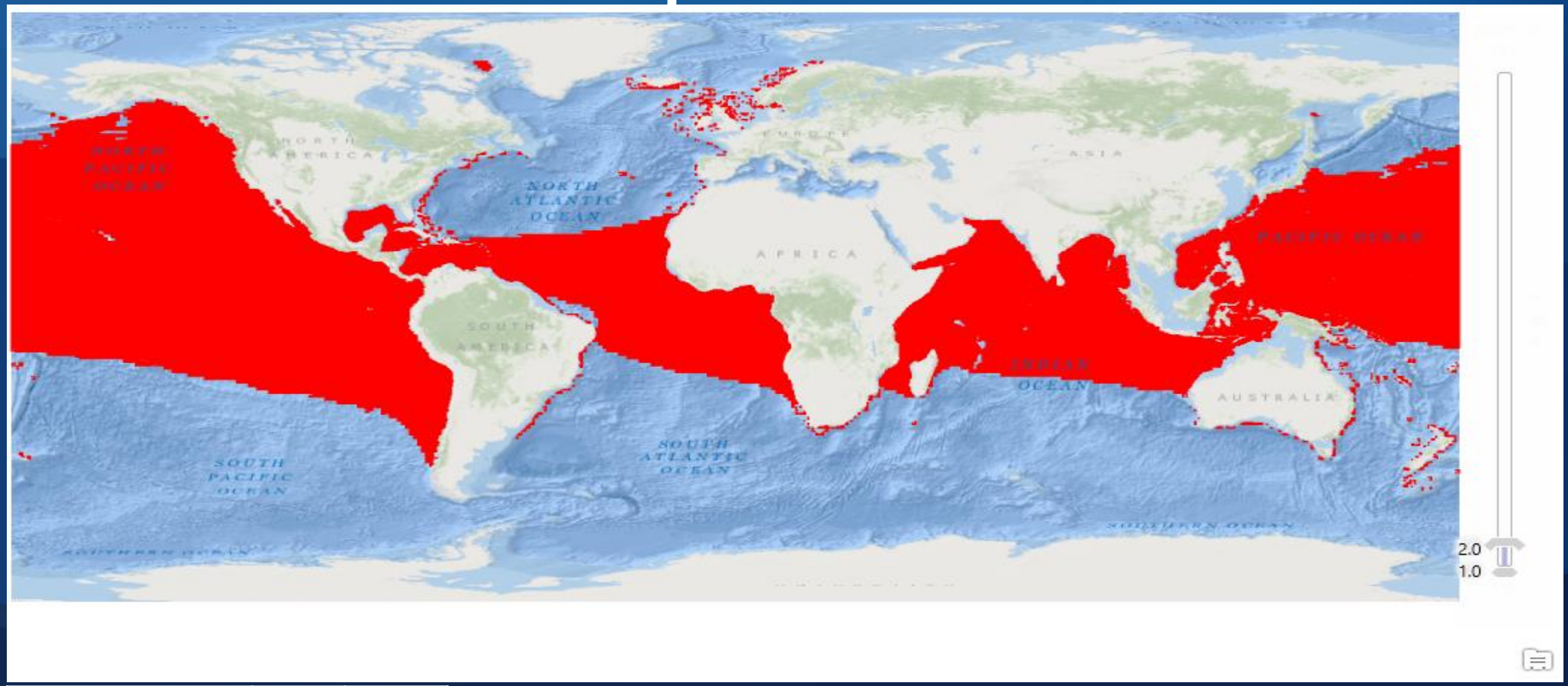
- 37 distinct volumetric region units from sea surface to seafloor
- Based on statistical clustering of 3D point data for six physical and chemical environment parameters (50 yr averages)
- 27 km by 27 km by variable depth, adequate for oceanic characterization, but insufficient for capture of coastal variation

EMUs at Depths





Examples of EMUs - Cluster 1



Thickness	
Min	5
Mean	467.165
Max	4225
Std	293.266

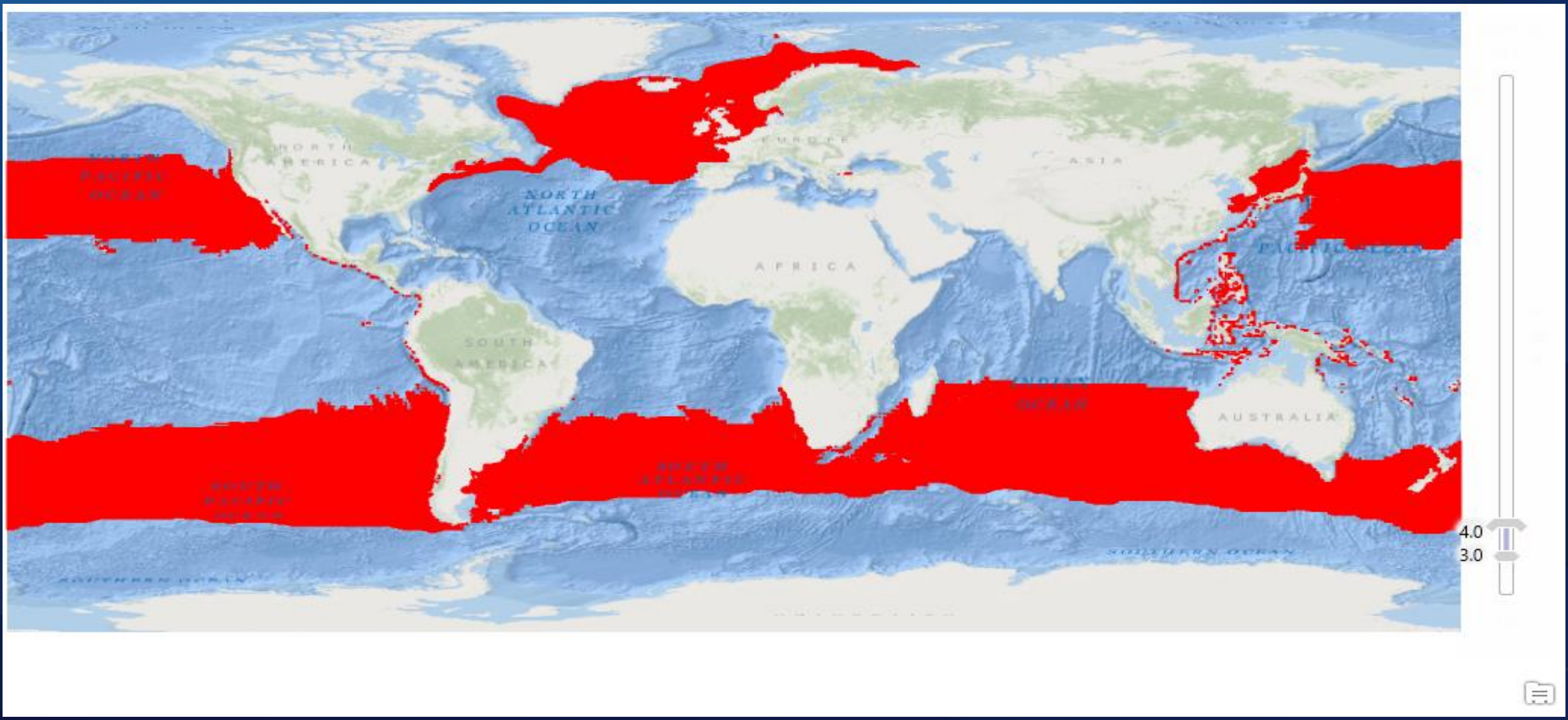
Temperature	Min	-0.434
	Mean	7.947
	Max	23.707
	Std	2.108
Salinity	Min	33.431
	Mean	34.568
	Max	36.822
	Std	0.359

Dissolved O2	Min	0.149
	Mean	2.002
	Max	3.517
	Std	0.789
Apparent O2 Utilization	Min	3.239
	Mean	4.675
	Max	6.802
	Std	0.596

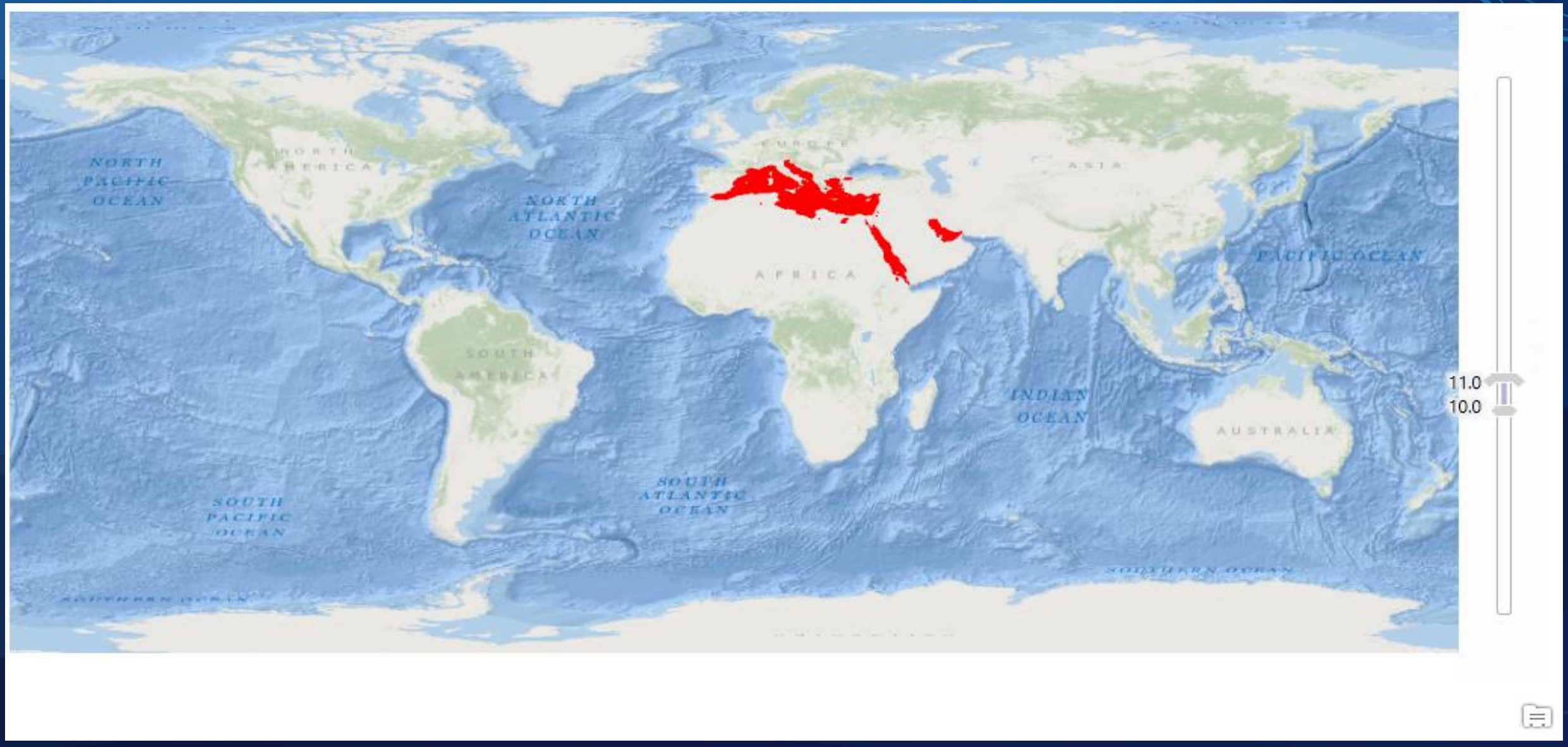
Percent O2 Saturation	Min	2.291
	Mean	29.635
	Max	48.761
	Std	11.028
Nitrate	Min	15.620
	Mean	32.559
	Max	41.897
	Std	2.423

Phosphate	Min	0.956
	Mean	2.374
	Max	3.348
	Std	0.230
Silicate	Min	5.269
	Mean	46.248
	Max	101.331
	Std	17.423

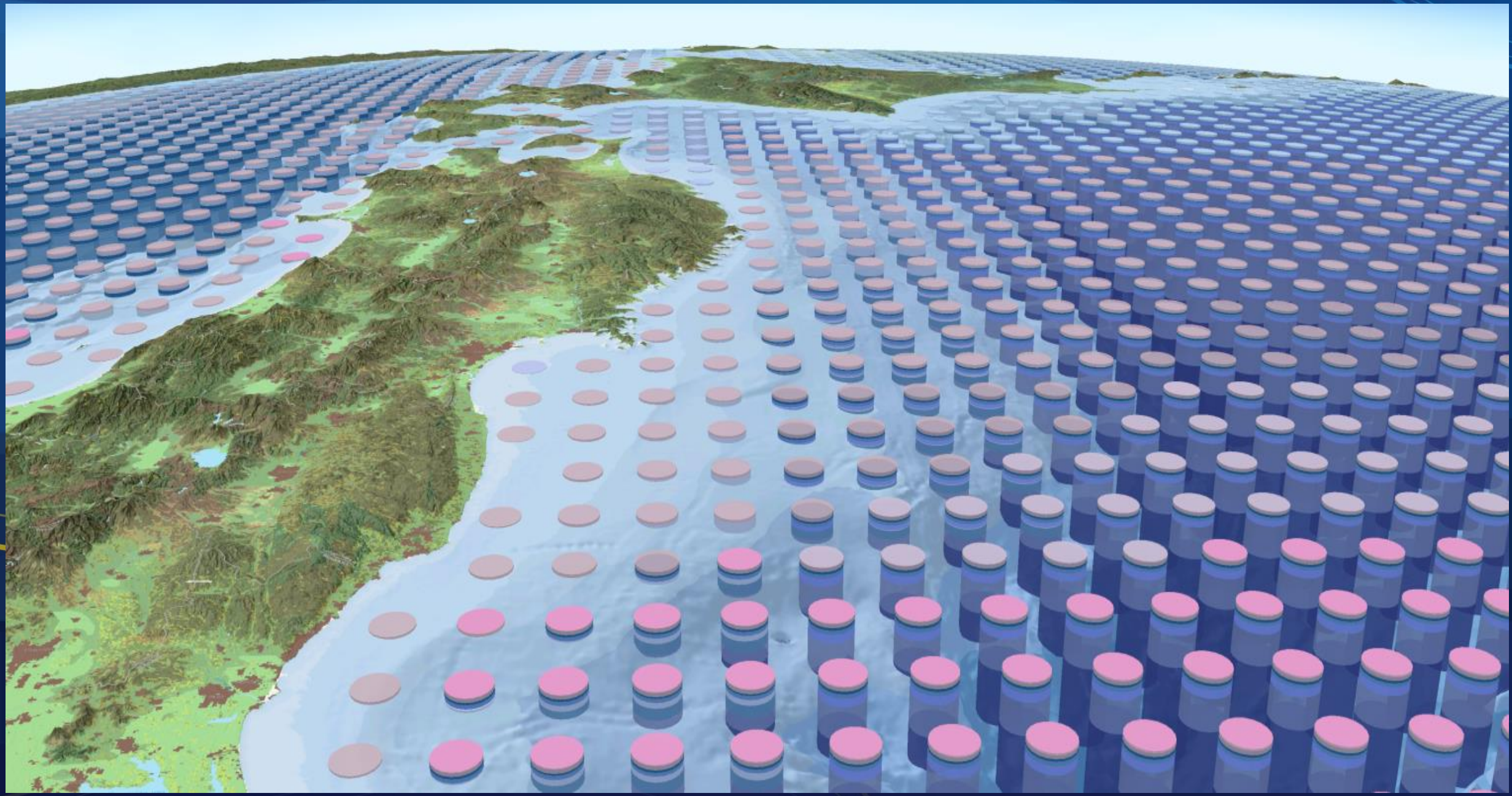
Examples of EMUs - Cluster 3



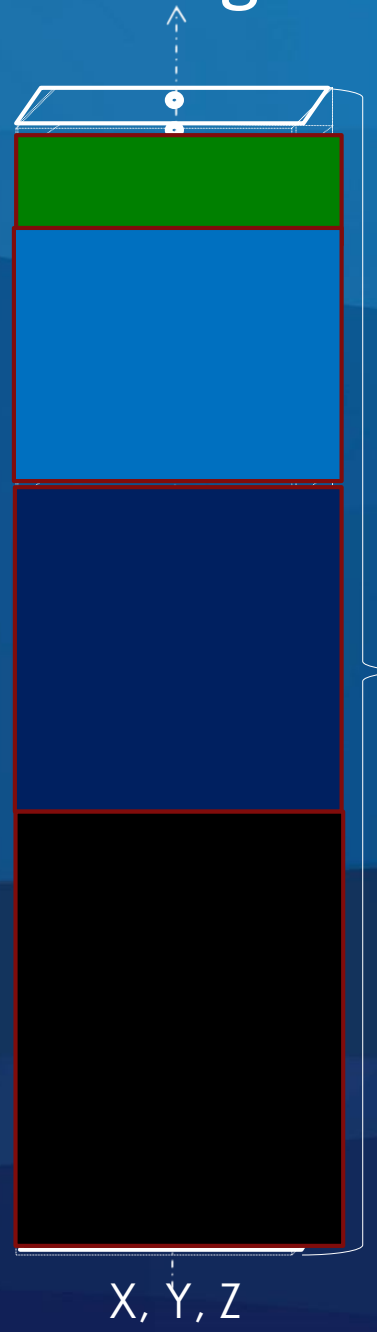
Examples of EMUs - Cluster 17



Visualizing the EMUs



Flattening the EMUs



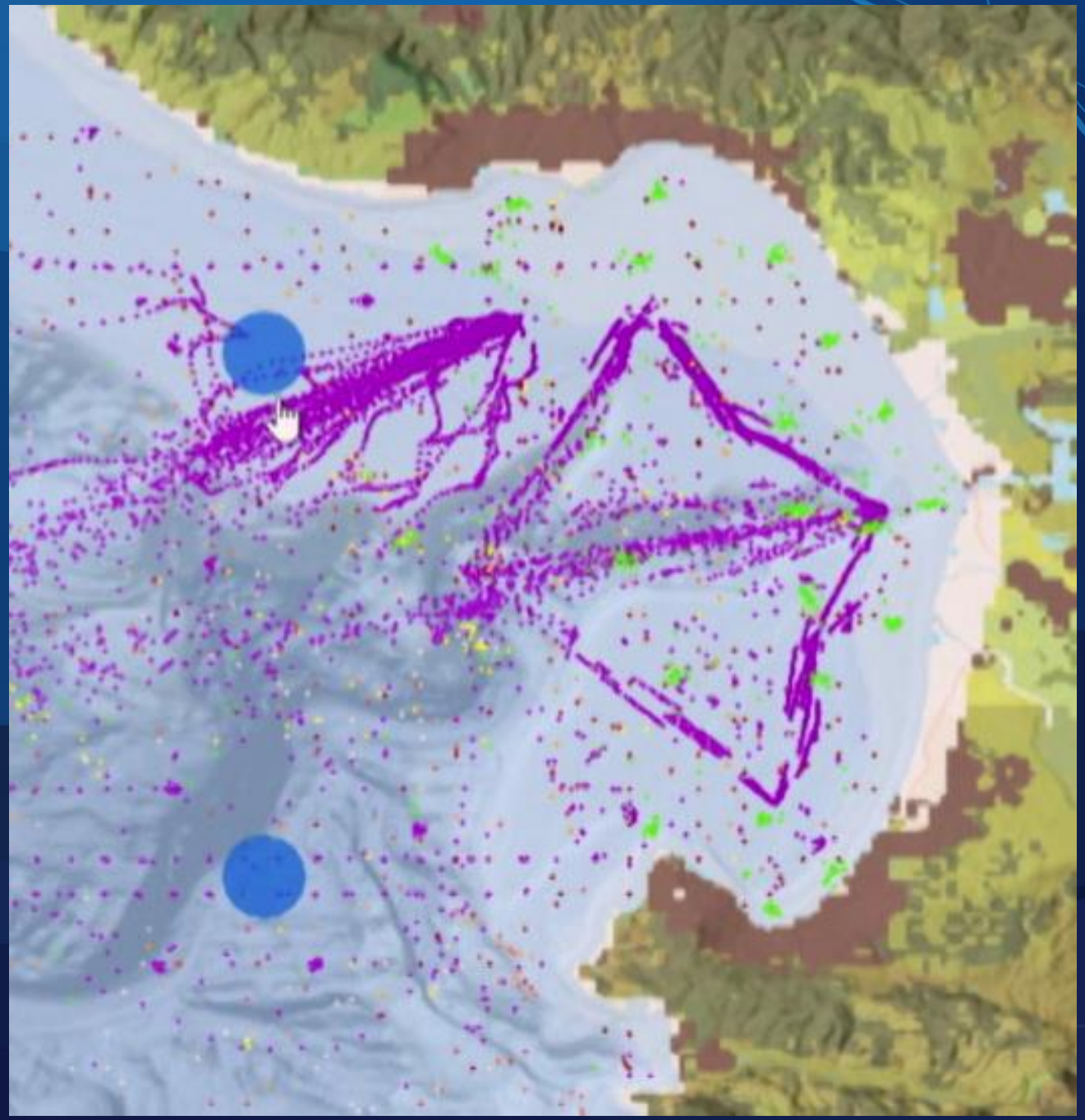
Sea Surface

Point attributes: x, y, z, temperature, salinity, dissolved oxygen, nitrate, phosphate, silicate

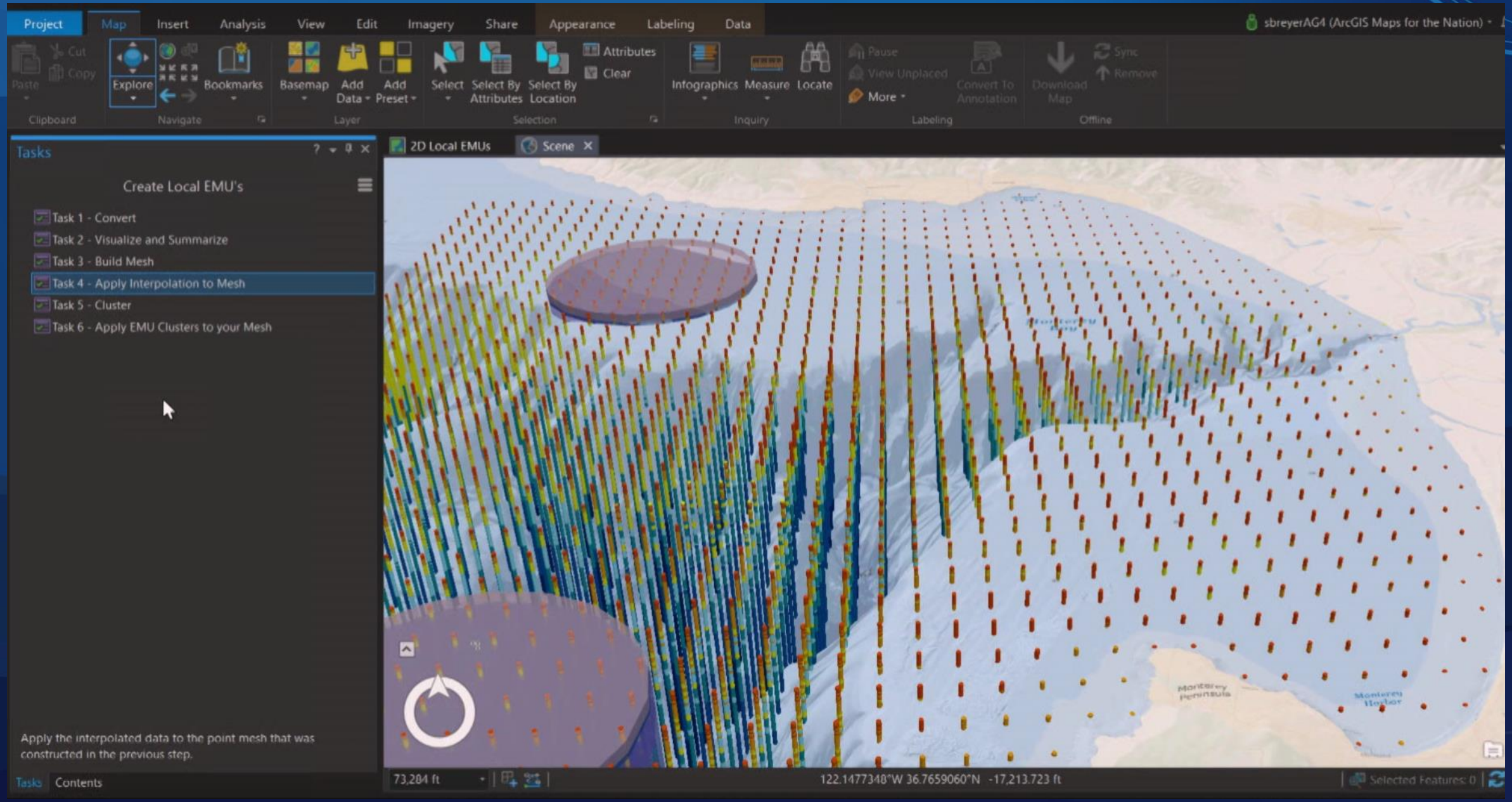
Seafloor

X, Y, Z

Localized EMUs



Localized EMUs



Global Ecological Coastal Units (ECUs)

JOURNAL OF OPERATIONAL OCEANOGRAPHY
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A new 30 meter resolution global shoreline vector and associated global islands database for the development of standardized ecological coastal units

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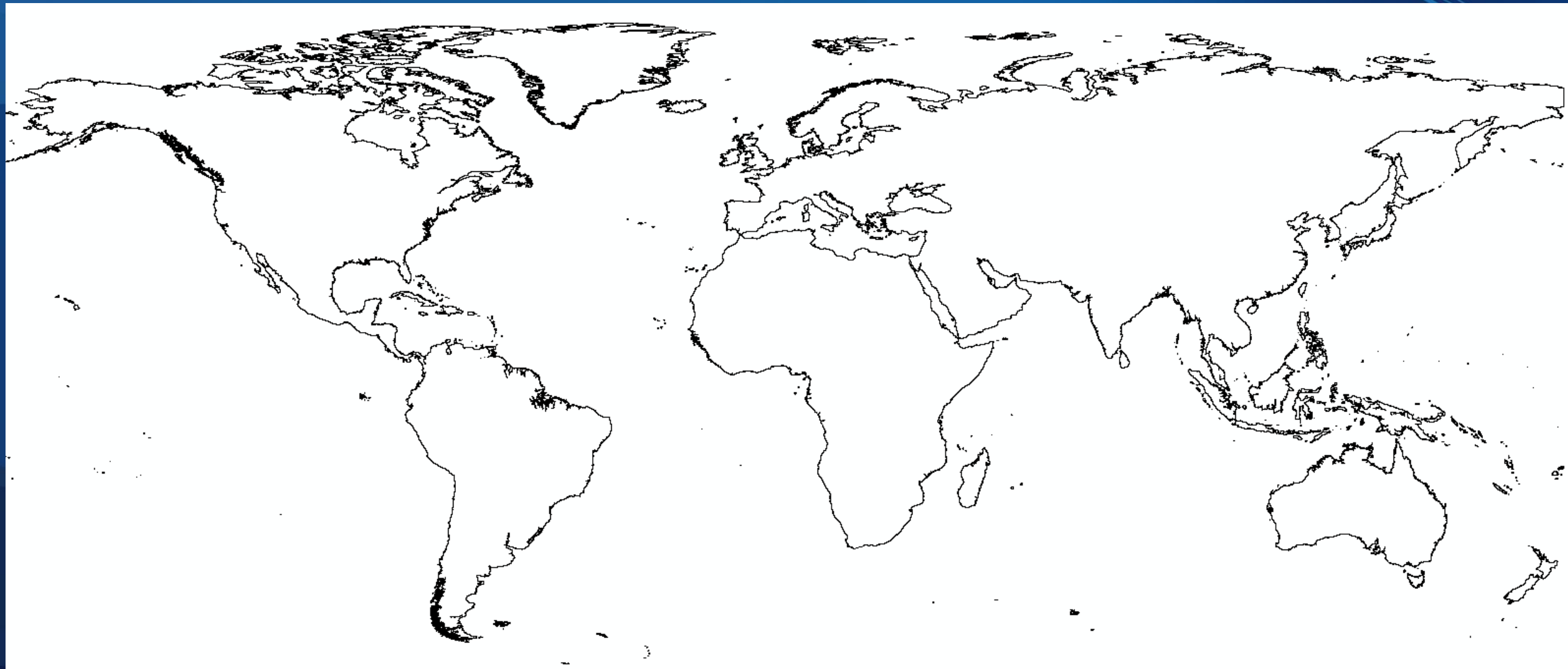
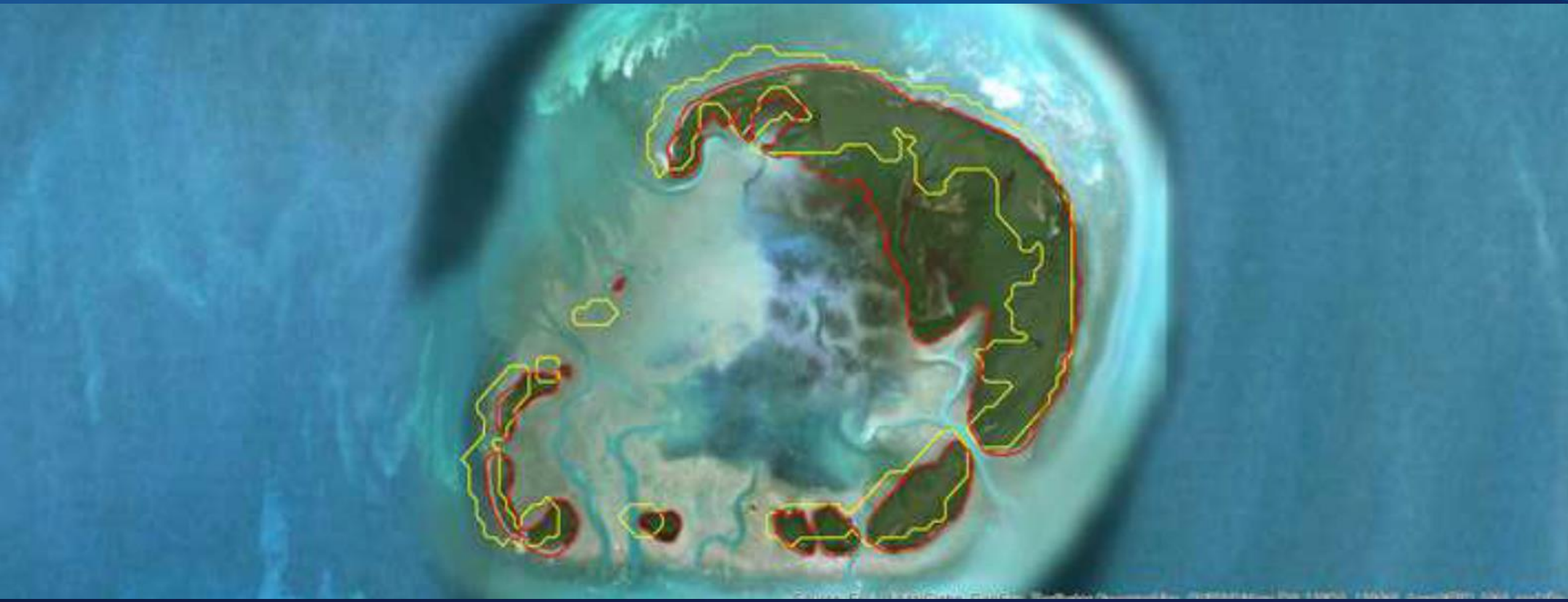
New Global Shoreline Vector (GSV) Data



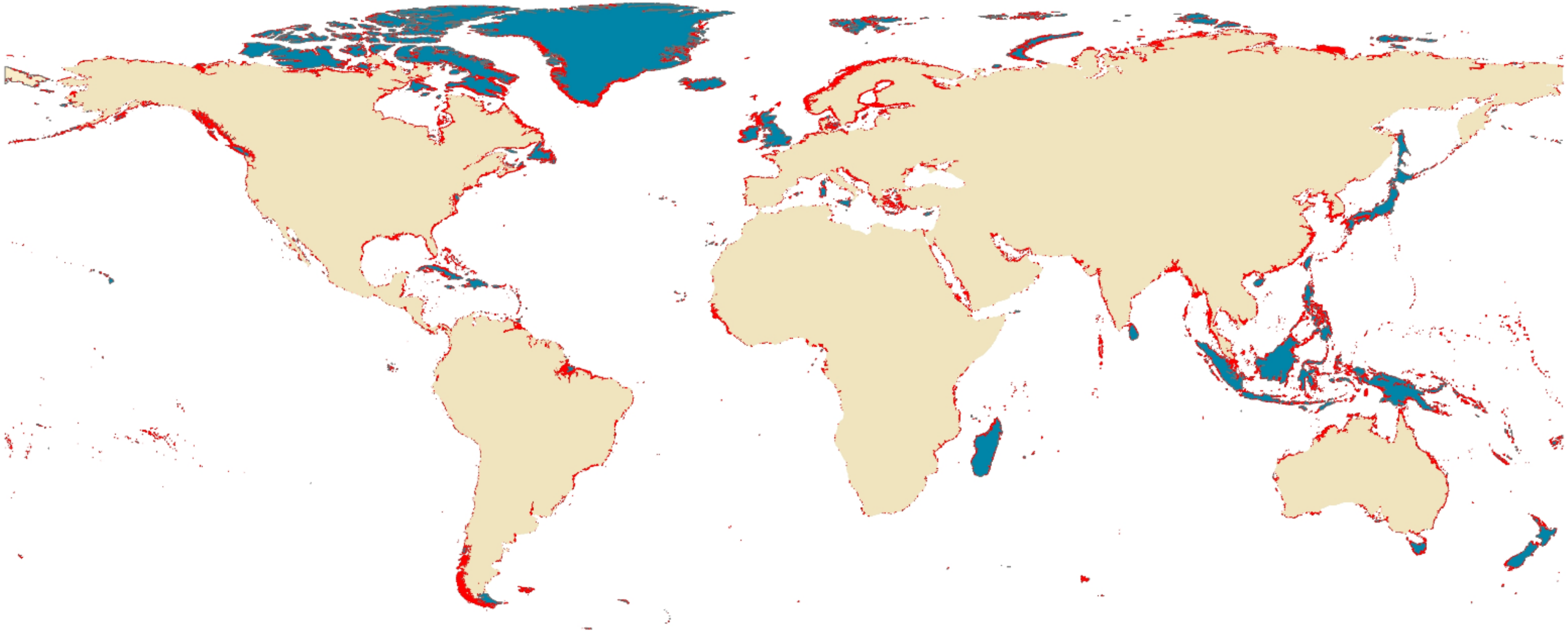
Extracted from 2014 Landsat imagery

We will quantitatively segment (stratify) the global coastal zone into environmentally and ecologically distinct units (ECUs).

GID vs. GSHHS

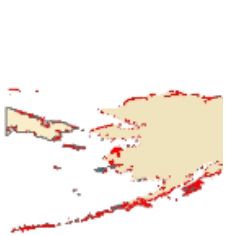


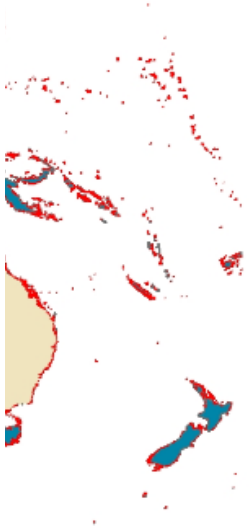
New Global Islands Data



Global Islands – 3 Size Classes

Landmass type	Number of polygons	Area (km^2)	Length of coastline (km)
Continental mainlands	5	125,129,046	813,467
Islands > 1 km^2	21,818	9,938,964	1,304,762
Islands ≤ 1 km^2	318,868	20,589	321,774





The Global Island Explorer

Global Island Explorer

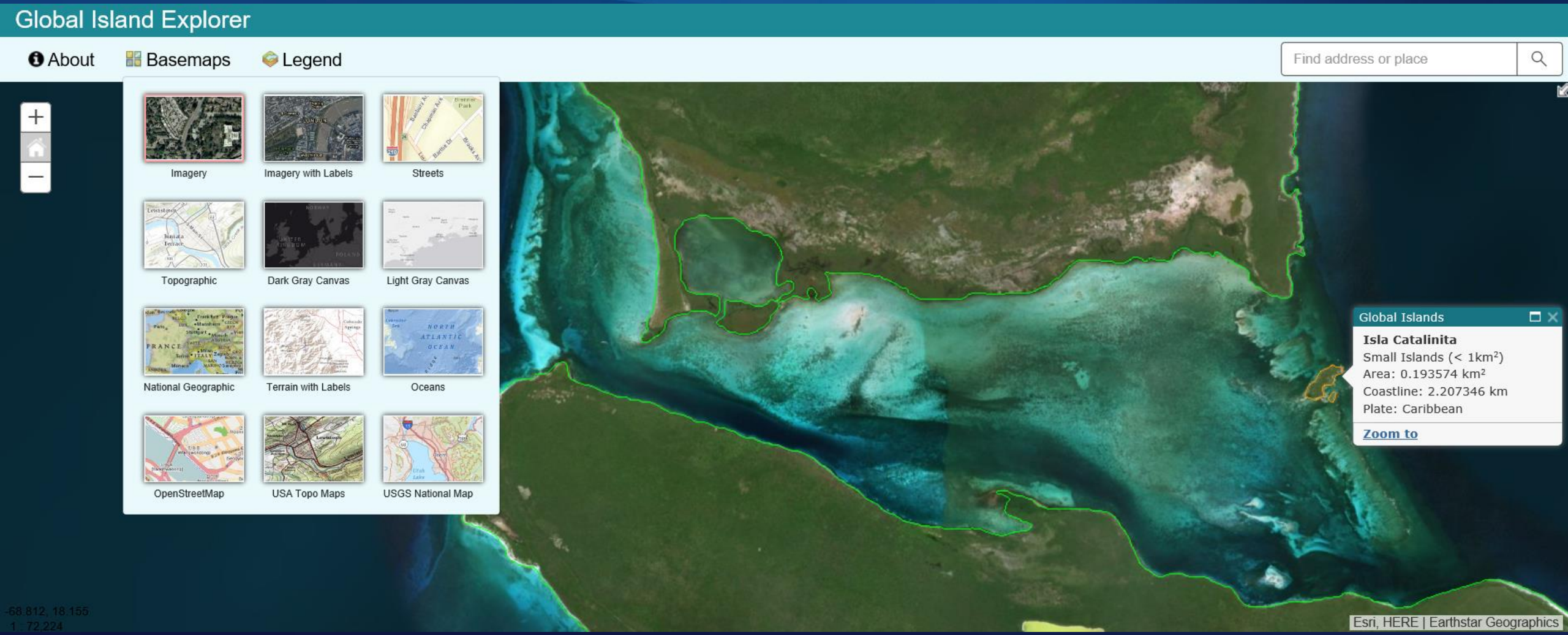
Welcome

Although ocean islands are ubiquitous on the planet, and are homes to a stunning variety of people, plants, and animals, there have been surprisingly few attempts to accurately delineate all the islands on Earth. Every landmass, no matter how big, is surrounded by ocean waters. Island sizes range from continental (e.g. Africa), to very large (e.g. Madagascar) to large (e.g. Tasmania) to medium (e.g. Maui), to small (e.g. Key West) to very small islands and tiny rock outcrops. Size is relative, however, and there is no accepted standard for what separates big islands from small islands. A new mapping of global coastlines from satellite imagery was used to develop a new global islands database, which can be accessed using the new Global Islands Explorer (GIE). The new islands data are also available for download.

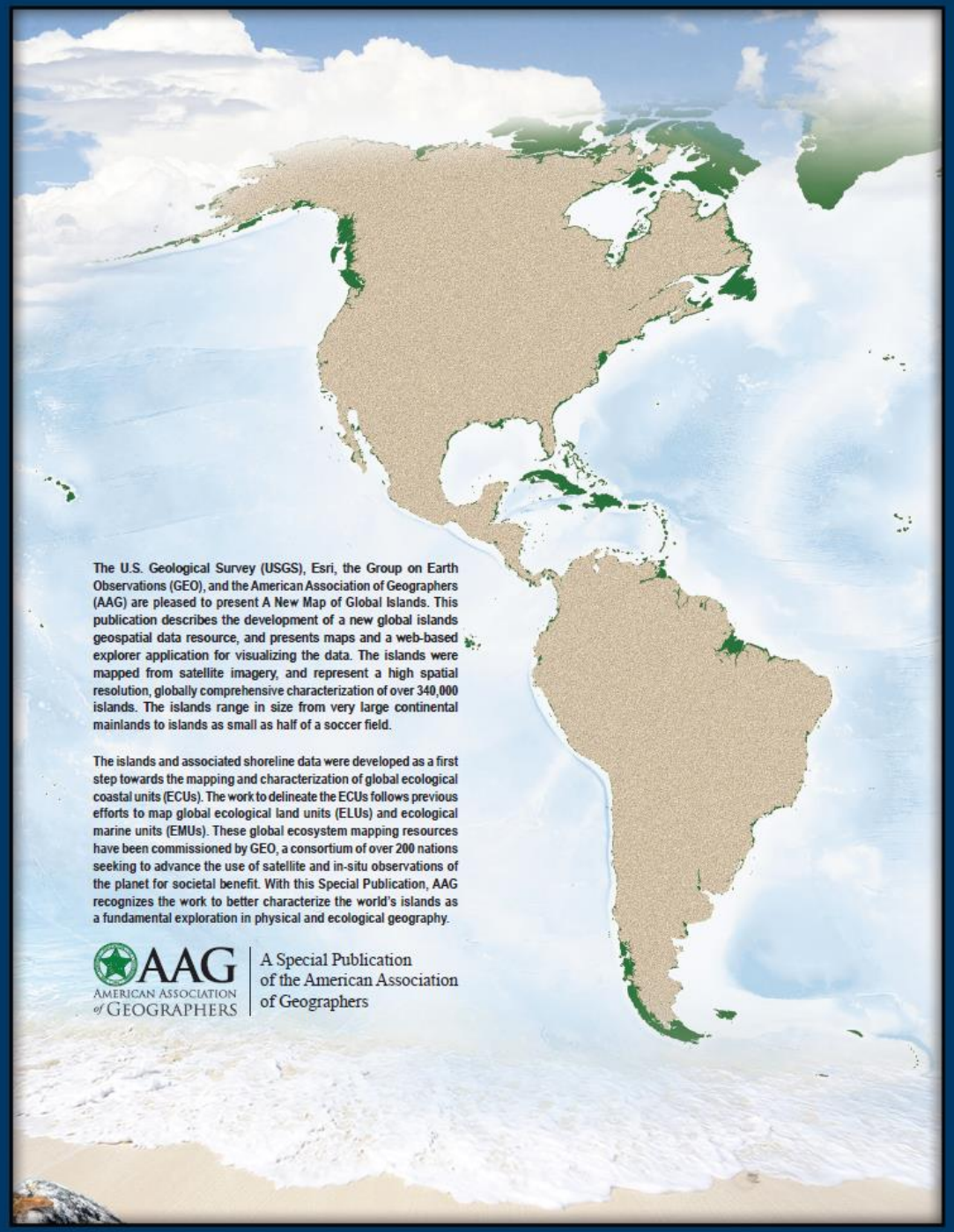
Global Island Explorer (GIE)

This resource was developed by the U.S. Geological Survey (USGS) in partnership with Esri. The tool was developed as part of a Group on Earth Observations (GEO) initiative called GEO Ecosystems (GEO ECO), and is associated with a GEO ECO task to develop global coastal ecosystems data. The tool allows for the visualization and query of the new global islands data, which includes 340,691 islands. Pan, zoom, and query functionality are included. The islands can be displayed over a number of backdrops including satellite imagery, topographic basemaps, light and dark background canvas, etc. A query of any island returns its name (in

The Global Island Explorer



A NEW MAP OF GLOBAL ISLANDS



The U.S. Geological Survey (USGS), Esri, the Group on Earth Observations (GEO), and the American Association of Geographers (AAG) are pleased to present A New Map of Global Islands. This publication describes the development of a new global islands geospatial data resource, and presents maps and a web-based explorer application for visualizing the data. The islands were mapped from satellite imagery, and represent a high spatial resolution, globally comprehensive characterization of over 340,000 islands. The islands range in size from very large continental mainlands to islands as small as half of a soccer field.

The islands and associated shoreline data were developed as a first step towards the mapping and characterization of global ecological coastal units (ECUs). The work to delineate the ECUs follows previous efforts to map global ecological land units (ELUs) and ecological marine units (EMUs). These global ecosystem mapping resources have been commissioned by GEO, a consortium of over 200 nations seeking to advance the use of satellite and in-situ observations of the planet for societal benefit. With this Special Publication, AAG recognizes the work to better characterize the world's islands as a fundamental exploration in physical and ecological geography.

AAG American Association of Geographers | A Special Publication of the American Association of Geographers

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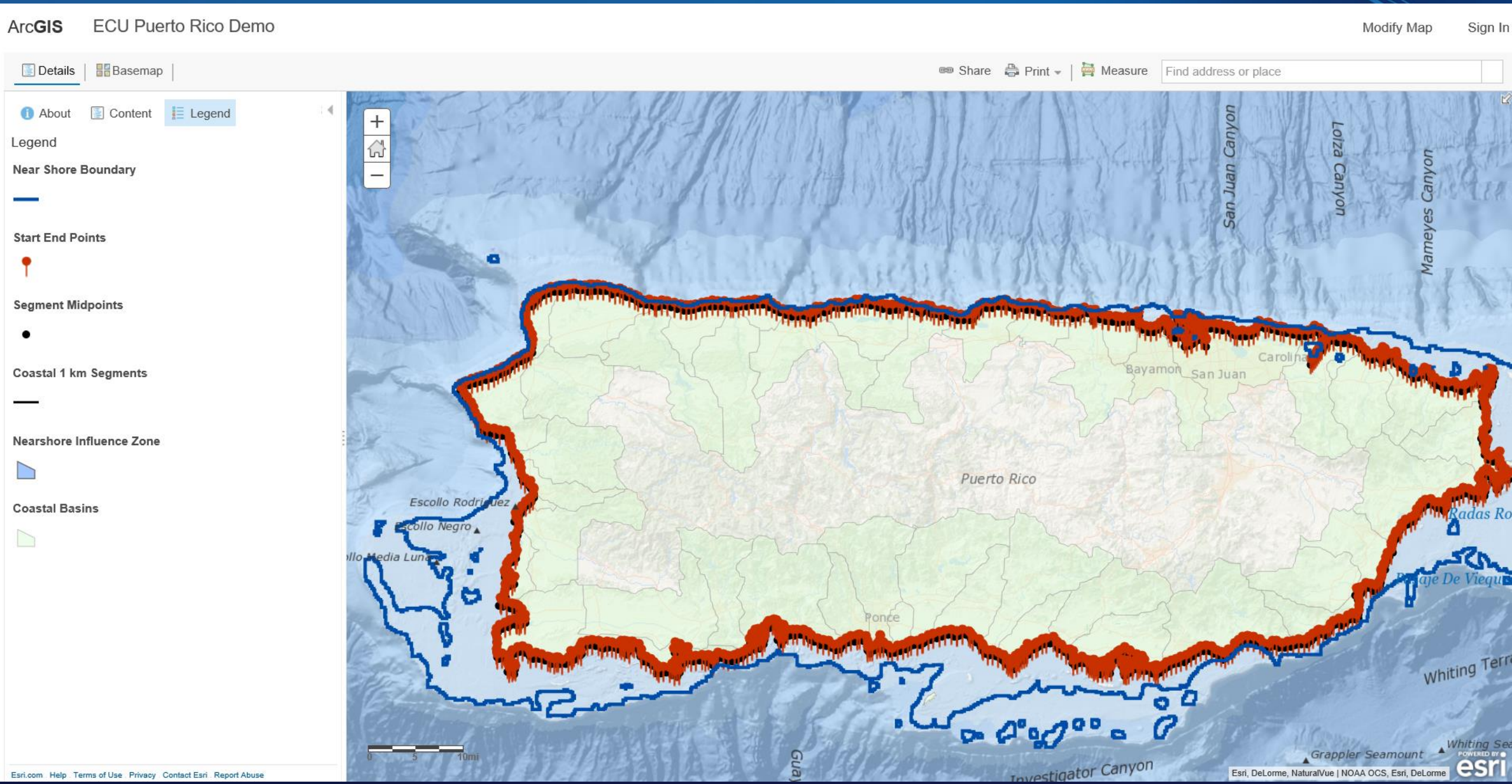
ECUs – Coastal Watersheds For Bounding Coastal Land Areas



ECUs – Segmenting the GSV and Identifying Associated Areas of Influence