



Latest Developments in Oceanographic Applications of GIS including ...

Near-Real-Time Interactive Map Exemplars & Scientific Empowerment Through Storytelling

Dawn Wright

Esri Chief Scientist

Affiliate Professor, Oregon State U.





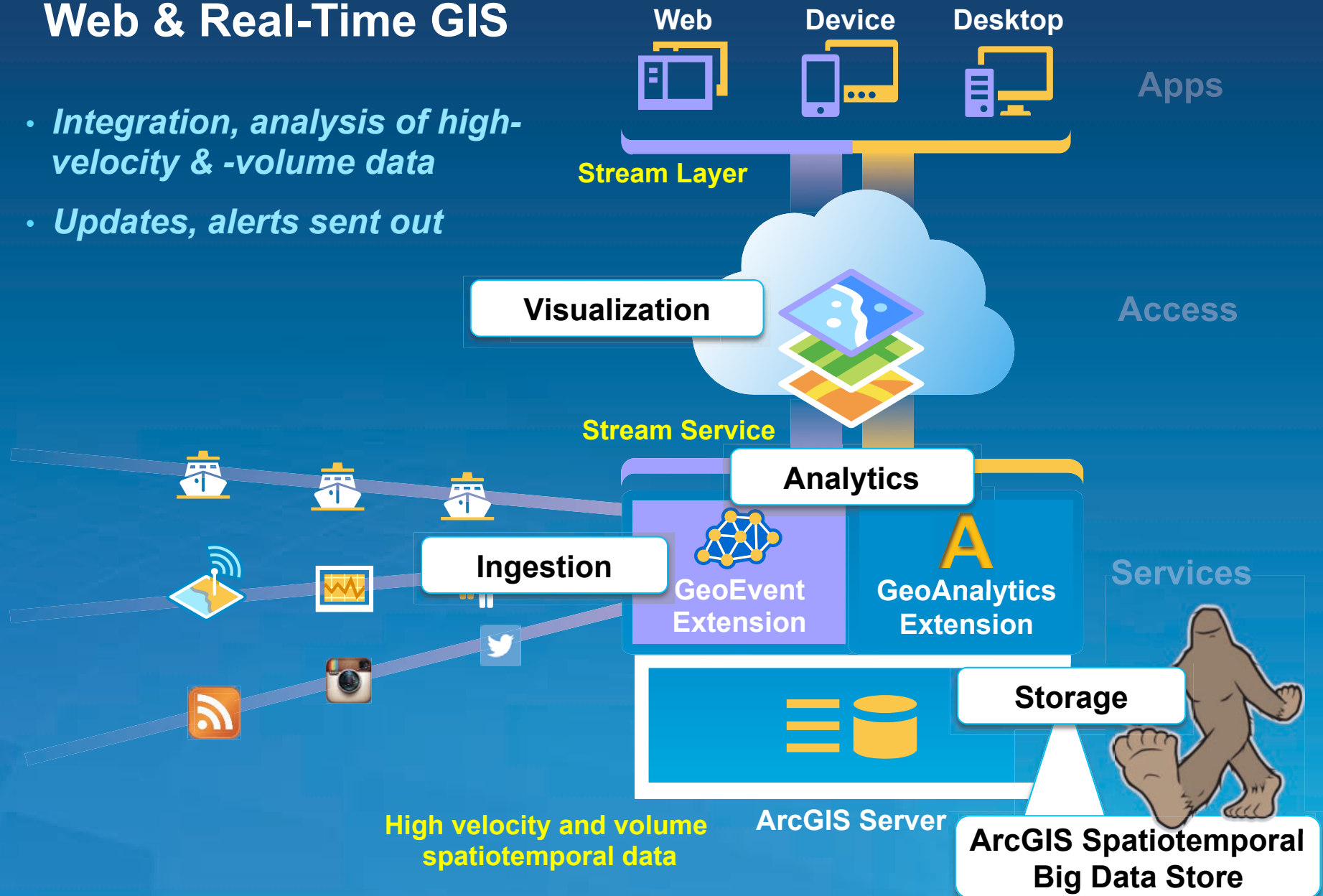
Analytics
Dashboards
Cool Maps
Storytelling Apps

Analytics....



Web & Real-Time GIS

- *Integration, analysis of high-velocity & -volume data*
- *Updates, alerts sent out*



Types of (Geo)Analytics

Calculate Density



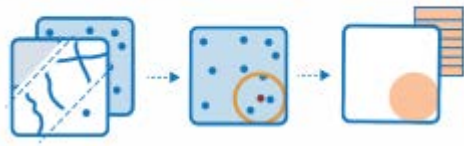
Find Hot Spots



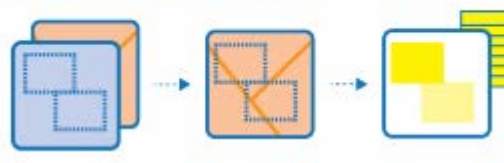
Extract Data



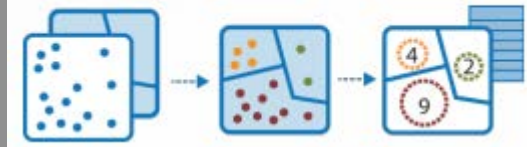
Summarize Nearby



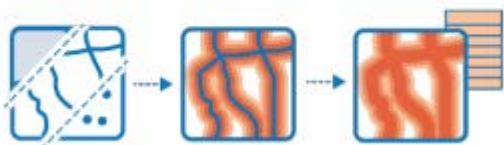
Summarize Within



Aggregate Points



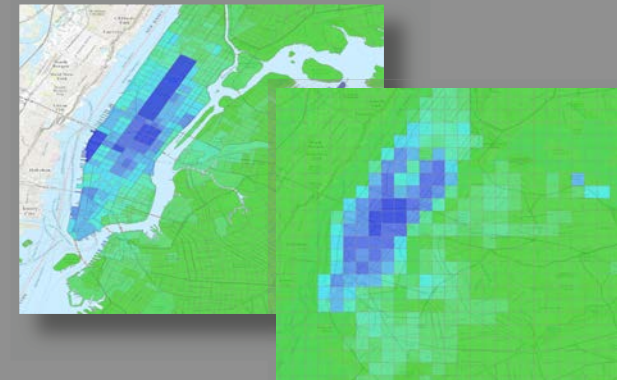
Create Buffers



Field Calculator



Aggregate by Polygons or Cells

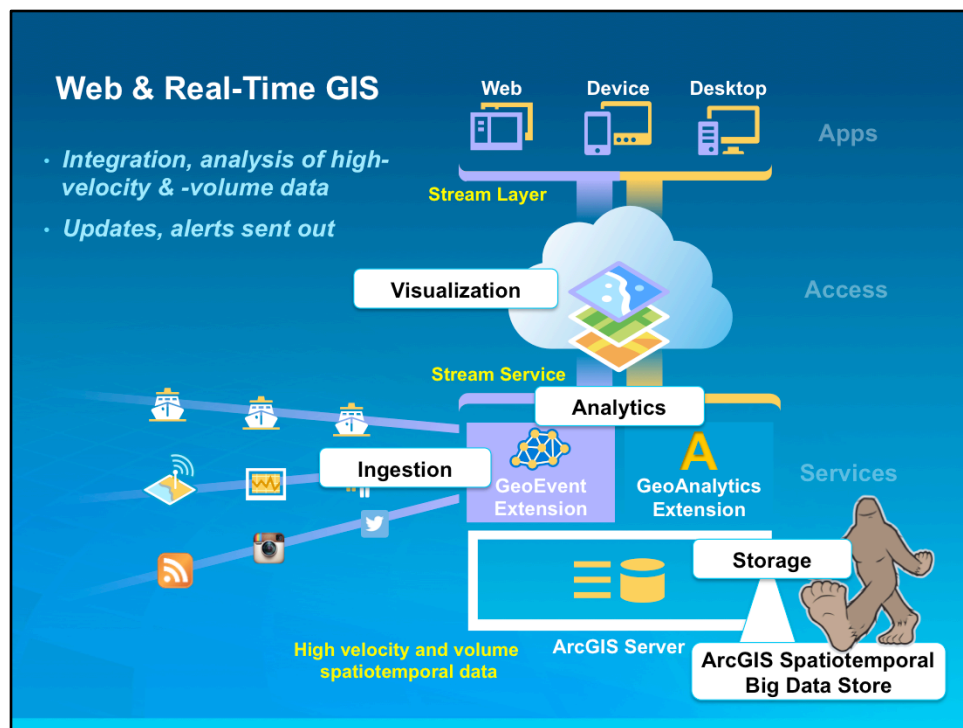


Find Existing Locations



Find Similar Locations





Thanks to Adam Mollenkopf, Esri Real-Time GIS Capability Team Lead and Ricardo Trujillo, GeoEvent Developer, amollenkopf@esri.com, rtrujillo@esri.com
links.esri.com/geoevent-wiki

We aim to register large data stores / data sets with ArcGIS Server, then distribute analysis across a cluster of machines for parallel processing

Performance example: buffer 8.2 million points or thousands of polygons in a little over a minute, Coming: ~250,000 writes to disk per second across 5 nodes

Many frameworks/technologies exist for distributing computation

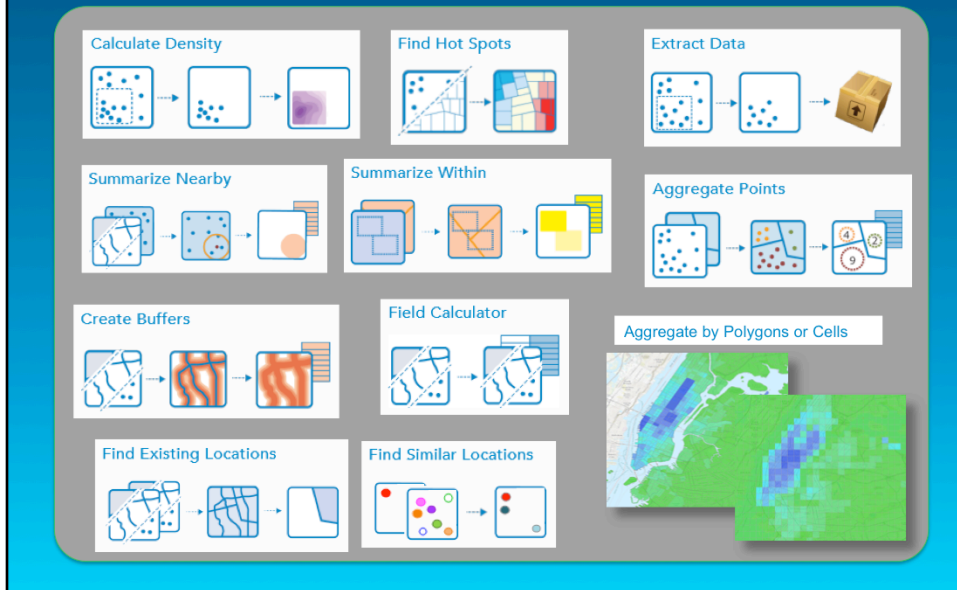
E.g., Hadoop, MapReduce, Spark

Spark: processes distributed data in memory; Supports MapReduce programming model

Includes additional framework level distributed algorithms

ArcGIS Server integrates these technologies on a cluster to solve analytic problems

Types of (Geo)Analytics



Parallelized batch analytics on tabular, vector, raster, and imagery datasets (big and standard data)
Performance example: buffer 8.2 million points or thousands of polygons in a little over a minute,

NetCDF output is supported on ...

Aggregate Points – Point in polygon aggregation (spatial join)

Aggregate by Cell – simple aggregation

Summarize Nearby – spatial join where left dataset and a distance are used to inflate the bounding box. A distance calculation is then employed (no drivetime/distance).

Summarize Within – a spatial join that is a generalization of Aggregate Points

Find Existing Locations – an attribute query followed by/with a spatial query (?); the attribute portion is SparkSQL, the spatial relationship is: intersections, within distance, contains, and within.

Find Similar Locations – non-spatial similarity search (SparkSQL).

Calculate Density – cell-based spatial aggregation by attribute with a weighted neighborhood/distance-based summarization.

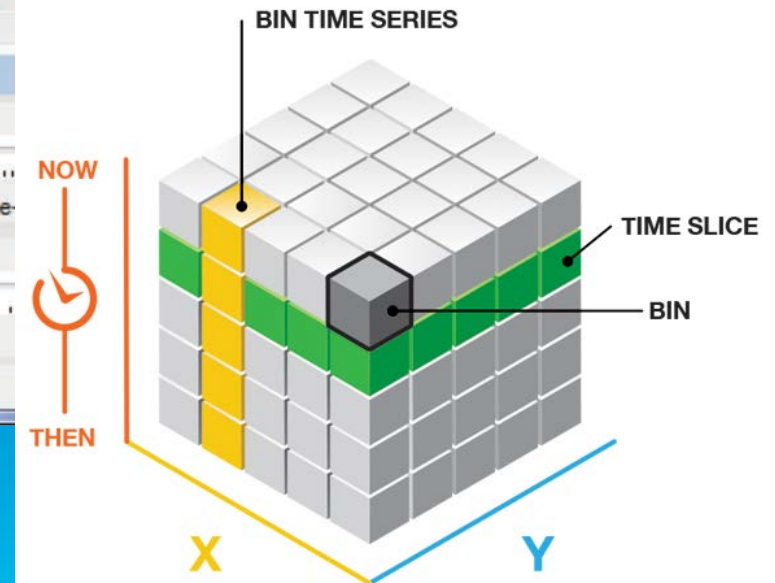
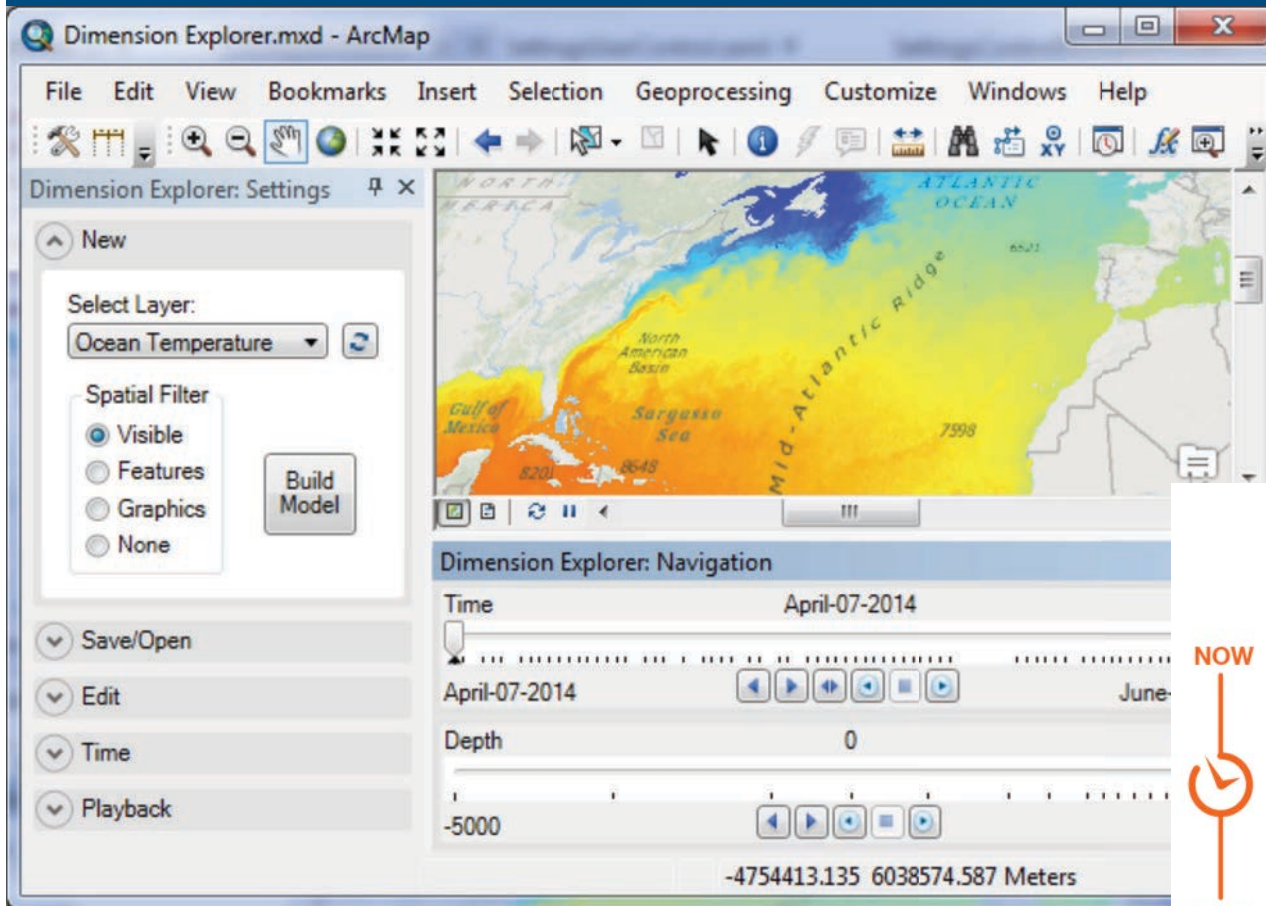
Find Hot Spots – very similar to Calculate Density but with the Getis-Ord G_i^* statistic. This can be cell-based (point observations) or polygon-based (polygon source data).

Create Buffers – simple spatial buffer generation across the dataset (the Java geometry library supports Euclidean and Geodetic buffer generation). This is done.

Extract Data – a simple region query with a specified output format.

Field (RASTER) Calculator – apply a Scala or SQL expression to each feature, one expression per field.

Dimension Explorer Add-In (Desktop)

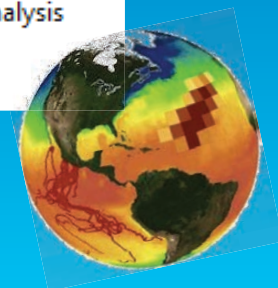
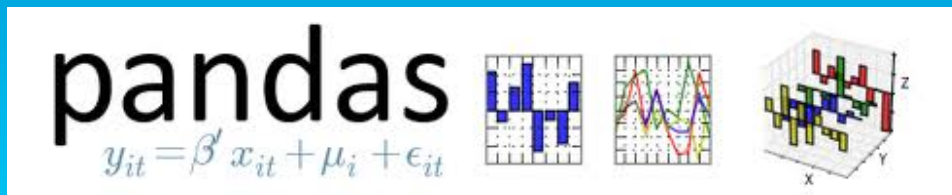
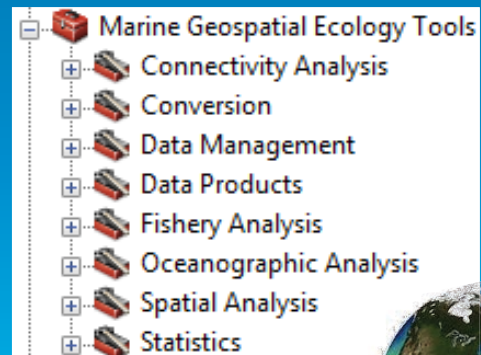


Interoperability / Crosswalking

Out of the Box



Simple Integration



r-arcgis.github.io

Welcome to the R – ArcGIS Community

Combine the power of ArcGIS and R to solve your spatial problems

The R – ArcGIS Community is a community driven collection of free, open source projects making it easier and faster for R users to work with ArcGIS data, and ArcGIS users to leverage the analysis capabilities of R.



Need the [R Statistical Software](#)? [Download it now.](#)

r-bridge-install Python

Install the R ArcGIS Tools

🔗 8 ★ 20

r-bridge C++

Bridge library to connect ArcGIS and R,
including `arcgisbinding` R library

🔗 3 ★ 17

r-sample-tools R

Sample tools illustrating R usage in
geoprocessing scripts

🔗 3 ★ 16

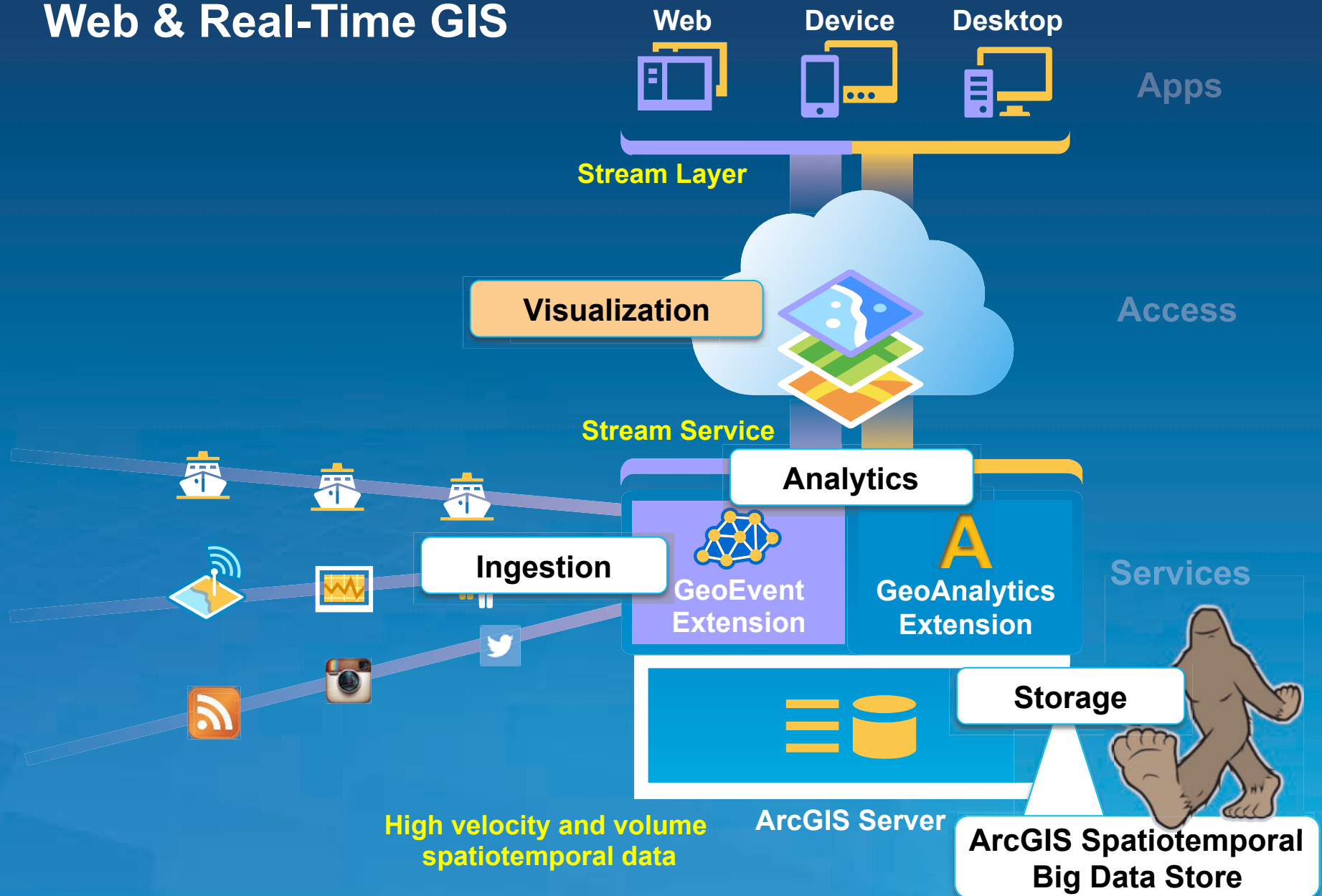
BROWSE ON GITHUB

Interoperability / Crosswalking

***GEOPORTAL
IS AWESOME!***



Web & Real-Time GIS



Dashboards...



Alley or Abandoned

29

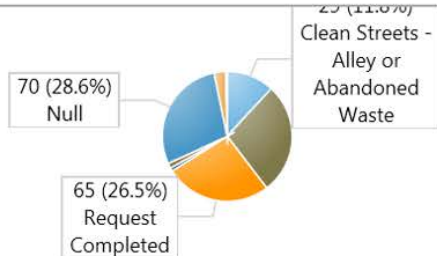
Data for Feb 14, 2015 Routes

All Routes - Count

245

Data for Feb 14, 2015 Routes

Routes on 2/14/15 Close codes



Completed

65

Data for Feb 14, 2015 Routes

Not Out

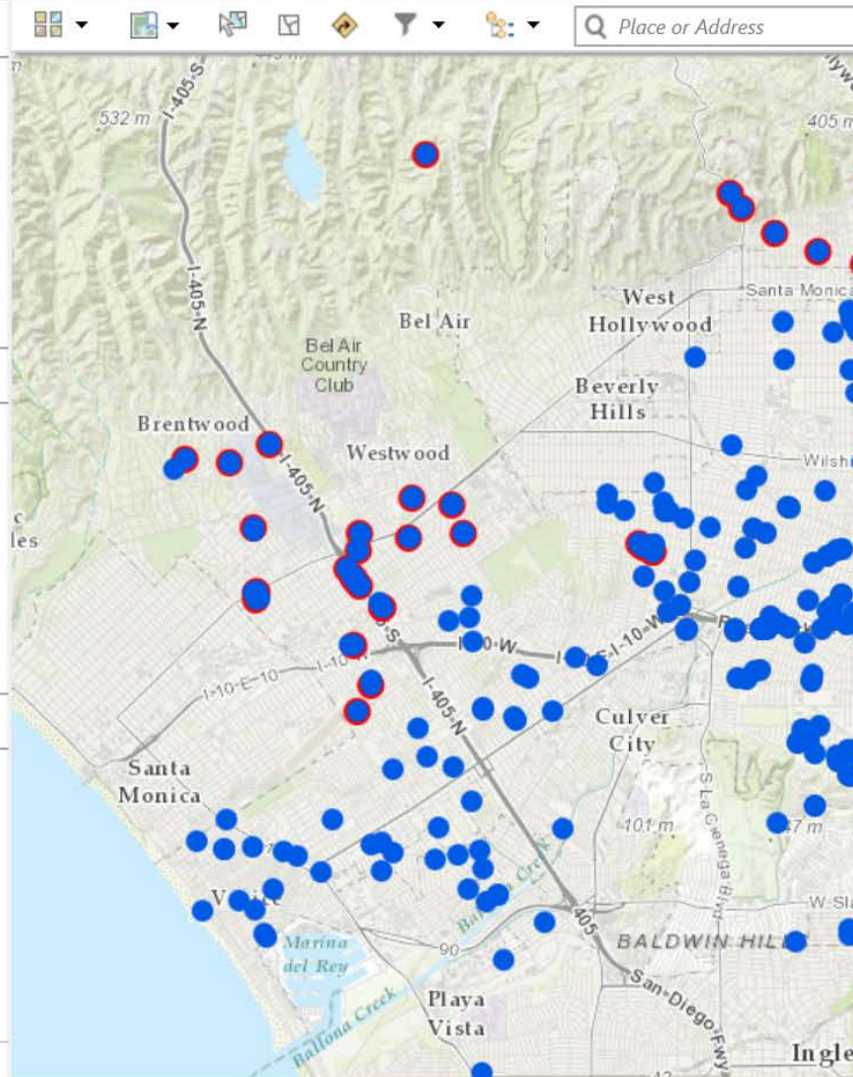
68

Data for Feb 14, 2015 Routes

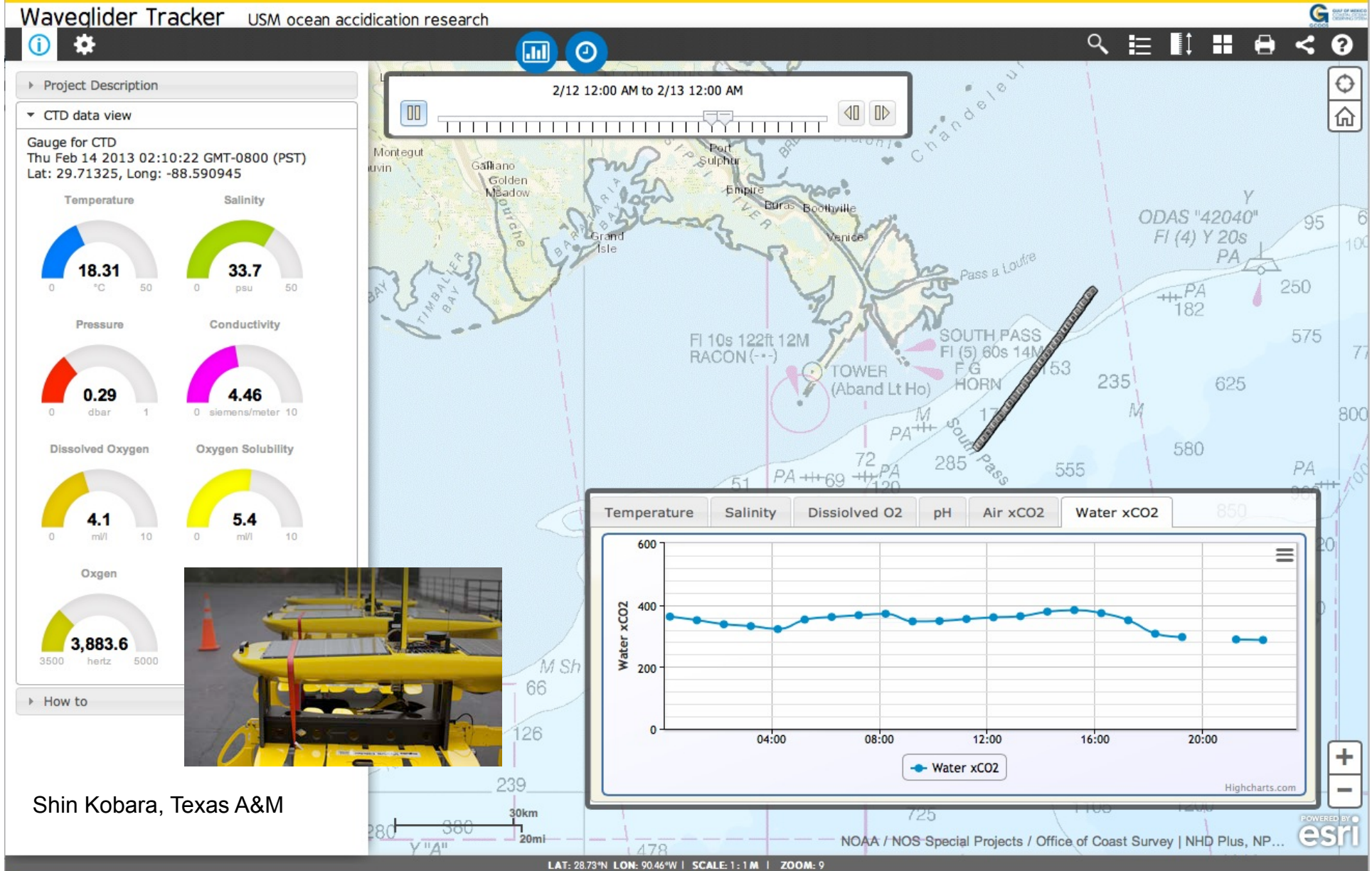
Encampments

7

Data for Feb 14, 2015 Routes



Wave Glider Sensor Dashboard: bit.ly/gcooswaveglider



From Kobara et al., 2015, *Ocean Solutions, Earth Solutions*

Active Vessels Dashboard Prototype



Esri Global Fishing Watch aimed at Illegal, Unreported, Unregulated Fishing

Cool Maps....





2,249

VOLUME

CELLS

1,442

SHIP LOCATIONS

2,249

AVERAGE

1.56

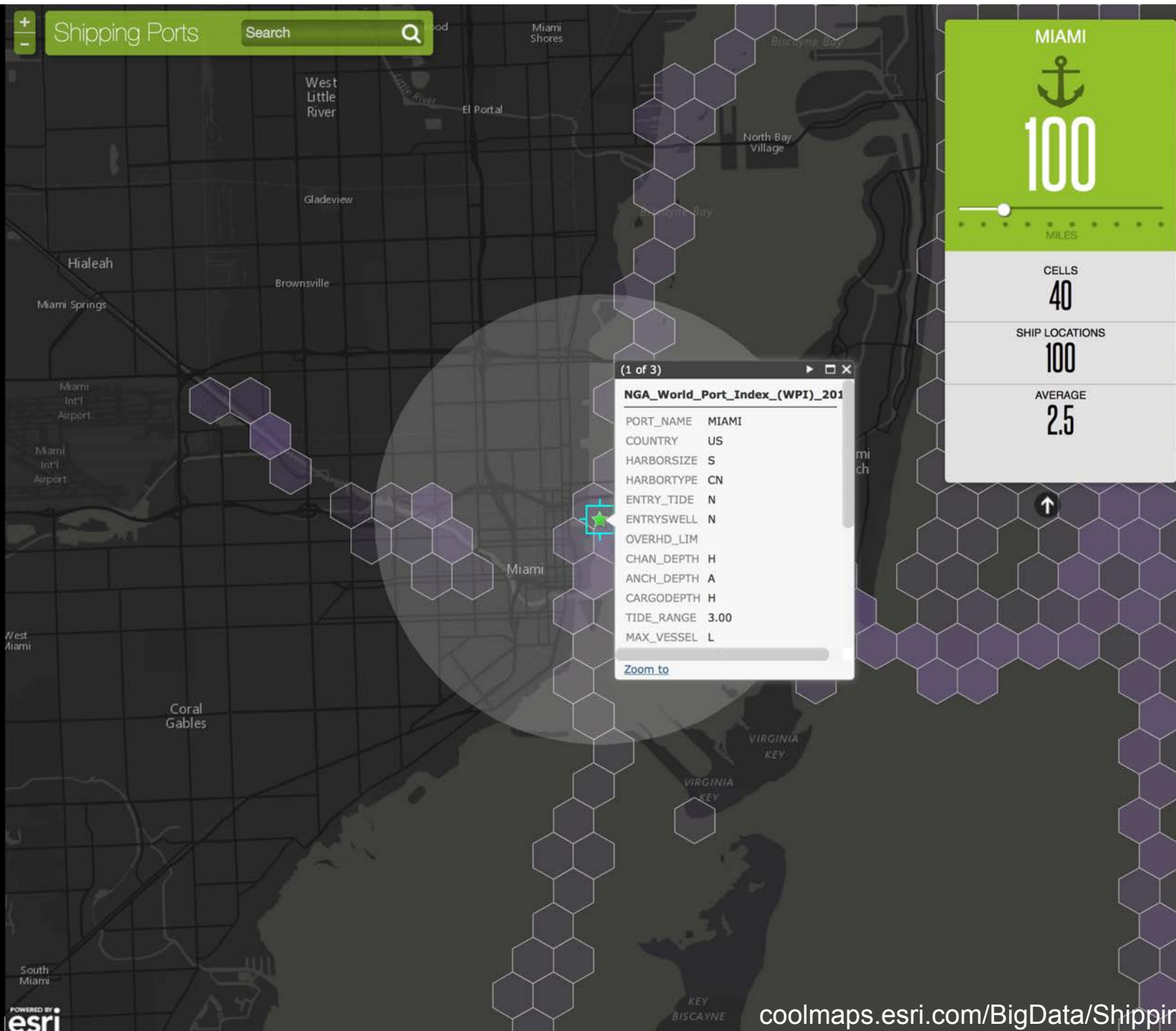
(1 of 2)

HexMiami:

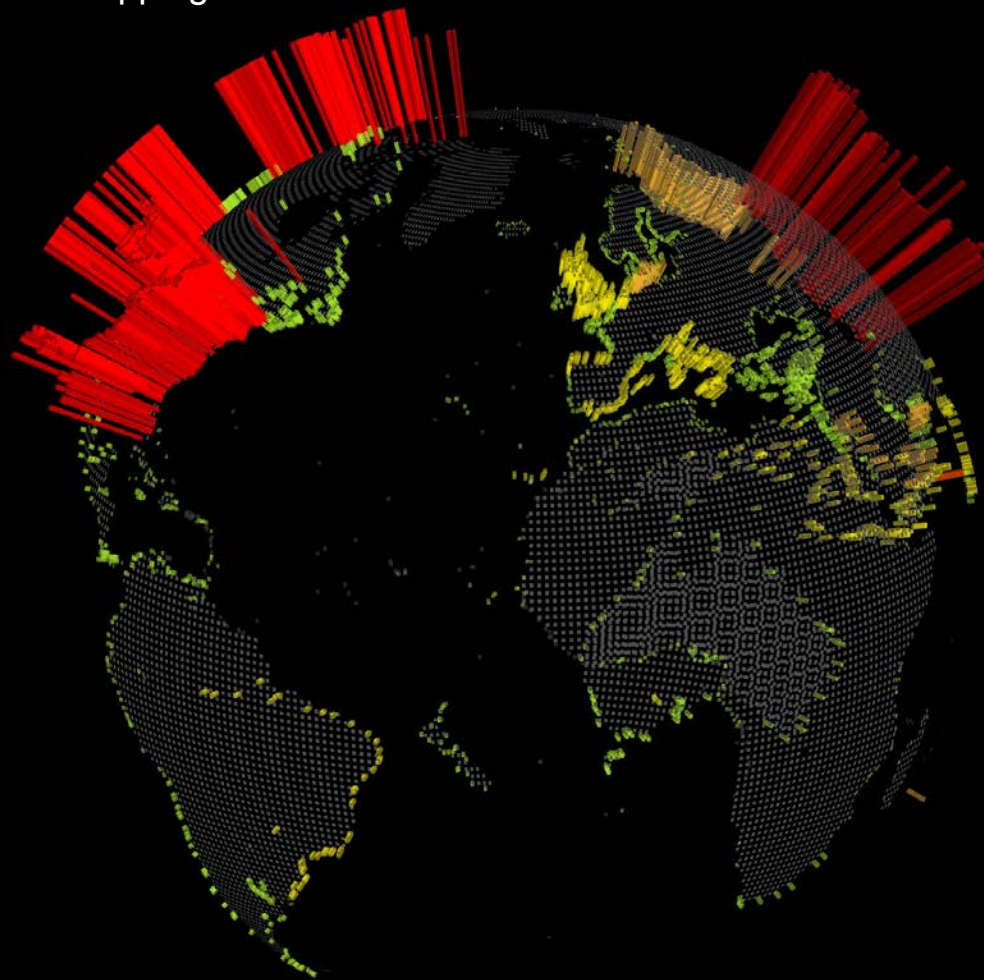
ORIGID 2,886

POPULATION 6

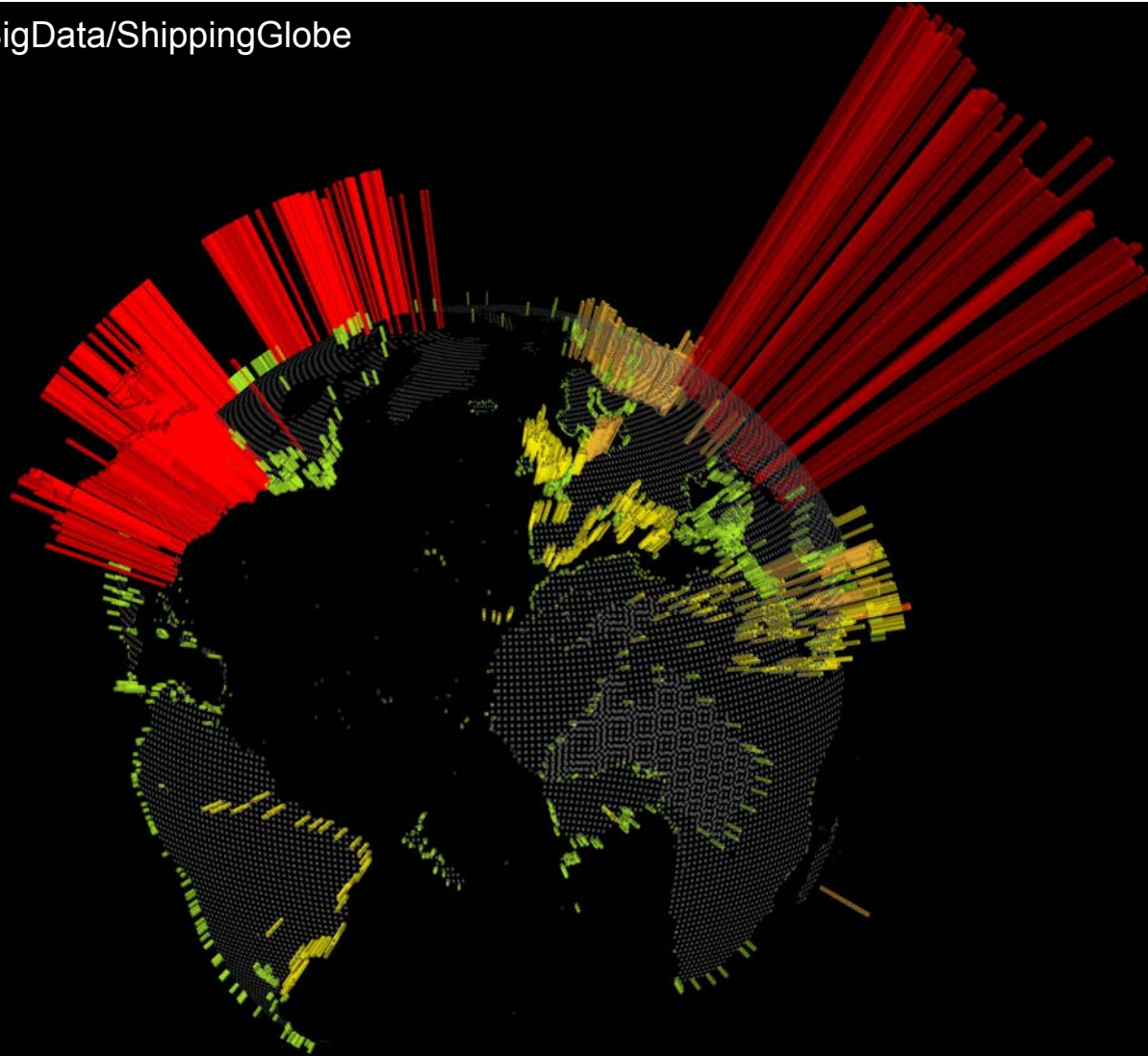
[Zoom to](#)



coolmaps.esri.com/BigData/ShippingGlobe

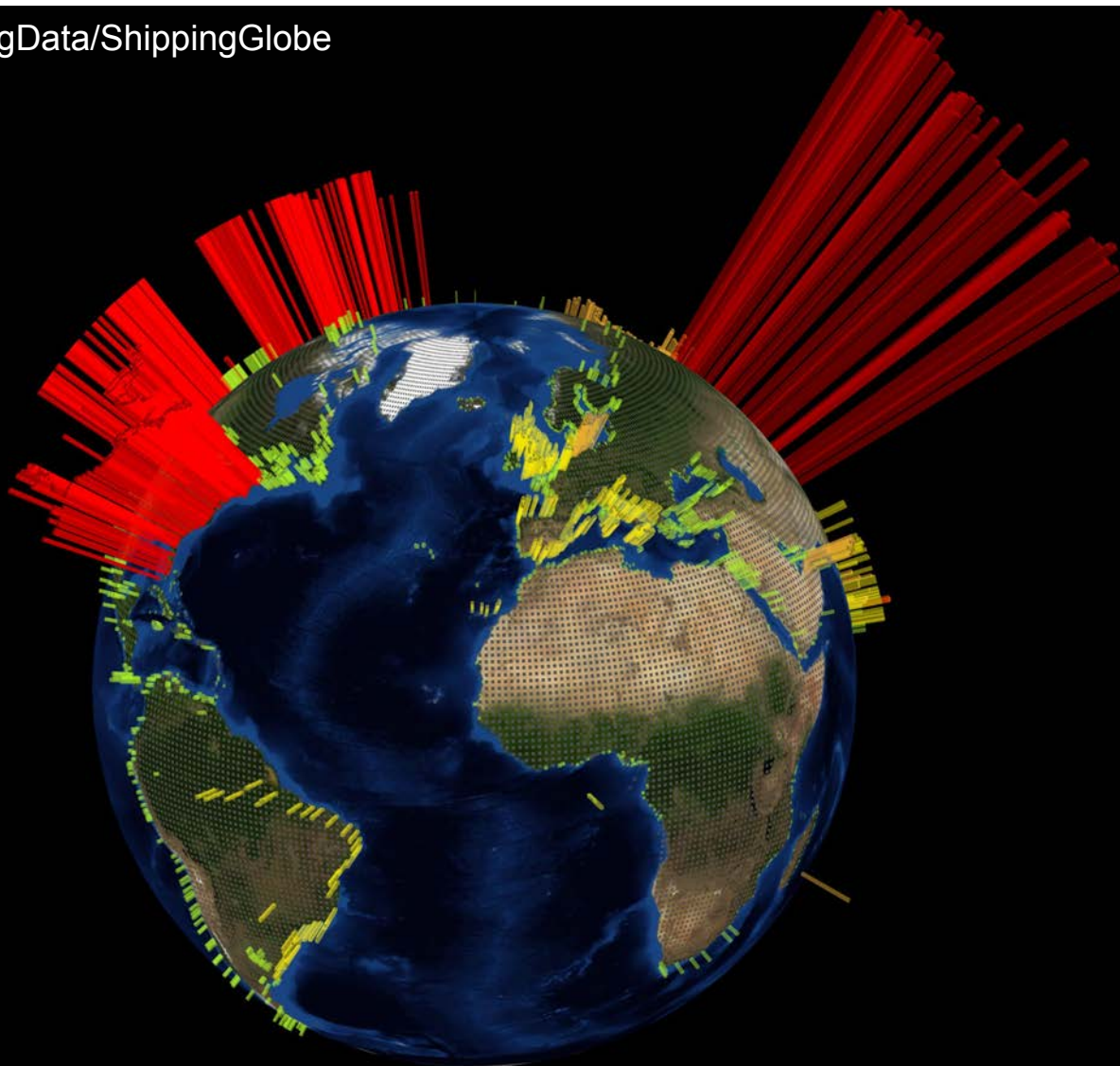


2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011



2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

coolmaps.esri.com/BigData/ShippingGlobe

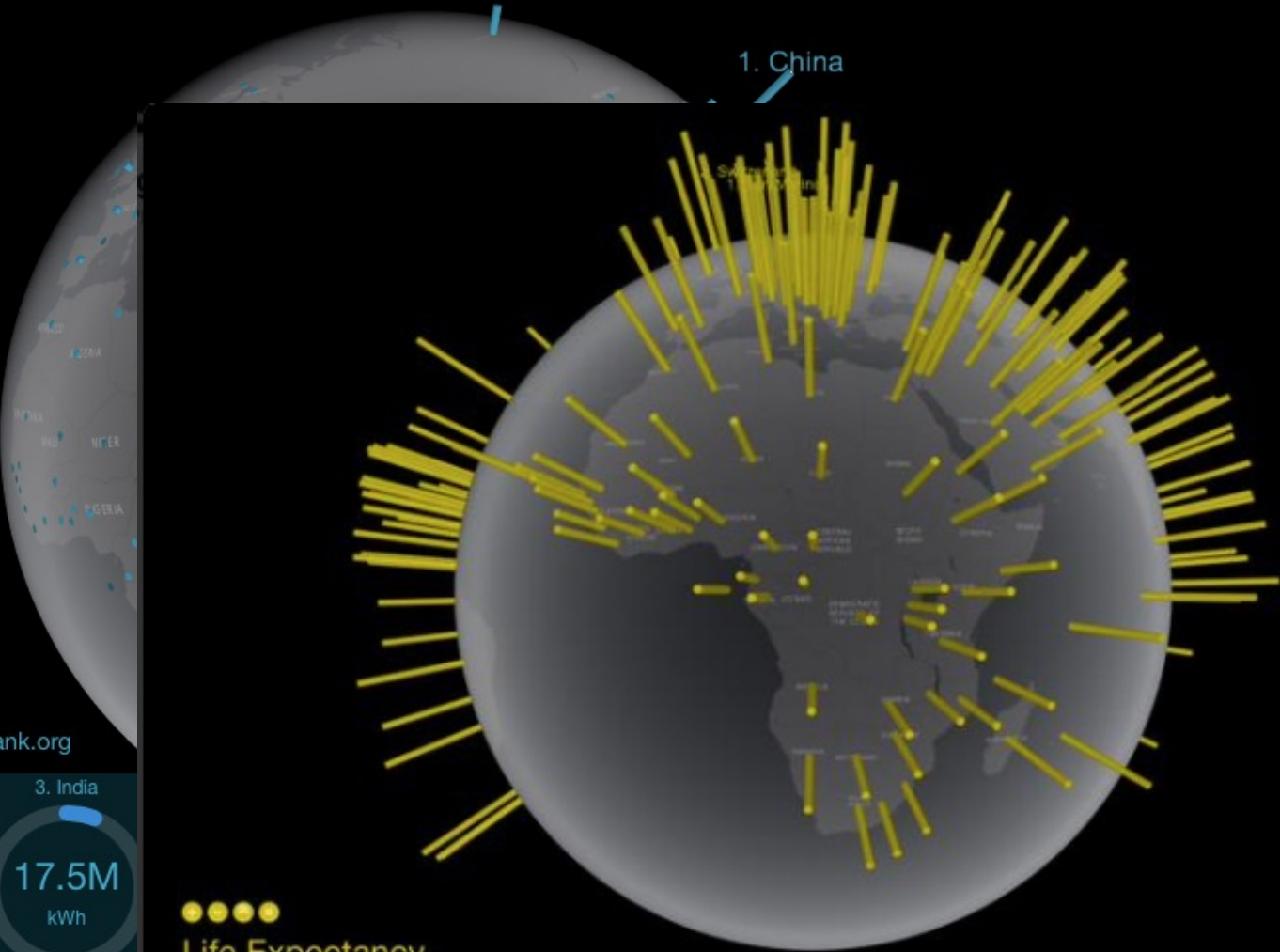


2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011



CO2 Emissions

CO2 Emissions (kilo tons) | Source: WorldBank.org



Life Expectancy

Life Expectancy (years) | Source: WorldBank.org



Once upon a time...



**“Stories are data with a soul,
...persuasive and memorable.”**

– Nancy Baron, Director of Science Outreach, COMPASS





*"I don't know why I don't care about the bottom
of the ocean, but I don't."*

Communicating with ...

“Story Maps”

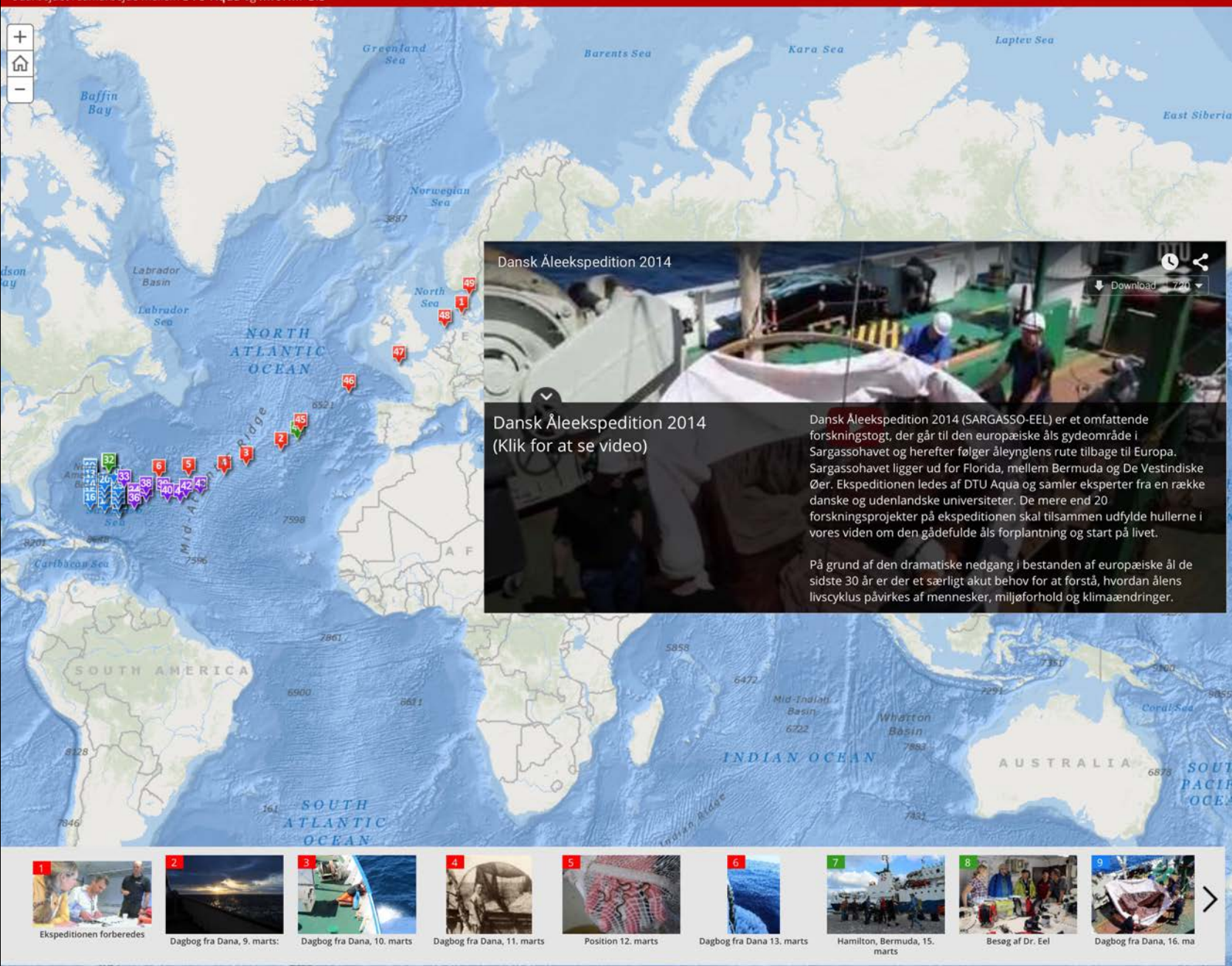


Dansk Åleekspedition 2014

esriurl.com/ocnstories formi GIS - Når viden skal ses [f](#) [t](#) [e](#)

DTU's havforskningsskib Dana var i marts og april 2014 på togt i Sargassohavet for at undersøge, hvilken rolle klimabetingede ændringer i ålens gydeområder spiller for ålens voldsomme tilbagegang i Europa.

Udarbejdet i samarbejde mellem DTU Aqua og Informi GIS

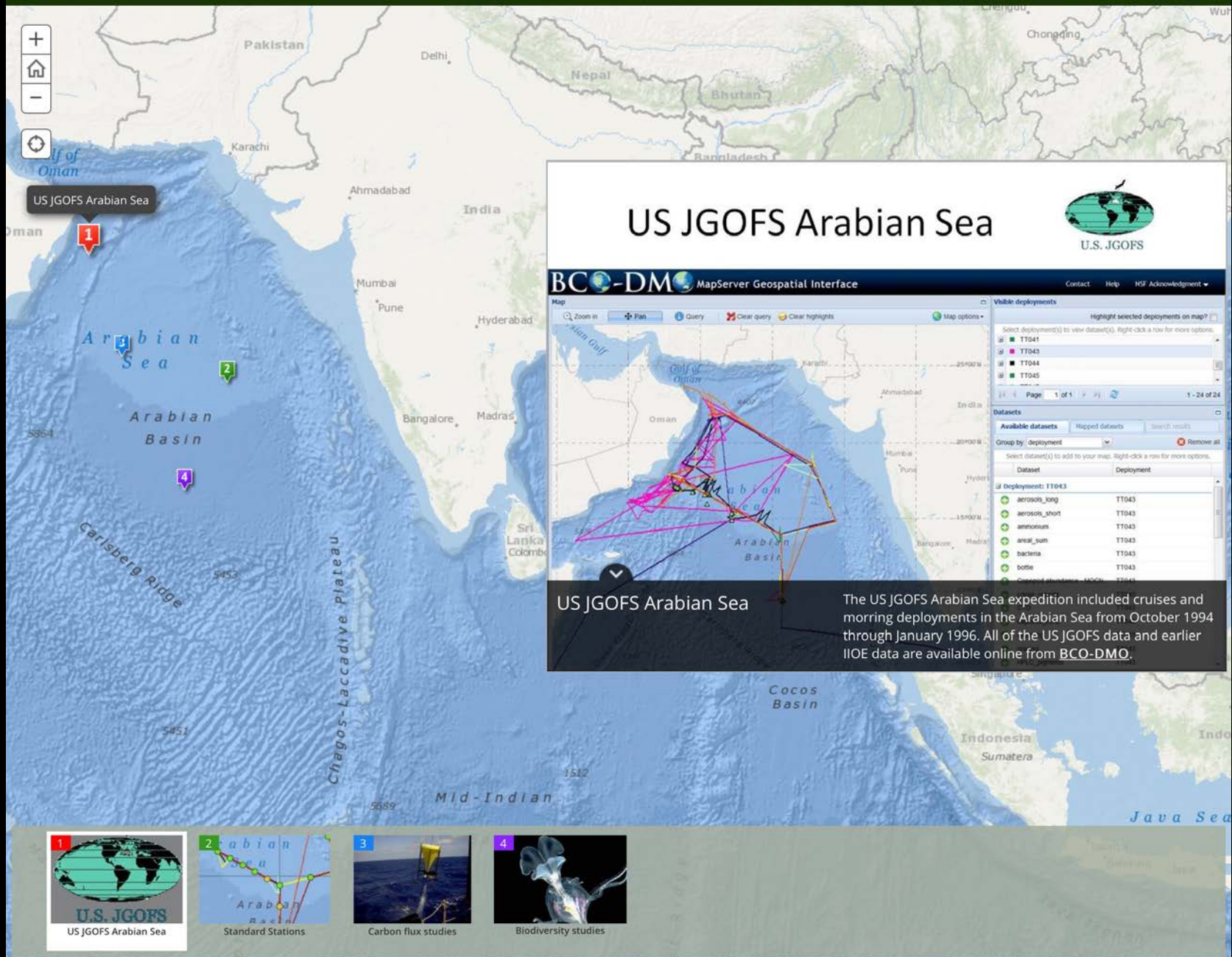


Indian Ocean Research Data: Past, Present and Future

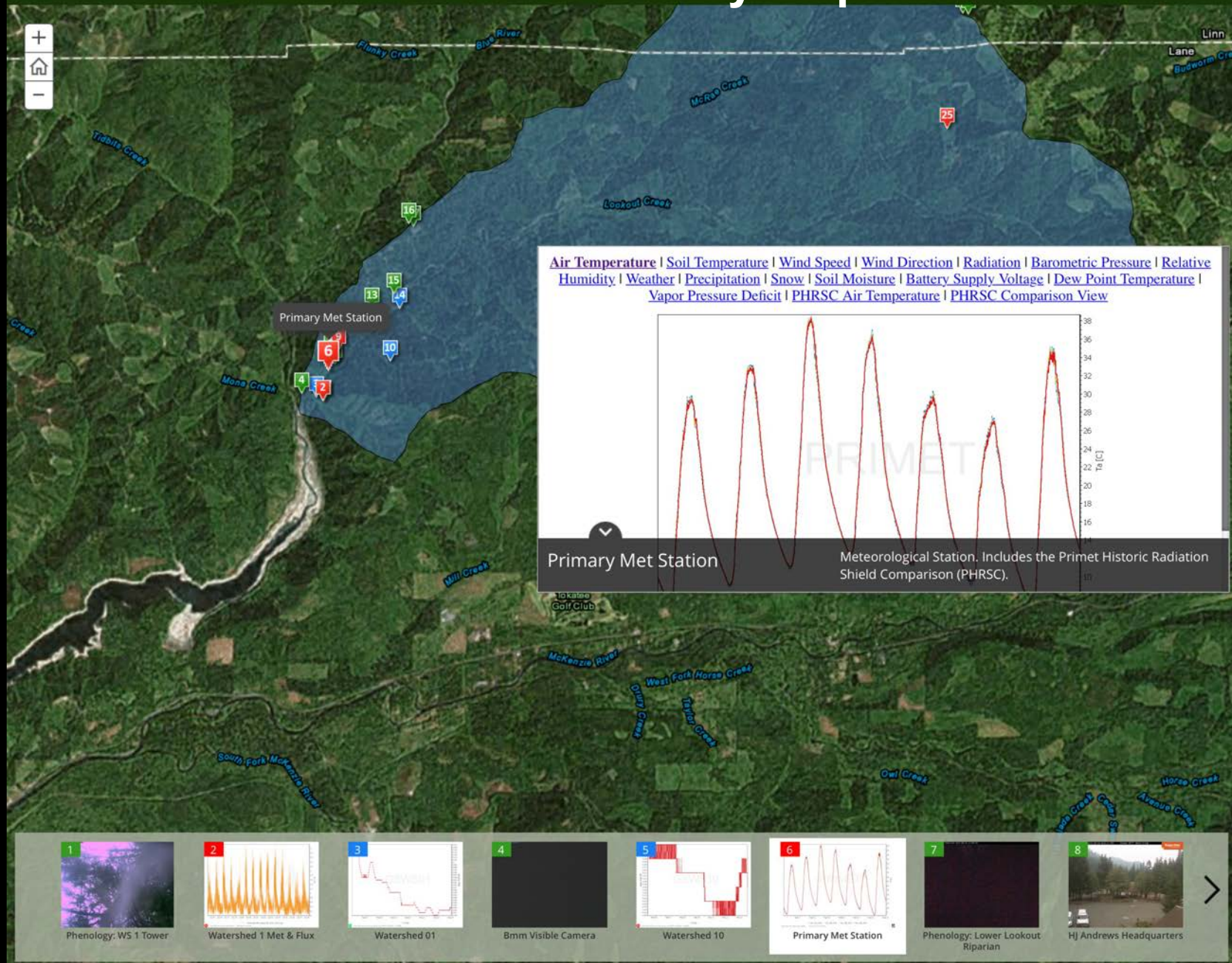
Cyndy Chandler, Woods Hole Oceanographic Institution, et al., PICO Spot 1 and PICO 1.2, EGU2015-2435

esriurl.com/ocnstories

A PICO story map [f](#) [t](#) [e](#)



Sensor dashboard as a story map



Ocean Acidification: Aragonite Saturation 1885 & 2095

A story map [f](#) [t](#) [l](#)

High CO2 emissions scenario



1 2 3 4

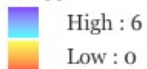
Ocean Acidification

Ocean acidification is literally causing a sea change and altering the fundamental chemical balance of ocean and coastal waters from pole to pole. One way to measure or see this change is "saturation state." Saturation state tells us how much calcium carbonate is in the seawater. Calcium carbonate and its mineral forms are important building blocks for shells and skeletons of marine life such as oysters, corals, and fish. A shift in saturation state (represented by omega (Ω)) alters how easily marine creatures can build and maintain their shells and skeletons. If Ω is less than 1 ($\Omega < 1$), conditions are corrosive (under saturated with respect to carbonate minerals), and shells and skeletons tend to dissolve. When $\Omega > 1$, waters are supersaturated with respect to calcium carbonate or aragonite, and conditions are favorable for shell growth.

Legend

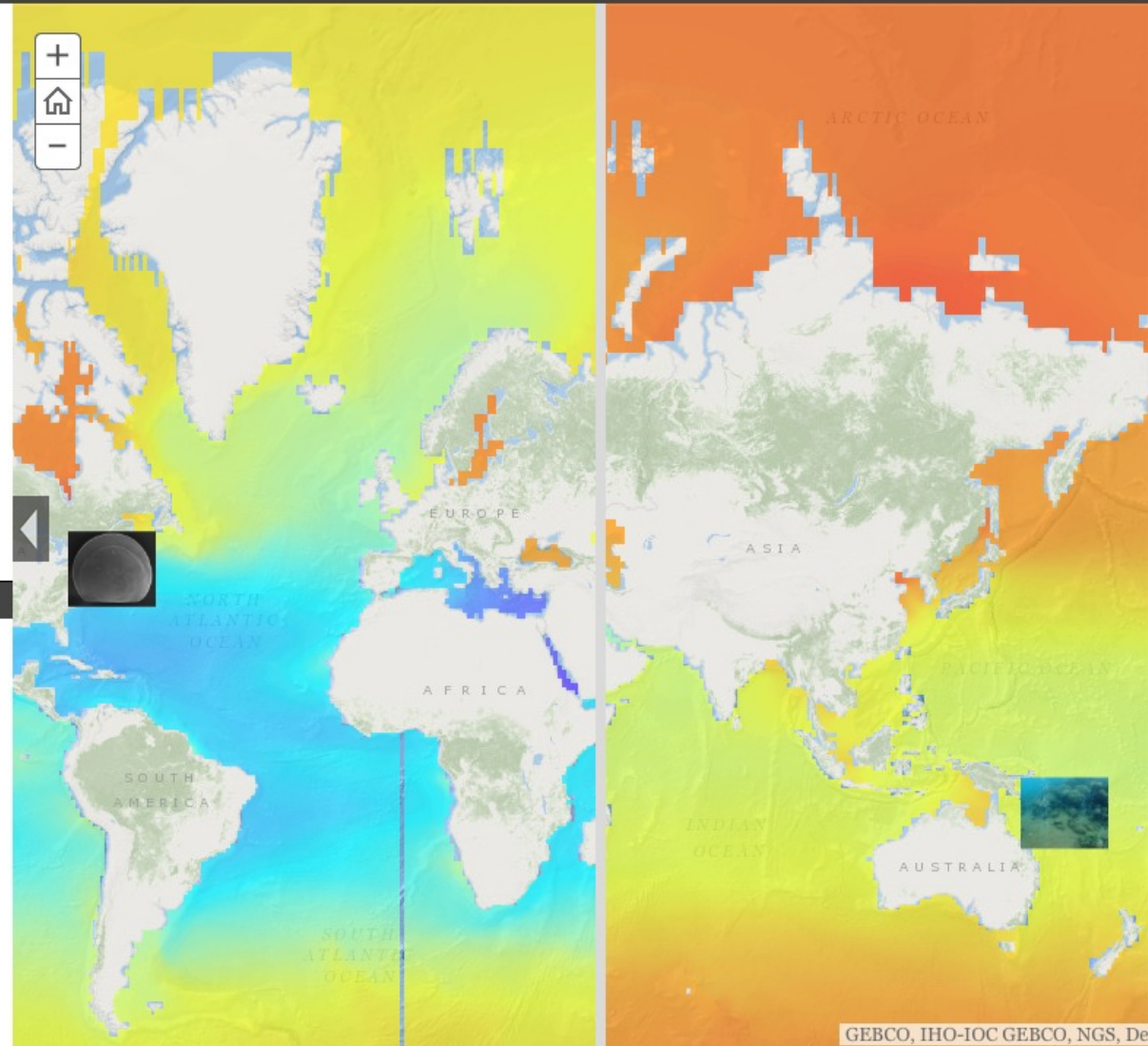
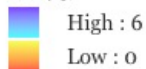
Omega Aragonite - 1855

Omega Aragonite (1855)



Omega Aragonite - 2095

Omega Aragonite (2095)



GEBCO, IHO-IOC GEBCO, NGS, DeLorme

POWERED BY
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Reefs at Risk Story Map

Explore data from the World Resources Institute showing reefs at risk. Click through the tabs to see the current situation and projections for 2030 and 2050.

A story map [f](#) [t](#) [s](#)

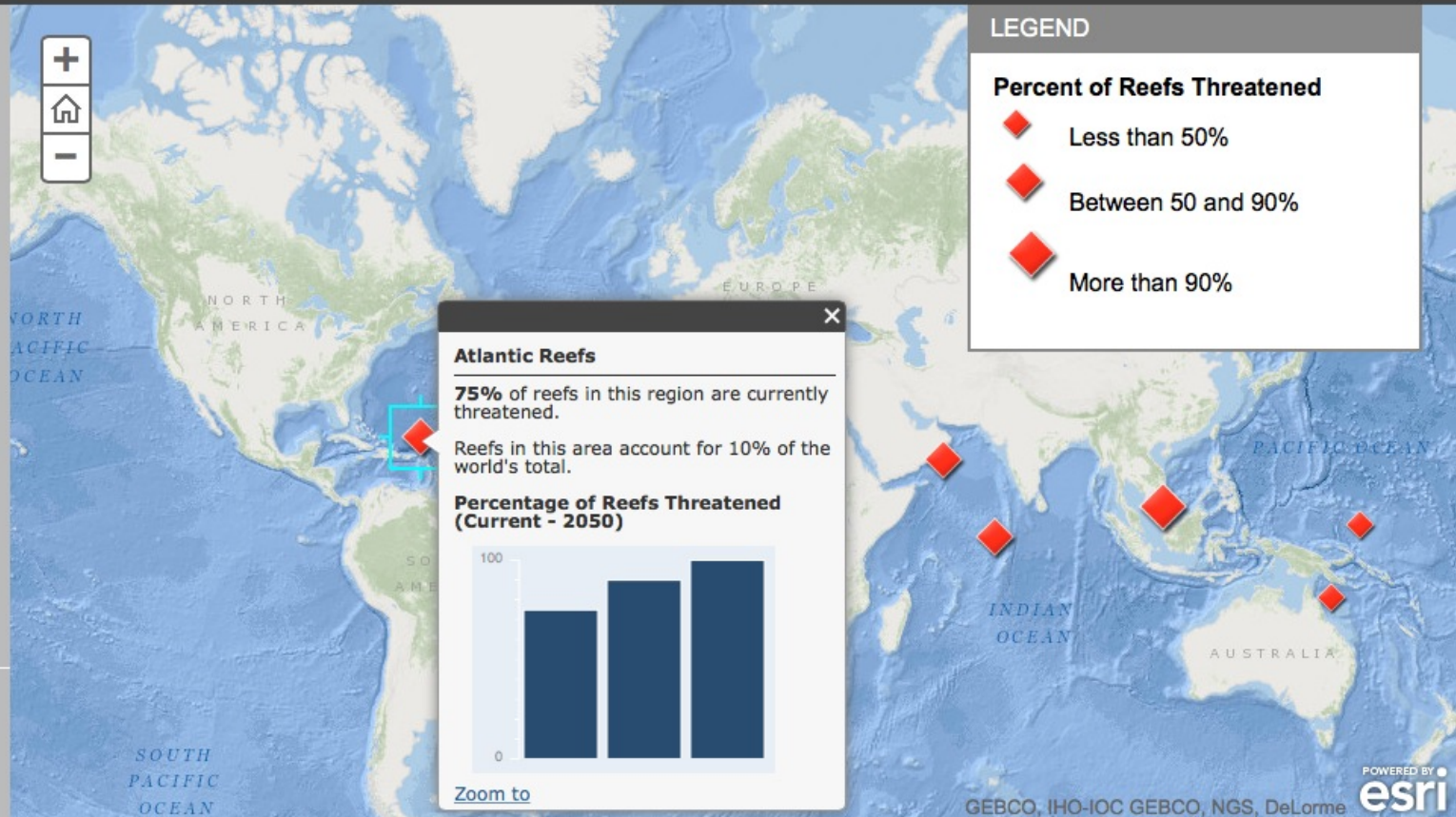


1 Reefs at Risk: Today

More than 60% of the world's reefs are currently threatened. Pacific and Australian reefs are currently the least threatened, while a staggering 94% of reefs in Southeast Asia are currently threatened.

Click on any icon to learn more about reefs in a particular region. You can zoom into any area to get a detailed view of where reefs are threatened at a local scale.

2 Reefs at Risk: 2030



WELCOME TO THE Anthropocene

We are Living in The Age of Humans

Earth is changing rapidly, and an increasing number of scientists say that humans have become the dominant force driving these changes. While the term has no formal definition, many agree that we are now living in an age shaped by human activity: the Anthropocene.

Evidence for the Anthropocene ranges from worldwide population booms to the expansive transformation of the landscape. But solutions are cropping up at the local level that could help create a more resilient global community.

Explore the maps below to see an atlas of human influences, as well as the cities that are helping to re-shape the way our species



esriurl.com/ocnstories

esri
gram

presents

SHARK GIS



A story map



SharkGIS

Human fascination with sharks dates back ages—long before *Jaws* or *Sharknado*. What is it about these mysterious creatures of the deep that sparks so much interest across time and cultures? In honor of Shark Week, we're taking a closer look at sharks using media and maps to better understand the ocean's fiercest predator.




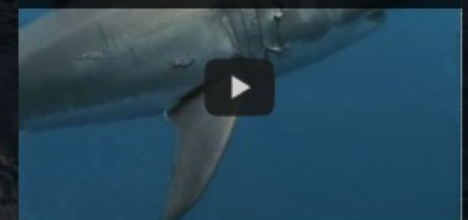


A story map     esri
SharkGIS

Ferocious Man-Eater?

Let's cut to the chase. The great white is probably the world's most notorious shark. While *Jaws* didn't do any favors for the white shark's reputation, nature filmmakers and shark advocates are trying to change public perception. In reality, *National Geographic* reports that humans are not the preferred prey of the great whites. Just try not to look like a seal the next time you go to the beach.

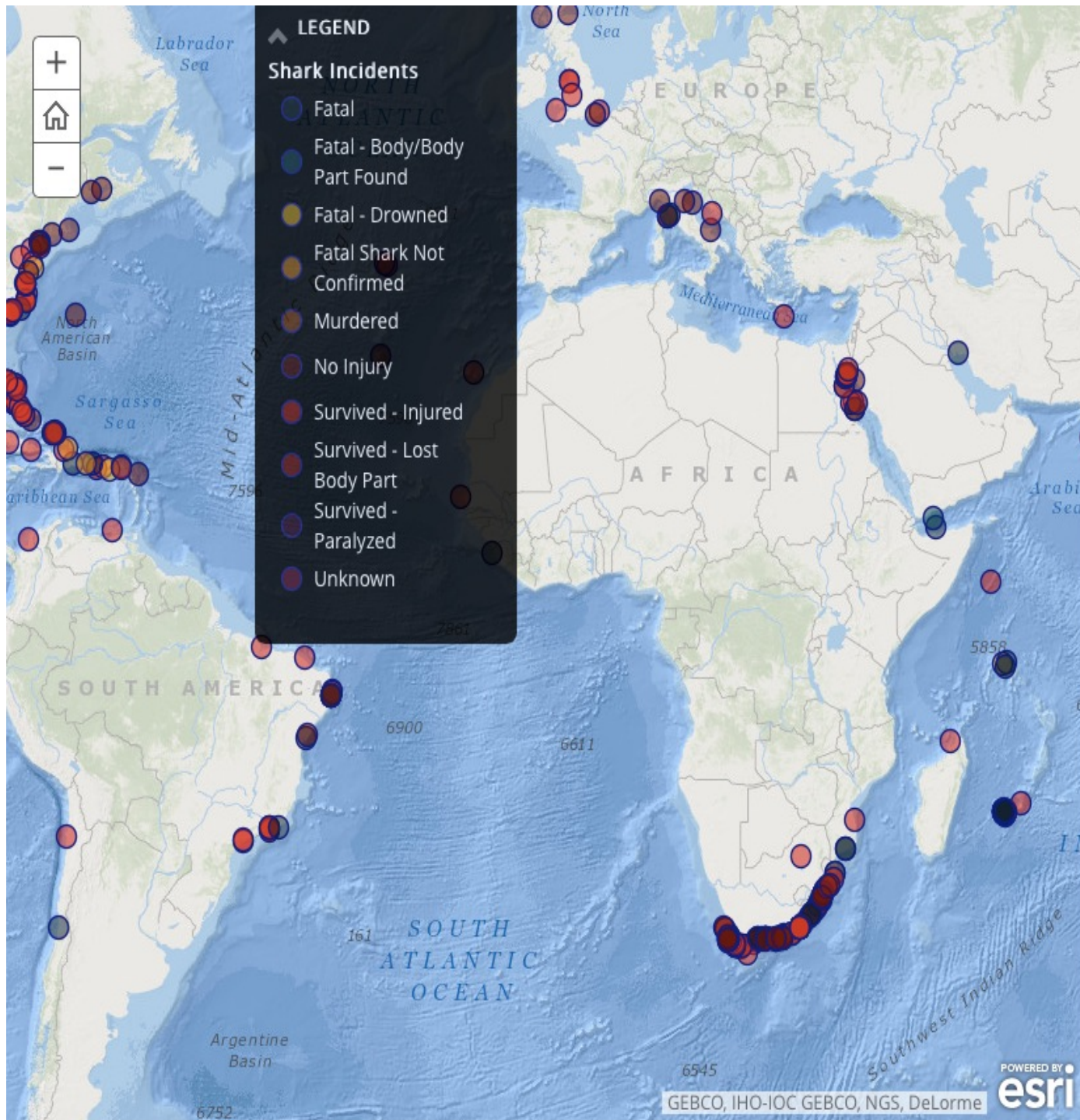
One Misunderstood Fish: The Great White 







Video: [Endless Ocean](#)

Photo: Lwp Kommunikáció [via Flickr](#)





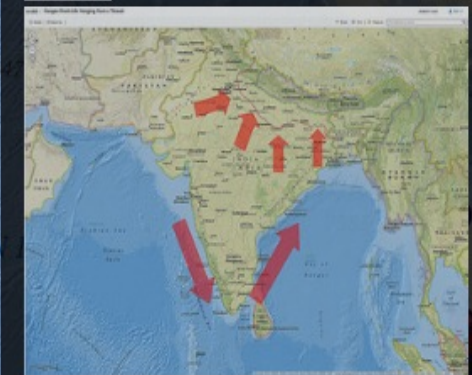
A story map     **SharkGIS**

Shark Maps

There are lots of maps on [ArcGIS Online](#) about sharks. [This map](#), created by Cameron Boehme, details all reported shark-person interactions between 1983 and 2012.

Here are a few other suggested web maps to check out. Why not make your own web map or story map for Shark Week?

Ganges Shark: Life Hanging by a Thread



Shark Protected Areas



A story map



NATURAL RESOURCES DEFENSE COUNCIL

Sonic Sea

Beluga Whale

The Cook Inlet beluga whale is one of the nation's most endangered marine mammals. Long a part of traditional life and culture, it has made its home entirely within the Inlet's icy, turbid waters, apart from all other members of its species.



Beluga Whale Habitat

In the 1990s the population collapsed from excessive hunting. Despite enormous efforts to recover it—including an absolute ban on subsistence hunting until its numbers rebound—it continues to decline. One of the most significant threats facing this vulnerable population is the steady industrialization of the Inlet. In addition to noise from Anchorage shipping, three oil and gas companies have conducted or proposed multiple years of seismic surveys within the beluga's critical habitat, in the Inlet's middle and upper waters, exposing it to high-energy airgun noise throughout most of the year.



A story map



NATURAL RESOURCES DEFENSE COUNCIL

Sonic Sea

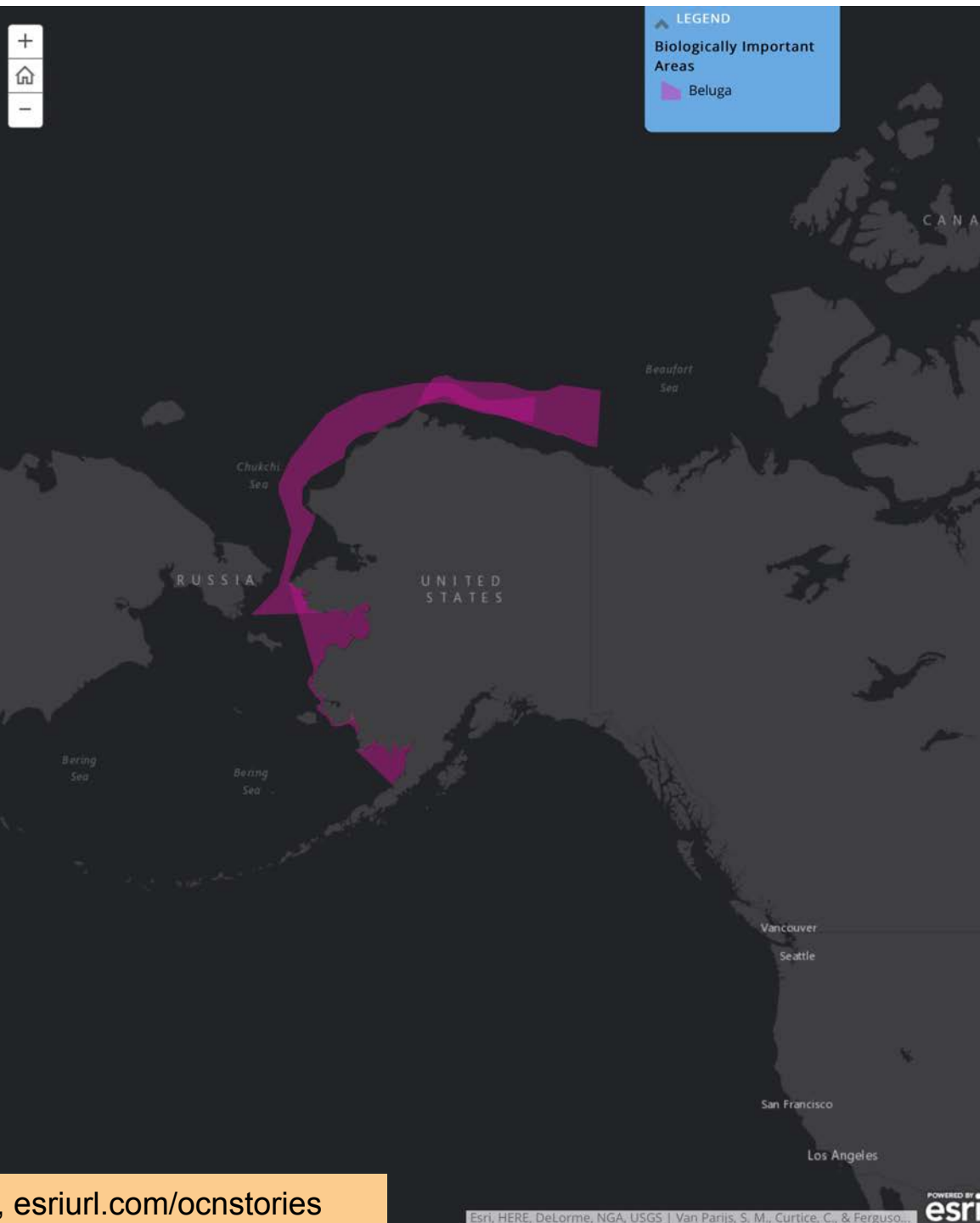
Beluga Whale Habitat

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Arctic Cargo Shipping Density

Action: In 2008, NRDC successfully defended the endangered species listing of Cook Inlet beluga whales, opposing an oil industry and State of Alaska lawsuit. Since then, we have fought the industry's untrammelled use of seismic airguns in the Inlet, challenging surveys in court and negotiating with the government to provide programmatic protection for the whales from the industrialization of their habitat.



A story map



NATURAL RESOURCES DEFENSE COUNCIL

Sonic Sea

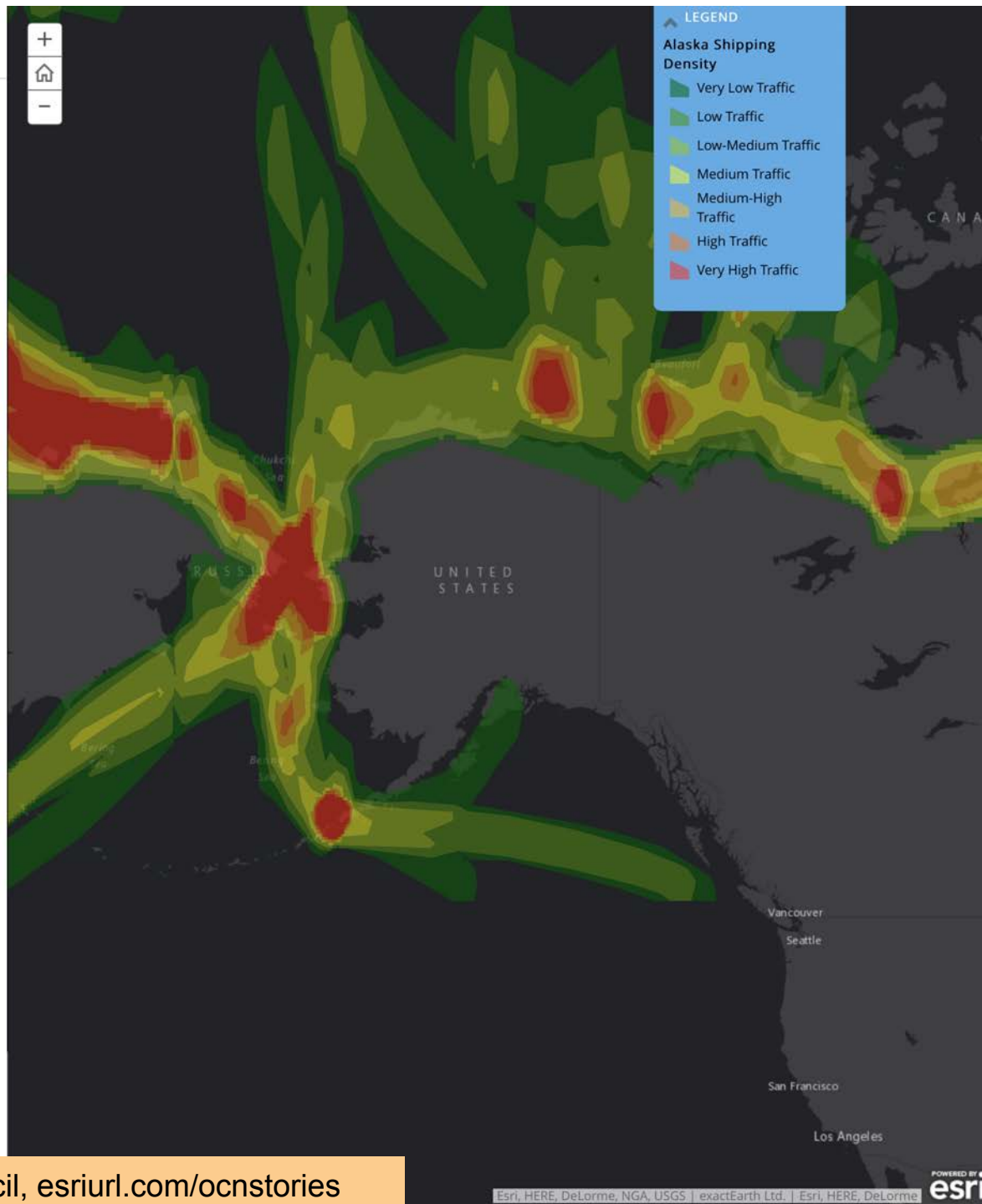
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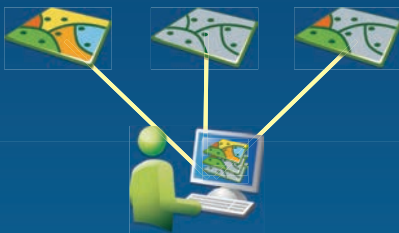


NRDC Campaign

NRDC pioneered work on underwater noise more than twenty years ago, successfully challenging a series of naval explosives trials that would have taken place just outside the newly established Channel Islands National Marine Sanctuary. Since then, we have undertaken a multi-sector campaign to bring this global problem into public awareness and under control. Our litigation has forced major producers of noise such as the U.S. Navy and oil-and-gas industry to seek compliance with federal environmental laws; has protected sensitive marine mammal habitat off California and Hawaii, in the Gulf of Mexico, and elsewhere; and has secured tens of millions of dollars for research. Our lobbying and policy work, in both the U.S. and abroad, is now driving the



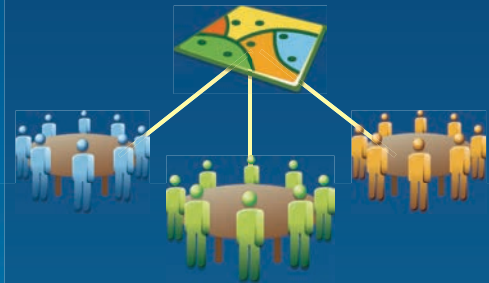
Final Chapter



Consider potential of stories and scientific storytelling via maps, photos, videos, more



Consider implications for education, training, certification?



Consider implications for ocean science contributions to society

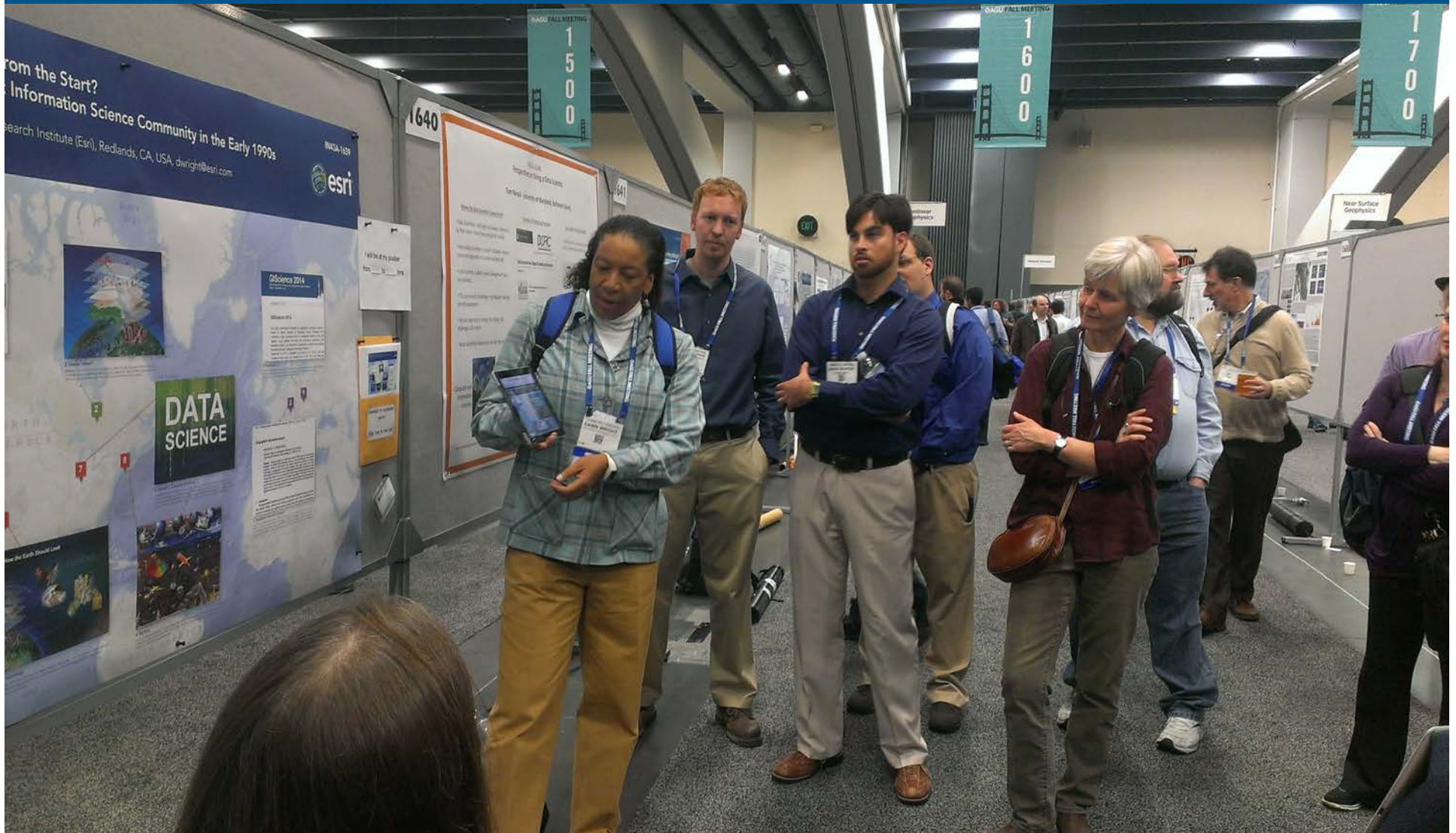
Dawn Wright
dwright@esri.com
@deepseadawn

esriurl.com/scicomm, esriurl.com/ocnstories, esriurl.com/ocnres

Extra Slides



Story map made into a conference poster with interactive version on table for discussion & questions, e.g., esriurl.com/agustories



esriurl.com/analyticalstories

Speaking the "Language" of Spatial Analysis via Story Maps

by Dawn Wright on September 15, 2014

Share 183 Tweet 402 Share 975

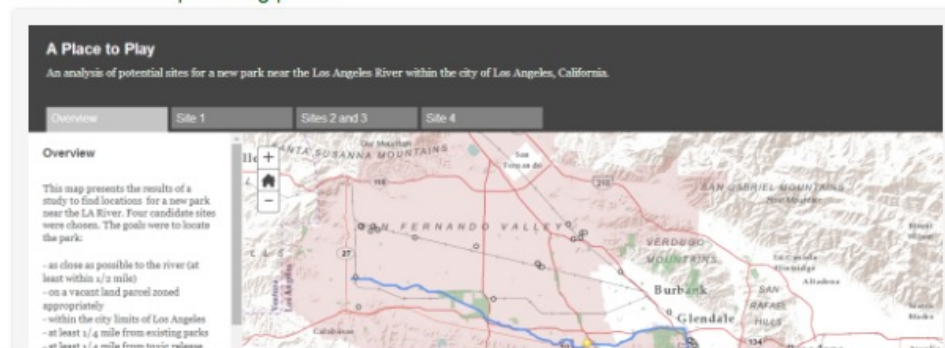
Last update: December 6, 2014

Spatial analysis has always been a hallmark of GIS, the "numerical recipes" which set GIS apart from other forms of computerized visualization and information management. With GIS we pose questions and derive results using a wide array of analytical tools to help us understand and compare places, determine how places are related, find the best locations and paths, detect and quantify patterns, and even to make spatial predictions.

As Chris Cappelli duly notes: *"The greatest potential for change and success occurs when we all understand and speak the same language—the language of spatial analysis."* (see related post on the **power of spatial analysis**). What better way to speak that language than via a story map? As people continue to explore and share their world using the medium of **story maps**, some are venturing beyond the simple map tour mode of points linked to photographs, toward "stories" that examine, explore, and showcase the results of a spatial analysis. **We'll likely see more of these analytical stories as the story map medium is introduced into more GIS courses, particularly at the university level.**

As you explore **the story of spatial analysis** **New!**, please see below a small catalog of analytical story maps. Be sure to visit again as I will try to add to this page throughout the year!

Tim Ormsby's **"Place to Play"** story map uses the **Tabbed Viewer app** (also known as the Text and Legend app) to showcase the results of a site suitability analysis for a new park near the Los Angeles River. See also his **prior blog post**.



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CTO, Esri R&D Center, Washington, D.C.



Brent Roderick

Data Marketing Manager



Bill Meehan

Director, Utility Solutions

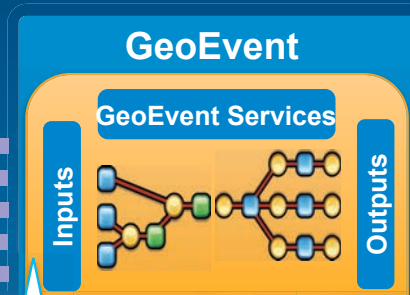


Dawn Wright

Esri Chief Scientist

How do I get real-time data into a GIS?

ArcGIS example: Use an Input Connector



You can create your own connectors.

Esri Out of the Box

- Poll an ArcGIS Server for Features
- Poll an external website for GeoJSON, JSON, or XML
- Features, GeoJSON, JSON, or XML on a REST endpoint
- Receive GeoJSON or JSON on a WebSocket
- Receive RSS
- Receive Text from a TCP or UDP Socket
- Subscribe to external WebSocket for GeoJSON or JSON
- Watch a Folder for new CSV, GeoJSON, or JSON Files

Esri Gallery

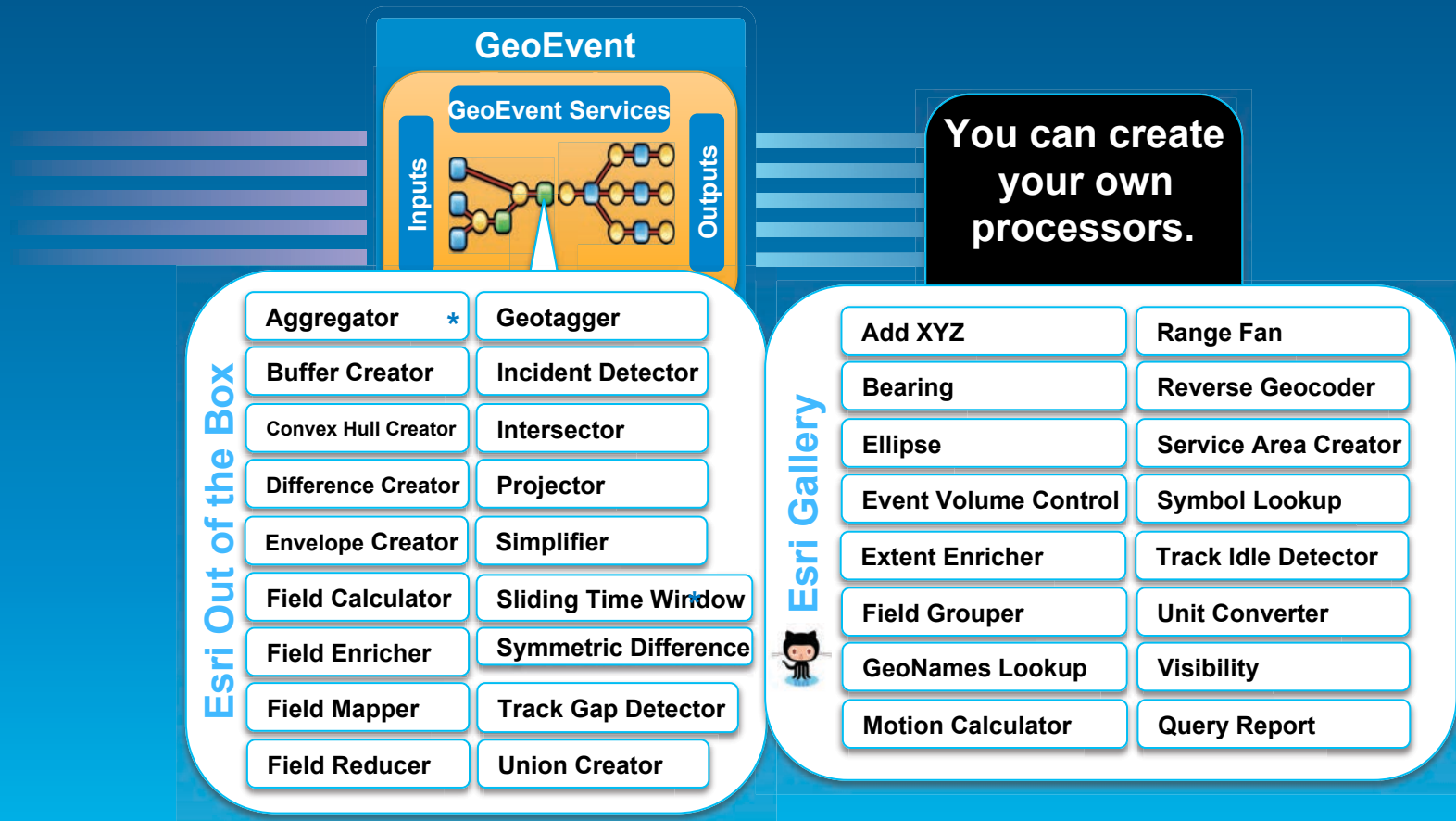
- ActiveMQ
- CAP
- Cursor-on-Target
- Flume *
- Instagram
- KML *
- Kafka *
- MQTT
- NMEA 0183
- RabbitMQ
- Sierra Wireless (RAP)
- Trimble (TAIP)
- Twitter

Partner Gallery

- CompassLDE
- enviroCar
- exactEarth AIS
- FAA (ASDI) *
- GNIP *
- Networkfleet *
- OSIsoft *
- Valarm
- Zonar *

Applying Real-Time Analytics

ArcGIS example: Use a GeoEvent Processor



How do I update and alert those who need it where they need it?

Disseminate notifications, alerts, and updates using an Output Connector



Getting Real-Time Data into Web Applications

Two patterns

- Feature layers **pull** from feature services
 - Web apps poll to get periodic updates
 - Must be backed by an enterprise geodatabase (EGDB)
- Stream layers **subscribe** to stream services
 - Web apps subscribe to immediately receive data
 - Low latency and high throughput

