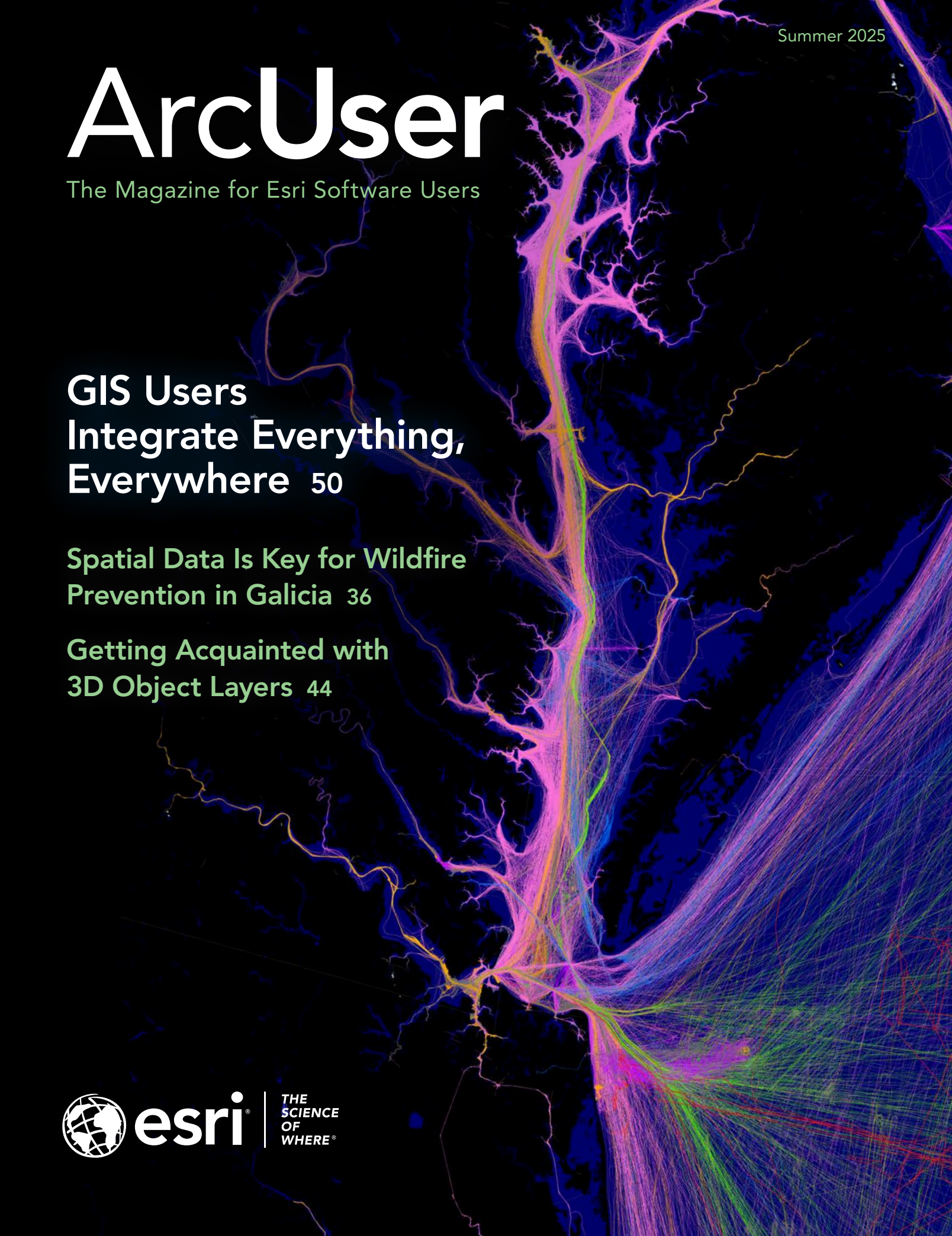
Summer 2025

ArcUser

The Magazine for Esri Software Users



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What It Means for GIS to Integrate Everything, Everywhere

"Integrate" is a powerful word in the world of GIS. It's typically used in reference to data, as in pulling spatial data from various sources, in various formats, for use in a comprehensive dataset. And in ArcGIS Pro, the Integrate tool analyzes the coordinate locations of feature vertices and helps ensure that vertices are connected.

At this year's Esri User Conference (Esri UC), the theme was GIS—Integrating Everything, Everywhere. Like the Integrate tool, this theme was all about cohesion and connection. Plenty of the presentations at the Plenary Session and during the rest of the week were about data management. But the conference itself is predicated on the idea that people are more organized and effective when we come together and collaborate, when we can network and share ideas that make our communities better. That's exactly what attendees were there to do.

Many of the articles in the summer 2025 issue of *ArcUser* follow this thread. Understanding how to migrate your data from ArcGIS Online into an enterprise geodatabase, learning tips to make your dashboards more effective and aesthetically pleasing, better understanding the ins and outs of 3D object layers—these are all ways to make your data work better for you.

Stories featured in this issue also highlight the ways GIS professionals are making their work more collaborative, data driven, and integrated. The Massachusetts Housing Partnership, a public nonprofit, is using housing data to help tamp down out-of-control housing prices and zoning laws across the state. In Oman, network management is a critical element for Oman Broadband's mission to deliver high-speed, affordable internet to the whole country. Communities in Indiana that are required to replace lead service lines are pooling their GIS resources to make their drinking water safer. The US National Park Service is developing new ways to integrate fossil data from regional parks into its national databases. And in the Spanish region of Galicia, spatial data is an essential part of wildfire mitigation as these disastrous events become more frequent near developed areas.

The common denominator is collaboration. When organizations work together to solve problems, when their data is organized, easily communicable, and freely shared, issues that at first glance might seem insurmountable become more manageable. Those who came together at Esri UC 2025 saw just that—that GIS makes the world easier to understand, more collaborative, and more integrated.

Ben Van Voorhis
ArcUser Editor

ArcUser

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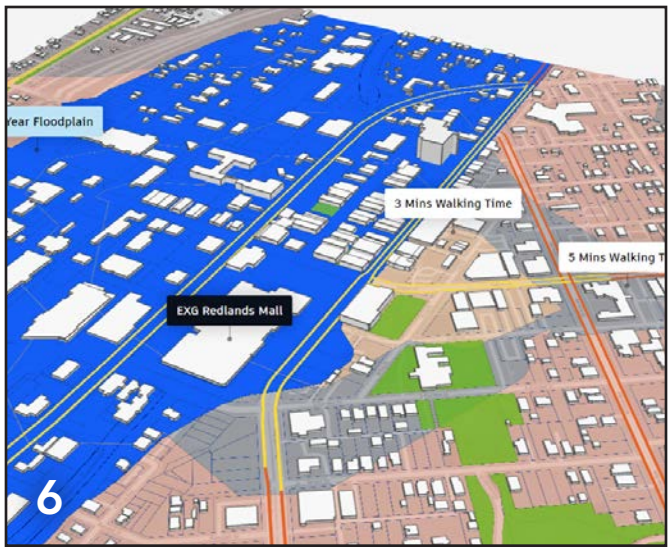
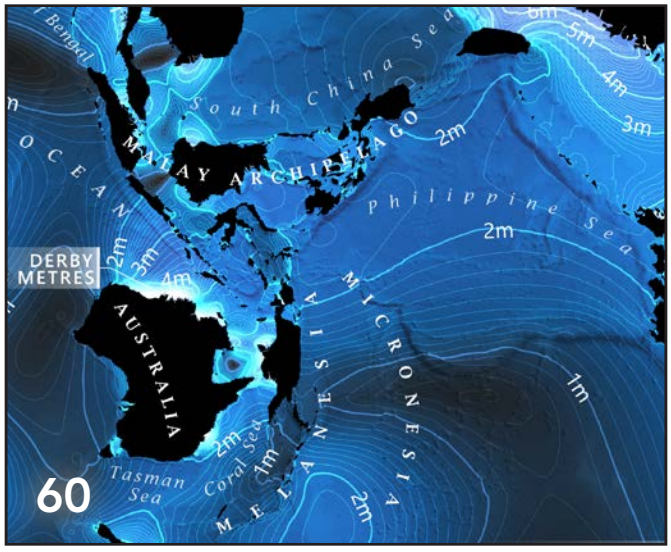
Departments



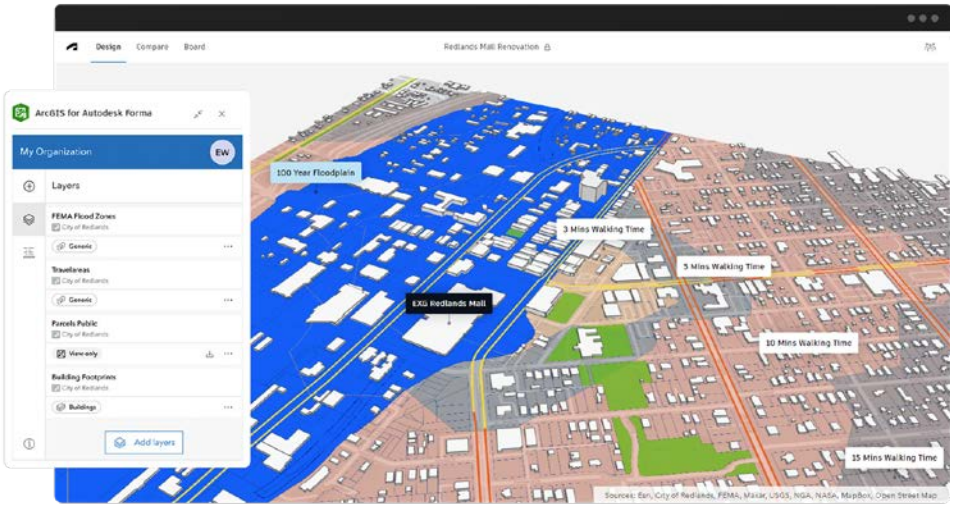


Briefly Noted

→ Introducing ArcGIS for Autodesk Forma

In June 2025, Esri released ArcGIS for Autodesk Forma. Developed in partnership with Autodesk, this app allows users to integrate authoritative data from ArcGIS into Autodesk Forma, providing a way for architecture, engineering, construction, and operations (AECO) professionals to transform their planning and pre-design work with geographic context. ArcGIS for Autodesk Forma allows for a more seamless collaboration between ArcGIS and Autodesk, enabling users to work within a single design environment without switching between platforms.

ArcGIS for Autodesk Forma will serve as an Autodesk extension, incorporating geographic data and geospatial services that enable greater analytics and insights into Autodesk offerings. With ArcGIS as a key part of design and construction, AECO professionals will have a deeper, more holistic understanding of projects connected to the social, built, and natural worlds. This new application elevates every design with ArcGIS content, including ArcGIS basemaps and select data layers from ArcGIS Living Atlas of the World.



↑ ArcGIS for Autodesk Forma integrates with Forma's cloud platform, allowing organizations to connect their authoritative ArcGIS data directly into Autodesk Forma designs.

To learn more about ArcGIS for Autodesk Forma, visit links.esri.com/forma.

→ Communicating the State of US Infrastructure

The American Society of Civil Engineers (ASCE) partnered with Esri to present the findings of the ASCE's 2025 *Report Card for America's Infrastructure*, using ArcGIS StoryMaps. Published every four years, the report card serves as a comprehensive evaluation of US infrastructure, using the familiar A through F school grading scale to indicate how well each sector operates for the public. Beyond the grades, the report provides key information on opportunities, challenges, and performance.

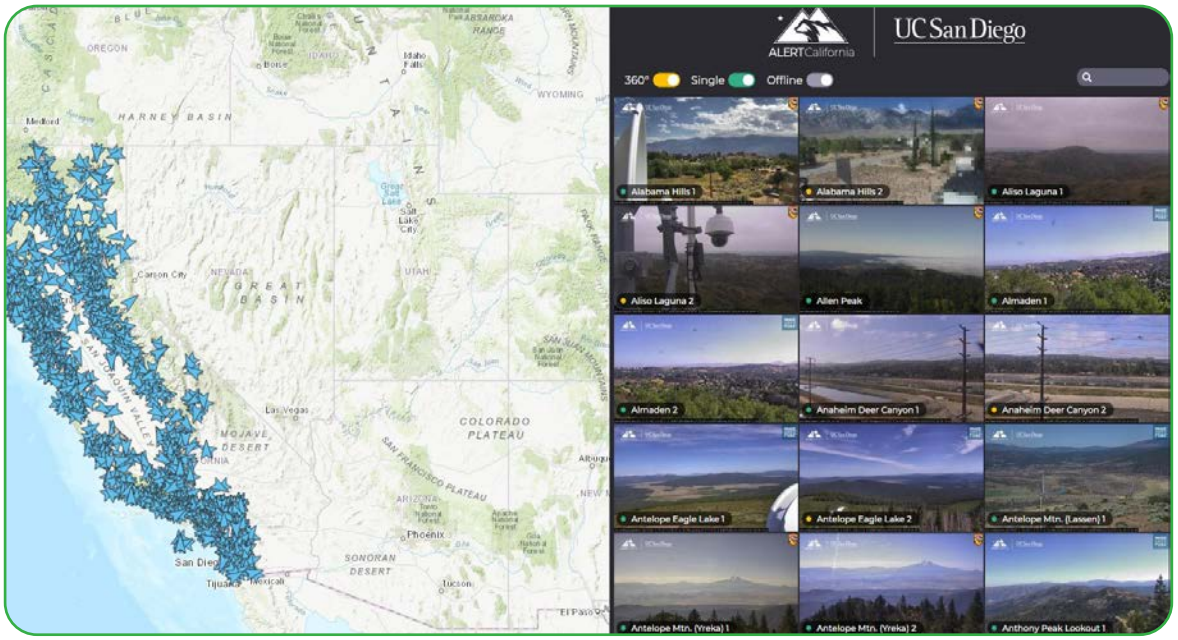
Federal, state, and local government agencies rely on the *Report Card for America's Infrastructure* as an essential planning resource. Officials at all levels use the report to prioritize infrastructure projects that impact the communities they serve. Because reports have life spans of four years and infrastructure is constantly changing, the dynamic flexibility of ArcGIS StoryMaps makes it ideal for providing incremental data between releases.

Explore the story about the 2025 *Report Card for America's Infrastructure* at links.esri.com/2025-report.

→ Better Awareness of Wildfires and Other Disasters

The University of California, San Diego's ALERTCalifornia program and Esri have launched a new map layer in ArcGIS Living Atlas of the World that provides instant access to live camera feeds across California. This collaboration comes at a critical time, as the state faces increasingly frequent and severe natural hazards, particularly wildfires, that threaten public safety, environmental health, and economic stability.

This freely available layer provides access to more than 1,150 high-definition, pan-tilt-zoom cameras and sensor arrays within ALERTCalifornia's growing network. The layer shows each camera's location, real-time viewshed, and current image. Organizations can add the ALERTCalifornia feeds into their own maps and dashboards, directly within ArcGIS. The strategically placed cameras provide continuous real-time imagery updated every 15 seconds.

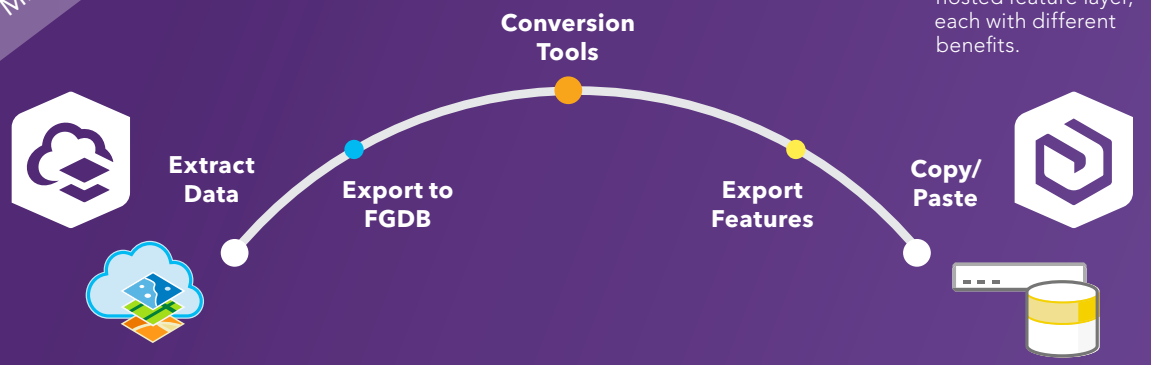


↓ The ALERTCalifornia map and camera feeds are a valuable resource for the preparation for, response to, and recovery from various natural disasters.

Emergency managers and first responders can use the new ALERTCalifornia layer directly in their ArcGIS applications to get real-time situational awareness. This enables users to access critical data when they need it most, helping them monitor and respond to natural disasters more effectively. The layer can be used with a variety of ArcGIS applications and maps, ensuring that the data is not only available but also actionable.

Learn more about the latest updates and how to use the ALERTCalifornia Live Cameras layer, visit its ArcGIS Living Atlas page at links.esri.com/alert.

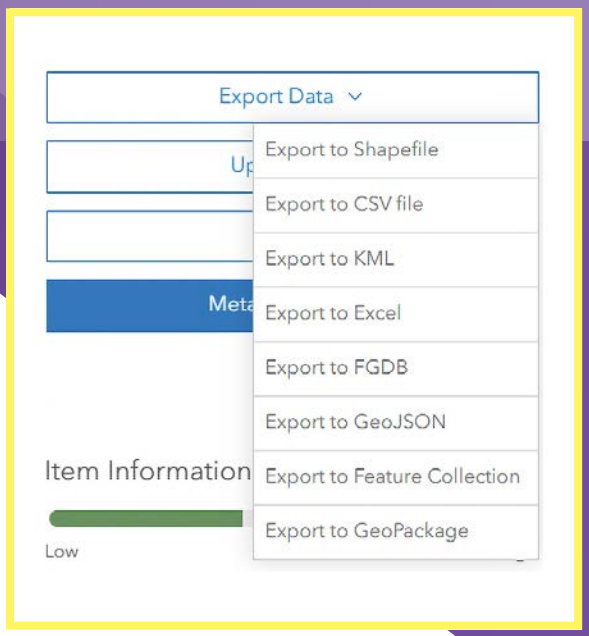
By Mike Jensen and Diana Muresan

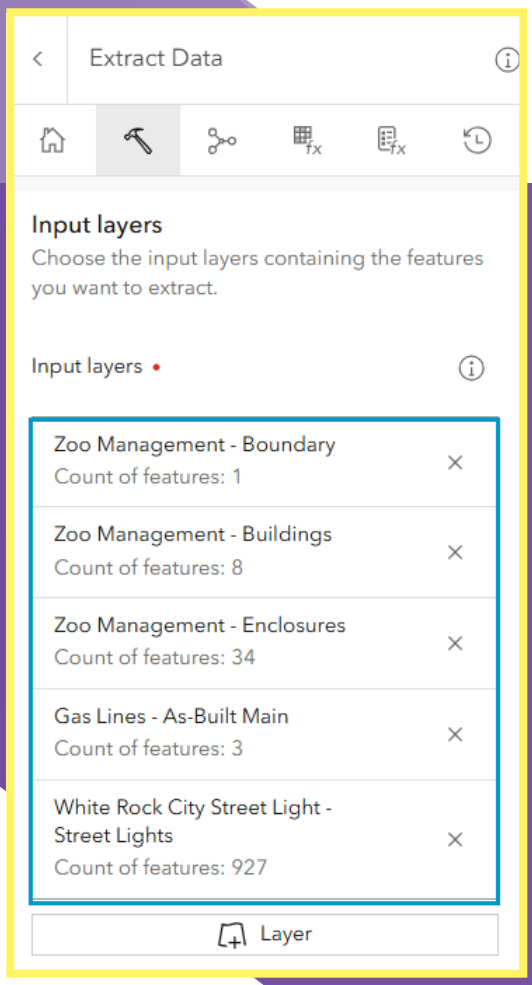


↙ There are multiple options to export data from a hosted feature layer, each with different benefits.

Migrating Your Data from ArcGIS Online to an Enterprise Geodatabase

In today's data-driven world, organizations are looking to optimize their geospatial data management workflows. Migrating data from ArcGIS Online to an enterprise geodatabase can be a transformative step that provides numerous benefits. For example, with enterprise geodatabases, you can take advantage of functionality that is unique to an enterprise geodatabase, such as versioning. Versioning allows multiple users to edit data simultaneously, in isolation from one another, with the option to review any conflicts. This helps organizations with many editors more effectively manage updates to their most critical GIS datasets.





←← Access the Export Data option from ArcGIS Online from the item page.

← The Extract Data tool can pull from multiple layers with different sources.

Regardless of the motivations for migrating your data, having a good understanding of the available options is crucial to avoiding potential complications.

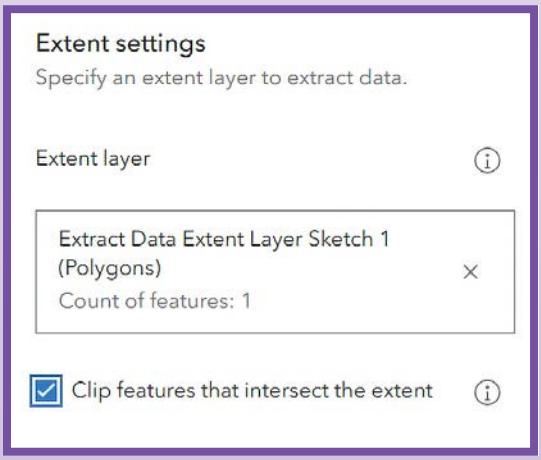
However, there are a few prerequisites to begin the migration process. First, you must own the features associated with your ArcGIS Online login or be an administrator, or the owner or administrator must configure the layer to allow others to export data. Second, you must determine what format to use when exporting data. There are multiple options with different benefits and drawbacks. You will also need an enterprise geodatabase connection with a database user who has permissions to add data.

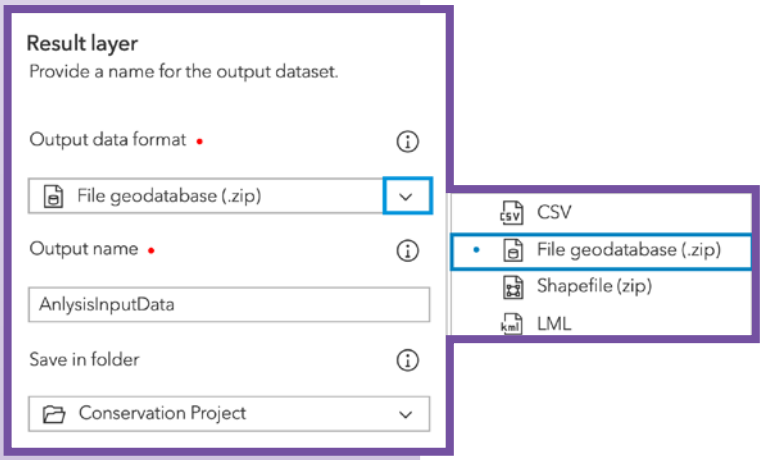
Export Data from ArcGIS Online

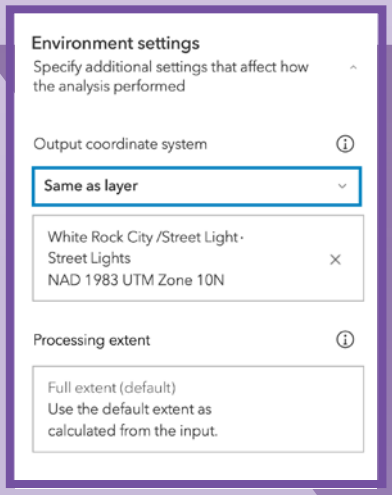
The Export Data menu is the primary option to download data from ArcGIS Online. This tool generates an item within your content in ArcGIS Online that encompasses the data from the selected layers in different formats. You can then download the data from that item to be used in ArcGIS Pro, Microsoft Excel, and elsewhere. The tool can be accessed from the item page when you want to download the full dataset.

There are multiple output formats to choose from. Depending on your workflow, you might choose one output format over the other.

- Use Export to Shapefile when most of your workflows are performed in ArcMap.
- Use Export to CSV file or Export to Microsoft Excel when you want to use the data in a tabular format or for data analysis. When you export point features to these formats, all attribute fields, and the x,y coordinates of each point, are exported. When exporting lines or polygons, only nonspatial attributes are extracted.
- Export to KML ensures you can use the data in ArcGIS Earth and Google Earth.
- Export to FGDB (file geodatabase) provides the most comprehensive export method. This is because it includes all the functionality applied at the feature class level, such as attribute domains, subtypes, contingent values, and attachments.
- Use Export to GeoJSON for the open data format that supports a seamless integration with JavaScript frameworks for exchanging and visualizing geospatial data on the web.
- Export to Feature Collection items are a subset of feature layers with focused and limited functionality.
- Use Export to GeoPackage when your analysis spans ArcGIS products and includes open data source software.







↑ You can specify an extent to extract data with the Extract Data tool.

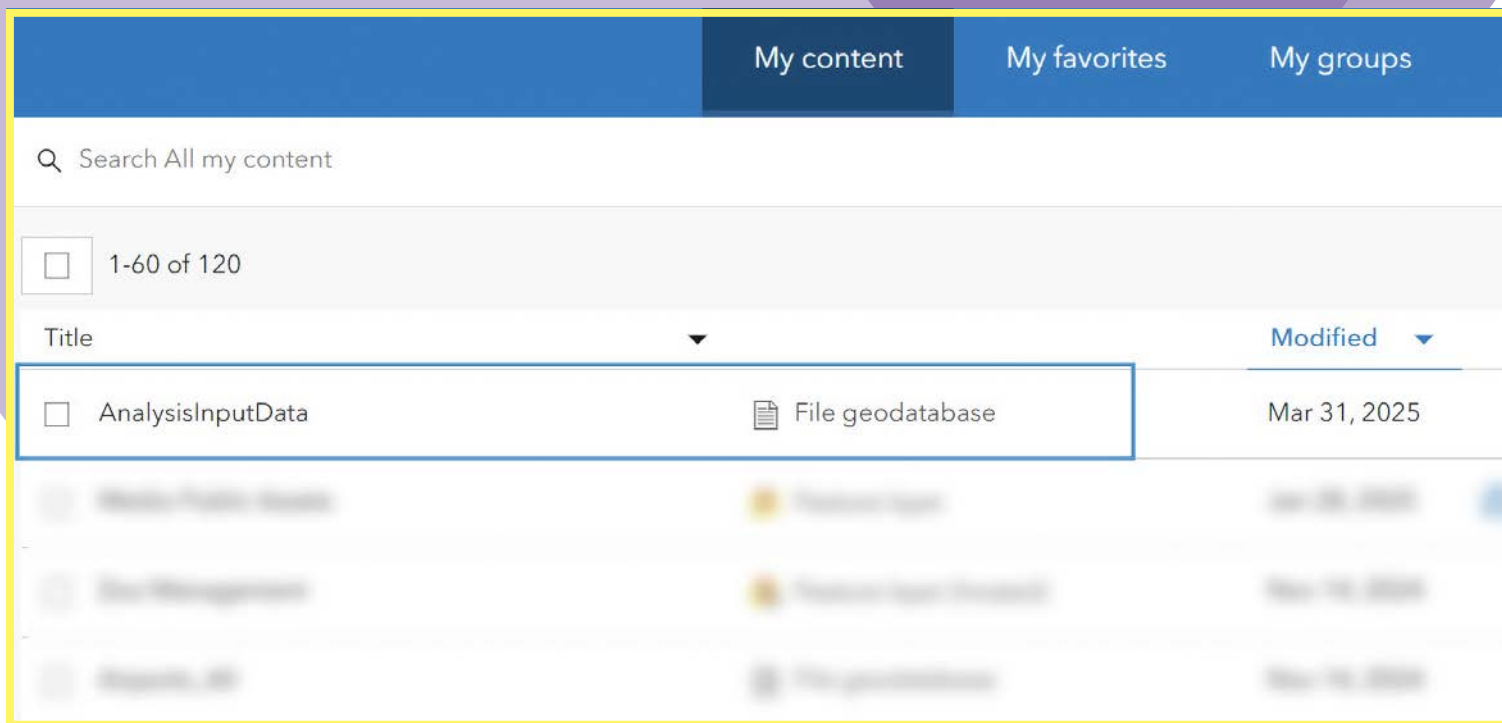
↗ With the Extract Data tool, you can name the output file and select the output folder.

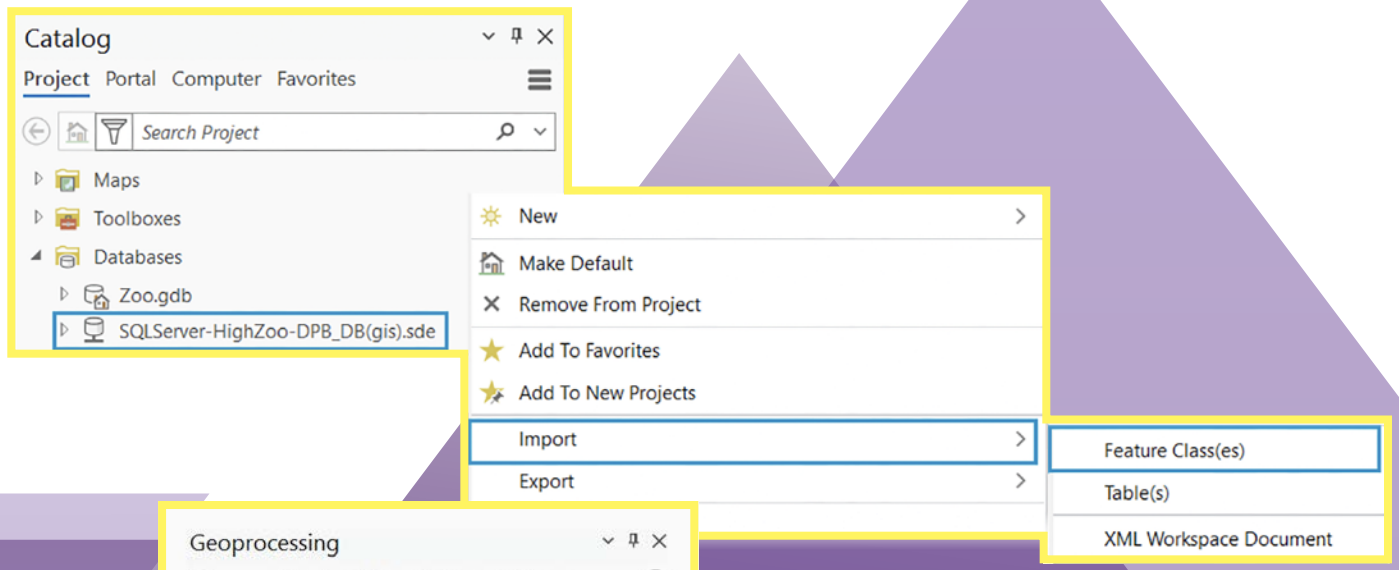
→ The Environment settings pane allows you to define the output coordinate system and the processing extent.

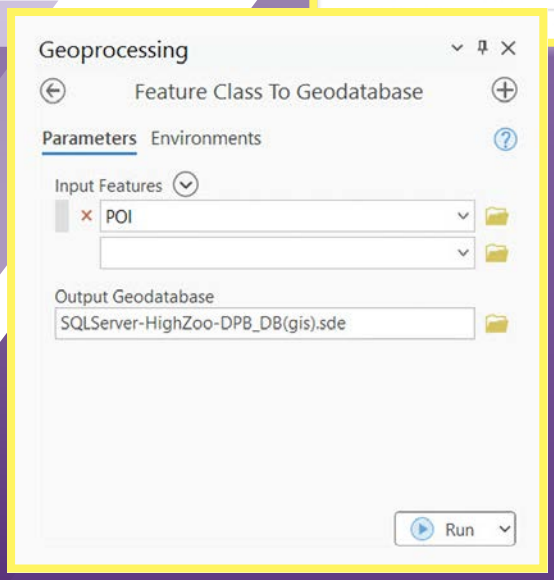
Alternately, you can access your data in Map Viewer using the Extract Data tool. This tool is located on the Analysis tab, and allows for more customization than the Export Data option on the item page.

Using the Extract Data tool, you can extract data from multiple web layers from different sources as input. You can also specify an extent to extract data, with the option to clip features based on that extent.

The Extract Data tool also comes with the ability to name the output file—which can only be a file geodatabase, .csv file,



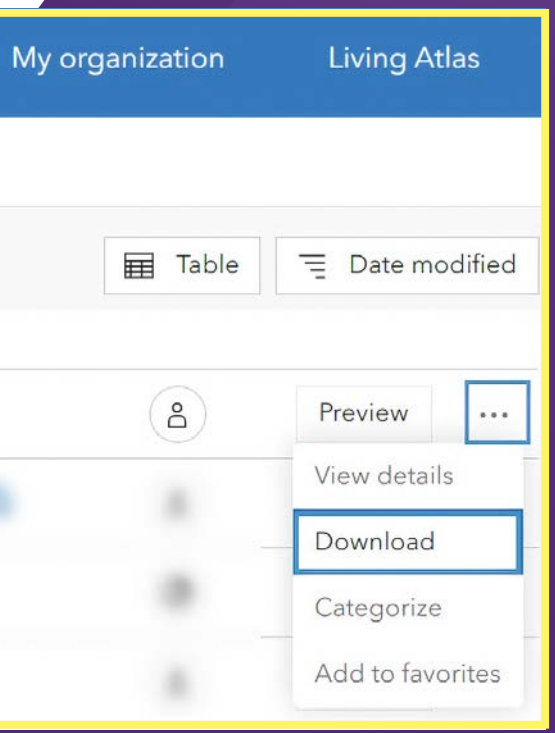




↑ The path to import a feature class to an enterprise geodatabase.

← Use the Feature Class to Geodatabase geoprocessing tool to import a feature class.

↙ The download option for the resultant file geodatabase.



shapefile, or .kml file—and select the output folder. The Environment settings pane allows you to define the output coordinate system and the processing extent.

If the web layer you want to export doesn't have the export option, ensure the Allow others to export to different formats option is checked.

Your output will be a hosted item containing a downloadable .csv file, file geodatabase, .kml file, or shapefile. You will then need to use the layer options to download the file locally before the data can be migrated to an enterprise geodatabase.

Import or Export Data from ArcGIS Online Using ArcGIS Pro

When accessing hosted feature layers in ArcGIS Pro, there are options available to import or export the data directly into an enterprise geodatabase.

First, it is necessary to connect to your ArcGIS Online account. You must be the owner of the data, or an administrator. If you are not the data owner or administrator, those users will need to share the dataset with you and configure the dataset to allow others to export the data. Sign in on the upper right corner of the ArcGIS Pro project.

To migrate the feature layer to an enterprise geodatabase, select your enterprise connection in the Catalog pane.

Click Import, then select Feature Class(es). The Feature Class To Geodatabase geoprocessing tool will open.

Note that choosing the Export option would also use the Feature Class To Geodatabase geoprocessing tool. A benefit of using Import is that it automatically populates the output enterprise geodatabase. Verify that the enterprise geodatabase connection is set for the data owner.

On the Feature Class To Geodatabase geoprocessing tool, select the browse button on the Input Features parameter. Select feature layers from ArcGIS Online or from a location downloaded from ArcGIS Online. You may need to extract the data first if the download is a .zip file.

Verify the output geodatabase connection and environment settings before running the geoprocessing tool. For example, double-check the following options on the Environments tab:

- Preserve Global IDs
- Transfer Geodatabase Field Properties
- Import a subset of the data using the Extent environment

Export Features Option

Another way to migrate your data from ArcGIS Online to an enterprise geodatabase is within an active map in ArcGIS Pro. After adding the desired hosted web feature layer to the map, access the Export Features tool from the layer's right-click context menu or from the Data tab on the ribbon. The output parameter can be set to convert the layer to a feature class directly in your enterprise geodatabase.

The tool allows for a single layer input, but you can customize it in several ways. Use it to define a SQL expression to select a subset of features; add, remove, reorder, and rename fields in the output feature class; or change field data type and merge field values into a single field.

Finally, using the Environments tab, you can define a new coordinate system and preserve certain geodatabase functionalities such as the following:

- Maintain Attachments
- Preserve Global IDs
- Maintain fully qualified field names
- Transfer field domain descriptions

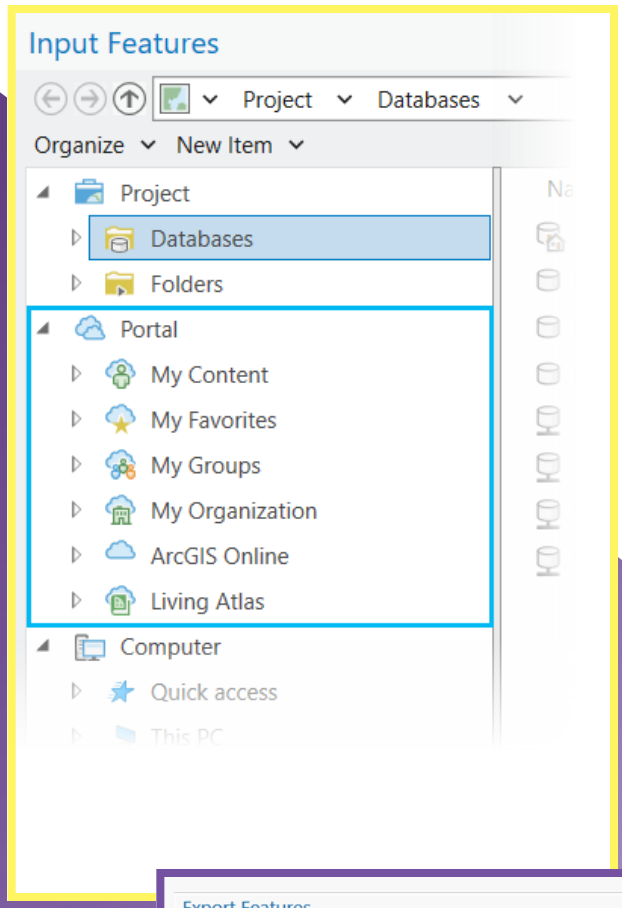
Note that you can also choose Export Table to export to a stand-alone table.

Sometimes the Export Features option will be grayed out on the web feature layer. Selecting Export Data avoids this situation. If you are a publisher in your organization and use ArcGIS Pro to share data with ArcGIS Online, enable the Export Data option during the publishing process. This controls whether a user other than the portal administrator or data owner can export the features from a web feature layer.

If you are not a publisher of the hosted layer or an administrator making changes to the existing web layer, try importing or exporting the data.

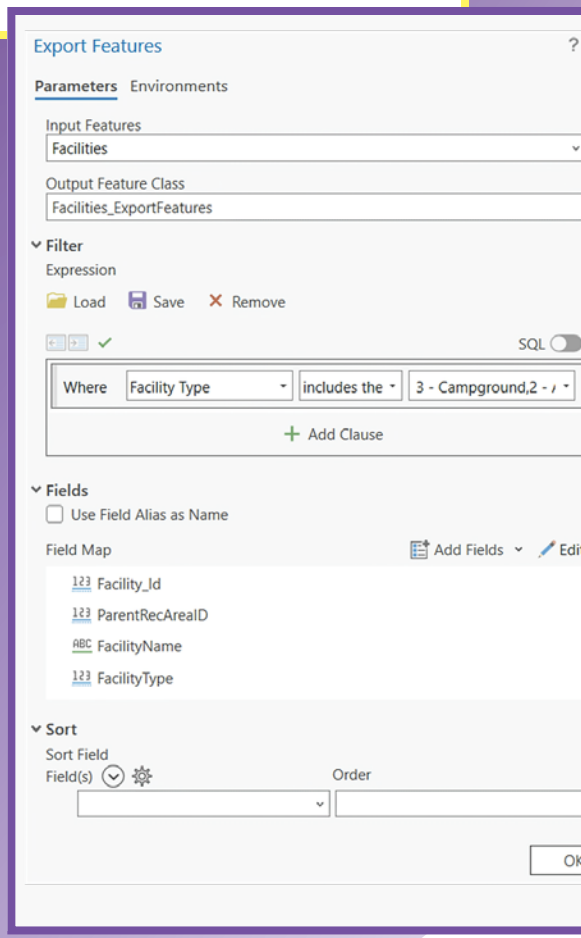
Download Data from ArcGIS Online Using ArcGIS API for Python

If you are a developer looking to eliminate manual steps or work with large volumes of data, you can download a copy of all your hosted web layers using ArcGIS API for Python. To extract data from one or more layers within a given extent, use the extract_data method. The extracted data format can be a file geodatabase, shapefiles, .csv, or .kml. Download and extract data with .zip files (such as File geodatabases and shapefiles) prior to using this method.



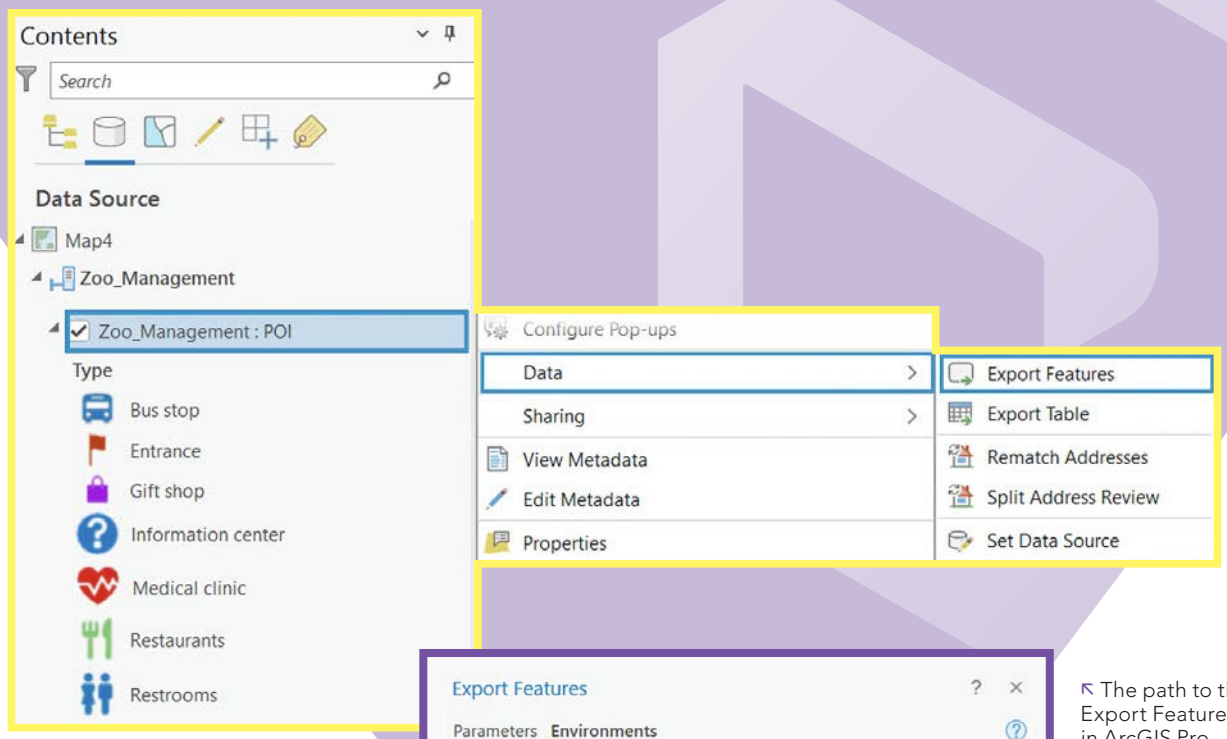
↗ The path to connect to portal content from ArcGIS Pro.

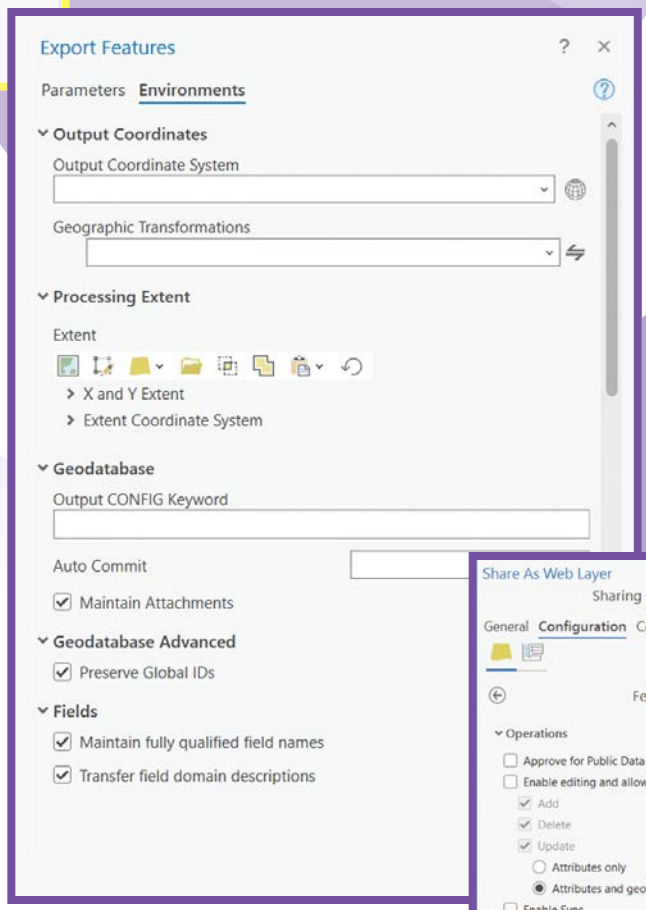
↘ The Export Features geoprocessing tool allows for a single layer input with a variety of customization.

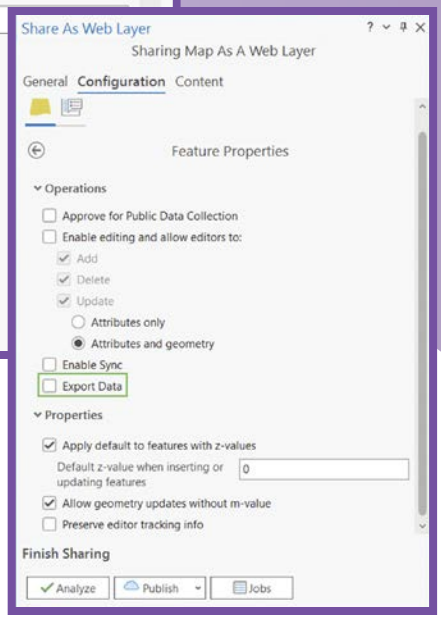


Downloading Services with Attachments

Downloading large feature services with attachments using the REST API can be challenging due to file size limitations. However, you can manage this by splitting the data into smaller batches. You can export subsets of the feature service data with attachments to a replica from a REST endpoint. Access this method from the View Details page. The Feature Service link opens the ArcGIS REST Services Directory page. A WHERE clause can be set to create a subset replica to an output URL. Once the replica creation is complete, download the .zip file and reference the data to migrate to your enterprise geodatabase.







↖ The path to the Export Features option in ArcGIS Pro.

← On the Environments tab, you can define a new coordinate system and preserve geodatabase functionality.

↓ The Environment settings pane allows you to define the output coordinate system and the processing extent.

When migrating data from ArcGIS Online to an enterprise geodatabase, there are multiple options to suit various workflow needs. Whether you are using the Export Data menu in ArcGIS Online, tools such as Feature Class To Geodatabase within ArcGIS Pro, or ArcGIS API for Python for large volumes of data, understanding and using these diverse options ensures that your organization can benefit from a seamless migration process and enhances your geospatial data management capabilities.

About the Authors

Mike Jensen loves to enhance the customer experience of Esri software and has many opportunities to do so as a product engineer on the geodatabase team at Esri. In addition to his GIS career, he loves to tinker with tech gadgets, beat on the drums, bake pies and brownies, tell and snicker at dad jokes, and enjoy quiet time in the country with family and friends.

Diana Muresan is a product engineer on the geodatabase team at Esri. Muresan is passionate about making a difference in people's lives using GIS. She is also a hiker and a true éclair and crepe lover in her free time.

Understanding the Mobile Operations and Offline Data Management System Pattern

The ArcGIS Well-Architected Framework provides IT and GIS professionals with a comprehensive set of ArcGIS system patterns to assist in designing an ArcGIS deployment tailored to an organization's needs.

In an increasingly mobile world, the ability to manage data effectively in both connected and disconnected environments is essential for organizations across various sectors. The mobile operations and offline data management system pattern not only provides a robust framework for delivering uninterrupted data access, it also empowers organizations with a comprehensive suite of online and offline mobile usage scenarios.

This system pattern facilitates a wide spectrum of functionality—including field data collection, editing, and operational tasks—through native applications, mobile databases, and advanced web-based data synchronization technology. Mobile users can also leverage offline data and maps on native devices for read-only or reference data workflows. By integrating these features, the mobile operations and offline data management system pattern can be a cornerstone for organizations seeking to optimize their data management strategies and elevate their operational capabilities.

There are several key benefits to designing and building a system based on this system pattern:

- **Enhanced Data Accessibility:** Users can access and update data in real time, regardless of their connectivity status, leading to improved decision-making and operational efficiency.
- **Increased Productivity:** By enabling mobile workers to perform tasks offline, organizations can reduce downtime and ensure that operations continue smoothly, even in challenging environments.
- **Improved Data Accuracy:** With the ability to synchronize data once connectivity is restored, organizations can maintain accurate and up-to-date information, reducing errors and enhancing data integrity.

Real Use Cases and Industries

Many industries can take advantage of the mobile operations and offline data management system pattern.

In the utility sector, mobile operations and offline data management systems empower mobile workers to perform essential tasks such as asset inspections, maintenance, and service requests. For example, utility crews can access real-time data on infrastructure, update work orders, and synchronize changes once they regain connectivity, ensuring efficient operations and improved service delivery.

Transportation companies utilize mobile data management systems to track shipments, manage inventory, and optimize routes. With offline capabilities, drivers can access critical information, log deliveries, and report issues without relying on constant internet access, enhancing operational efficiency and customer satisfaction.

Emergency response teams benefit from mobile operations systems that allow them to access critical information in real time, even in remote areas with limited connectivity. Firefighters, paramedics, and police can view maps, access incident reports, and communicate with command centers, ensuring a coordinated and effective response to emergencies.

Deployment Patterns

When deploying mobile operations and offline data management systems, organizations have a range of deployment patterns to choose from, each of which suits different needs. These deployment patterns include software as a service (SaaS), Windows/Linux, and Kubernetes. However, not all system pattern capabilities are available for each deployment option.

- **The SaaS deployment** offers a cloud-based solution that provides organizations with a streamlined approach to hosting their mobile operations systems. This deployment pattern is ideal for organizations that seek a quick time-to-market solution and prefer standardized systems and solutions.
- **The Windows/Linux deployment** offers the flexibility to host the system on local servers. This deployment pattern caters to organizations with stringent data security requirements or those operating in regulated industries.
- **The Kubernetes deployment** represents a hybrid approach, combining the benefits of both cloud and on-premises solutions. This deployment pattern allows organizations to store sensitive data on premises while leveraging the scalability and accessibility of the cloud environment. It is particularly beneficial for organizations heavily invested in Kubernetes-based deployments.

The mobile operations and offline data management system pattern is a vital framework for organizations seeking to enhance their data management capabilities in a mobile-first world. By leveraging various deployment options and real-world applications, organizations can improve operational efficiency; increase productivity; and ensure that critical data is always accessible, regardless of connectivity. This system pattern will empower organizations to navigate the complexities of modern data management and drive innovation in their operations.

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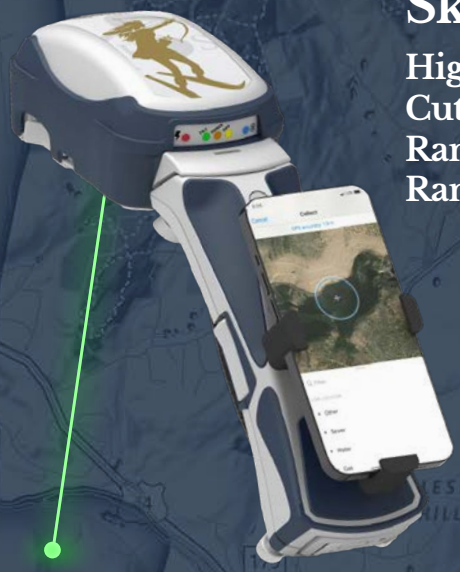

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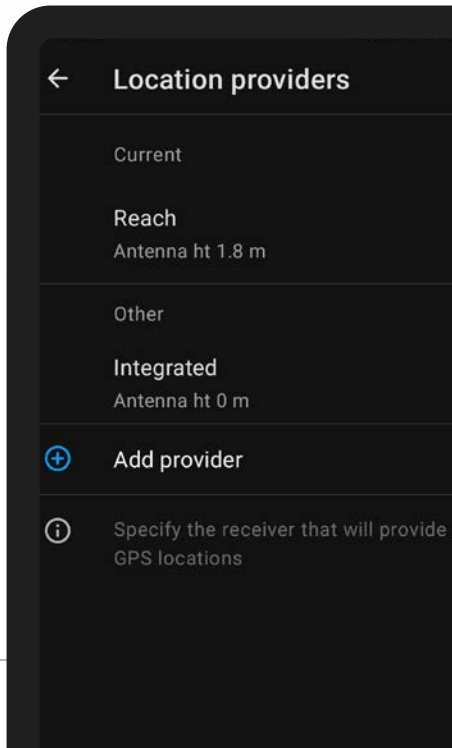
ESCAMBIA COUNTY SAFEGUARDS THE WILDLIFE OF FLORIDA'S COASTLINE

By Sam Pepple

Sea turtles and beach mice might not look like frontline defenders of Florida's coast, but for Kindall Butler, an environmental specialist for Escambia County, they are precisely that. To protect these species and the delicate ecosystems they support, the team she coleads monitors over 12 miles of beaches. The team uses high-accuracy GNSS technologies such as Reach RS2+ and Reach RX receivers from Esri partner Emlid alongside GIS tools like ArcGIS Survey123, ArcGIS Field Maps, and ArcGIS Pro.



↓→ ArcGIS Field Maps connects easily to the Reach receiver.

Before adopting modern GIS and GNSS solutions, monitoring sea turtle nests for Escambia County was a labor-intensive process involving manual tape measurements and phone GPS, often accurate only within 15 feet. In the storm-prone Gulf Coast, that margin for error made post-storm nest recovery nearly impossible.

"If we lose a nest because of a hurricane or overwash and we lose our stakes, we still need to be able to find where it was," Butler said. "Having that accurate point is crucial."

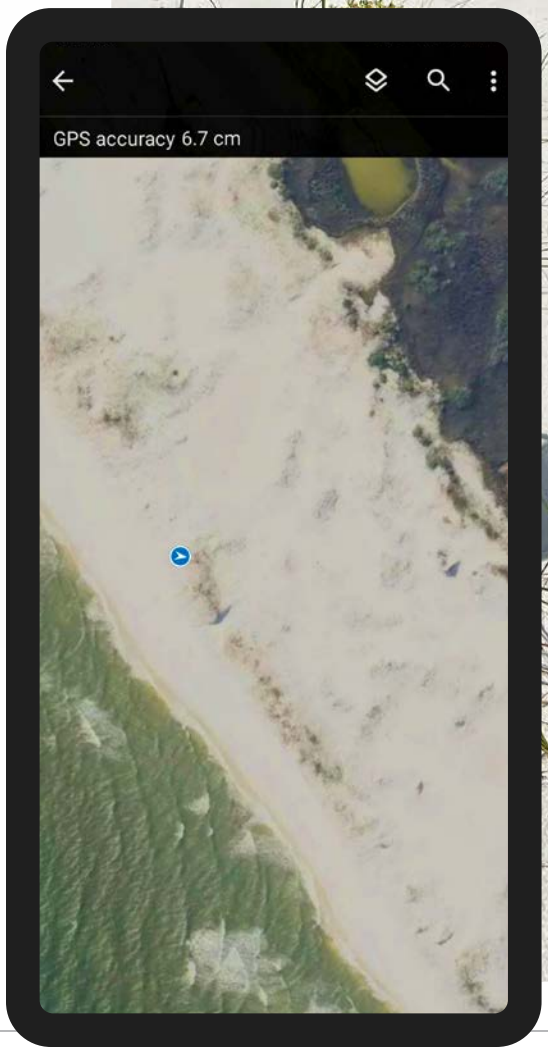
Now, Butler's team can get one-foot-accuracy data. This solution enables the reliable pinpointing of nests and streamlines the team's workflow. Along with improving data precision and efficiency, Escambia County's new setup ensures that staff can respond faster and with greater confidence, even after storms disrupt physical markers.

Smart Conservation and Time Savings

When volunteers see turtle activity on the beach, they log the information in an ArcGIS Survey123 form. This alerts Butler's team to the rough location of the nest. With this, the team can validate the presence of nesting activity and capture the coordinates with the Emlid Reach RS2+ or Reach RX receiver and ArcGIS Field Maps.

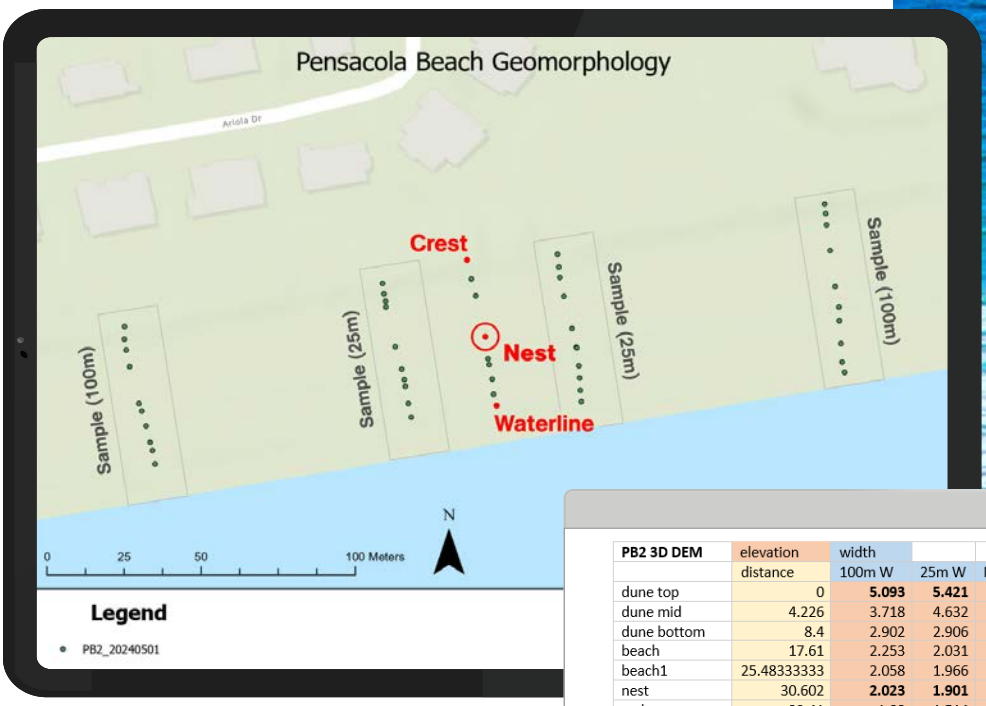
To achieve high-accuracy data, the Reach receivers are connected to a Networked Transport of RTCM via Internet Protocol

↓ Butler's team monitors sea turtles with Reach RX and ArcGIS Field Maps.

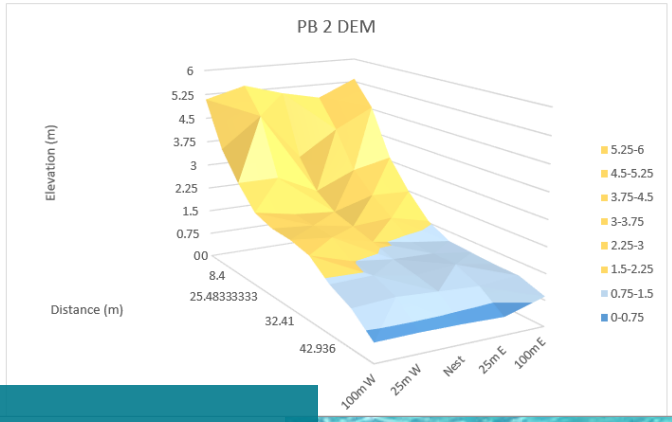


(NTRIP) service to get real-time kinematic (RTK) GNSS corrections. The receivers can then be connected to ArcGIS on an iPhone, which is used as a data collector. The Reach RX is connected with ArcGIS Field Maps via Bluetooth, while the Reach RS2+ connects over the TCP server.

This high-accuracy workflow saves a significant amount of time for the nest-recording and -locating portions of the work. For nest recording, the team previously needed two people to use tape measures, taking about 20 minutes for each nest. With the GNSS workflow, only one person needs to walk to the site and, within seconds, save the measurements digitally.



PB2 3D DEM	elevation	width				
	distance	100m W	25m W	Nest	25m E	100m E
dune top	0	**5.093**	**5.421**	**5.075**	**4.819**	**5.347**
dune mid	4.226	3.718	4.632	3.193	3.96	4.56
dune bottom	8.4	2.902	2.906	2.332	2.847	3.108
beach	17.61	2.253	2.031	1.929	2.281	2.239
beach1	25.48333333	2.058	1.966	1.753	1.835	1.553
nest	30.602	**2.023**	**1.901**	**1.577**	**1.372**	**1.209**
rack	32.41	1.88	1.514	1.365	1.333	1.163
RHTL	38.88	1.398	1.434	1.245	1.325	1.117
water	42.936	1.099	1.176	1.102	1.034	1.108
water1	46.688	0.564	0.576	0.558	0.515	0.854



The one-foot data accuracy for nest locating also means a much shorter period of digging to find each nest. Before, members of Butler's team might hand-dig large holes for hours, only to come up empty-handed. "No one wants to be digging in a 15-foot radius when you could be in a 1-foot radius," Butler said.

The precise location data feeds directly into the team's nesting site suitability analysis using ArcGIS Pro. Starting at the nest location, staff measure elevation points along a line from the dune crest to the waterline. Team members then compare these elevation profiles to adjacent beach sample profiles without nests, first 25 meters away and then 100 meters away.

"If we find that turtles only nest at certain elevations, we can advocate for policies to maintain those elevations and create protected zones," Butler explained.

This early-stage research is part of a broader effort in Escambia County to influence land-use policy and coastal development in ways that benefit both wildlife and residents.

As a result, the conservation work doesn't stop with turtles. The Escambia County team also uses Reach RS2+ and ArcGIS Survey123 to monitor the endangered beach mouse population. Elevation data helps pinpoint potential high-ground refuge areas, which are critical for survival during hurricanes.

↑↑ The Escambia County team compares nest elevation profiles (points measured from the waterline to the dune crest) with other beach samples in ArcGIS Pro.

↑ A digital elevation model created from data collected with ArcGIS Field Maps and Emlid Reach receivers.

↑ Butler opens a track tube to check for beach mouse activity.

Beach mouse presence is monitored at different elevations using track tubes. These track tubes are PVC pipes with card stock and an ink pad inside. The tubes are placed 300 meters apart and baited at the end of the tube. If beach mice are present, they will leave inked paw prints on the cardstock.

Escambia County staff check the tubes every other month and complete an ArcGIS Survey123 form that tracks the presence or absence of beach mouse activity. If there is a deviation from the normal activity at a track tube site, an ArcGIS Pro map will alert the team to that location.

The same GNSS and GIS workflow supports shoreline erosion monitoring and artificial reef mapping. While reef mapping presents unique challenges, like maintaining a GNSS lock from a moving boat, Butler's team is continuing to expand its capabilities as time goes on.

A More Accurate and Efficient Process

Through its conservation efforts for both the beach mouse and the sea turtle, Escambia County is seeing a slew of benefits from its modernized GNSS and GIS workflow.

For one thing, significantly increased data accuracy helps Butler's team precisely record and locate the turtles' nests and the mice's activities. The data collection and location process is also now faster and easier, and stakeholders have more access to visualize and disseminate data.

On top of this, Escambia County is growing a historical database to help answer questions about dune elevation preferences. These answers could result in greater efficacy of conservation programs aimed at helping endangered species.

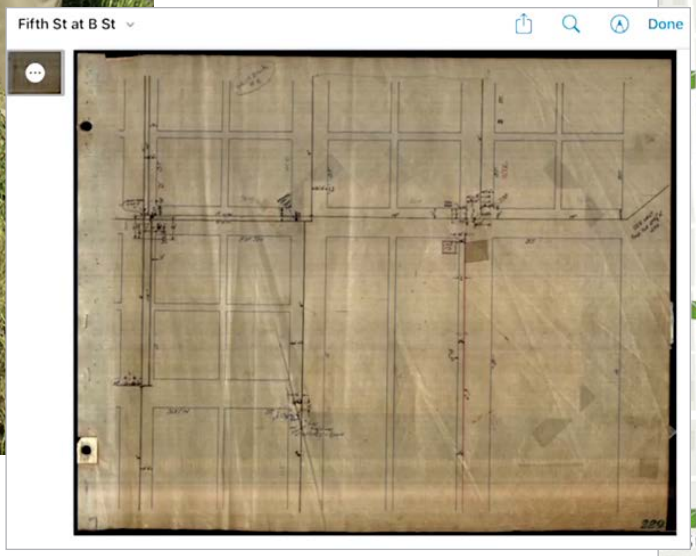
From habitat mapping to policy advocacy, integrating ArcGIS software and Emlid hardware is transforming coastal conservation. For Escambia County, it's not just about collecting data—it's about protecting ecosystems that shield inland communities from storm damage and preserve biodiversity for future generations.

"This work helps us balance public access with environmental responsibility," Butler said. "We're doing everything we can to protect these species—and the coastlines we all depend on."

About the Author

Sam Pepple is a geospatial content creator. Since earning his degree in GIS and cartography from Ohio University in 2008, he has held a variety of roles across the geospatial technology industry: from cartographer at *National Geographic* to account executive at Pix4D, and enterprise positions at senseFly and Skycatch. His career has consistently centered on translating complex geospatial concepts into clear, compelling insights.

← Abonmarche staff collecting water data in the field.



GIS Leads the Way

For Indiana's Lead Service Line Replacement

By Jeffrey Weaver, George Nikokiris, and Joe Eberts

In 2024, the US Environmental Protection Agency finalized its Lead and Copper Rule Improvements (LCRI), which require drinking water systems across the country to remove every lead service line (LSL) and all lead-tainted galvanized pipes within 10 years. As part of this mandate, every Public Water System (PWS) is required to complete an inventory documenting water service line materials, and community leaders have been working toward compliance nationwide. Critical deadlines have been identified, and state and federal agencies expect PWSs to continuously update and submit these inventories.

For many Indiana PWSs, these requirements can be hefty initiatives with significant knowledge barriers and resource challenges. Faced with incomplete water records, a heavier workload, and a lack of digital tools to improve speed and data accuracy for inventory submittal, communities are often unsure where to begin.

Funding from the Indiana Department of Environmental Management and the Indiana Finance Authority provided PWSs

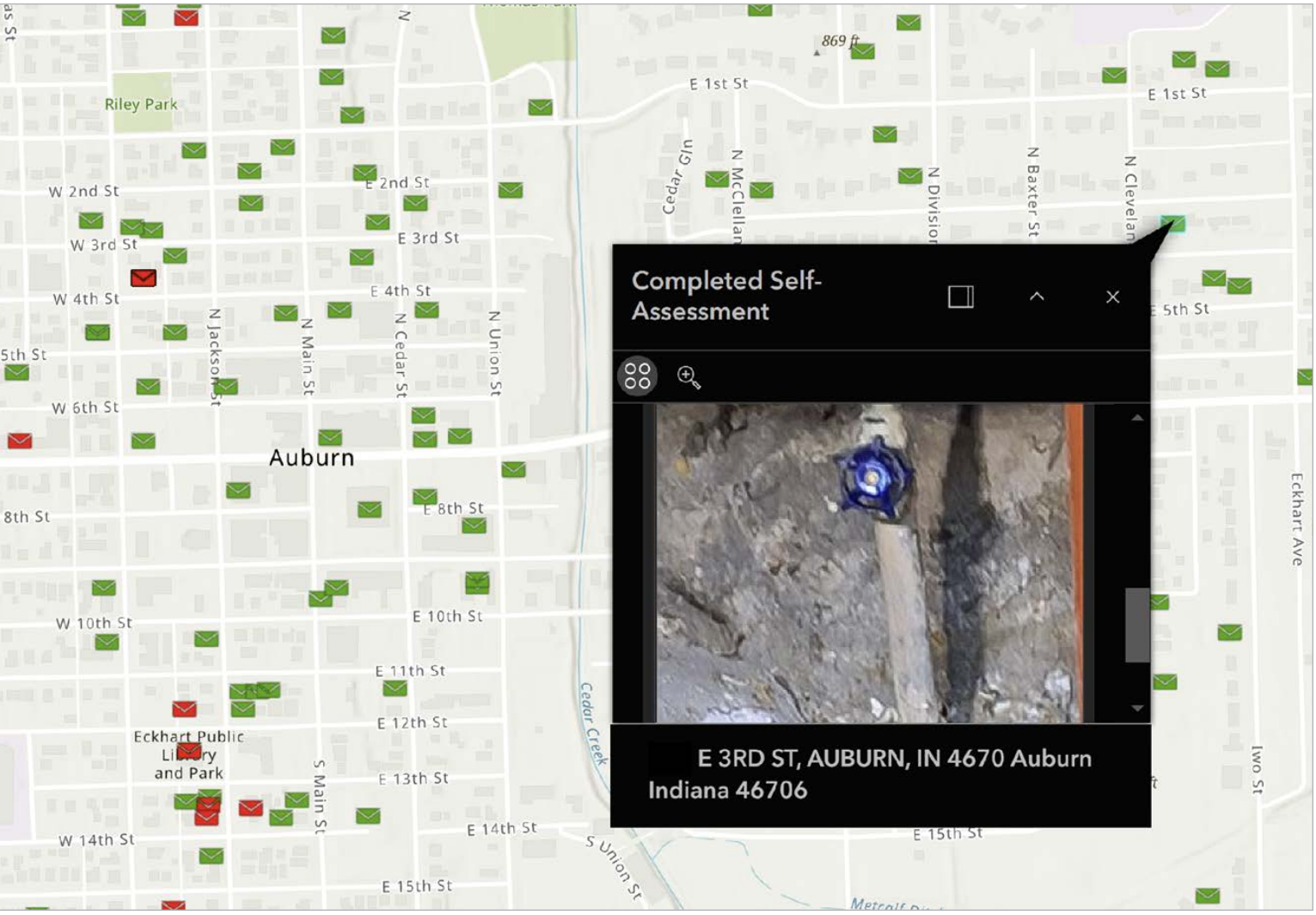
with needed support. In addition, third-party consultants and technology firms helped manage workflows, relieving the strain of daily operations.

Abonmarche—a company that provides surveying, engineering, and site development services, among others—has been assisting communities across the state of Indiana in achieving compliance. With a multidisciplinary approach that includes the use of ArcGIS Online, ArcGIS Field Maps, and other GIS tools, Abonmarche has been able to jump-start communities' ability to meet service line inventory and replacement requirements and to secure and administer funds for the future of their lead service line replacement.

Project Delivery Sites and PWS Partnerships

Abonmarche's work with each PWS included a platform known as a Project Delivery Site (PDS), based on ArcGIS Online. Each PDS was designed to host the community's GIS data and enable residents to share project progress. Staff at each PWS benefited by being able to concentrate on content without the need to understand how to administer an ArcGIS Online site. After project completion, each community was left with a functional GIS platform, and Abonmarche has continued to provide on-the-job training, standard operating procedures, and support.

Each PDS also includes a site created using ArcGIS Hub that organizes people,



↖ Some communities were faced with the need to digitize incomplete or manually recorded paper records.

↑ Auburn's self-assessment of lead service lines can be accessed through the city's Lead-Safe Auburn site, created using ArcGIS Hub.

to ensure residents were informed early and thoroughly. Since the city already used ArcGIS Online in its operations, the Abonmarche team was able to use ArcGIS Hub to configure a site quickly. The Lead-Safe Knox site was populated with information about the city's Lead-Safe program, making the site the central repository of education and information.

"We found the hub site to be exactly what we needed in communicating the program's goals to our residents," said Estok. "The concentration of information in this repository was efficient, and our staff pointed residents in the right direction."

Now residents can easily find lead service line information and quickly understand the program's goals through self-education. This solution provides residents with detailed information, which reduces phone calls and emails to city staff.

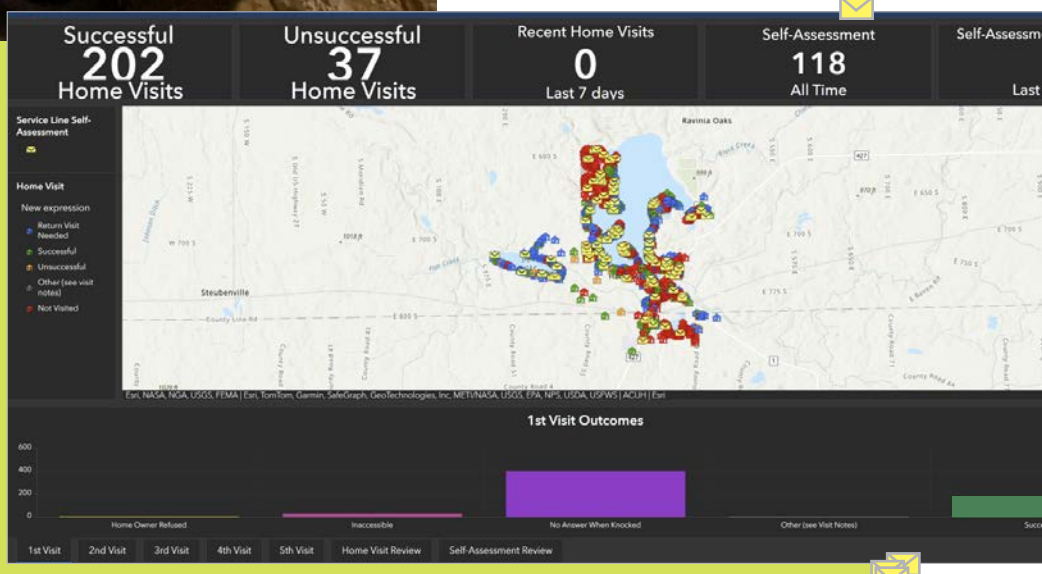
data, and tools through information-driven initiatives such as surveys and FAQs.

Several partner communities also needed help to synthesize data sources when developing a service line inventory. This included digitizing historical records (as-builts, documents of record, tap cards) as well as converting existing GIS data into a more compatible and comparable data schema. Using GPS receivers to collect the accurate location of water infrastructure components (water meters, access pits, and curb stops) was crucial in this effort.

Knox, Indiana

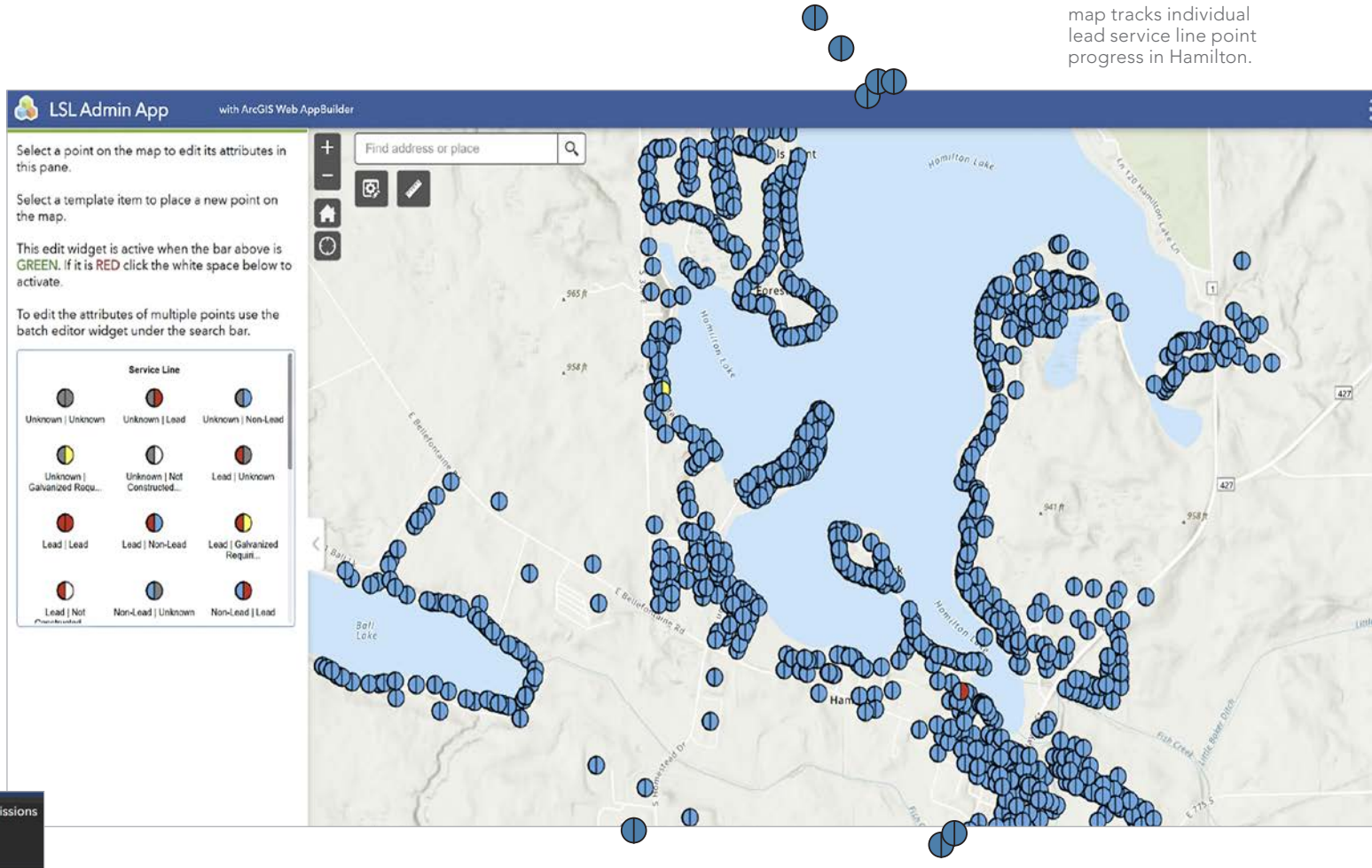
With around 3,600 residents, the City of Knox, Indiana, needed to address citizen concerns regarding the impact of the city's service line inventory program. Mayor Dennis Estok and his staff wanted a solution that consolidated information and utilized specific program FAQs.

Communication in smaller communities is magnified, so the approach needed



↑↑ An Abonmarche staff member documents service line materials during a home visit in Hamilton, Indiana.

↑ The Town of Hamilton tracks lead service line home visits in a dashboard created with ArcGIS Dashboards.



↓ An administrator map tracks individual lead service line point progress in Hamilton.

Auburn, Indiana

Auburn, Indiana, is a thriving community with a strong commitment to infrastructure and public health. Like many others, Auburn is actively working on its lead service line inventory and replacement program.

City staff took advantage of Esri's Lead Service Line Inventory solution, embedding the ArcGIS Survey123 module within their Lead-Safe Auburn hub site. This module enabled hundreds of residents to complete an LSL survey, including uploading photos of their service lines. Residents could also schedule appointments for a staff field visit. Auburn used resident submissions to perform quality control, review, and convey progress to the public. The process developed into an inexpensive way to build resident support and compliance.

In addition to a service line inventory, the LCRI require access to bilingual information and visual and auditory options for persons with disabilities. These capabilities are built into hub sites, requiring no additional configuration to meet the requirements.

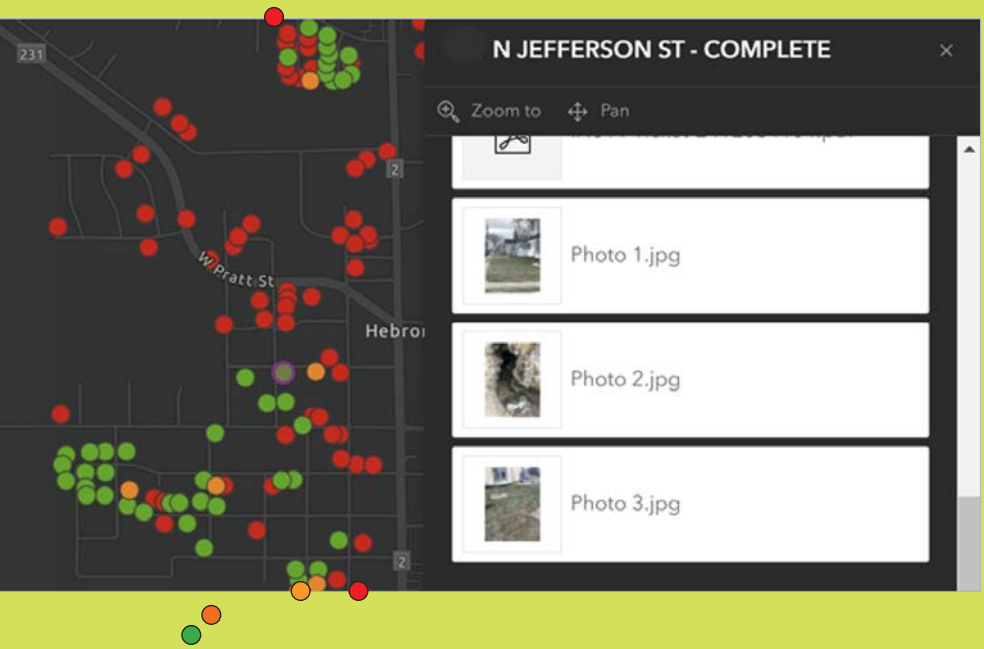
"We found the hub site and self-assessment survey highly effective in getting us started on our journey," said Randy Harvey, water superintendent for the City of Auburn. "The access to live data and the ease of administering these tests through GIS relieved a lot of pressure on our staff. The concentration of information on our hub site made it easy to communicate the goals of our program to residents."

City staff were easily able to configure Esri's out-of-the-box solutions to meet the city's needs. Self-assessments were more affordable than potholing, data collected by citizens drove decision-making, and residents with lead service lines were quickly notified.

Hamilton, Indiana

The Town of Hamilton needed boots-on-the-ground support to identify service line material. Luckily, grant funding allowed community outreach representatives to assist in door-to-door home visits. A web app built using ArcGIS Field Maps Designer simplified, standardized, and expedited the home visit process. After a few days of collecting data using iPads, a comparison was made of the success rate versus time of day during each visit. This led to scheduling field crews earlier or later in the day in certain areas. Necessary return visits were quickly identified and scheduled. The simple Field Maps Designer interface allowed for quick data entries, resulting in each visit lasting about 10 minutes.

The home visit crews used a few August weekends to capture data from 202 successful home visits.



achieved based on existing known values. On the other hand, if service line material is relatively unknown, potholing may be a desirable choice, barring more cost-effective methods. Even limited data about known materials among unknowns can statistically raise the confidence level of a model.

Using LSL funds, Hebron potholed over 50 locations during a two-week period. Crews used ArcGIS Online maps to track underground utilities, and ArcGIS Field Maps to verify addresses, notify customers, capture service line material types, and confirm dig completion and restoration. ArcGIS Dashboards enabled town leaders to monitor progress in real time. The start-to-finish process maintained accountability for both the town and contractors.

↖ A dashboard created for Hebron, Indiana, tracks potholing for contractors.

↓ Abonmarche staff demonstrate the potholing process in Hebron.

"We are known as a vacation community, and I knew capturing the data needed for the inventory would be a challenge given this fact," said Brent Shull, Hamilton town manager. "With so many configurable GIS tools to record the information, we found the right solutions that fit perfectly to our community's needs."

Hebron, Indiana

Like cities and towns all across Indiana, the growing community of Hebron is committed to maintaining a safe and reliable drinking water system for its residents. To comply with LCRI regulations, Hebron utilized hydroexcavation (pot-holing) to locate and document service line materials. This ensured compliance while protecting infrastructure and reducing costs associated with traditional excavation methods.

The town used system data to train a machine-learning model that helped prioritize hydroexcavation sites. If a sizable percentage of the service line material is known through records, home visits, or customer survey submissions, selecting a potholing site nearby is less valuable since a high confidence value may be

How Your Community Can Prepare

ArcGIS Online has been the key to updating and maintaining PWS GIS data, and Esri's Lead Service Line Inventory solution was configured to support additional functionality and reporting capabilities. This includes web maps and dashboards to streamline inspections, construction management, resident engagement, and administration. Customers have also taken advantage of PDSs that enable Esri partners like Abonmarche to set up and help administer platforms based on ArcGIS Online. Additionally, Abonmarche works with PWSs that do not have GIS, using available grant funding from the IFA to get GIS-based solutions in place to support service line inventory and replacement requirements.

If your community still needs to inventory and replace lead service lines to comply with the LCRI, keep the following steps in mind:

1. **Identify your existing LSL data.** If you do not have an existing service line inventory, begin by gathering historical system records and information to develop an initial inventory. If you do have one, cross-check your current inventory against the new requirements and update as needed. Take advantage of ongoing opportunities to collect data in the field, such as when replacing meters or performing main repairs and replacements.
2. **Identify supporting data for your LSL inventory.** Supporting data such as water main age, building age, and meter information can be used to build your LSL inventory. If you have this data available, ensure that it is up-to-date and as accurate as possible.
3. **Initiate discussions to accomplish full LSL replacements.** For many systems, achieving full LSL replacement can be a challenge. Explore and identify replacement programs and funding options, including assistance programs for customers who cannot pay to replace their portion of the service line. Discuss factors to prioritize replacements, such as targeting areas with vulnerable populations or disadvantaged customers.
4. **Prepare for rapid notification** Understand the various engagement time frames and delivery methods. Begin developing the required notification materials and coordinate with the appropriate departments and adjacent organizations.

About the Authors

Jeff Weaver is an information systems professional with extensive experience in planning, developing, implementing, and managing digital projects. Since joining Abonmarche in 2021 as the director of digital solutions, Weaver has rolled out innovative solutions to streamline operations and improve business processes. Weaver holds a degree from Indiana University and is committed to innovation and leveraging technology to drive business success.

George Nikokiris has been a GIS specialist and project manager at Abonmarche since 2022. With a solid GIS foundation, Nikokiris has consistently delivered customized solutions that address diverse spatial and data-driven challenges. Nikokiris holds a degree from DePaul University and is focused on delivering impactful results through strategic planning and expert application of GIS technologies.

Joe Eberts is a seasoned GIS technician and project manager at Abonmarche, bringing over a decade of experience in GIS to his role. Since joining the team, Eberts has leveraged his extensive background to support and enhance various GIS projects through meticulous data management and spatial analysis.

Connecting Oman
with Improved Network Management

By Ashlee Hornbuckle and Andrew Wright

In 2014, the Sultanate of Oman set out to reshape its digital future with the establishment of Oman Broadband Company. Tasked with the ambitious mission of delivering high-speed, affordable internet to communities across the nation, the company quickly became a cornerstone of Oman's telecommunications transformation. But as the network expanded, the challenges of scaling and managing such a vast infrastructure began to surface.

By 2024, Oman Broadband achieved remarkable milestones—bringing fiber coverage to nearly a million premises and connecting over 300,000 active subscribers. Yet, beneath this success lay a pressing question: Could the systems and processes that had fueled its early growth sustain its vision of 95 percent urban broadband coverage by 2030?

To continue building a connected Oman, staff needed to rethink the company's approach to network management.

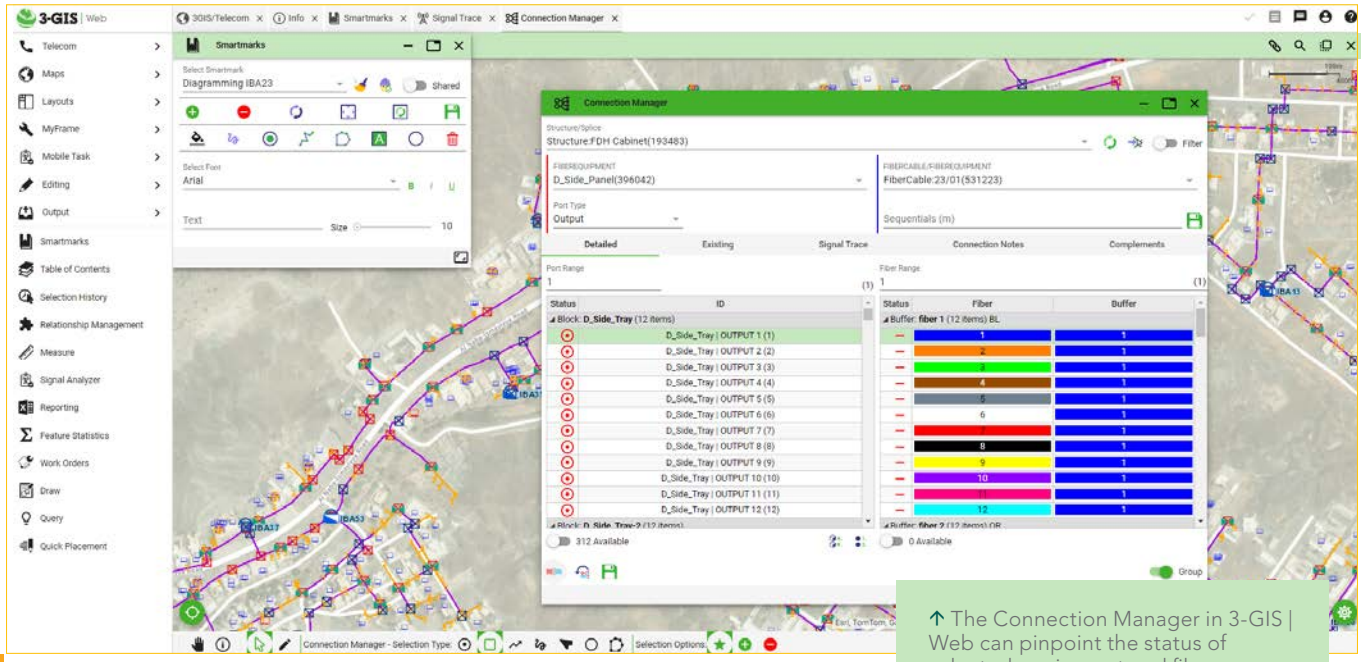
Oman Broadband turned to 3-GIS, an Esri partner known for its GIS-based telecom solutions, to develop tools to both streamline operations and prepare for future challenges. The result of this partnership is 3-GIS | Web, a cloud-based platform powered by ArcGIS Enterprise that allowed Oman Broadband to vastly improve its network management.

The Tipping Point

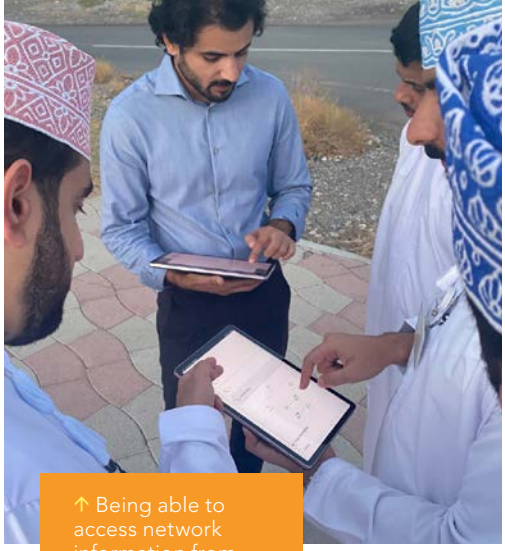
Oman Broadband's existing technology was struggling to keep pace with the demands of modern network operations. Data processing took days to complete, manual workflows slowed project timelines, and limited field connectivity posed significant risks to efficiency. For the company's leadership, it became clear that transformation wasn't just an option—it was a necessity.

In 2020, Oman Broadband began searching for an updated management solution to optimize the company's fiber network management strategy. With years of experience leveraging Esri software and a dedicated GIS team supporting the entire organization, the company aimed to stay within the ArcGIS ecosystem. Oman Broadband's previous development of mobile viewer apps and dashboards to track progress had already proved that ArcGIS technology was central to the company's operations.

The partnership with 3-GIS and the development of 3-GIS | Web marked a turning point for Oman Broadband's efforts. Designed for usability, the platform introduced advanced GIS editing capabilities and detailed light path tracing, enabling engineers to trace any fiber in the network directly from the map. This streamlined process not only accelerated issue resolution but also enhanced customer service standards.



↑ The Connection Manager in 3-GIS | Web can pinpoint the status of selected equipment and fiber.



↑ Being able to access network information from the field accelerates customer turn-up.

Beyond fiber tracing, 3-GIS | Web's diagramming tools empower engineers to handle complex network layouts with ease, converting intricate designs into actionable projects. The platform has also transformed network utilization analysis. Tasks like determining the usage of splices and cabinets, which once took four hours, now require only minutes, freeing up valuable time for other priorities.

Data loading processes have also seen dramatic improvements. Loading fiber-to-the-home project data, which previously took 10 days, now takes just eight minutes. This efficiency allows Oman Broadband to connect over 400 new customers daily, significantly accelerating broadband deployment timelines and driving revenue growth.

3-GIS's efforts have also extended beyond office users. Site engineers, once constrained by limited tools, now leverage 3-GIS | Mobile to trace fiber connectivity with speed and accuracy—capabilities previously restricted to office systems. Contractors at Oman Broadband can access critical network data on the go, ensuring efficiency in tasks like updating network information and managing assets in real time.

Oman Broadband has also introduced a transformative shift in processes by enabling contractors to document customer connections directly on-site. This automation streamlines the last-mile connectivity process, enhancing both the speed and quality of service—from the moment a customer places an order to final service activation. The integration of 3-GIS technology with the company's business support system ensures every customer request is processed with precision, enabling timely and accurate installations.

Scaling for the Future

Behind the scenes, 3-GIS | Web has expanded access to critical network data, replacing a system that supported just 30 users with one that now serves over 300. Engineers, contractors, and decision-makers all benefit from centralized, accurate data that enhances operations at every stage. Advanced features like automated task management and signal tracing have become indispensable, enabling teams to work smarter and faster.

Today, partly due to the increase in efficiency, Oman Broadband's operations have been modernized, strengthening the company's position as a regional leader in digital transformation. Looking ahead, Oman Broadband plans to leverage GIS technology to anticipate network maintenance needs, optimize resource allocation, and enhance customer satisfaction.

↑ Team members from Oman Broadband, Esri, and 3-GIS celebrate the implementation of the 3-GIS solution.

For telecom professionals, Oman Broadband's journey speaks powerfully to the potential of GIS for network management. By embracing cutting-edge solutions and reimagining traditional workflows, even the most complex fiber networks can be navigated with the right tools and a clear vision.

About the Authors

Ashlee Hornbuckle has over 10 years of experience in the GIS industry, spanning lidar, UAV surveying and mapping, and telecommunications. She has spoken on best practices and emerging technologies to help GIS professionals tackle unique challenges. During her time at 3-GIS, she has helped enterprises maximize their returns by providing guidance on selecting the right asset management solutions for their telecom network needs.

Andrew Wright has worked in the GIS industry for over 15 years in both the public and private sectors. He has been with 3-GIS since 2015 and currently serves as a senior consultant. During his time at 3-GIS, Wright has worked within the support and implementation teams in North America and in Europe, the Middle East, and Africa, helping global enterprises elevate their fiber management strategies.

MASSACHUSETTS ADDRESSES HOUSING DENSITY & AFFORDABILITY STATEWIDE

By Keith Cooke

Picture the quintessential American Main Street: shops nestled side-by-side, apartments above, pedestrians browsing cafes and bookstores. In most cities in the US, this arrangement is ironically illegal to build, deemed too dense by modern zoning laws.

Density—the number of units in a given area—is governed by these zoning laws. Most US zoning regulations, dating to the early 20th century, restrict housing types in specific zones. This constrains supply, drives up prices, and undermines housing affordability.

Today, roughly 75 percent of residential land is zoned for single-family homes. By understanding and reforming these laws, communities can foster economic growth and promote development. In Massachusetts, one group is working to make this possible statewide. The Massachusetts Housing Partnership (MHP), a public nonprofit, helps residents, volunteers, policymakers, and local leaders visualize the density that already exists in their communities. One of the primary tools the organization uses to achieve this is Residensity, an interactive web app developed with software such as ArcGIS Pro and ArcGIS Web AppBuilder and launched in 2023 by MHP's Center for Housing Data. The tool displays housing units per acre and by population level.

A Bigger Vision

Massachusetts is no stranger to the housing affordability crisis. In 2024, the state's median price for a single-family home was $609,900; in Boston, it was $900,000.

In response, the state legislature in 2021 passed the Massachusetts Bay Transportation Authority (MBTA) Communities Law, which requires half of the state's 351 municipalities to allow multifamily housing in locations with good access to transit. In 2024, Governor Maura Healey passed the Affordable Homes Act, authorizing $5.16 billion in spending over the next five years, along with nearly 50 policy initiatives to counter rising housing costs.

MHP consults on local and state housing policy with data and tools that help communities meet the new requirements. Additionally, MHP has loan programs that support the construction and preservation of multifamily housing. It has lent $1.5 billion toward affordable housing development since its founding in 1985.

Each municipality makes its own zoning rules, but in this case, the state requires localities to adopt compliant zoning to add greater

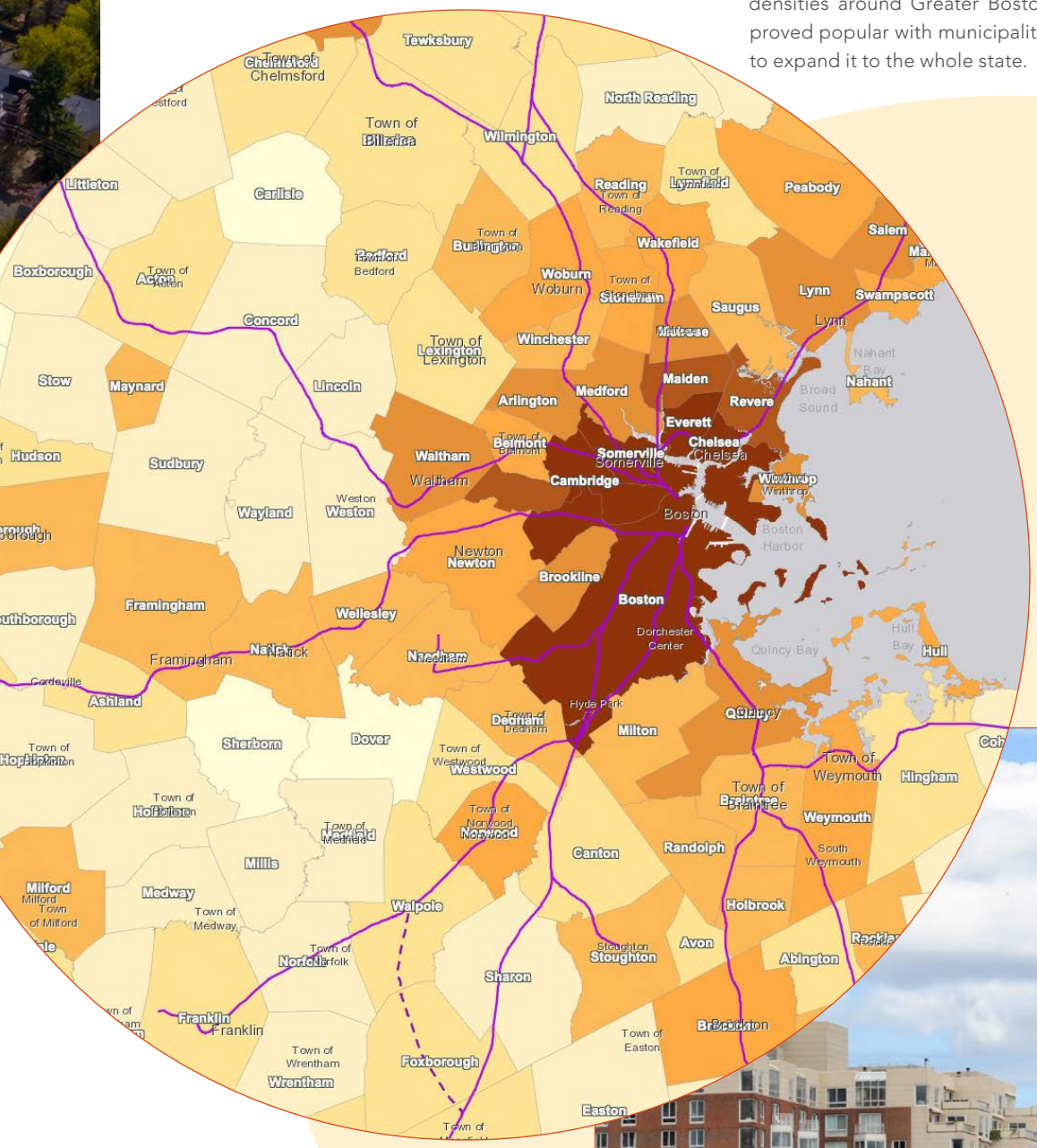
density around transit stations. When the MBTA Communities Law passed, it required communities with transit stops to allow 15 housing units per acre, equivalent to a small apartment building or a cluster of townhouses. This state mandate became a polarizing element of the law.

"If you're not aware of what 15 units per acre looks like, it's something that can sound really scary," said Tom Hopper, director of the Center for Housing Data at MHP. "Density is objective; it's something that we can use to set standards and guidelines, but it's also something that can be misinterpreted really easily."

It can be difficult for residents to grasp how people and buildings occupy space. A three-story development seems tall until it's compared to the height of a typical utility pole—both are usually around 30 feet high.

Hopper and his team make maps to reframe how people think about density. "We realized that, for people to become comfortable with the level of density outlined in the law, we needed to contextualize it in the neighborhoods they love," Hopper said.

Hopper's work on Residensity was inspired by an earlier success. In 2019, the Center for Housing Data launched the Transit-Oriented Development Explorer (TODEX), with interactive maps revealing densities around Greater Boston's 261 transit stations. The tool proved popular with municipalities and residents. Hopper set out to expand it to the whole state.



↖ An aerial view of Porter Square in Cambridge, Massachusetts, illustrates how building density declines the farther you get from downtown Boston.

← Residensity is a mapping tool that allows users to explore and analyze residential density anywhere in Massachusetts.

↓ The neighborhoods along MBTA tracks could accommodate much more housing to adhere to the MBTA Communities Law.

Data Informs the Density Conversation

Residensity and TODEX rely on the same dataset, which requires drilling down to the parcel level to determine how many units are in each plot of land. This data comes from MassGIS, the state's GIS team. The team gathers and updates land use and housing tax assessment maps from each municipality.

In Residensity, the state's Next Generation 911 addressing system data and third-party real estate data are combined with MassGIS data to create a picture of density in Massachusetts. A spatial join in ArcGIS Pro was used to add accurate address counts to each parcel across the state. Hopper's team then used Web AppBuilder to create the tool itself, which allows users to zoom in and out of neighborhoods or search specific addresses to get detailed parcel information. (In 2026, users will no longer be able to build apps in Web AppBuilder. When Web AppBuilder fully retires in 2027, apps will no longer be accessible for viewing.)

"If you want to find out where the densest development in your neighborhood is, or if you're looking for developments that are over 15 units per acre, you can see it in the interface. It gives people a really accurate and data-driven approach for conversations about density," said Matija Jankovic, MHP senior research analyst.

Members of MHP's community assistance team, which has helped over 130 municipalities comply with the MBTA Communities Law, use Residensity to find existing examples of density. Instead of providing an abstract illustration of a dense housing development, consultants can point to an apartment building that already fulfills zoning requirements as a model to inform future development.

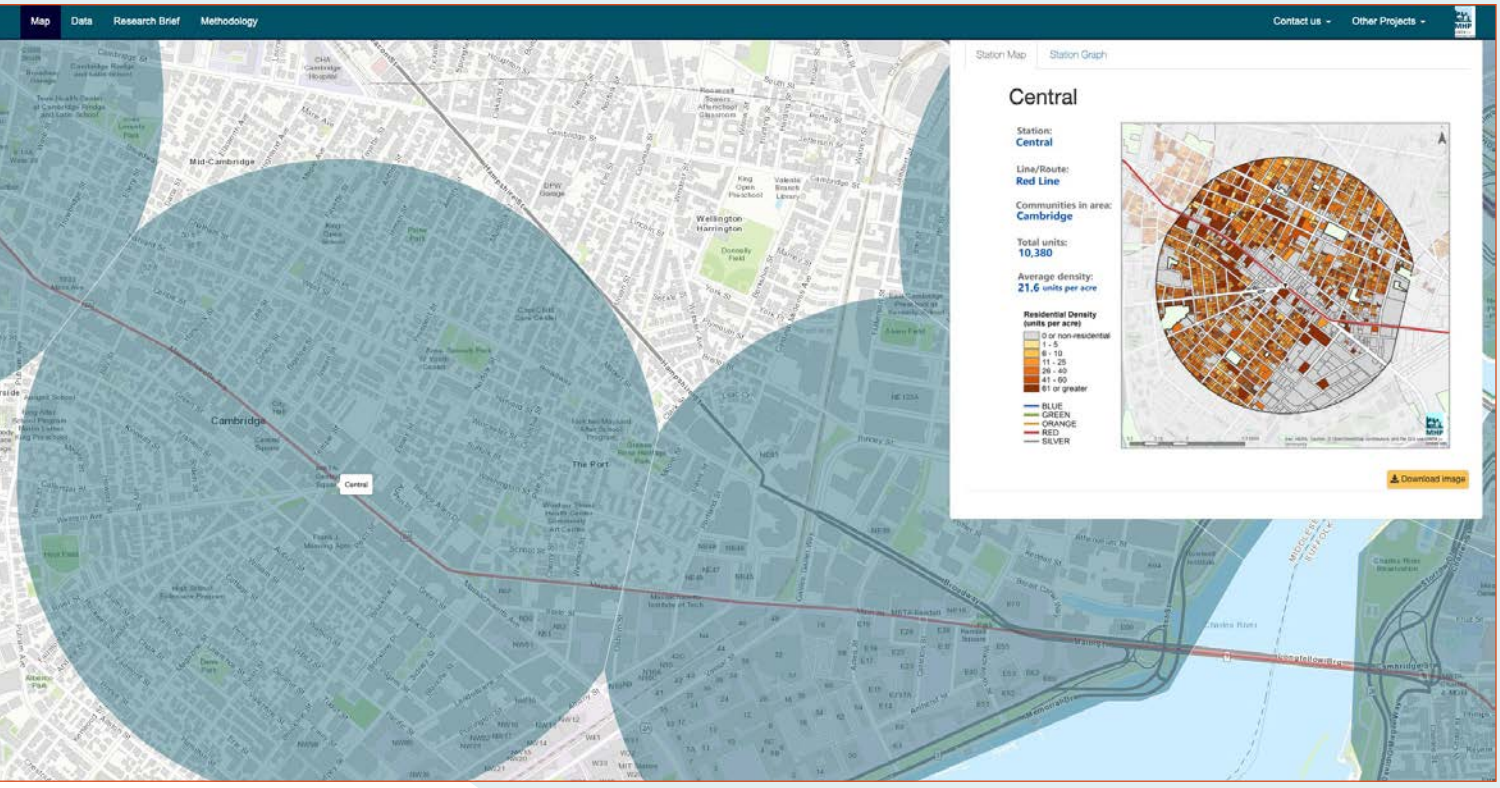
In Braintree, a suburb south of Boston, city councillor Meredith Boericke turned to the tool to highlight the positive impact that zoning updates could have on the city's economic vitality. With Residensity, she identified existing multifamily properties that exceeded the rule of 15 units per acre. This helped constituents understand what density already looked like in their community and allowed them to visualize future housing developments accurately.

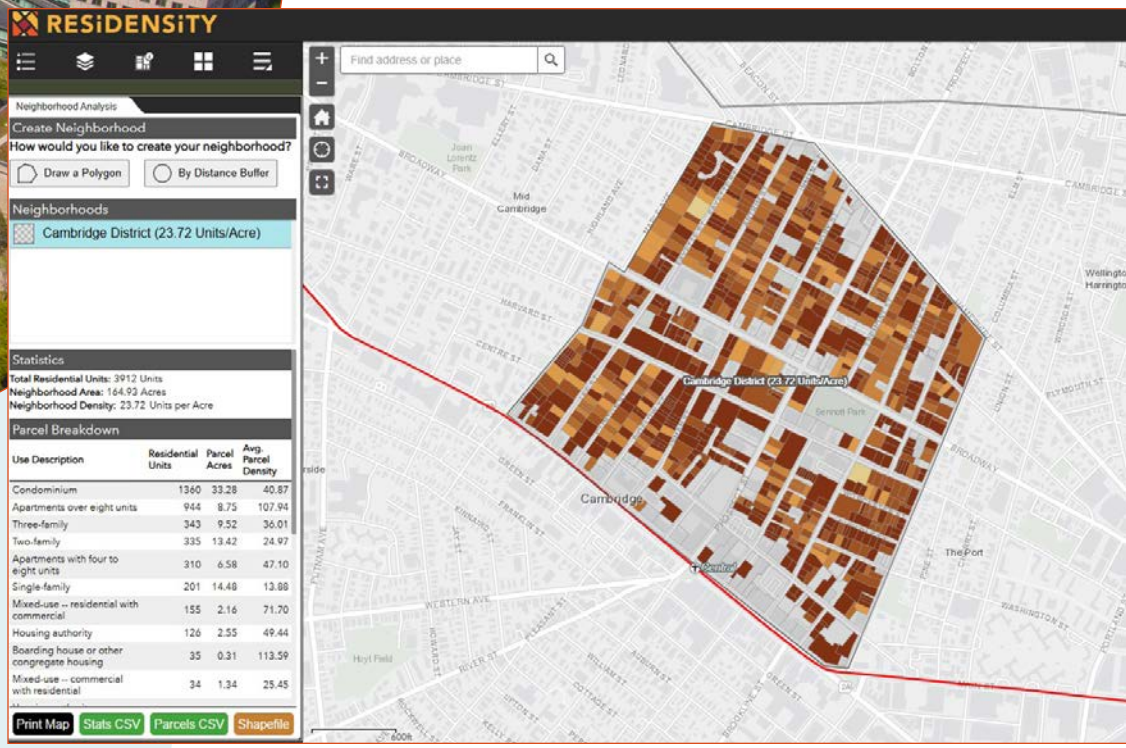
→ There is a great deal of development going on around Cambridge city center, and with new zoning laws the mix of housing is set to increase.

↓ Massachusetts Housing Partnership's Center for Housing Data created the Transit-Oriented Development Explorer (TODEX) to allow users to view the density and housing mix around each Massachusetts Bay Transit Authority station.

Across the state, Residensity is making an impact. Local planners and municipal staff frequently access it to examine parcels and investigate density in their municipalities. Housing advocates and residents use it to explore neighborhoods and communicate development patterns. People post screenshots from the tool to their social media accounts, spurring conversations about housing. And passionate residents use it to bolster their pro-housing messaging at zoning meetings and city council sessions.

"Before this tool, there wasn't a comprehensive way to look at density in the state," Jankovic said. "It's really interesting to see





→ Massachusetts residents can use the Residensity tool to explore housing data in their neighborhoods. The map shows where density is highest, and data reveals the breakdown of housing types and number of residential units.

how patterns are concentrated and how there are very clear spatial dynamics at play."

Insights to Build a Better Future

Since its launch, Residensity has uncovered where land is being used efficiently and identified areas that could benefit from higher-density developments.

There were also some unexpected discoveries. "Residensity highlights the differences between types of housing," said Hopper. "We've seen single-family neighborhoods that are actually denser than some multifamily developments. To me, that says you can achieve density in a number of different ways that fit community needs. We always talk about multifamily versus single family, but it's a lot more complex than that."

Adding to that complexity are accessory dwelling units (ADUs), which are smaller, secondary housing units located on the same lot as a single-family home. Examples include converted basements, attic spaces, and detached structures like backyard cottages. ADUs can provide affordable housing options and help increase the overall density of a neighborhood without significantly altering its character.

The Massachusetts Executive Office of Housing and Livable Communities is using the Residensity dataset to ask questions about where ADUs would be most appropriate and how a statewide ADU policy might impact residents.

The tool also caught the attention of other researchers, including from environmental, transit, and public health organizations. Staff members from the National Zoning Atlas project contacted Hopper's team to talk about scaling parcel-level unit count and density data to the national level. A handful of states have expressed a desire to develop similar tools, but it's hard to do without accurate statewide tax assessor and parcel data.

With insights from data-rich maps, town centers have the potential to look like the quintessential Main Street again. But housing is just a piece of the puzzle. Maps can reveal how much land is relegated to urban sprawl, such as parking lots or commercial development like warehouses. In cities that prioritize density, maps show how communities have made room for local parks and other public spaces for everyone to enjoy.

"It's not just about housing and transit but knitting all of this stuff together: civic life, environmental planning, resilience, and climate impact," Hopper said. "Analysis like this always highlights how far we have to go, but it's valuable, and we can use this information to communicate better."

About the Author

Keith Cooke is the global industry manager for community development at Esri. A graduate of Auburn University, he has been a GIS professional since 1994 and has worked for planning and community development agencies at the regional and municipal levels in Alabama and North Carolina. Prior to this role, he was an account executive at Esri for 15 years, working with over 100 local governments.

Increasing Survey Efficiency with ArcGIS Maps SDK for .NET

By Sneha Suresh and Mike Branscomb

For over 15 years, frox Die IT Fabrik has been developing software solutions for digital surveying and mobile GIS data acquisition.

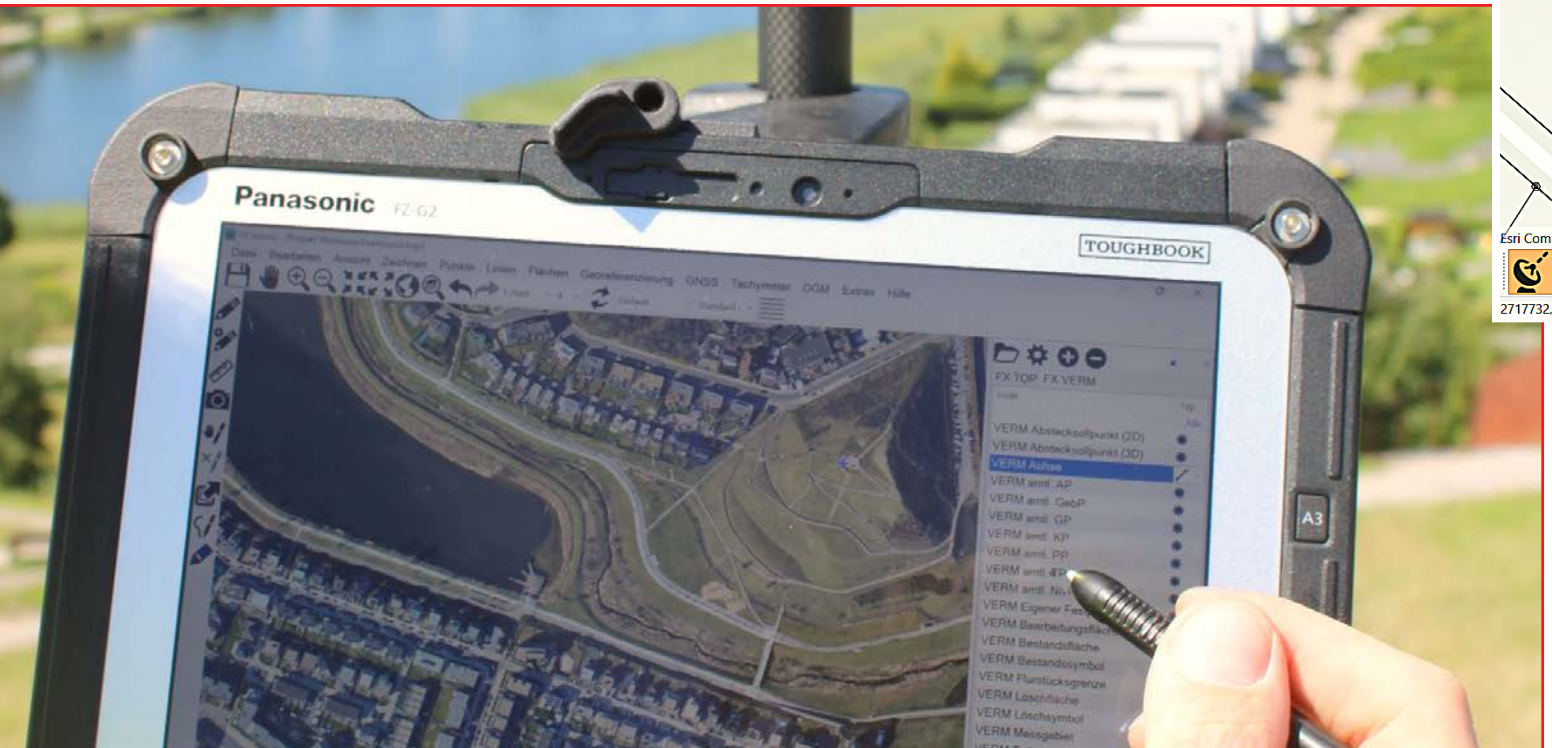
The company delivers high-precision measurement tools for critical infrastructure and has a diverse client base that includes government agencies, infrastructure firms, environmental organizations, and utility providers. Because of this, frox's suite of digital surveying and mobile GIS applications—such as FX Smart, FX Reality, FX Collector, and FX Survey—need to be able to work effectively and efficiently in a variety of situations.

However, the company has faced technical difficulties typical of code bases that have evolved over several years. A traditional, monolithic software architecture began to slow down maintenance, updates, and innovation. Furthermore, with the upcoming retirement of the software's underlying GIS technology, ArcGIS Engine, fast approaching in 2026, engineers at frox seized the opportunity to modernize.

The goal was to transition to an architecture with a smaller footprint for lightweight applications designed for modern mobile devices and rugged tablets. Frox also aimed to use a developer kit that supported the latest high-performance layer types within the ArcGIS ecosystem, particularly for the integration of vector tile basemaps. It had to build applications that would run seamlessly in both online and offline environments. Finally, frox needed flexible, self-contained deployments that would allow applications to be deployed side-by-side on devices, simplifying ongoing maintenance and management.

A Surveying Solution

With existing expertise in .NET and C#, the frox development team turned to ArcGIS Maps SDK for .NET. Not only does the SDK include a modern 64-bit architecture



and support for the latest Microsoft .NET application development platform, it also enabled the development team to integrate its existing processes of continuous integration and delivery, saving the time required to reimplement them. The modern, asynchronous design of the API, along with support for .NET features such as nullability, allowed frox to build applications that are more responsive and robust than they were previously. Comprehensive support for the .NET Multi-platform App UI (MAUI) desktop and mobile cross-platform framework were also crucial to frox's decision to use .NET Maps SDK.

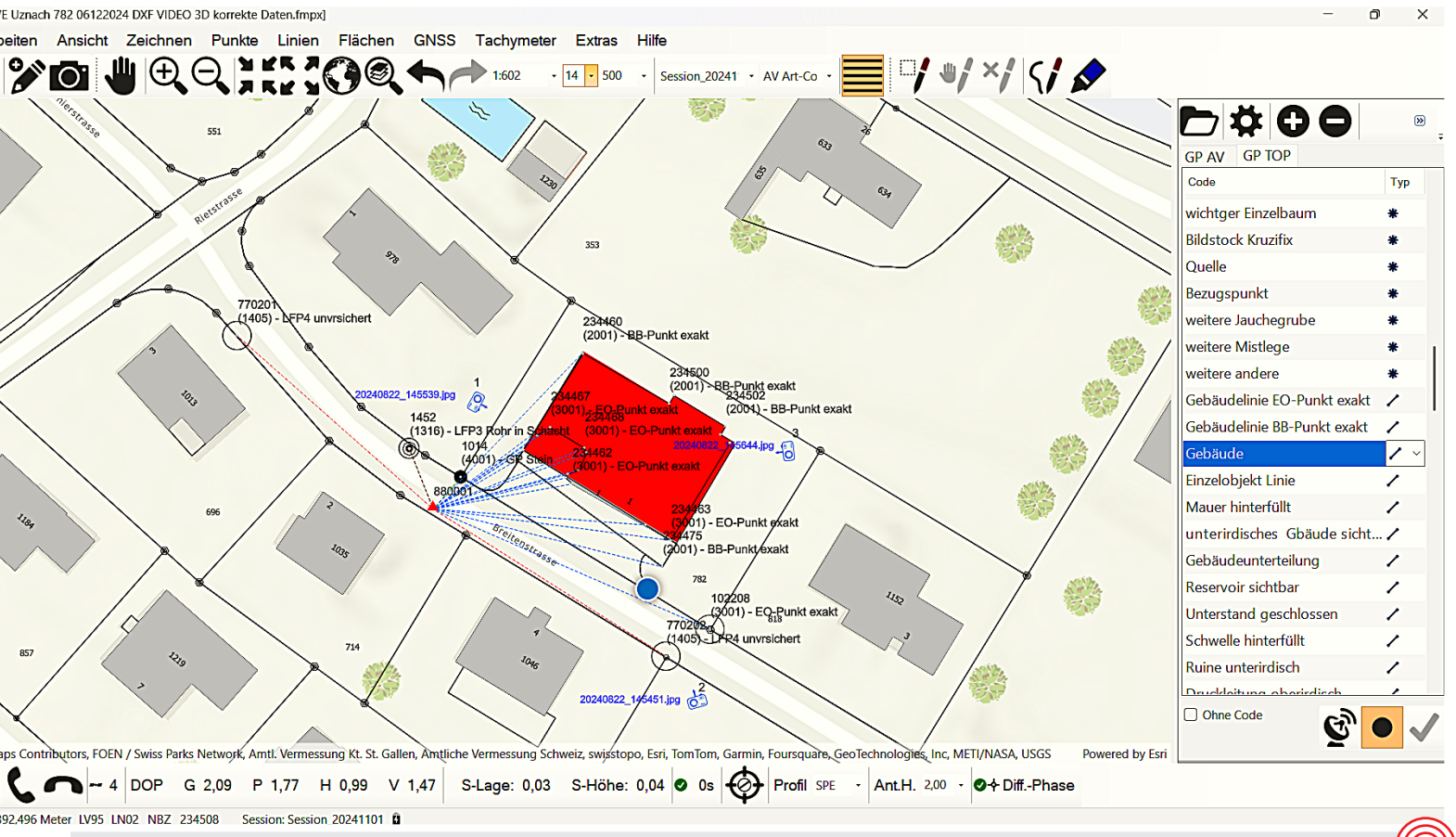
To facilitate a smooth transition for its development team and end users, frox opted for an incremental migration approach to reimplementing functionality while maintaining a period of dual operation, during which the team added the new logic using .NET Maps SDK to the existing architecture.

The first step was to separate the business logic, GIS logic, and UI logic. Next, the team abstracted the core logic and implemented it to support both the current MapView UI control in .NET Maps SDK and the corresponding legacy MapControl in ArcGIS Engine. The final stage was to methodically migrate each feature or function.

A crucial workflow within FX Survey includes the ability to import CAD plans so that users can visualize and interact with these designs. To support this workflow, the team used functionality in .NET Maps SDK to create new mobile geodatabases on the device, define table schemas, and populate those tables with data.

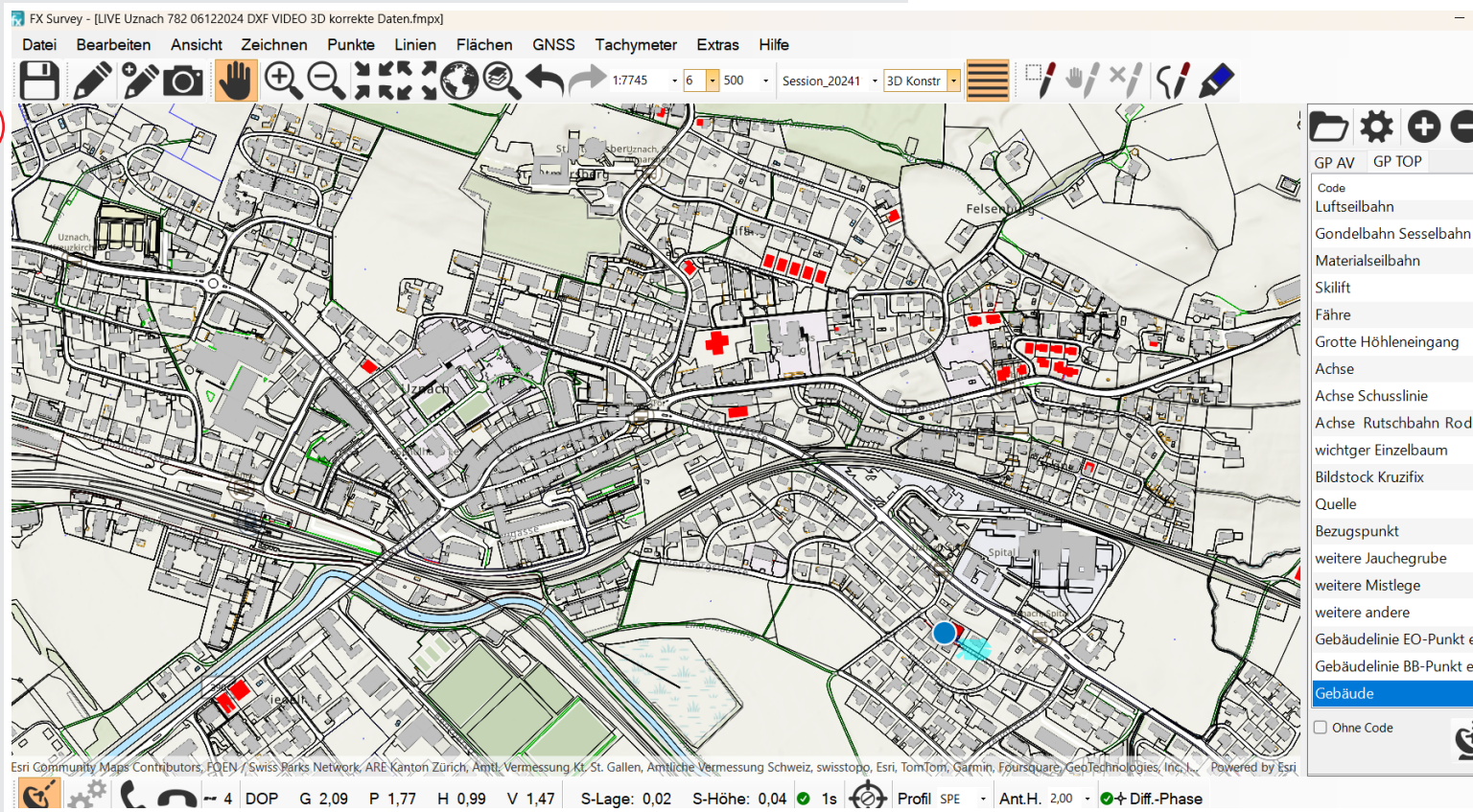
The development team also took advantage of the open-source toolkit included with ArcGIS Maps SDKs for Native Apps, which simplified development by offering controls that can be used out of the box or customized to meet specific requirements. Frox used the BasemapGallery control to give end users easy access to a choice of high-performance basemaps from either ArcGIS Location Platform or their own organizations. Frox also implemented the dynamic legend control to help users understand symbols and styles on maps.

"The extensive and deeply integrated functions in FX Survey, coupled with the complexity of the existing code, made the transition a significant challenge that took over a year, said Christoph Babilon, frox's head of business development. "However, we can now assert with complete confidence that this decision was the right one, as the performance,



↑ FX Survey software displaying a map with numerous points of interest highlighted.

← FX survey being used on a Panasonic Toughbook FZ-G2.



↑ CAD data displayed in FX Survey.

← In the field at a construction site with FX Survey.

stability, and usability have been elevated to an entirely new standard."

A Successful Implementation

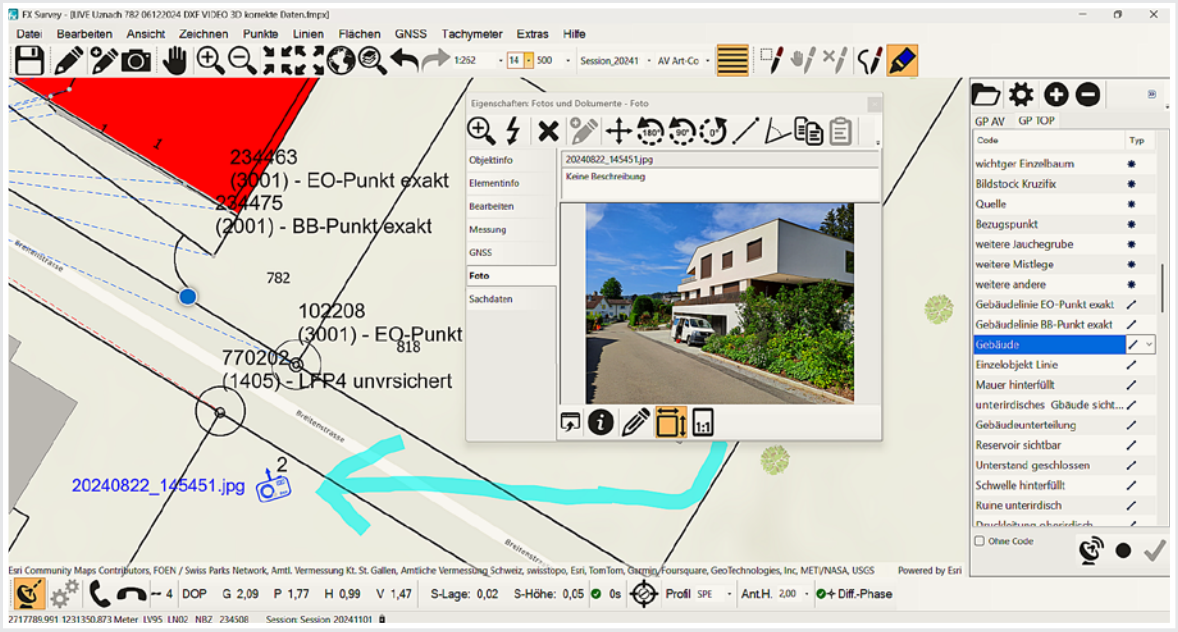
The Native Maps SDK collection provides common API patterns for working with online and offline data. With this capability, FX Survey can support both online and offline scenarios, ensuring data access in the field and allowing mobile workers to continue their tasks even with limited or no network connectivity. With .NET Maps SDK, frox could also take advantage of the deployment options offered by ArcGIS, including software as a service (SaaS) via ArcGIS Online, self-hosting with ArcGIS Enterprise, and consumption-based data and location services through ArcGIS Location Platform. The integration with ArcGIS Location Platform and ArcGIS Online unlocked access to ready-to-use, high-performance basemaps. Familiar fundamental concepts within .NET Maps SDK, coupled with extensive documentation, samples, tutorials, and an active online community, significantly reduced the learning curve for the development team.

After the successful migration, FX Survey pilot users reported a 25 percent reduction in time spent on measurements in the field and an 80 percent reduction in time spent during postprocessing in the office, primarily due to the high accuracy of the data at time of capture.

A key feature of frox's FX Survey solution is its efficient, robust, and secure flow of digital data and information between the field workforce and the back office. With the flexible licensing model of Native Maps SDKs, frox has created solutions that are relevant to customers both with and without existing ArcGIS implementations. For instance, customers with established ArcGIS setups can take advantage of their existing user types.

Moreover, frox developers found significant value in their ongoing engagement with Esri engineers and leaders, both through the Esri Community channels and at in-person meetings during Esri's international developer summits. The frox development team members could seek advice, confirm their design and implementation strategies, and stay informed about upcoming releases.

Frox has an ambitious road map for FX Survey, including maximizing offline workflows using web maps and offline map areas. Additionally, the team is focused on continuing to harness the cross-platform capabilities of .NET Maps SDK to leverage existing .NET and C# development skills for a range of mobile apps, including FX Reality and FX Smart for Android and iOS.



← The FX Survey interface displaying a map with plotted points, lines, and a photograph.

About the Authors

Sneha Suresh is a product marketing manager on Esri's developer marketing team. She is a passionate marketer with over eight years of experience spanning various sectors including IT, ride hailing, and gaming. Suresh earned her MBA from Cornell University's Johnson School of Business and holds a bachelor's degree in electronics engineering from the University of Mumbai.

Mike Branscomb is a product manager for ArcGIS Maps SDKs for Native Apps and ArcGIS Maps SDKs for Game Engines at Esri. With over 20 years of experience working in the Esri ecosystem, he specializes in .NET, Local Server, and 3D scene layers. Branscomb is also a Scrum Product Owner with over 10 years of experience guiding teams through the product development life cycle.

Spatial Data Is Key for Wildfire Prevention in Galicia

By Alberto Cerrillo

In recent years, as wildfires have become more frequent around the world near developed areas and structures such as houses and roads, they have shifted from being merely an environmental threat to an existential one. Due to the growing ferocity of these wildfires, which in many cases makes them nearly impossible to manage, local governments have gone beyond equipping emergency services with response tools and begun focusing on prevention. Brush mitigation efforts, for instance, have proved essential in decreasing the chances of fires spreading to cities and critical infrastructure, ensuring the protection of residents as well as evacuation routes.

Southern European countries are among the most affected by wildfires every year. In certain areas, such as the Spanish region of Galicia, structural factors contribute to the proliferation of these fires. The ongoing depopulation of rural areas has led to the abandonment of agricultural land and its gradual conversion into forest. Consequently, forest coverage now accounts for almost 70 percent of the region, with more than 300 municipalities situated in its immediate surroundings.

GIS has become essential in enhancing wildfire prevention and minimizing its impact. A clear example of this is Xunta de Galicia, the regional government of Galicia. It has introduced a platform called Xesbio that is designed to manage the removal of dead wood and dry vegetation that builds up year after year.

Developed by Esri partner Vexiza using tools such as ArcGIS Web AppBuilder, Xesbio simplifies administrative tasks related to vegetation management. In Galicia, landowners are responsible for ensuring that plots near populated areas are properly maintained, which means both the regional government and local municipalities must monitor their progress before wildfire season to issue sanctions if necessary.

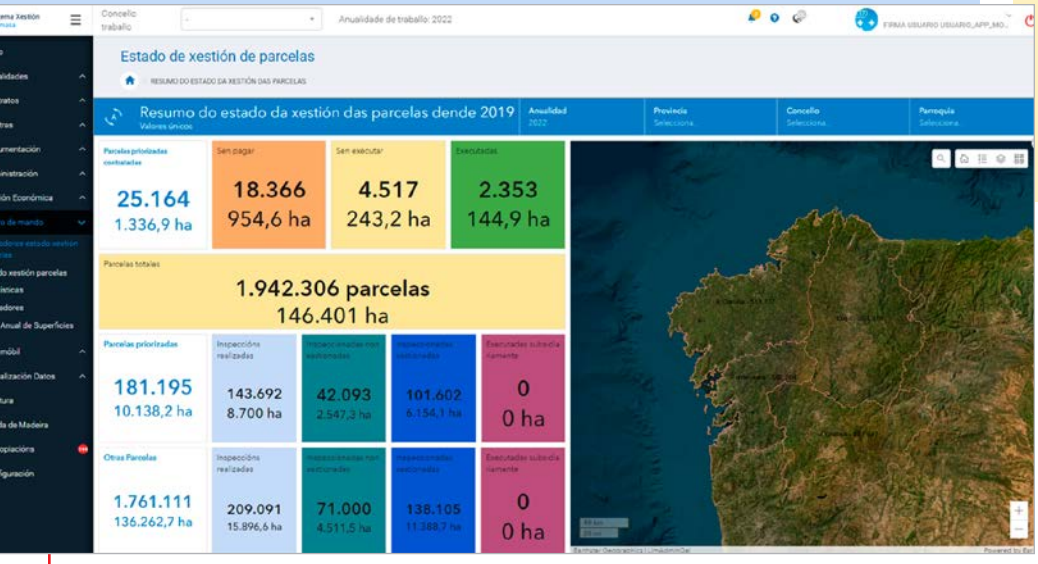
How ArcGIS Supports Risk Assessment and Vegetation Control

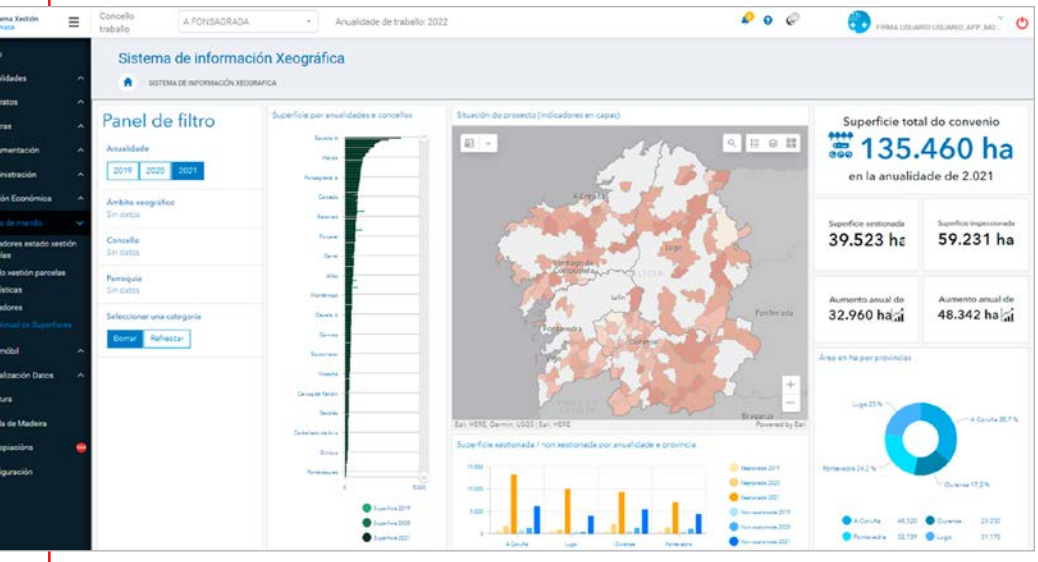
To assist workers responsible for verifying that parcels meet required standards, Vexiza developed a mobile field solution based on ArcGIS Runtime SDK for Android, enabling staff to record inspection data such as the presence of highly flammable biomass, along with photographs. Since many inspections are conducted in areas with limited connectivity, operators can work offline, and the data will synchronize once a connection is restored.

ArcGIS Web AppBuilder was also used to build dashboards that fully leverage GIS data. A key dashboard highlights the parcels that may pose a significant risk in the future based on automated criteria such as their location in areas that have previously experienced major wildfires. To achieve this, Xesbio is fully integrated with other ArcGIS ecosystems from Xunta, such as Xeocode, which is used for real-time wildfire management and from which Xesbio retrieves historical data.

Xesbio also integrates data collected during inspections, displaying the progress of cleaning tasks on the parcels on

↑ The mobile app allows users to access all the information stored on the platform, identify parcels close to houses, and record inspection results.





← Dashboards offer an instant snapshot of the progress being made on parcels preparing for wildfire season, along with pending tasks.

↙ The platform allows users to filter information for a specific time period, with data organized by province, delivering an overall picture of what is happening throughout the region.

KPI cards and time-series graphs, while showing any parcels that are not yet in compliance on the map. This is further enhanced by the integration with available land records information, which includes details about parcel geometries, owners, and market value.

Moreover, since the regional government itself offers vegetation management services through a public entity, another dashboard allows users to check pending tasks on parcels that have signed agreements with that entity. This feature is particularly useful for identifying areas where work still needs to be completed, ensuring that every parcel is accounted for, and helping prioritize actions based on urgency and available resources.

This set of dashboards fully leverages the powerful customization capabilities of ArcGIS. Users can filter maps to display only the data that is most relevant to their specific needs, such as focusing on particular municipalities, provinces, or years. This level of customization ensures that each user, whether a local official or a wildfire prevention team member, can quickly access the insights they need without being overwhelmed by irrelevant data. As a result, decision-makers can enhance their analysis, identifying where resources are most needed.

Bringing Together GIS and Tools for Document Management

Within this ecosystem, additional parcel management tools are integrated with spatial information, allowing for a comprehensive and efficient approach to vegetation management and wildfire prevention. One of the key features of this system is the ability to handle contract agreements directly with landowners for biomass removal services.

The platform also allows for the issuance of official notifications to landowners whose parcels fail to meet fire safety regulations, prompting them to take action before wildfire season. These notifications are legally binding and can be tracked within the system, ensuring that no parcel is overlooked. Thus, local authorities can enforce regulations more effectively, fostering greater accountability and enhancing overall fire safety standards in the region.

By integrating ArcGIS technology into every stage of the wildfire prevention process and ensuring full traceability of all managed information, with every action taken on a parcel being recorded, Galicia has made significant progress toward a more resilient approach to managing fire risk, safeguarding its residents and critical infrastructure.

About the Author

Alberto Cerrillo is the CEO and cofounder of Vexiza, an Esri partner in Spain specializing in the development of GIS solutions with ArcGIS applied to meteorology and emergency management, particularly forest fire prevention. Cerrillo holds a degree in geography and is a geodesy and cartographic engineer. He has led a wide range of GIS projects to better understand the natural environment and the risks it poses to people and infrastructure.

NAVIGATING THE CHANGING LANDSCAPE OF GEOSPATIAL CAREERS

By Tammy McCracken

Now more than ever, the geospatial technology industry is undergoing a significant transformation driven by rapid technological advancements and an increasing demand for innovation. As a result, job responsibilities are evolving at a rate that can seem overwhelming, requiring professionals to adapt and develop new skills to remain relevant.

But how exactly are things changing? What does it mean for GIS professionals, employers, and the future of work? And what are the concrete steps you can take to make sure you're keeping up with a landscape that is constantly shifting under your feet?

Emerging Technologies and Changing Roles

Transformational breakthroughs, particularly in generative artificial intelligence, are reshaping industries and tasks across all sectors. These technological advances, however, are converging with a broader array of challenges, including economic and political volatility, geoeconomic realignments, environmental challenges, and evolving societal expectations. The World Economic Forum's *Future of Jobs Report 2025* paints a forward-thinking picture of the evolving landscape of careers, and it is clear that GIS and spatial analytics play a significant part in this transformation.

The report underscores the seismic shifts brought about by technological advancements like AI, big data, and automation. In the realm of GIS, these technologies are not just buzzwords, they are impactful forces. These advancements automate data processing, enhance predictive modeling, and elevate decision-making, fueling business engines to reach new heights. By harnessing these technologies, GIS professionals can uncover previously hidden patterns, predict future trends with unprecedented accuracy, and make real-time decisions with more confidence.

Just as crucial to the future of the GIS industry is the ongoing process of shifting from a carbon-based economy to a more sustainable and environmentally friendly one. It involves reducing greenhouse gas emissions, promoting renewable energy sources, and implementing practices that protect and restore the environment. As the world grapples with this transition, the demand for GIS professionals is skyrocketing, whether it comes to environmental monitoring, disaster response, or sustainable urban planning.

Also at the forefront of this effort are digital access and data management. For GIS careers, this translates to a growing demand for expertise in data governance, integration, and interoperability. Managing and analyzing vast datasets is core to the work of GIS professionals, and this role is becoming ever more vital to present-day and future organizations.

And with the foregrounding of jobs related to AI, big data, and environmental stewardship, new roles are emerging. In the GIS industry, this means new and evolving positions that leverage these technologies.

Geospatial AI specialists, for instance, automate complex geospatial tasks, and their work enables organizations to make real-time decisions with greater accuracy and efficiency. These specialists integrate artificial intelligence with geospatial data to develop advanced analytical models and predictive tools. By leveraging AI, they can uncover hidden patterns and trends in spatial data, providing organizations with deeper insights and more informed strategies.

The role of climate resilience analysts has also evolved significantly. As the severity and frequency of climate-related events have increased, the need for specialized professionals who can not only analyze but also predict and mitigate these impacts has become more apparent. These analysts work on projects related to disaster risk reduction, sustainable development, and environmental conservation, and help organizations develop strategies to adapt to changing environmental conditions and enhance their resilience against natural disasters.

> "To succeed in the evolving geospatial technology field, professionals must adopt an initiative-taking approach in developing new skills and staying updated on industry trends."

Another role that has evolved significantly in recent years is the digital twin engineer. The concept of digital twins traces back to NASA's Apollo program, where engineers created detailed simulators to troubleshoot spacecraft systems from Earth. However, it was only with the advent of the Internet of Things (IoT) and big data analytics that digital twins found their true potential in a variety of industries. Digital twins enable more efficient urban planning, infrastructure management, and environmental monitoring. By simulating and optimizing various scenarios, these specialized engineers help organizations improve resource allocation, reduce operational costs, and enhance overall efficiency.

Of course there are many other emerging or changing positions that offer organizations the ability to harness cutting-edge technologies to drive innovation, improve decision-making, and achieve sustainable development goals. As these positions continue to evolve, they will play a key role in shaping the future of the geospatial technology field and the broader landscape of work.

Staying Ahead of the Curve

In this changing landscape, GIS professionals must blend interdisciplinary skills into their technical approach to problem-solving. Project management skills, for instance, help in coordinating and executing geospatial projects efficiently, while domain-specific knowledge in areas such as urban planning, environmental science, or public health enables GIS professionals to apply their technical expertise to real-world challenges.

Additionally, the ability to adapt, upskill, and reskill is essential for GIS professionals to keep pace with technological changes and leverage new tools and methodologies effectively. Addressing skill gaps and tapping into diverse talent pools fosters innovation by bringing in fresh perspectives and ideas. This adaptability and continuous learning are crucial for maintaining relevance in a competitive job market and for driving progress within the industry.

To succeed in the evolving geospatial technology field, professionals must adopt an initiative-taking approach in developing new skills and staying updated on industry trends. This journey begins with embracing continuous learning. Enrolling in courses and obtaining certifications from Esri can keep you current with the latest technologies and methodologies. Esri offers a range of training options, including online courses, instructor-led training, and self-paced learning modules. Attending industry workshops, webinars, and events such as the Esri User Conference provides valuable insights from experts and keeps you abreast of emerging trends.

Gaining practical experience is equally important. Seek internships and project opportunities to apply your skills in real-world scenarios. Practical experience is invaluable for understanding the complexities of geospatial data and technologies. Engaging in volunteer projects that require GIS expertise not only helps you gain experience but also expands your professional network.

Developing technical skills is a cornerstone of success in this field. Mastering GIS software and familiarizing yourself with advanced features and functionalities can set you apart. Enhancing your technical capabilities by learning programming languages such as Python, R, and SQL is elemental for data analysis, automation, and the development of custom geospatial solutions. Staying on top of emerging technologies like AI, machine learning, and the IoT will give you a competitive edge, as will understanding how these technologies integrate with GIS.

However, technical skills alone are not enough. Soft skills are equally vital. Effective communication, for example, is crucial for conveying complex technical information clearly and concisely to nontechnical stakeholders, ensuring that your insights are understood and actionable. Cultivating strong teamwork and collaboration skills enhances project outcomes and fosters innovation.

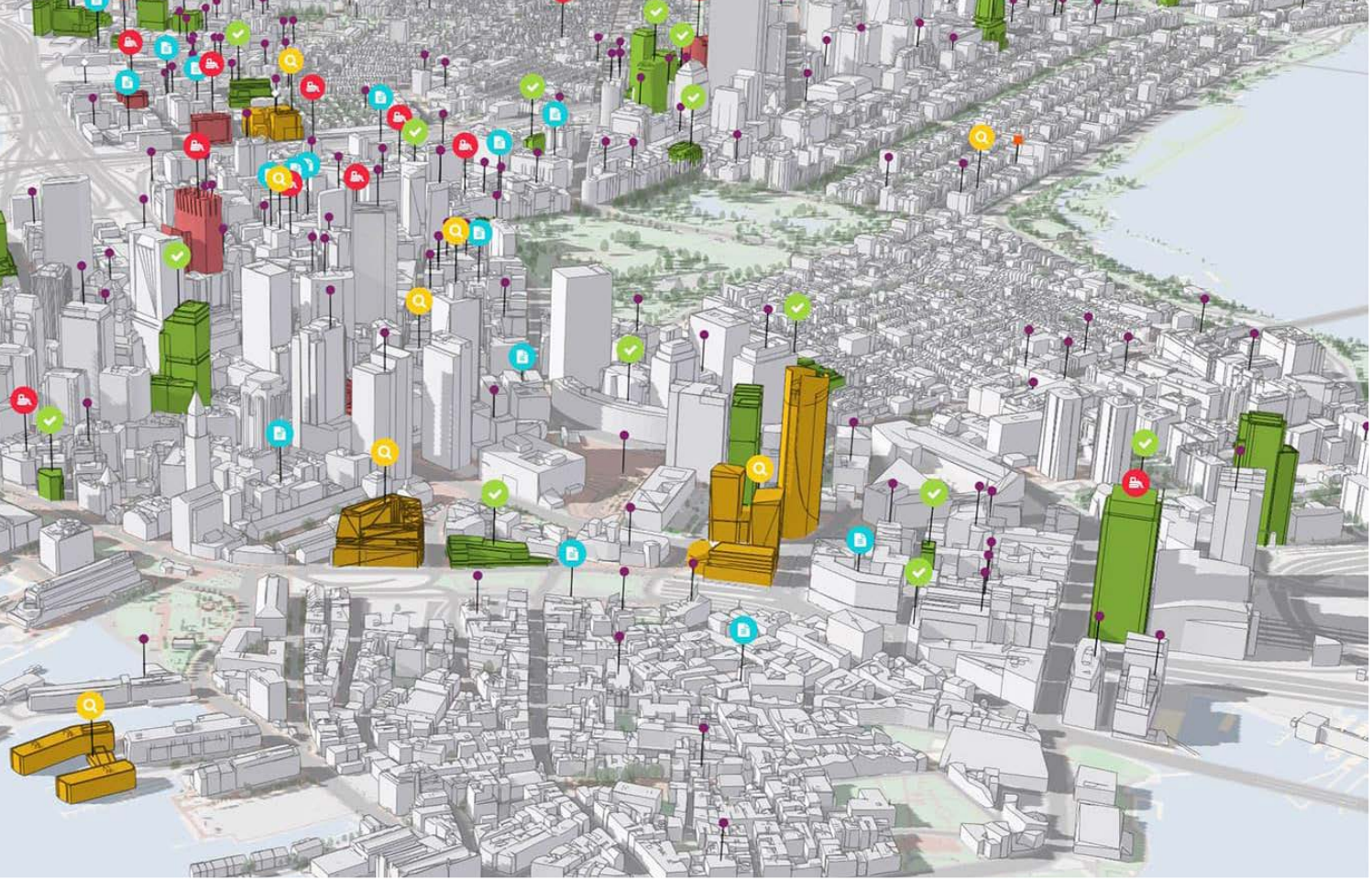
Building a professional network is another key opportunity for career growth. Joining professional organizations such as the American Association of Geographers (AAG) or the Geospatial Professional Network (GPN)—formerly the Urban and Regional Information Systems Association (URISA)—provides valuable resources, networking opportunities, and industry updates. Engage with industry professionals on platforms like LinkedIn, participate in discussions, and stay informed about the latest developments in the geospatial technology industry.

Staying engaged and up-to-date on industry developments is essential. Subscribing to Esri publications keeps you informed about the latest research, trends, and innovations. Participating in online forums and communities where GIS professionals share knowledge, discuss challenges, and collaborate on projects, such as Esri Community, can also be highly beneficial. Additionally, contributing to thought leadership by authoring articles, presenting them at conferences, and sharing your expertise can establish you as a leader in the field and open new opportunities.

Over time, GIS skills are becoming not just relevant but essential. And as the industry evolves, professionals must adopt an initiative-taking approach in developing new skills, embracing continuous learning, and adapting to the latest trends. By honing both technical and soft skills, stepping into leadership roles, and staying in the loop on emerging and changing technologies, GIS professionals can drive innovation and contribute to the advancement of the field. The landscape is changing, and those who adapt and innovate will stay on their feet.

About the Author

Tammy McCracken is a senior consultant on Esri's emerging technologies market team. With over 25 years of experience in geospatial projects, she has developed cutting-edge spatial solutions with artificial intelligence and machine learning as well as communicated with vast sensor networks in smart city efforts. McCracken holds a bachelor's degree in information management from the University of Maryland and is pursuing her MS in analytics from the Georgia Institute of Technology.



HOW TO BUILD A GIS DEPARTMENT FROM THE GROUND UP

By Molly Casey

When you start a new GIS department at an established organization, it can feel like what comes next is a total mystery. People can be suspicious of anything new, and it's your job to determine this new department's trajectory. Like a detective, you must find evidence that explains the *who*, *why*, *where*, and *how* of the department. Who is involved? Why is it necessary? Where will data be organized? And how will you get the department off the ground?

As the GIS manager at R.E.Y. Engineers—a land survey, civil engineering, and remote sensing company—I had a lot of research to do to get a GIS department started. Now, R.E.Y. is embracing GIS, and our GIS department is helping the organization operate more efficiently and effectively.

WHO

These are the two most important *whos* to consider when you are discovering what your GIS department will become:

- Who will support you?
- Who will be using your systems?

These may or may not be the same stakeholder. You know GIS will be valuable to your organization—that's why you're doing this! If you're lucky, you are already part of a group that is working together and knows how beneficial GIS can be. But you need other people in your company to support this endeavor.

First, read the room. Are there others in your organization who are interested in GIS? Even if they may not be your target audience, involve them in the effort. Whenever my coworkers ask me a GIS question, I make a point to enthusiastically explain the answer. Show coworkers your current projects along with GIS applications others are working on. Ask for people's opinions of your projects to generate conversation. Word of mouth is powerful, so do what you can to get others

on your team. This will look different for every organization based on its structure.

Be patient and persistent. Support will grow slowly. Some people may be less interested in GIS because they are busy or don't yet see how it can be applied. Don't be discouraged. This isn't personal. Not everyone has the capacity to be a cheerleader, and that's OK. Bring along everyone you can. When they see how GIS applies to your organization's mission, they will come around.

This brings us to the second *who* on our list: the user. Whether your GIS products are internal or external, you need to consider what your stakeholders need and why. At R.E.Y., we are using GIS as a project management tool internally while trying to grow our external market. The project management angle helps my coworkers learn more about GIS in a hands-on environment, which grows GIS support.

WHY

The best way to strengthen your case is with a motive. Keep your *why* in mind. GIS is a massive umbrella you can put many things under. It is easy to get overwhelmed or sidetracked. Establishing the reason you are creating this GIS department will help you create focused goals. What gaps are you looking to fill? What will you use GIS to accomplish?

Once you have your *why*, share it. Communicate with decision-makers in your organization about why this department is being established. This will give your coworkers an entry point. Even if they don't understand how GIS works, they likely understand the value of data management or communication. Use your *why* to make this department more tangible.

Be a good listener. The thing you are creating may be exciting, but does it have a reason to exist? Solutions should be solving something. A new GIS department should be a response to a need. Otherwise, you may become frustrated when people don't use your product, and users will be frustrated because it's not what they need.

WHERE

We've all come across file structures that look like a crime scene. When establishing a new GIS department, you also need to establish early on where everything will be stored. Your organization hopefully already has file structures. If so, do your best to align new efforts with the existing file structure. At R.E.Y., we use project numbers and names to distinguish projects, so when I create a relevant ArcGIS Online map or application, I create folders using that same structure.

Starting off organized will boost your efficiency and credibility. Leave breadcrumbs through process documentation for yourself and others. Whenever I work on a new project, I create a Microsoft Word document to explain the *how* and the *why*. In this document, I include things I tried that failed, opinions I got from others on the project at each stage, and questions I have. This helps me pick up where I left off, rather than feeling lost; and if another person needs to work on or take over the project, they will be able to retrace my steps.

HOW

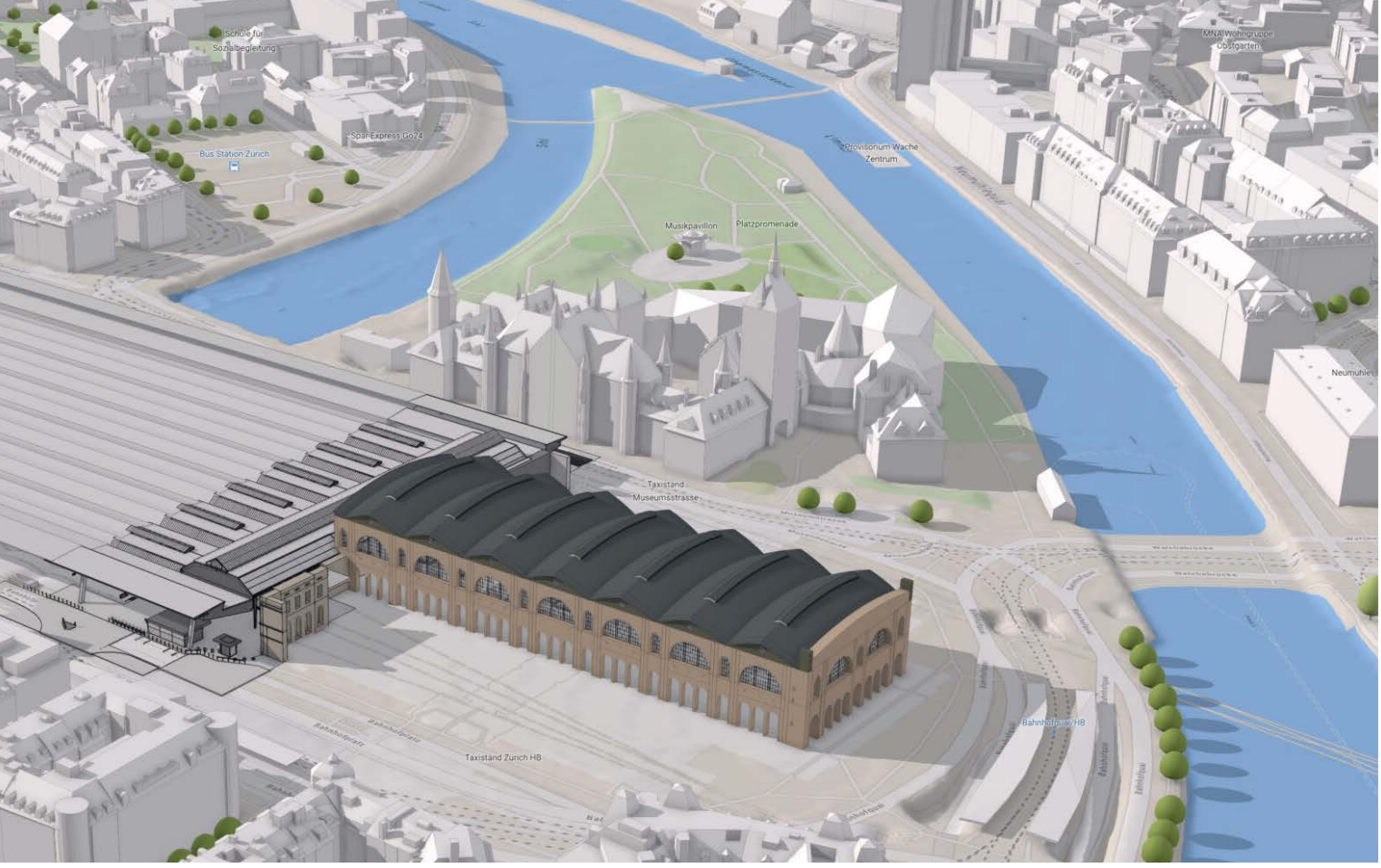
How will you actually create your GIS department? Be honest with yourself about who is currently involved, what your current resources are, what your future resources may be, what assumptions you are making, why you are creating this department, what your timeline is, and where things will be stored.

Considering all of this carefully will lead you to a plan. Your plan will change as you go. Mine changes all the time, but it gives me direction. Make your plan as specific as possible. Communicate your plan clearly with anyone involved. Highlight where you could use support from coworkers or your employer to make the department a reality. This will open the door for more questions and variables that need to be considered.

Mysteries are not solved by having all the information up front. They are solved by finding the most relevant details and piecing them together. When you create your GIS department, you won't be able to predict the future, and you won't have all the answers. But by taking all these factors into account, you will have a clear path forward to building a GIS department for your organization.

About the Author

Molly Casey is a GIS project manager at R.E.Y. Engineers, where she founded the organization's GIS department. To foster greater integration of GIS within the organization, she has spearheaded initiatives such as a monthly newsletter to share valuable tips and insights on how to incorporate GIS into existing workflows. Casey uses her creativity and problem-solving skills to foster a culture of innovation and shared knowledge within R.E.Y., and to pave the way for a more data-driven approach to surveying, engineering, and remote sensing projects.



Getting Acquainted with 3D Object Layers

In web GIS, the demand for managing a wide variety of 3D data is rapidly growing. The support for 3D models is especially important due to their widespread use across various industries. Thus far, scene layers have been the means to address this demand. However, this 3D object workflow requires all necessary data to be managed locally (as a multipatch feature class) and published as a web layer for visualization. While this method works well for static 3D content that doesn't need frequent updates, it lacks flexibility; any data changes require the layer to be republished.

By Nikola Marincic

↑ A highly detailed 3D model capturing Zurich's train station, geolocated within a realistic and accurate 3D environment. The model is securely stored in the 3D object layer, and it can be edited at any time without republishing the layer.

With the 3D object layer, however, not only can you host your 3D models in ArcGIS Online and ArcGIS Enterprise, but you can also add, update, or delete these 3D features directly on the web using Scene Viewer or custom web apps built with ArcGIS Maps SDK for JavaScript. As a result, ArcGIS can function as a system of record for geolocated 3D objects such as buildings, building parts, street furniture, bridges, or underground structures.

It's easy to see how 3D object layers can be applied across industries. For instance, architects, engineers, and urban planners can georeference and evaluate their designs directly within a 3D context, leveraging 3D basemaps. Government agencies can further streamline and digitize the electronic submission process for building and planning documentation. They can also provide public access to downloadable 3D assets, enabling faster and more efficient workflows for their users. Archaeologists can create and update 3D models of excavation sites, preserving detailed records of their findings. Alternatively, historical sites can be reconstructed virtually, enhancing

understanding of civilizations and enriching educational practices. Models of existing buildings or their exported parts can be seamlessly integrated within the context provided by other 3D layers.

You can also upload models in various formats. Upon upload, your models are securely stored in the 3D object layer without loss and are accurately geolocated. Once you store a 3D model, you can easily update its position, orientation, scale, and other custom attributes without altering the source files.

The capabilities of the 3D object layer are realized by integrating a 3D object scene layer with a 3D object feature layer.

Publishing a 3D Object Layer

To create and publish a 3D object layer, you can use either ArcGIS Online or ArcGIS Pro (3.2 or newer). ArcGIS Online provides a more streamlined workflow for publishing an empty layer. However, if you are using a projected coordinate system (PCS), it is better to set up your project and publish the layer using ArcGIS Pro.

Choosing the appropriate spatial reference for a GIS project is crucial. To ensure compatibility of the 3D object layer with your project, publish it using the same spatial reference.

To visualize your data on the globe, use a global scene and make sure your 3D object layer is published using the World Geodetic System (WGS) 1984 coordinate system. To work in a PCS suitable for your geographic area, use a local scene. Ensure that your data (including basemaps and layers) and your 3D object layer are published in that PCS. This ensures maximum accuracy in georeferencing your 3D content.

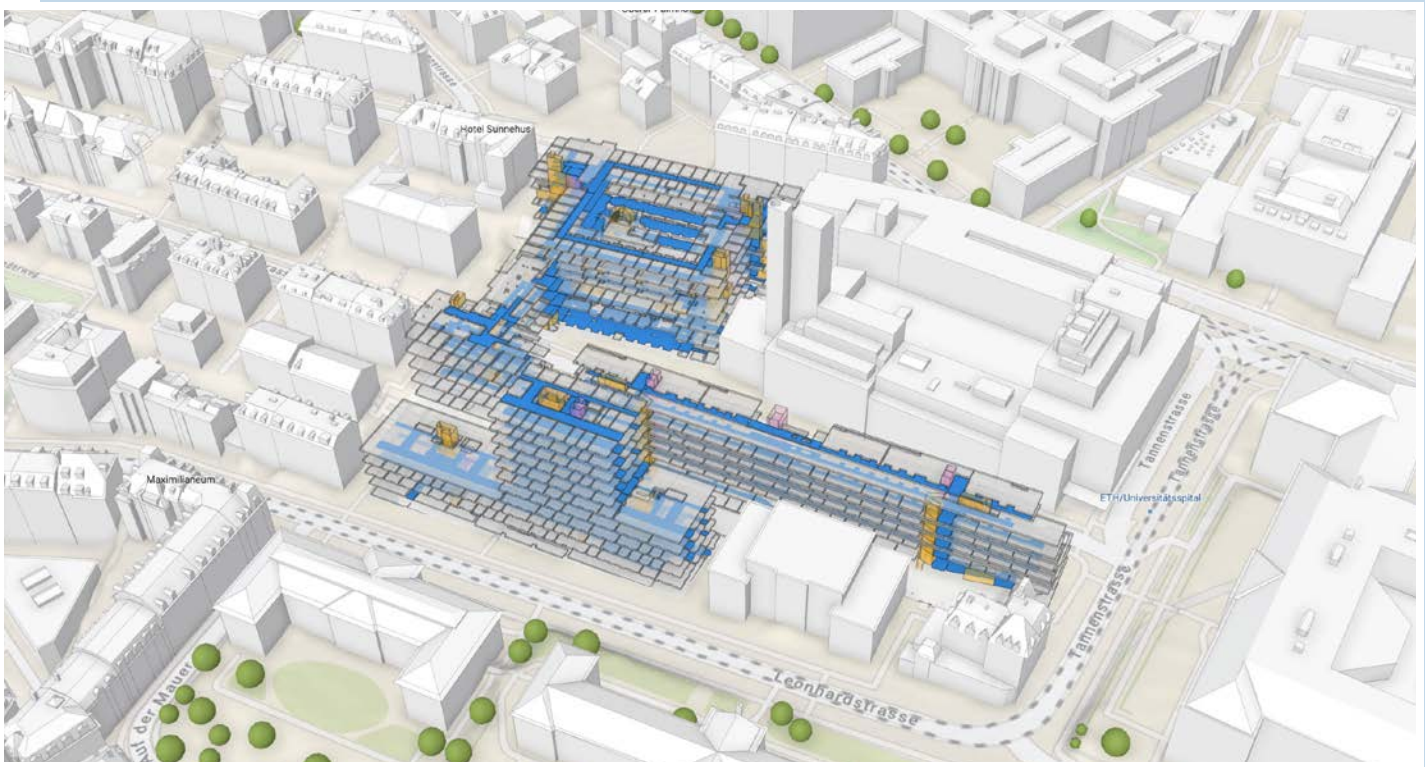
While Web Mercator is a commonly used PCS for visualizing web GIS content, it introduces significant distortions and scale variations. It is not recommended for a local scene (projected) or as a spatial reference for publishing 3D object layers.

Sharing 3D Object Layers

When sharing a 3D object layer with other people, consider two key questions:

- Who should be able to perform edits such as adding, updating, and deleting models?
- Who should be able to view the layer and its edits?

To define your sharing setup, you have two tools at your disposal: the layer's sharing settings and the option to enable or disable editing. Different sharing scenarios require different combinations of these two settings.



↑ Models of existing buildings or their exported parts can be seamlessly integrated within the context provided by other 3D layers.

The scene layer enables efficient display, while the associated feature layer serves as a database, enabling ad hoc editing and querying. There may be a temporary performance impact during the editing process, as edited features are drawn from the feature layer rather than the optimized scene layer cache. The extent of this impact on your workflow will depend on the number and complexity of the edits. However, once editing is complete—or at regular intervals—you can rebuild your 3D object layer through a process known as caching, restoring it to its full efficiency.

Each layer has three default sharing options: Owner, Organization, and Everyone (public). When you publish a layer, you are its owner. Administrators in your organization have owner-type permissions on all items. In ArcGIS Online, clicking the item's sharing button opens a dialog box where you can set the default sharing level and group sharing. Publishing a 3D object layer creates two items—a 3D object scene layer

and a 3D object feature layer. The sharing options for these layers must match.

In the ArcGIS ecosystem, groups provide a flexible way to broaden users' access to resources inside and outside your organization. By using group sharing, you can extend access beyond the default levels of Owner, Organization, and Everyone. For instance, if your default sharing level is Owner and you share a layer with a group of four members (excluding the owner), all five members will have access to the layer.

In ArcGIS Online, within the Share dialog box, you can point to Set group sharing; click Edit group sharing; select the groups you wish to grant access to; then click Apply.

Understanding, Enabling, and Disabling Layer Editing

Editing on the 3D object layer must be enabled once to activate its capabilities. After this initial activation, you can disable editing, restricting edits to the owners.

In ArcGIS Pro, you enable editing by checking the Enable editing option. You can verify this in Portal for ArcGIS after publishing. Open the item page for the associated feature layer, click the Settings tab, then scroll down to the Feature Layer (hosted) section. Ensure that these options are checked: Enable editing; Keep track of changes to the data (add, update, delete features); Add; Delete; Update; and Attributes and geometry. If you forgot to enable editing in ArcGIS Pro, check all of the above options and click Save to confirm the changes.

To disable editing after it has been enabled, simply uncheck Enable editing on the same page and click Save. Note that creating an empty 3D object layer in ArcGIS Online automatically activates editing capabilities.

Sharing Scenarios

Combining sharing settings and enabling/disabling editing enables many layer-sharing scenarios. To implement the following scenarios, it is assumed that you have initially enabled layer editing.

- **Owner-only viewing and editing:** If the sharing level is set to Owner for both layers (the default option in ArcGIS Pro), only the owners can view and edit the layer.
- **Organization viewing—editing according to user roles:** If you share your layers with your organization and the editing is enabled, the user roles within your organization will define layer editing permissions. For example, users with Editor or Publisher rights can make edits, while users with the Viewer role can only view the layer and its edits.
- **Organization viewing—owner editing:** If you shared your layers with your organization per the previous example, disabling editing on the feature layer will keep the viewing permissions intact but restrict editing permissions to the owners.
- **Public viewing—owner editing:** Here, anyone can see the layer and its edits, but only the owners can perform edits. If using ArcGIS Pro, you must first check Approve for Public Data Collection, on the Configuration tab. Then enable editing to allow editors to add, delete, and update attributes and geometry. After your layer is successfully published, disable editing. If you initially had a different sharing configuration for your 3D object layer and wish to transition to this one, first disable editing on the feature layer; then, for both layers, set the sharing level to Everyone (public).
- **Restricted viewing—owner editing:** This configuration allows granular access to view the layer, while editing access is restricted to the owners. Set the default sharing level and extend the access by choosing which groups to share the layer with. Make sure the groups you share with are not shared update groups (explained in the following scenario). Finally, disable editing.
- **Restricted viewing—restricted editing:** This scenario makes use of shared update groups to manage who can make edits. All group members will be able to edit the layers shared with it. When creating a shared update group, ensure that the

Shared Update option is enabled within Group designations from the beginning, as this option cannot be modified once the group is created. Share both layers with the shared update group. If necessary, include other, nonshared update groups to provide more granular viewing permissions. Finally, disable editing on the feature layer to restrict editing access to the owners and Shared Update group members.

↓ A web scene featuring the city center of Zurich, Switzerland.

Editing 3D Models in Scene Viewer

Scene Viewer allows a simple, out-of-the-box setup for editing 3D models, making it a great place to start with 3D object layer editing.

To enhance your editing experience, click Settings at the top of the editor. This will reveal tool tips and snapping options. If you wish to place or update your models using numerical coordinates, toggle on Enable tooltips. To be able to place your models precisely on corners, edges, or surfaces of other features, toggle on Enable snapping. Additionally, make sure to activate the following options: Geometry guides and Feature to feature. In the Snapping layers collapsible panel underneath, select the layers to which your features will snap.

If snapping is activated and the relevant snapping layers are enabled, your model will automatically align with the corners, edges, or surfaces of nearby features during placement. You will notice orange lines indicating the alignment.

To utilize tool tips while placing your model, press Tab. A modal will appear next to the cursor with five editable fields—X, Y, Z, Orientation, and Scale—along with three lock widgets for the axes. You can now manually input the values in these fields. To leave this mode, press the Esc key.

If you decide to change a model's position, rotation, or scale at a later stage or remove it entirely, you can easily do this using the Editor widget. Performing any of these operations (add, update, delete) in any supported client does not require republishing the 3D object layer.

Currently, you can upload and store your 3D models in the following formats:

- **COLLADA (.dae)**
- **Autodesk Filmbox (.fbx)**
- **Autodesk Drawing (.dwg)**
- **Industry Foundation Classes (.ifc)**
- **Universal Scene Description (.usdc, .usdz)**
- **Wavefront (.obj), GL Transmission Format (.glTF)**
- **Binary GL Transmission Format (.glb)**

If the intrinsic unit of the 3D model is not specified when loaded into a global scene, it will be interpreted as a meter (1 unit = 1 meter). Conversely, if the model is loaded into a local scene, the assumed unit corresponds to the unit of the projected coordinate system. Per specification, glTF models (.glb and .glTF) will always be interpreted as modeled in meters.

Uploaded models, including textures, can be up to 100 Mb in size for reasonable display and editing performance.

Caching 3D Object Layers

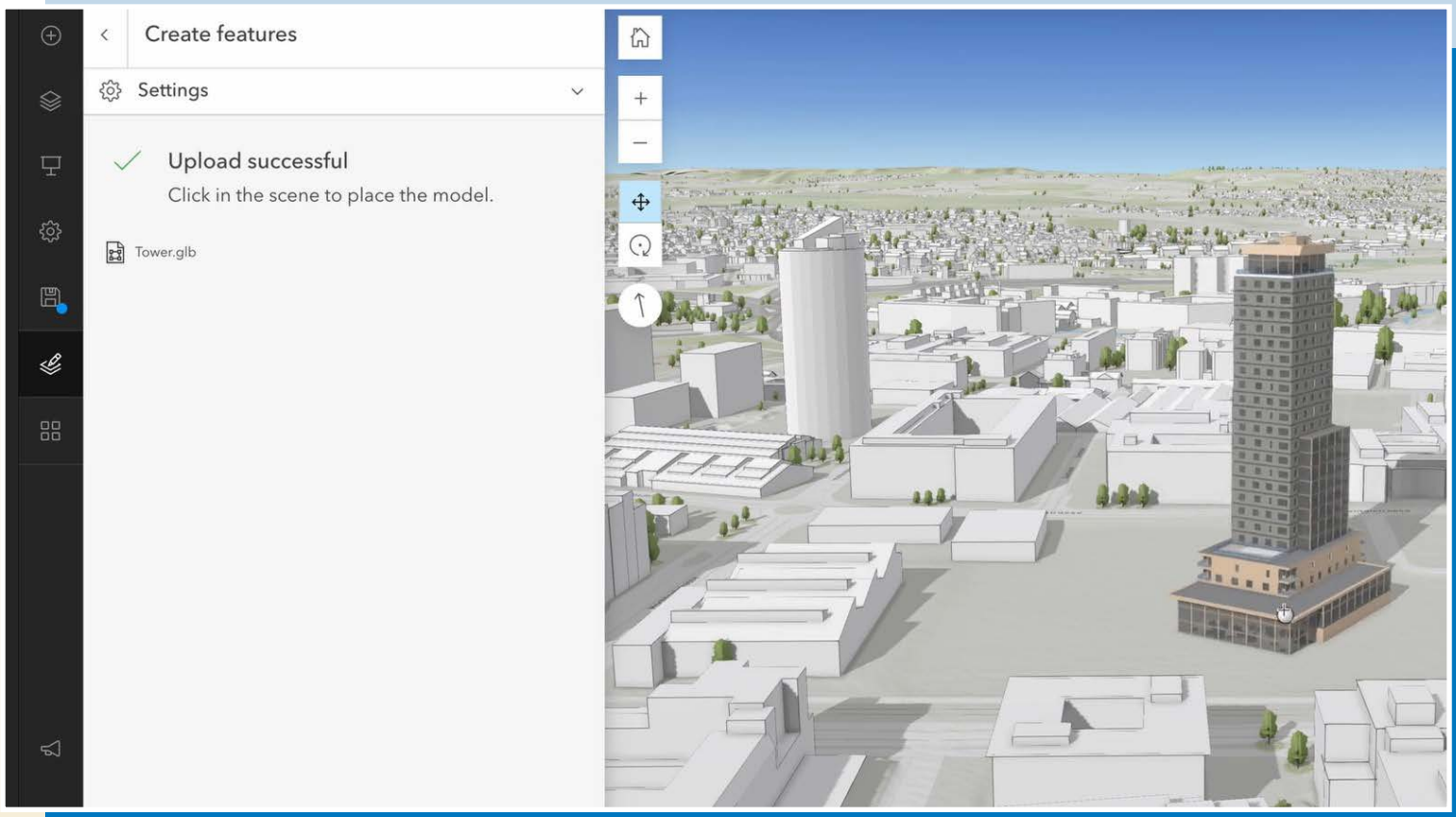
Editing the 3D object layer temporarily affects display and loading performance. This impact varies depending on the complexity of the models and the number of edits. The more edits you make without rebuilding the scene layer cache, the more the scene performance will be impacted, as all new or updated models will display in full detail. Uploading more objects to the 3D object layer in one session will increase the time required to optimize them for performance in the subsequent phase.

Once editing is complete, a process known as caching is used to rebuild the 3D object layer with all the changes made during the editing phase. This restores the optimal loading and display performance, even with numerous newly added 3D features. Keep in mind that caching is a computationally intensive server-side operation. Its usage incurs costs measured in credits. The more data needs to be cached, the more credits the operation will require.

Best Practices

It is difficult to provide a one-size-fits-all strategy for effectively balancing editing and caching. This challenge arises from the wide range of possible scenarios involving model sizes and complexity, the number of models, and the number of editors and edits they make. Therefore, the most effective approach is to learn through experience by adhering to the following best practices:

- **Plan your edits, test, and iterate.** Group your edits logically to minimize the number of cache rebuilds. If you notice significant performance degradation after adding a certain number of models, consider concluding the editing session and caching the changes made to the layer before starting again. Document your findings (including the number and average complexity of models added before impact degradation), and use this knowledge to refine your editing and caching strategy. This can help maintain performance and reduce the frequency of performance degradation during the editing phase.
- **Regularly rebuild the cache.** If the project requires ad hoc editing over



↑ Uploading a 3D model in Scene Viewer.

time, schedule regular cache rebuilds to integrate changes and restore the scene layer to its full efficiency. This helps maintain optimal performance, especially after significant editing sessions.

- **Educate your team.** Ensure that all team members involved in editing scene layers understand these best practices. Consistently applying these guidelines will help maintain performance and efficiency across the board.
- **Optimize models and textures.** Three-dimensional models are created for various purposes. Some will be appropriate for your use case, while others might cause issues. The most common issues involve the complexity of the model's geometry and the size of its textures. High geometric complexity can lead to visualization problems, especially when automatic Level of Detail (LoD) simplification reaches its optimization limits. Large textures can also be an issue as they will take up much of your valuable storage space and slow down uploads and downloads.

In scenarios where you are working with a limited number of 3D models and have powerful client-side hardware, optimization may not be necessary, even for overly complex models. In case a need for optimization arises, consider the following steps:

- **Simplify geometry.** Use your preferred 3D modeling software to reduce the complexity of exported geometry. For instance, in Blender, you can unsubdivide the mesh or utilize the limited dissolve feature to eliminate unnecessary vertices and edges separating flat regions. If exporting an IFC model from Revit, adjust the tessellation level on the Level of Detail tab; this will simplify some Revit elements like elbows, floors, railings, and pipe fittings. Depending on your needs, choose between extra low, low, or medium level of detail.
- **Reduce texture size.** Large textures are among the most common contributors to large model file sizes. Consider downscaling your textures if they contain details that do not contribute to your visualization.
- **Export selectively.** If you are exporting purely for visualization, consider including only the layers relevant to your visualization. This typically involves removing some interior walls, furniture and fixtures, construction details, plumbing, electrical and HVAC components, site utilities, and other elements that do not contribute to the visualization.

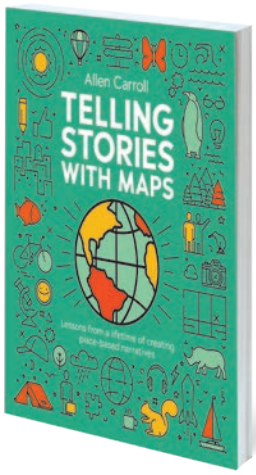
About the Author

Nikola Marincic is a product engineer on the ArcGIS Maps SDK for JavaScript team, specializing in enhancing the 3D capabilities of web GIS. As a former architecture professor, he is committed to developing well-designed and structured products. In his spare time, Marincic enjoys composing music and running.

Bookshelf

Telling Stories with Maps: Lessons from a Lifetime of Creating Place-Based Narratives

By Allen Carroll



While humans have used maps for centuries—from scraping patterns in the sand to charting every place on Earth—the digital age has revolutionized the way maps are created, distributed, and consumed. The internet has enabled maps to interact with other multimedia elements, including photos, videos, audio, and text, to tell countless tales about the world. In *Telling Stories with Maps: Lessons from a Lifetime of Creating Place-Based Narratives*, author Allen Carroll—bringing his 27 years of experience working for both the National Geographic Society and Esri—showcases how maps tell stories and enrich narratives with context and insight. The book, which features a foreword by Lonely Planet cofounder and renowned travel writer Tony Wheeler, contains rich illustrations, with examples ranging from traditional maps to the latest digital visualizations. Readers will be inspired to produce place-based narratives that intrigue their audiences. June 2025, 244 pp. Ebook ISBN: 9781589487956 and print ISBN: 9781589487970.

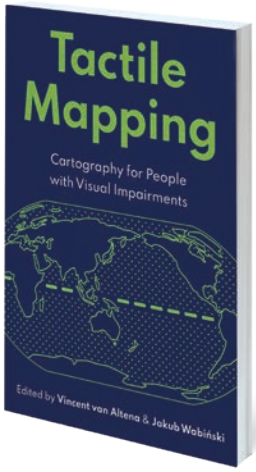
Esri Advanced Guide to Python in ArcGIS

By Dave Crawford and Daniel Yaw

Are you ready to take your Python knowledge to the next level? *Esri Advanced Guide to Python in ArcGIS* teaches readers how to integrate Python with ArcGIS capabilities. With step-by-step tutorials that get increasingly complex with each chapter, authors Dave Crawford and Daniel Yaw teach readers technical and problem-solving skills that can be applied to job-focused assignments, including understanding client needs, performing market analytics, and managing ArcGIS Online organizations. Intermediate- and advanced-level programmers looking to enhance their GIS capabilities will be able to take the concepts outlined in the book and immediately use them in projects. June 2025, 268 pp. Ebook ISBN: 9781589488243 and print ISBN: 9781589488236.

Tactile Mapping: Cartography for People with Visual Impairments

Edited by Dr. Vincent van Altena and Dr. Jakub Wabiński



While most people rarely think about their eyes' capacity to capture the world around them, for many people, injuries, illnesses, aging, and other health issues hinder their ability to see and navigate their surroundings. When it comes to maps, assistive technology can only do so much and often can't relay the nuances of a landscape, changes in elevation, or the presence of nearby bodies of water. This lack of geographic awareness makes it difficult for people with visual impairments to explore unfamiliar neighborhoods and gain a geospatial understanding of local, regional, and international phenomena. Tactile maps can be life-changing for people with visual impairments, offering them greater independence and inclusion. Yet much of the research done in this field has been inaccessible to a broader audience. *Tactile Mapping: Cartography for People with Visual Impairments* aims to bridge this gap by exploring the subject from a multidisciplinary perspective, illustrating cartographic theory with real-life case studies and user stories. A collaboration among skilled professionals, domain experts, and people with visual impairments, *Tactile Mapping* offers fresh insight from three perspectives: user experiences, scientific research, and practical implementations. The book offers cartographers and other geography practitioners new knowledge on the foundations and methods of presenting geographic information in more accessible ways. August 2025, 270 pp. Ebook ISBN: 9781589488366 and print ISBN: 9781589488359.

For more information on all Esri Press publications, visit esri.com/esripress.

GIS Users Integrate Everything, Everywhere

The summer of 2025 marked the fourth time Layne LeBleu has attended the Esri User Conference (Esri UC), held July 14–18 in San Diego, California.

"Vibes are high," said LeBleu, a GIS and asset management analyst for the public works department at the City of Hillsboro, Oregon. "It's really cool to see a bunch of people talking about the work they've been doing and the steps you can take to be a bigger advocate for the work you're doing."

LeBleu is one of more than 15,000 GIS professionals who attended the conference to explore and celebrate the latest advances in geospatial technology. Over 14,000 people tuned in virtually. Attendees came from all over the world, from a variety of industries and levels of expertise. They were excited about emerging technologies like geospatial AI, meeting like-minded professionals, and learning about new capabilities to incorporate into their work.

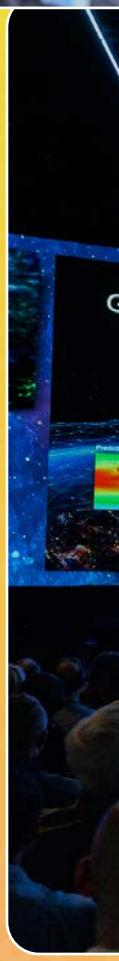
"[I'm here] to learn innovations in GIS, see what's going on and what's new," said Irene Egbulefu, GIS analyst for Travis County, Texas, who was attending the conference for the third time. "My company uses a lot of GIS, so we need to be up-to-date with what's going on."

No matter how far they traveled or what topics captivated them, attendees were focused on finding and sharing ideas to improve their work through special interest group meetings, user presentations, technical sessions, and more. This was the central thrust of the conference: combining GIS knowledge, data, content, and analytics to help individuals and organizations make informed decisions and create positive change in the world—in other words, Integrating Everything, Everywhere, the theme of this year's Esri UC.

At the start of the Plenary Session that kicked off the conference, Esri President Jack Dangermond spoke to this idea.

"Our world is evolving rapidly," he said. "Our lack of collaboration is now threatening our future—some say even the future sustainability of life itself. These challenges suggest that we need a new approach that integrates our collective knowledge [and] creates a better future."

This approach is geography—the language that provides a common understanding of the science of our world.



The Plenary Session was dedicated to highlighting new capabilities within ArcGIS and showcasing how users of ArcGIS technology are using the language of geography to better their workplaces and communities.

AI, Meet ArcGIS

It was no surprise that AI was a hot topic for both presenters and attendees. In his opening remarks, Dangermond noted that we are entering a new age with the rapid advancement of AI.

"Our world needs much more than this technology," he emphasized. "It needs your work—the work of GIS professionals playing this vital role in what comes next."

Esri solution engineers Jess Altamira and Caitlin Marin demonstrated ways that AI is being built in across the ArcGIS ecosystem to not only help geospatial professionals complete their tasks but also open up the technology to other users.

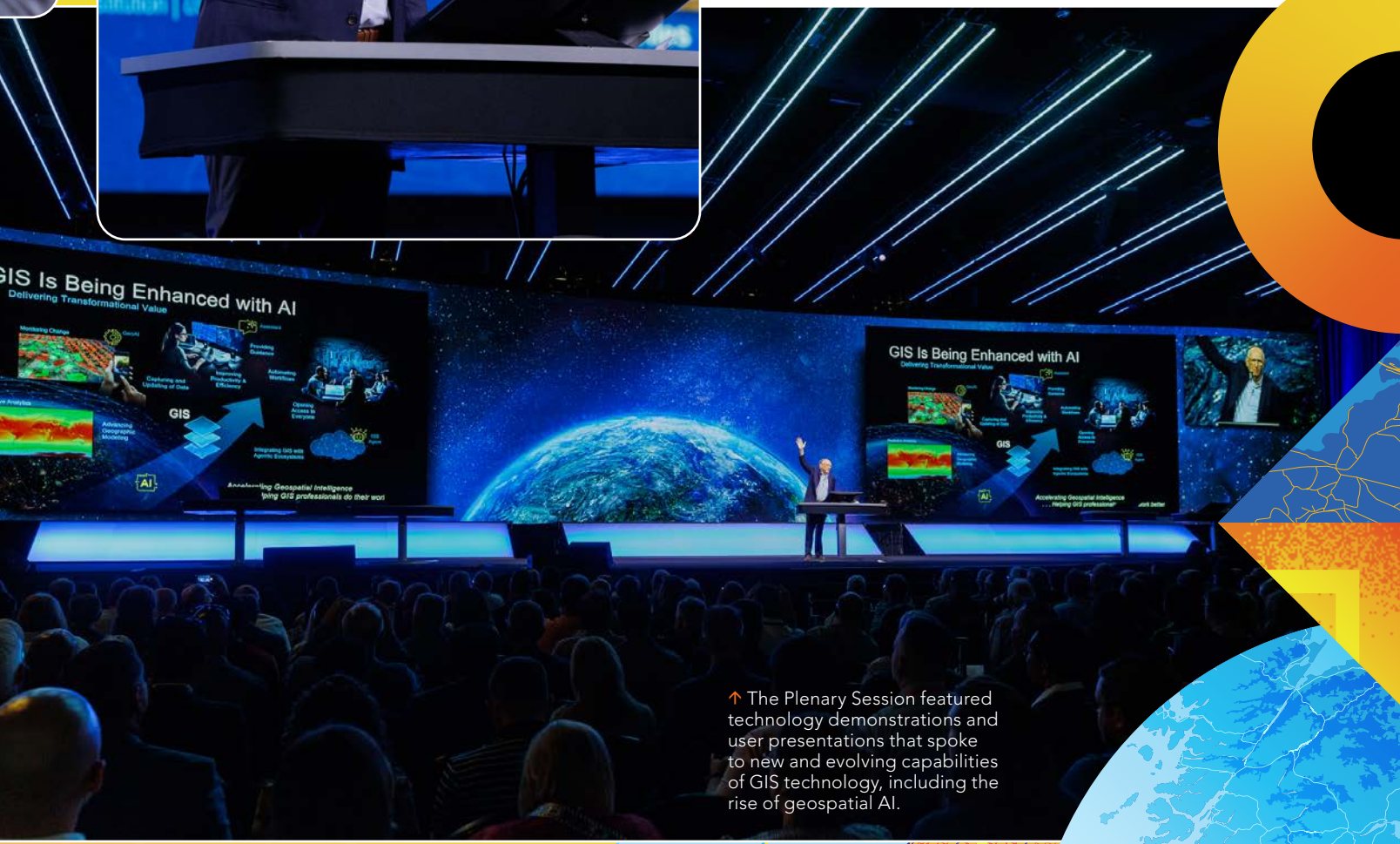
Using ArcGIS Survey123, Marin showed how, by simply uploading a photo of a damaged sidewalk, AI could fill out a related service request form and correctly categorize the request type, identify potential safety hazards, and choose the appropriate city department to notify about the issue. Then, Altamira—speaking Tagalog, which was automatically translated into English—demonstrated how AI can transcribe a voice recording and even translate different languages while filling out relevant fields in the form.

"By integrating AI into GIS, we can enhance data collection workflows and make them accessible for anyone," Altamira said.

Geospatial AI can also be used in ArcGIS to train deep learning models and automate workflows. Altamira took a few images of roads in Chattanooga, Tennessee, and manually marked cracks and potholes in

← In his Plenary address, Jack Dangermond emphasized the importance of collaboration and the power of geography as a language for common understanding.

←← More than 15,000 people attended the 45th annual Esri User Conference.



↑ The Plenary Session featured technology demonstrations and user presentations that spoke to new and evolving capabilities of GIS technology, including the rise of geospatial AI.

the asphalt. She then used those images to train a deep learning model to detect damage in scores of images.

"Imagine how long it would take to assess every single photo for damage," Altamira said. "With our newly trained AI model, we can identify damage locations and generate those results in just a few minutes."

The Present and Future of GIS Capabilities

AI wasn't the only game-changing technology showcased at the Plenary Session.

Esri senior solution engineer Kelly Holleran took audience members on a tour of new and updated basemaps and imagery in ArcGIS Living Atlas of the World, including updated National Land Cover Database imagery and Esri's enhanced Bioclimate Projection layers.

Esri solution engineer Megan Hendrick used a proposed data center in Ann Arbor, Michigan, to demonstrate how tools such as the new COGO Reader and Vertices and Nodes in ArcGIS Pro simplify data editing and management processes.

Enhancements to data editing and management extend to the field as well. ArcGIS Field Maps will soon support a to-do list experience that lets users prioritize their tasks, go step-by-step through their work, and update network data. All this can be done in Field Maps while working offline.

To illustrate new capabilities in spatial analysis, Esri solution engineer Dr. Lakeisha Coleman used H3 hexagons—a global grid system that provides stable analysis areas at multiple scales—to help site local government and commercial services using detailed data from Esri's updated ArcGIS Tapestry, a collection of market segmentation data that classifies neighborhoods into distinct segments and life mode groups.

Coleman's colleague, Esri solution engineer Russell Sands, then showed the audience how ArcGIS is integrated in Microsoft products, including Excel, Power BI, and notebooks. In Excel, users can map their geographic data and insert geospatial analysis functions directly into their spreadsheets. With ArcGIS for Power BI, users can bring spatial analytics to their reports, allowing decision-makers to see the results of their complex analyses with one click. And ArcGIS GeoAnalytics for Microsoft Fabric enables users to define and run analytics in notebooks, plus leverage dozens of spatial functions and tools from ArcGIS. Soon, with ArcGIS Maps for Microsoft Fabric, users will be able to explore their fabric data in Map Viewer, too.

After a presentation demonstrating the evolving capabilities of reality mapping, Esri technology leader Taisha Fabricius, Esri product engineer Hasret Gümgümcü, and Esri software engineer Stefan Arisona demonstrated the capability of XR Viewer. This tool provides a new way to visualize 3D data by bringing together multiple map layers in a single scene. Designed to present any web scene as an immersive environment, XR Viewer allows multiple users to work together in the same scene at the same time, either from a bird's-eye view or at ground level. The viewer lets you work just as you would in a traditional mapping environment by turning layers on and off, but also includes realistic effects like weather and atmospheric lighting. Experiences can be created in XR Viewer with web scenes; 3D layers; and data from Map Viewer, from Scene Viewer, or shared in ArcGIS Online. While the immersive experience looks great through a VR headset, it isn't required. XR Viewer is already available in beta to all ArcGIS users.

GIS Users Take Center Stage

Of course, the central focus of the Plenary Session—and of Esri UC as a whole—is the work of GIS users. Many dedicated GIS professionals spent their time on the Plenary Session stage breaking down this fascinating and critical work.

GIS experts from San Francisco International Airport described how they integrated multiple systems into their GIS to map and manage more than half

↑ Presenters from CAL FIRE explained how the department leverages GIS to map fire perimeters.

← Eric Hamilton, from CVS Health, described the company's mission to use GIS to make the world of health care easier to understand and navigate.

↙ Esri engineers demonstrated the new XR Viewer, an immersive tool for visualizing data in 3D.

a million assets with a 3D digital twin. Josephine Young, the airport's director of infrastructure information management, described the airport as a small city that never sleeps, with a GIS that represents more than 700,000 features, including natural gas and jet fuel lines, airfield lights, planes, parking garages, and more than 15,000 rooms. Supported by the digital twin app, Young said that the airport's new operation center "will act as the nerve center of the airport to make sure that there's a seamless guest experience."

Aurecon—an international design, engineering, and advisory firm—followed up with a presentation about HumeLink, a massive infrastructure project. HumeLink aims to build new transmission lines in southern New South Wales and connect renewable energy to Australia's electricity grid. The firm's goal is to protect the land and natural resources by "planning with purpose, assessing with impact, and reporting with integrity," according to Em Tantau, Aurecon's product leader for technical engineering. To communicate the hundreds of layers and attributes necessary for finding the best corridor for the transmission line, the firm built the Root Planning assessment tool. The tool enables Aurecon staff to map and quantify data layers like soil and slope into risk and opportunity scores.

"The key to this complex project is to make our delivery simple and well understood through a suite of digital design tools powered by GIS," said Martin Russell, director of GIS, Environment & Planning at Aurecon.

The next user presentation was from CVS Health, detailing how the company leverages GIS to make the world of health care easier to understand and navigate. Sean Horman, senior manager of analytics services at CVS, explained that when the state of Texas suffered a major power crisis in 2021 as a result of winter storms, it left CVS trying to coordinate disaster response across dozens of teams. The company had the data to answer questions such as which medication deliveries would be disrupted, but the data was siloed. This crisis led to the development of the Crisis Command Central application. The app is designed to put assets into a geographic context and provide real-time visibility

into the operations and hazards across the business. When a severe storm occurs, CVS can now see what stores are operational, which colleagues are affected, and which medication deliveries are vulnerable. CVS also uses the same GIS foundation for CVS Specialty, as well as the consumer-facing CVS Health app. Geographic context helps inform daily transactions by integrating data and real-time weather information.

With the massive Los Angeles wildfires of January 2025 still on the mind of many Southern California residents, the presentation from the California Department of Forestry and Fire Protection (CAL FIRE) was imbued with a sense of gravity. CAL FIRE maps fire perimeters by using remote sensing and GIS data from airplanes flying 10,000 to 12,000 feet above fires. This information goes to fire analysts and incident commanders to determine where a fire is located and where it may go, helping airborne research data specialists protect people and resources from wildland fires—before, during, and after fire events. CAL FIRE research data specialist Logan Hansen described how a flight app powered by ArcGIS Pro provides custom geoprocessing tools, features, and layouts.

The Science of When Meets the Science of Where

The keynote speech was given by Dr. Kirk Johnson of the Smithsonian National Museum of Natural History. As the museum's Sant director, Johnson oversees the world's largest natural history collection.

"In the same way that GIS is more than just about maps, museums are more than just about exhibits for kids," he said, explaining that they are places of knowledge creation and sharing.

Johnson described the goal of providing people with online access to about 1.1 billion specimens in the world's largest natural history museums, to help aggregate knowledge and provide solutions to the world's challenges, including mosquito-borne diseases, volcanic eruptions, reduced biodiversity, sea level rise, and recent rapid increases in the planet's surface temperature.

"We've entered a time where unexpectedly the Earth's geologic changes are happening on a human time scale," he noted. "GIS is a really powerful tool for being able to interpret what's going on in the future. My appeal to you is that you use the skill set that you have. Use GIS as a toolkit, and perhaps you can be some major part of how we negotiate the century in front of us."

Empowering Future Generations Through Science, Data, and Education

Closing out the Plenary Session was a presentation from students at the Colegio Agustiniano in Chitré, Panama, and their director, Sister Esther Maria Rodriguez Aranda, who focused on educational transformation through GIS. During the COVID-19 pandemic, Rodriguez Aranda began to wonder if the school was preparing the children for the uncertain future that lies ahead. After a student named Juan Diego introduced her to GIS, Rodriguez Aranda began a quest to introduce geospatial analysis tools in the school curriculum.

Rodriguez Aranda worked with Esri to start a GIS program that would connect education, science, and technology. The

← The Map Gallery showcased work from the global Esri community, including this snapshot of Dave Taylor's *Oceanic Oscillations* map on the Expo floor.

program began with 17 students and 3 teachers and has now grown to more than 300 students, with 100 trained specifically in remote sensing.

"Now they map, analyze, create, and lead solutions for the community," said Rodriguez Aranda.

Nieves Joel Perez Moreno, Ricardo Enrique Sanchez Gonalez, and Maria Jose Sepulveda Calle—students at the Colegio Agustiniano in Chitré—led individual presentations covering topics such as artificial lakes that are impacted by drought, urban expansion in Panama, and biodiversity research.

The final presentation was from student Franccesca Angelli Cravioto Salvatierra, who analyzed urban expansion in her hometown of Chitré. The results of this analysis show increased population growth in the central part of the city, and a corresponding increase in land surface temperatures.

Cravioto Salvatierra stressed that this is a call to action. "We need digital, accessible tools like maps that anyone can use," she said. "Chitré's future shouldn't be a guess. It should be a choice, one made with information, clarity, and vision."

Rodriguez Aranda echoed this sentiment in her closing remarks, emphasizing that the students in the GIS program are "learning to map based on real community problems, using the power of data with accessible tools, and committed to sustainable solutions and action that serve the community."

It was a reminder that the call for using GIS to integrate everything, everywhere is not just an abstract notion. Organizing and visualizing data leads to informed decision-making, and this kind of action leads to communities that work better for everyone. As Cravioto Salvatierra noted, the future shouldn't be built on guesswork. It should be a choice. As Esri UC attendees know well, geography is a common language that helps make it a better one.

Esri Education Summit Highlights GIS Successes & Opportunities in Schools

Held July 12–15 in San Diego, just prior to Esri UC, the Esri Education Summit provided opportunities for educators and school administrators to learn from each other while sharing success stories, best practices, and learning strategies related to geospatial technology. The summit also highlighted Esri education initiatives, which support educators in nurturing the next generation of GIS experts. Presenters discussed a variety of topics, including the following:

- **The Guide to the Geographic Approach** is a set of resources that teaches learners how to apply a geographic approach to real-world problems while linking lessons to web-based GIScience concepts.
- **Esri's K–12 education program** has partnered with the National Geographic Society to create a free web app called National Geographic MapMaker and is developing teaching resources for earth science and world geography classes.
- **The Geospatial Semester Program** is a partnership between James Madison University and several Virginia school districts in which high school students earn college credit and use GIS to understand local community issues and propose solutions.
- **Esri's Young Professionals Network** supports students as they move from college to GIS careers.
- **A partnership** between The Nature Conservancy and the National Geographic Society provides education and leadership experiences for young conservationists.

"I appreciated the wide variety of perspectives, including [from] individuals who work with primary and secondary teachers and students, as well as those connected to higher education and nonprofits or informal educational organizations," said attendee Rebecca Theobald, an associate research professor in the Department of Geography and Environmental Studies at the University of Colorado Colorado Springs. "The more ideas that can be shared about how to engage students and instructors with online mapping tools, the better. We need [more] students who will be ready to ask difficult questions and explore the answers using GIS."

→ Attendees of the Esri Education Summit were excited to share successes and strategies from the world of GIS education.

ELEVATE Your Dashboards with Themes

By Ally Shah, Leann Kurias, and David Nyenhuis

With ArcGIS Dashboards, it is important that your data has a look and feel that suits the story you are trying to tell. You may be delivering a business brief or planning a land-conservation project with your community—each of these will involve different colors and styling options that best communicate the data to your audience.

This is where dashboard themes come in. Within ArcGIS Dashboards, there are several provided themes that you can apply with a single click. You can also create custom themes to match your organization's style guidelines and user environments, complement the data, and more. The theme is saved with the dashboard and applied to both desktop and mobile views.

When you create a dashboard, you will see theme options available in the Theme panel. The light theme option is applied by default. Switching between theme options is easy, allowing you to choose one that suits your needs. All provided themes have been tested for appropriate contrast between text and foreground, ensuring that your dashboard is not only attractive but also easy to read. When adding a new chart, built-in colors for data visualizations are paired with colors in the layout for a professional, consistent aesthetic.

Using the theme panel, these theme options can also be applied to dashboards created prior to the June 2024 update. Your current theme will appear as a custom theme. To switch to the new theme, simply copy a new one for use from the themes list. If you want to try modifying an out-of-the-box theme, it will override your existing custom theme.

Custom Themes

Creating a custom theme, whether from scratch or based on an out-of-the-box theme, is simple and efficient. To copy and configure it, use the Customize selected theme button—you will see a custom theme panel displayed. Here you'll find

Light

Dark

Meadow

← You can apply out-of-the-box dashboard themes with a single click.

Forest

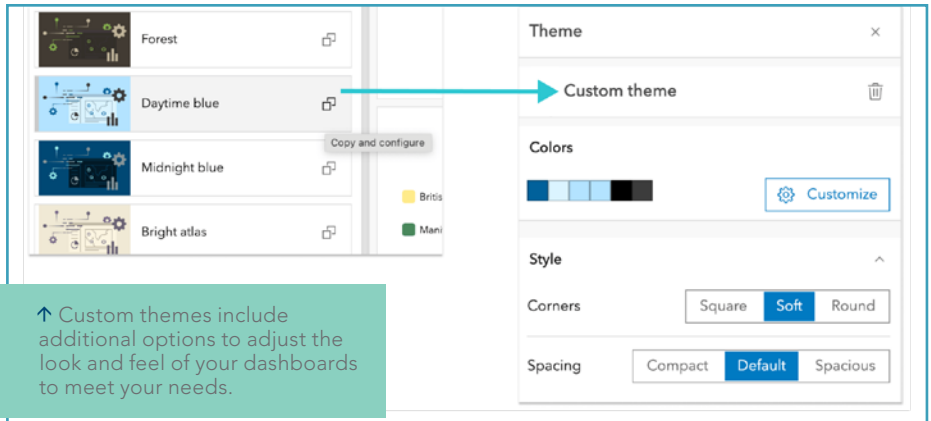
Enhanced Contrast

Daytime Blues

Midnight Blue

Bright Atlas

Classic Atlas

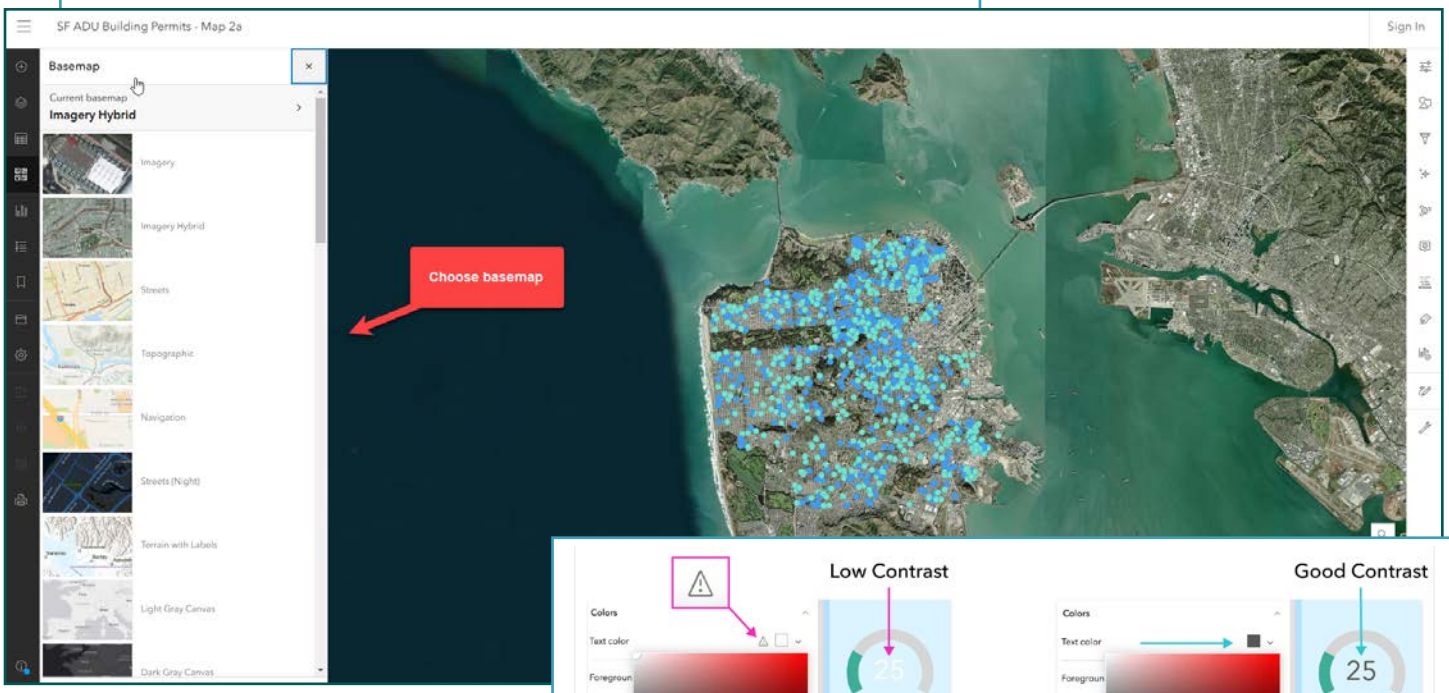


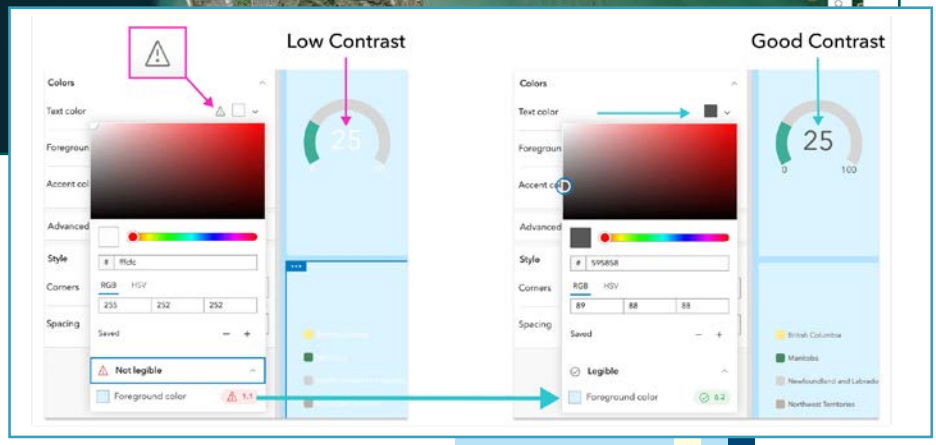
↑ Custom themes include additional options to adjust the look and feel of your dashboards to meet your needs.

Basemaps That Match Your Theme

Basemaps play an important role in making your data stand out. When it comes to aligning a map with the overall theme of a dashboard, balance is key. The right basemap can help tie your dashboard together, ensuring that the map's geographic context enhances your data without overpowering the overall design.

Many basemaps come with color-rich schemes and intricate details, which can





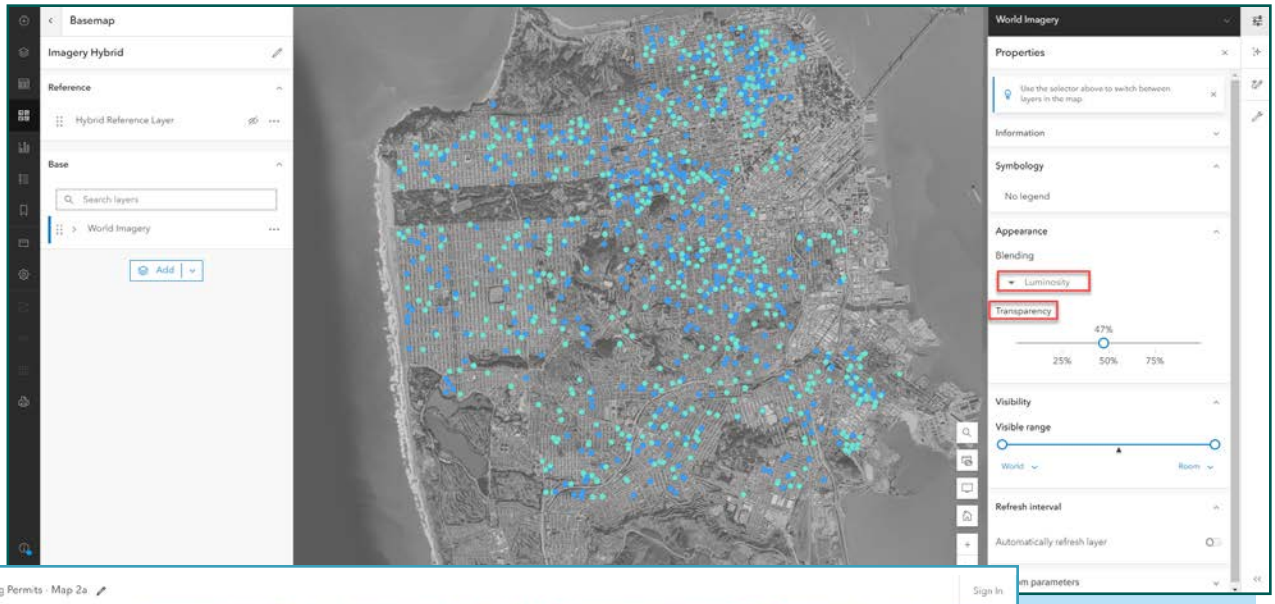
↑ If you need to adjust colors to meet contrast standards, try gradually sliding the color picker vertically until you see the alert disappear.

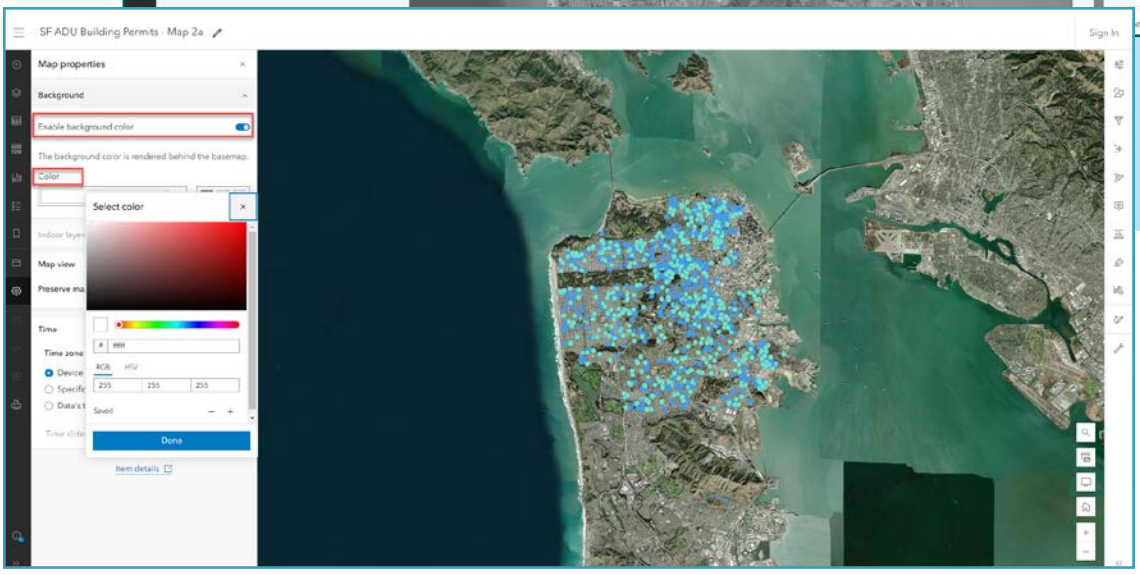
↑↑ Choosing a basemap.

options to further customize your colors along with additional styling controls for corner radius and element spacing.

Digging deeper into custom theme settings will help you find additional options to tailor the look and feel of your dashboard to meet your needs. In the Color section, click Customize to see options to edit the colors in your dashboard. Three key colors are used for the text, foreground, and accent for your dashboard, and they play a significant role in the overall appearance. If you expand the Advanced colors panel, you will see additional color options to adjust areas of the dashboard that were previously unavailable for adjustment.

If you're working with brand guidelines from your organization, this may be where you choose to incorporate them. As you adjust colors, you may notice an alert next to the color you've changed. These are part of a built-in color contrast checker, which can ensure that you've achieved adequate contrast between text and foreground. If this alert shows up, open the color picker and expand the area at the bottom to see where contrast may need improvement. As you adjust the color, you will see the alert in the panel disappear and the contrast checker will provide a positive indication.





↖ How to apply a background color.

← How to apply luminosity blending.

be distracting and diminish your data's ability to stand out. They can also compete with the theme colors in the dashboard. In such cases, ensuring that the basemap complements your dashboard theme is essential for maximizing both aesthetics and clarity.

To choose a basemap, open Map Viewer and access the Basemap pane by clicking the Basemap option on the Contents toolbar. You can then select from various basemap types, such as topography, imagery, or streets.

Whether your dashboard is using a provided theme or a custom one, the basemap's color is important in complementing your dashboard's overall color scheme.

Tint Your Basemap

If your map requires important geographic context, such as road networks or city boundaries, but the color scheme of the basemap clashes with your dashboard theme, you can easily adjust the basemap colors. Let's take the permits dashboard shown here as an example to demonstrate how to modify the basemap to better align with its dashboard theme.

1. **Open the web map in Map Viewer** and start by selecting a basemap that provides the necessary geographic context for your data. In this case, World Imagery provides context to proposed building locations.
2. **To match the overall look and feel** of your dashboard, apply a background color. From the map properties option on the Contents toolbar, click Enable background color to select a color that complements the theme.
3. **Combine blend modes** with effects to fine-tune the appearance of your map. Adjusting the transparency can help you control the visibility of underlying layers, while blend modes give you additional control over how the layers' colors and textures are displayed.

As an example of this last point, applying luminosity blending to the permits web map helps the data stand out by softening the colors in the basemap.

To apply this effect, point to the Basemap pane on the Contents toolbar and click Current Basemap.

First, select the layer and click Properties. Then under Appearance, in the Blending drop-down menu, select Luminosity. Finally, adjust the transparency as needed to improve the overall aesthetic.

The result is a map that aligns with the dashboard's theme and accentuates the data points, all while providing important

satellite imagery context for reviewing construction sites.

(Tip: Turn off the web map's background color in Map Viewer and instead set it in the dashboard. This allows you to try different dashboard themes and see the tinting happen directly in the dashboard.)

Additionally, adjusting your effects can enhance specific map features, such as roads. Subtle adjustments can help the map align with the dashboard's design.

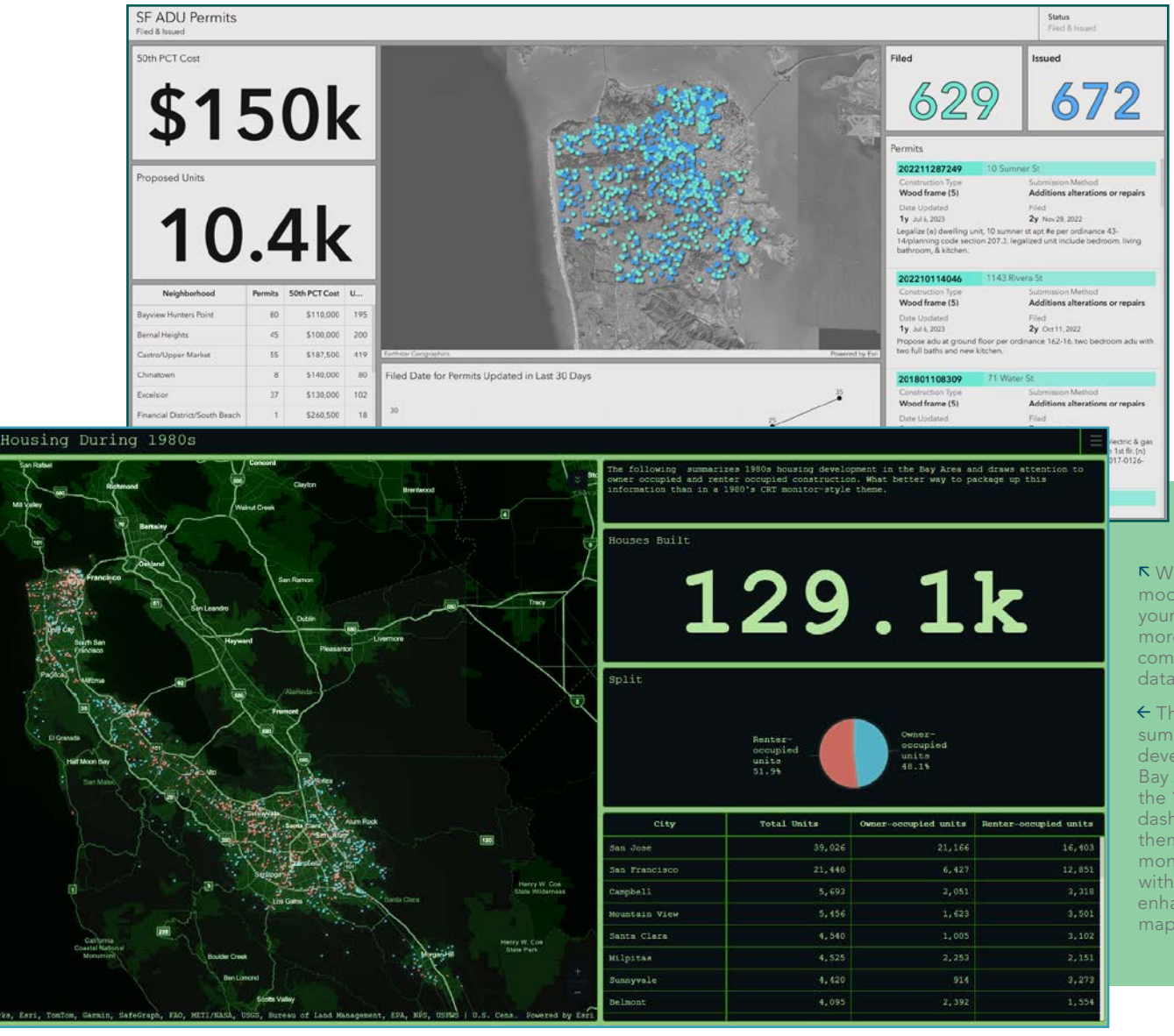
Balancing your basemap with the dashboard theme is key to ensuring that the data remains clear and easy to interpret. The goal is to adjust content-rich basemaps—by tinting or modifying them—to complement the dashboard theme without overshadowing the data itself. A visually appealing map can enhance your dashboard's effectiveness. When done thoughtfully, themes allow you to achieve both a beautiful design and a functional dashboard that communicates critical information.

About the Authors

Ally Shah is a senior product designer at Esri whose work is focused on the ArcGIS Dashboards application.

Leann Kurias is a product engineering writer at Esri, specializing in dashboard development and documentation for the ArcGIS Dashboards team. With a master's degree in business analytics and economics, she is passionate about using data to drive business solutions.

David Nyenhuis is a product engineer and UX designer on the ArcGIS Dashboards team at Esri. He enjoys geeking out about data visualization, advancing real-time GIS, and sketching new dashboard features on whiteboards.



↖ With blend modes and effects, your basemap can more effectively communicate your data.

← This dashboard summarizes housing development in the Bay Area during the 1980s. The dashboard's custom theme evokes a CRT monitor-style look with effects that enhance specific map features.

PATHFINDER GEOSPATIAL

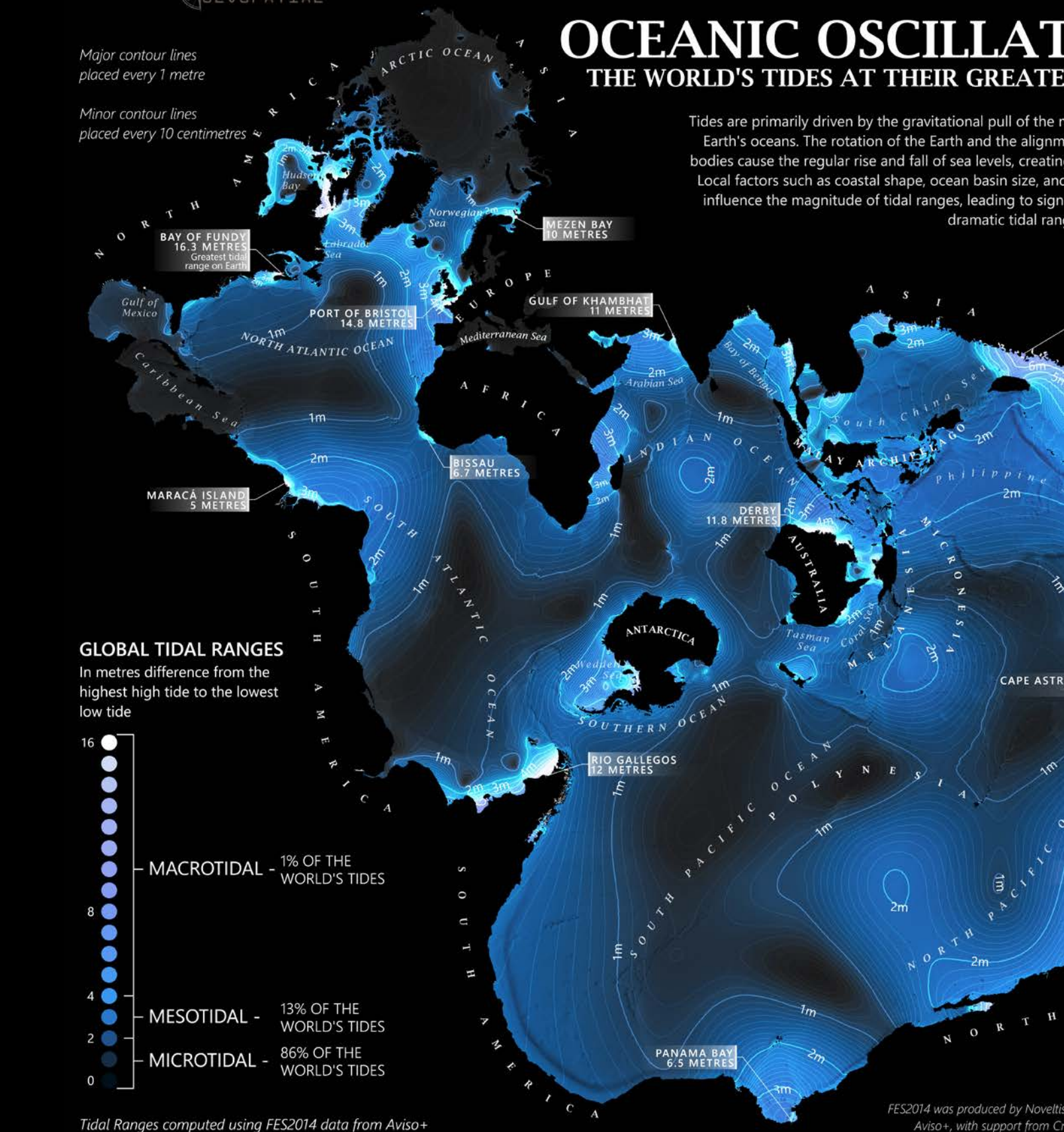
OCEANIC OSCILLAT

THE WORLD'S TIDES AT THEIR GREATE

Tides are primarily driven by the gravitational pull of the m
Earth's oceans. The rotation of the Earth and the alignm
bodies cause the regular rise and fall of sea levels, creatin
Local factors such as coastal shape, ocean basin size, and
influence the magnitude of tidal ranges, leading to sign
dramatic tidal rang

Major contour lines placed every 1 metre

Minor contour lines placed every 10 centimetres



GLOBAL TIDAL RANGES

In metres difference from the highest high tide to the lowest low tide

16
8
4
2
0

- MACROTIDAL - 1% OF THE WORLD'S TIDES
- MESOTIDAL - 13% OF THE WORLD'S TIDES
- MICROTIDAL - 86% OF THE WORLD'S TIDES

Tidal Ranges computed using FES2014 data from Aviso+

FES2014 was produced by Noveltis Aviso+, with support from Cr

"I pursued a job in tourism, working as a horseback trail guide and a dog sled guide for a bit. I was an honest-to-goodness cowboy, riding a horse through pens of cattle, looking for sick cattle, and treating them."

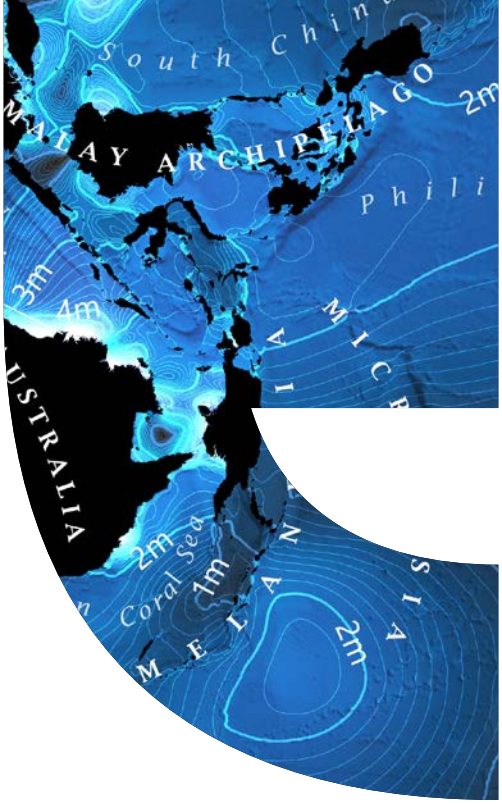
FROM COWBOY TO CARTOGRAPHER

By Christie Roland

With a background in tourism, geography, and even cattle wrangling, Dave Taylor forged an unconventional path to becoming a GIS team lead. Taylor is a cartographer and analyst with Pathfinder Geospatial, a company that provides data acquisition and analysis services along with cartographic design. Determined to stay ahead of the curve, he embraced the shift from ArcMap to ArcGIS Pro, mastering its modern tools to create stunning visualizations.

In 2024, Taylor's *Oceanic Oscillations* map, showing the range and variety of Earth's tides, was featured on maps.com for both its eye-catching design and the depth of information it conveys. The map is also a stunning use of the Spilhaus map projection, which displays the world's oceans as a single, connected body of water.

In this interview, Taylor shares the story behind his *Oceanic Oscillations* map, the power of ArcGIS Living Atlas of the World, and how pushing past ArcGIS Pro's learning curve unlocked a new level of creative cartography.



Q. How did you become a GIS team lead and a cartographer?

I came into it from a bit of an odd direction—at least I think so. I double-majored in tourism and geography and did a little bit of work with ArcView in school. I had always thought it was interesting, but at the time, I wasn't ready to dive into it. Instead, I pursued a job in tourism, working as a horseback trail guide and a dog sled guide for a bit. I was an honest-to-goodness cowboy, riding a horse through pens of cattle, looking for sick cattle, and treating them. At some point, I decided I should probably find a job where, when it's -40 [degrees] outside, I can choose to stay inside.

I thought back to my days in school and realized I was good at GIS and enjoyed it as well. So, I worked my way through GIS books and enrolled in a local GIS program to obtain a certificate. My first GIS job was for a company that handled land leases and other things for oil, gas, telecom, and renewable businesses. I started doing data entry using Google Earth until one day, I overheard a colleague expressing the need for a good map. Luckily, they had an ArcMap license, and I jumped at the chance to apply my skills and enjoyment for making maps. After that, I helped them go from making maps in Google Earth and PowerPoint to showing what is possible with GIS. Within a year, it became a core offering, and I became their first GIS technician.

Q. I enjoy seeing maps entirely made in ArcGIS Pro. The *Oceanic Oscillations* map happens to be one of those, and Esri cartographer John Nelson noticed it. How did you move from making maps in ArcMap to making ones in ArcGIS Pro only?

I wasn't one of the early adopters of [ArcGIS] Pro, but I did get into it early, knowing ArcMap was eventually going to phase out. During some downtime at my company, I decided for one month I would not open ArcMap until I absolutely needed it. And that was a painful time, as I could run ArcMap with my eyes closed. I was doing very basic, technical-looking maps in [ArcGIS] Pro using default settings that got the point across. I always thought those beautiful maps I saw were made in Adobe Illustrator or Photoshop, and that a GIS analyst like me could never make anything like that. One day, I discovered the Cartography. MOOC Esri offers and found that you can do a lot of cool stuff right in [ArcGIS] Pro. You've just got to be willing to click that scary button on the side, which opens the settings of your layers, to change your fonts a little bit, adjust your spacing, and tinker. And that was it. The rest is history. Now, if I can't make a map in [ArcGIS] Pro, then generally that just means I can't make it.

Q. It certainly looks like you put a lot of effort and thought into getting this *Oceanic Oscillations* map just right. It is engaging and fantastic. I'd like to know what inspired you to create it.

Growing up on the east coast of Canada, I was within a half-day's drive of the Bay of Fundy, which is famous for having the most dramatic tides in the world. This was a pet project, to see what kind of map I could create, and I remember John Nelson had made a video of how to visualize glacial recession over time. He showed the process of pulling these different images from Sentinel[-2], and I thought that might be a good way to show the tides. I knew I'd need to find an image of the tide all the way in and all the way out to show the progression; however,

> "Without [ArcGIS] Living Atlas, I wouldn't be able to complete projects like these."

it took a long time to find a complete dataset. I finally discovered raster data of the different tidal ranges for not just the Bay of Fundy but the whole world in the ArcGIS Living Atlas of the World. It was created by Keith VanGraafeiland, a product engineer at Esri. Thankfully, he did all the hard work of taking this very complex dataset and turning it into something that anyone can easily consume. I just had to make it pretty.

Q. What was the biggest challenge you encountered with making the map? And how did you overcome it?

It's a bit of a 90/10 thing; 10 percent of the work on the map takes 90 percent of the time. The hardest part was the text. With a Spilhaus projection, you've got to have some reference of where the land is. Africa's easiest to spot. Antarctica and Australia are easy to spot. Even Canada and the United States are easy to understand. But when you look at South America, it starts at the top of the map and goes all the way to the bottom. It's such a strange way of looking at the world compared to what folks are used to. I needed to start with the label engine, let it do its best job, and then manually place all the text. It can be tricky to show all the depths of these tides while maintaining legibility.

Another challenge was what to label. I wanted to use callouts to draw attention to some of the most impressive tidal

ranges in the world, like the Bay of Fundy; and Ungava Bay, Canada; and others, in Argentina. However, this made the map feel unbalanced. Therefore, I did a combination of big and not-big tides that helped draw the viewers' attention to the other side of the map. For example, parts of Asia get to 6.5 meters, which, while not nothing, is small compared to the Bay of Fundy's 16 meters. That happens almost daily, and you can imagine the change in the landscape as ports go from completely dry to floating large ships in half a day.

Q. Can you walk us through your decision-making process for the visual elements?

I've always found that the dark design works well with the Spilhaus projection because you've got so much negative space around it. If you were to reverse that with the land white and the tides in black, it wouldn't be quite as eye-catching. While other projections focus on displaying the land, Spilhaus does a good job of showing the coastlines without breaking them up. Once you move to the edges, the coastlines begin to fade into the background.

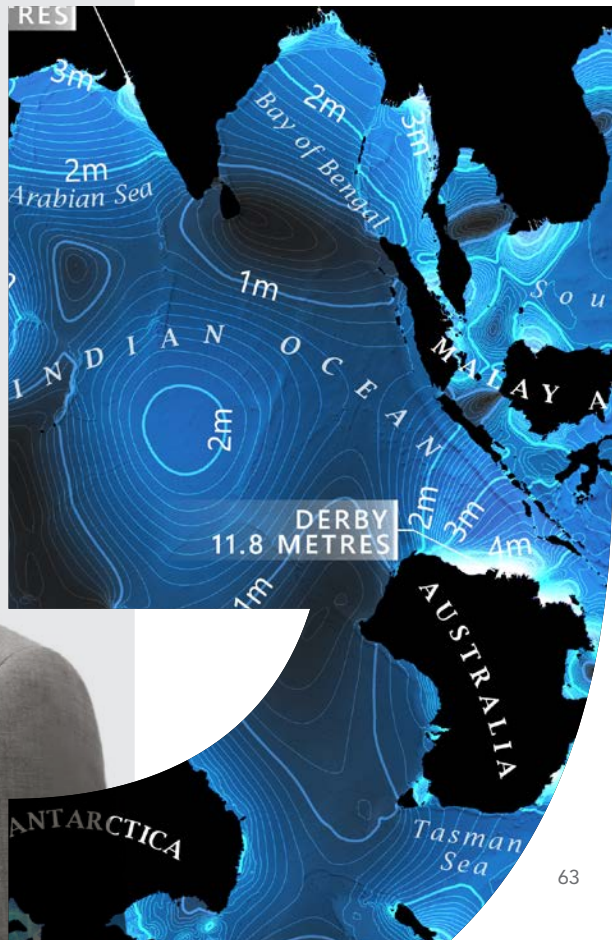
The tidal range layer itself is used four times with various blend modes, helping areas with very little tide stand out. John Nelson gets credit for this because his instructional videos on how to use blend modes aided me in keeping the Sea of Japan, which experiences almost no tides, from disappearing into Asia's mainland. Additionally, there was a lot of playing around with applying blending and transparency to create different combinations of tidal ranges. The result shows how much I love bathymetry and *National Geographic* maps. Their ability to use faint, pale shading and contour lines to create the illusion of depth and height. I was lucky to also find another dataset in ArcGIS Living Atlas, the Gridded Bathymetry Data [GEBCO], and easily add it to create context and texture—emphasizing how the underwater relief contributes to the tides.

Q. It's clear all the elements came together to create a visually stunning map that, to me, just glows. You really tapped into ArcGIS Living Atlas, using ready-made data to hone your cartography skills and complete fulfilling mapping projects. How beneficial was this approach?

I think it will make or break a project if you can find this stuff in [ArcGIS] Living Atlas. If I had to scour the Internet to find these different path image layers and turn them into something usable, it would be time-consuming. The hard part is finding the data in a format that you can use. Without [ArcGIS] Living Atlas, I wouldn't be able to complete projects like these.

About the Author

Christie Roland is the product marketing manager for ArcGIS Pro. Before coming to Esri, she studied heritage preservation and GIS in graduate school. In her spare time, Roland enjoys exploring the outdoors, hanging out with family, and trying new recipes.



GIS Drives Campus Asset Management

By Cassandra Galindo

Like many other colleges, the State University of New York at Cortland (SUNY Cortland) has a lot to keep track of on its 191-acre campus in central New York state. Every day, the university's facilities management department uses GIS technology to help the campus run smoothly. The department encompasses several subgroups, including environmental health and safety; operations; maintenance; and planning, design, and construction.

"We're like a small city within a city," explained Adam Levine, the department's GIS manager. "We're involved in a little bit of everything."

The department often collaborates with project planners, contractors, and the local community to create and maintain maps and digital request systems. One early GIS use case included using ArcGIS Experience Builder to create an app that tracked all 1,357 fire extinguishers on campus, which are required to be recharged every six years and inspected regularly to ensure functionality. The app includes an interactive map that displays the location of each fire extinguisher, ensuring that staff can quickly locate fire extinguishers and enabling inspectors to view each extinguisher's maintenance history and record inspection details.

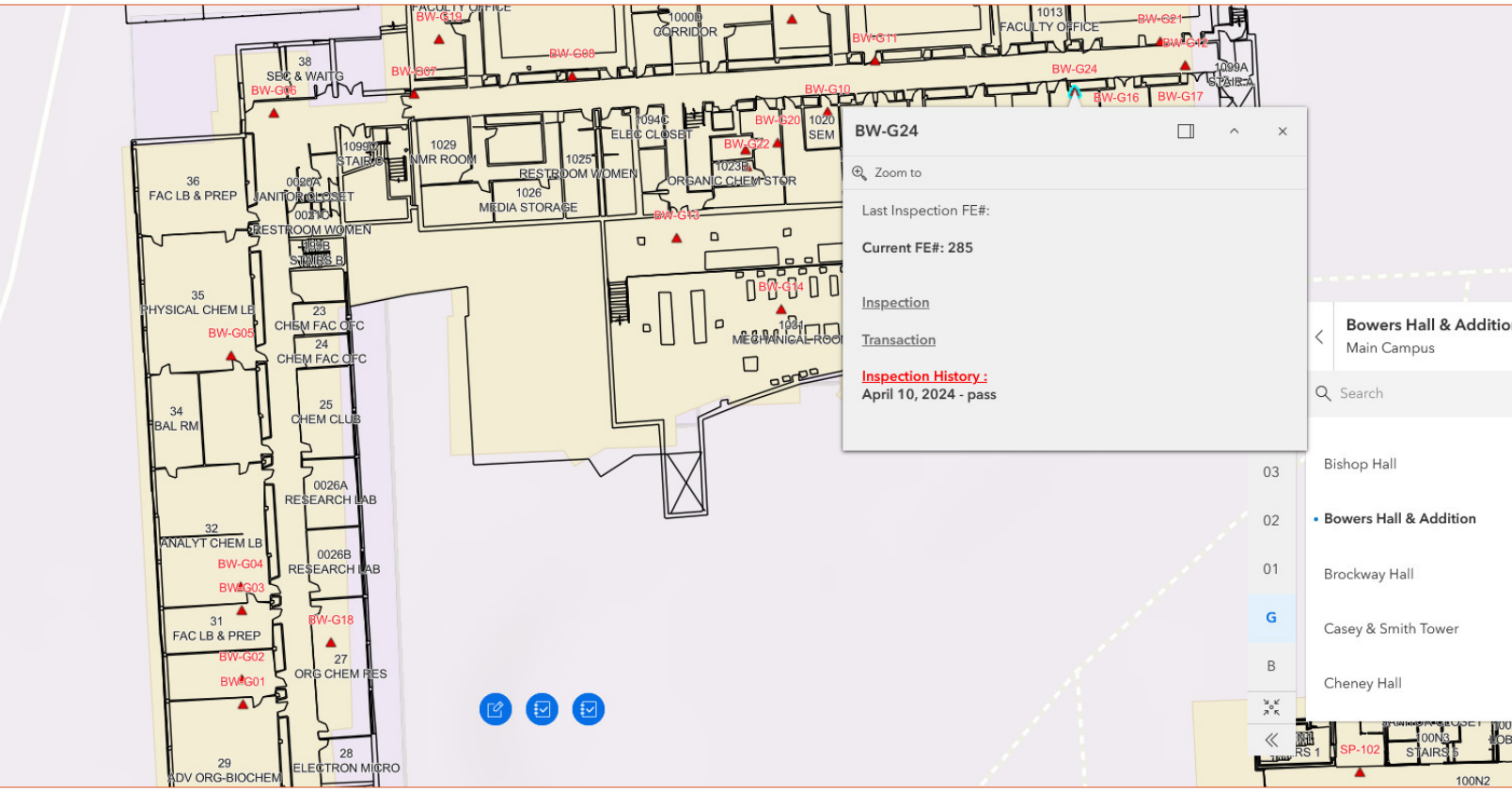
This app was the first big success for indoor GIS mapping at SUNY Cortland. And it was part of a series of GIS implementations that showed university administrators the technology's potential for outdoor and indoor asset management.

Transforming Campus Assets

When Levine started managing the department's work order system and other large-scale data systems in 1999, most processes were paper based. All asset updates were done manually on paper—something that became especially challenging as campus construction increased. Recognizing the need for better management, Levine's supervisor decided to adopt GIS to handle the growing infrastructure and prevent errors related to outdated information. The university partnered with a full-service GIS solutions company to transform the data into an interactive, maintainable system.

Around the same time, Levine took a GIS course and began exploring potential uses

→ SUNY Cortland's 191-acre campus requires robust asset management.

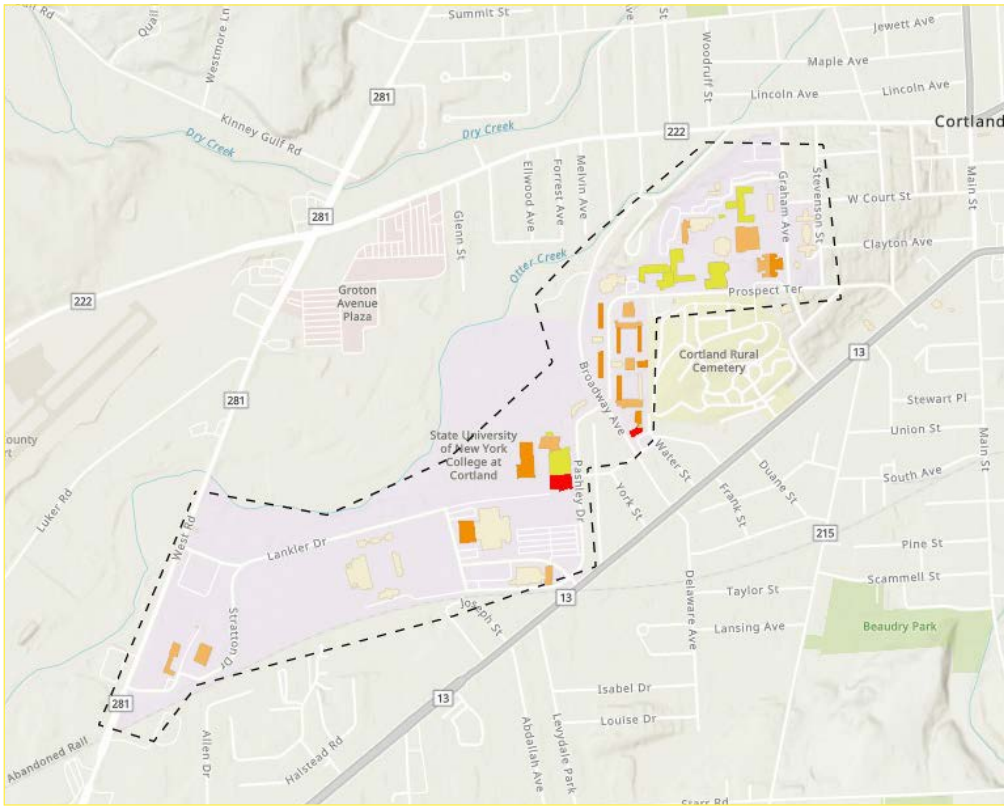


for GIS around campus. As the university's first GIS manager, he quickly found ways to leverage the technology and gain support.

"The variety of applications means there's never a dull moment with GIS," he said. "It applies to so many fields. . . . Keeping up with it while finding new ways to do things has been so much fun."

One of his first GIS projects helped electricians and night crews replace light bulbs in 699 outdoor light fixtures on campus. Levine assigned each light a number and created an interactive web map with symbols that indicated the lights that needed attention. This system, which improved efficiency, is still used today.

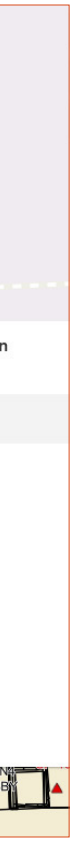
Later, Levine and a team of talented interns created interactive web maps and apps covering everything from on-campus utilities and accessibility features to bike racks and roof warranties.



The Move to Mapping Indoors

Prior to the COVID-19 pandemic, Levine had taken over many space-management

"...there's never a dull moment with GIS."



← An interactive map shows campus fire extinguishers, marked as having passed or failed inspection.

↙ A map shows campus building roofs, differentiated as having active or expired warranty coverage.

responsibilities across campus. At the time, the department had two distinct datasets to work with—one with small-scale CAD files and the other with building information that SUNY Cortland reports to the state, such as details about rooms on campus and what they contain.

Levine saw an opportunity to merge these datasets into a space-management tool with GIS. He created dashboards that provide quick access to a variety of information such as the total number of classrooms, types of rooms, and square footage. The department updated data on campus buildings, and Levine used CAD drawings to gather information on other useful features.

"Details like the number of sinks [and] toilets and the need to replace or add fixtures are crucial," said Levine.

Levine refined his indoor map as much as possible until he realized he needed a better way to connect the indoor assets to their physical locations.

The data model in ArcGIS Indoors ensured more accurate maps—integrated in Experience Builder through ArcGIS Online. The resultant indoor mapping system has helped modernize department operations.

Levine also built a space-management tool to help the department propose and review space and numbering changes. Proposed changes are highlighted in red, making it easy to track and approve before submitting them to the state system.

Other indoor map features include the ability to track vacant spaces. With a straightforward Yes/No field and a filtering option, staff can easily locate vacant spaces that are larger than a certain size, such as 1,000 square feet. This feature has provided the right conditions for future indoor applications.

"I'm always looking for different opportunities to use GIS and save others time," Levine said.

Eventually, Levine expanded his indoor mapping system by using ArcGIS Field Maps for property control management. Property control managers can now record locations of university assets such as furniture and equipment and verify that they are still in use, helping ensure that all property is tracked and maintained.

Managers can also track changes to indoor wayfinding signage. Levine plans to use ArcGIS Field Maps to record assets including each type of sign. Each template will feature drop-down options, imagery, and sign locations while allowing staff to update and maintain signage details.

Impacting Campus Operations

Levine said indoor mapping has been crucial to inspiring broader GIS use at the university. One of several new products is a GIS-based exterior asset survey that streamlines tracking of requests for maintenance of sidewalks, roads, catch basins, and exterior stairs and railings. With automated workflows, Levine hopes to make it easier for staff to update and submit requests via web or mobile devices.

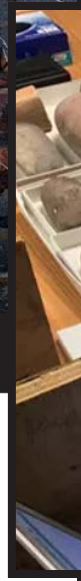
"What I've gathered from my career in GIS is that it's just such a great collaborative tool and technology," Levine said. "These projects are helping people see the benefits, get excited, and ask questions."

About the Author

Cassandra Galindo is a content writer at Esri. Fueled by iced coffee and a passion for prose, she shares the power of GIS through case studies, *Esri Blog*, print publications, and other media. She earned her BA in creative writing from University of California, Riverside, and previously worked in journalism and public relations.

NATIONAL PARK SERVICE STREAMLINES FOSSIL DATA COLLECTION

By Sunny Fleming



Waterfalls, geysers, sprawling canyons, and snow-capped mountains are the natural treasures typically associated with US national parks. Mostly unseen are the prehistoric relics—the fossils. They indicate where and how ancient life lumbered, burrowed, swam, slithered, and thrived millions of years ago.

It's only through fossil discovery and preservation that people know about prehistoric butterflies frozen in volcanic ash in Colorado, North America's oldest human footprint in the sands of New Mexico, a herd of more than 200 ancient horses in Idaho, or entire petrified forests in Wyoming.

National Park Service (NPS) staff don't just do conservation and education work—they also manage and protect fossils found in national parks. In recent years, NPS has been standardizing how it tracks and documents these fossils using a range of GIS tools such as ArcGIS Dashboards and ArcGIS Experience Builder. ArcGIS Survey123 allows NPS staff to collect and record data about a found fossil and upload that data to a GIS database. This helps them preserve ancient treasures and share what they learn.

Before 2005, park staff relied on handwritten notes for fossil records. When new discoveries were made, they'd search through old paperwork, consult land surveys, and ask longtime employees about similar finds in the area. This manual approach often led to errors and duplicated work.

There had to be a better way. That was the thinking among park staff in the Glen Canyon National Recreation Area as well as in the NPS Paleontology Program and the geographic resources division of the park system's Intermountain Regional Office. Together, staff at these locations began developing a new standard for keeping track of fossils, one that would allow for better visualization of a park's paleo resources, provide the ability to ask broad questions of the data, and help in making decisions about monitoring and managing those resources.

That's when Amanda Charobee was hired as a GIS specialist for the Intermountain Regional Office. She worked closely with Glen Canyon to create a standardized solution for fossil data collection and collation that could be expanded to other parks in the region.

BRINGING EFFICIENCY TO PALEONTOLOGICAL DATA COLLECTION

The NPS paleontological team, based in Washington, DC, frequently works with individual parks when a need arises, especially in parks that don't have paleontologists on staff. That need sometimes occurs when there's a major construction project in the park, where erosion or changing lake water levels have increased, or when the park's staff develop plans to inventory and monitor their

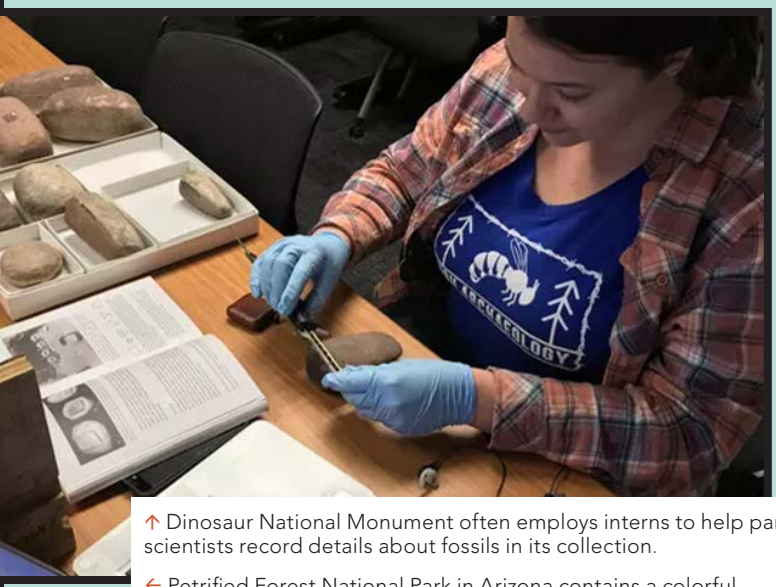
paleo resources. While large fossil-rich parks have their own paleontologists, other parks partner with outside experts like state geological surveys to document discoveries.

To bring the needed uniformity to how fossil discoveries are documented, Charobee worked with fellow NPS GIS specialist Meghan Thompson to create a mobile app that any staff member can download to a phone or tablet. From this app, data collected about fossils syncs to a shared database.

ArcGIS Pro was used for the development of the geodatabase schema underpinning the data management system. Collected and updated data can be integrated into spatial data engines (SDEs) for individual parks. Although not all regions currently use SDEs, the overall data management project is structured to ensure that it can adapt and grow to fit different workflows.

To build the mobile app and database, Charobee worked with rangers and paleontologists to identify a total of 55 key data fields, including survey routes, search areas, fossil locations, specimen details, photos, and monitoring information. Thompson then took that foundational plan and created a more general standard for all parks in the region to follow.

↓ This fossilized wasp from the Eocene Epoch is the mascot of Florissant Fossil Beds National Monument in Colorado.



↑ Dinosaur National Monument often employs interns to help park scientists record details about fossils in its collection.

← Petrified Forest National Park in Arizona contains a colorful concentration of 225-million-year-old petrified wood fossils.

↓ The fossils at the Quarry Exhibit Hall in Dinosaur National Monument, including this allosaurus skull, are the most photographed fossils in the world.

"By adopting a uniform protocol, we have developed a cohesive framework that allows effective sharing and management of paleontological resources," said Thompson.

At Glen Canyon, Charobee and Thompson faced a major challenge: The park has 770 different locations where fossils have been discovered since 1928, which meant having to organize a massive amount of data and details, including more than 2,500 photos.

So far, Thompson and the team developing the new data management system have worked with 34 parks in the eight states that make up NPS's Intermountain Region, collating all existing paleontological data and uploading it to a secure shared site.

The web app for this project was built using ArcGIS Experience Builder, which hosts the project home page. It includes information regarding the project; its status; and links to individual dashboards for each park, created with ArcGIS Dashboards. Because of the sensitive nature of the compiled data, this site is secure and accessible only to authorized staff through curated groups.

The Intermountain Region includes Arches National Park, Bryce Canyon National Park, Colorado National Monument, Grand Canyon National Park, Petrified Forest National Park, Yellowstone National Park, and Zion National Park—all of which are well-known for their paleontological findings. Of the region's 87 parks, 74 have paleontological resources. Eventually, Thompson plans to connect with parks nationwide to collect and manage paleontological data. Standardizing data, formats, and technology, Thompson said, will strengthen fossil protection in parks and eventually make it possible to more easily identify imperiled fossil sites based on the locations of other fossil finds.

KEEPING FOSSILS AND DATA SAFE

Privacy, even within individual parks, has been a top priority for fossil information. Information about exactly where fossils reside is

strictly guarded to prevent theft or damage. Fossils have official protection under the Paleontological Resources Preservation Act, passed in 2009.

"Fossil theft is a huge problem," Charobee said, not only inside the national parks but around the world. The database is hosted on the park service's secure server for sensitive GIS data, with each participating park assured that its data will remain viewable to only those who need access.

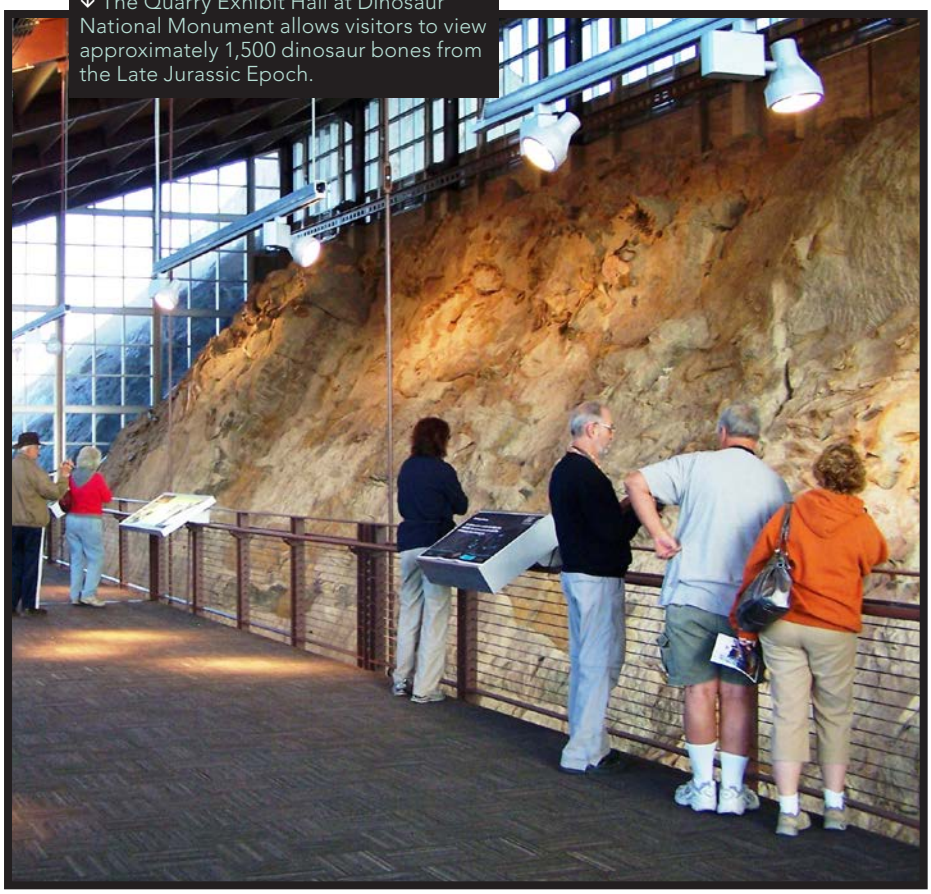
To learn from a fossil, it is essential to know exactly where it was found. Once removed from its original location by a collector or tourist, a fossil loses valuable clues into how the animal may have behaved when it was alive and what the environment was like, Charobee said.

For instance, workers at Glen Canyon, which spans parts of Arizona and Utah, recently found fossilized dinosaur feces. How exactly did the dinosaurs relieve themselves? Researchers had a better idea after observing well-preserved tracks near the fossilized waste (coprolites). Seeing how the tracks and coprolites were arranged led paleontologists to theorize that the dinosaur had crouched.

Now, those dinosaur footprints and fossilized feces are among the fossil resources recorded in the NPS paleontology program records. Ultimately, park staff can use the fossil collections and related data to not only provide immersive and interpretive experiences for national park visitors, but also improve awareness, resource management, and education.

ABOUT THE AUTHOR

Sunny Fleming is Esri's industry lead for the domains of environment, conservation, and natural resources. Throughout her career, she has applied GIS concepts and technology to environmental policy, conservation, and natural resources, from monitoring species in the field to helping state parks manage assets and assess their economic impacts. She continues to pursue her passion for the environment by helping industry leaders streamline and improve their work with GIS technology, whether in the field or in the office, and whether setting policy or managing wildlife and resources.



↓ The Quarry Exhibit Hall at Dinosaur National Monument allows visitors to view approximately 1,500 dinosaur bones from the Late Jurassic Epoch.

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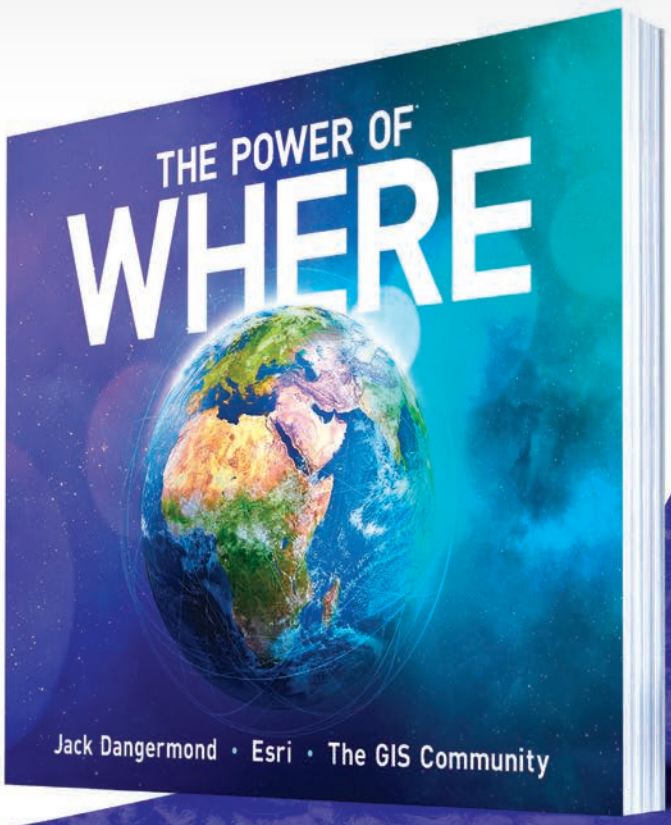

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