Building Accessible Web Apps with ArcGIS Maps SDK for JavaScript and Calcite

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2025 ESRI DEVELOPER & TECHNOLOGY SUMMIT

Agenda

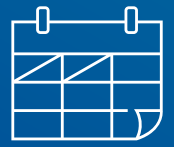
- Introduction to Accessibility
- Web Content Accessibility Guidelines (WCAG)
- Build Accessibility into Mapping Apps
  - High contrast
  - Live regions and map descriptions
  - Focus trapping
  - Handling animations
  - Consistent focus
- Testing, tools and resources
- Road ahead

Introduction to accessibility

Why is accessibility important?

1.3 billion

Number of individuals living with a disability worldwide



2030

By this year, 2 billion people will need at least 1 assistive product

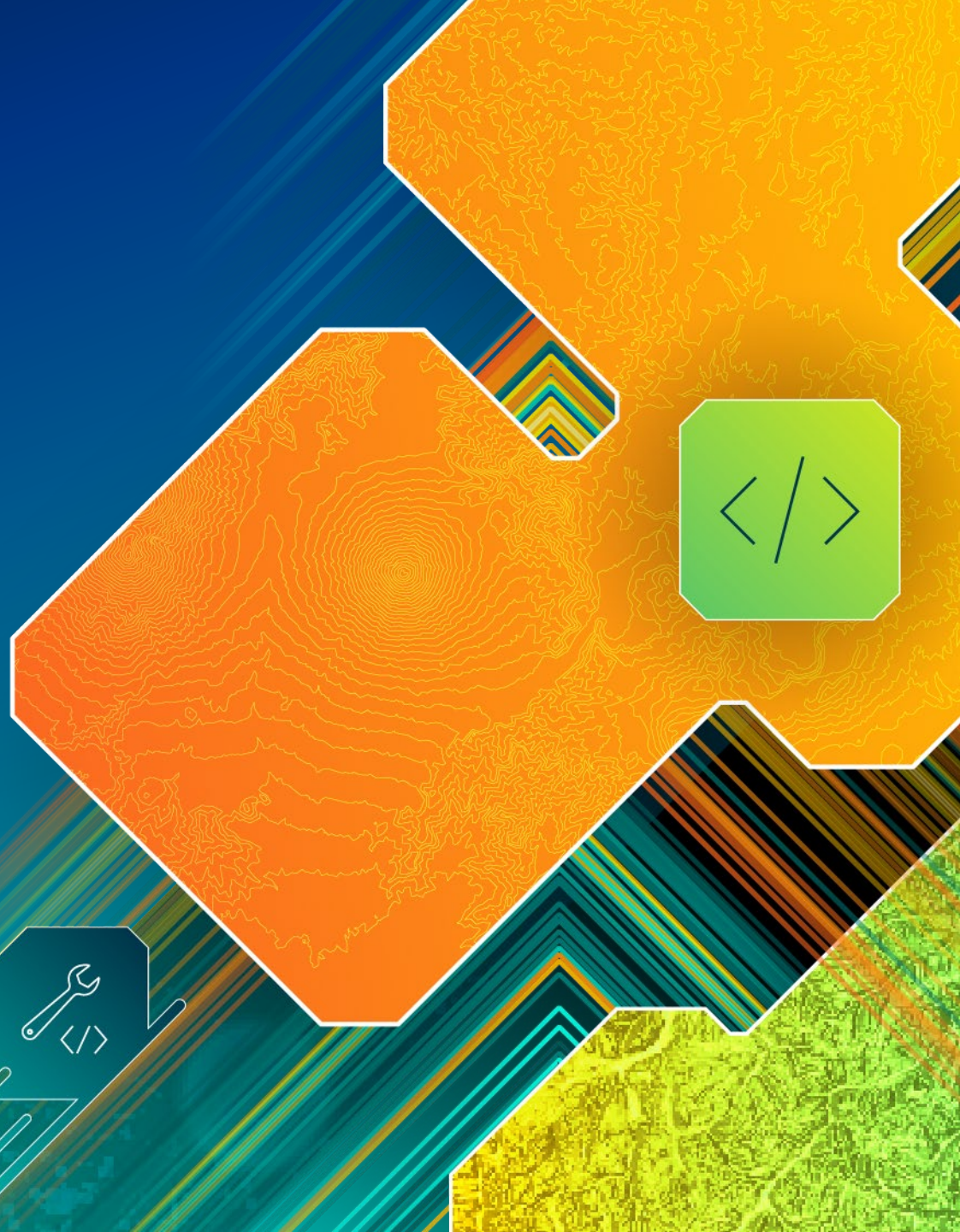
25+

Countries that currently have web accessibility laws and policies

20%

Percentage of web traffic that could come from a person with a disability

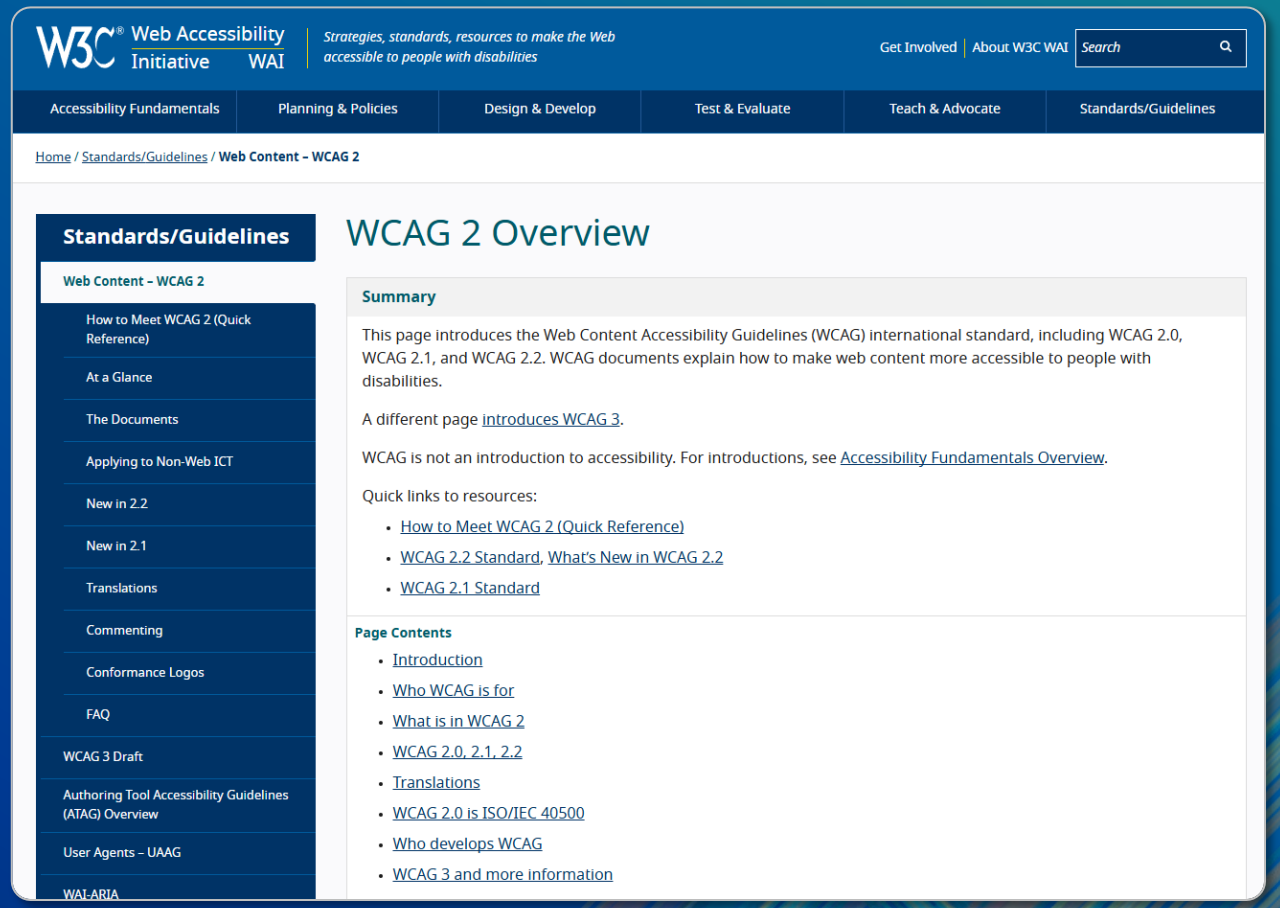
Web Content Accessibility Guidelines



Web standards

Web Content Accessibility Guidelines (WCAG) 2.2

- Success Criterion
  1. **P**erceivable
  2. **O**perable
  3. **U**nderstandable
  4. **R**obust
- Levels
  - **A**: Basic
  - **AA**: Desirable (Many organizations)
  - **AAA**: Comprehensive



WCAG examples

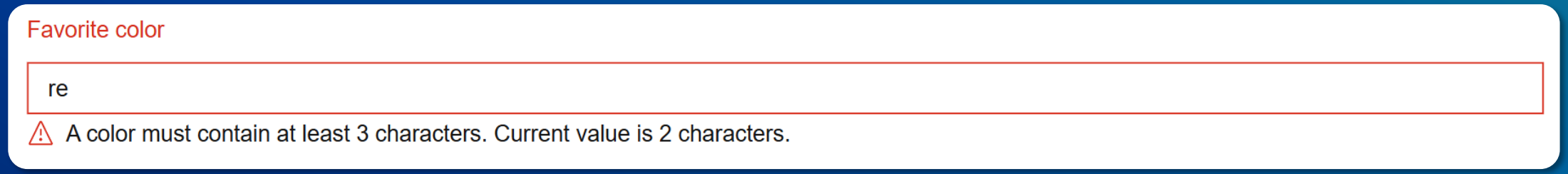
Levels and their meaning

Level	Success Criterion	Description
A	1.4.1: Use of Color	Color is not used as the only visual means of conveying information, indicating an action, prompting a response, or distinguishing a visual element.
AA	1.4.3: Contrast (Minimum)	The visual presentation of text and images of text has a contrast ratio of at least 4.5 to 1.
AAA	1.4.6: Contrast (Enhanced)	The visual presentation of text and images of text has a contrast ratio of at least 7 to 1.

1.4.1: Use of Color

Level A

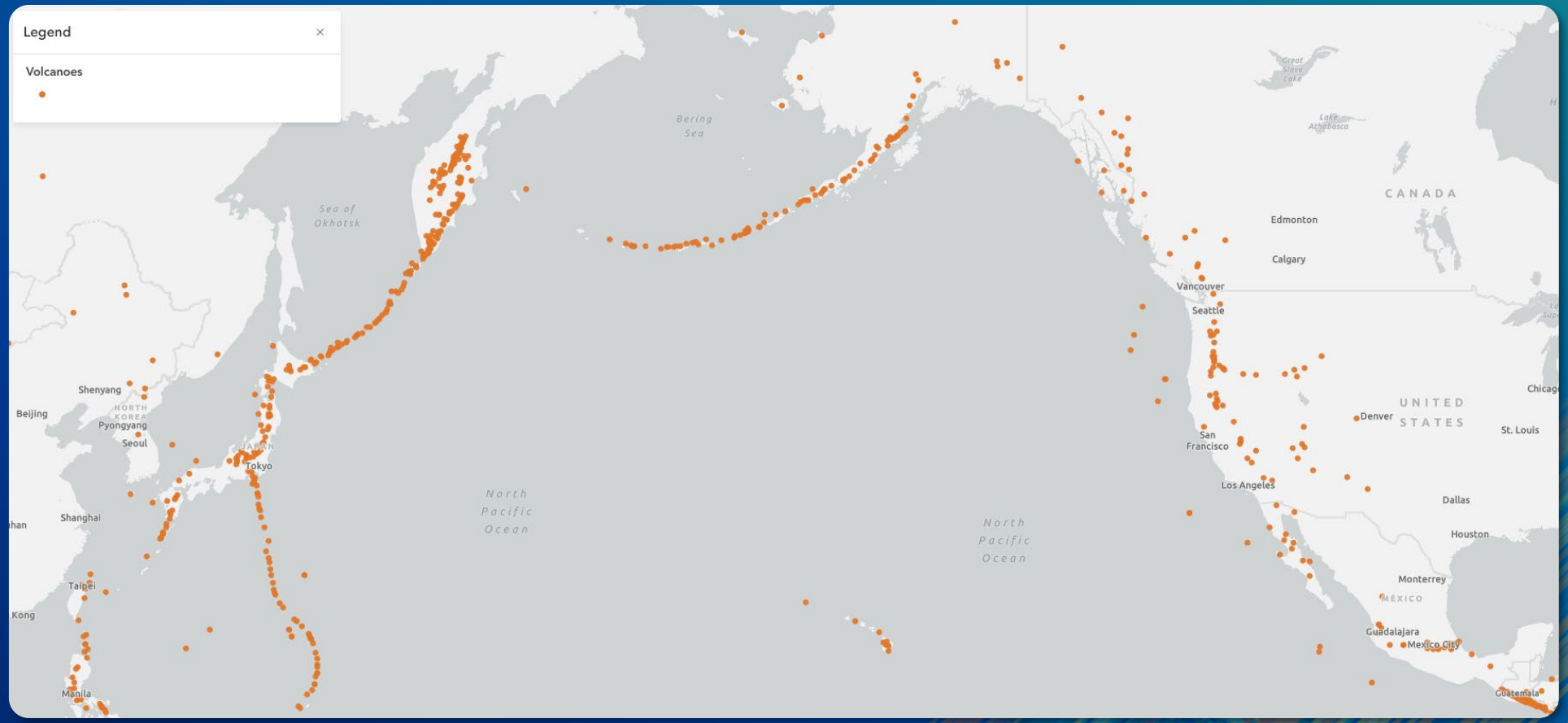
Color is not used as the only means of conveying information, indicating an action, prompting a response, or distinguishing a visual element.



1.4.3: Contrast (Minimum)

Level AA

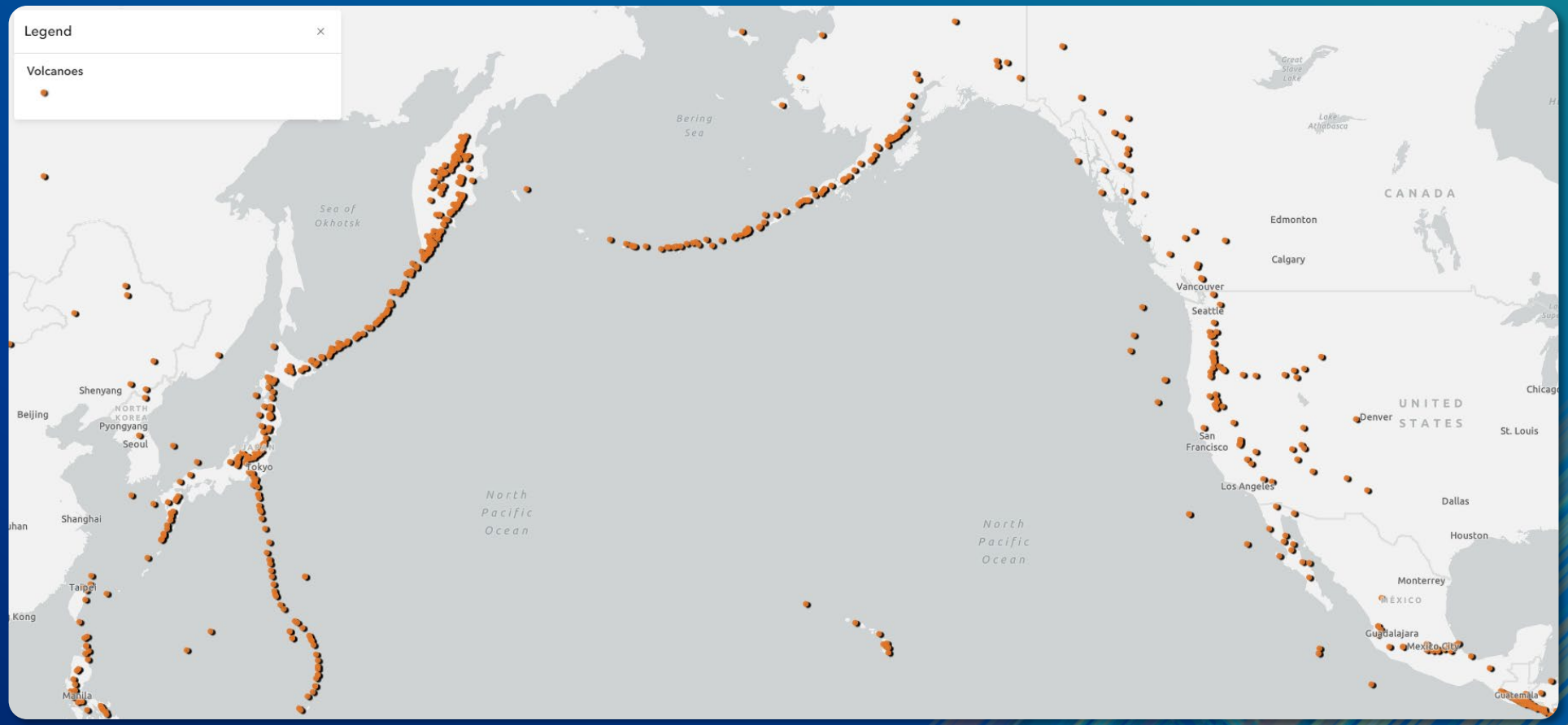
The visual presentation of text and images of text has a contrast ratio of at least 4.5 to 1.



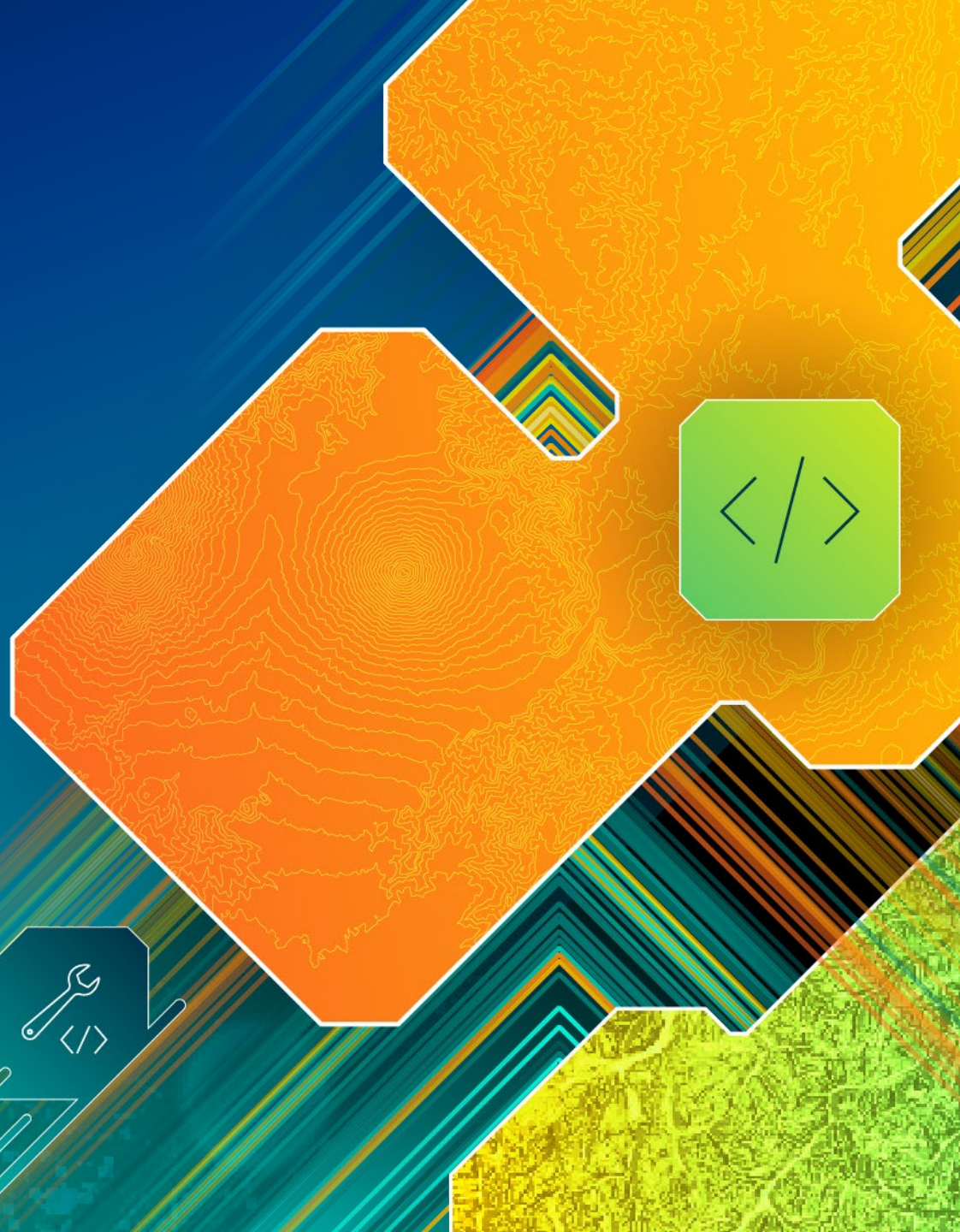
1.4.6: Contrast (Enhanced)

Level AAA

The visual presentation of text and images of text has a contrast ratio of at least 7 to 1.



Build Accessibility into Mapping Apps



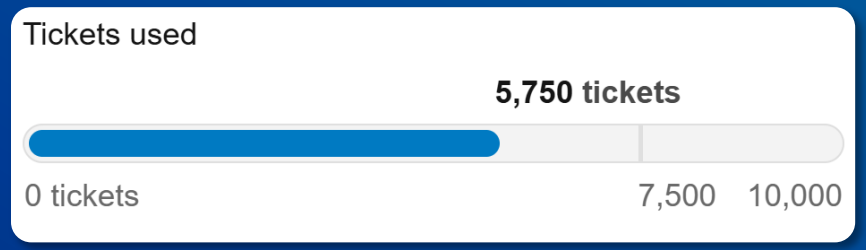
High contrast

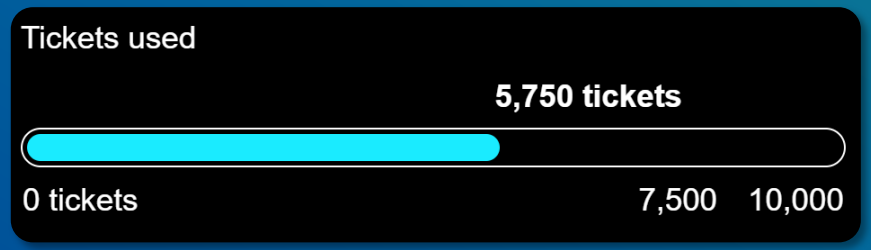
1.4.3 Contrast (Minimum)

- **1.4.3: Contrast (Minimum)** – Level AA
  - Visual presentation has a contrast ratio of at least 4.5 to 1
  - Benefits visual, low vision, and cognitive impairments

High contrast in components

calcite-meter, calcite-button, calcite-link

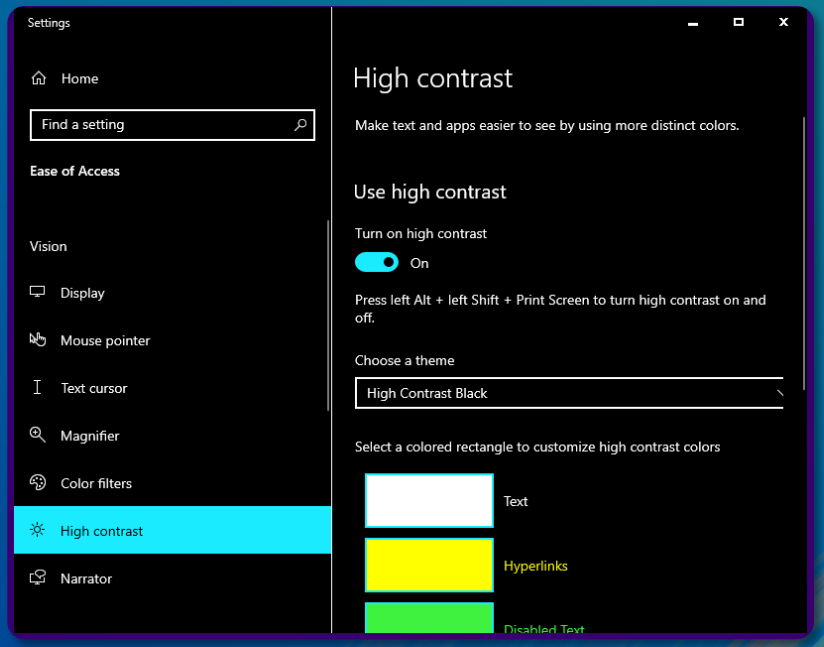


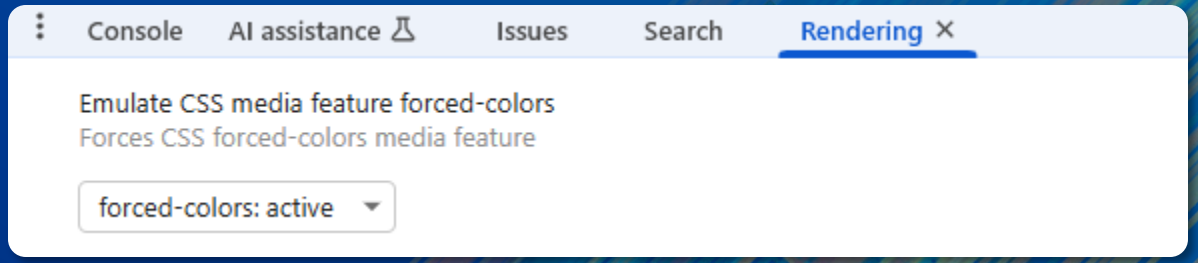


forced-colors CSS media feature

https://developer.mozilla.org/en-US/docs/Web/CSS/@media/forced-colors

- Detects if user agent has enabled forced colors mode
  - Browser setting
    - Chrome Rendering tab
  - Windows high contrast mode



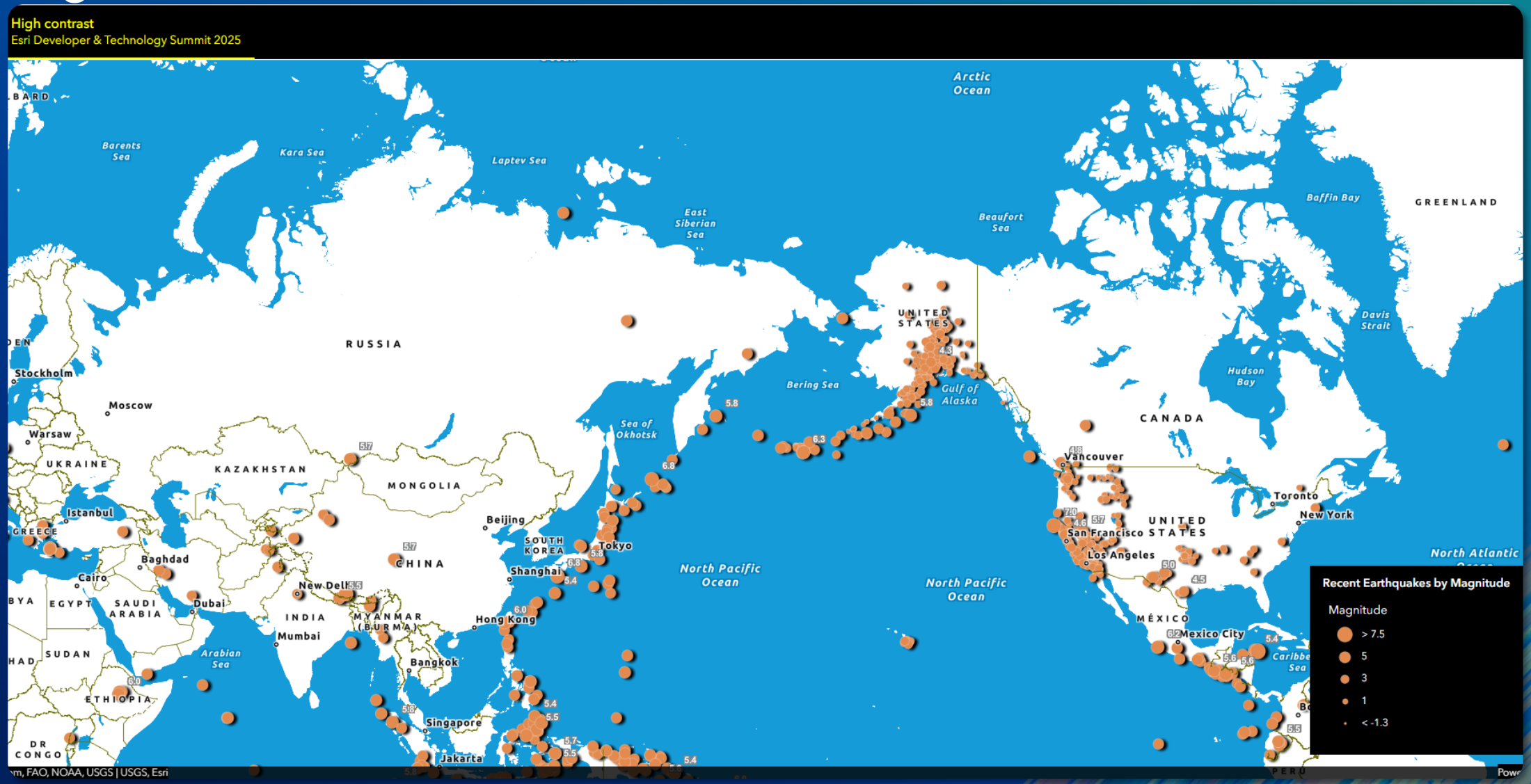


matchMedia markup

```
const contrastMedia = matchMedia("(forced-colors: active)");

mapEl.basemap = contrastMedia.matches ? highContrastDarkBasemap : "dark-gray-vector";
```

High contrast demo



High contrast markup functionality

```
require(["esri/Basemap"], (Basemap) => {
  const mapEl = document.getElementById("mapEl");

  const highContrastDarkBasemap = new Basemap({
    portalItem: {
      id: "3e23478909194c54992eaaee78b5f754" // Dark
    },
    title: "High contrast dark theme",
    id: "high-contrast-dark"
  });

  const highContrastLightBasemap = new Basemap({
    portalItem: {
      id: "084291b0ecad4588b8c8853898d72445" // Light
    },
    title: "High contrast (light theme)",
    id: "high-contrast-light"
  });

  // If high contrast is enabled, display a high contrast basemap, else display a gray basemap
  if (contrastMedia.matches) {
    mapEl.basemap = isDarkMode ? highContrastDarkBasemap : highContrastLightBasemap;
  } else {
    mapEl.basemap = isDarkMode ? "dark-gray-vector" : "gray-vector";
  }

  // High contrast support with basemap and layer effects
  const contrastMedia = matchMedia("(forced-colors: active)");
  function checkContrastMedia() {
    try {
      if (mode == "dark") {
        mapEl.basemap = contrastMedia.matches ? highContrastDarkBasemap : "dark-gray-vector";
        //mapEl.basemap = "dark-gray-vector";
        contrastMedia.matches ? mapEl.map.layers._items[2].effect = "bloom(1.5, 0.5px, 0.1)" :
                                mapEl.map.layers._items[2].effect = "bloom(0, 0px, 0)";
      } else {
        mapEl.basemap = contrastMedia.matches ? highContrastLightBasemap : "gray-vector";
        //mapEl.basemap = "gray-vector";
        contrastMedia.matches ? mapEl.map.layers._items[2].effect = "drop-shadow(3px, 1px, 3px)" :
                                mapEl.map.layers._items[2].effect = "drop-shadow(0px, 0px, 0px)";
      }
    } catch(err) { }
  }

  // Event listeners on map load and high contrast media query
  mapEl.addEventListener("arcgisViewChange", checkContrastMedia);
  contrastMedia.addListener(checkContrastMedia);
});
```

High contrast
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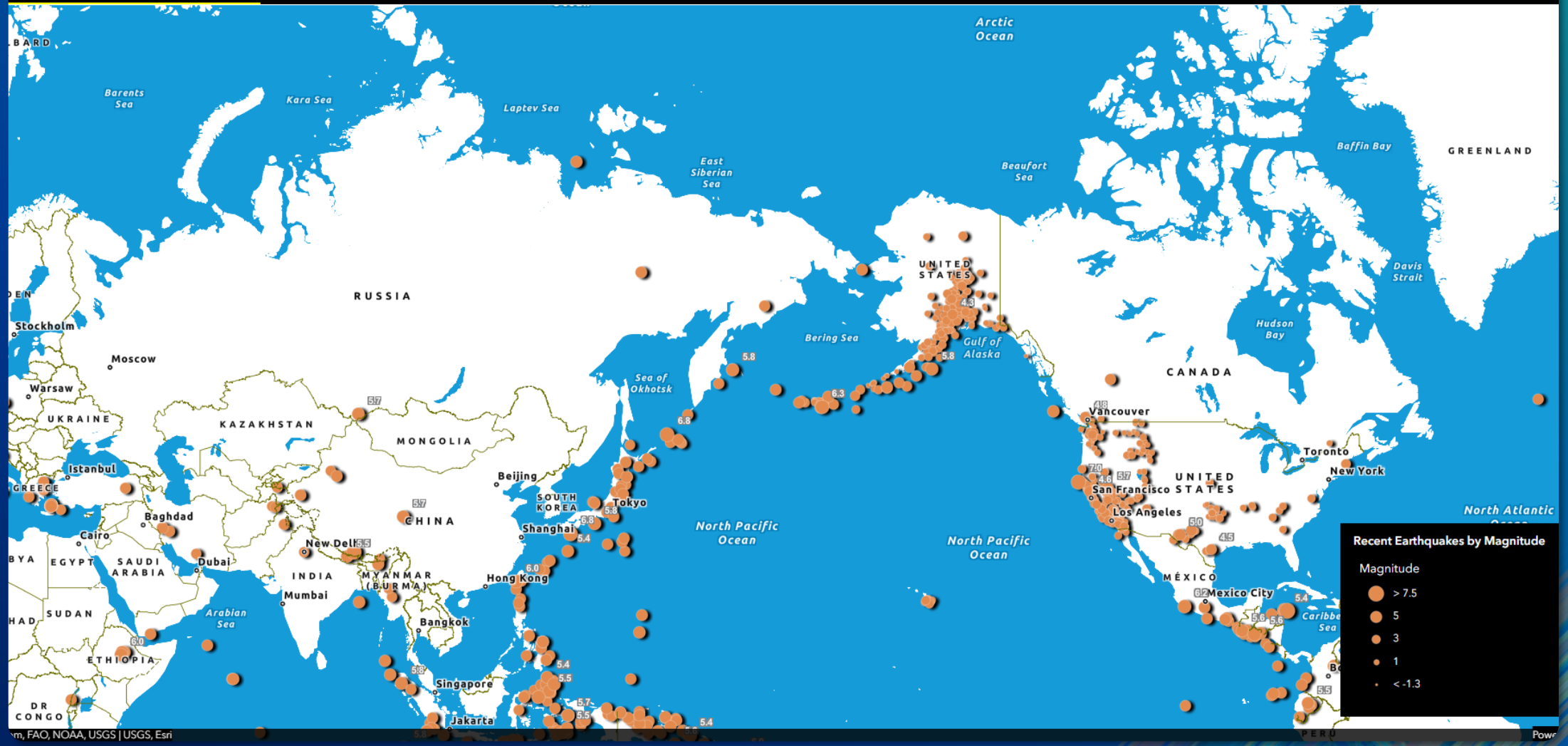


aria-describedby

WCAG 1.1.1 Non-text content

- All non-text content that is presented to the user has a text alternative that serves the equivalent purpose (Level A)
- **aria-describedby links an element to additional descriptive text**, making it available to screen readers.
- Helps provide **context and details** about maps for visually impaired users.
- Works well with **long descriptions** (e.g., a list of landmarks, routes, or important locations).

Aria Live Regions

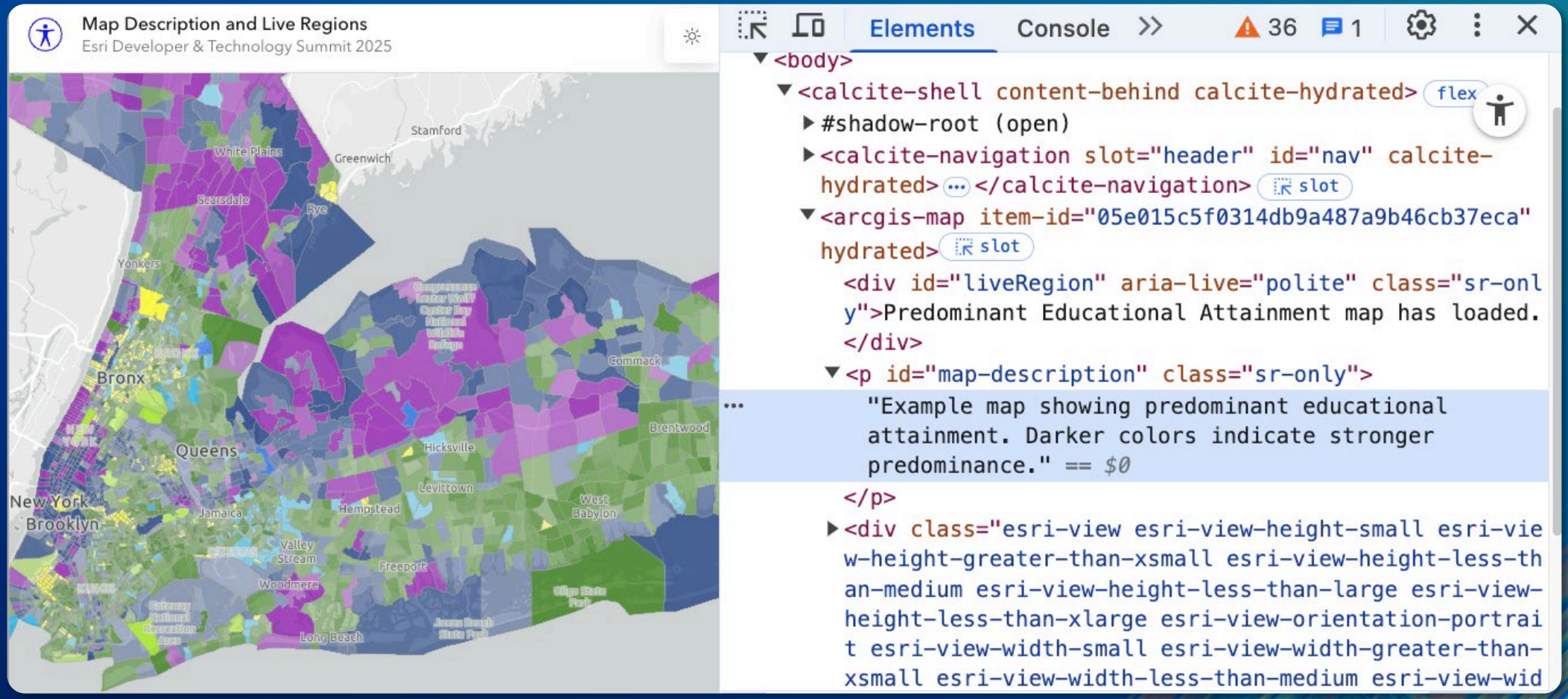
- ARIA (Accessible Rich Internet Applications) **Live Regions** help assistive technologies announce dynamic content updates.
- Used for content that updates **without user focus**, such as notifications, chat messages, or form validation messages.
- **ARIA attributes:**
  - aria-live="polite" – Announces updates **when idle**, avoiding interruptions.
  - aria-live="assertive" – Announces updates **immediately**, interrupting other speech.
  - aria-live="off" – Default setting; no announcement occurs.

Live region and aria-describedby

```
mapEl.addEventListener("arcgisViewReadyChange", handleArcgisViewReadyChange);

function handleArcgisViewReadyChange(event) {
  const mapDescription = document.getElementById("map-description");
  const { portalItem } = event.target.map;
  liveRegion.innerText = `${portalItem.title} map has loaded.`;
  mapDescription.innerText = portalItem.snippet;
  document.querySelectorAll(".esri-view-surface").forEach(el =>
    el.setAttribute("aria-describedby", "map-description")
  );
}
```

Live Regions and aria-describedby



Focus trapping

1.4.3: Contrast (Minimum) and 2.1.2: No Keyboard Trap

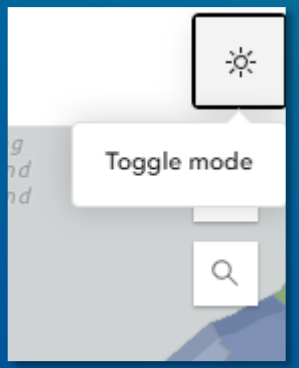
- **1.4.3: Contrast (Minimum)** – Level AA
  - Visual presentation has a contrast ratio of at least 4.5 to 1
  - Benefits visual, low vision, and cognitive impairments
- **2.1.2: No Keyboard Trap** – Level A
  - Ensure keyboard users don’t get stuck in an interface
  - Benefits keyboard users including visual and cognitive impairments

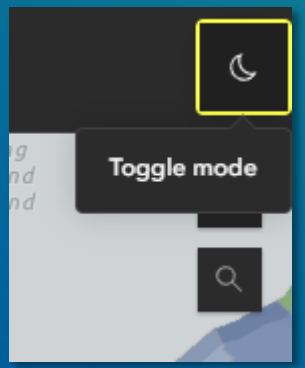
Focus color

Contrast support

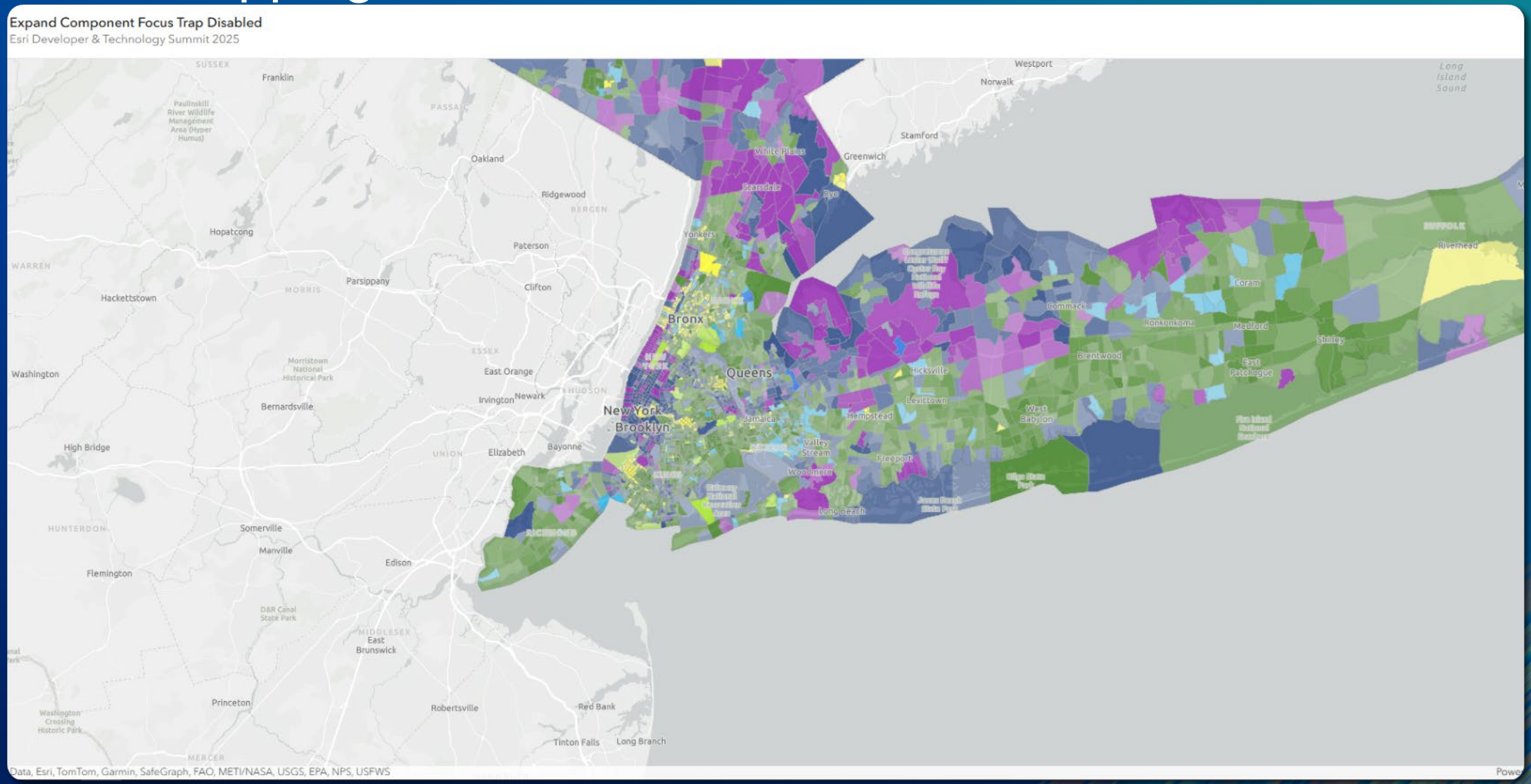
```css
/* Light mode */
body,
:focus {
  --calcite-color-brand: #000;
  --calcite-color-focus: var(--calcite-color-brand);
}

/* Dark mode */
body.calcite-mode-dark,
.calcite-mode-dark :focus {
  --calcite-color-brand: #FEFE4D;
  --calcite-color-focus: var(--calcite-color-brand);
}
```





Focus trapping demo



Focus trapping HTML markup

```
<arcgis-map item-id="05e015c5f0314db9a487a9b46cb37eca">
  <arcgis-home position="top-right"></arcgis-home>
  <arcgis-expand id="expand-el" focus-trap-enabled="false" close-on-esc position="top-right" mode="floating">
    <arcgis-search id="search-el"></arcgis-search>
  </arcgis-expand>
</arcgis-map>
```

Mutation observers

https://developers.arcgis.com/javascript/latest/watch-for-changes/#using-a-mutation-observer

- **Component events emit a change to their state**
  - Initiated internally
  - User interaction
  - Setting an attribute or property
- **Mutation observers watch for changes in the Document Object Model (DOM) tree**
  - All documented attributes trigger an observer

```
const mapEl = document.querySelector("arcgis-map");
mapEl.addEventListener("arcgisViewChange", (Event) => {
  const { zoom } = event.target;
  console.log(`The zoom is ${zoom}`);
});
```

`arcgisViewChange` event fires when aspects of the View changes

Mutation observers continued…

https://developers.arcgis.com/javascript/latest/watch-for-changes/#using-a-mutation-observer

```
<!-- Before panning the map -->
<arcgis-map item-id="05e015c5f0314db9a487a9b46cb37eca"></arcgis-map>

<!-- During map panning -->
<arcgis-map item-id="05e015c5f0314db9a487a9b46cb37eca" updating></arcgis-map>
```

```
const mapEl = document.querySelector("arcgis-map");
const observer = new MutationObserver((mutations, observer) => {
  for (let mutation of mutations) {
    console.log(`Mutation observer: ${mutation.attributeName} changed to ${mutation.target[mutation.attributeName]}`);
  }
});

// Start observing the map's attributes for changes, such as the updating property
observer.observe(mapEl, { attributeFilter: ["updating"] });

// Change the zoom level after 10 seconds
setTimeout(() => {
  mapEl.zoom = 7;
}, "10000");
```

Resetting focus functionality

Mutation observers and reactiveUtils

```
require(["esri/core/reactiveUtils"], (reactiveUtils) => {

  const mapEl = document.getElementById("mapEl");

  // reactiveUtils to watch for when the popup is opened and closed
  // Resource: https://developers.arcgis.com/javascript/latest/watch-for-changes/#watch-for-changes-in-the-api
  mapEl.addEventListener("arcgisViewReadyChange", () => {
    reactiveUtils.watch(() => mapEl.view.popup.visible, (visible) => {
        if (mapEl.view.popup.visible) {
           mapEl.view.popup.focus();
        } else {
          searchEl.focusSearch();
        }
      }
    );
  });

  // Initialize the mutation observer
  // Resource: https://developers.arcgis.com/javascript/latest/watch-for-changes/#using-a-mutation-observer
  const observer = new MutationObserver((mutations, observer) => {
    for (let mutation of mutations) {
      // Set focus on the arcgis-search if the component is expanded
      // Else set focus on the arcgis-expand
      if (mutation.target[mutation.attributeName] == true) {
        searchEl.focusSearch();
      } else {
        const expandEls = document.querySelectorAll(".esri-expand__toggle > calcite-action");
        expandEls[0].setFocus();
      }
    }
  });

  // Start observing the arcgis-expand's "expanded" attribute
  observer.observe(expandEl, {
    attributeFilter: ["expanded"]
  });

});
```

Expand Component Focus Trap Disabled

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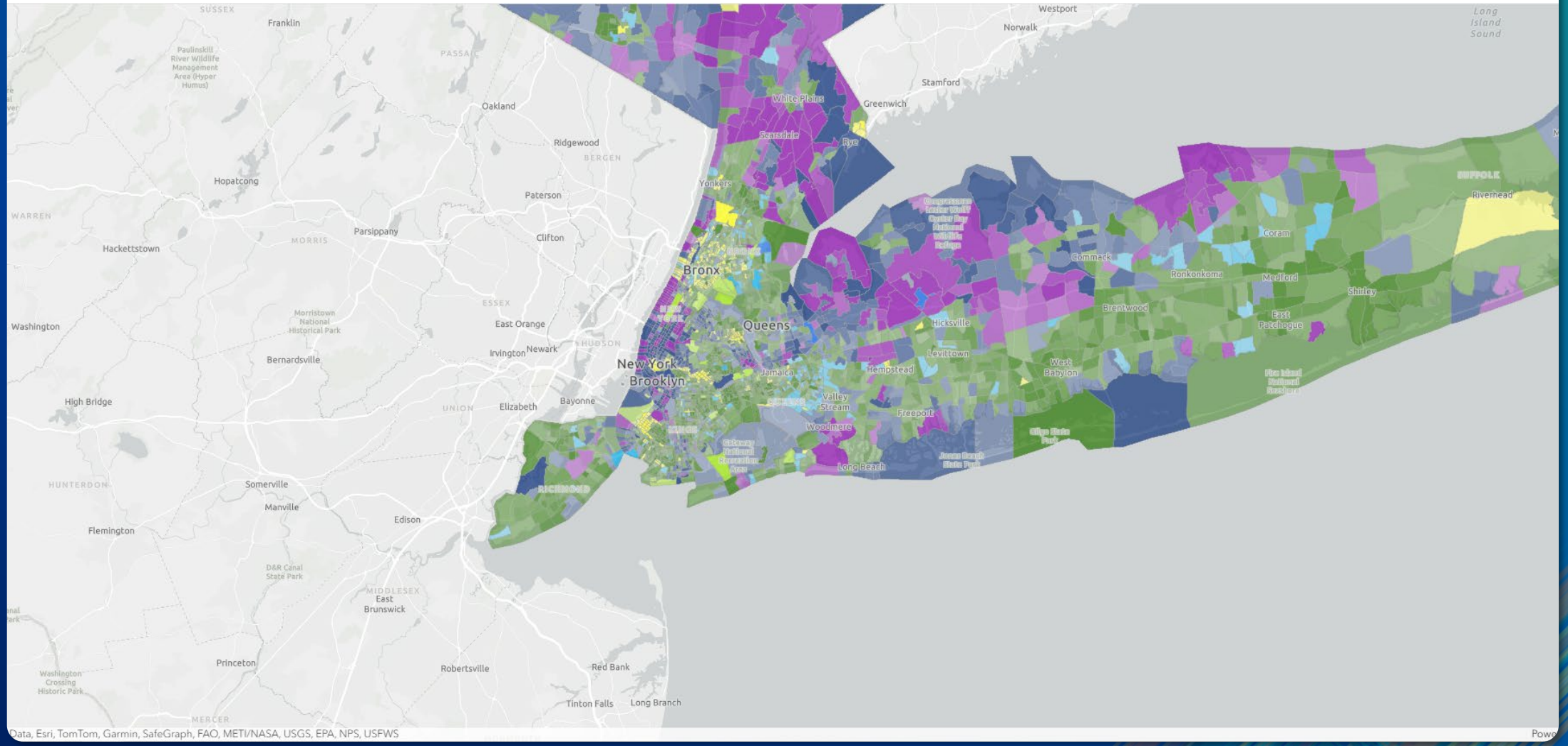


Prefers reduced motion

2.2.2 Pause Stop and Hide and 2.3.3 Seizures and Physical Reactions

- **2.2.2 - For content that moves, blinks or scrolls that starts automatically and lasts more than 5 seconds (A)**
  - **Ensure there is a mechanism to pause, stop or hide**
  - **Flashing/Blinking must be evaluated against 2.3.1 and 2.3.2**
- **2.3.3 – Animation from Interactions (AAA)**
  - Motion animation can be disabled *unless essential*

Prefers reduced motion : GoTo Transitions

View, Popup, Bookmarks, Search, Locate and more

- **goTo() Method Update (v4.30)**
  - Respects user preference for reduced motion.
  - Animates by default unless the user prefers reduced motion.
- **Customization Options**
  - Override using esriConfig.respectPrefersReducedMotion
  - Or per-call animate property.
- Refer to **Implementing Reduced Motion** guidelines.

Detect User Preferences

Detect via CSS

```
@media (prefers-reduced-motion: reduce) {
  #animationControl {
    display: block;
  }
}
@media (prefers-reduced-motion: no-preference) {
  #animationControl {
    display: none;
  }
}
```

Detect User Preferences

Detect via JavaScript

```
const mediaQuery = window.matchMedia("(prefers-reduced-motion)");
mediaQuery.addEventListener("change", (event) => {
    handleAnimation(event.matches);
});
```

Prefers reduced motion

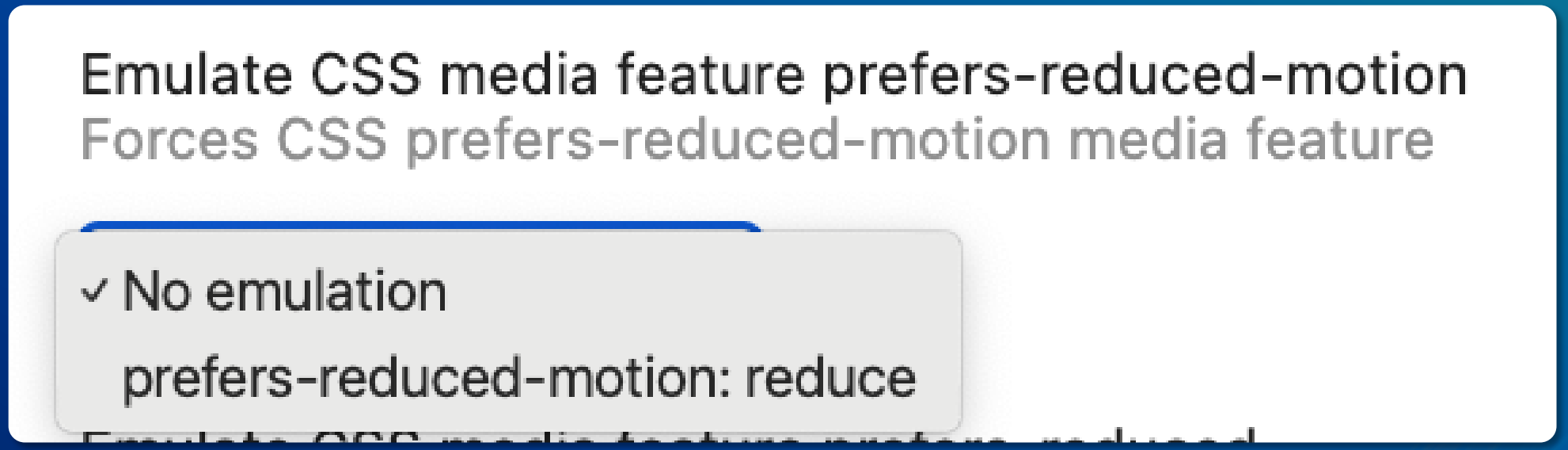
Animated Symbols

- Animated symbol support added to Map Viewer
- Disable Animations
  - Set playAnimation for symbols to false
  - Automatically
  - Provide play/pause controls

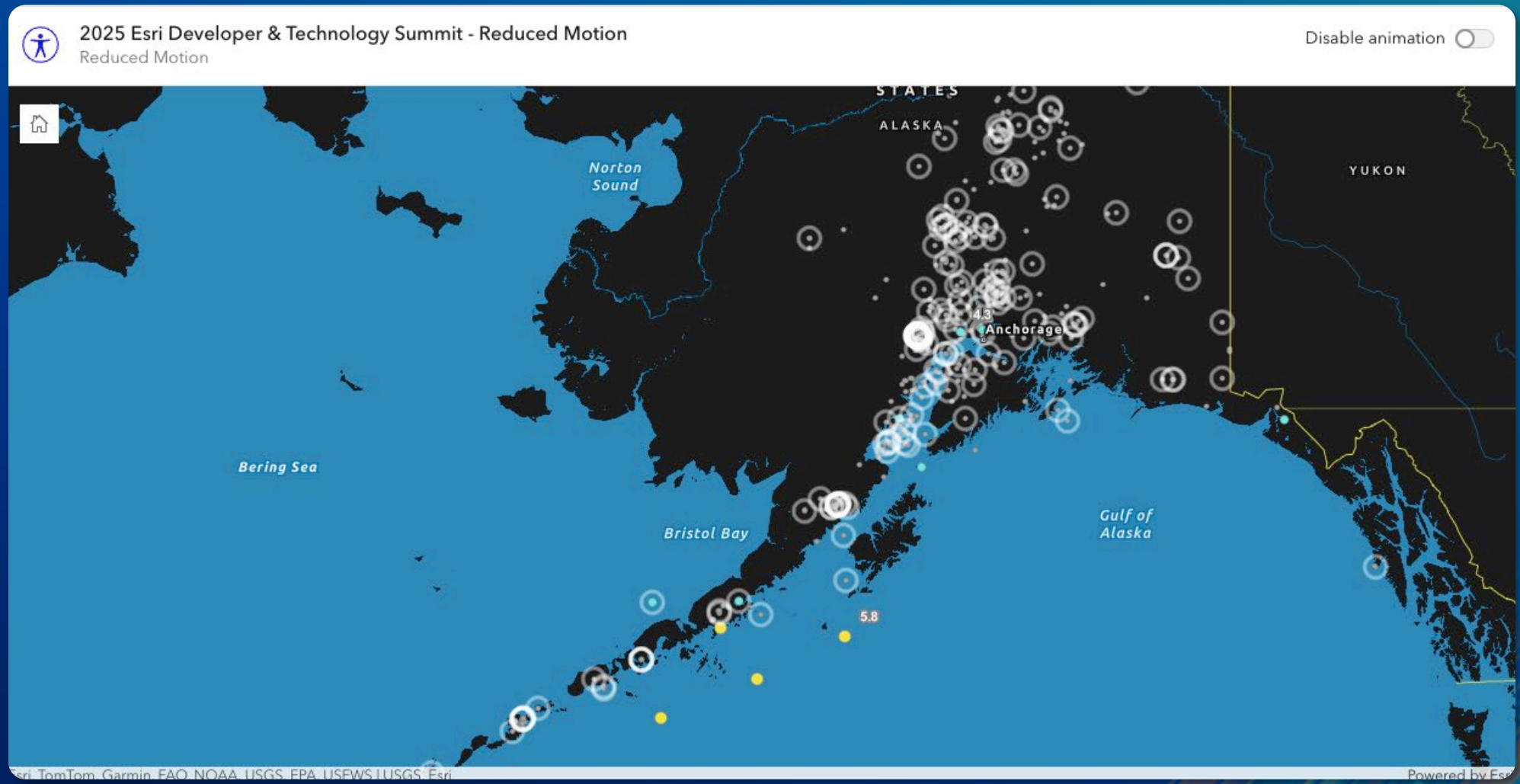
```
    const disableAnimations = (obj) => {
        for (const key in obj) {
            if (obj[key] && typeof obj[key] === 'object') {
                disableAnimations(obj[key]);
            }
            if (key === 'playAnimation') {
                obj[key] = false;
            }
        }
    };
    disableAnimations(renderer);
    return renderer;
}
```

Quickly test prefers reduced motion

Chrome Developer Tools > Rendering tab



Demo: Prefers Reduced Motion

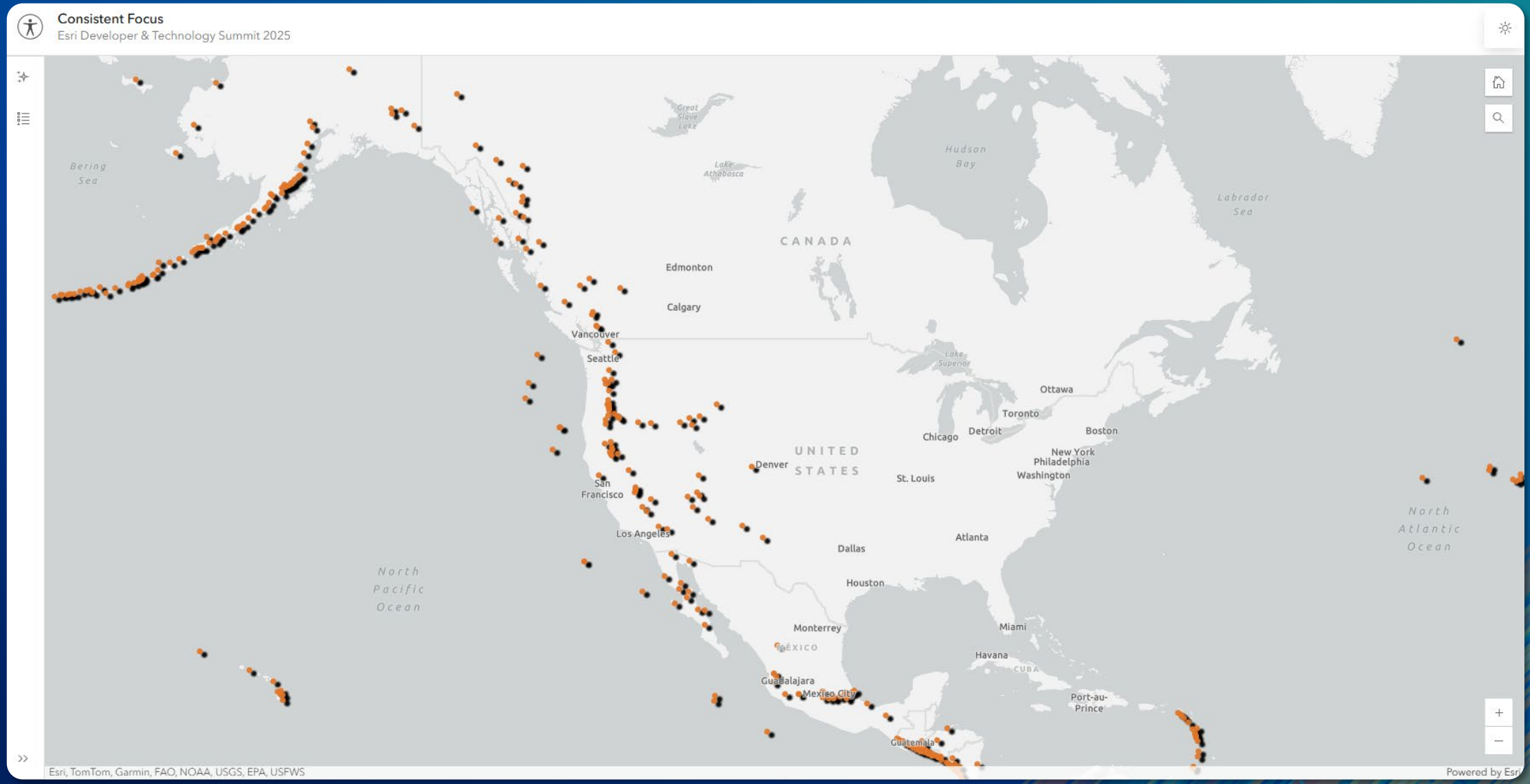


Consistent focus

2.4.3 Focus Order and 2.1.1: Keyboard

- **2.4.3: Focus Order** (Level A)
  - Navigate sequentially to preserve meaning and operability
  - Dialogs
    - Shift focus to dialog when open
    - Shift focus back to the previous element when the dialog is closed
  - Benefits visual and cognitive impairments
- **2.1.1: Keyboard** (Level A)
  - Functionality is operable through a keyboard interface
  - Benefits visual, low vision, and mobility impairments

Consistent focus demo



Consistent focus HTML markup

```
<calcite-shell content-behind>
  <calcite-navigation slot="header">
    ...
  </calcite-navigation>
  <calcite-shell-panel slot="panel-start" display-mode="float-content">
    <calcite-action-bar id="custom-action-bar" slot="action-bar">
      <calcite-action data-action-id="layer-effects" icon="effects" text="Layer effects"></calcite-action>
      <calcite-action data-action-id="legend" icon="legend" text="Legend"></calcite-action>
    </calcite-action-bar>
    <!-- Layer effects -->
    <calcite-panel heading="Layer effects" height-scale="l" data-panel-id="layer-effects" closable closed>
      <!-- Bloom effect -->
      <calcite-block open heading="Bloom" description="Apply a neon-like glow">
        ...
      </calcite-block>
      <!-- Drop shadow effect -->
      <calcite-block open heading="Drop shadow" description="Apply a drop shadow">
        ...
      </calcite-block>
    </calcite-panel>
    <!-- Legend Panel -->
    <calcite-panel heading="Legend" height-scale="l" data-panel-id="legend" closable closed>
      <arcgis-legend reference-element="arcgis-map" position="bottom-right"></arcgis-legend>
    </calcite-panel>
  </calcite-shell-panel>

  <arcgis-map item-id="c2a3444863f2466aaad9efa6e65063e1" id="mapEl" basemap="gray">
    <arcgis-home position="top-right"></arcgis-home>
    <arcgis-expand id="expand-el" focus-trap-enabled="false" close-on-esc position="top-right" mode="floating">
      <arcgis-search id="search-el"></arcgis-search>
    </arcgis-expand>
    <arcgis-zoom position="bottom-right"></arcgis-zoom>
  </arcgis-map>
</calcite-shell>
```

Consistent focus functionality

arcgis-expand, arcgis-search, popup

```
// reactiveUtils to watch for when the popup is opened and closed
// Resource: https://developers.arcgis.com/javascript/latest/watch-for-changes/#watch-for-changes-in-the-api
mapEl.addEventListener("arcgisViewReadyChange", () => {
  reactiveUtils.watch(() => mapEl.view.popup.visible, (visible) => {
      if (mapEl.view.popup.visible) {
        mapEl.view.popup.focus();
      } else {
        searchEl.focusSearch();
      }
    }
  );
});
```

```
// Initialize the mutation observer
// Resource: https://developers.arcgis.com/javascript/latest/watch-for-changes/#using-a-mutation-observer
const observer = new MutationObserver((mutations, observer) => {
  for (let mutation of mutations) {
    // Set focus on the arcgis-search if the component is expanded
    // Else set focus on the arcgis-expand
    if (mutation.target[mutation.attributeName] == true) {
      searchEl.focusSearch();
    } else {
      const expandEls = document.querySelectorAll(".esri-expand__toggle > calcite-action");
      expandEls[0].setFocus();
    }
  }
});

// Start observing the arcgis-expand's "expanded" attribute
observer.observe(expandEl, {
  attributeFilter: ["expanded"]
});
```

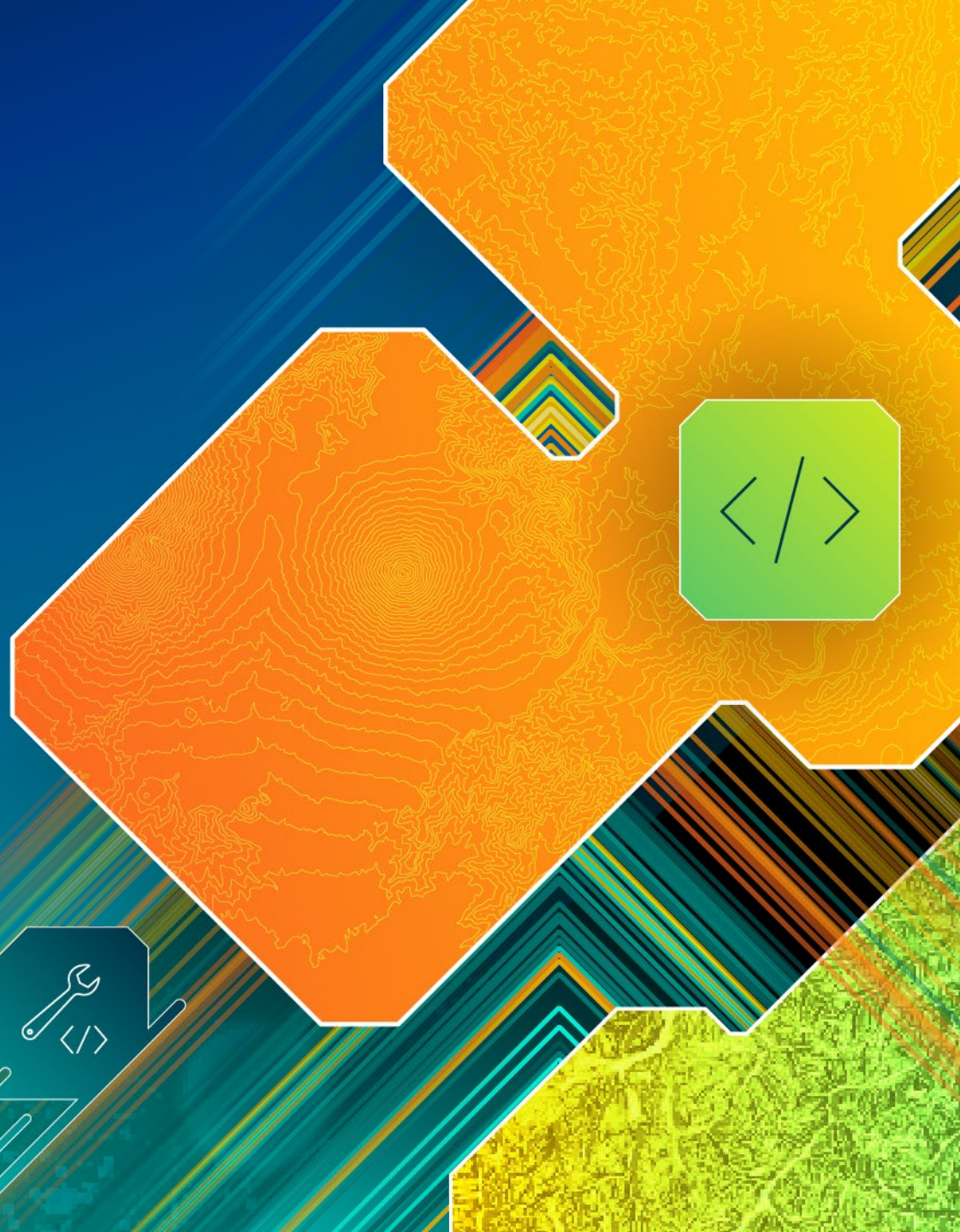
Consistent focus functionality continued

calcite-action-bar, calcite-action, calcite-panel

```
const actionBarEl = document.getElementById("custom-action-bar");
let activeWidget = "";

  // Active action
  const handleActionBarClick = ({ target }) => {
    if (target.tagName !== "CALCITE-ACTION") {
      return;
    }

    if (activeWidget) {
      activeActionEl = document.querySelector(`[data-action-id=${activeWidget}]`).removeAttribute("active");
      activePanelEl = document.querySelector(`[data-panel-id=${activeWidget}]`).closed = true;
    }

    const nextWidget = target.dataset.actionId;
    if (nextWidget !== activeWidget) {
      document.querySelector(`[data-action-id=${nextWidget}]`).active = true;
      document.querySelector(`[data-panel-id=${nextWidget}]`).closed = false;
      activeWidget = nextWidget;
      document.querySelector(`[data-panel-id=${nextWidget}]`).setFocus();
    } else {
      activeWidget = null;
    }
  };

  actionBarEl.addEventListener("click", handleActionBarClick);

  // Panel interaction
  const panelEls = document.querySelectorAll("calcite-panel");
  for (let i = 0; i < panelEls.length; i++) {
    panelEls[i].addEventListener("calcitePanelClose", () => {
      document.querySelector(`[data-action-id=${activeWidget}]`).closed = true;
      document.querySelector(`[data-action-id=${activeWidget}]`).active = false;
      document.querySelector(`[data-action-id=${activeWidget}]`).setFocus();
      activeWidget = null;
    });
  }
```


Consistent Focus
Esri Developer & Technology Summit 2025
Bering Sea
Great Slave Lake
Lake Athabasca
Hudson Bay
Labrador Sea
CANADA
Edmonton
Calgary
Vancouver
Seattle
Lake Superior
Ottawa
Toronto
Chicago
Detroit
Boston
New York
Philadelphia
Washington
UNITED STATES
Denver
St. Louis
San Francisco
Los Angeles
Atlanta
Dallas
Houston
North Pacific Ocean
North Atlantic Ocean
Monterrey
Miami
MEXICO
Havana
CUBA
Guadalajara
Mexico City
Port-au-Prince
Guatemala
Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS
Powered by Esri

Testing, Tools and Resources



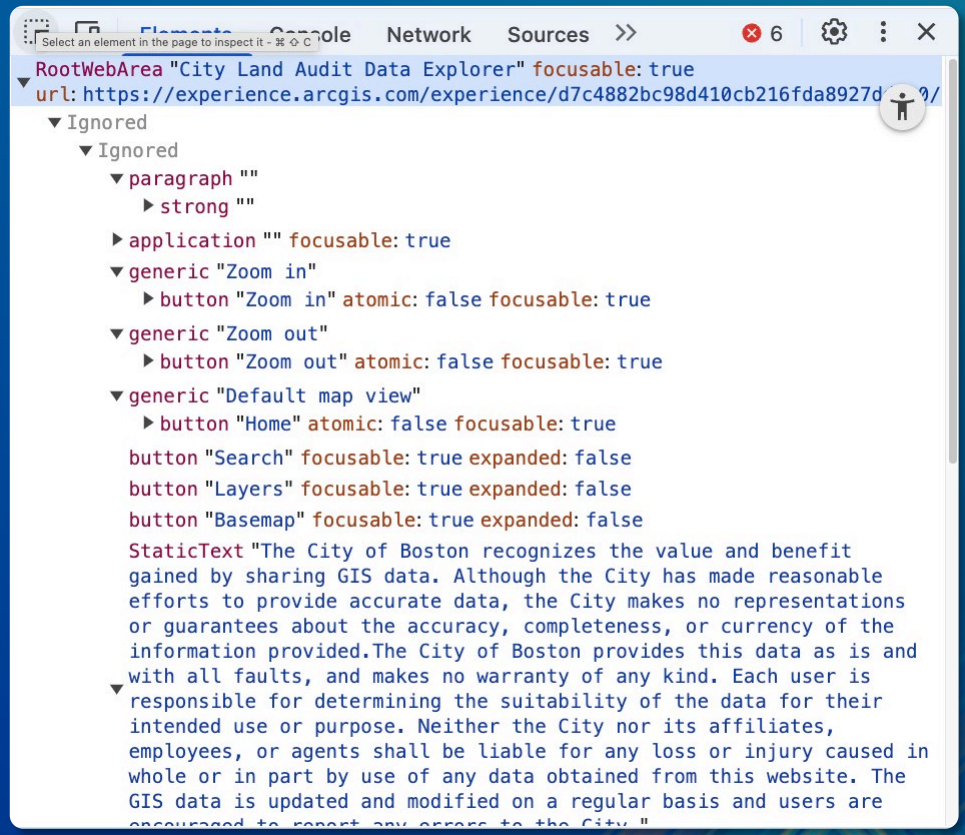
Accessibility testing

1. **User acceptance testing** (e.g., real-world performance)
2. **Manual testing** (e.g., Screen readers – JAWS, NVDA, VoiceOver)
3. **Automated testing** (e.g., Browser extensions)
    - Third party browser extensions cannot guarantee accessibility
    - Approximately 30% of accessibility concerns are evaluated with automated tests
    - The best way to test accessibility is with a human, but automated tests can provide general guidance
    - As browsers and extensions update, conflicts can arise and trigger unrelated errors without warning

Browser testing tool: Accessibility tree

Representation of HTML elements that are relevant for assistive technology

- Chrome & Firefox developer tools
  - Firefox: Right-click > Inspect accessibility properties
  - Chrome: Right-click > Inspect > click accessibility icon in upper corner
- Used by assistive technology to interpret the site content



Invalid accessibility bugs #1

`calcite-button` and labels

- Label mismatch, where **`label`**/**`aria-label`** differ from visible text
- Matching text is suggested, and some automated testing tools flag as an issue
  - No criterion mentions matching
  - Recommendation for visible text into label
- 2.5.3: Label in Name

```
<calcite-button label="Select: Funding">
  Select
</calcite-button>
```

Invalid accessibility bugs #2

`calcite-input`

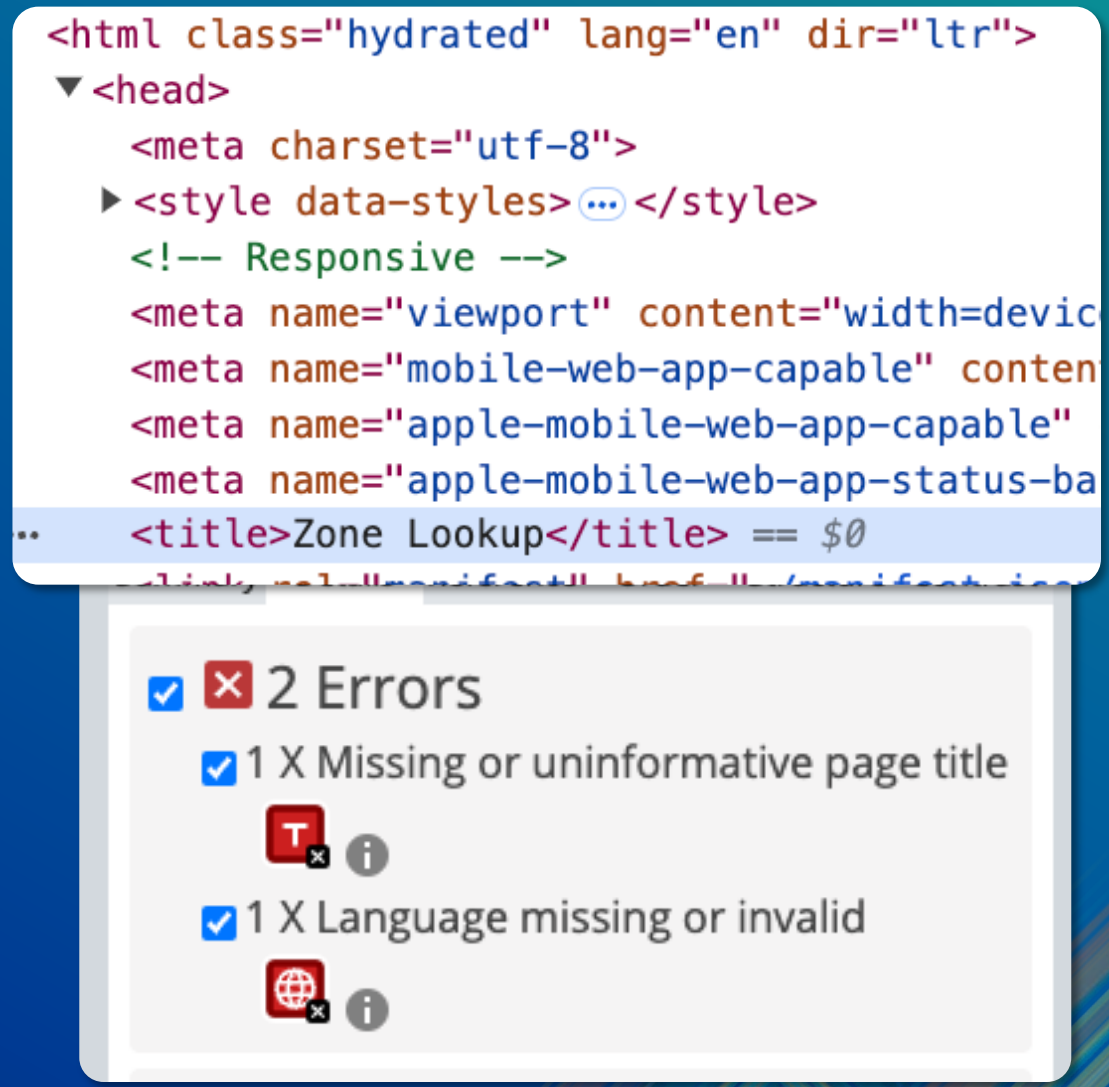
- Input's **`clearable`** button is not accessible via keyboard
- Why it's invalid
  - Follows native input behavior
  - The **`value`** can be cleared with "esc", "backspace" and "delete" keys or selecting the text and clearing the value
  - Calcite's research and design considerations
  - Follows 2.1: Keyboard

```
<calcite-input clearable></calcite-input>
```

Invalid accessibility bugs #3

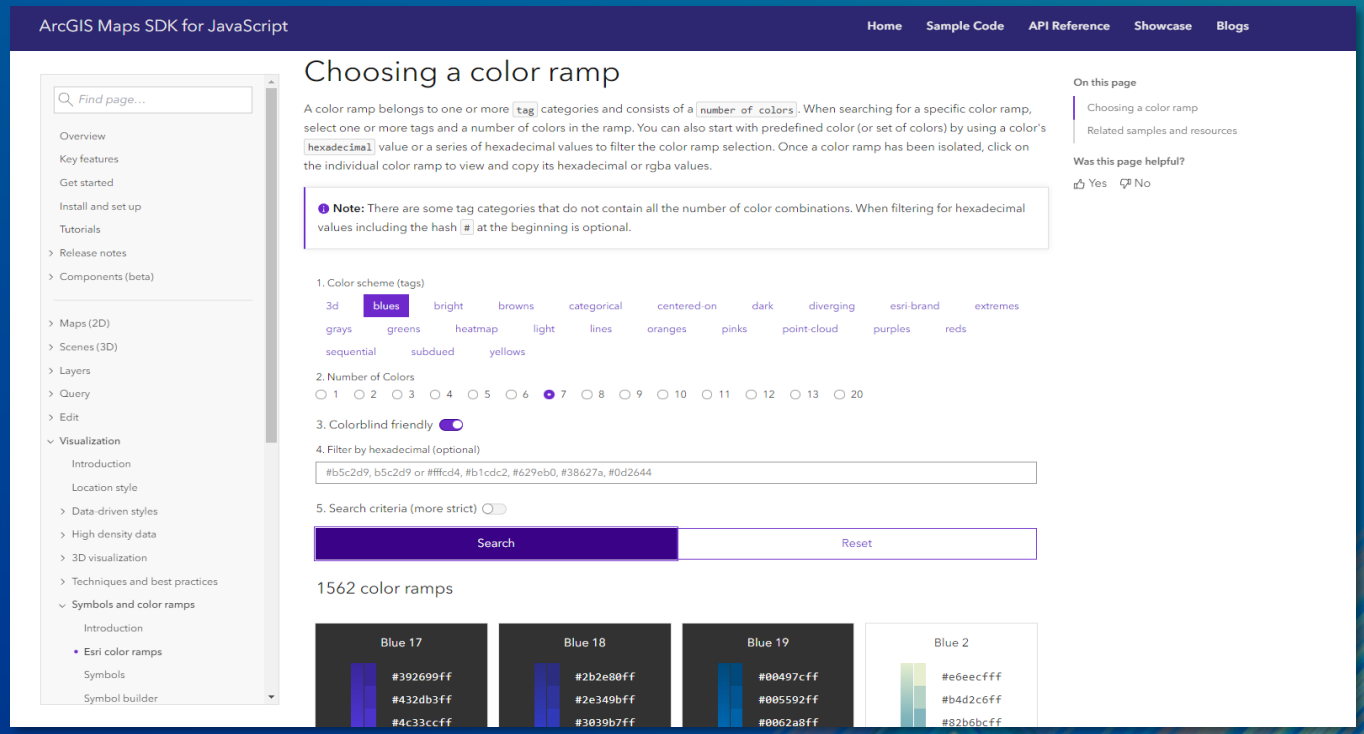
Missing content

- Language missing or invalid
- Missing or uninformative page title
- Why it might be invalid
  - Value is set dynamically



Accessibility tools

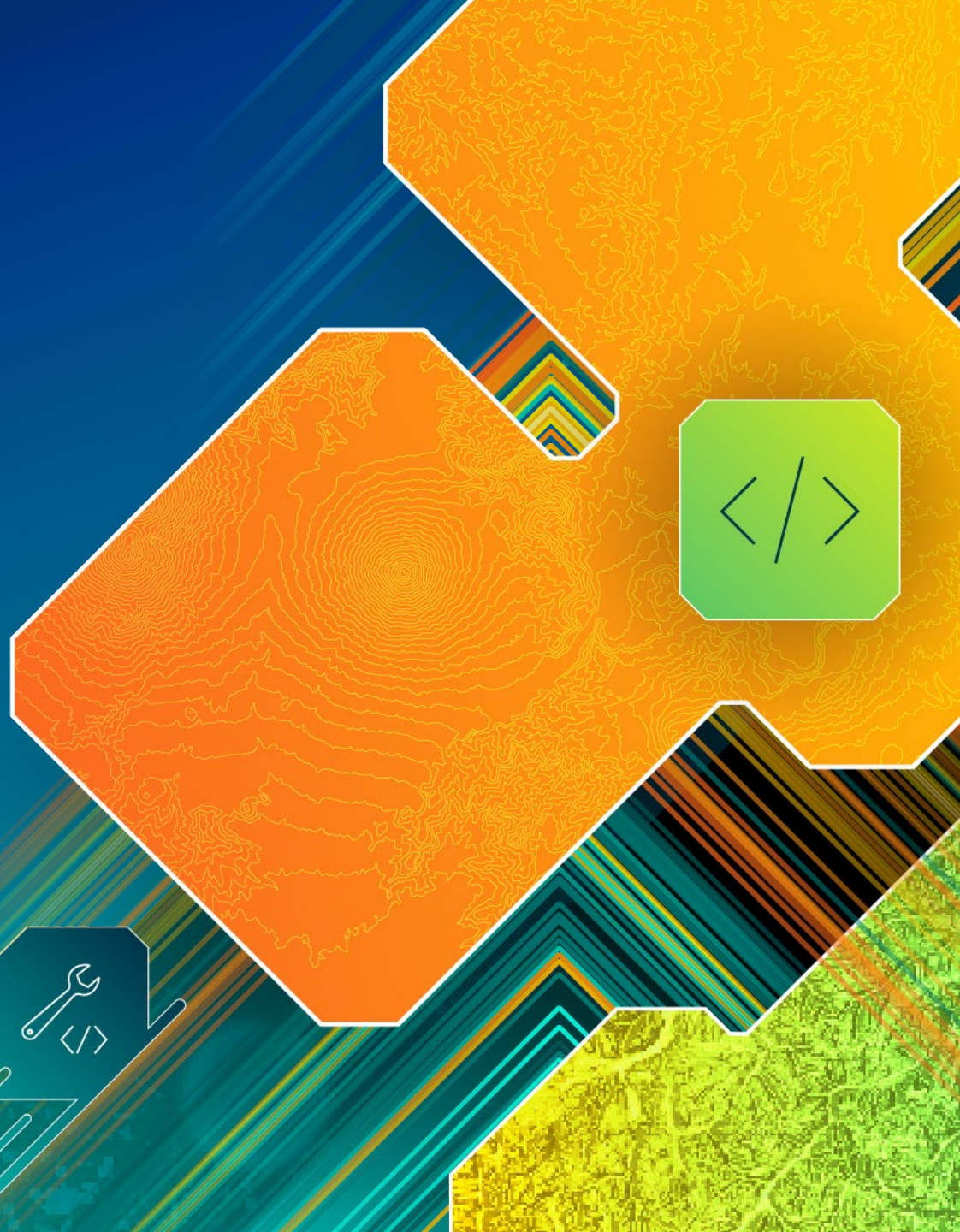
- Color ramps by Esri
- Contrast Grid by Eightshapes
- Browser extensions
  - Colorblindly
  - axe by Deque
  - WAVE by WebAIM
  - Accessibility Insights by Microsoft
  - Accessibility Checker by Silktide



Accessibility resources

- GitHub demos and code: https://esriurl.com/a11y-ds-2025
- Resources and tools: https://esriurl.com/a11y-resources
- Esri Community: https://esriurl.com/a11y-community
- Developer guides
  - https://esriurl.com/js-a11y
  - https://esriurl.com/calcite-a11y

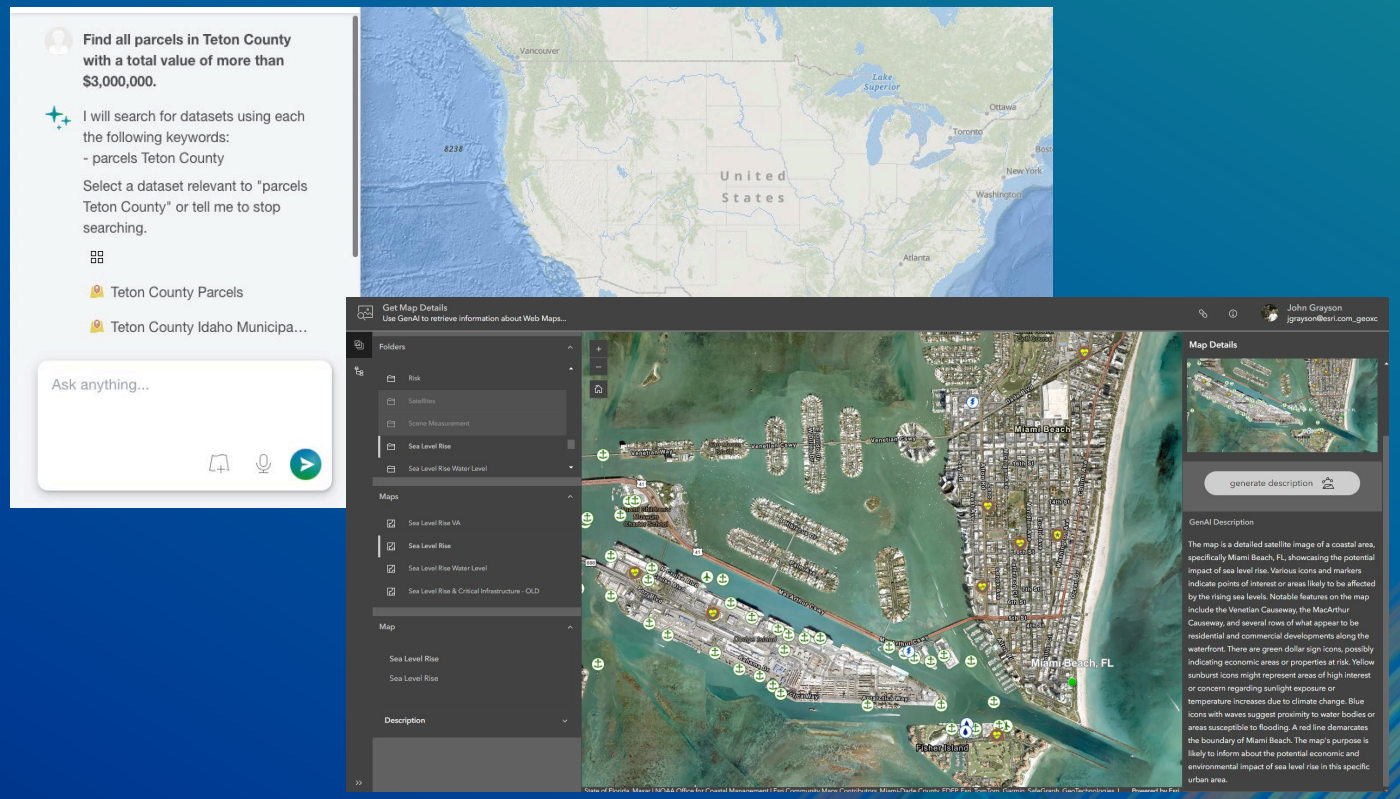
Road Ahead



Artificial Intelligence

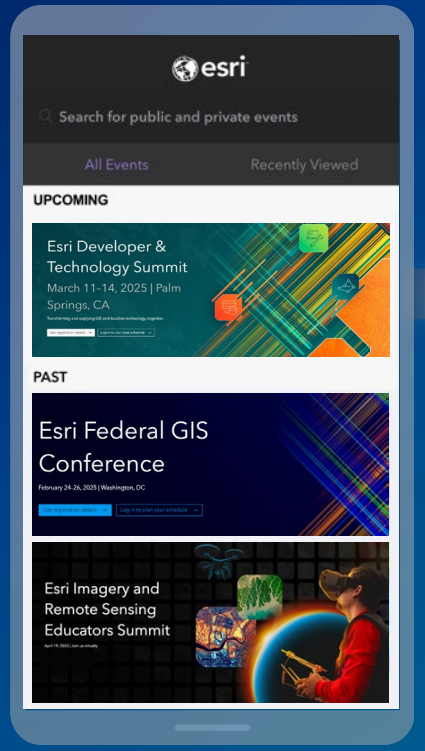
Research areas

- Enhance apps with chat option
  - Voice or text based interactions
- Automated descriptions
  - Not always accurate with maps
  - Good for images

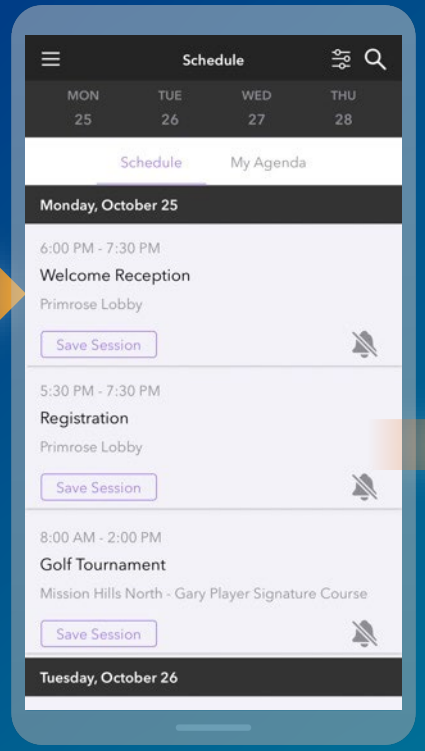


Please share your feedback in the app

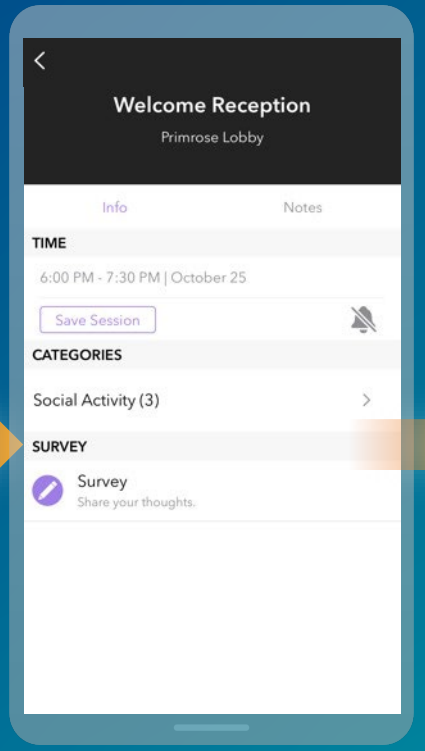
Download the Esri Events app and find your event



Select the session that you attended



Scroll down to "Survey"



Log in to access the survey