

Feasibility Study to Interactive Workshop: Building End-user Capacity to Integrate Earth Observation Data into Federally Endangered Atlantic Salmon (*Salmo salar*) Habitat Monitoring in Maine

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ABSTRACT

Changes in temperature and precipitation patterns, along with alterations in land cover threaten ongoing conservation efforts for Federally Endangered Atlantic salmon (*Salmo salar*) in Maine. Earth observation data offers a unique perspective for habitat monitoring that can complement habitat restoration and conservation activity on the ground. As a dual capacity building program, the NASA DEVELOP National Program strives to build the capacity of program participants by leveraging Earth observation data to address environmental concerns across the globe, while also building capacity in partner organizations to integrate Earth observation data into their decision making practices. Between September 2021 and August 2022, three NASA DEVELOP teams demonstrated the feasibility of utilizing NASA Earth observations including Aqua Moderate Resolution Imaging Spectroradiometer (MODIS), Terra MODIS, Landsat 5 Thematic Mapper (TM), Landsat 8 Operation Land Imager (OLI), and Shuttle Radar Topography Mission (SRTM) in conjunction with Sentinel-2 MultiSpectral Instrument (MSI) to assess temperature, precipitation, and land use land cover (LULC) over time throughout salmon habitat in Maine. While the first two teams completed projects that were categorized as NASA DEVELOP's traditional feasibility projects, the third and final project team generated resources and planned an interactive workshop to transfer project methods to end-user organizations. Ultimately, the goal of this work was to not only inform the partner's ongoing salmon population recovery and habitat restoration initiatives but provide tools that allow partner organizations to continue integrating Earth observation data into their work beyond their partnership with the program. This project serves as a case study within the NASA DEVELOP Program and provides lessons learned for moving beyond traditional feasibility studies to more interactive partner engagement and knowledge transfer practices.

A SPECIES ON THE BRINK OF EXTIRPATION

LAST WILD POPULATIONS IN MAINE, USA

Atlantic salmon were historically found throughout New England, located in the Northeastern United States. However, factors such as overfishing, pollution, dam construction, and logging activity have resulted in dramatic population declines. The last wild Atlantic salmon, known as the Gulf of Maine Distinct Population Segment, are found in Maine and protected under the Endangered Species Act.

SALMON ARE SEA-RUN FISH

As an anadromous species, juvenile Atlantic salmon spend up to three years in freshwater streams before undergoing physiological changes that allow salmon to survive in the marine environment until they return to freshwater to spawn. This makes salmon an integral component of Maine's freshwater and marine ecosystems.

Image Credit: DSF

THREATS TO SALMON RECOVERY

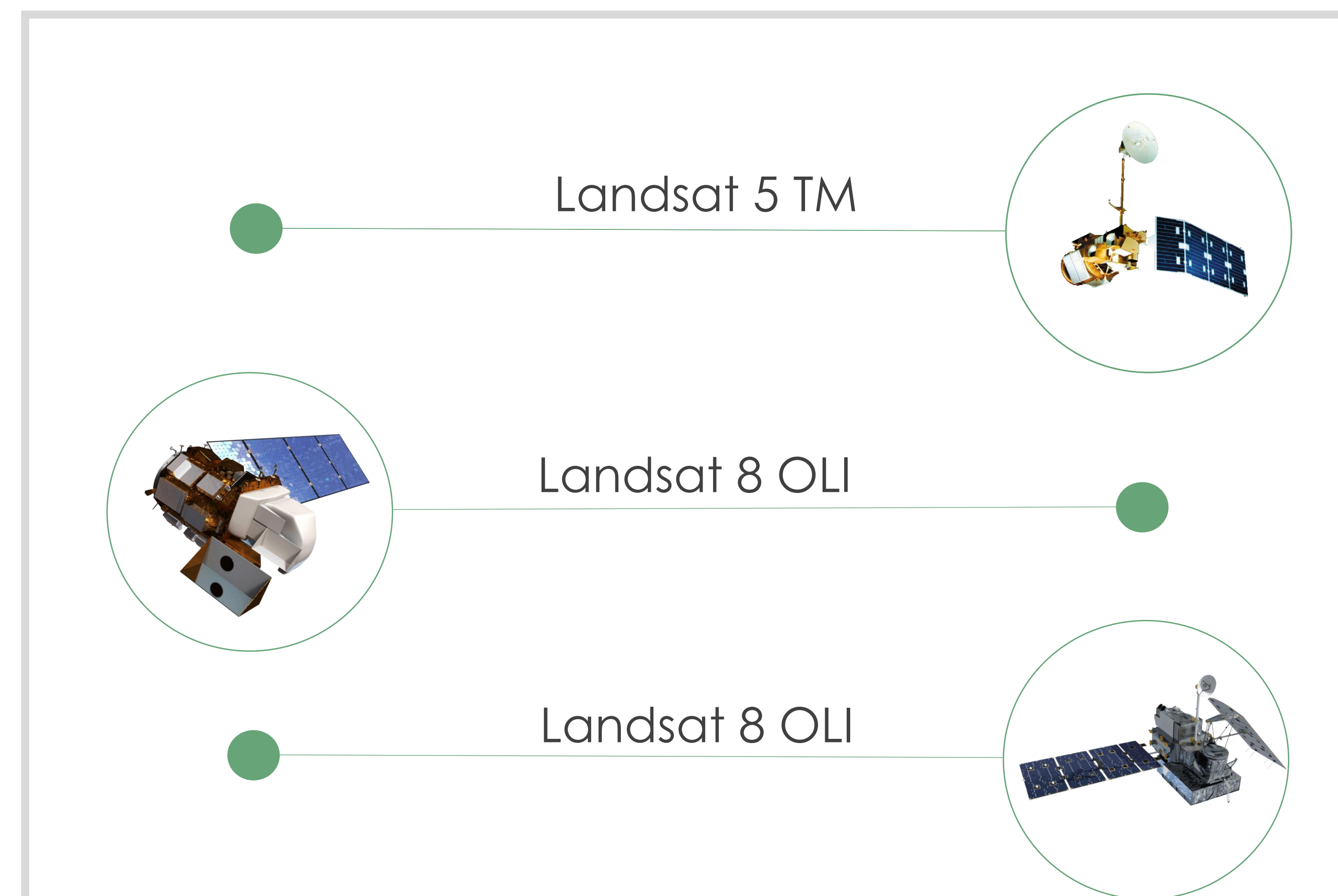
Shifting patterns in temperature and precipitation paired with changes in land use and land cover threaten the survival of juvenile salmon in Maine streams. **Warming waters** affect salmon physiologically, influencing their ability to compete for resources. **Reductions in precipitation** alter streamflow and habitat connectivity. Changes in land cover, including **loss of forest cover**, can alter stream shading and increase water temperature.

Image Credit: DSF

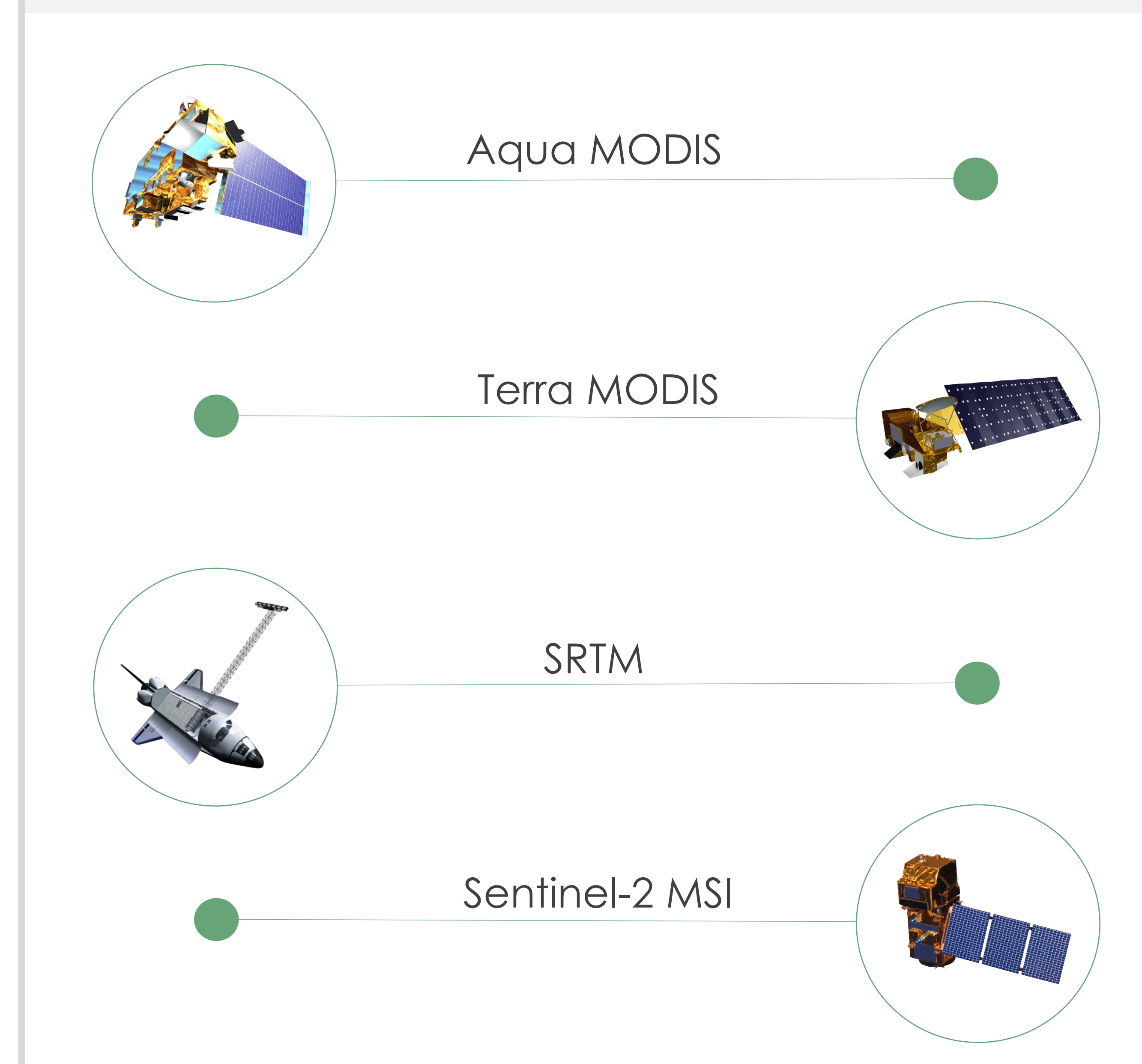
MULTI-PHASED PROJECT TO ADDRESS END USER NEEDS

The NASA DEVELOP Program partnered with the **Downeast Salmon Federation** and the **Department of Marine Resources**. Both organizations are involved in salmon population recovery efforts that strive to improve riverine habitat quality and increase the number of salmon that migrate to the ocean.

MONITORING EARTH FROM SPACE



Earth observation data can inform Federally Endangered Atlantic salmon management practices as land cover and climate changes in Maine, USA



BUILDING CAPACITY AT ALL STAGES

PHASE 1 Track land cover, temperature, and precipitation trends

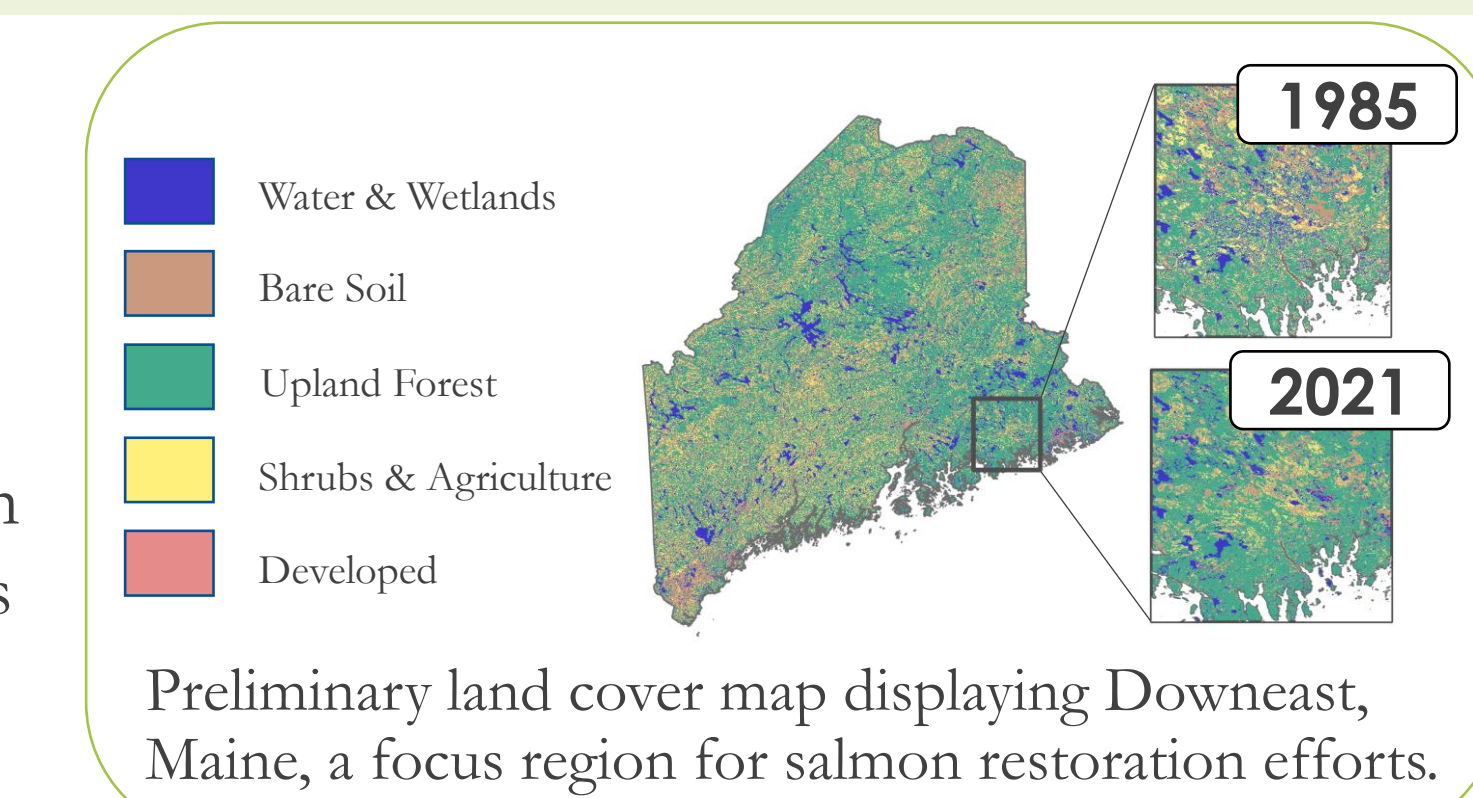
Fall 2021 | Feasibility Study

End User Capacity Built ○○○

- ▶ Exposure to application of Earth observation
- ▶ Received curated data in ready-to-use formats

Summary

- ▶ Demonstrated the feasibility of using Landsat 5 TM, Landsat 8 OLI, and Sentinel-2 MSI to assess how land cover changed throughout critical salmon habitat between 1985 and 2021
- ▶ Gathered and analyzed monthly temperature data from Terra MODIS and precipitation data from GPM IMERG between 2000 and 2020



PHASE 2 Explore relationships between land cover and temperature

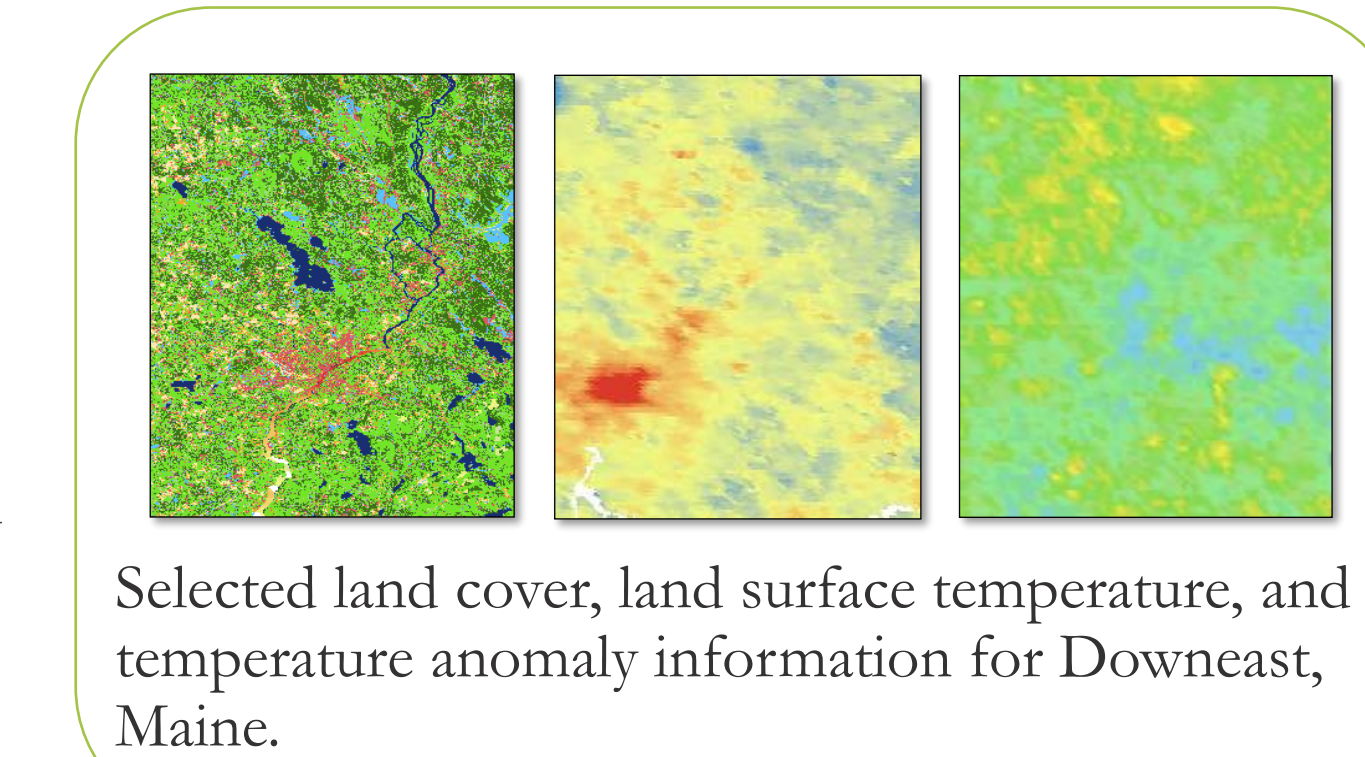
Spring 2022 | Feasibility Study

End User Capacity Built ○○○

- ▶ In-depth discussions on applications of Earth observations
- ▶ Received curated data in ready-to-use formats and extensive map package including land cover and temperature maps

Summary

- ▶ Refined land cover maps between 1985 and 2021 to distinguish between coniferous and deciduous forest types using Landsat 5 TM, Landsat 8 OLI, and Sentinel-2 MSI
- ▶ Examined relationships between land cover and temperature throughout salmon habitat
- ▶ Explored accuracy of Terra MODIS as a proxy for stream temperature when in-situ data is unavailable



PHASE 3 Plan interactive workshop to build partner capacity

Summer 2022 | Virtual Workshop

End User Capacity Built ○○○○

- ▶ Collaborated in lesson plan development
- ▶ Participated in interactive workshop
- ▶ Received resources to continue using Earth observation data

Workshop Duration

- ▶ 3 Hours

Workshop Topics

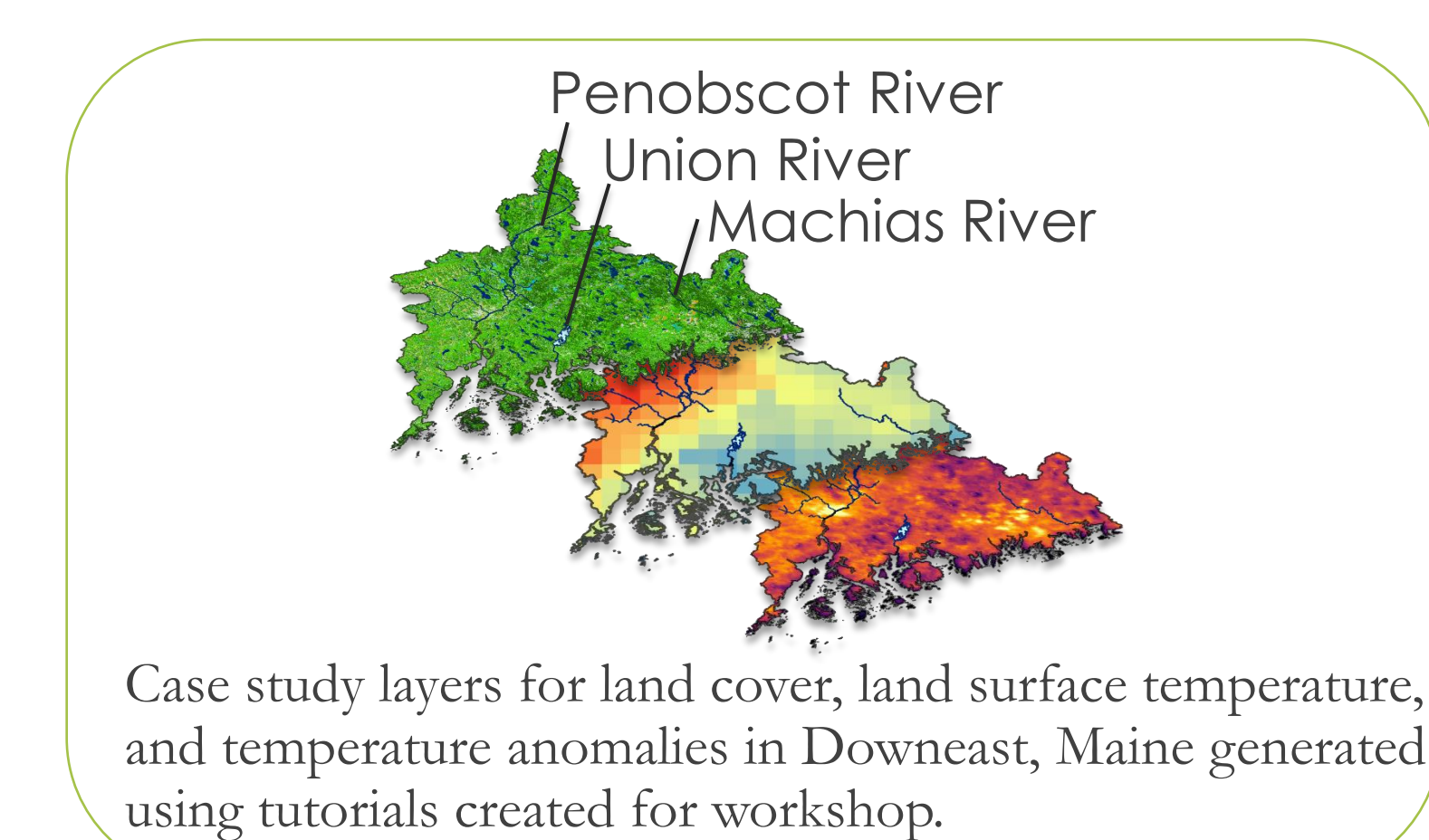
- 1 Earth Observation Overview
- 2 Data Acquisition Tutorial
- 3 Land Cover Mapping Tutorial
- 4 Climate Tutorial
- 5 Discussion & Questions

Workshop Resources

- Tutorials
- ▶ Earth observation overview
 - ▶ Introduction to Earthdata
 - ▶ Introduction to Google Earth Engine
 - ▶ Introduction to EarthExplorer
 - ▶ Mapping land cover and precipitation
 - ▶ Mapping land cover
- Case studies
- ▶ Local examples applying material outlined in tutorials

Lessons Learned

- ✓ Collaborate with end user to develop resources and lesson plan
- ✓ Create agenda
- ✓ Pre-record demonstrations to avoid communication delays
- ✓ Make workshop materials available prior to workshop
- ✓ Incorporate interactive elements
- ✓ Include event registration for larger workshops



Maine Ecological Forecasting

For more information visit:

