3DHP Hydrography in Alaska and the Potential for Increased Utility

Joseph Jones, Program Manager, April 11, 2025

Agenda

Presentation Goals:

01
Overview of 3DHP Production

02
Software and Tools Used

03
Source and Ancillary Data

04
Terrain and GMI Integration

05
Flowline Generation and Classification

06
Quality Control Processes

07
WBD Creation and Attribution

08
Virtual Watershed Applications

Software Requirements

ArcGIS Pro

*ArcMap 10.6

QGIS

SAGA 3.14

Global Mapper 25.0

Metadata Wizard

*Extensions: Data Reviewer, Arc Hydro, Spatial Analyst, Proprietary Add-Ons and Toolboxes

Acquiring Source and Ancillary Datasets

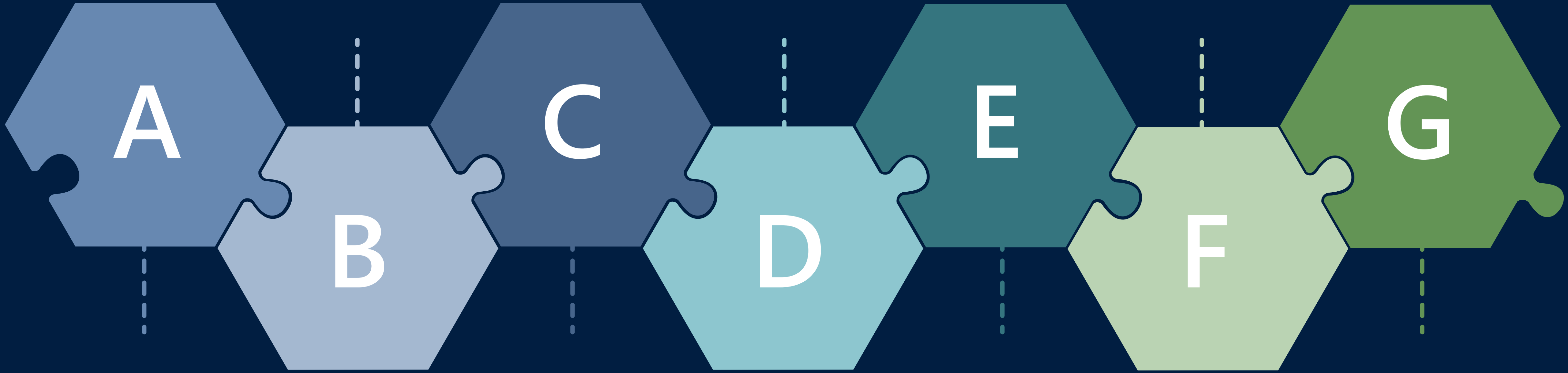
Source Data

- USGS DTM
- ORI (Orthorectified Radar Image)
- IfSAR Breaklines
- NHD (National Hydrographic Data)
- GMI (Geomorphic Indicator)
- DPA (Define Project Area)
- Target Densities
- GNIS (Geographic Names Information System

Ancillary Data

- Transportation
- Culverts
- Glaciers

Preprocess IfSAR Breaklines



A: Use the buffered HUC08 boundary to select the breaklines that fall within the project area

B: Attribute the hydro type if it isn’t defined with ocean, lake, or river through visual inspection

C: Assess the NHD waterbodies. Include breaklines that intersect with NHD waterbodies that are over 2 acres

D: Assess islands and only keep ones that meet specification. For rivers and lakes, the min. size is 0.12 acres. For ocean islands, the minimum size is 1 acre

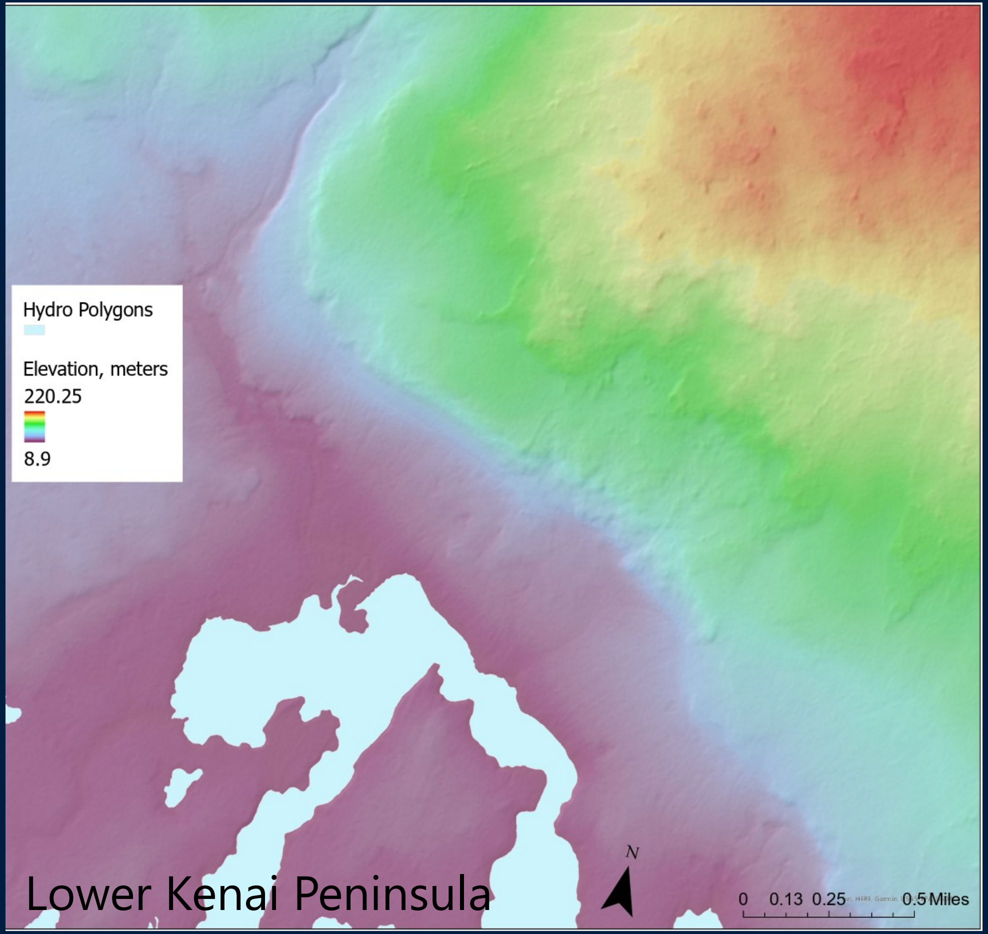
E: Smooth and simplify the breaklines

F: Check for vertices that are too close and fix using proprietary tools

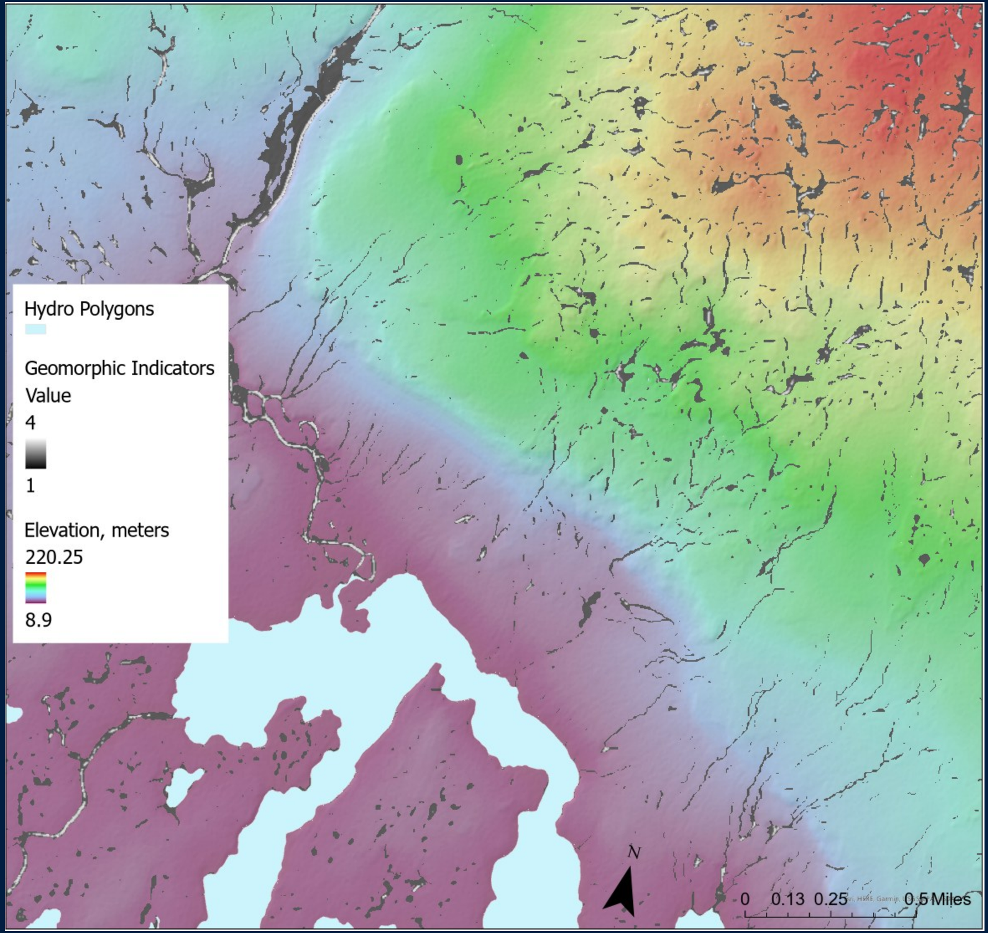
G: Flowline generation

Generation of 3DHP from Digital Elevation Model (IfSAR 5m example)

Raw Terrain

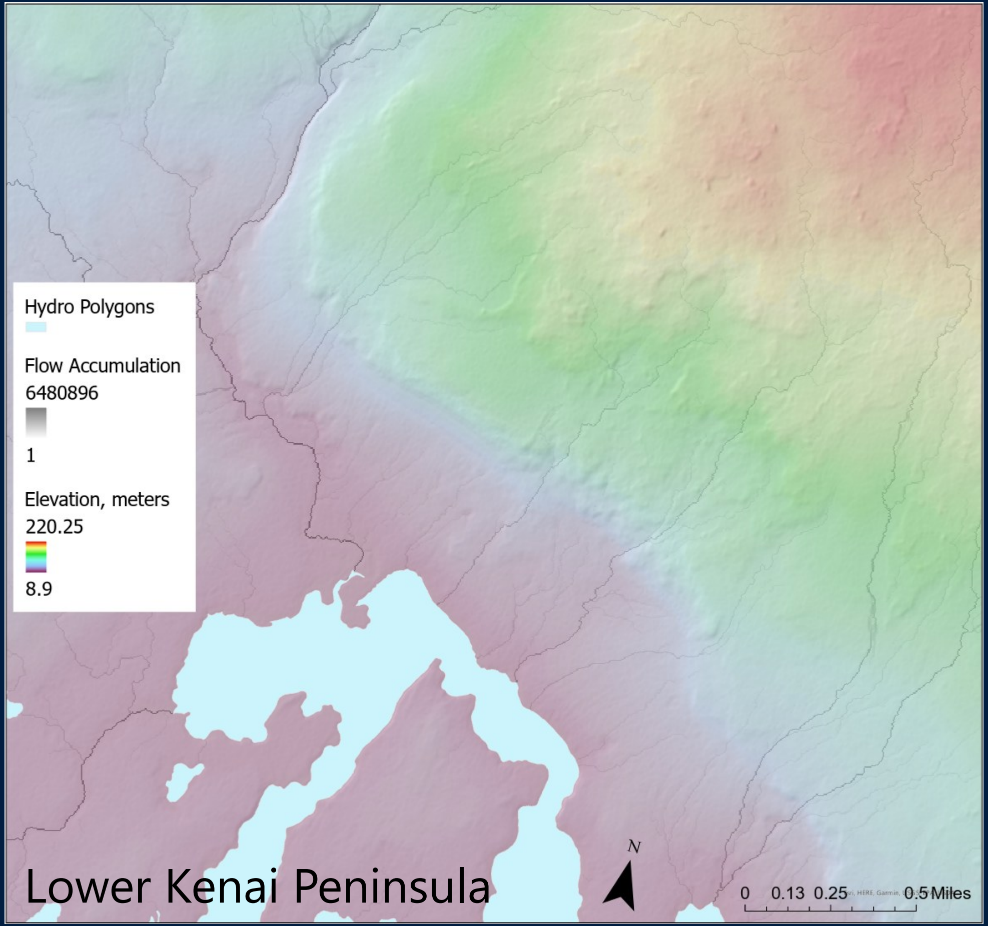


+ Geomorphic Indicators

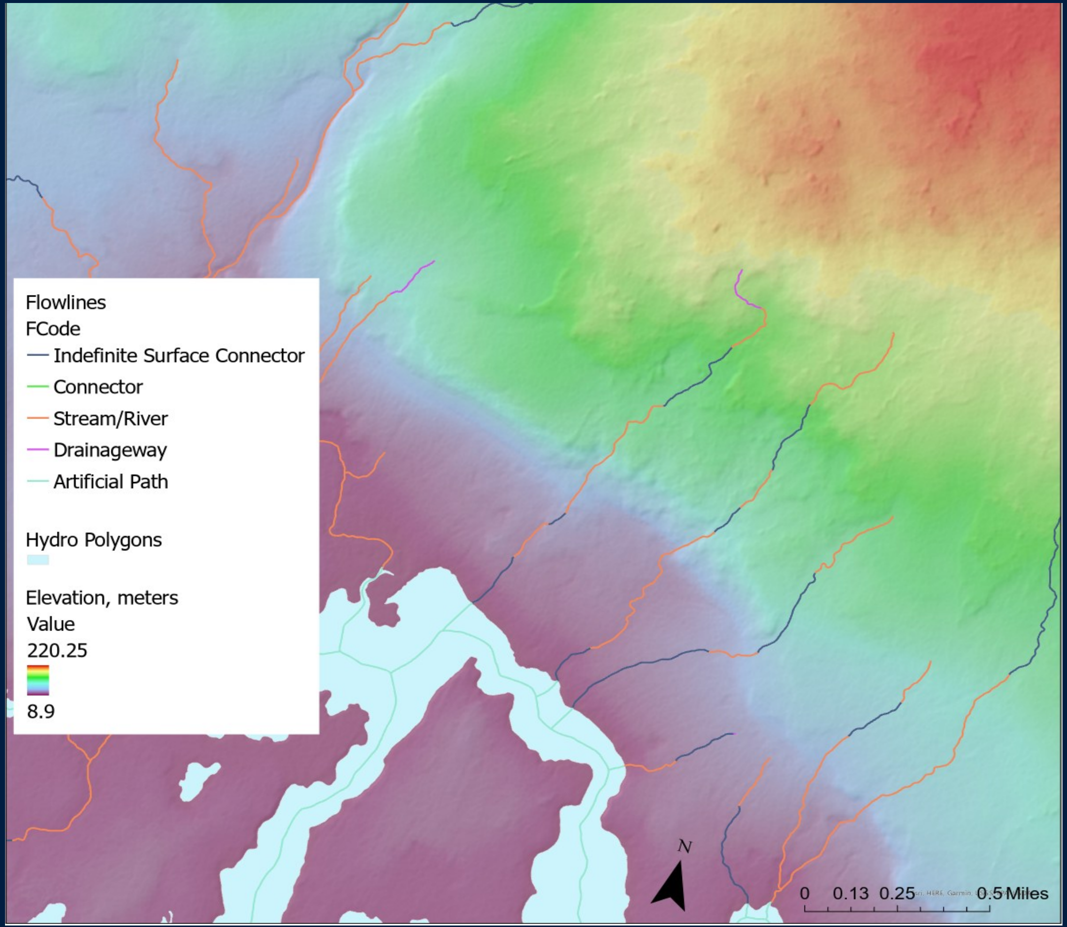


Generation of 3DHP from Digital Elevation Model (IfSAR 5m example)

Channel heads and flow path location determined from flow accumulation + GMI

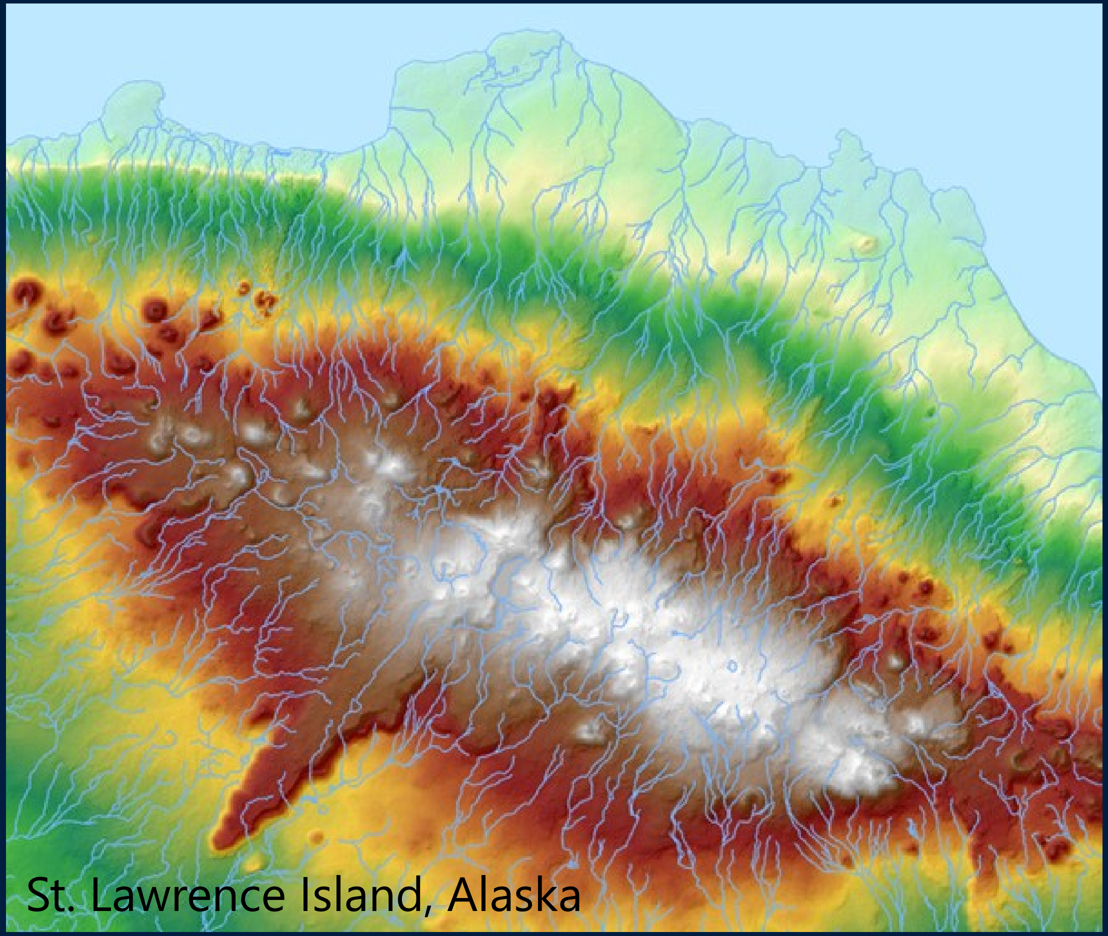


Flowlines generated and classified



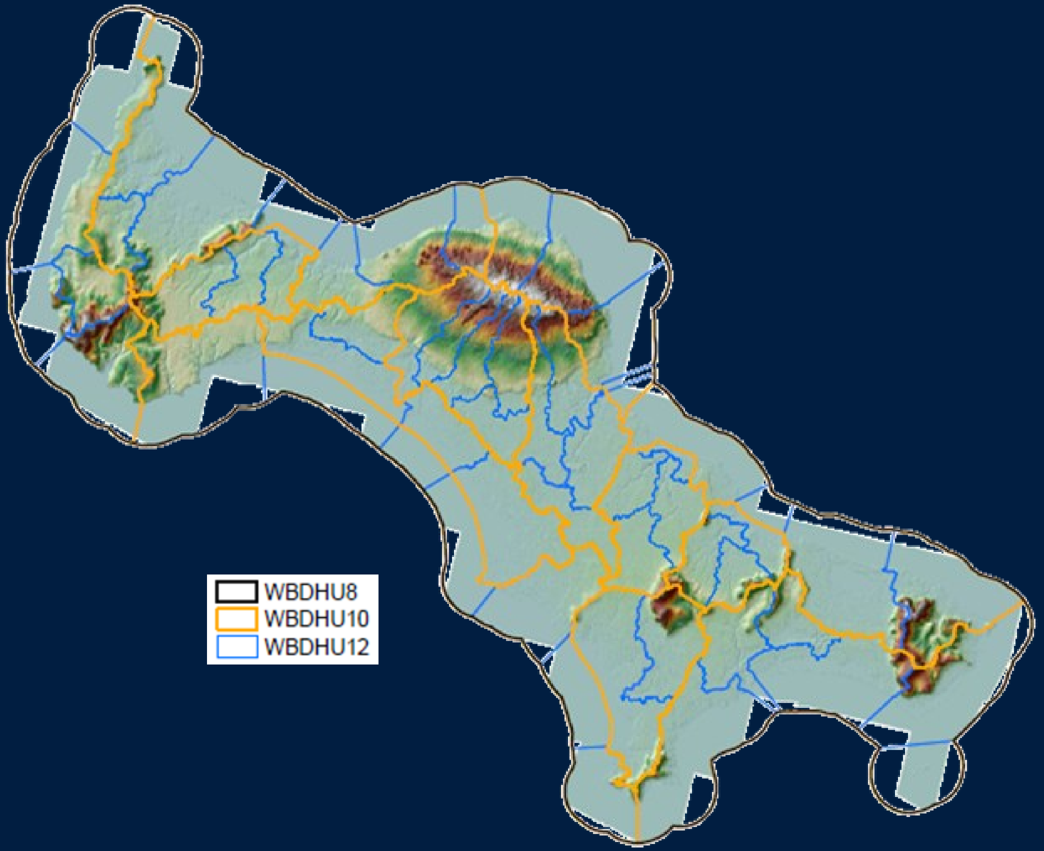
Initial Flowline Review and Feedback

- Preliminary Flowline Validation Workflow
  - Compare flowlines against GMI to confirm geomorphic alignment
  - Inspect against high-resolution imagery for visual consistency
  - Identify and document hydro feature issues (e.g., misalignments, missing segments)
  - Submit corrections to the hydro modeling team for revision

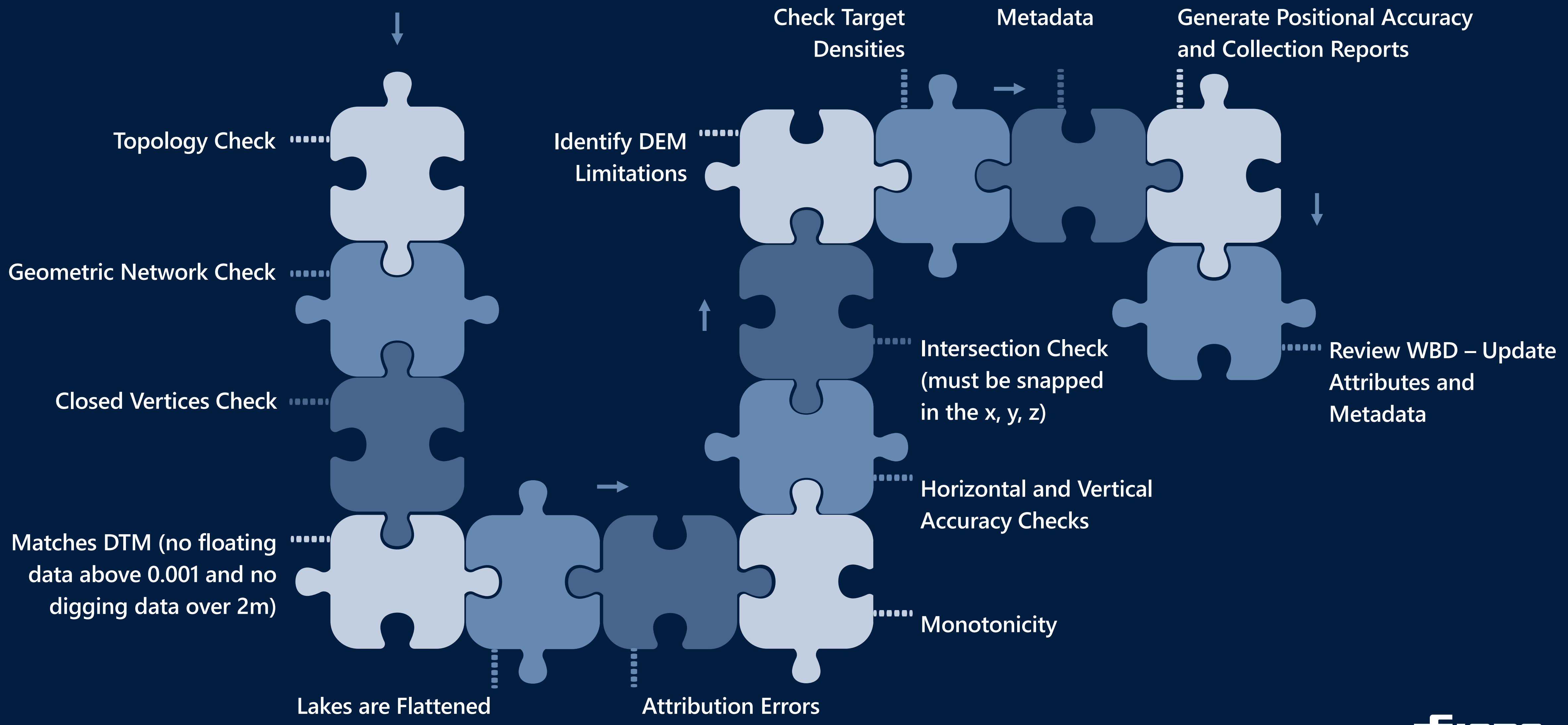


Creating Hydrologic Units from 3DHP Flowlines

- Preliminary HUC12 boundaries generated from terrain and flowlines
- The hydro team populates full WBD schema: WBD Line, HU08, HU10, HU12
- Boundaries reflect topographic flow, not administrative lines
- Supports routing, watershed modeling, regional and national hydrologic planning



Final Quality Control Process

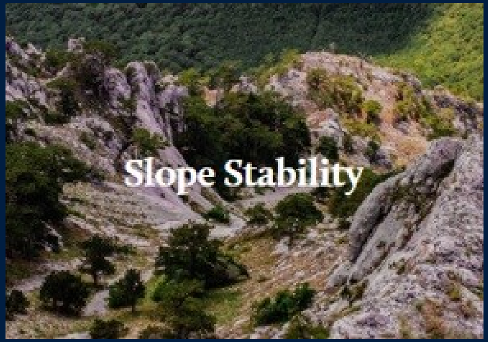


Building on the Power of 3DHP to Create a Virtual Watershed Solution

Our Virtual Watershed leverages the robust foundation provided by the USGS 3D Hydrography Program (3DHP) linework, enhancing its capabilities to incorporate additional hydrographic products and analysis tools. This value-added product is designed to complement and expand the utility of 3DHP, providing new insights and applications.

The Virtual Watershed supports resource management, planning, and review, with scalability from small project areas to entire watersheds and landscapes. By addressing critical hydrographic and watershed challenges, it strengthens the ability of local, state, and federal agencies to make informed decisions.

Virtual Watershed Concept



Expanding the Virtual Watershed with Advanced Analytical Capabilities

Our advanced algorithms enable the Virtual Watershed to provide significant insights into hydrology, geomorphology, and ecology. These capabilities support comprehensive resource management and planning, addressing critical watershed challenges for federal, state, and local stakeholders.

Hydrology

Drainage Area

Mean Annual P (Precipitation)

Mean Annual Flow

Flow Velocity

Stream Power

Stream Order

Geomorphology

Channel Width and Depth

Floodplain Width

Valley Width

Channel Sinuosity

Elevation

Gradient (Any Length Scale)

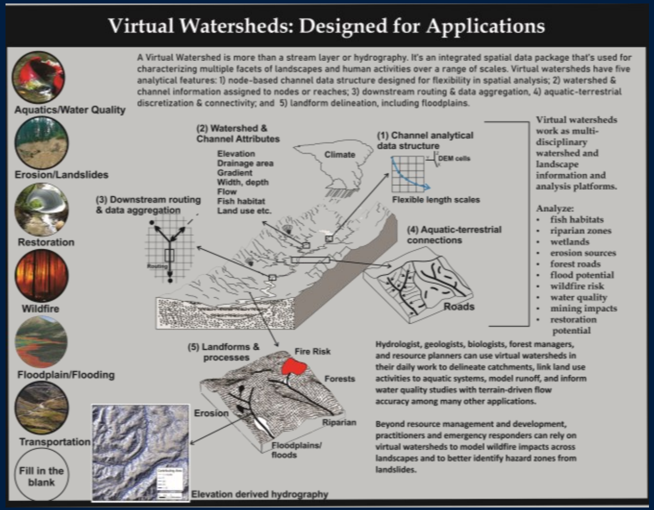
Ecology

Fish Habitats

Radiation Loading

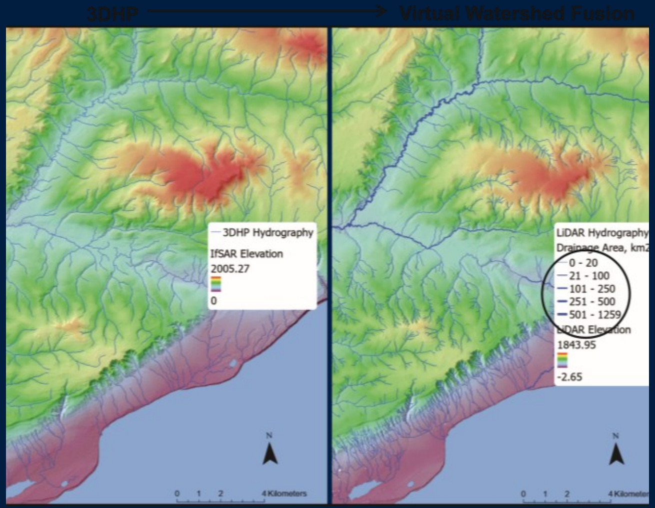
Max Downstream Gradient (Fish)

From Elevation to Intelligence – DEM and 3DHP to Virtual Watershed Fusion



Virtual Watershed

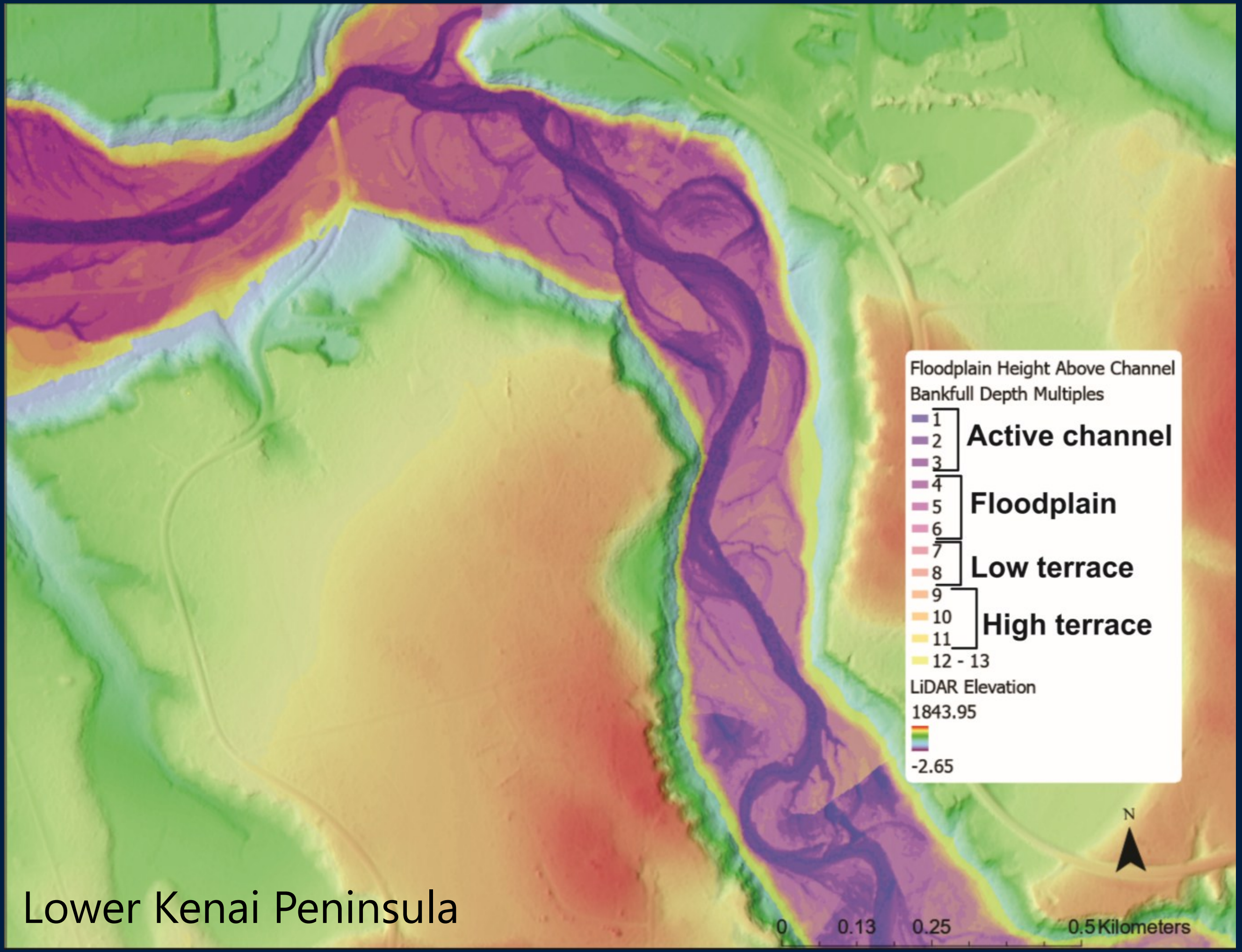
3DHP



Transforms static terrain into dynamic hydrologic intelligence

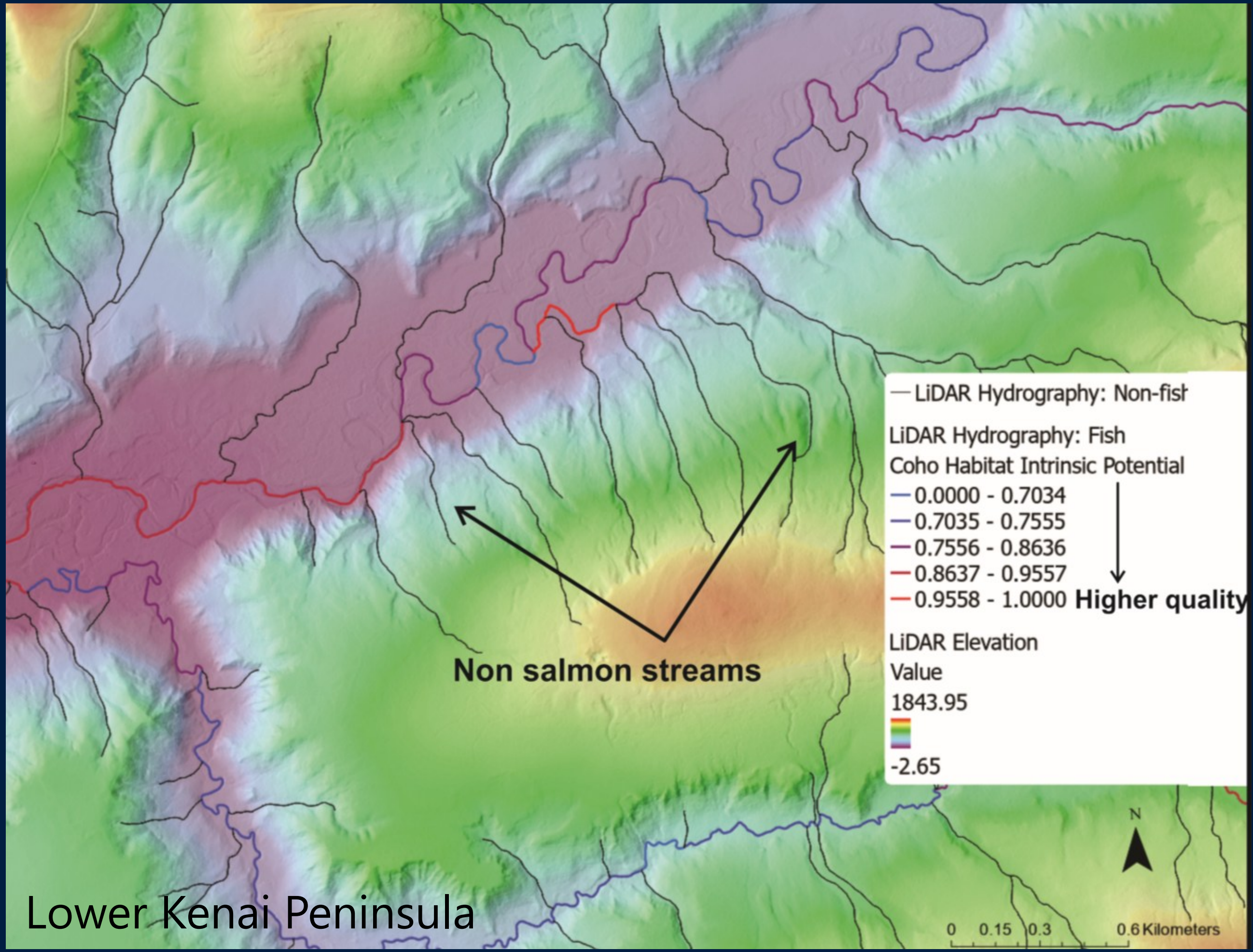
Stratified Floodplain Zones – Interpreting Bankfull Height in 3D

- Lidar-derived floodplain stratification by elevation
- Zones represent multiples of bankfull depth
- Active Channel (1–3), Floodplain (4–6), Low Terrace (7–8), High Terrace (9–13)
- Supports floodplain management and ecological restoration



Mapping Habitat Potential – Virtual Watershed with Coho IP

- Differentiates fish vs. non-fish stream reaches
- Color-coded Coho salmon habitat intrinsic potential (IP)
- Based on slope, confinement, and other lidar-derived factors
- Guides restoration and conservation prioritization



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Thank you

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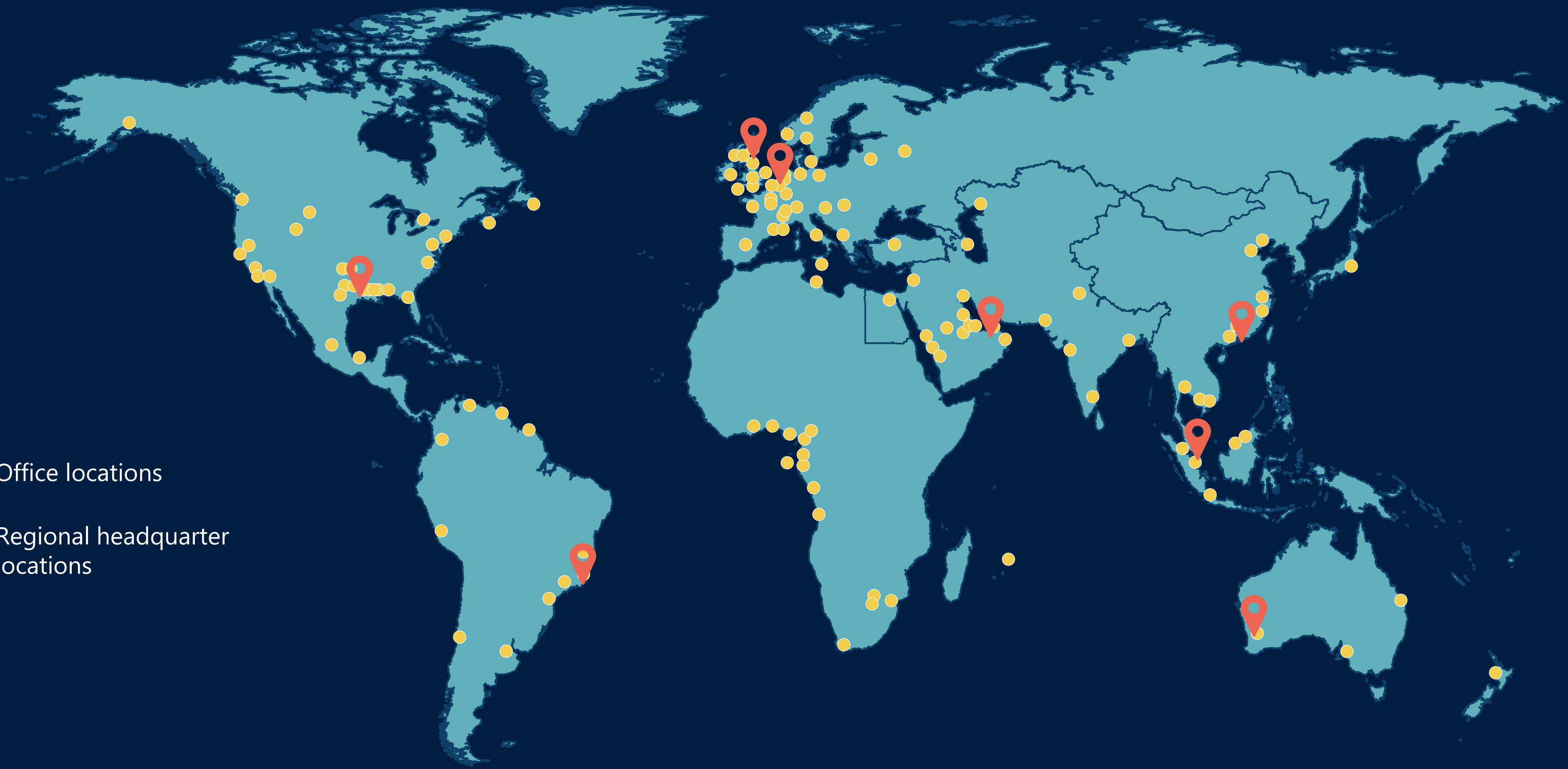
https://www.fugro.com/expertise/surveying-and-mapping

Joseph Jones, Program Manager, Fugro

About Fugro

Global player with local presence

We meet our clients' need locally by mobilizing global resources quickly and effectively



Office locations

Regional headquarter locations

Why Fugro?

Acquire & Integrate Different Types of Data

Fugro is a leader in geo-data acquisition with extensive expertise in both the land and marine environments. While data acquisition is what we are best known for, data integration across disciplines and environments (land, marine, and in between) is what sets us apart from competition.

Offer End-to-End Solution

Fugro's wide portfolio of services from site screening to modeling, from satellite imagery or deep-sea remote monitoring to planning, distinguishes us from our competitors and allows the delivery of an integrated and efficient solution.

Single Source of Truth for Informed Decision-making

Aligned with its mission, Fugro offers clients the potential to unlock insights through latest technologies and cutting-edge digital solutions thus eliminating siloed information, fragmented solutions, and blind spots for decisionmakers.

Consultative Approach to Fulfilling Client Needs

Through its co-design process, Fugro seeks to assist clients in identifying their problems, and understanding their unique needs, and then jointly develop a tailored solution.

Trusted Partner with Worldwide Record

Due to its global reach and local presence, Fugro has acquired vast experience around the globe and delivered various scopes with unparalleled quality, which allows transferable technologies and expertise to the client's project with a strong determination to deliver.

Ranked 23rd in Newsweek's "**World's Most Trusted Companies 2024**", Business & Professional Services category.

Differentiating through innovation

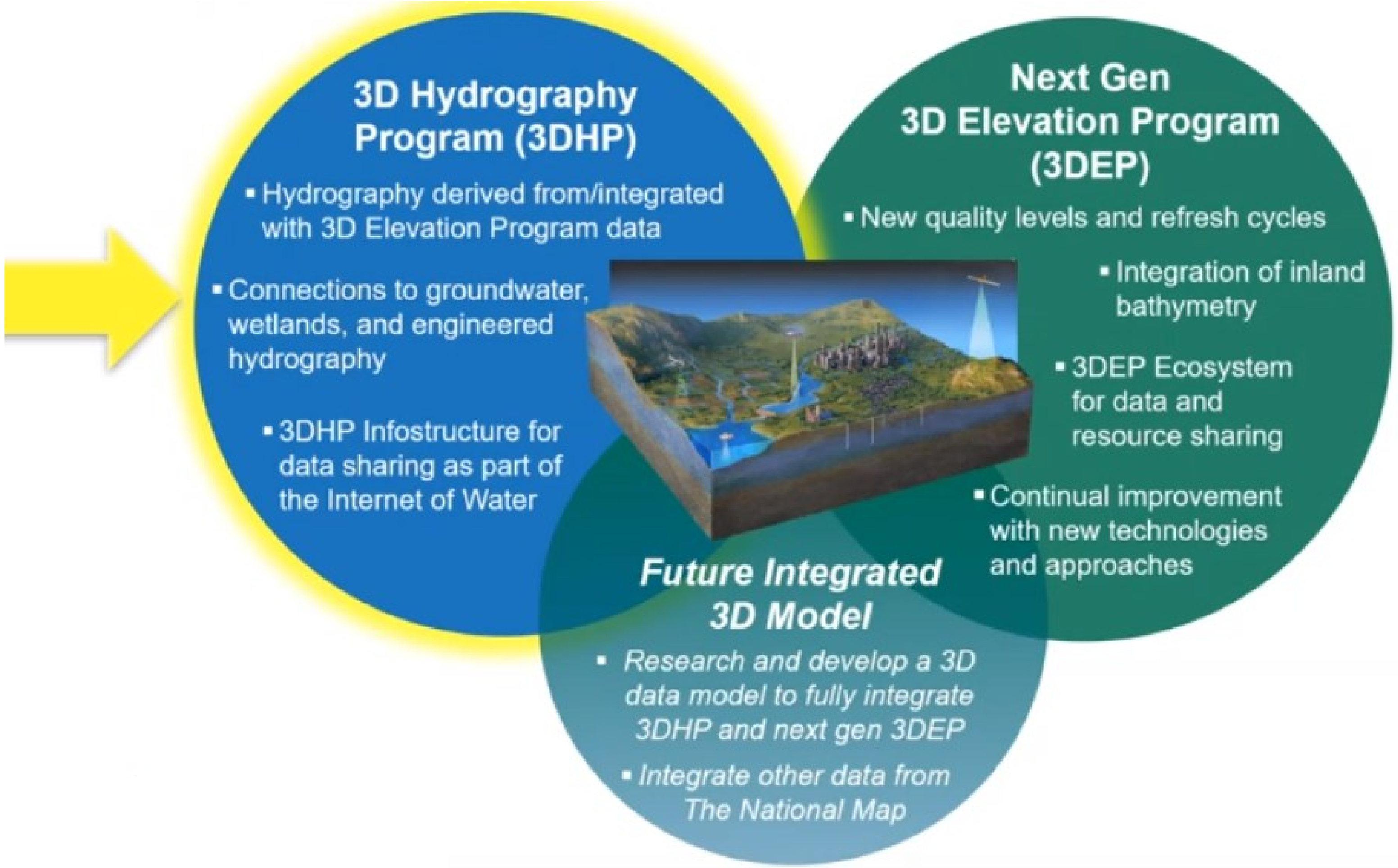
We develop differentiating technologies for client solutions and applications

28	39
Innovations brought to the market since 2022	Priority patents filed in 2023

- Mobile, autonomous robots and sensors
- Remote operations and support services
- Analytics and cloud automation services
- Insights and delivery

USGS 3DNTM

3D National Topography Model



USGS The National Map Your Source for Topographic Information

Integrates elevation and hydrography datasets to model the Nation's topography in 3D

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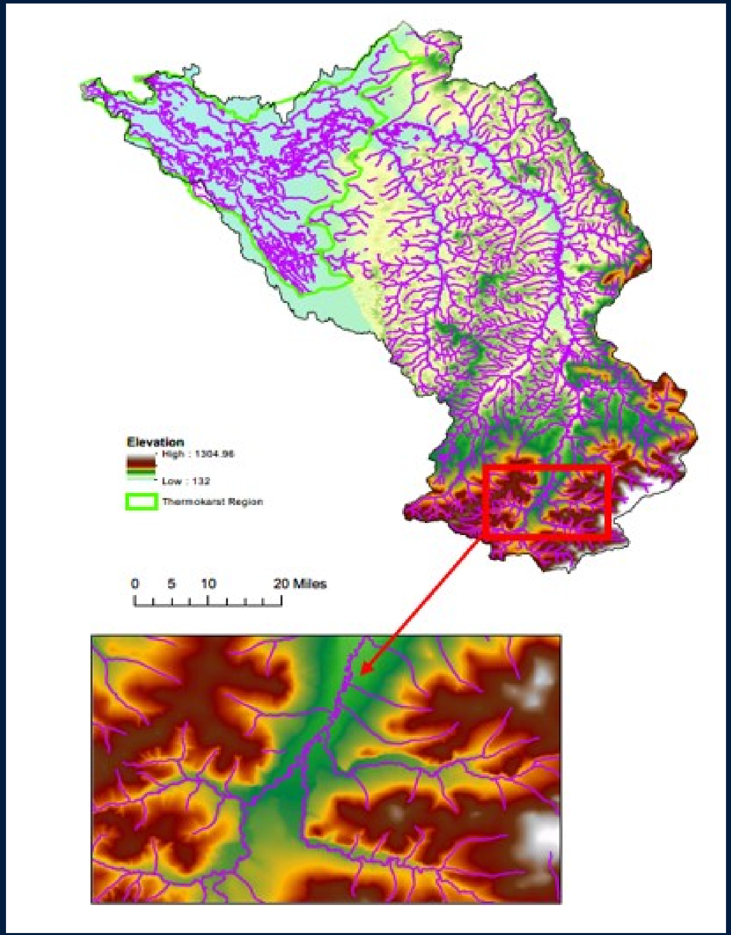
Benefits to updating National Hydrography Datasets (NHD)

Hydrography Requirements and Benefits Study (HRBS), conducted in 2016:

- **Annual benefits**: The NHD program yielded annual benefits of $538 million. If all user needs were met through the development of the next generation of hydrography data, this could increase to $1.14 billion.
- **User participation**: Over 500 users from federal, state, local, tribal governments, nonprofits, academia, and the private sector participated. They linked specific mission-critical activities (MCAs) to hydrography data.
- **Top benefits by business use**:
  1. River and Stream Flow Management
  2. Water Quality
  3. Water Resource Planning and Management
  4. Flood Risk Management
  5. River and Stream Ecosystem Management
  6. Natural Resources Conservation



USGS 3D Hydrography Program Goals

- Improved Mapping Accuracy to replace older datasets
- Follow 3DEP Best Practices
  - Governance
  - Include 3DHP in the 3DNTM DCA
  - Contract through USGS Geospatial Products and Services Contracts
  - Allow for cooperative data acquisition
  - Specifications and data validation
- Enhanced Flood Modeling
- Ecosystem Management
- Interoperability with other datasets such as soils, transportation networks, and other infrastructure
- Enable the "Internet of Water"

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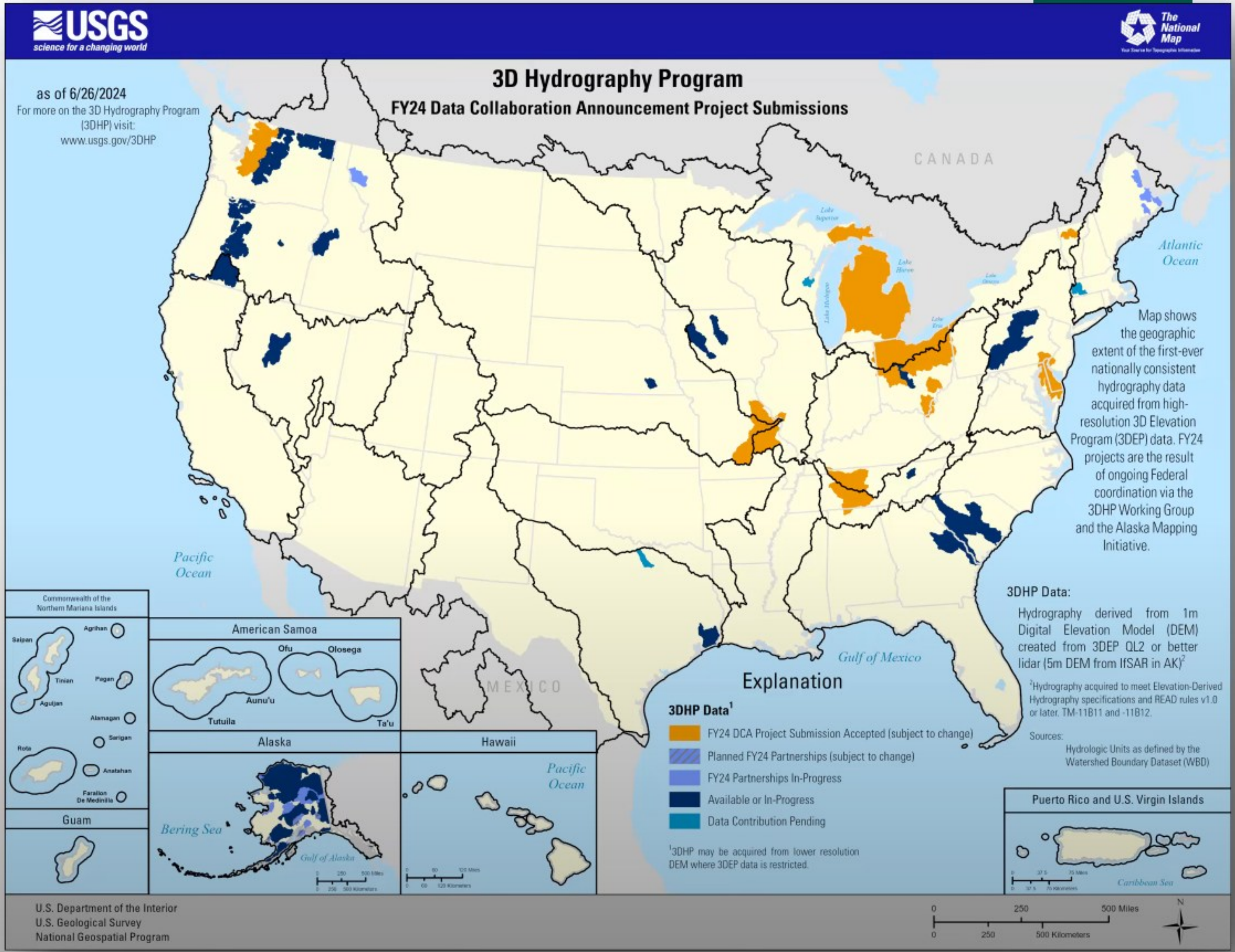
3DHP FY24 Data Acquisition

CONUS-HI-Territories

FY24 in progress (sq mi)	FY24 in planning (sq mi)	FY 24 Total (sq mi)
45,622	57,796	103,418

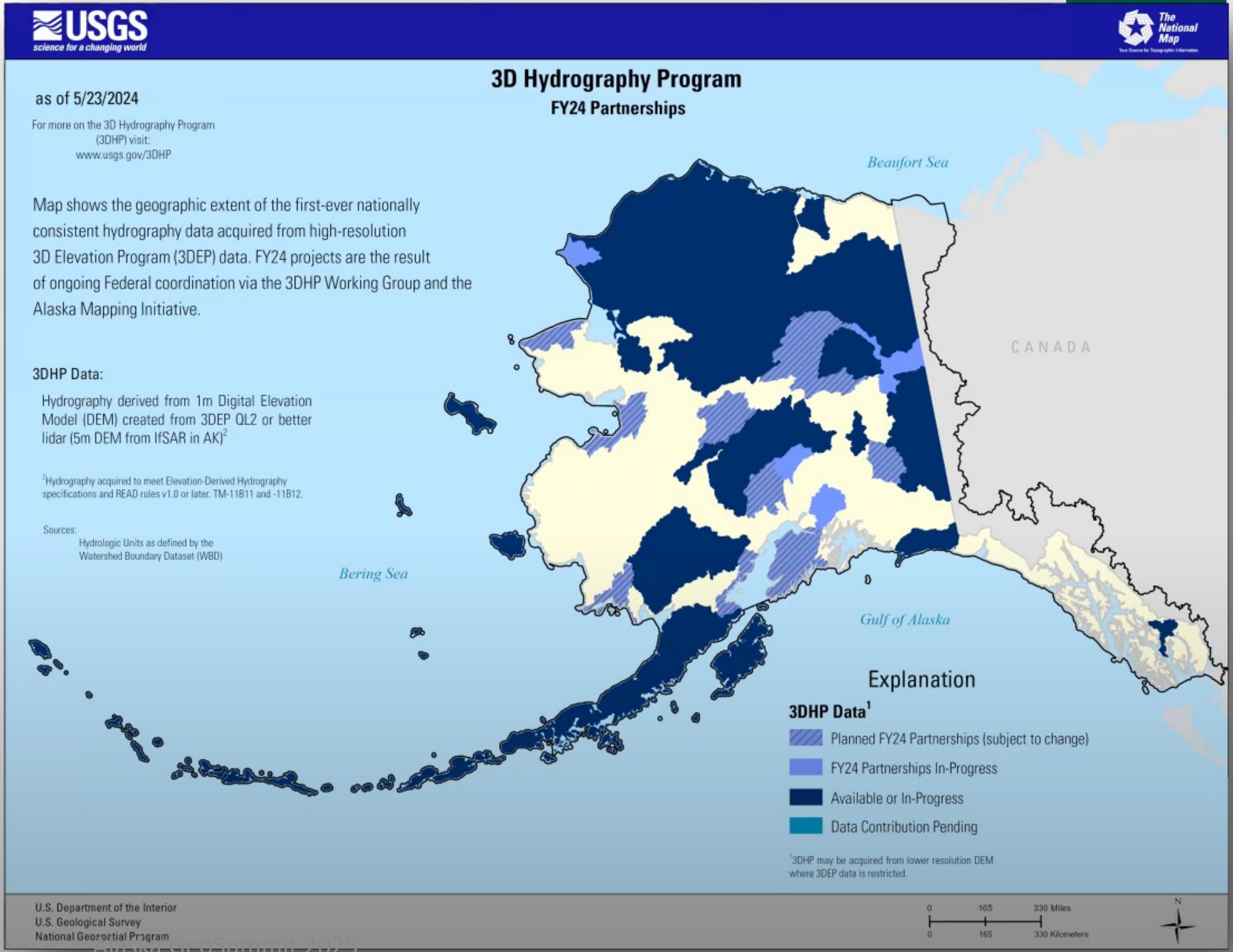
- 2 federal projects – in progress
  - Maine (NRCS)
  - Montana (USFS)
- DCA GPSC – in planning
  - Delaware
  - Ohio
  - Pennsylvania
  - Tennessee
  - Vermont
- DCA financial assistance
  - Michigan - awarded
  - Missouri - in development
  - Washington – in development
- Additional Federal-only projects being finalized

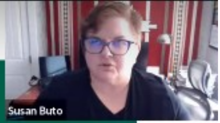


3DHP FY24 Data Acquisition

Alaska

FY24 in progress (sq mi)	FY24 in planning (sq mi)	FY24 Total (sq mi)
42,775	29,576	72,351

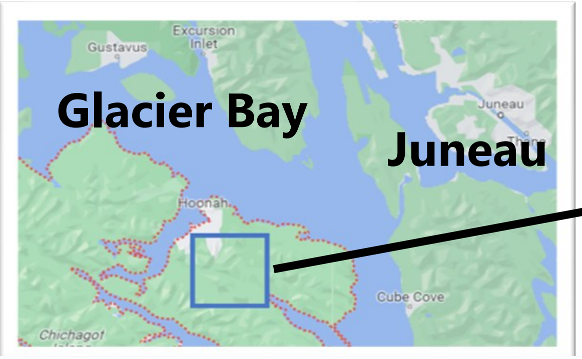


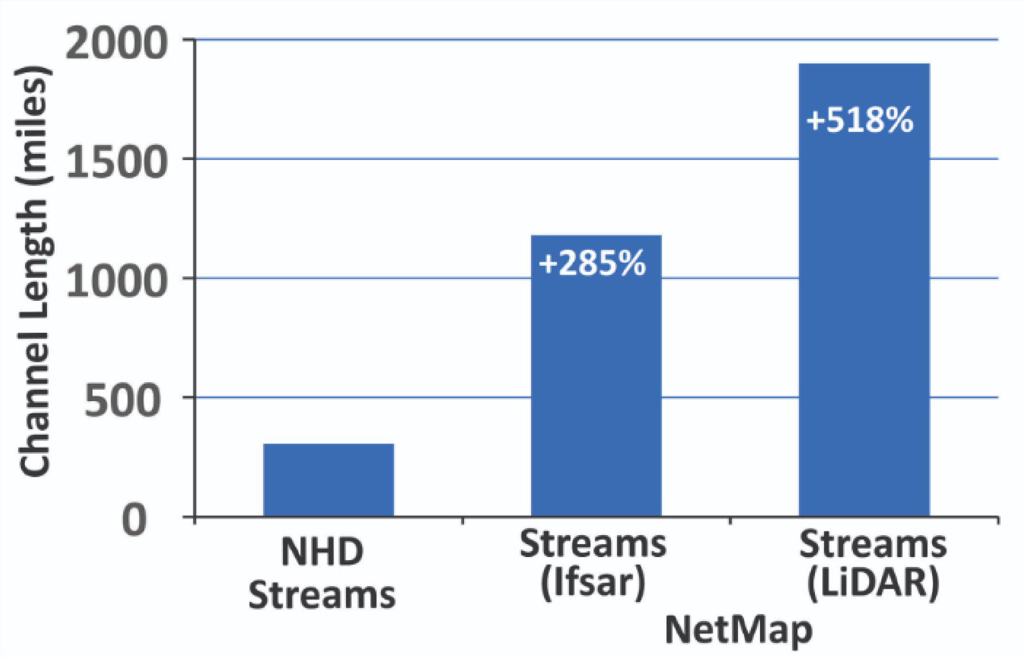


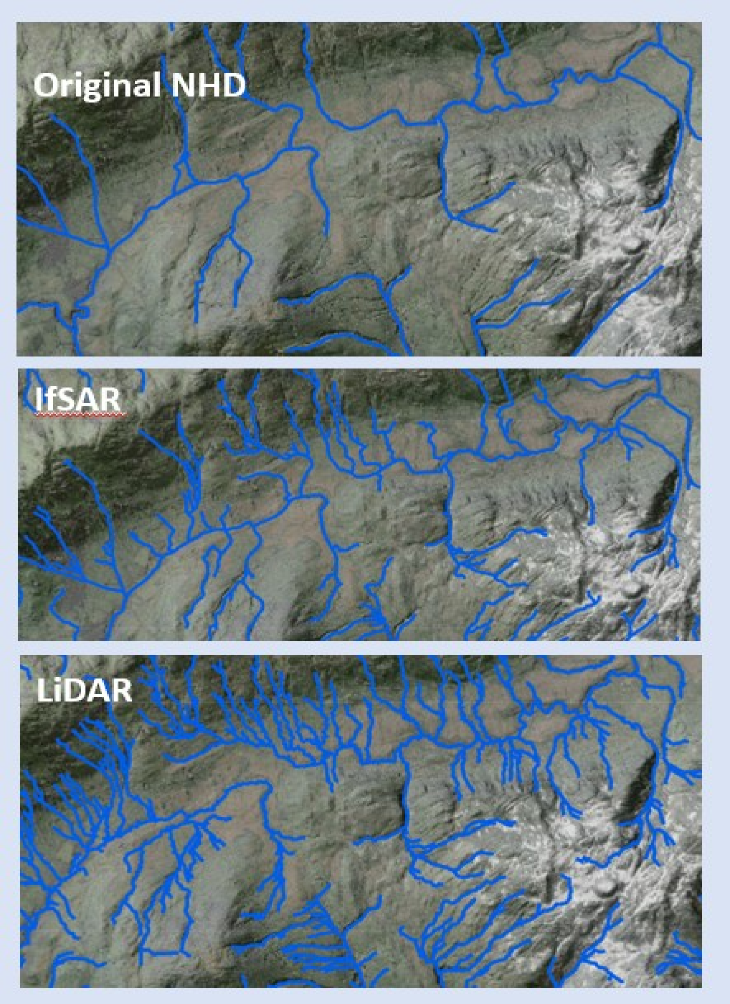
USGS science for a changing world

The National Map
Your Source for Topographic Information

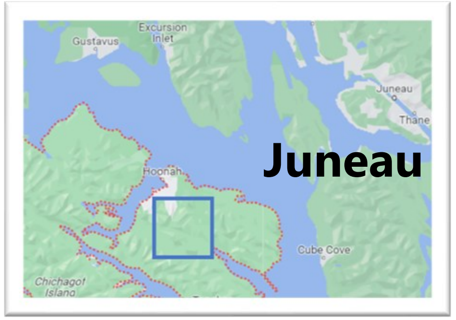
Southeast Alaska (Tongass National Forest): Increasing Mapped Channels



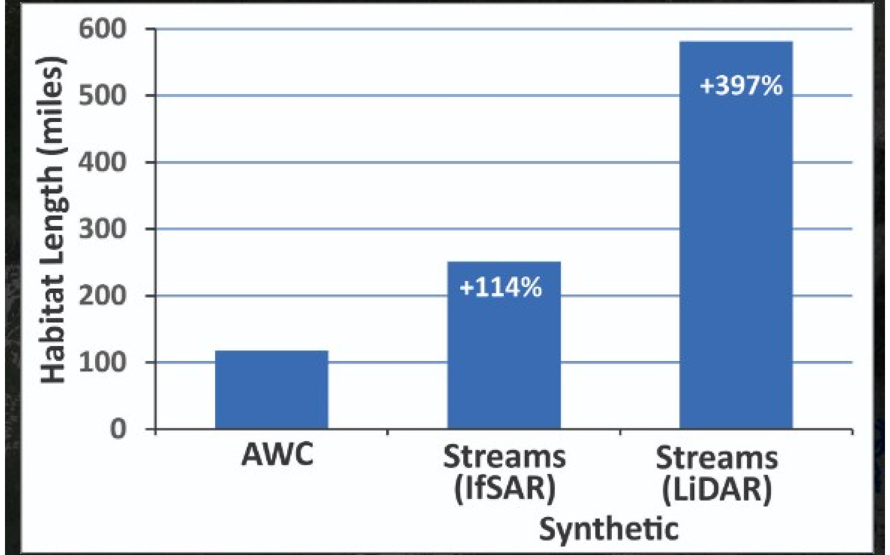


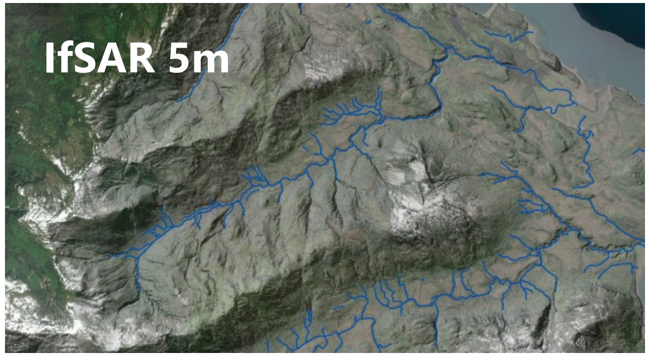


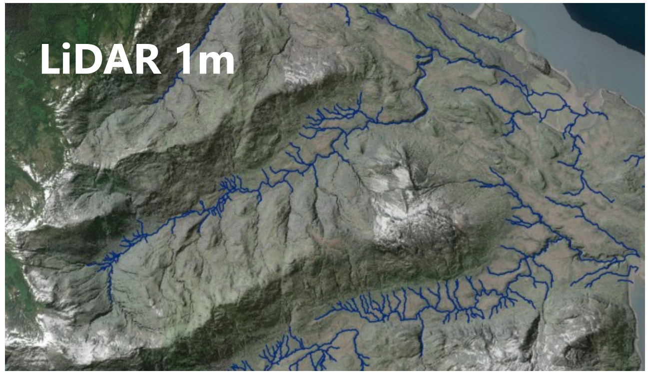
IfSAR & LiDAR Increase the Predicted Extent of Fish Habitats



Finer DEM resolutions show a significant increase in the length of salmon-accessible streams.







USGS 3DNTM

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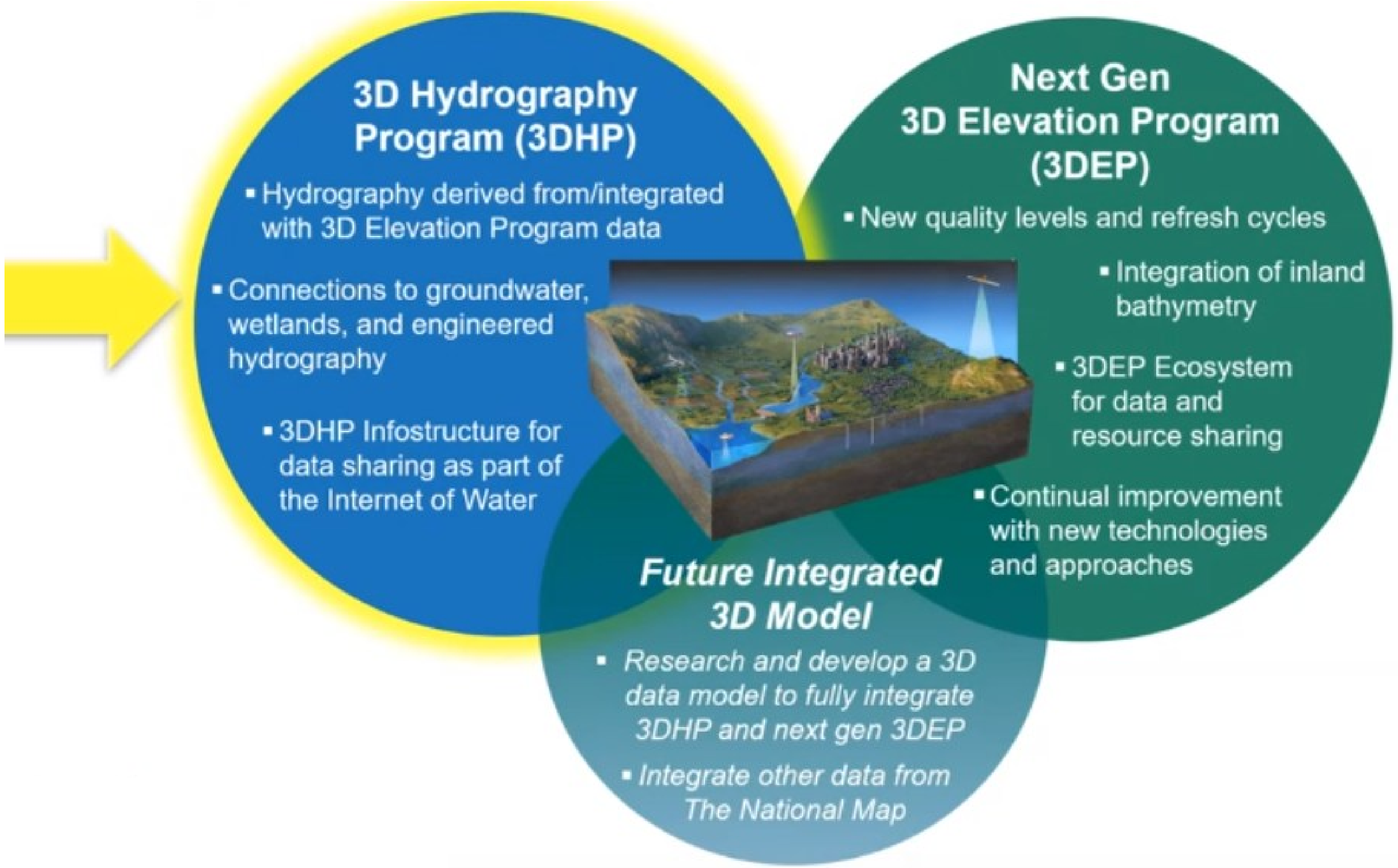

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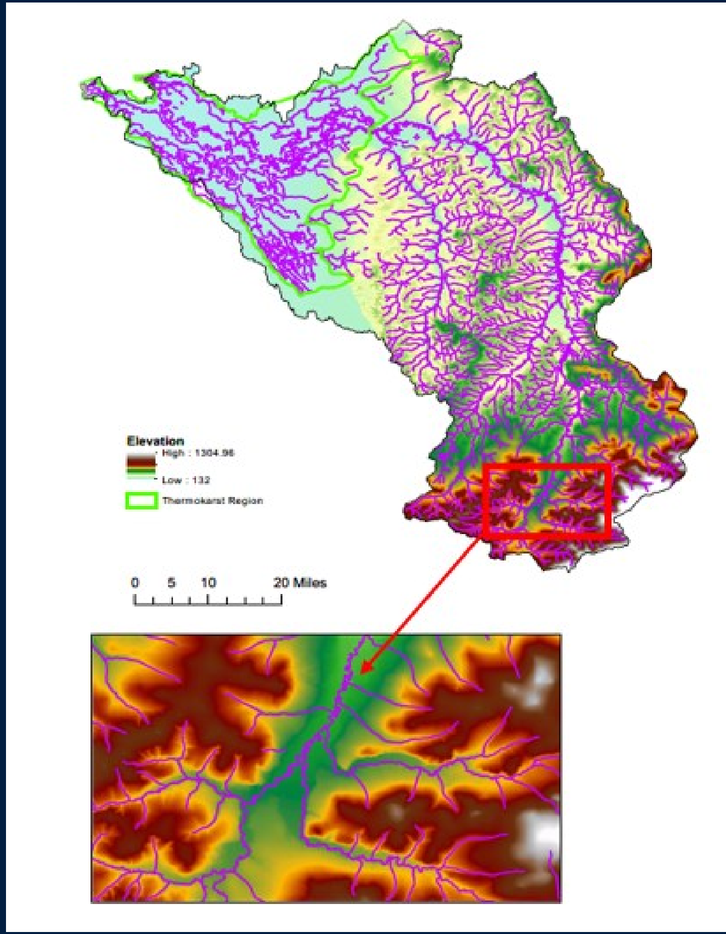

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Mean annual flow

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Geomorphology

Channel width and depth

Floodplain width

Valley width

Channel sinuosity

Elevation

Gradient (any length scale)

Ecology

Fish habitats

Radiation loading

Max Downstream Gradient (Fish)