

The dynamic colors of the Klamath River and what they tell us about the source and transport of sediments.

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Engineering



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Chief Product Officer



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Founder and CEO



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Founder and COO

Input Data

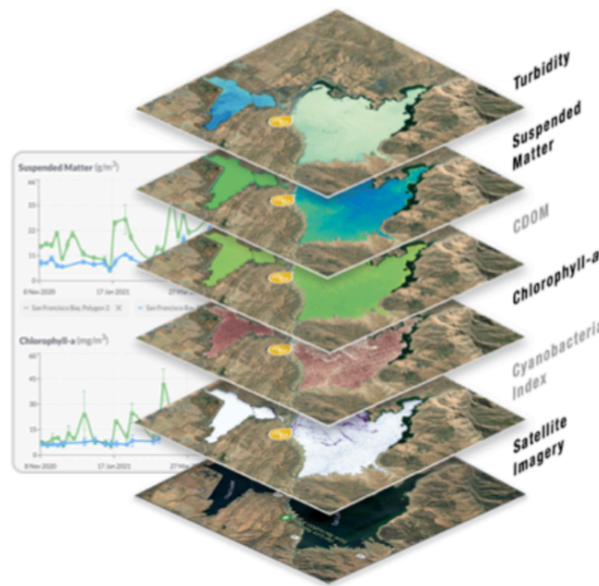
Satellite + Gybe Sensor
+ Weather Data



Comprehensive
Additional Data Sources

Water Data

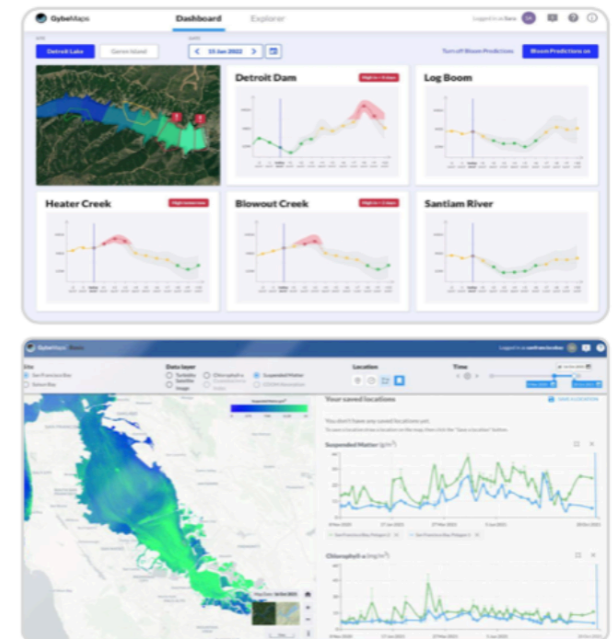
Time series + Data Maps
and derived information



Extendable
Enabling New
Parameters & Analytics

GybeMaps™ App

Decision making tools



Actionable
Prediction, Alerting,
and Collaboration Features

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Klamath River

Dam Removal

Color of the Water

Environmental monitoring — Spectroscopy

What does it tell us?

Some stories the water tells as it crosses the landscape

(Algal Blooms, Fires, and Hydraulic Mining)





Goal:

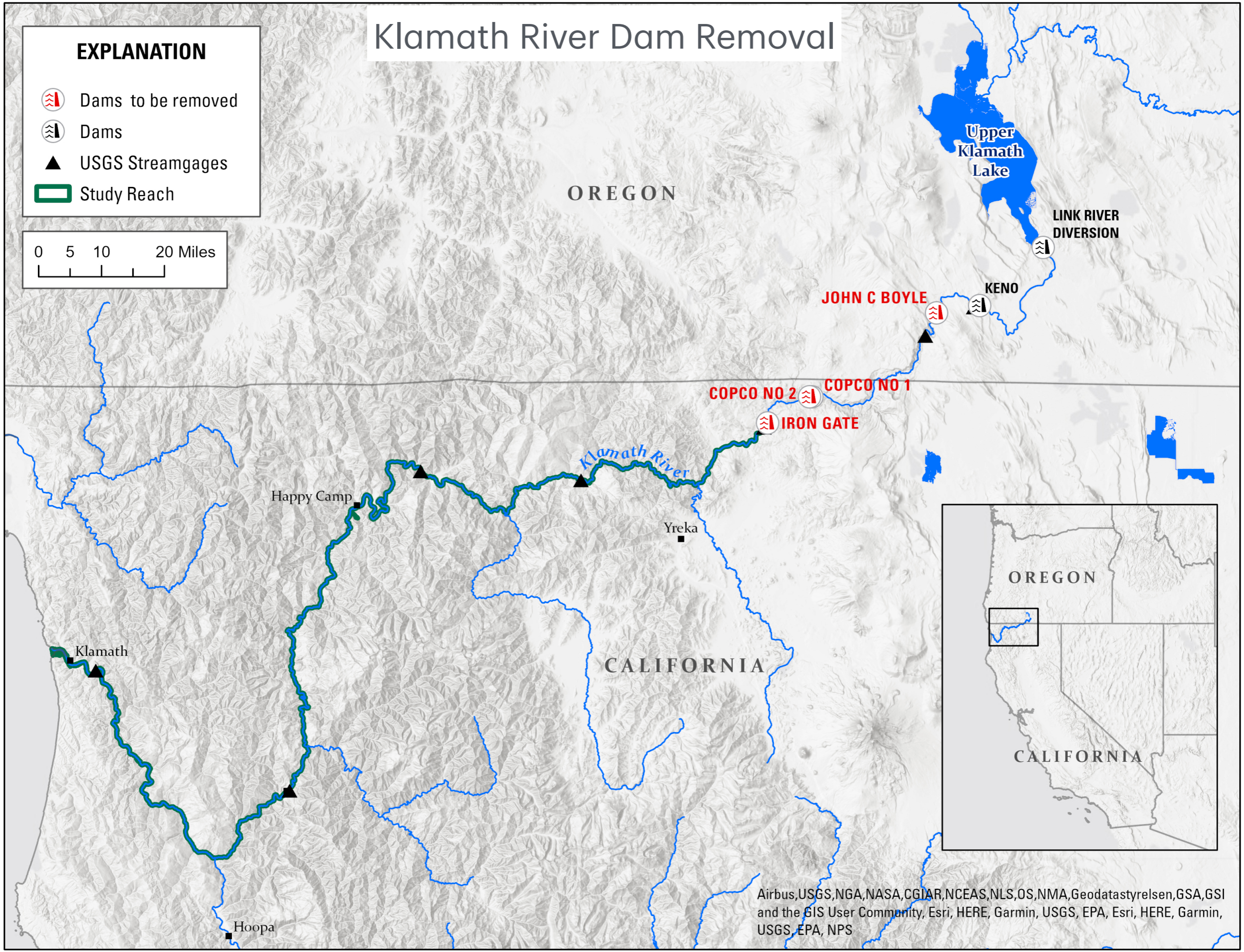
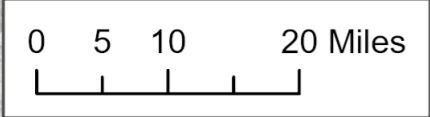
Stimulate ideas for incorporating projects in environmental monitoring into the physics curriculum.

Papers at: <http://www.aquahue.net>

Klamath River Dam Removal

EXPLANATION

-  Dams to be removed
-  Dams
-  USGS Streamgages
-  Study Reach



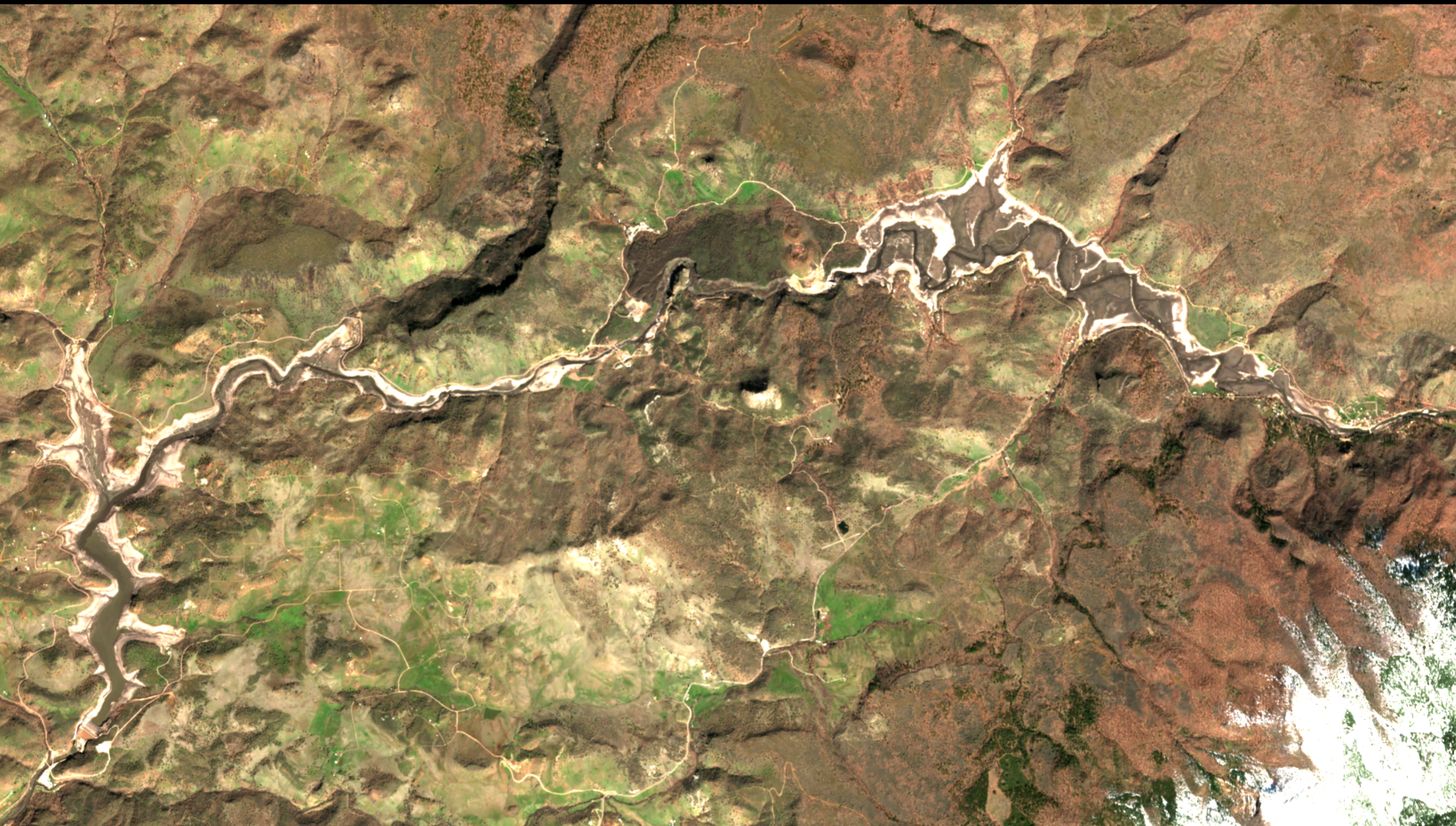
Airbus, USGS, NGA, NASA, CGIAR, NCEAS, NLS, OS, NMA, Geodatastyrelsen, GSA, GSI and the GIS User Community, Esri, HERE, Garmin, USGS, EPA, Esri, HERE, Garmin, USGS, EPA, NPS

Harmful Algal blooms formed 300 km upstream killed Salmon throughout the whole river and this led, eventually, to the removal of the dams past year.

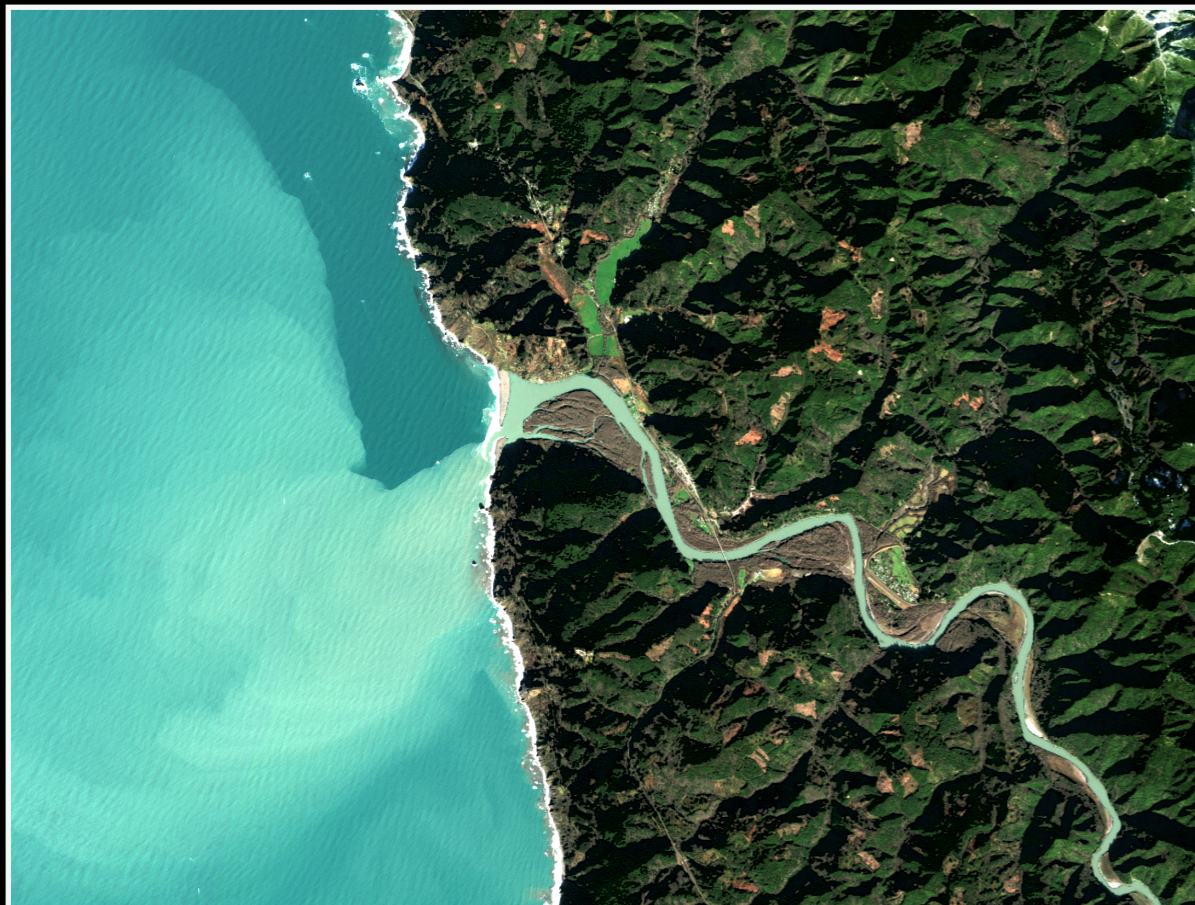
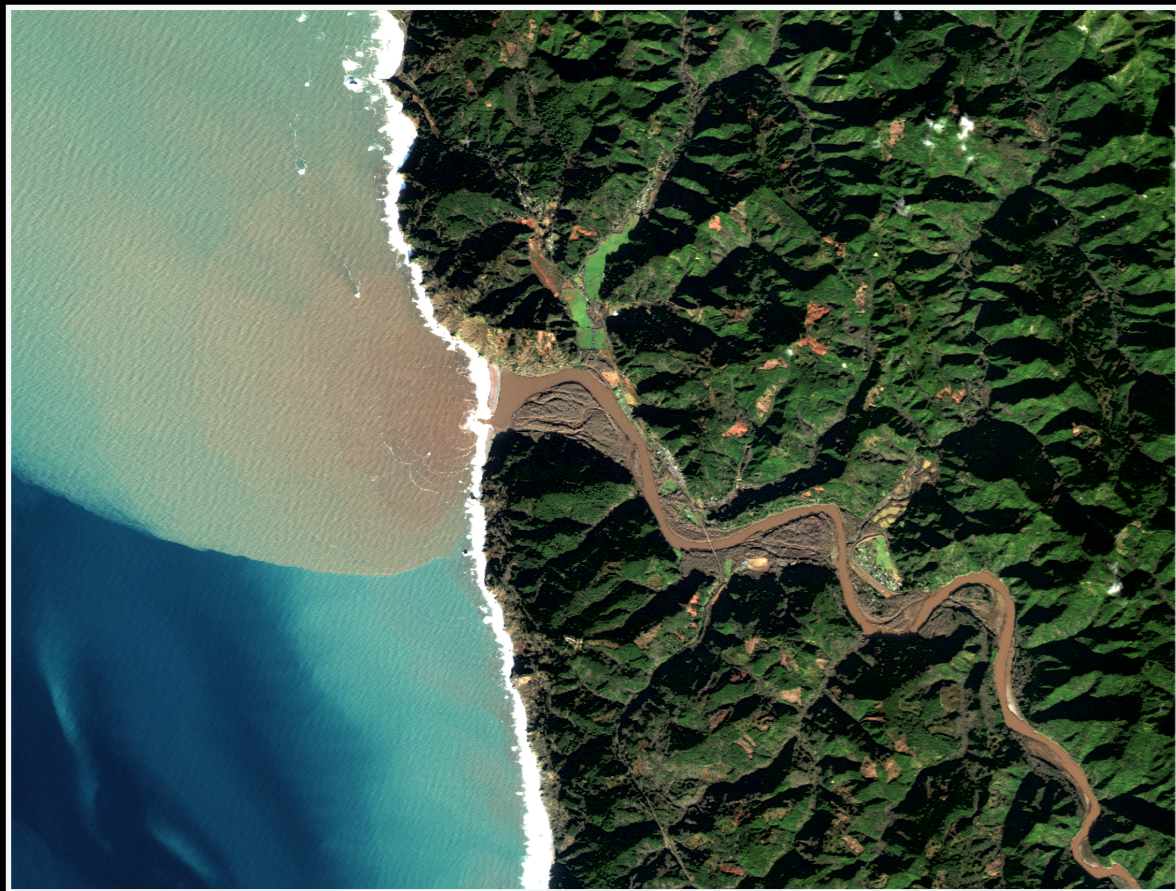


2023-09-19

After dam removal



2024-03-17



Water Types at Turwar Gauge -- Klamath Estuary

Clear
2023-01-20



Green
2024-05-21



Brown
2022-12-11



Turquoise
2023-01-20



Olive
2024-03-07

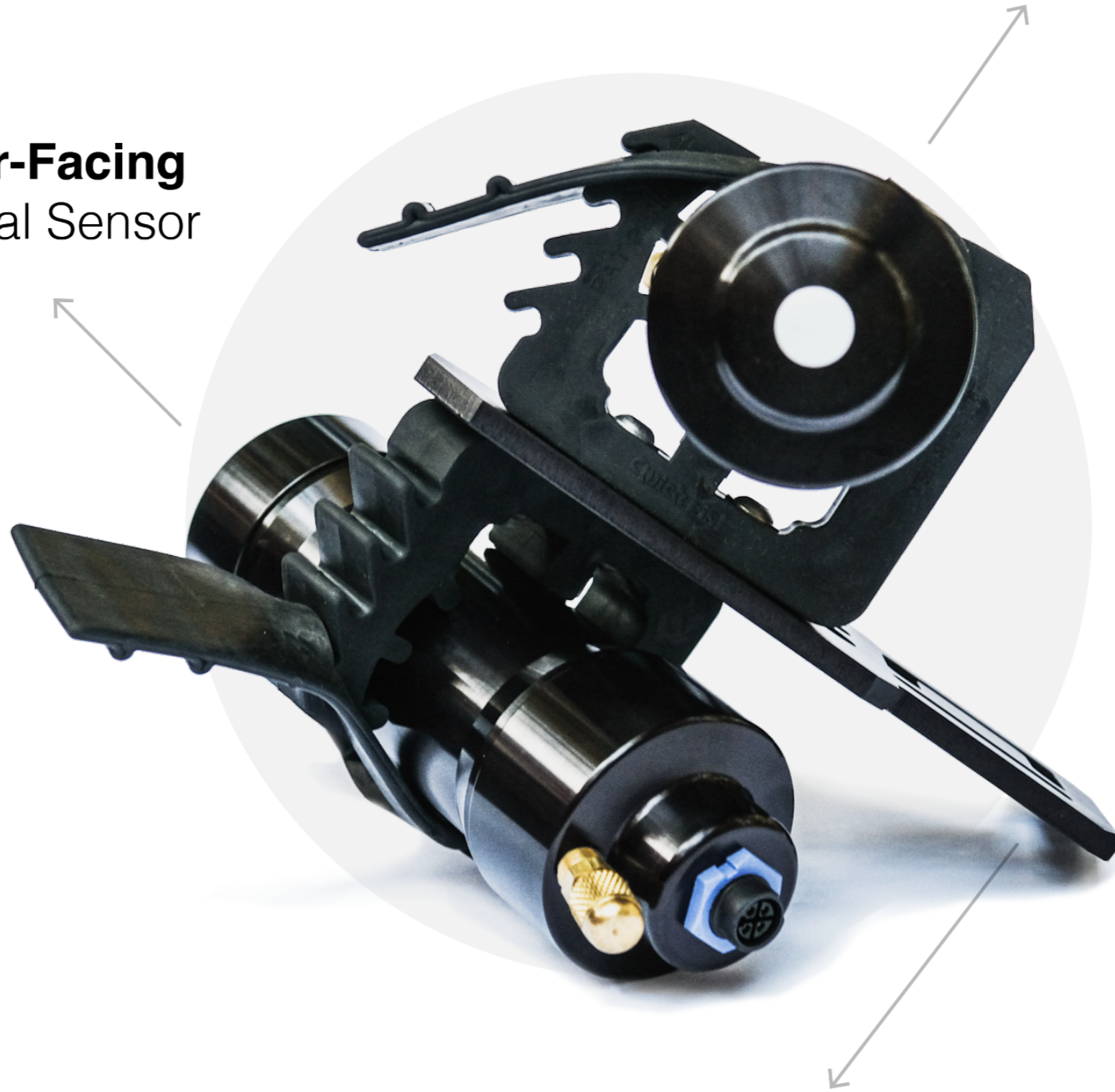


Red
2022-12-28



Sky-Facing
Optical Sensor

Water-Facing
Optical Sensor



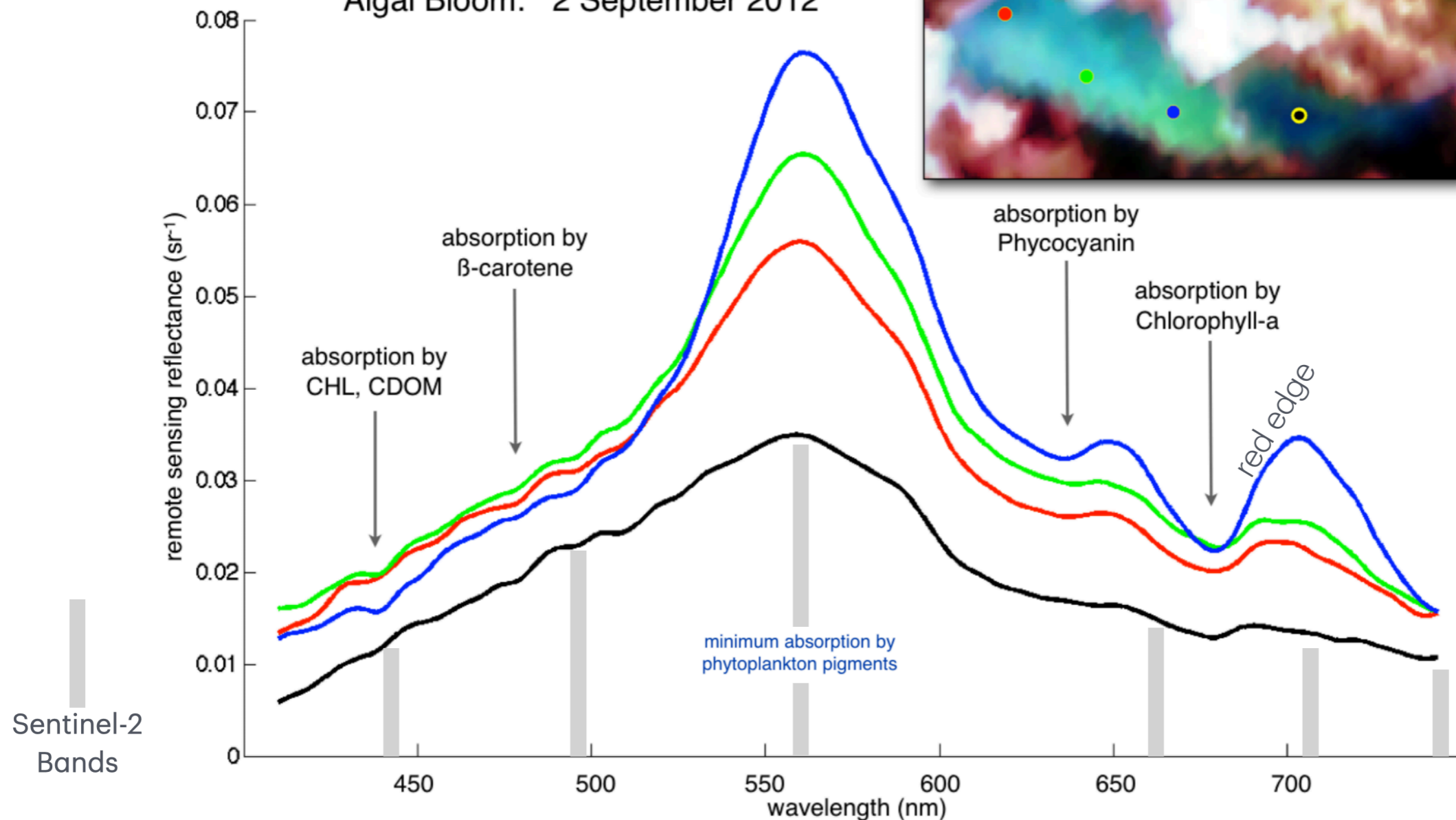
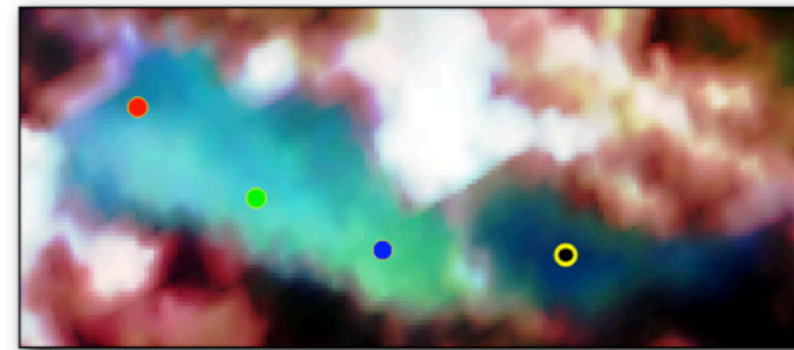
Sensor
Bracket

Estimating Target Products (eg. turbidity, chlorophyll concentrations) from IOP's or Remote Sensing Reflectance (Rrs)

The oceanographers' remote-sensing reflectance

$$R_{rs}(\theta_r, \phi_r) \equiv \frac{L_r(\theta_r, \phi_r)}{E_d} \quad (\text{sr}^{-1}),$$

Spectrum Examples from Dexter Reservoir
Algal Bloom: 2 September 2012



Requa - Klamath River Estuary

Gybe Requa Sensor







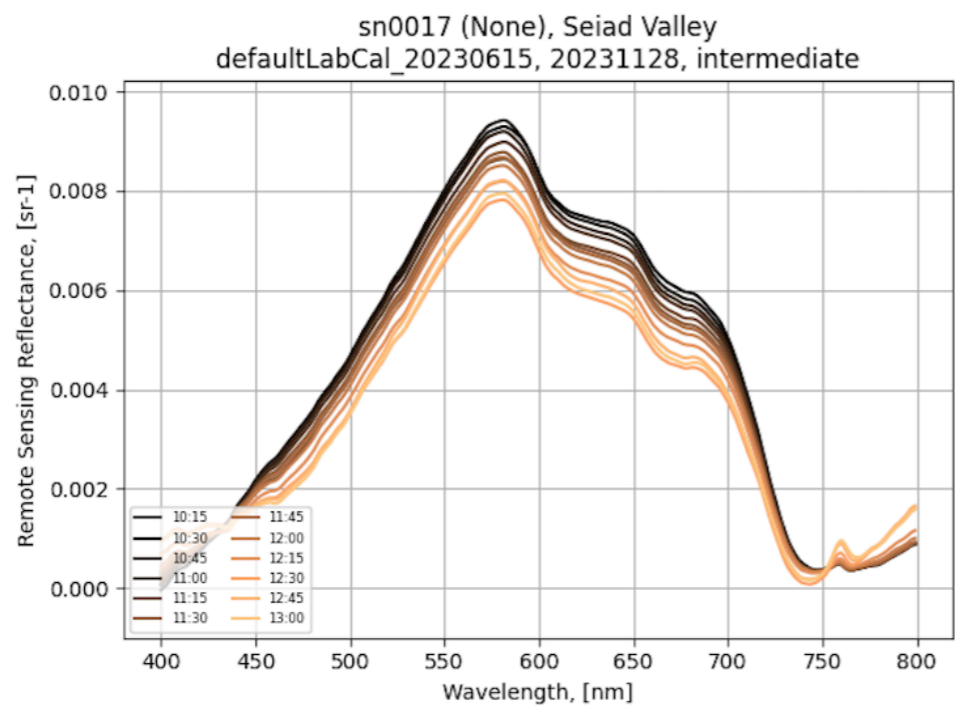
S2A/MSI 2023-11-28 19:12:49
 ρ_s RGB



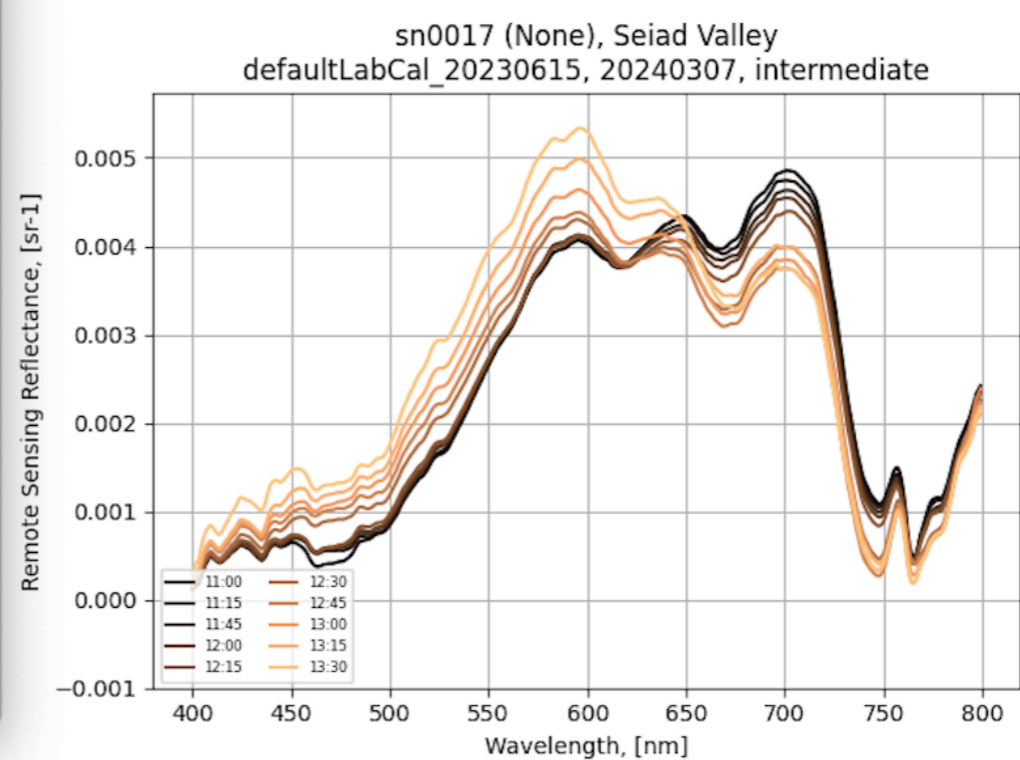
S2A/MSI 2024-03-07 19:12:57
 ρ_s RGB



G2_Rrs_intermediate_202...



G2_Rrs_intermediate_20...



2022-12-28

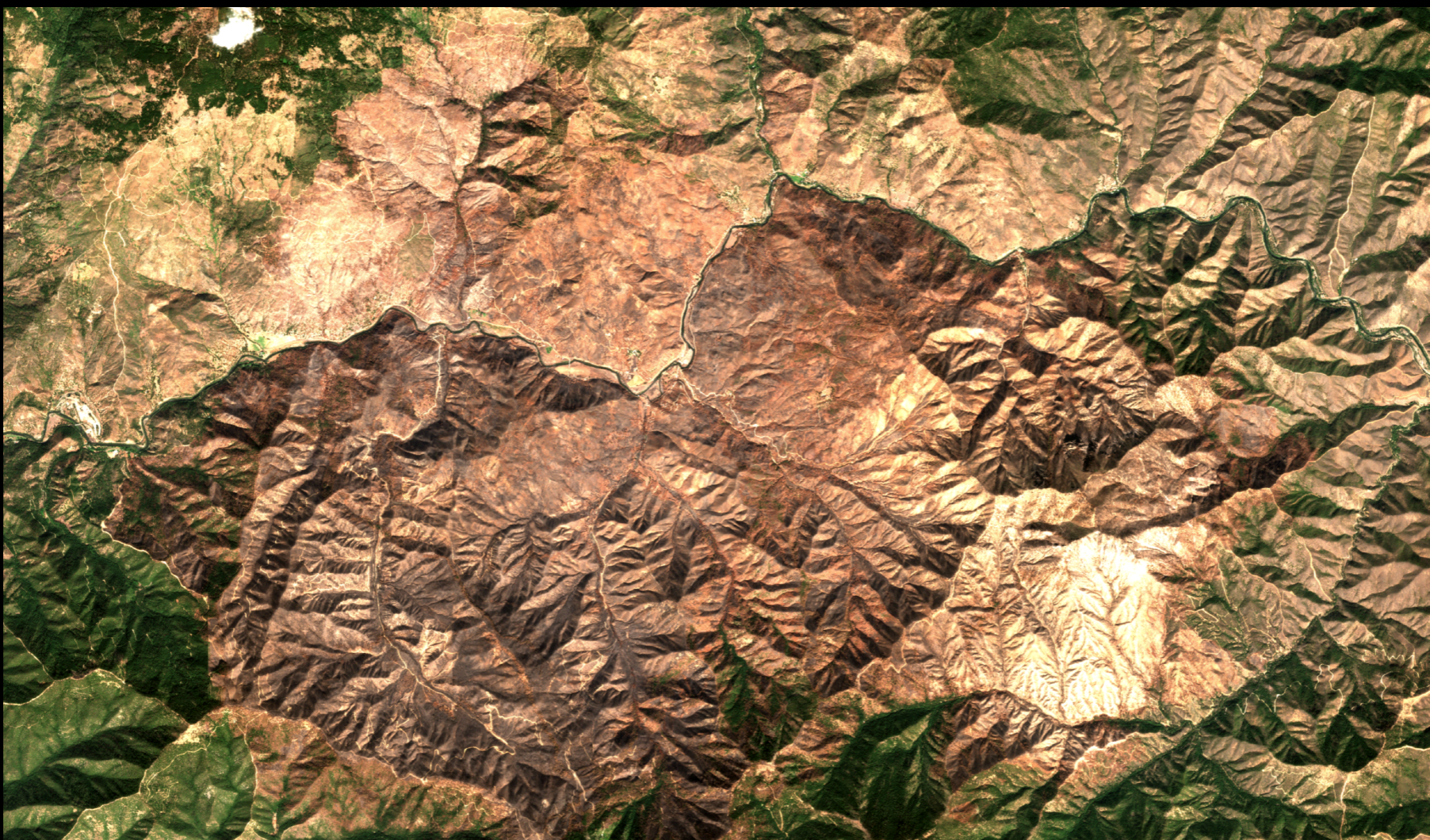


2022-07-26



McKinney Fire
29 July 2022
till
7 Sept 2022

2022-09-29



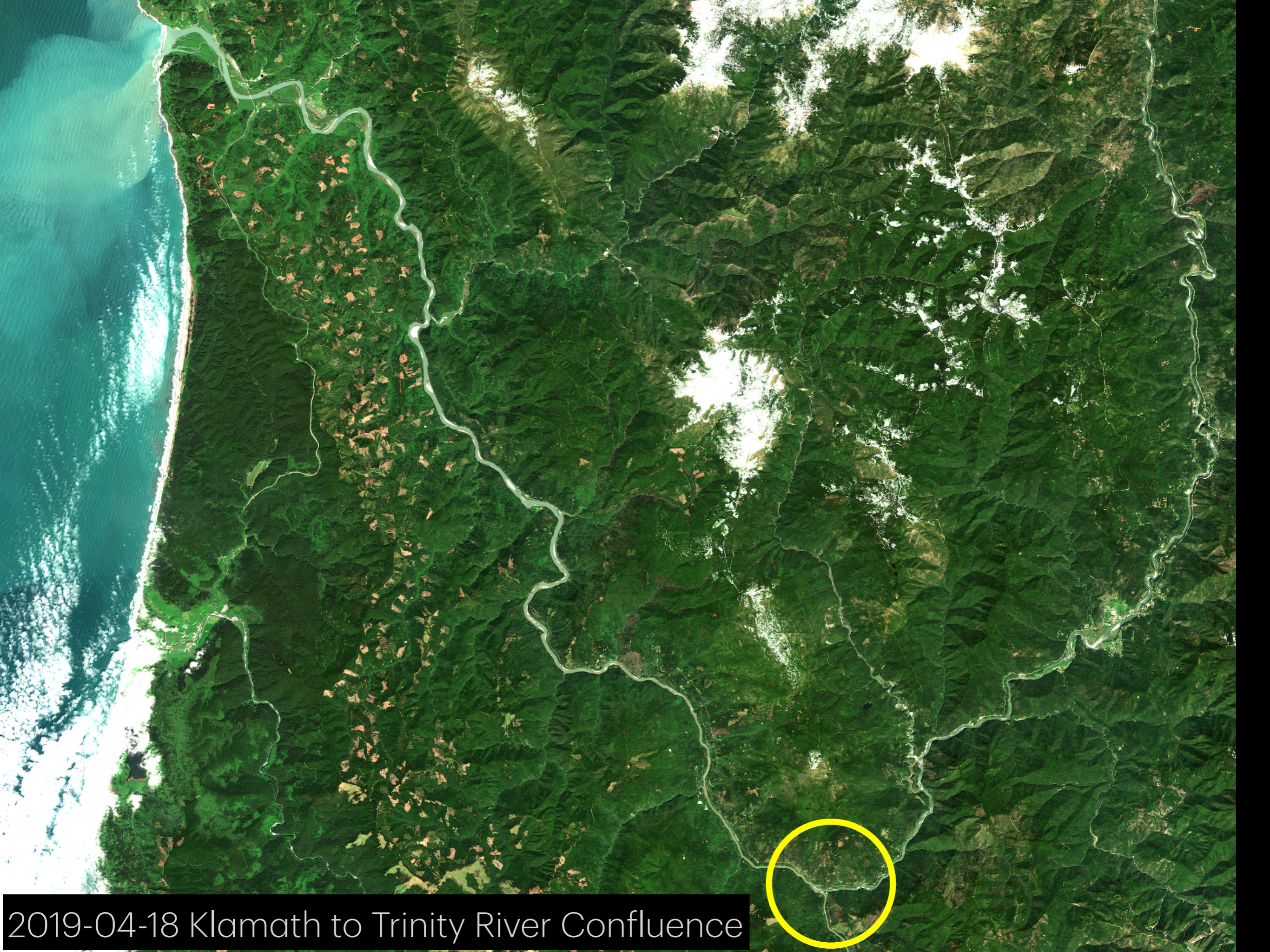
2022-12-28 Walker Bridge



Gybe Walker Bridge Sensor



Walker Bridge Install



2019-04-18 Klamath to Trinity River Confluence

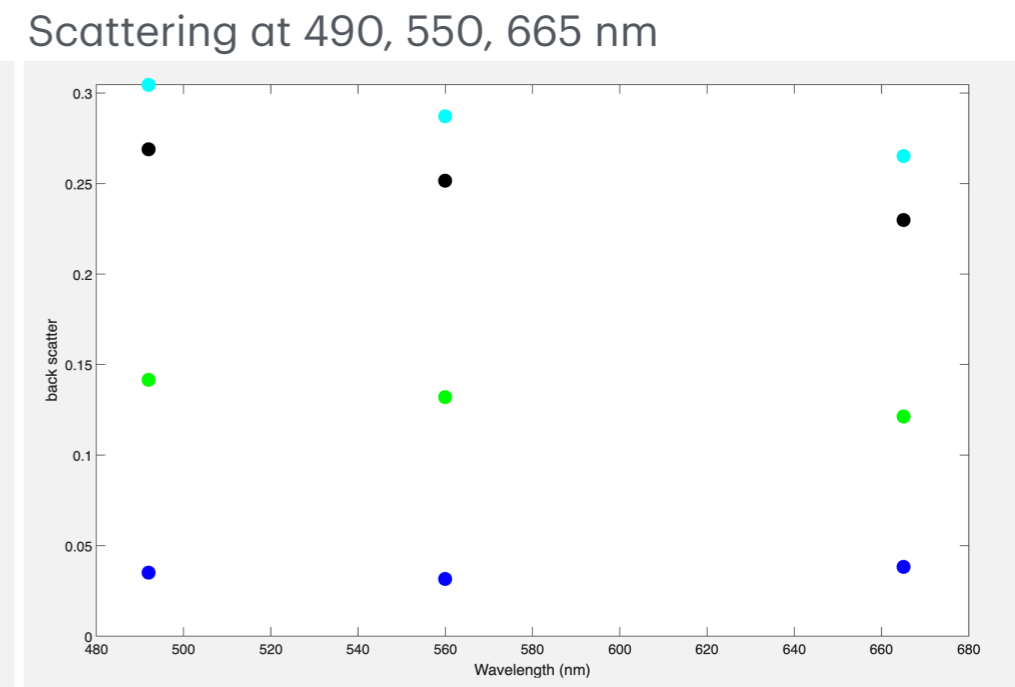
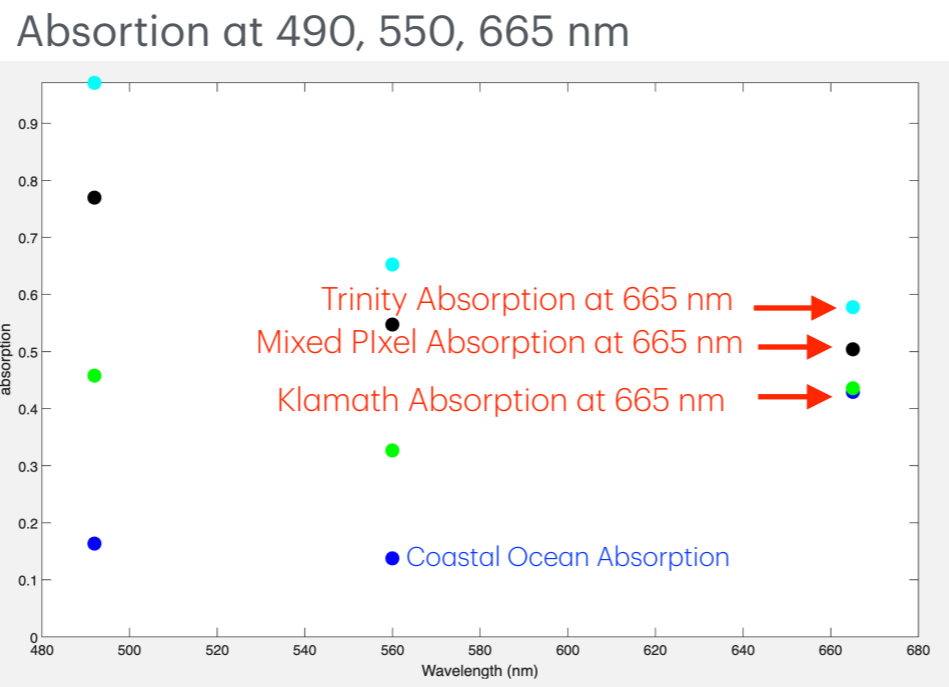
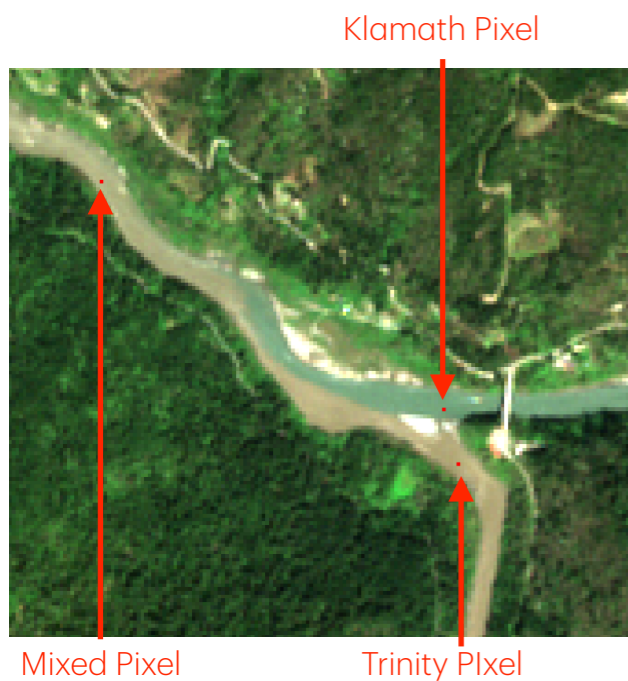


2019-04-18 Klamath - Trinity River Confluence

Can we use the color of the water before and after mixing at the confluence to gauge the (relative) discharge of the Klamath and Trinity Rivers?

Maybe ...

We can estimate (spectral) absorption and scattering from Remote Sensing Reflectance as shown below. Assuming the two streams are 'well mixed' (good assumption), and the scattering can be neglected (usually not a good assumption), then the change of absorption should vary linearly with discharge. Back of the 'envelope' estimate for this scene is:



Reference for Algorithm: Pitarch, J., Vanhellefont, Q., 2021. The QAA-RGB, Remote Sensing of Environment 265, 112667.

Use 660 nm band (mass balance ...):

52% of water is from Klamath and 48% from Trinity

From instream USGS Gauges:

Klamath Discharge at Orleans 20,000 ft³/s

Trinity Discharge at Hoppa 16,500 ft³/s

Discharge of Klamath relative to Trinity at Confluence 16,500/(16,500+20,000) = 0.55, or

55% of water is from Klamath and 45% from Trinity

Solve for α

$$M = \alpha m_1 + (1-\alpha) m_2$$

$$= \alpha m_1 + m_2 - \alpha m_2$$

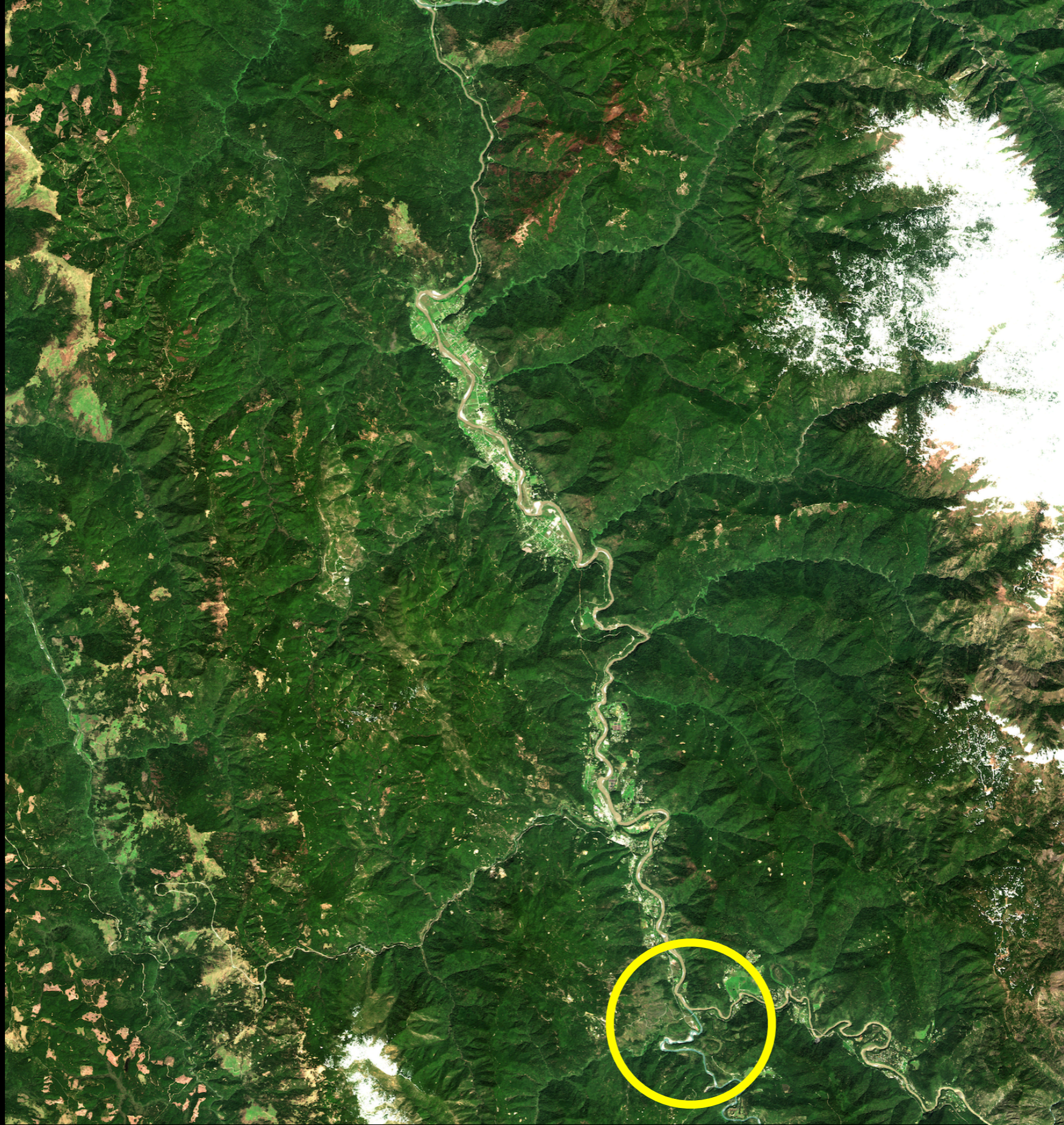
$$= \alpha (m_1 - m_2) + m_2$$

$$\frac{M - m_2}{m_1 - m_2} = \alpha$$

$$M = a - mx$$

$$m_1 = a - kl$$

$$m_2 = a - tr$$

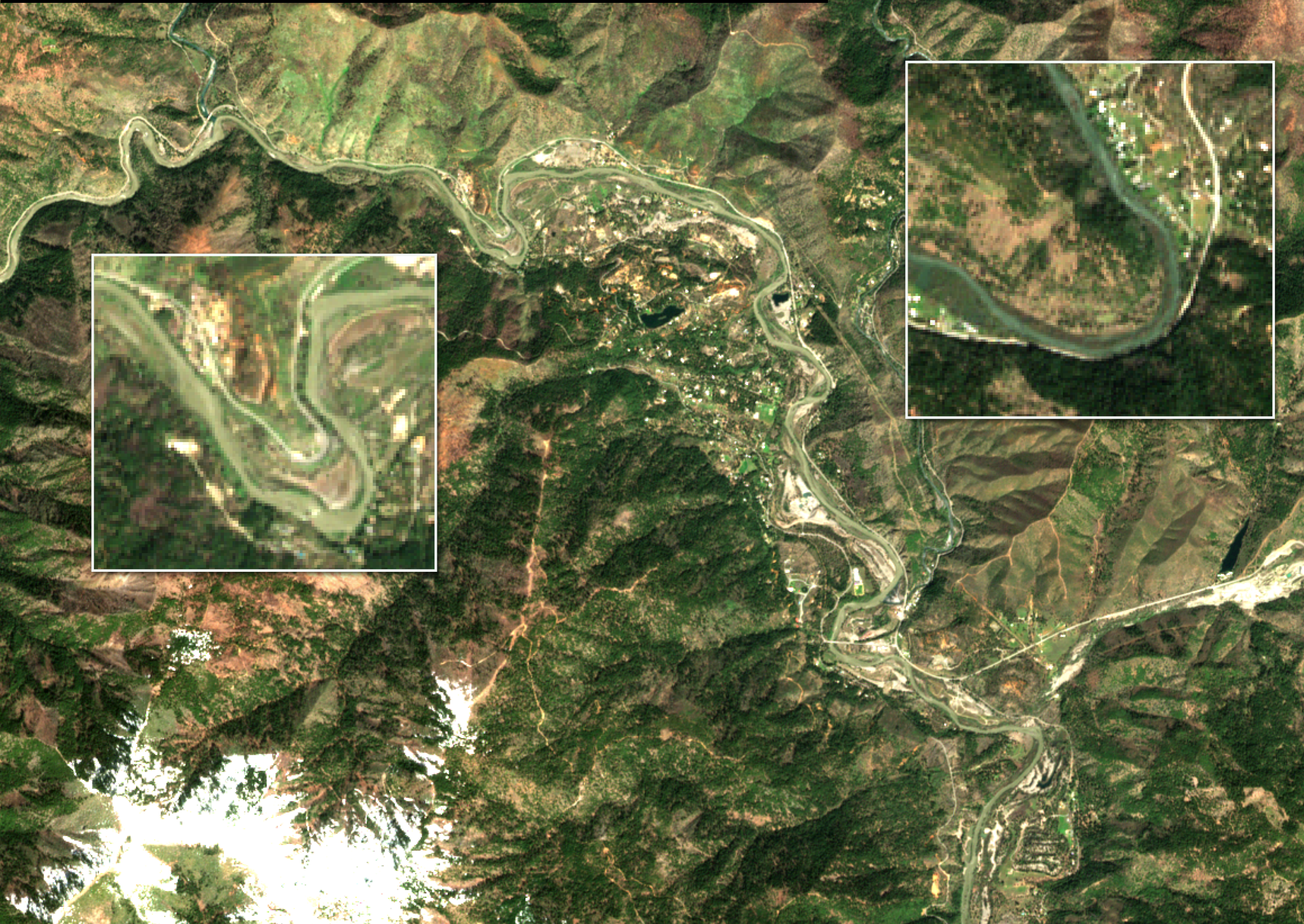


2019-04-18 Trinity River - South Fork Confluence

2019-04-18 Trinity River - South Fork Confluence



2019-04-18 Trinity River - North of Junction City, CA



Hydraulic Mining on the Trinity River





Prior to restoration, the Trinity River at Oregon Gulch ran in a straight line and mountains of mining tailings blockaded the bank. Photo: Aaron Martin, Yurok Tribal Fisheries Department

Trinity River Restoration began in 2022 at Oregon Gulch



In Phase 1 of the Oregon Gulch project, thousands of cubic yards of legacy mining tailings were removed from the site. Photo: Aaron Martin, Yurok Tribal Fisheries Department



2025-12-30

<http://www.aquahue.net>