Real time monitoring using sensor technology

Detection of Submarine and Intertidal Groundwater Discharge to Kinvara Bay, Galway, Ireland

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Submarine Groundwater Discharge

What is SGD?

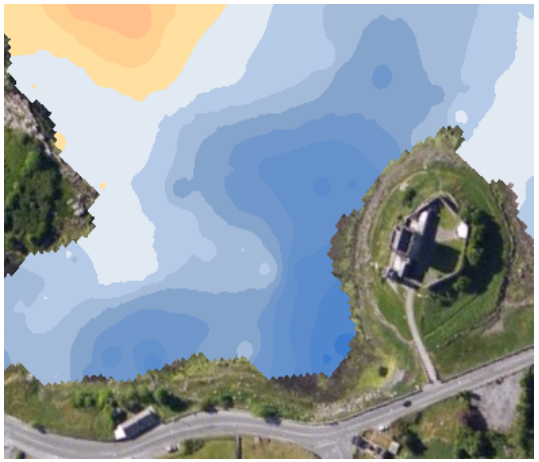
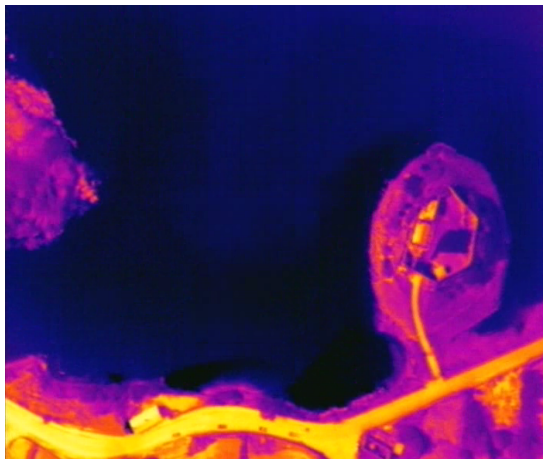
- Groundwater flow across the seabed to the coastal ocean
- Occurs in almost all coastal areas as either seepage or submarine/ intertidal springs

Why is SGD research important?

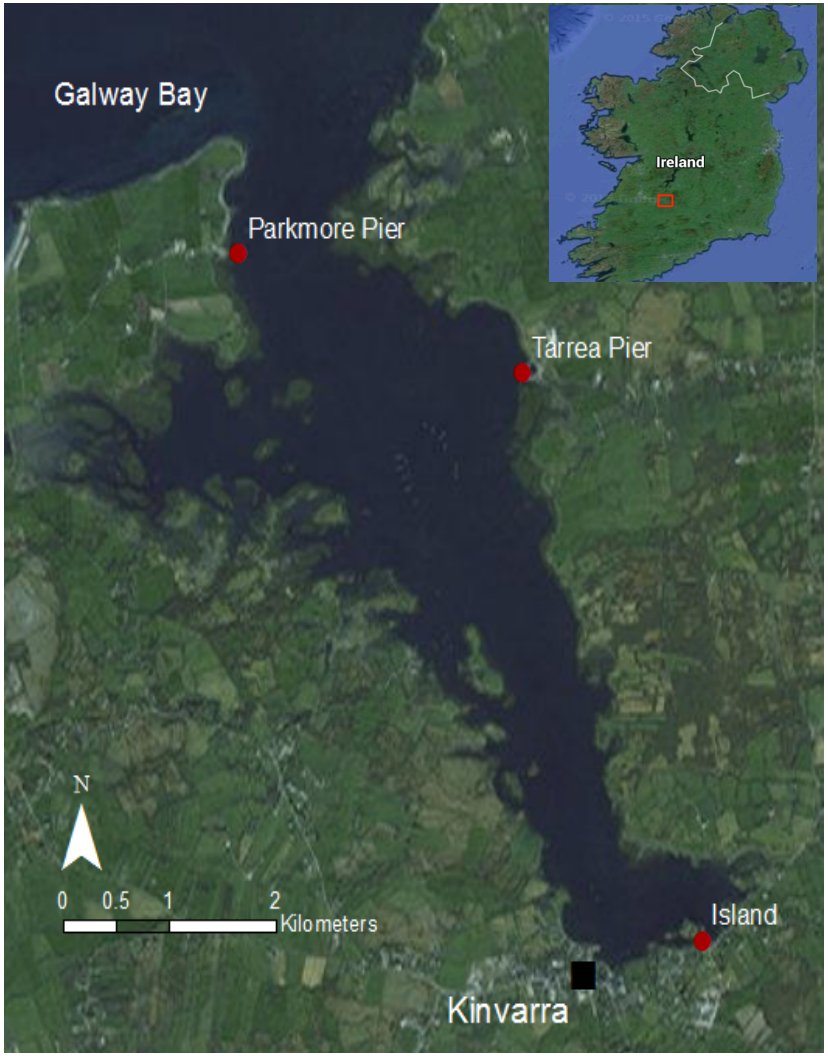
- Important pathway for transport of contaminants, nutrients, which put marine ecosystems at risk
- Due to the difficulty in locating and gauging SGD, it has been underestimated until recently

Motivation

- To locate examples of submarine groundwater discharge using a combination of in-situ and remotely sensed data
- To determine if thermal infrared imagery can be correlated with in-situ temperature measurements
- To determine if remotely sensed imagery can be used as a surrogate for more expensive in-situ sensing when tracking water types

Study Site: Kinvara Bay

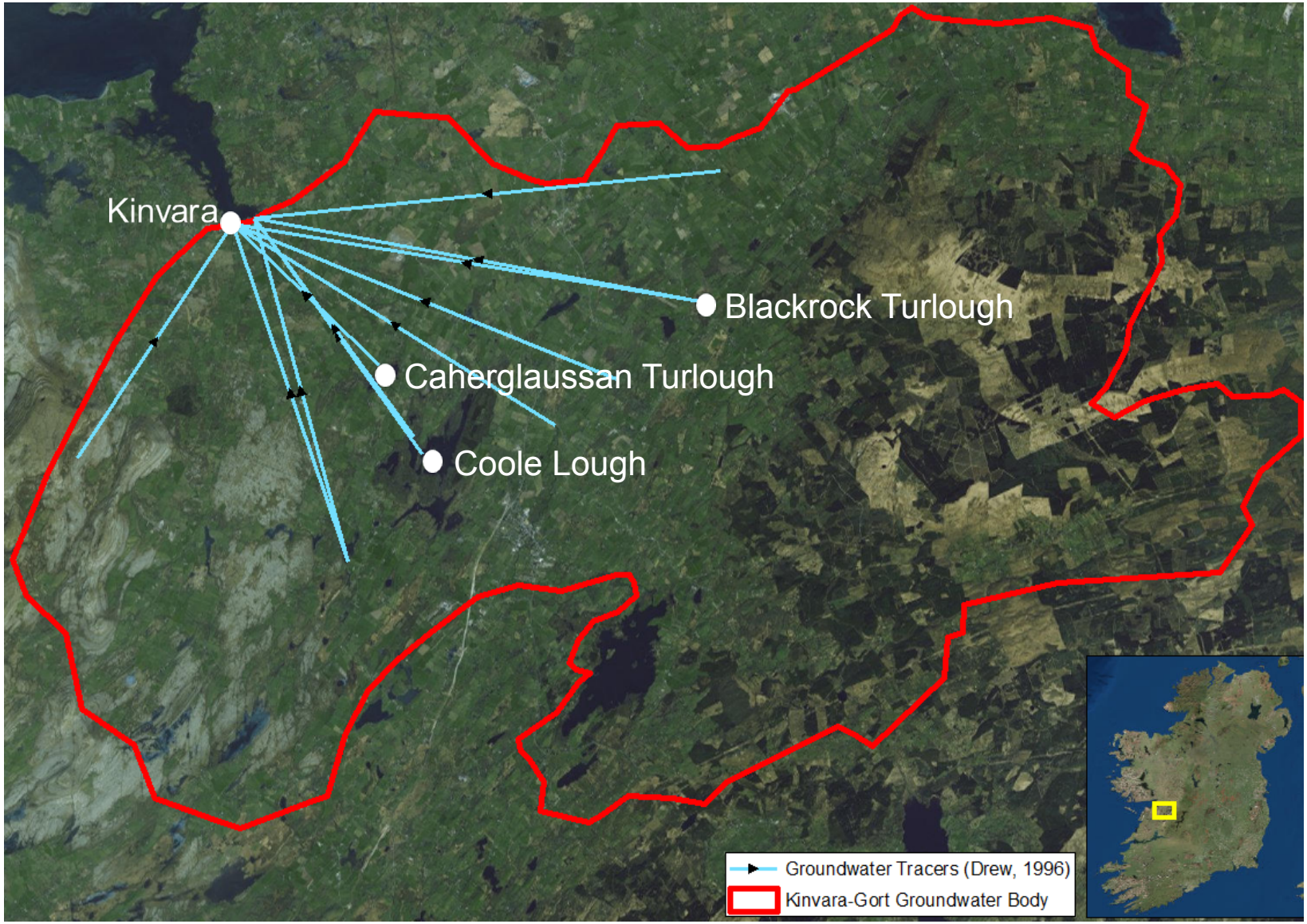


- Located in the West of Ireland in the south-easten part of Galway Bay

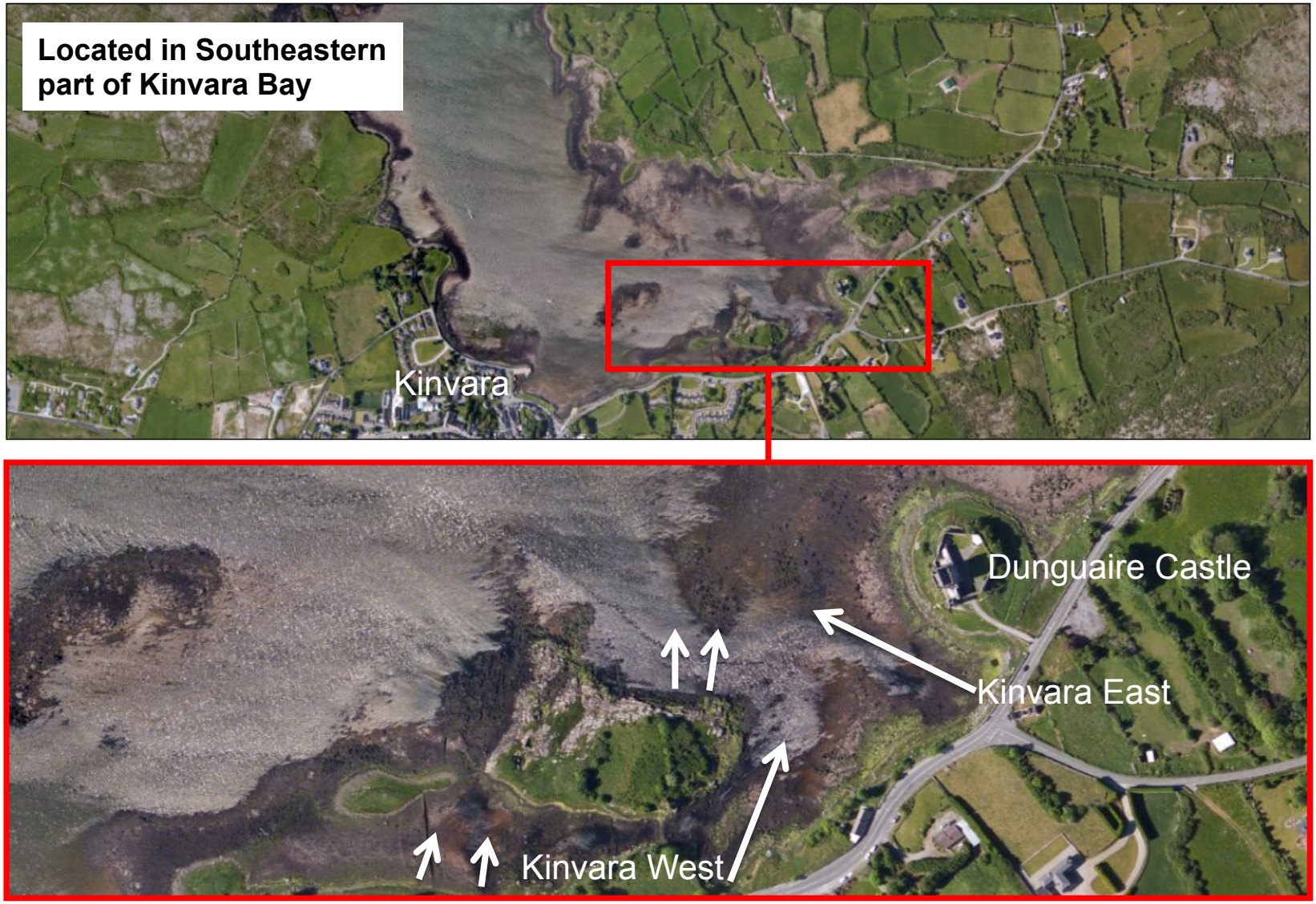
Why Kinvara?

- Geology is characterised by Carboniferous limestone, which is susceptible to karstification
- Kinvara-Gort karstic aquifer is well developed and has a significant hydraulic connection to Kinvara Bay

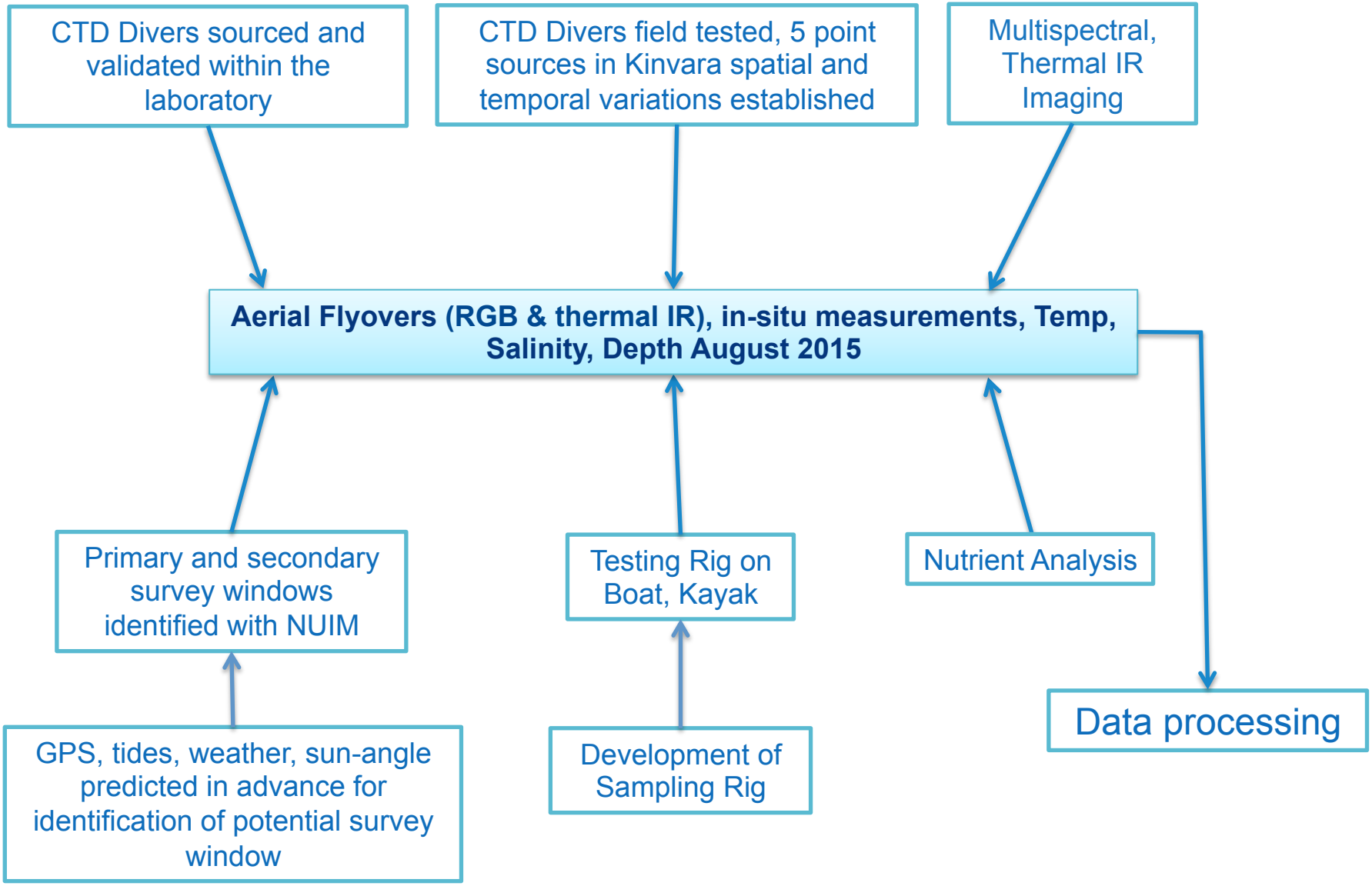
Kinvara: Hydraulic Connection



Location of Freshwater Springs



Kinvara Project Mission Planning



Kinvara Transects

- 25-28 August 2015
- CTD Diver probe was mounted on sampling rig towed from behind the rib or kayak
- Garmin GPS unit used to track location
- Coordinated with NUIM flyovers (RGB & thermal IR)

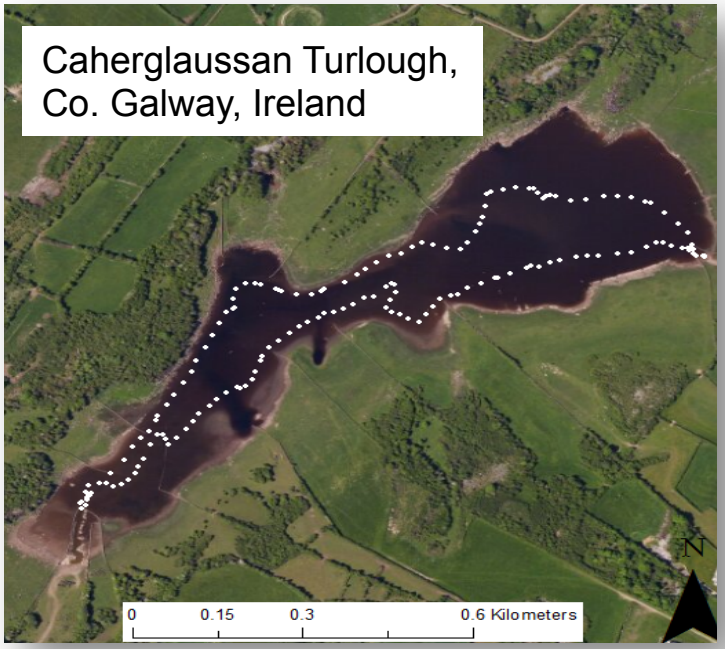
Ground Truthing CTD August 2015

GPS transects of:

- Kinvara Bay
- Caherglaussan Turlough

Data collected:

- >65,000 CTD measurements
- ~ 40 grab samples for nutrient analysis



Aerial Flyover Flight Plan NUIM August 2015

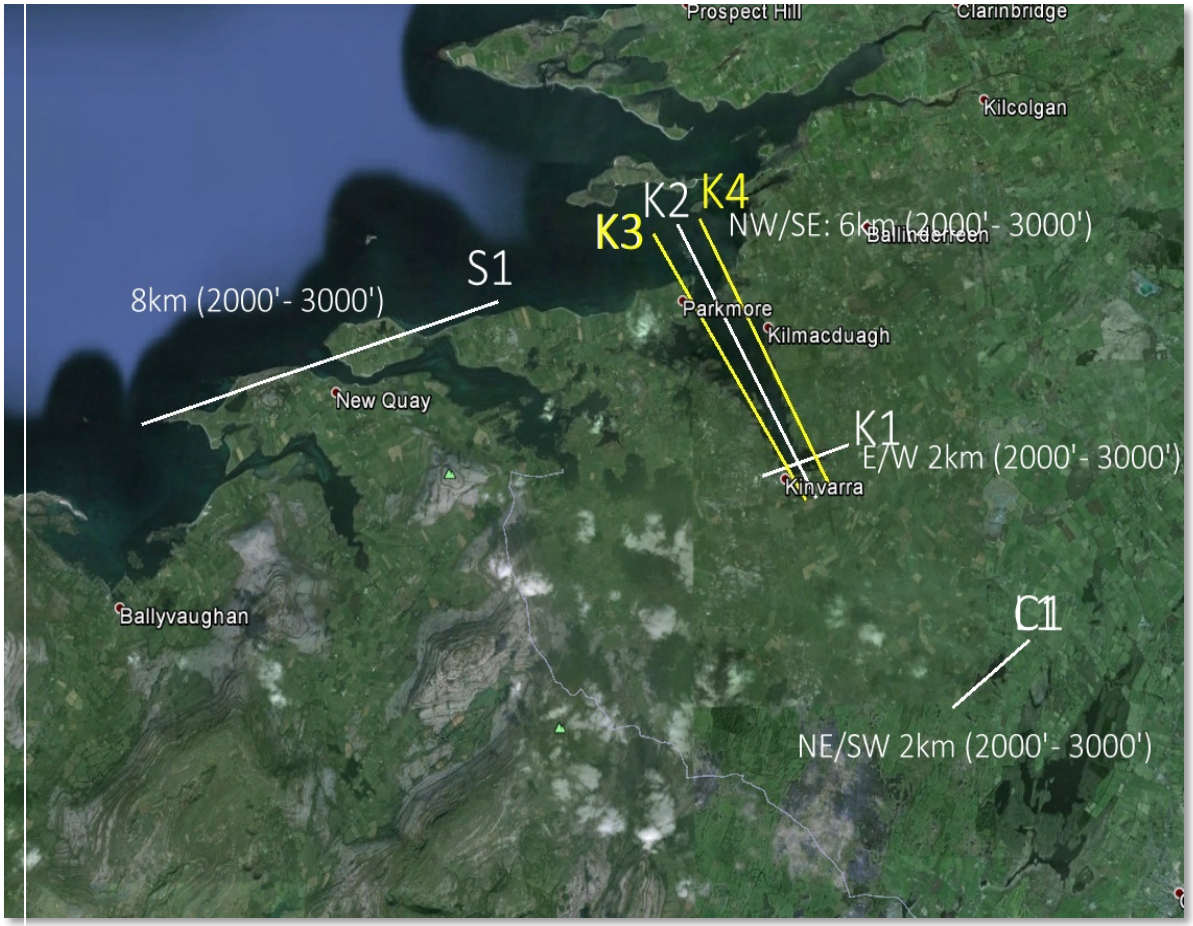
Flight Plan

C1
Lake Survey, Caherglassun Turlough
(between 2000' and 3000')

K1 & K2
Submarine Groundwater Discharge
(between 2000' - 3000')

K3 & K4
Shallow Bay shores
(between 2000' and 3000')

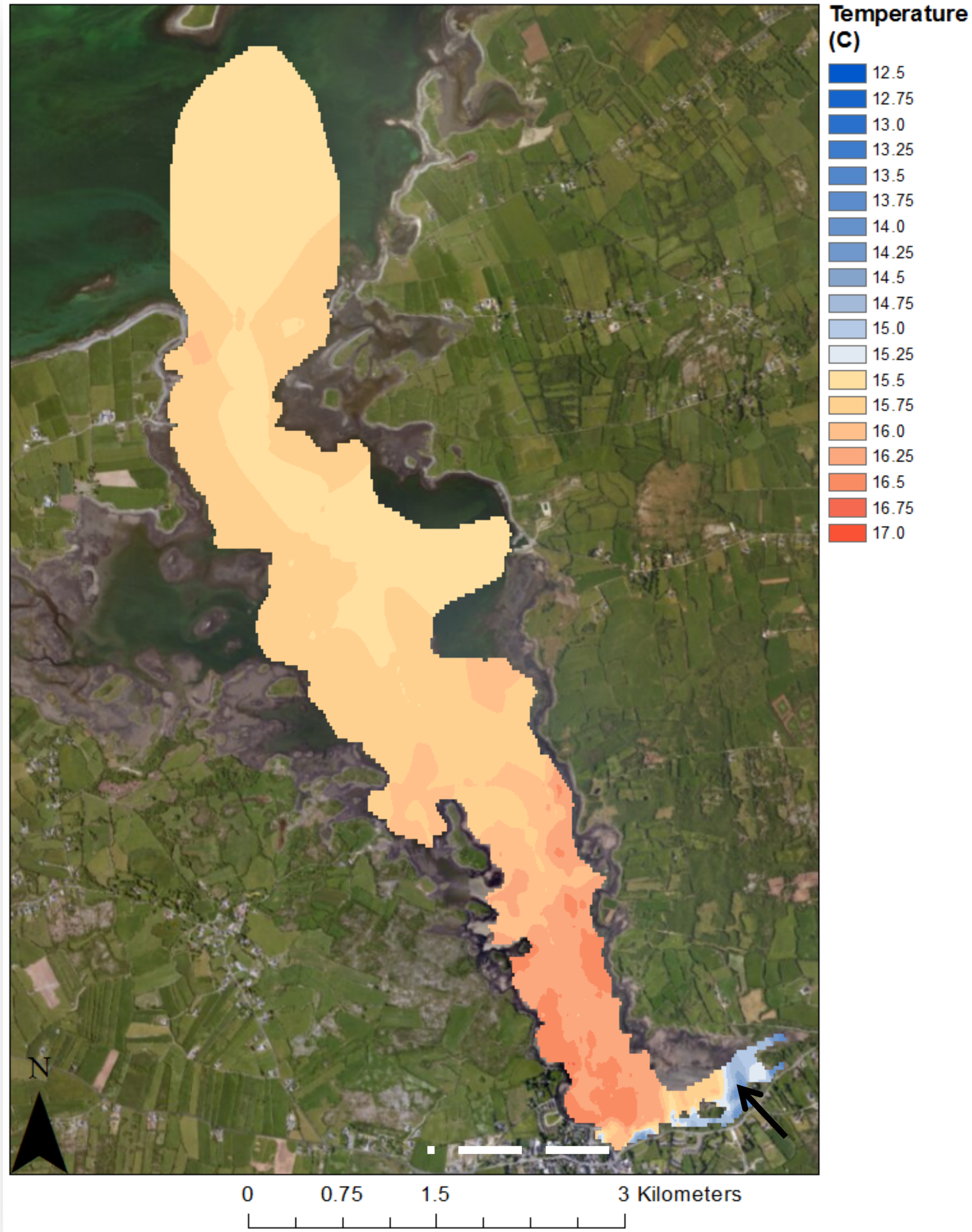
Sensors
RGB, Multispectral, Thermal



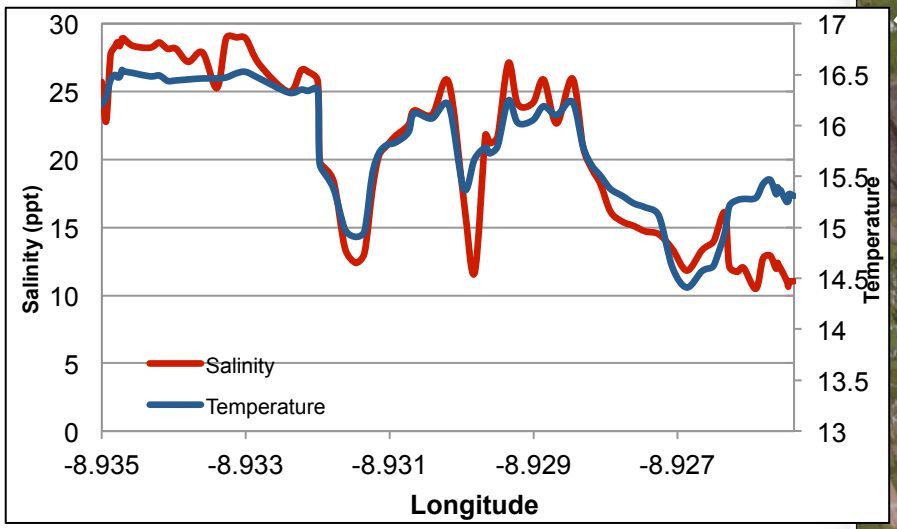
Correlation of in-Situ Temperature

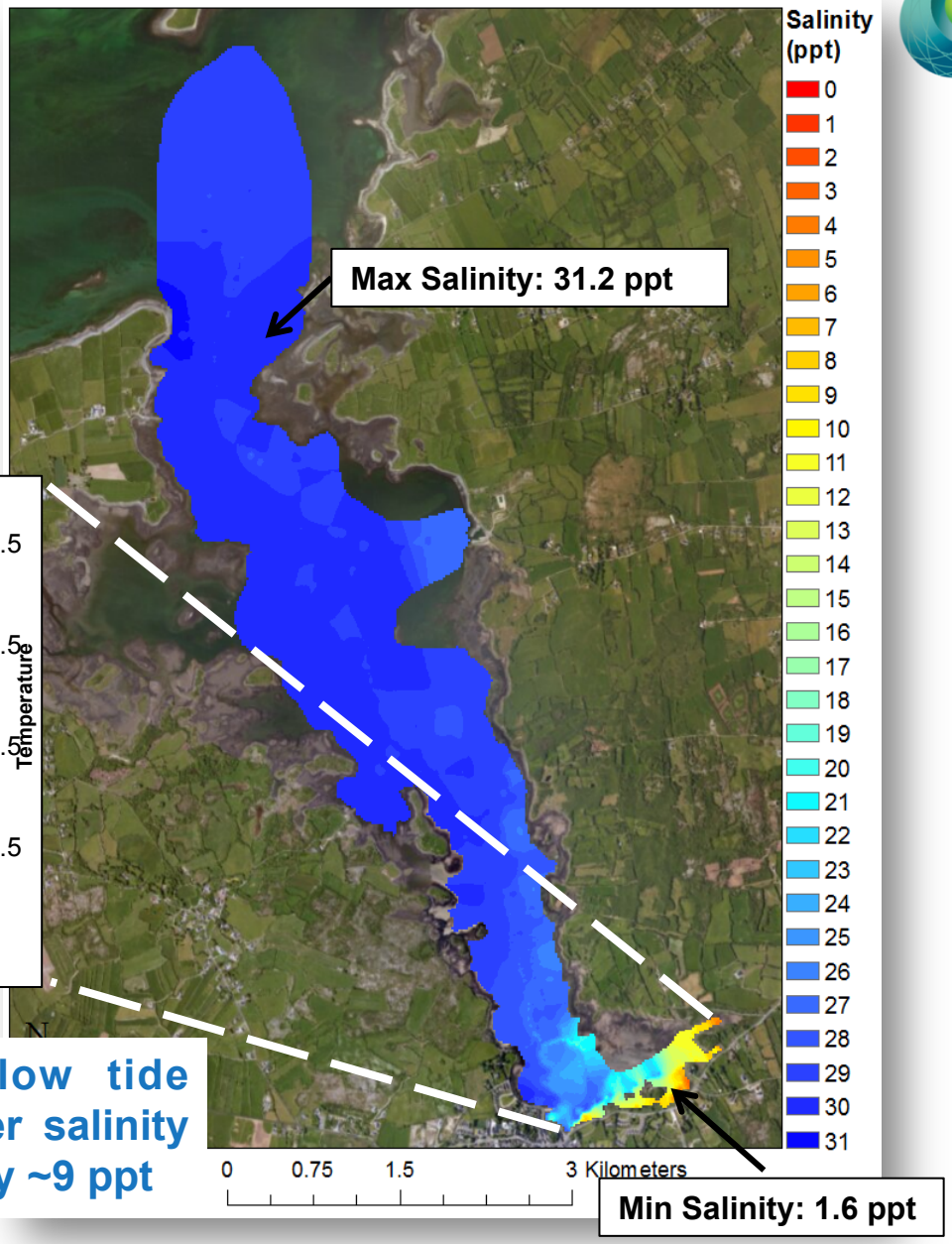
High Tide urements

Using ArcGIS software, **the in-situ temperature** and salinity data was spatially interpolated to produce heat maps



Correlation of in-Situ Temperature and Salinity Measurements

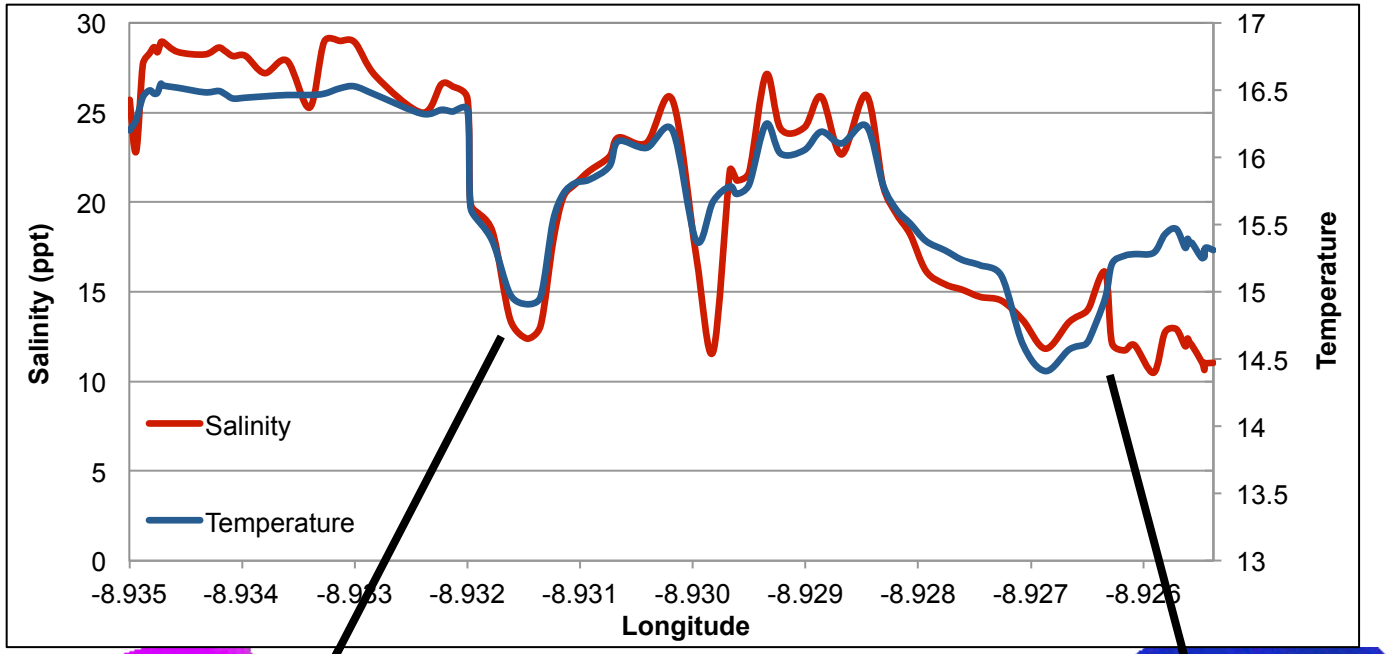


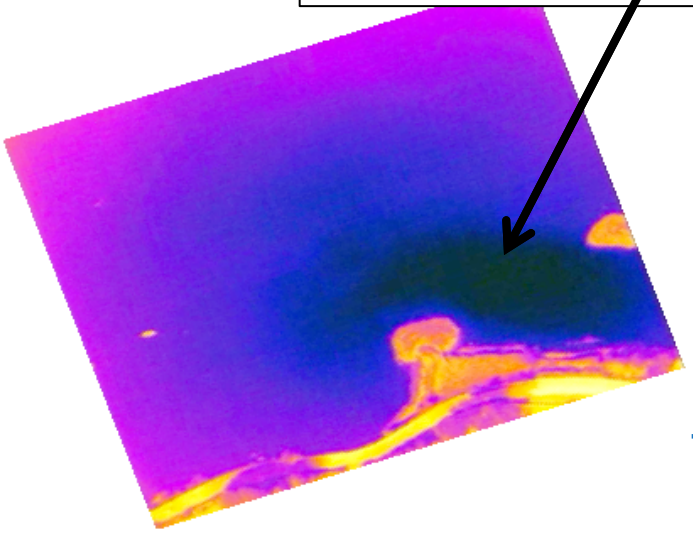


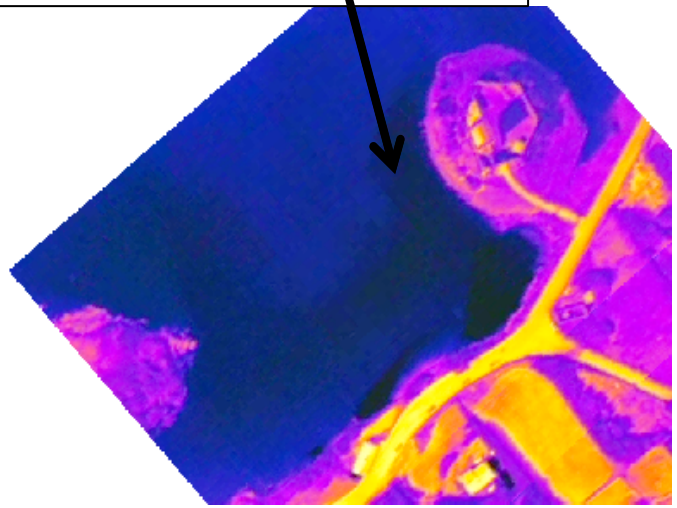
Groundwater discharge during low tide decreases the average surface water salinity of the southern part of Kinvara Bay by ~9 ppt

Correlation of In-Situ Features and Remote Thermal Imaging

In-situ temperature profile





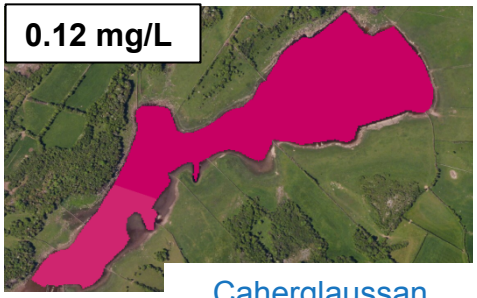


Thermal IR profile

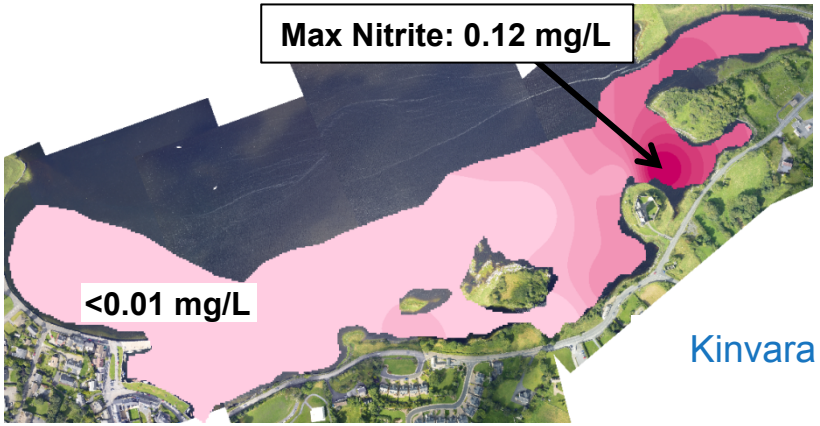
Nutrient Measurements

Nutrient levels at high tide

Nitrite

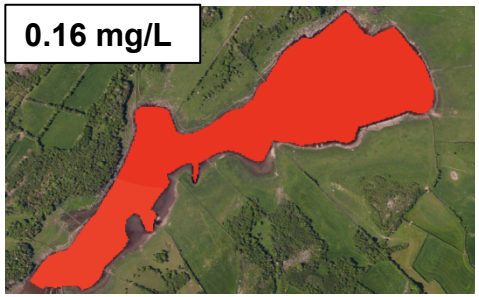


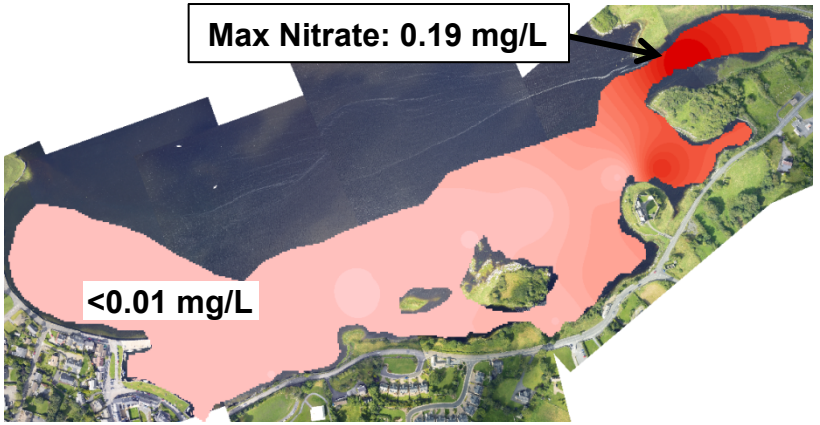
Caherglaussan Turlough



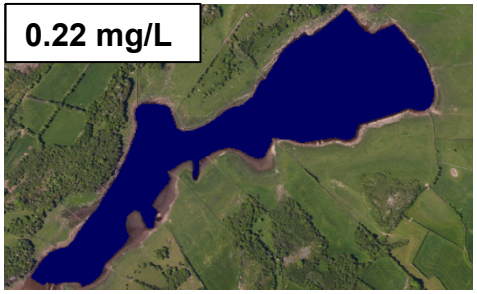
Kinvara Bay

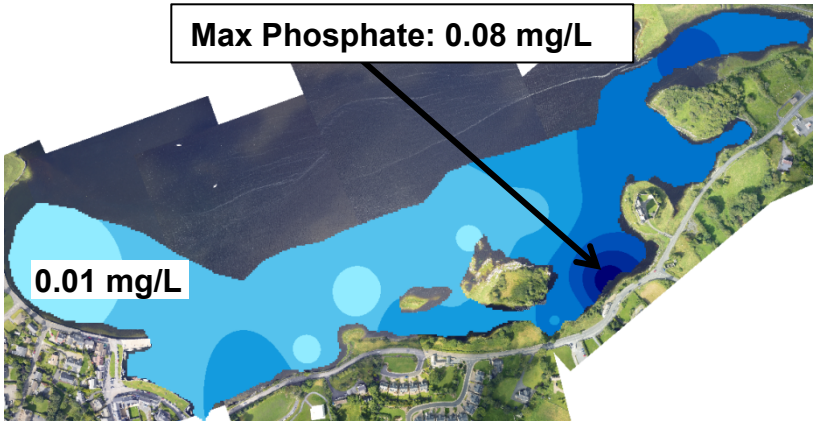
Nitrate





Phosphate





Conclusions

- In-situ sea surface temperature and salinity values have revealed cold freshwater plumes along the southern coastline of Kinvara Bay
- SST and salinity are well correlated
- Initial thermal IR imagery correlates well with in-situ data, establishing its potential for mapping SGD
- Initial nutrient analysis suggests a hydraulic link between the bay and nutrient from freshwater tourloughs
- Further work needed to explore the correlation between nutrient concentration and multispectral imagery

Temperature patterns appear to be strongly correlated with nutrient and salinity levels in the bay

Acknowledgements

Shane Burke
Sail Galway bay
Bob Welch