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Environmental Protection Agency

Assessing the potential of drones to take water samples and physico-chemical data from open lakes

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MHS

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MARINE & COASTAL SCIENCES

epa Research
Climate - Water - Sustainability
Identifying pressures • Informing policy • Developing solutions

Introduction

- Large scale hydrological monitoring programmes require deployment of boats to sample large open lakes
- Such monitoring = considerable personnel in the field & are therefore expensive
- Associated health & biosecurity risks

- Sampling some sites challenging, especially in remote locations

Introduction

- Unmanned Aerial Vehicles (UAVs) – significant potential to collect water samples & hydrochemical data
- Water sample & data collection via UAVs may prove significantly safer & cheaper

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Review

Can drones be used to conduct water sampling in aquatic environments? A review

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Significant Limitations To Date:

- Low volume of water collected
- Significant differences in parameters obtained via drone samples versus sampling by boat

Hexarotor - Ascending Technologies Firefly

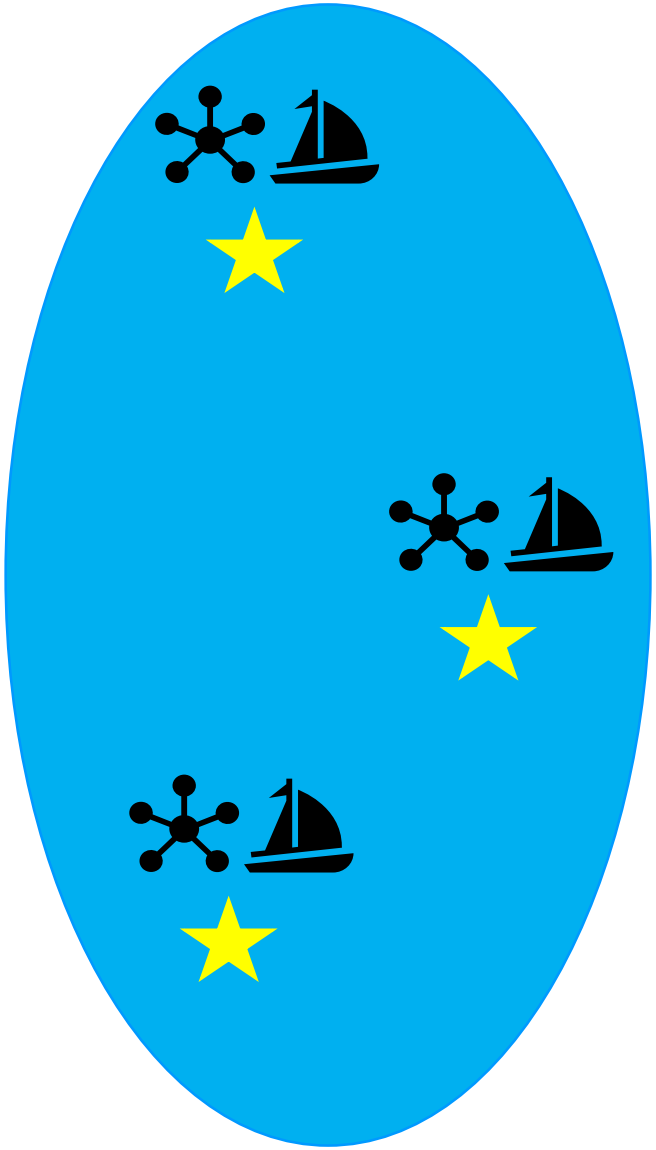
Research Project Aims

Assess the applicability of UAVs for open lake sampling

Evaluate whether water samples and physico-chemical data collected using the UAVs satisfies the WFD objectives

Examine whether UAVs can offer a quicker, cost effective, less labour intensive and safer lake sampling protocol

Experimental Field Trials using UAV



- **Four** lakes
- **Three** sampling stations on each lake
  - **Three** samples via both boat and UAV
- Sample capture success rates
- Parameters: chlorophyll *a*, nitrate, nitrite, total oxidised nitrogen, ammonia, ortho-phosphate, alkalinity, colour, total phosphorus, heavy metals


DJI Matrice 600 Pro

Results – Volume of water sampled

Previous Research:

- **60ml** (Ore *et al.* 2013; 2015, Detweiler *et al*. 2015; Chung *et al.* 2015, Song *et al*. 2017)
- **130ml** (Koparan & Koc 2016; Koparan *et al*., 2018a,b)
- **250-330ml** (Terada *et al*. 2018)

- This study: **2L**

Results – Sampling success rates

Previous Research:

- **90%** (Ore *et al.* 2013) for indoor trials but **69-83%** outdoor trials (Ore *et al.* 2013; 2015)
- **60-66%** (Koparan & Koc 2016; Koparan *et al*., 2018)

- This study: **100%**

Results – Comparison of parameters

Previous Research: Majority didn't compare results

- Ore *et al*. (2013,2015) & Detweiler *et al*. (2015)
  -Temperature ~1°C
- Chung *et al*. (2015)
  -Temperature ~0.5°C
- Koparan & Koc (2016) Temperature different?
- Song *et al*. (2017)
  -Temperature & conductivity similar, chloride via UAV =317.2mg/L vs. 182.2mg/L via hand collected samples

Results – Comparison of parameters

Previous Research: Majority didn't compare results

- Koporan *et al*. (2018)

  -Temperature (t=0.1,d.f.=18,p=0.91)
  mean diff.= 0.25mg/L (7.18 mg/L vs. 6.93mg/L)

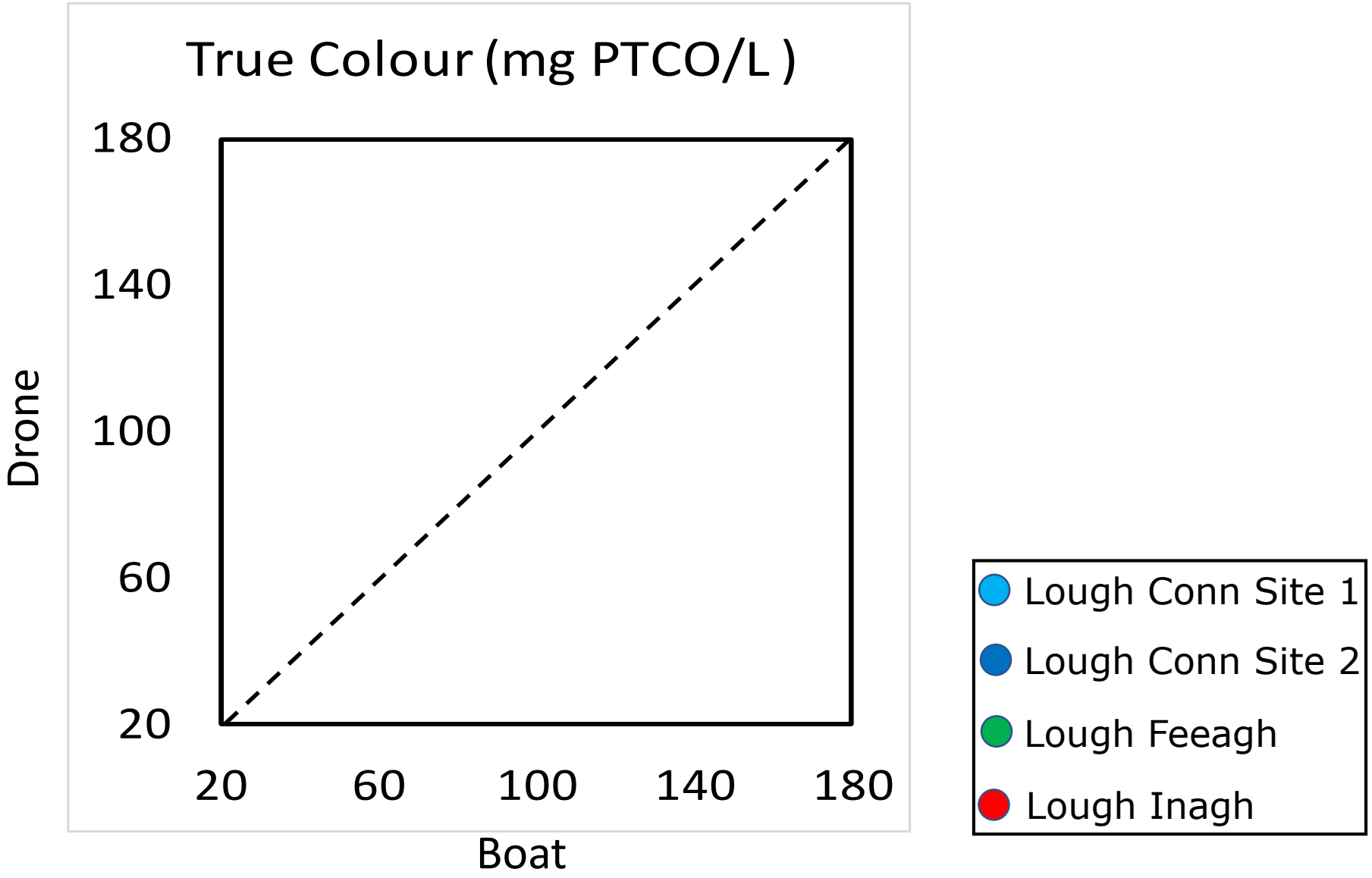
  -Oxygen (t=10.1, df=18, **p<0.001**)
  mean diff.=0.25mg/L

  -Conductivity (t=1.59, d.f.=18,p=0.13
  mean diff.=0.7µS/cm

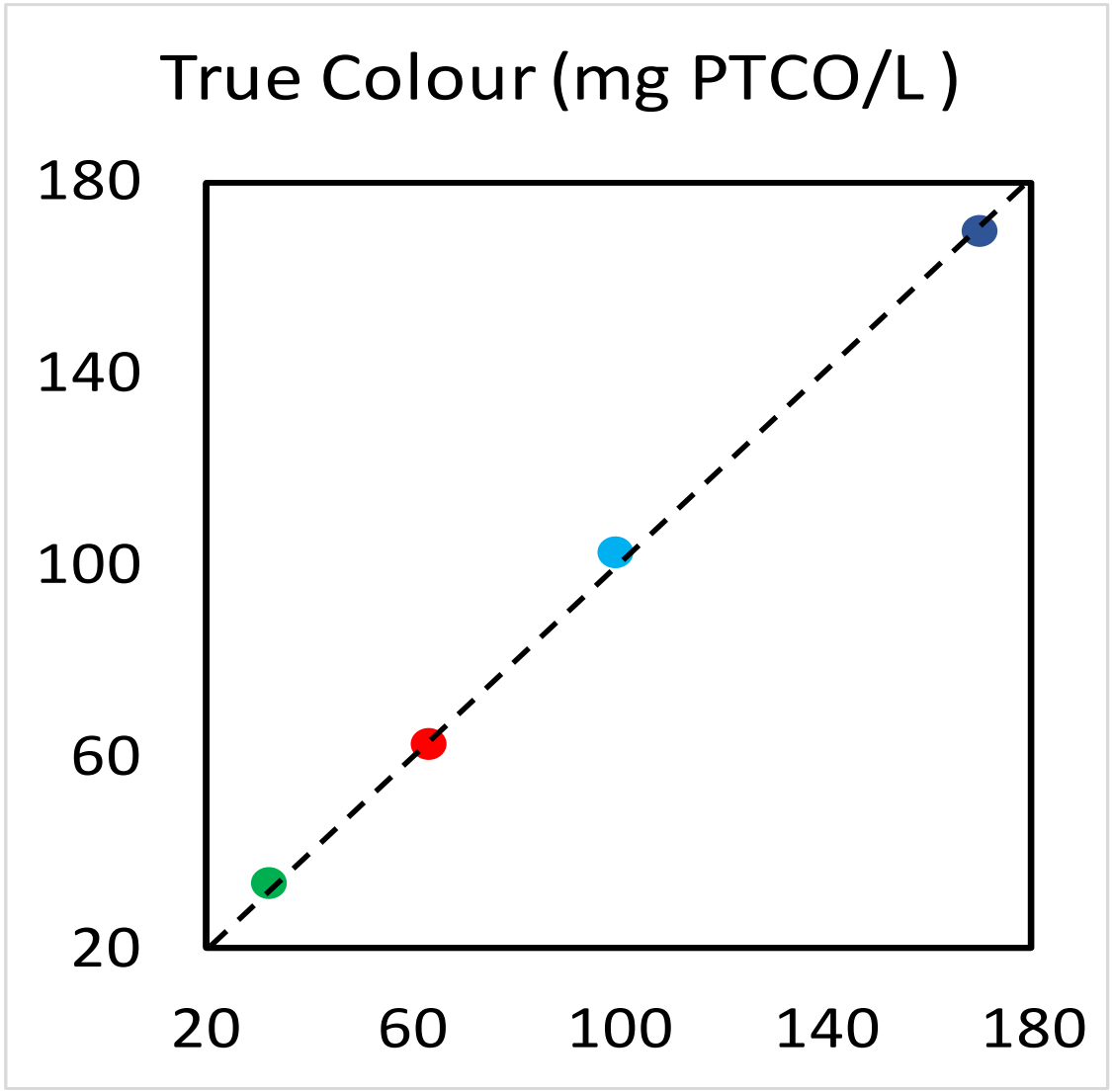
  -pH (t=3.3,d.f.18,p=0.004)
  mean diff.= 0.04

  -Chloride (t=-12.1,d.f,=18,**p<0.001**)
  mean diff.=1.49mg/L (5.46mg/L vs.3.97mg/L)

Results – Comparison of parameters



Results – Comparison of parameters

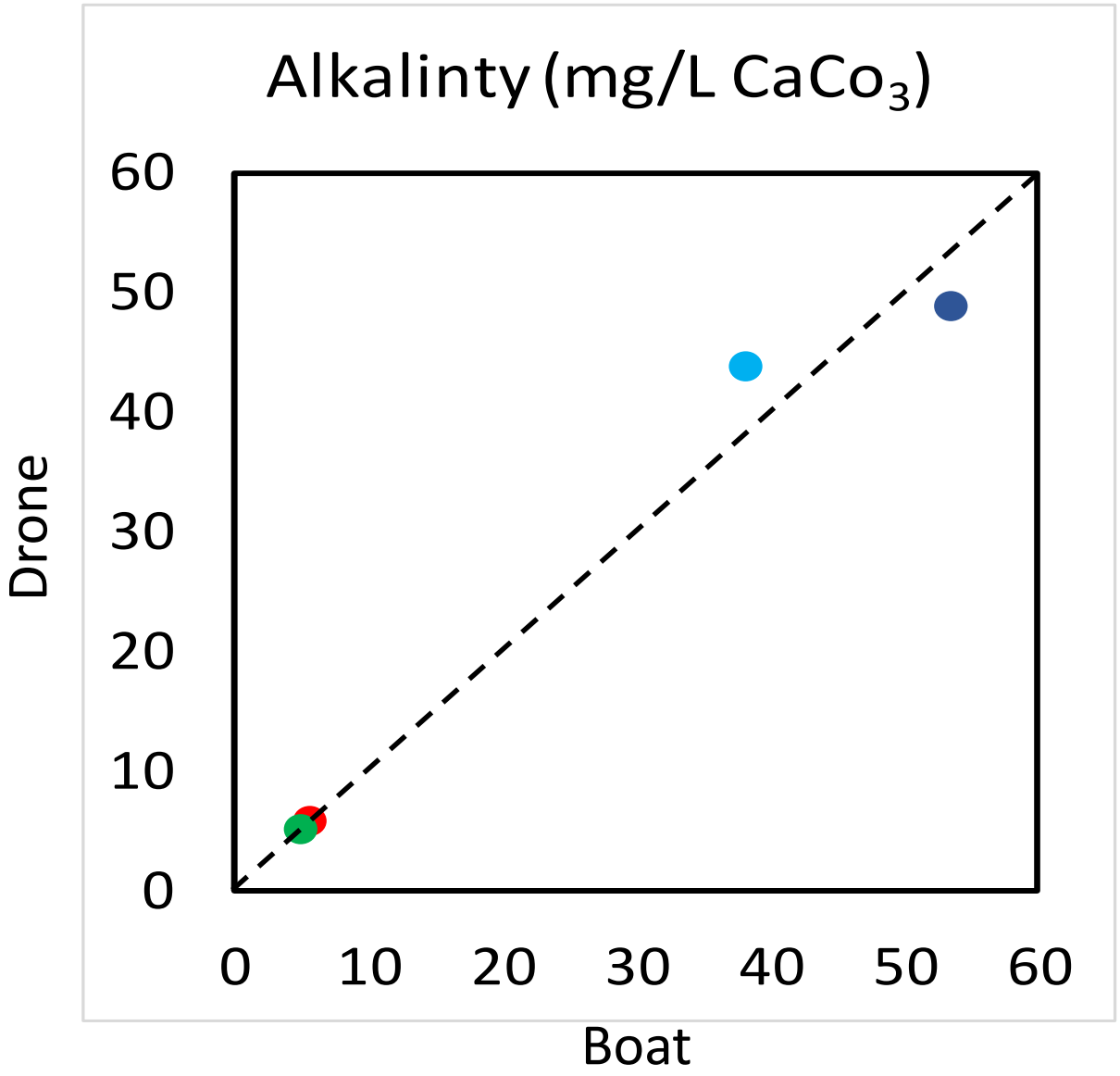


Paired t= 0.916,
d.f. =3,
p = 0.92

Mean diff.=0.075

- Lough Conn Site 1
- Lough Conn Site 2
- Lough Feeagh
- Lough Inagh

Results – Comparison of parameters

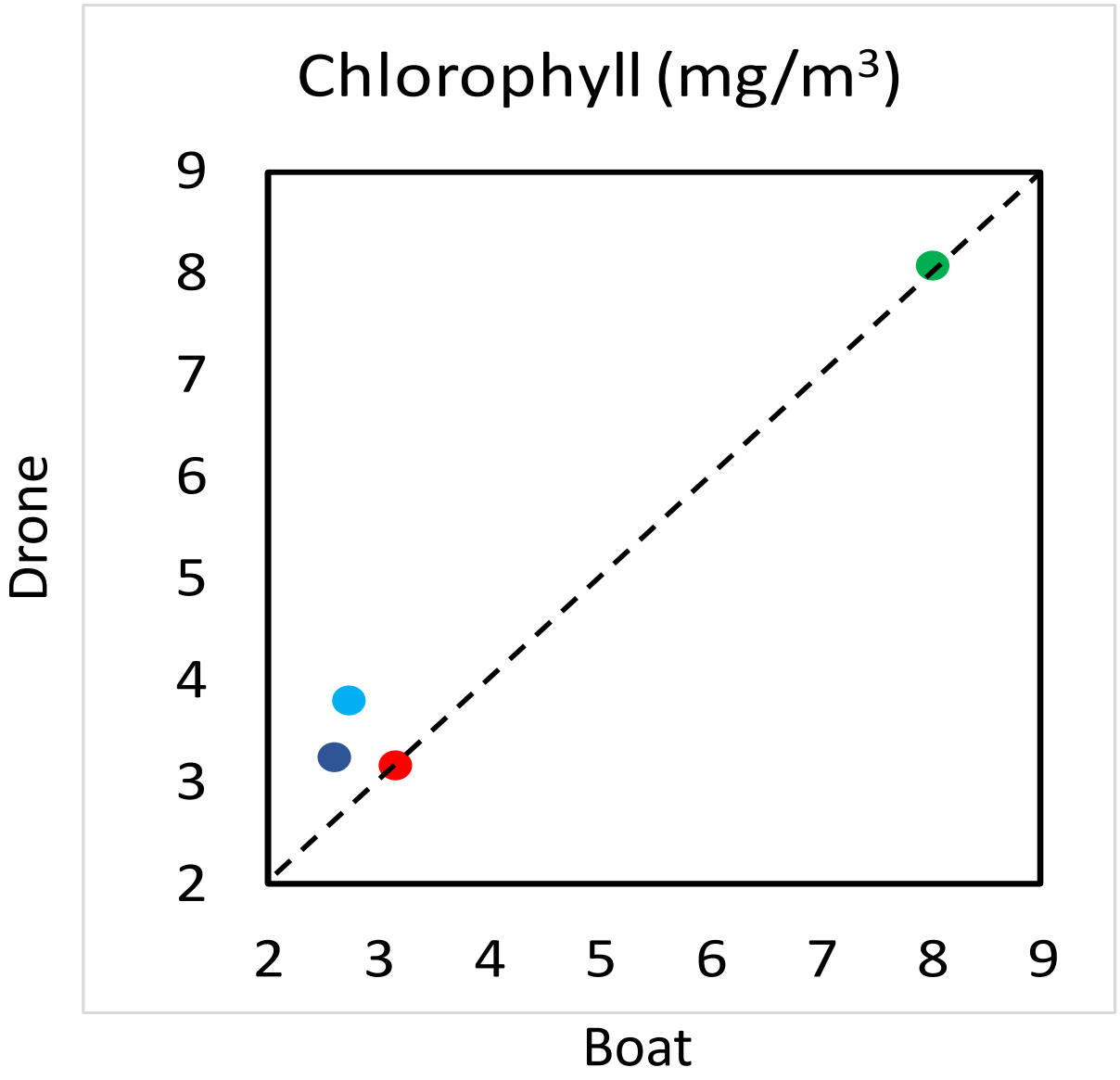


Paired t= -0.038,
d.f. =3,
p = 0.972

Mean diff.=-0.081

- Lough Conn Site 1
- Lough Conn Site 2
- Lough Feeagh
- Lough Inagh

Results – Comparison of parameters



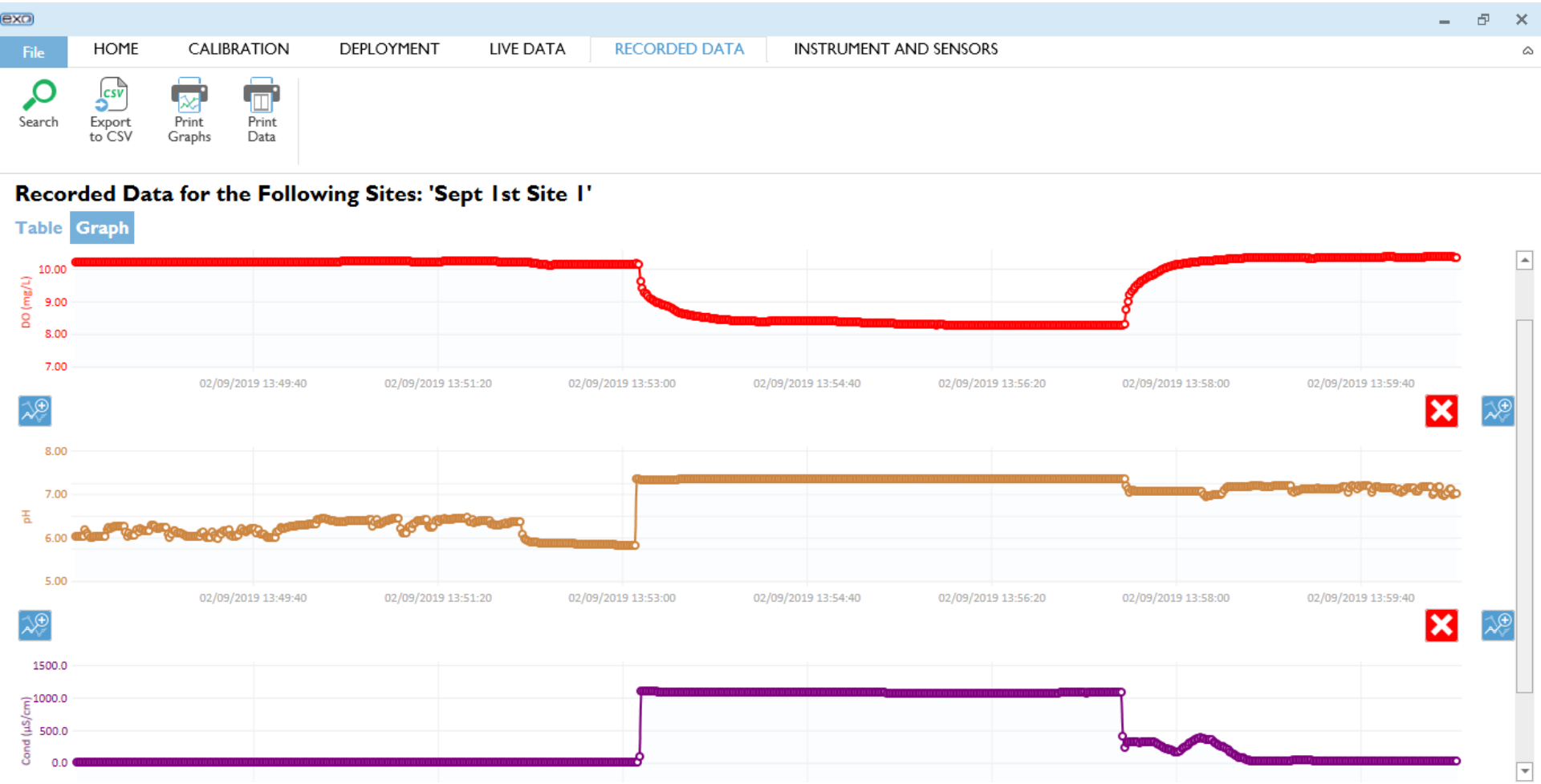
Paired t= -1.642,
d.f. =3,
p = 0.199

Mean diff.=-0.408

- Lough Conn Site 1
- Lough Conn Site 2
- Lough Feeagh
- Lough Inagh

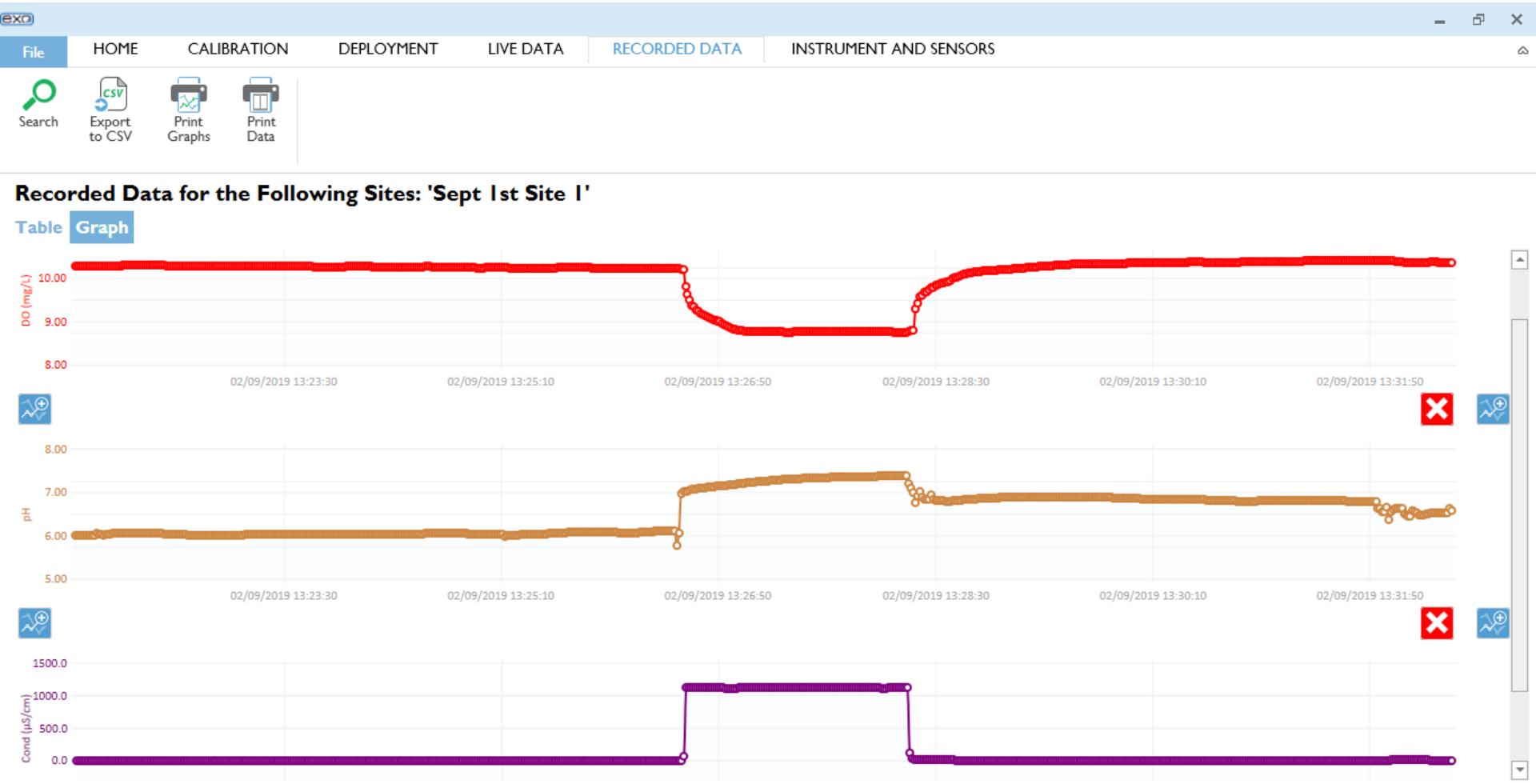
Real Time Data Recording:

Drone data over 12 mins

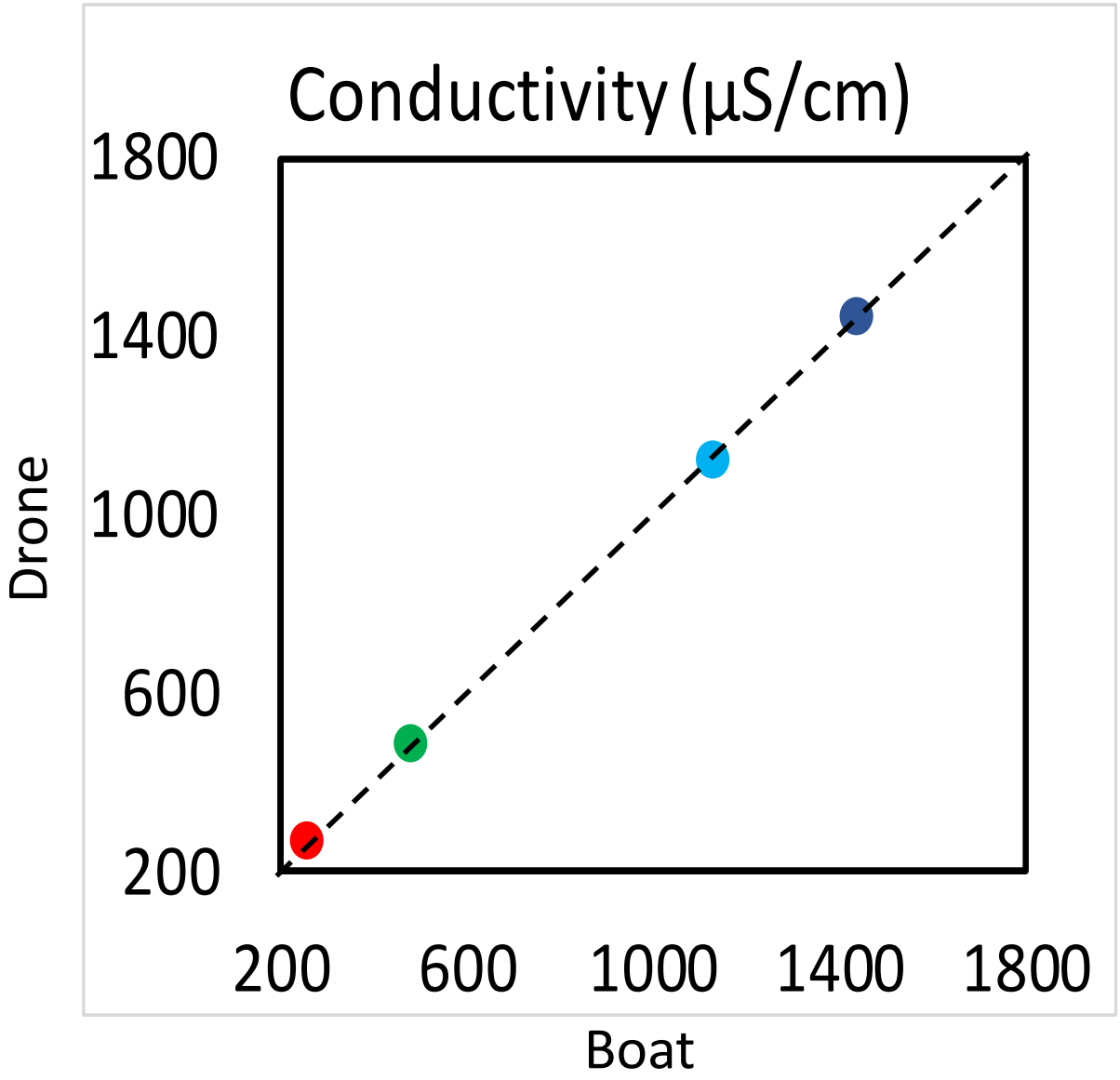


Real Time Data Recording:

Boat data over 11 mins



Results – Comparison of parameters

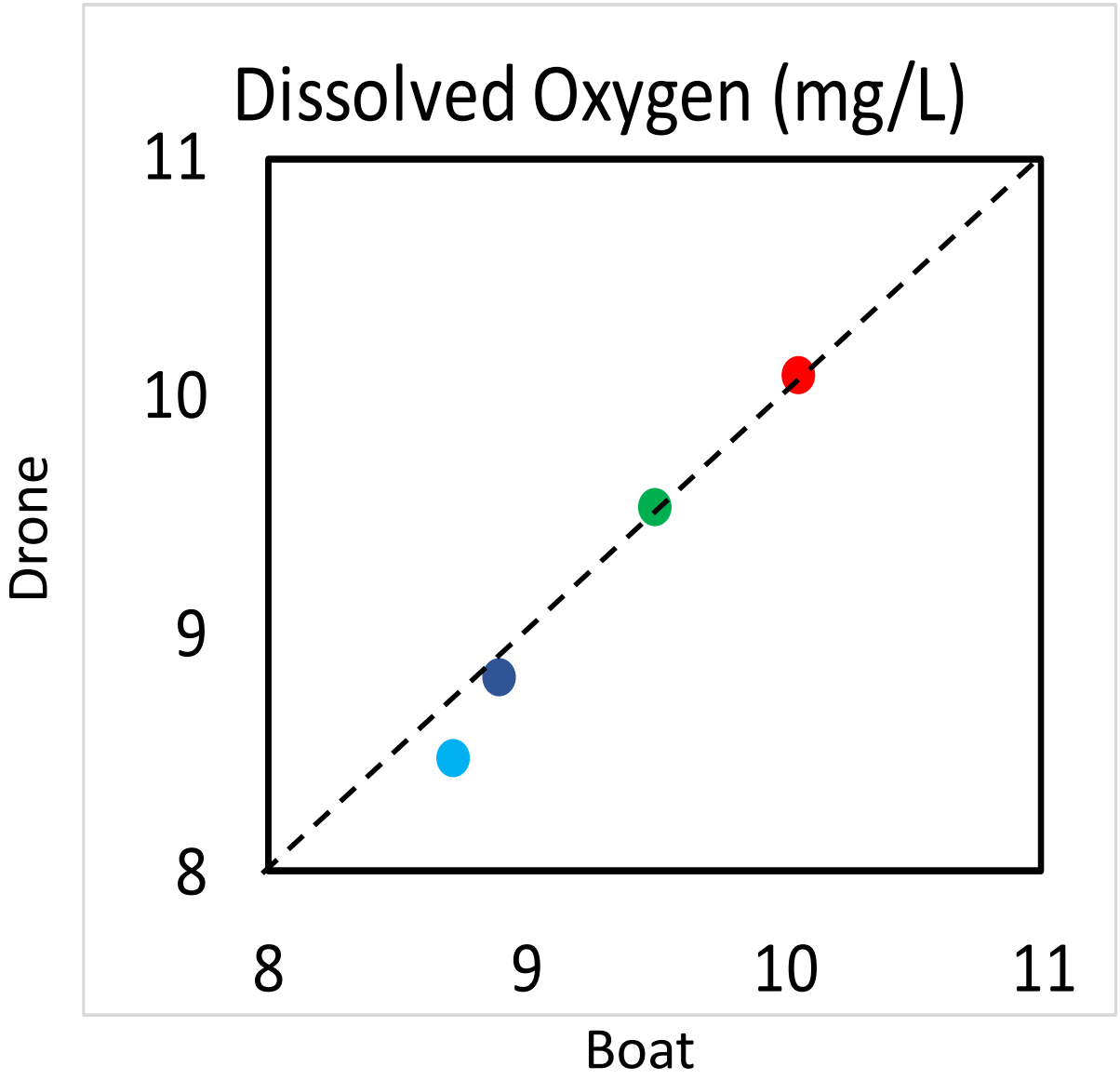


Paired t= 0.916,
d.f. =3,
p = 0.427

Mean diff.=4.99

- Lough Conn Site 1
- Lough Conn Site 2
- Lough Feeagh
- Lough Inagh

Results – Comparison of parameters

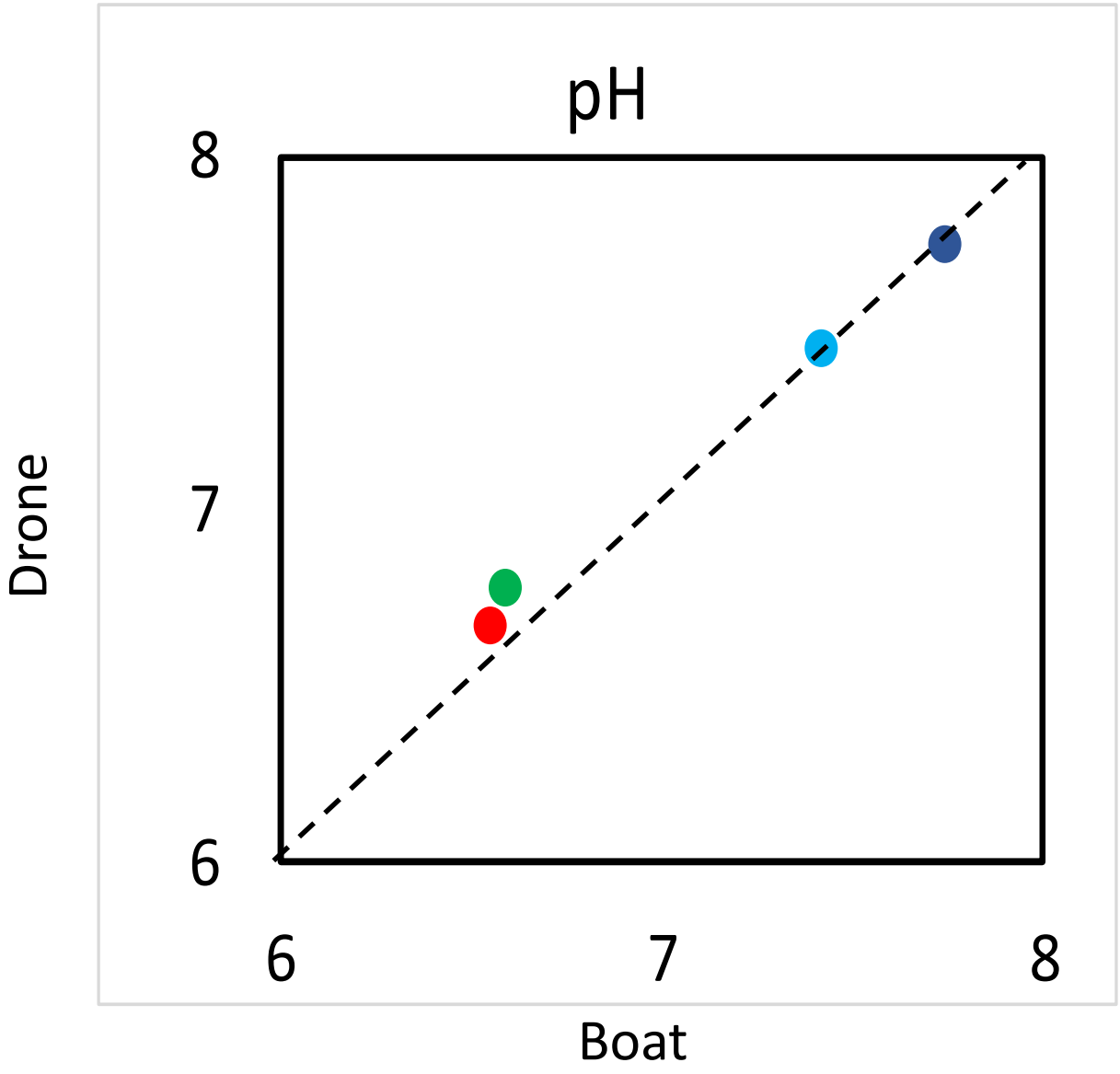


Paired t= 1.169,
d.f. =3,
p = 0.327

Mean diff.=0.08

- Lough Conn Site 1
- Lough Conn Site 2
- Lough Feeagh
- Lough Inagh

Results – Comparison of parameters

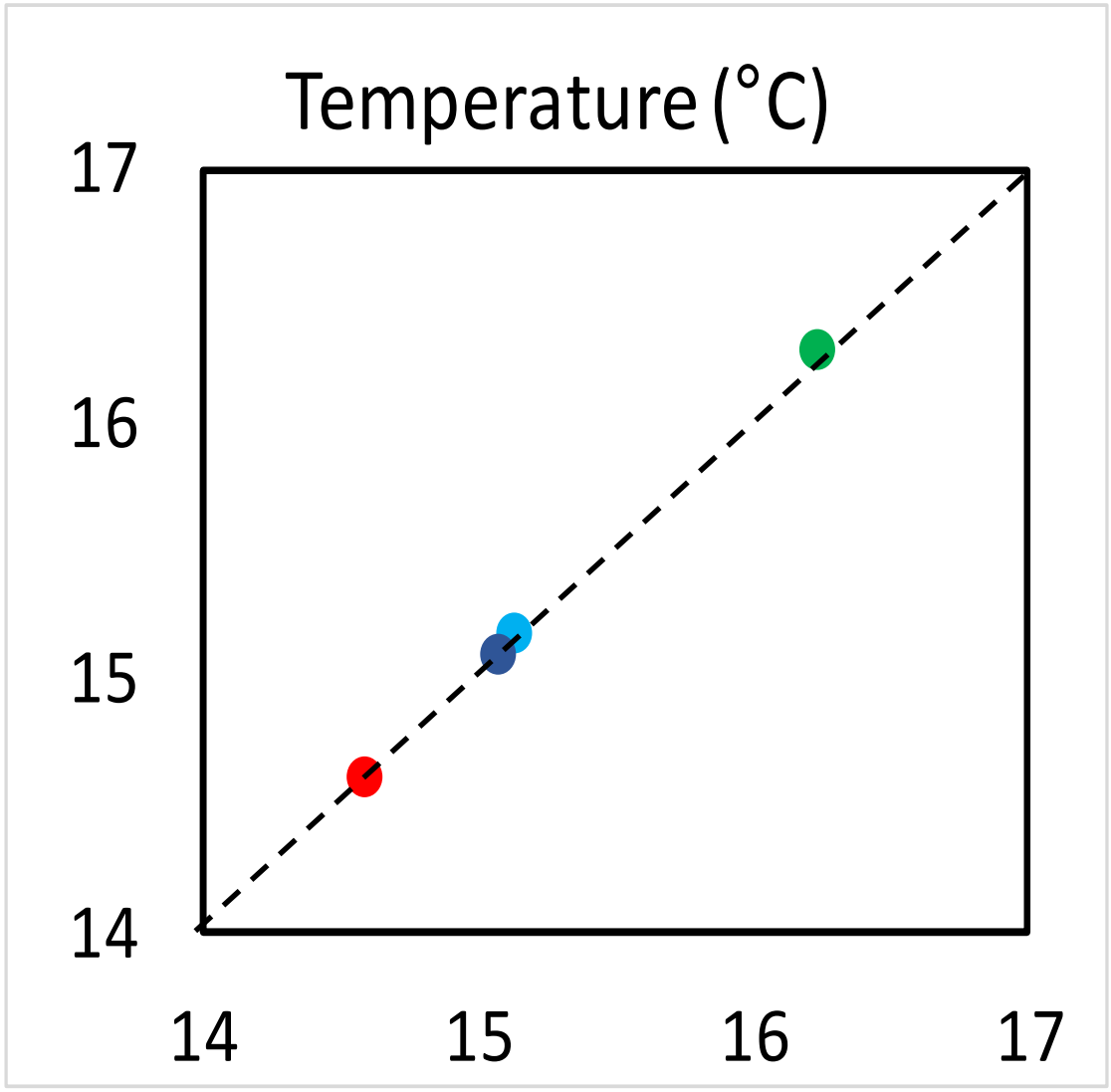


Paired t= -1.832,
d.f. =3,
p = 0.164

Mean diff.=0.078

- Lough Conn Site 1
- Lough Conn Site 2
- Lough Feeagh
- Lough Inagh

Results – Comparison of parameters



Paired t= -3.576,
d.f. =3,
p = 0.037

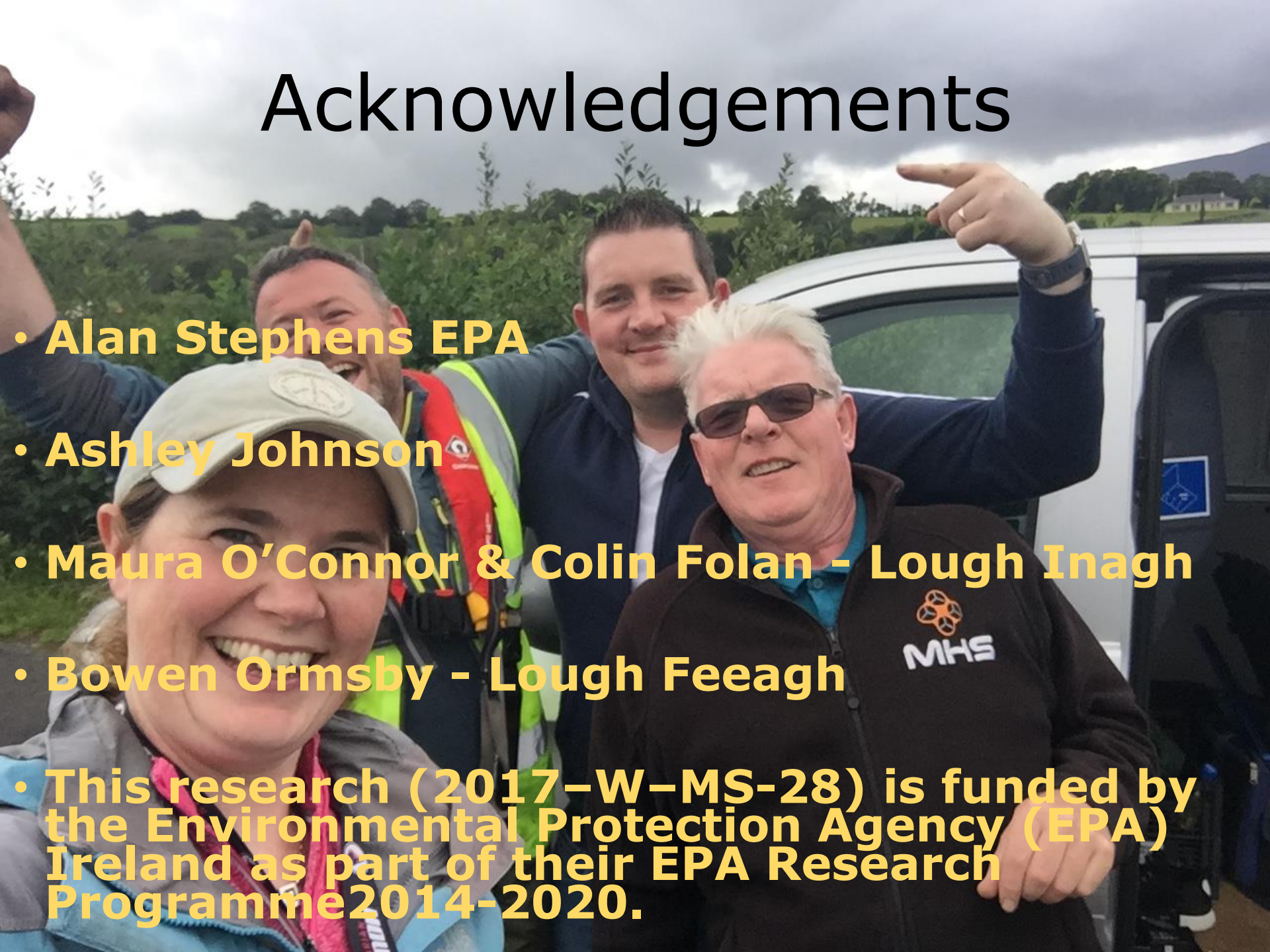
Mean diff.=0.023

- Lough Conn Site 1
- Lough Conn Site 2
- Lough Feeagh
- Lough Inagh

Summary

- Volume of water collect via drone = 2L
- Successful sample collection 100% of time (highest previous 83%)
- No difference in parameters
- More data needed!

Acknowledgements



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Thank you!!

Save the date: End of Project Workshop GMIT, Galway, 24th & 25th February 2020

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