

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

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# The Project Team



# EPA Water Call 2017

## Potential for the use of drones for the purposes of open lake water sampling

### Objectives & Expected Outputs:

- Investigate the current potential of drone technology for the purposes of water sampling
- Determine if current technology can be adapted to meet current WFD lake sampling requirements
- Assess the drone's capacity for taking field measurements, e.g. temperature, dissolved oxygen, pH, conductivity, etc. The results are to be validated with standard monitoring techniques
- Examine remote data management possibilities for in-situ field measurements
- Based on the outcomes of the above research, undertake a field demonstration to further evaluate the potential to replace the use of boats with drones for surface water body
- Provide evidence regarding the potential use of drones as a more cost effective, less labour intensive & safer WFD lake sampling programme

# Background

## EU Water Framework Directive (WFD)(2000/60/EC)

- Introduced in 2000 and adapted into Irish law in 2003 (17 years ago)
- Europe wide approach to surface and ground water conservation and management
- Key aim is to ensure “Good Ecological Status” (GES) of all European waters
- Requires large scale ecological monitoring programmes

# Background

## EPA WFD Lake Monitoring Programme:

- Lakes must have a surface area of  $> 50$  ha, be an active source of drinking water or be protected (EU Habitats /Birds Directive)
- Of the 12,000 lakes in Ireland, 856 lakes are included in the monitoring programme
- Subset of 215-378 representative lakes monitored every three years
- Monitoring of water chemistry is undertaken by local authority personnel
- Requires use of a boat
- Issues around accessibility, costs, health & safety, biosecurity, time consuming

# Background

## Identifying Pressures with the WFD

Need for GES for all EU surface & ground waters (WFD)

Requires large scale ecological monitoring & samples programmes

Require trained personnel, expensive, time consuming, resource intensive, pose health & safety & biosecurity risks, accessibility

## Informing Policy

EU WFD & Habitats Directive

EPA Lake Monitoring programme procedures

Increase monitoring of inaccessible/remote and unmonitored lakes

## Developing Solutions – Application of drones

With a water chemistry payload for 1 L water sample retrieval & physico-chemical data collection

Reduce water sampling costs, time & resources

Decrease health & safety and biosecurity risks

# Research Aims

Assess the applicability of drones for open lake sampling



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

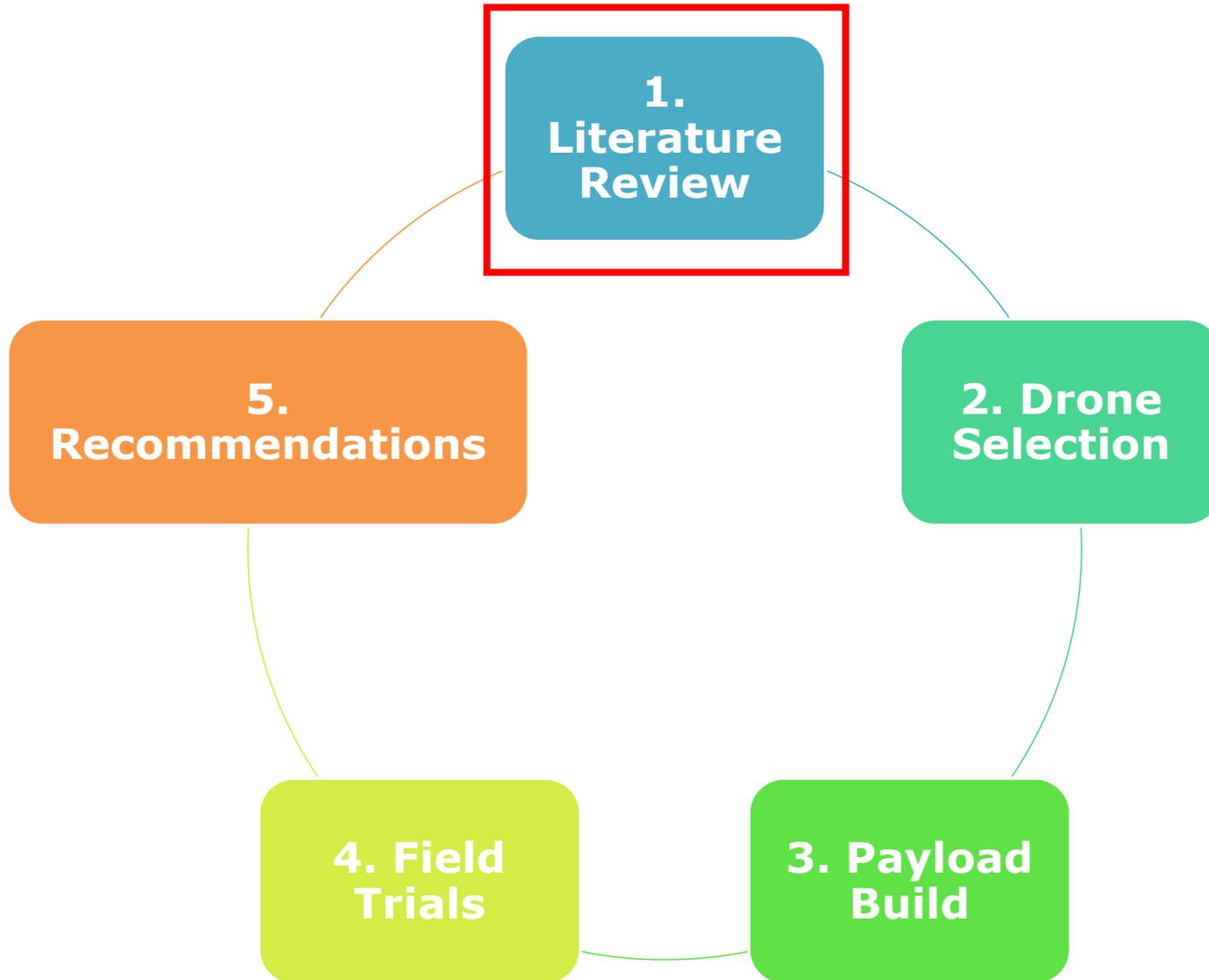


Determine whether drones can be deployed to increase the accuracy of extrapolated trophic status for unmonitored lakes



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

# Core Project Work Packages



# 1. Literature Review

Aims of the literature review:

- Evaluate the use of drones to collect water samples and in-situ physico-chemical data in freshwater environments, synthesising and reviewing the current literature
- Identify knowledge gaps and technological developments needed to advance the use of drones to conduct water sampling in aquatic environments in the coming decade

# 1. Literature Review

Major research groups in the field:

- NIMBUS research lab in Nebraska-Lincoln, USA<sup>1,2,3,4</sup>,
- Chung in UC Berkeley, USA<sup>5</sup>,
- Koperan in Clemson University, South Carolina, USA<sup>6,7,8</sup>,
- Terada research group, Japan<sup>9</sup>

Major commercial groups in the field:

- HATCH & DJI, Canada<sup>10,11,12</sup>
- Rise Above Custom Drone Solutions, Australia<sup>13</sup>
- Sphere Drones, Australia<sup>14</sup>

No research in this field currently within Europe or Ireland\*

# 1. Literature Review

Specifications of drone platforms used to conduct water sampling vary

- Off-the-shelf<sup>1,2,3,4,9</sup> versus custom build<sup>6,7,8</sup>
- Maximum payload weights 600 grams<sup>1,2,3,4</sup> – 12 kg<sup>9</sup>
- Maximum flight times 20<sup>1,2,3,4</sup> – 40 mins<sup>9</sup>
- Operating systems autonomous and/or operator controlled<sup>1-9</sup>

# 1. Literature Review

Specifications of water sampling payloads attached to drones to conduct water sampling

- All custom-built - chassis system with tube and micro pump<sup>1,2,3,4</sup>, metal free high-density polyethylene sampling bottle<sup>9</sup>, "thief-style" water sampler<sup>6,7,8</sup>
- Quantities of water collected 60<sup>1,2,3,4</sup> – 130 ml<sup>6,7,8</sup>
- Water sampling capture rates 60 – 80%<sup>2,3,6,7</sup>
- Water sampling times 40 mins<sup>4</sup> – 2 hrs<sup>1,2,3</sup>
- Onsite analysis of temperature<sup>4,6,7,8</sup>, conductivity<sup>4,6,7,8</sup>, pH<sup>6,7,8</sup> and dissolved oxygen<sup>6,7,8</sup>
- Real-time data monitoring of physico-chemical variables<sup>4</sup>
- Additional laboratory testing of sulphates<sup>1,2,3,9</sup>, chlorides<sup>1,2,3,4,6,7,8,9</sup>, stable isotopes<sup>9</sup>

# 1. Literature Review

Comparison of water sampling methods and experimental design employed within freshwater environments

Sources	No. of sampling sites	Replication	Methods Compared	Total sample size	Statistical comparison
1,2,3	5	3	Manual grab sample & use of hand-held probes from Kayak versus drone-assisted water sampling from Kayak	30	None
4	9	3	Manual grab sample & use of hand-held probes versus HOBO in-situ sensors versus drone-assisted water sampling	81	None
7	3	3	Manual grab samples & use of hand-held probes from Kayak versus drone-assisted water sampling	18	Paired t-tests

# 1. Literature Review

Key considerations for the future & the current research:

- Type and payload capacity of off-the-shelf drones
- Increase sampling success rates
- Meaningful comparison of water chemical parameters taken using boat and drone
- Adapt robust statistical experiment design
- Wider selection of water chemistry parameters
- Detailed cost benefit analysis
- Flight beyond visual line of sight (BVLOS)

# 1. Literature Review



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Review

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

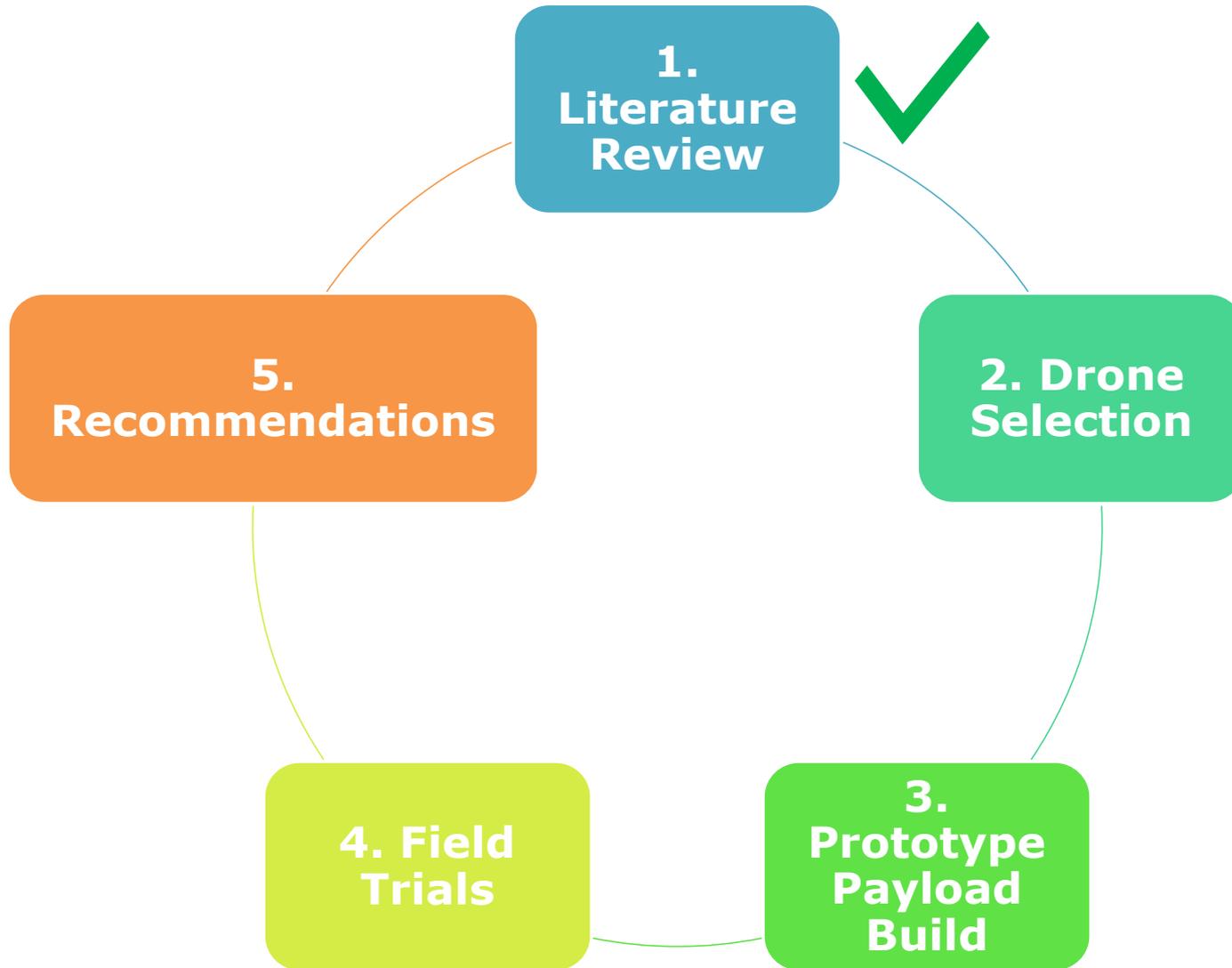
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# Core Project Work Packages



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