An aerial photograph showing a dense forest of green trees. In the lower portion of the image, a stream flows through a clearing. The stream is bordered by tall grasses and several yellow flag iris plants (Iris pseudacorus) are visible along the bank. The water in the stream is dark and reflects the surrounding greenery.

# Utility of unmanned aerial vehicles for mapping invasive plant species: a case study on yellow flag iris (*Iris pseudacorus* L.)

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# Invasive plants impact everyone

- Invasive species cost \$30 billion per year



- Invasive plants cost Canadians \$2.2 billion



# Invasive plants in aquatic ecosystems are under reported

Challenges associated with detecting and mapping aquatic invasive species

- Traditional survey methods (on-foot and boating) can be time consuming and face accessibility issues
- Remote sensing techniques lack the required resolution



# Can an off the shelf UAV imaging system be used for invasive weed mapping

- DJI Phantom 3 Professional
  - 12.4 MP visible light camera
  - Georeferenced, high resolution imagery
  - Inexpensive (~\$2500 at time of study)
  - Portable
  - Easy to fly
  - Reliable



# Yellow flag iris

- Native to Europe, Western Asia and North Africa
- Readily invades new areas via seeds and rhizome fragments
- Typically invades wetland ecosystems that surround lakes
- Can occur in monocultures or in mixed stands with cattail



# Detection and mapping of yellow flag iris

- Two study areas within the central interior of BC
- Little White Lake
  - 5.67 km<sup>2</sup>
  - Wide shoreline
  - Unobstructed by tree canopy – ideal for UAV imagery
- Dutch Lake
  - 3.9 km<sup>2</sup>
  - Narrow shoreline
  - Obstructed forest canopy – difficult for UAV image collection



# Pix4D was used for mapping lake shore and generating the 2-D orthomosaic

- Little White Lake
  - camera angle =  $90^\circ$
  - Flying time = 5 h
  - Traditional field survey = 10 h
- Dutch lake
  - camera angle =  $45^\circ$  facing the shore (to look under tree canopy)
  - Flying time = 5 h
  - Traditional field survey = 6 h



# Little White Lake

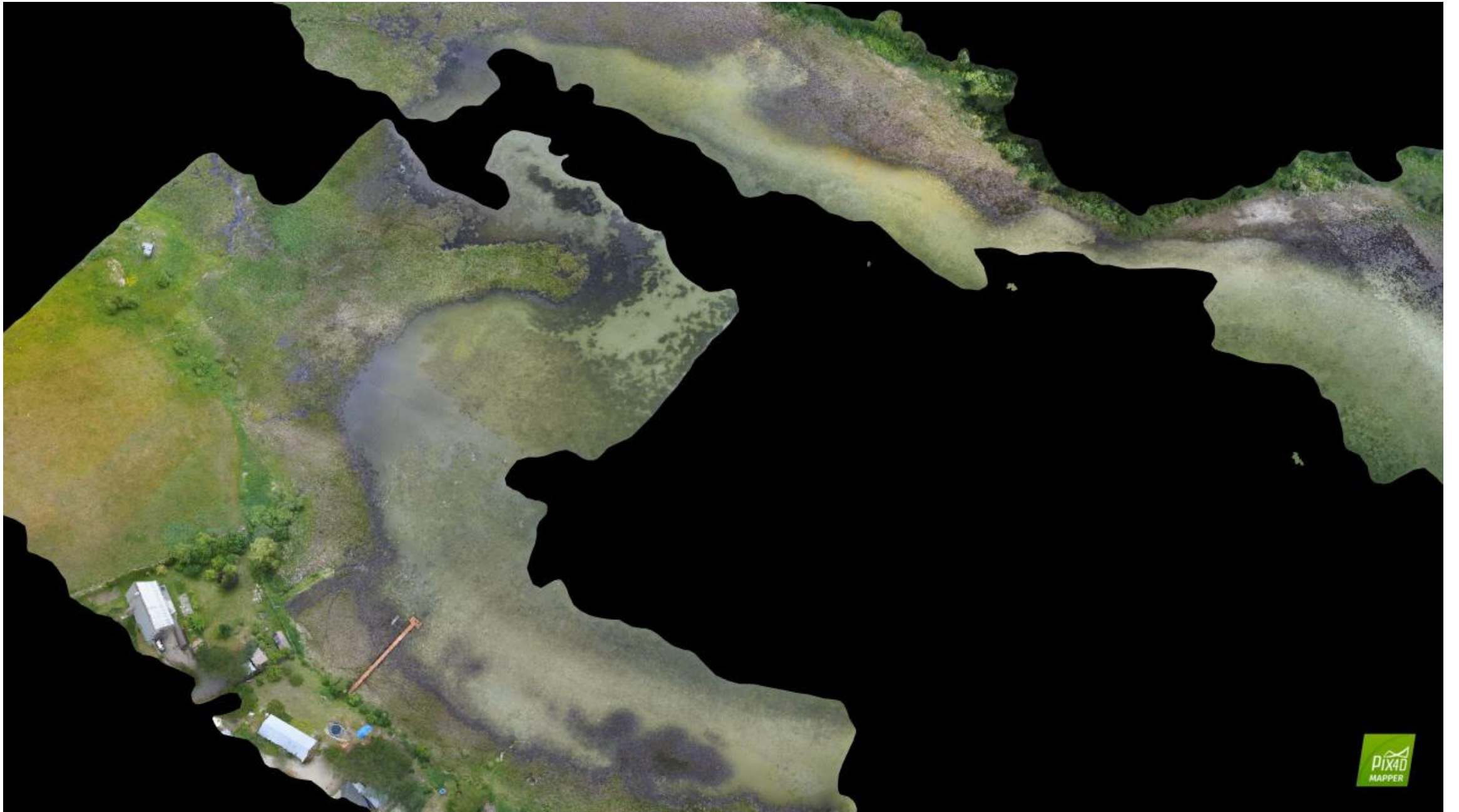




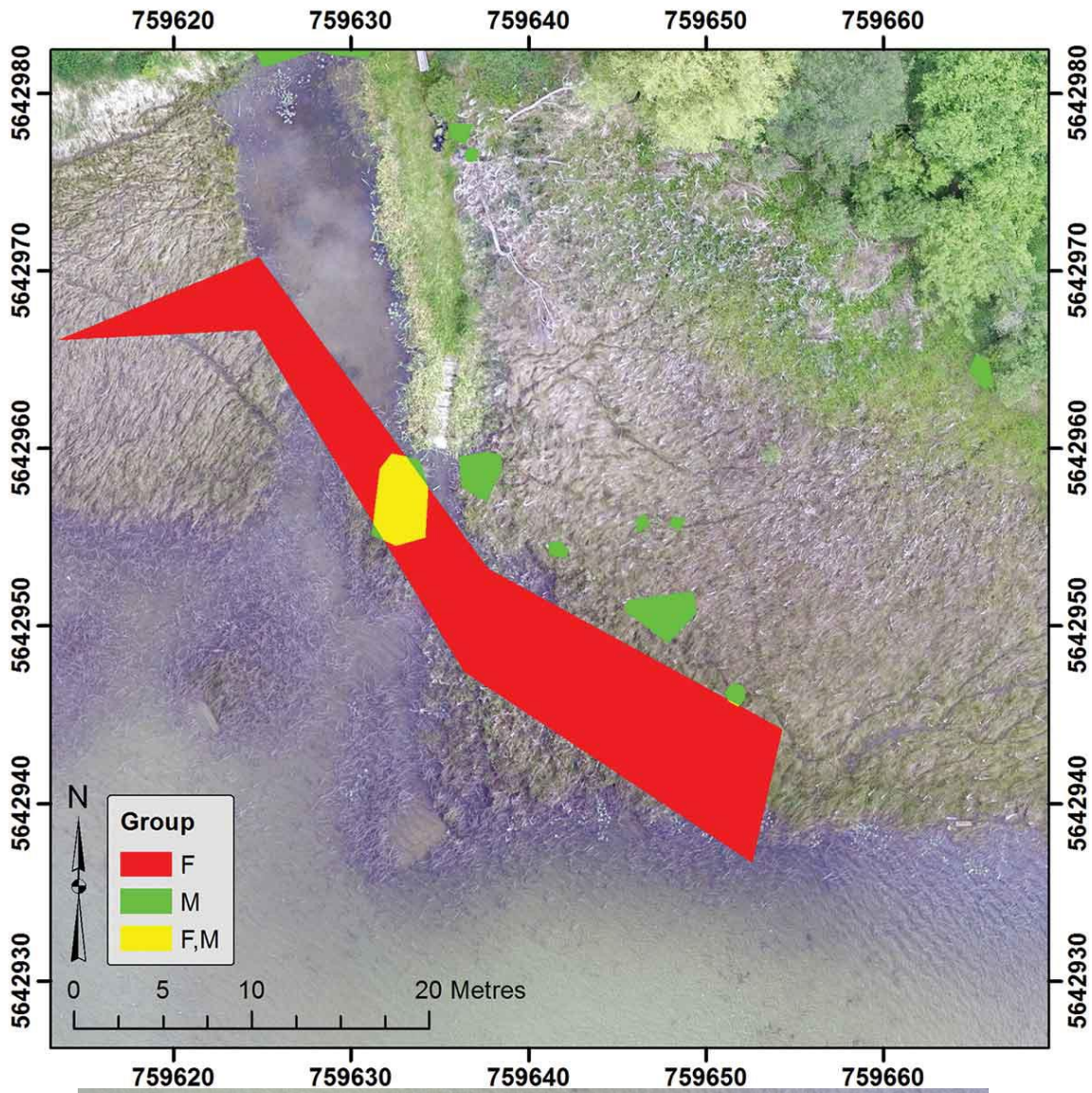




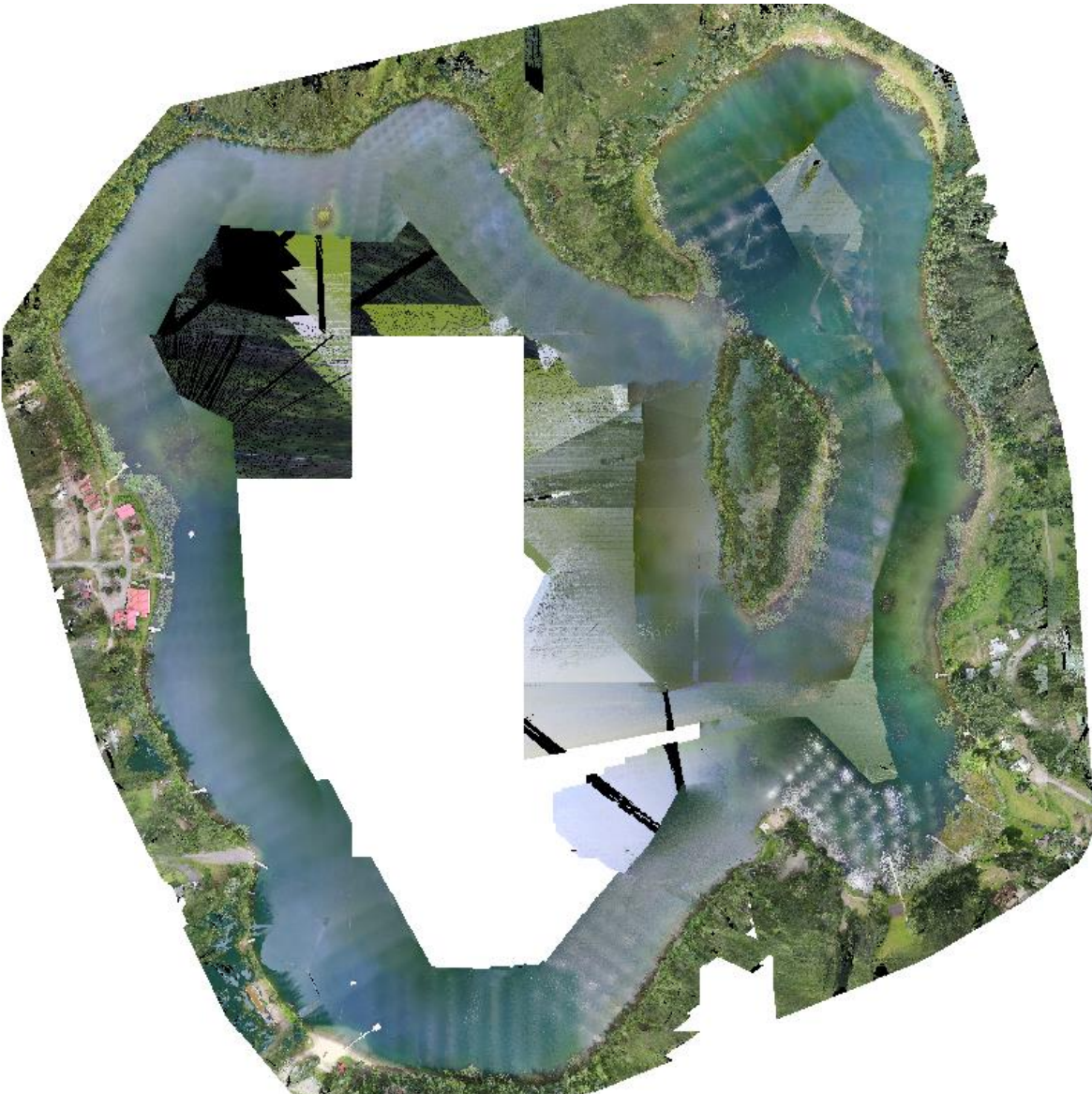








# Dutch Lake



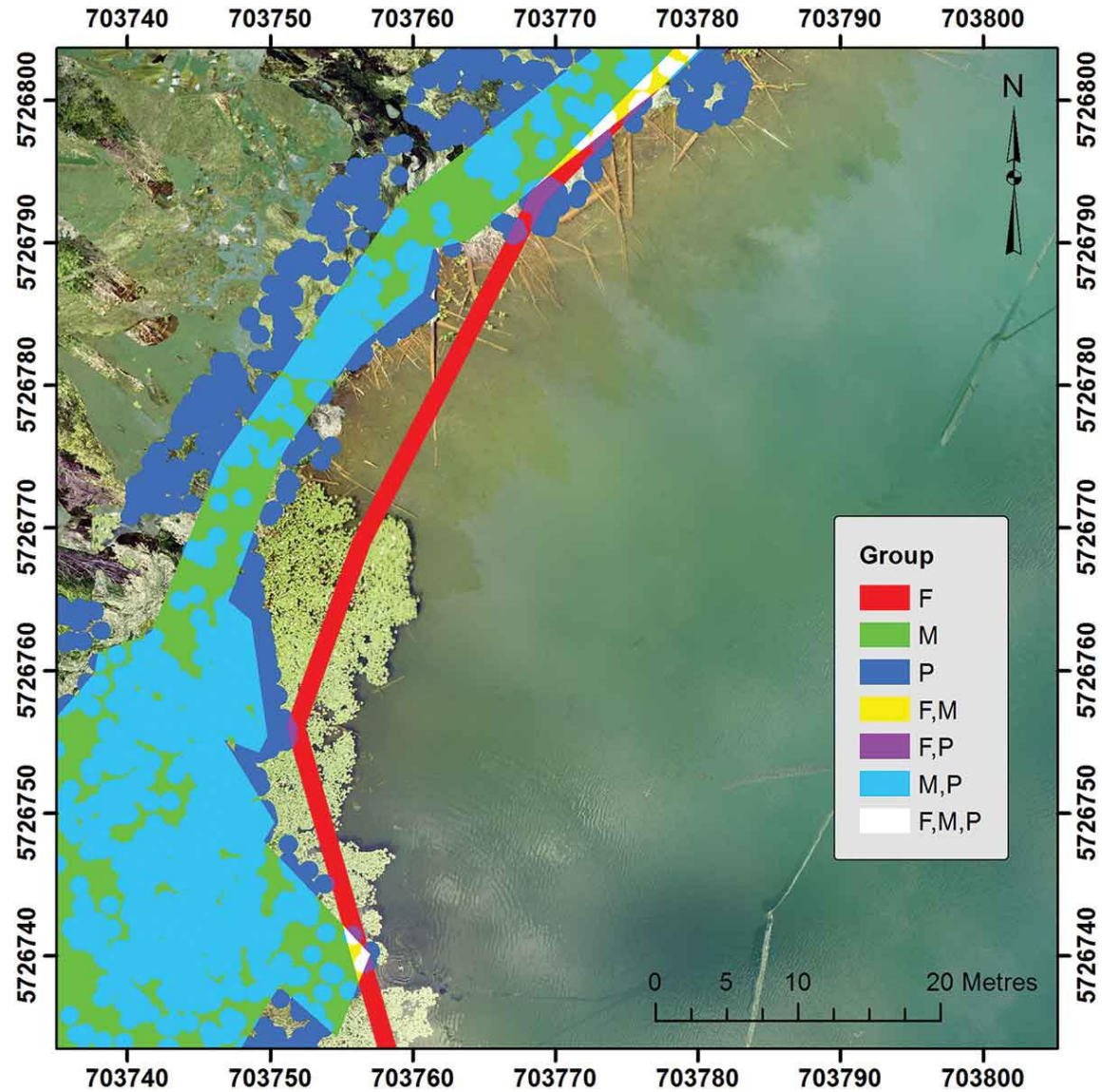
# Dutch Lake







# Comparison of yellow flag iris mapping methods



# Comparison of yellow flag iris mapping methods

	Dutch Lake			Little White Lake	
Method of Detection	Field Survey	UAV mapping - manual image interpretation	UAV mapping - automated image interpretation	Field Survey	UAV mapping - manual image interpretation
Person-hours	6	18	18	10	10
Total Area of YFI (m <sup>2</sup> )	4573	8494	16319	592	344
Estimation	64%	100%	192%	168%	100%
Benefits	<ul style="list-style-type: none"> <li>• Low man hours</li> </ul>	<ul style="list-style-type: none"> <li>• Most accurate</li> <li>• Lower pesticide/ treatment costs</li> <li>• High definition orthophoto</li> <li>• No safety risks</li> </ul>			

# An off-the-shelf UAV would be a useful tool for environmental managers

- High-resolution map of the invasive species
- Greater accuracy in certain situations
  - Invasive plant needs to be distinguishable from the native vegetation
  - Weather dependent
- Reduced safety concerns and ecosystem damage
- Can be used to improve calculations for herbicide or other treatment

# Future Work



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