Needle in a haystack

Finding hawkweed using remote detection

NSW
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Hawkweed Partners

Hawkweed biology

Orange hawkweed

- *Asteraceae* (Daisy) family, native to Eurasia
- Perennial herbs, grows by seed & stolon
- Allelopathic.
- Forms dense mats, excluding other vegetation
- Peak flowering - between (Dec-Jan) 6-8 weeks
- Seed viable for ~5 years (OHW) and ~2 years (MEH)

In NSW:
Orange hawkweed (*Pilosella aurantiaca*)
Mouse-ear hawkweed *(Pilosella officinarum)*

Prohibited Matter under the
NSW Biosecurity Act 2015

Mouse-ear hawkweed

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Hawkweed – Global and National impact

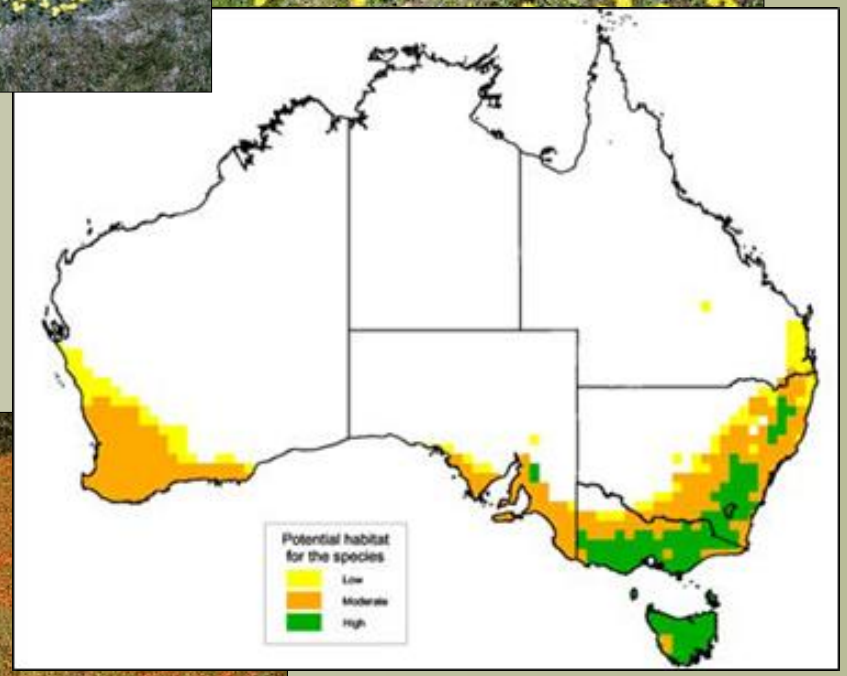
Major weeds in USA, Canada, Japan, Patagonia and New Zealand

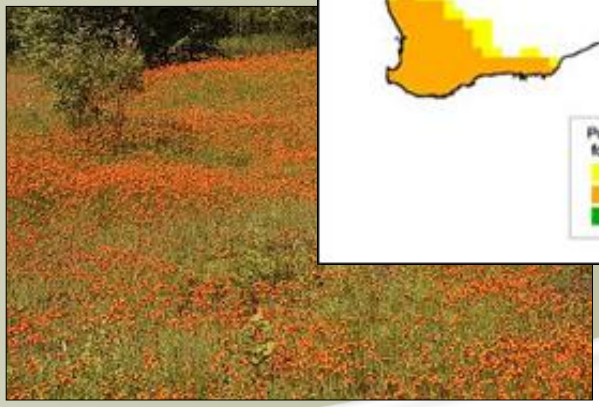
(NZ – 6 million ha infested)

Threatens **biodiversity** and **agricultural productivity**

27 million ha at risk south-east Aust,
potential loss of <u>$68 million p.a*.</u>

<u>Eradication</u> the most cost-effective response





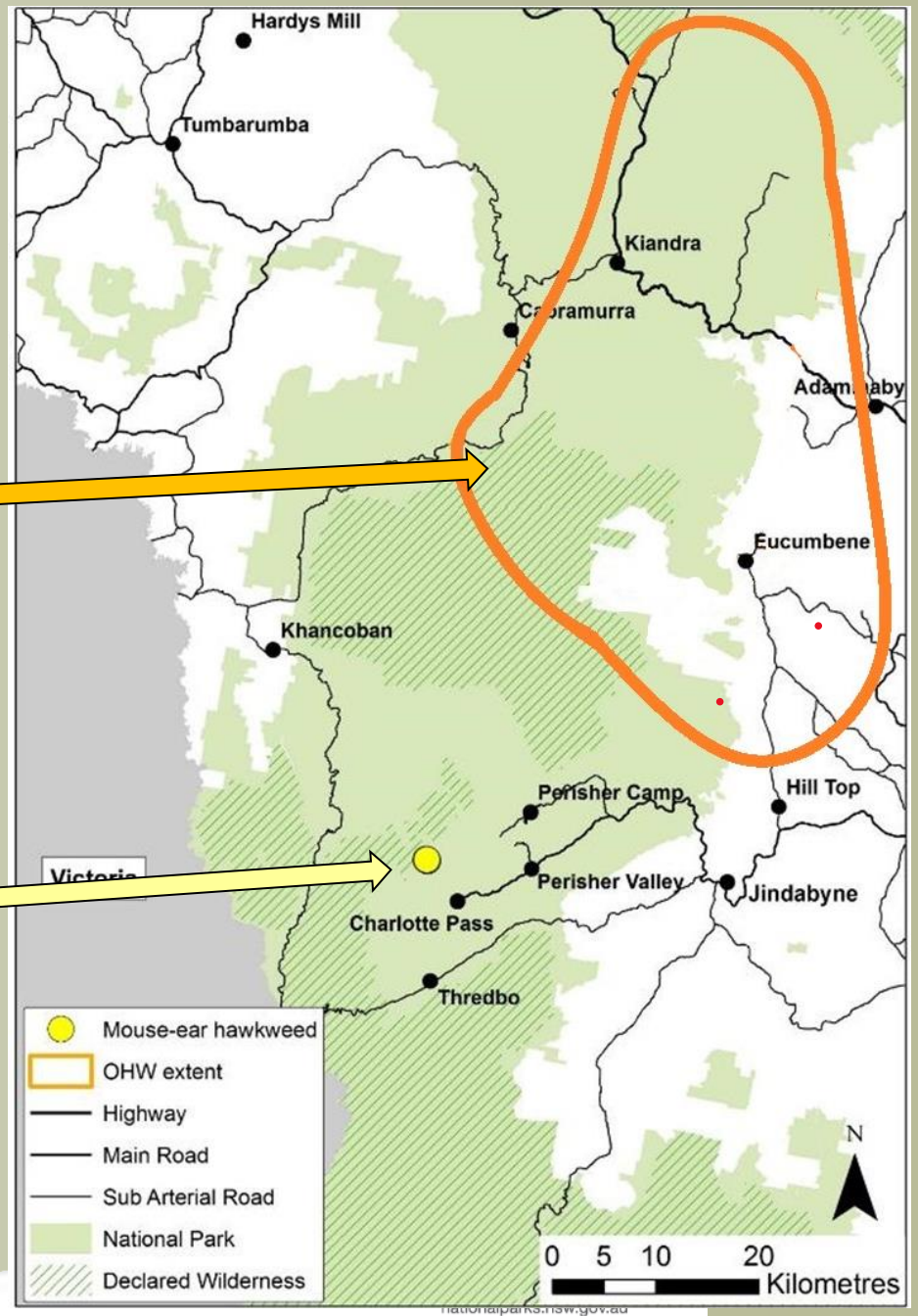
Hawkweed – NSW

Orange hawkweed

- Sub-alpine regions of Kosciuszko NP and adjoining land to the east
- Garden escapee (sold up to 2005)
- First recorded naturalised in 2003
- Total area 20/21: **20m²**

Mouse-ear hawkweed

- Alpine region of Kosciuszko NP
- Discovered December 2014
- Two infestations near Blue Lake
- Total area 20/21: **0.5m²**



NPWS eradication program

Key operational objectives

- delimit the infestation
- halt reproduction and control all plants
- completely exhaust the seedbank

Surveillance strategies

- Unmanned aerial vehicles (drones)
- Imagery & other remote sensing
- Volunteer/staff ground surveys
- Helicopter assisted surveys in remote areas
- Weed eradication detection dogs

To eradicate, every plant must be found

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The task at hand

Finding the 'needle'

- OHW rosettes 5-20 cm diameter, flowers <2 cm → small target
- High resolution imagery required ↑ need for detection automation
- 12 years into eradication and it's now rare in the landscape
- Large extent → pressure for efficiencies, huge data generated
- Remote and rugged and need helicopters to access
- Eradication - accuracy paramount

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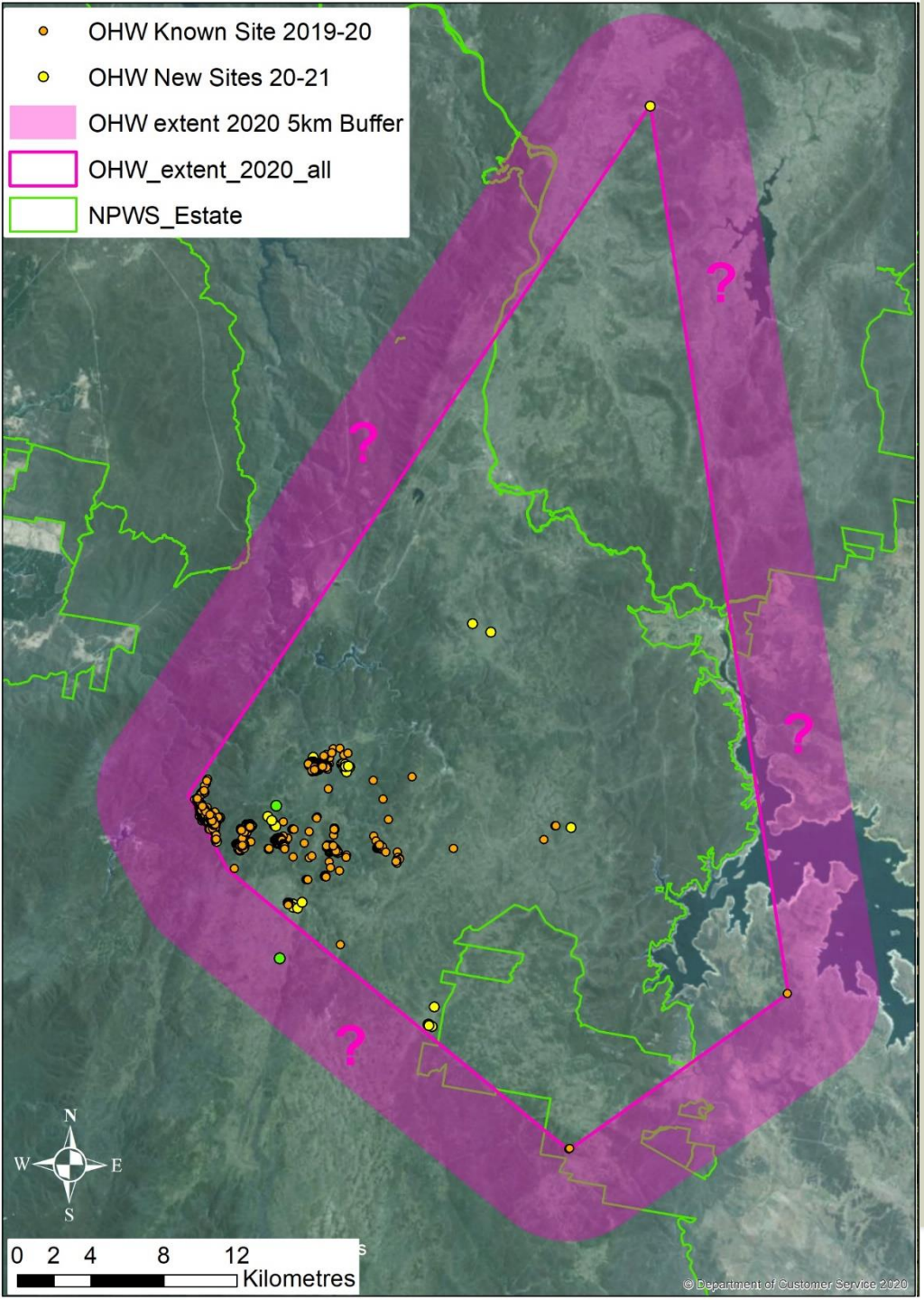

Delimitation

What does it mean?

- Finding the outer edges of the entire infestation
- Determining boundary through modelling
  - Habitat suitability (UNE)
  - Wind dispersal (UNE; weather stations)
  - Disturbance and human impact

The impact of the 2020 bushfire

- The fire has likely burned the existing seed bed
- Hawkweed thrived post-fire – no competition (UoW)
- Nutrients from the ash have stimulated regrowth
- The bushfire has allowed for us 'see through' the canopy – huge advantage for drone surveillance

Same location, same hawkweed

North

Orange Hawkweed Drone Surveillance

Image credit: Heli Surveys 2021

NSW

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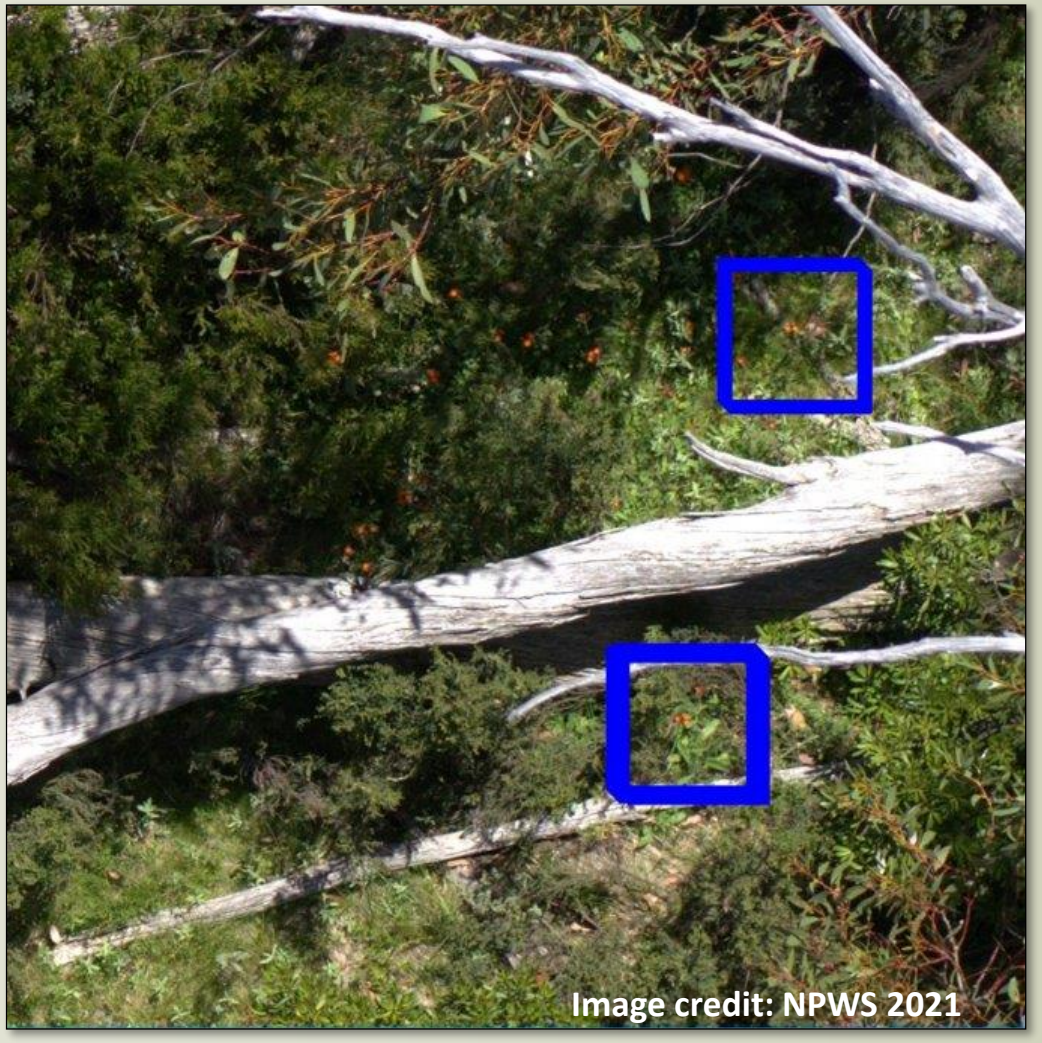
Why remote detection?



Advantages

- Delimitation – large extent, remote and rugged
- Drones – large areas at low cost
- Capable of surveying more than 50 hectares a day
- OHW flower algorithm automates detection process

Challenges

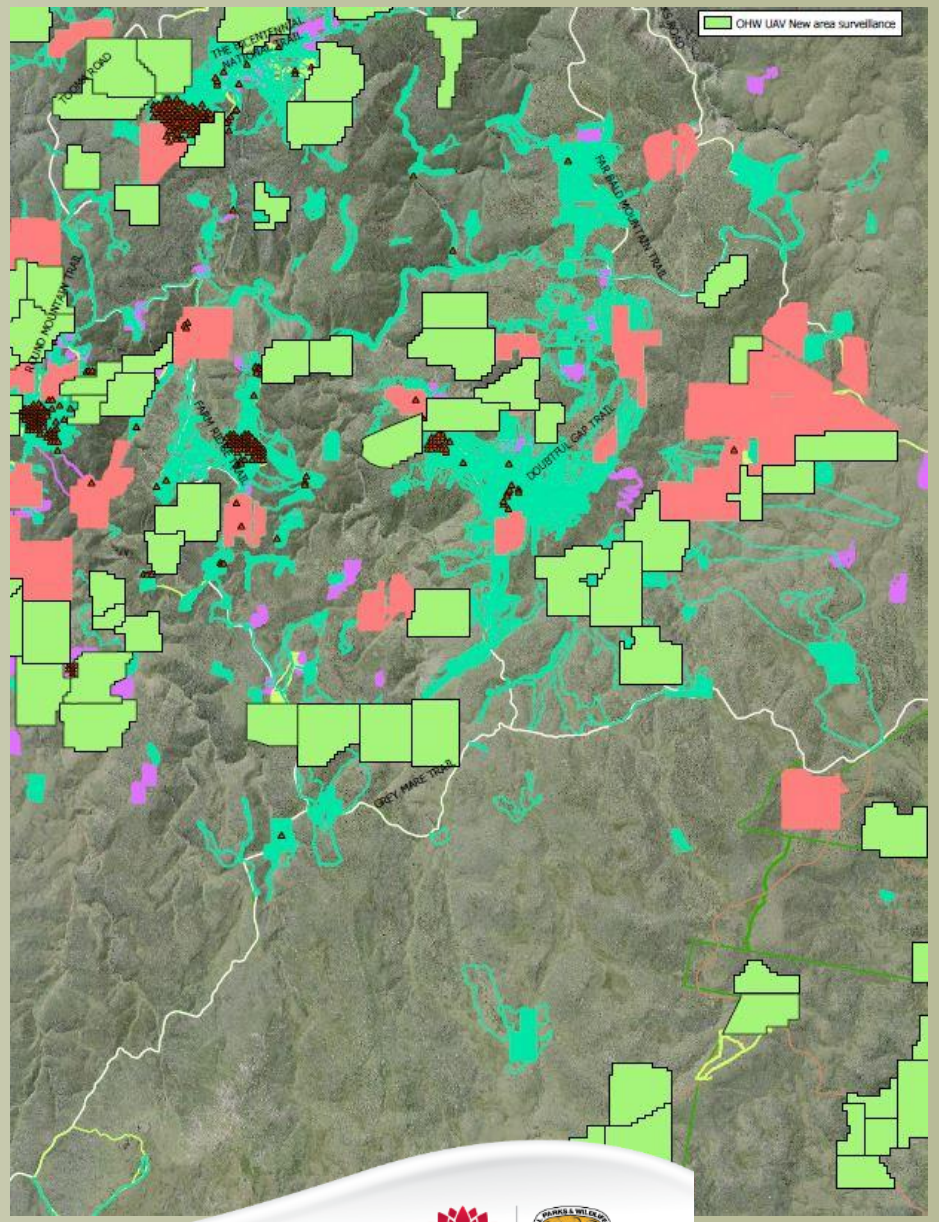
- Generates large amounts of data
- Data interpretation and processing
- Limited flowering window

UAV Site selection

- High priority survey areas:
  - ➢ dispersal/habitat suitability model
  - ➢ drone ‘suitable’

⇩

- Topography, line of sight, tall vegetation
- Vehicle based
- Helicopter assisted



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Drone Operations

- DJI Matrice 600 & a Sony Alpha r7 DSLR
- RGB images at 2.4mm GSD – very high-resolution photography
- Automated flights at 30m AGL based on 2m LiDAR DEM
- Flight speed 6 meters per second
- Visual line of sight maintained (controller modifications to allow further flight distance)
- Drone season starts December

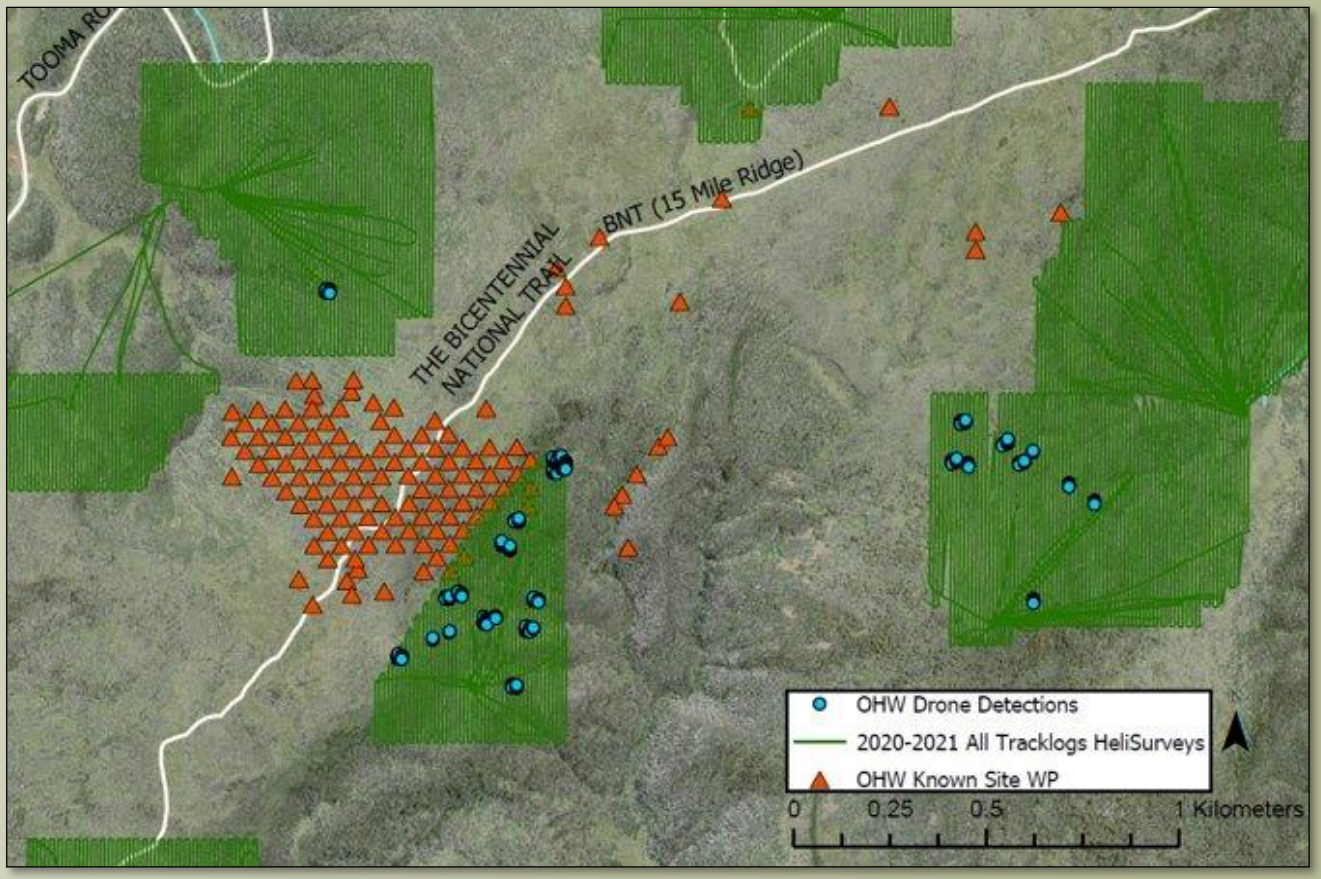
Data Processing

- 1. Data transfer and storage (TB's of images)
- 2. Algorithm processing
- 3. Algorithm detection cull (false positives)
- 4. Image georeferencing
- 5. Ground truth detections

Surveillance efforts

This 20/21 Hawkweed season:

- Heli Surveys covered 2242ha (2 drones/4 pilots/45 days flown)
- NPWS covered 237ha (2 drones/3 pilots/11 days flown)
- 20 confirmed detections and still counting
- 1 new area identified (Cesjacks, at Munyang Range)
- Effort:
  - Equal to ~ 410 staff days
  - Humans ~ $660/ha
  - Drones ~ $54/ha



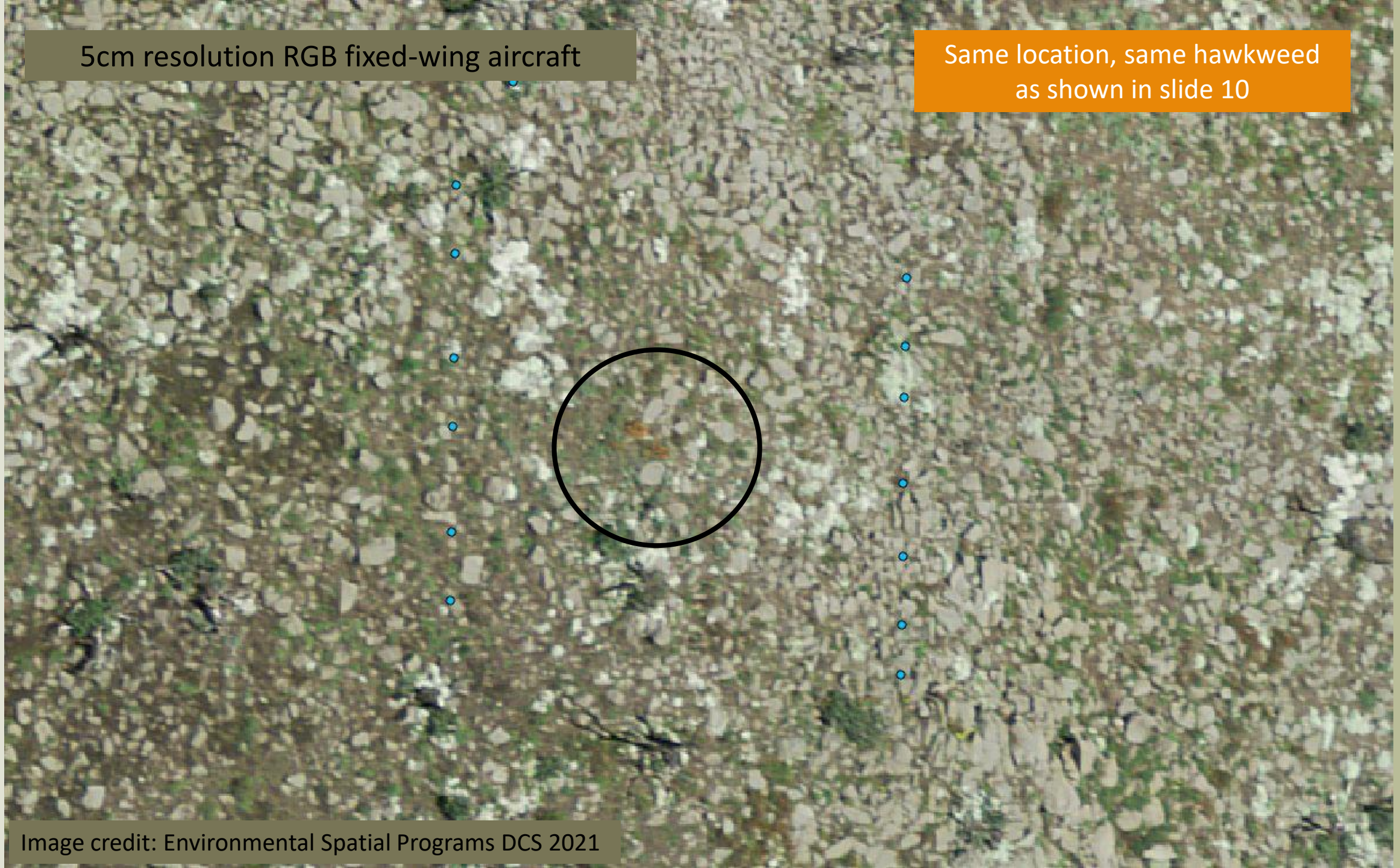
Future direction

- Need to cover larger areas more quickly
- Larger resolution to cover more area

Options under trial:

- Ms/RGB drone and/or aircraft/satellite (broadest scale)
- 5-6cm **aircraft** RGB capture (broad scale)
- 1cm **drone** (local) **and 2cm heli** RGB (@ scale)
- 1cm **drone** (local) **and 1cm heli** RGB
- 2.4mm drone (site) current technique

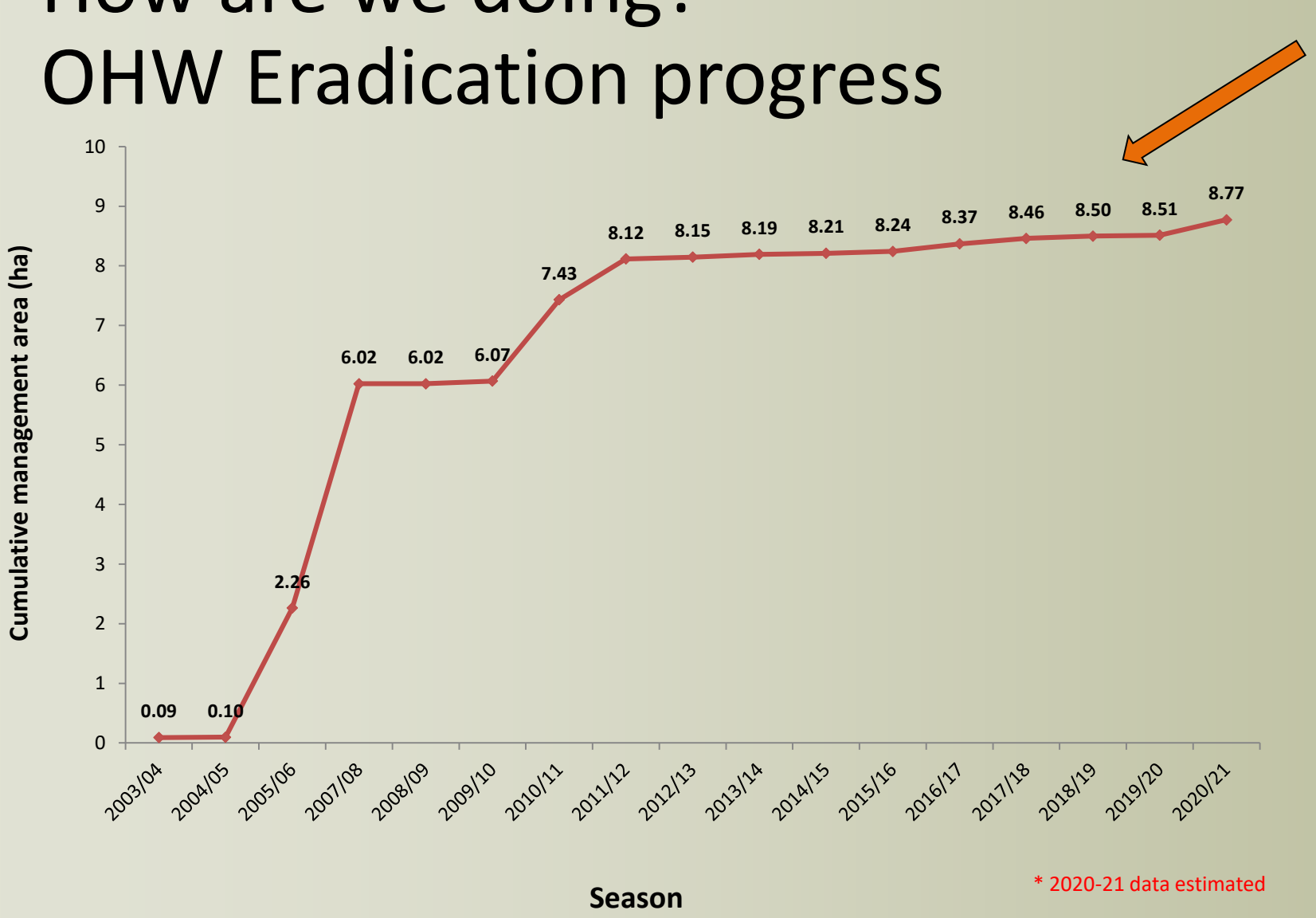
Example pixel sizes relative to detection target


5cm resolution RGB fixed-wing aircraft
Same location, same hawkweed as shown in slide 10
Image credit: Environmental Spatial Programs DCS 2021

Detection with multi-spectral imagery

- OHW flower algorithm limitation – short season and small target
- CSU grant funding for weed remote detection
- Multispectral –analysis underway to determine feasibility

How are we doing?
OHW Eradication progress



* 2020-21 data estimated

Cumulative area of orange hawkweed infestations

- Common indicator of delimitation
- Delimitation – plateau post 2011/12
- **Massive increase in survey** area (not shown)
- Spike in 2020-21 but **small in comparison** to earlier years

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Thank you

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www.environment.nsw.gov.au/pestsweeds/OrangeHawkweed.htm

www.environment.nsw.gov.au/pestsweeds/MouseEarHawkweed.htm