Automated Airborne Pest Monitoring - a novel technological approach to monitor *Drosophila suzukii*

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Automated Airborne Pest Monitoring
of *Drosophila suzukii* in Crops and Natural Habitats

AAPM: Automated Airborne Pest Monitoring

Drosophila suzukii:
- Fruit fly Spotted Wing Drosophila SWD
- Males are detectable by their two black spots on the wings
- Spreading in Europe since 2008 (first report in Spain)
- Attacks (pre-) ripe soft berries, cherry, grapes, plums…
- Monitoring conducted with liquid-baited cup-style traps

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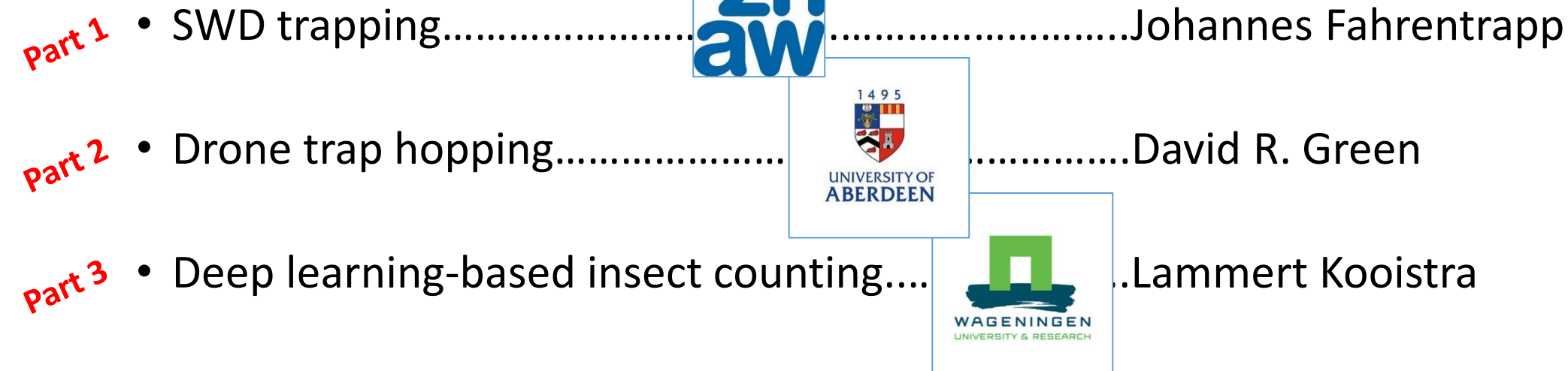# Aim: Autonomous drone trap hopping, target insect counting, advice to producers
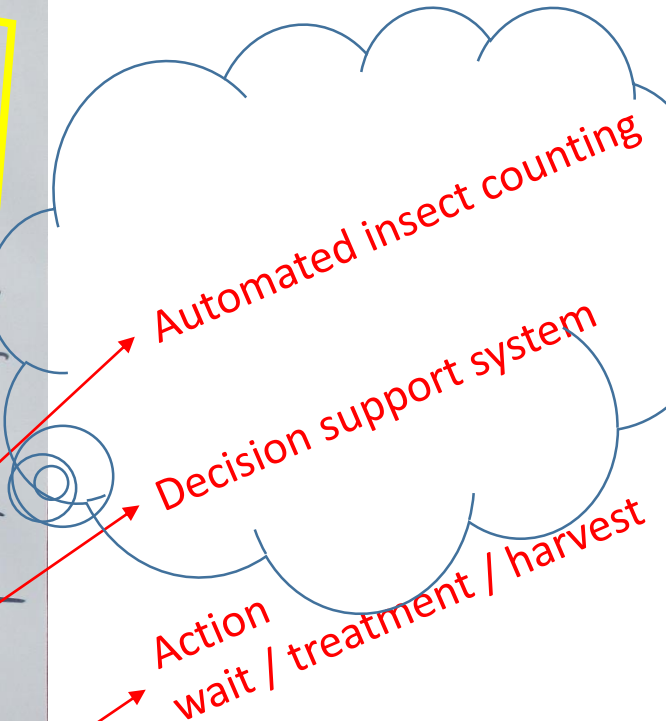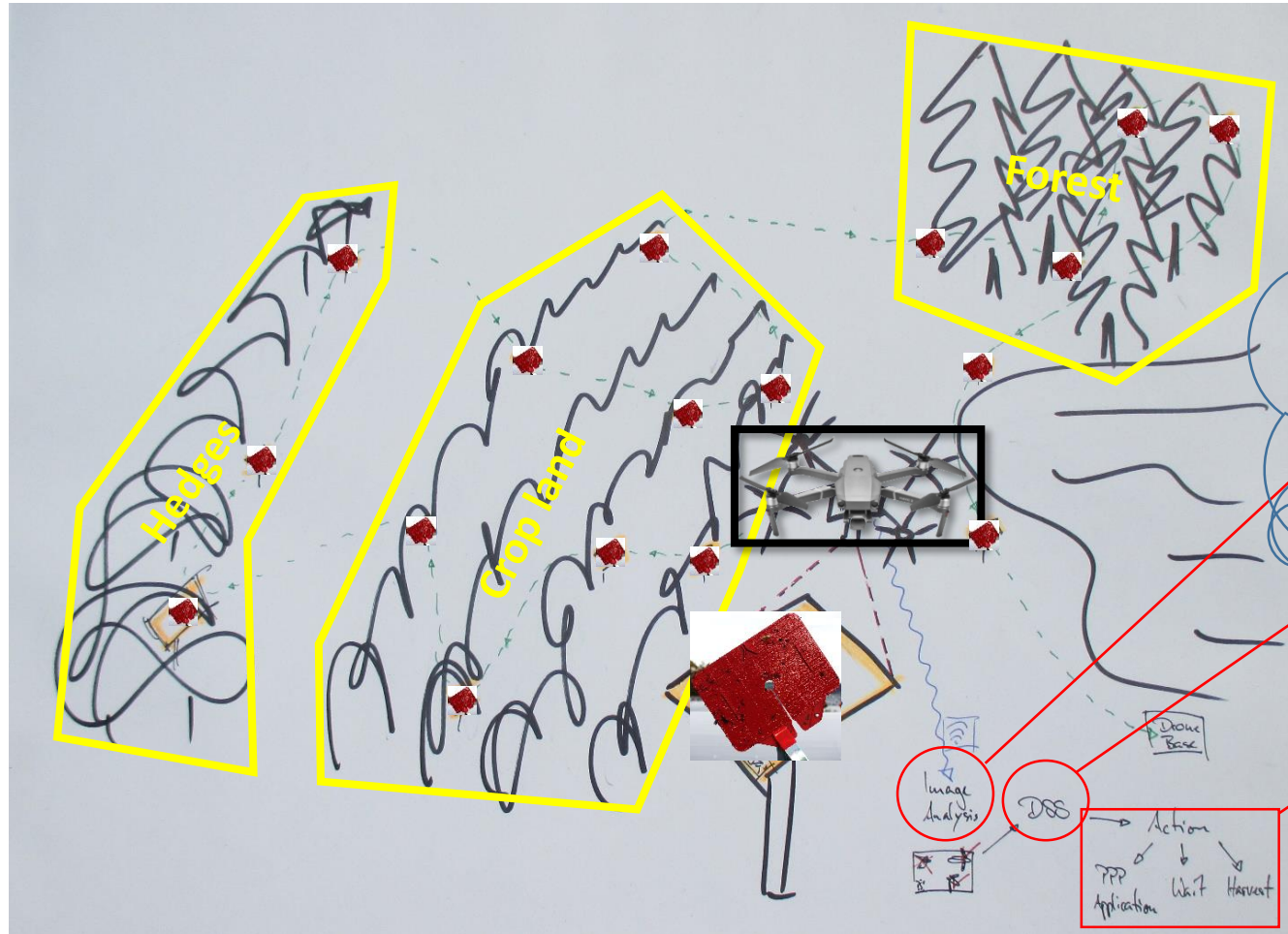
- ...for population monitoring
- ...in agricultural and natural environments
- ...to deliver data for decision support systems
- ...to solve research question

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Project

- Three-year project: April 17 – March 21
- Three Partners
- Three major parts

Part 1
  - SWD trapping...Johannes Fahrentrapp

Part 2
  - Drone trap hopping...David R. Green

Part 3
  - Deep learning-based insect counting.....................Lammert Kooistra

Target insect trapping (Field trials 2016)

• Required: Planar photographable traps

→ Sticky traps

	blue	orange	red
Traps	452	452	452
Sum	1612	1247	2943
Mean	4	3	7
SD	37	28	68

Red performed best, but poor efficiency when compared to cup traps.

Drone accessibility

- Mean: 4.2 SWD.. accessible

- Mean: 1.7 SWD.. not accessible

SWD walks the glue

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Several prototypes

Insect entrance holes

Window

Liquid bait

Lab trials: sticky trap vs. prototype

prototype
sticky trap

1h 2h 3h 4h 5h 6h 24h+

23.10.2019

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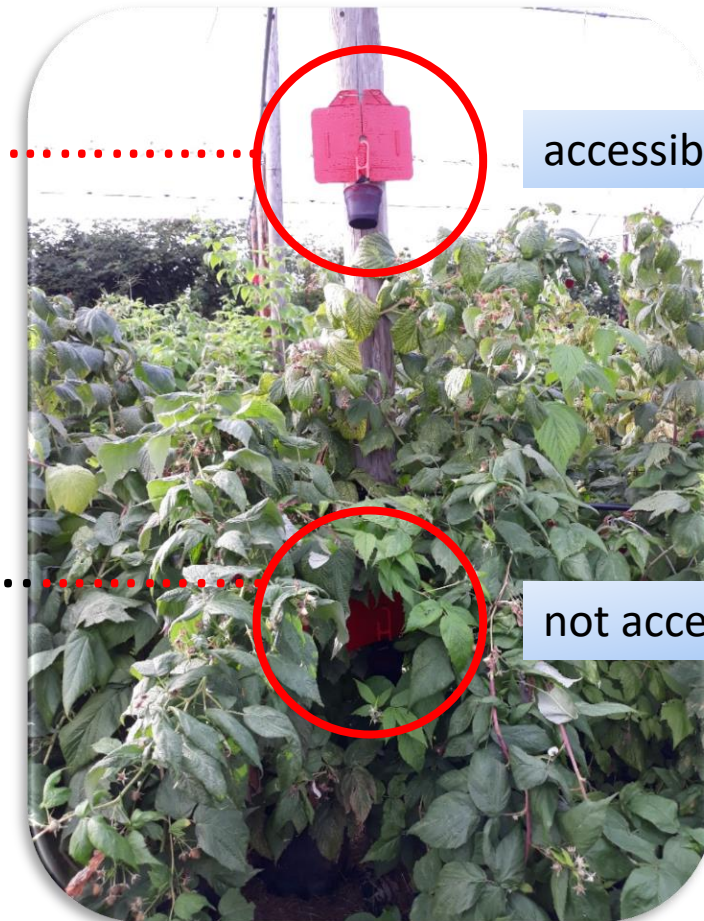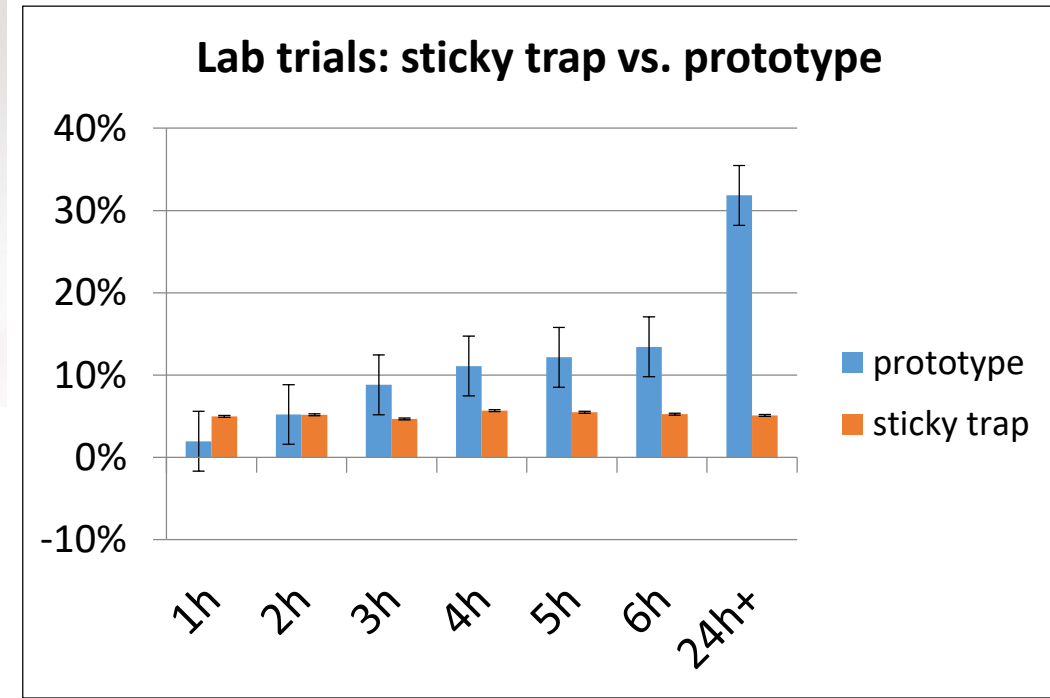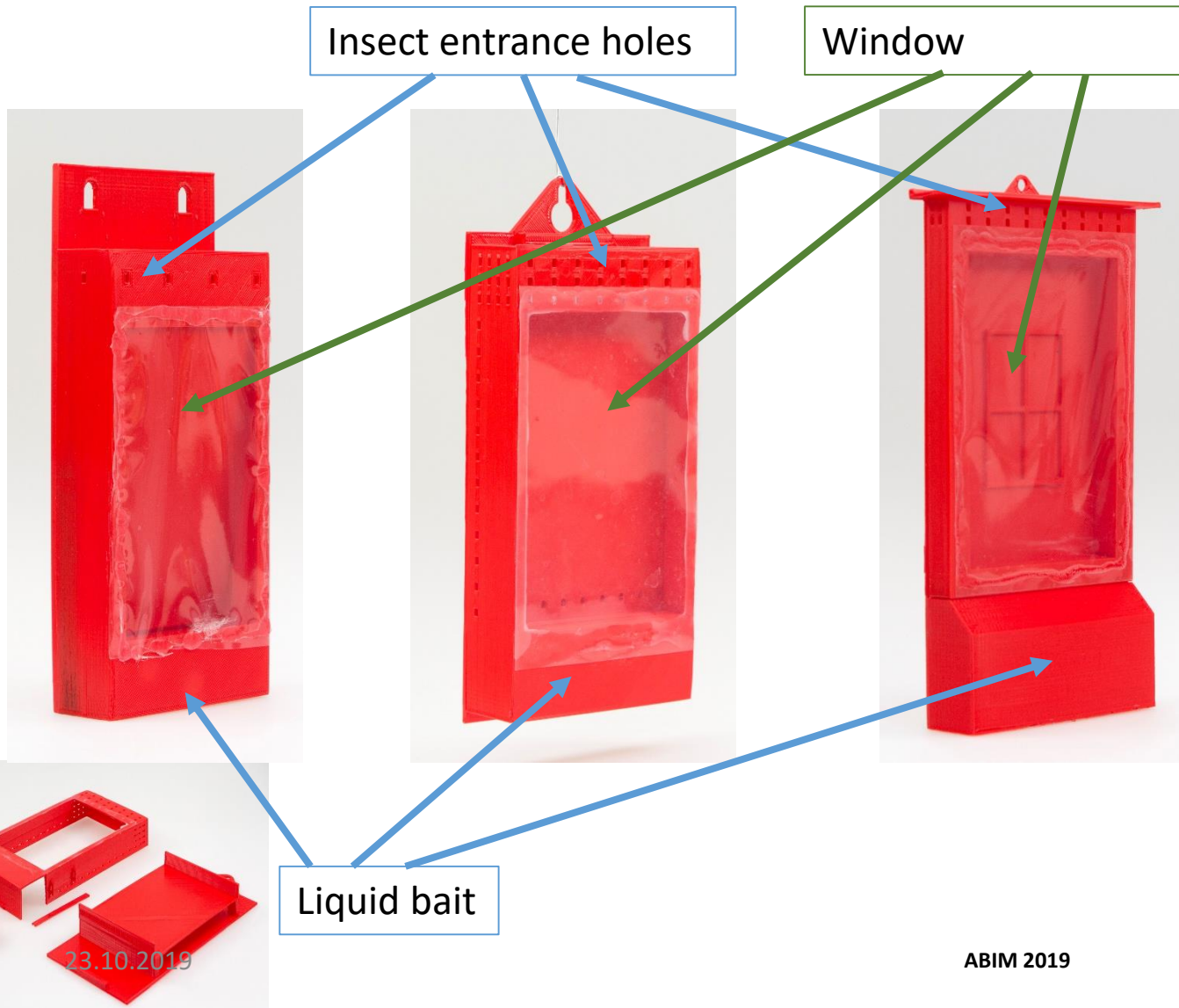
Field performance of prototype traps

Raspberry field

Vineyard
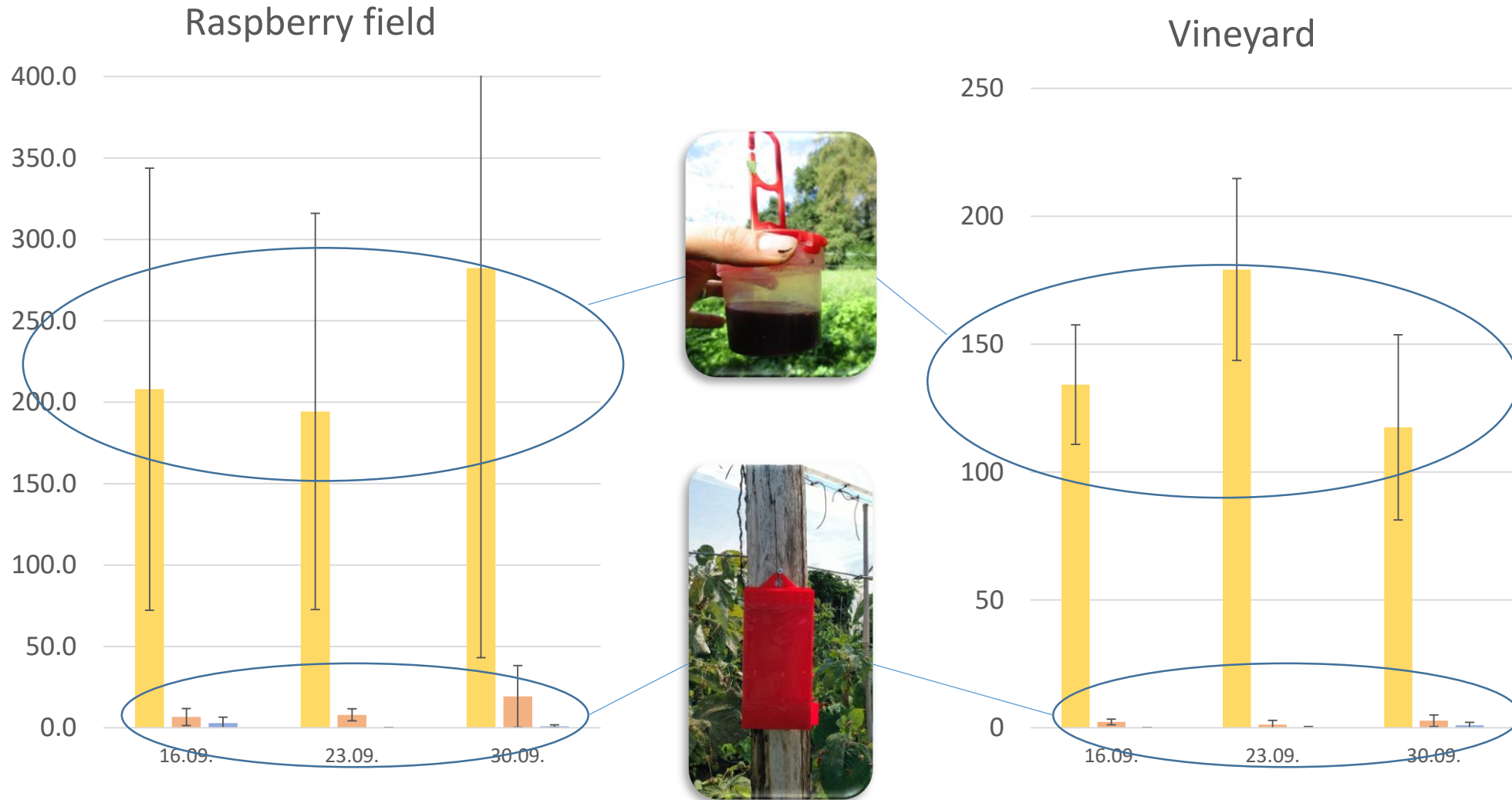
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Major requirements for high resolution imagery

- Traps are positioned vertically above canopy

- Camera to trap: 50-80cm

- Autonomous positioning of drone in front of trap

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UAV Flight tests

aim: <mark>off-the-shelf equipment</mark>

Flight tests with

- Inspire 1,
- Mavic 1
- Mavic 2 Pro,
- Mavic 2 zoom
- and
- RTK4X equipped with SonyRX100M4 20Mpixel

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UAVs

Practicality
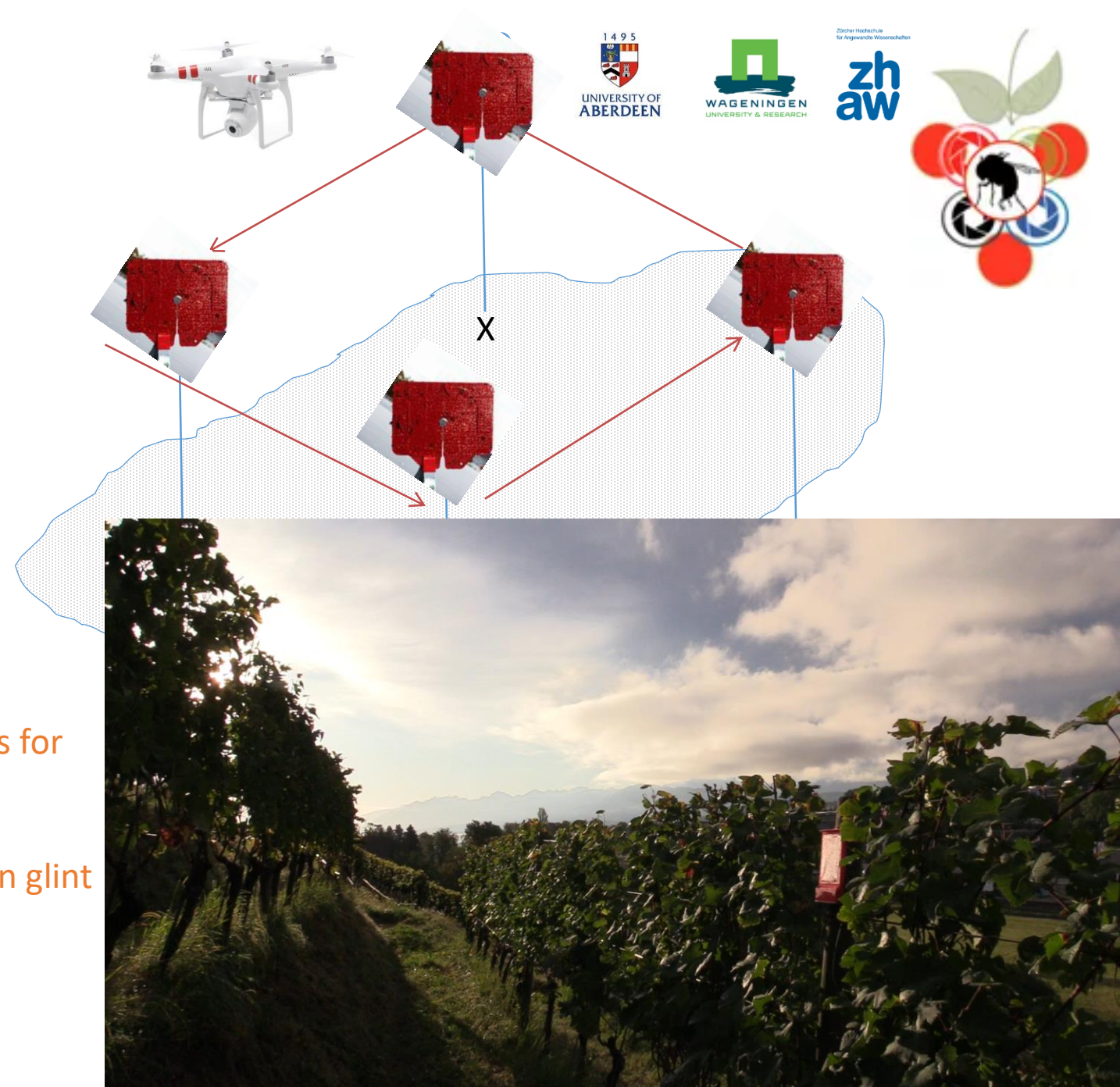
- Autonomous Flight is possible

- X and Y positioning is acceptable

X

X

X

X

Mavic 2 Pro

Approximately 4 inches difference
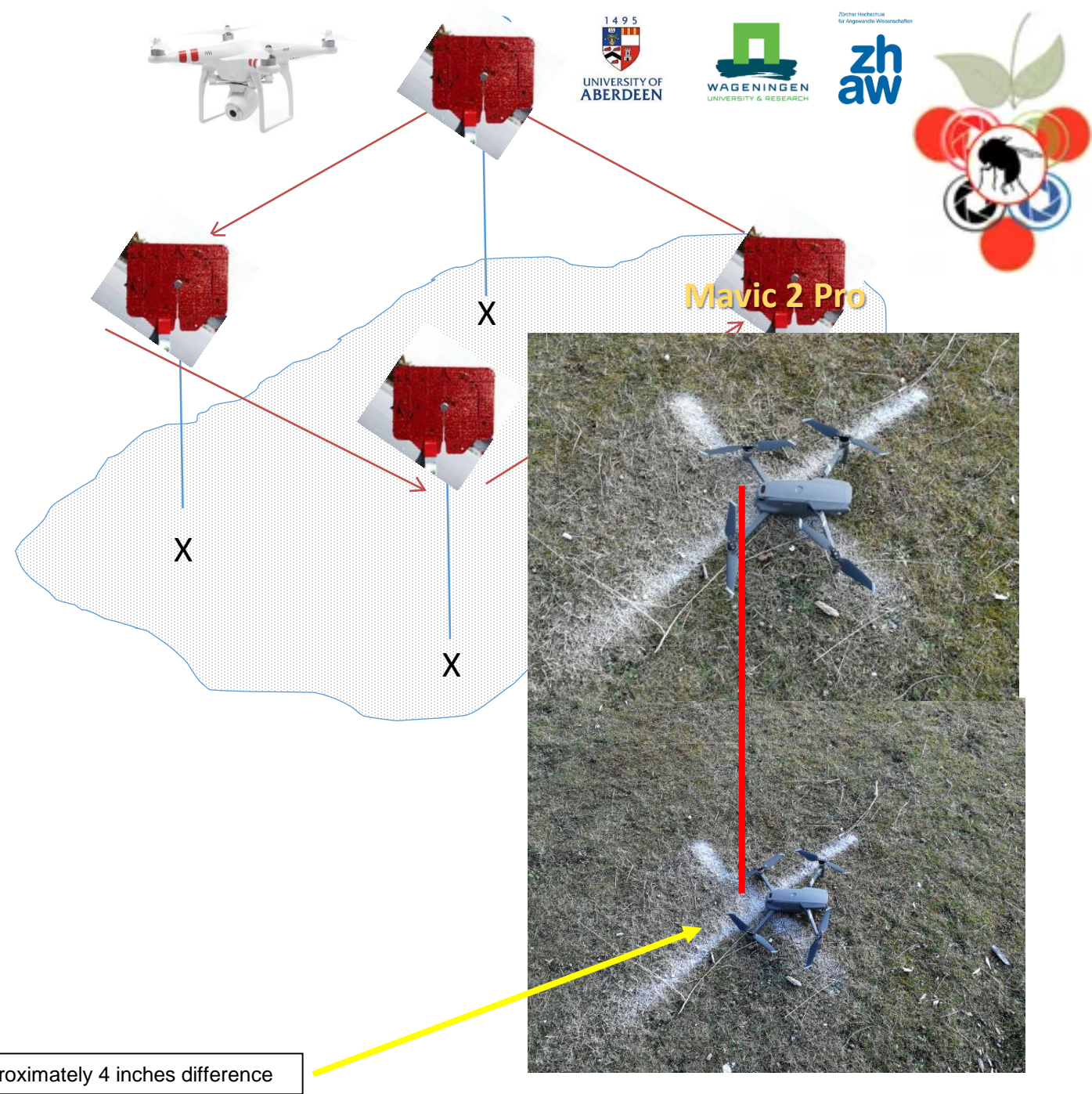
UAVs

Practicality

- Autonomous Flight is possible

- X and Y positioning is acceptable

Constraints

- Z positioning is more difficult

- Positioning of the camera – rotate, position, perpendicular

- Weather e.g. wind, overcast, sunny poses problems for photographic data

- acquisition: movement of fly trap (unless fixed), sun glint on shiny sticky surface, dull or sunny conditions

- Repeatability of Autonomous Flights

UAVs

Practicality
- Autonomous Flight is possible

- X and Y positioning is acceptable

Constraints
- Z positioning is more difficult

- Positioning of the camera – rotate, position, perpendicular

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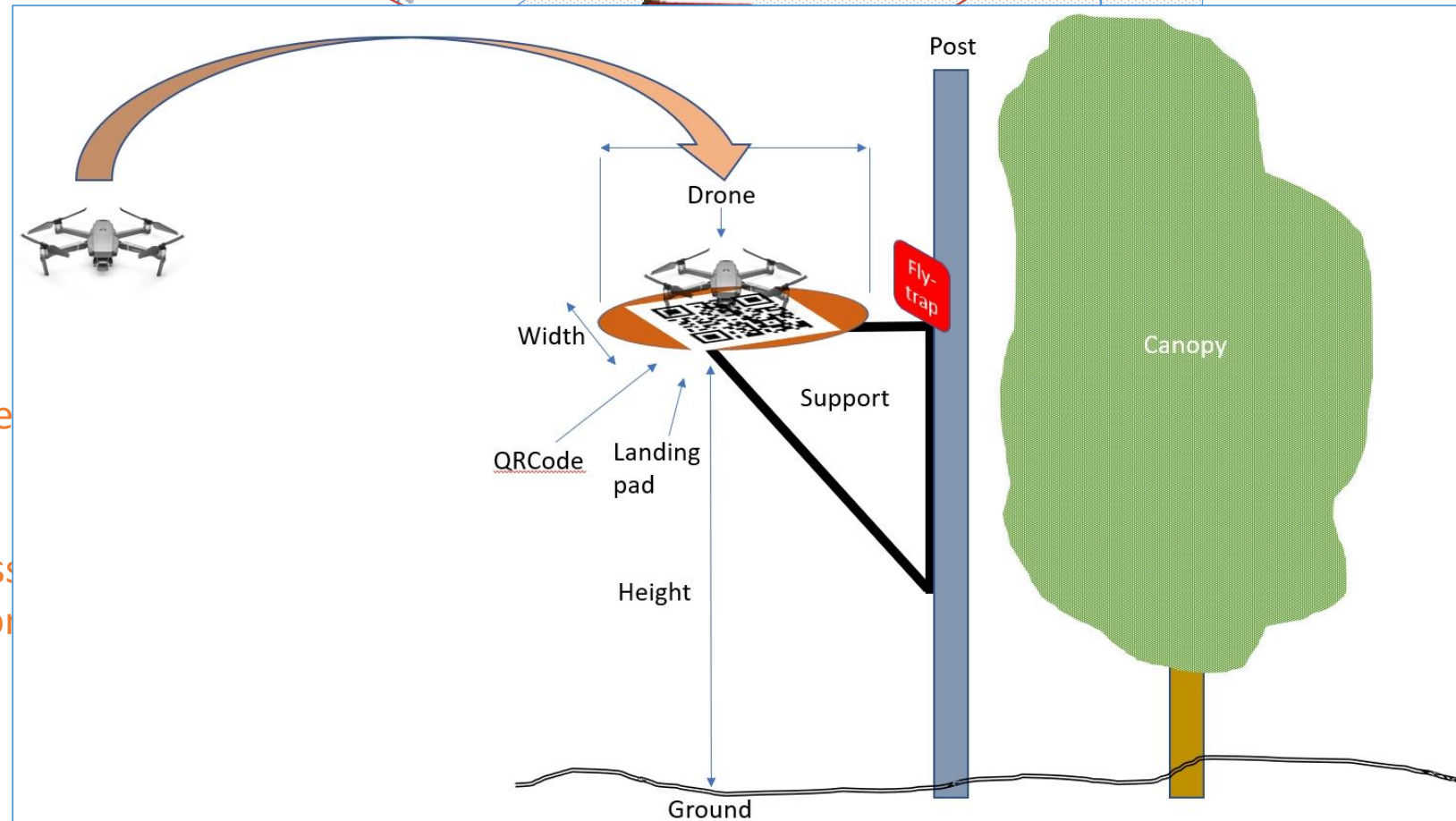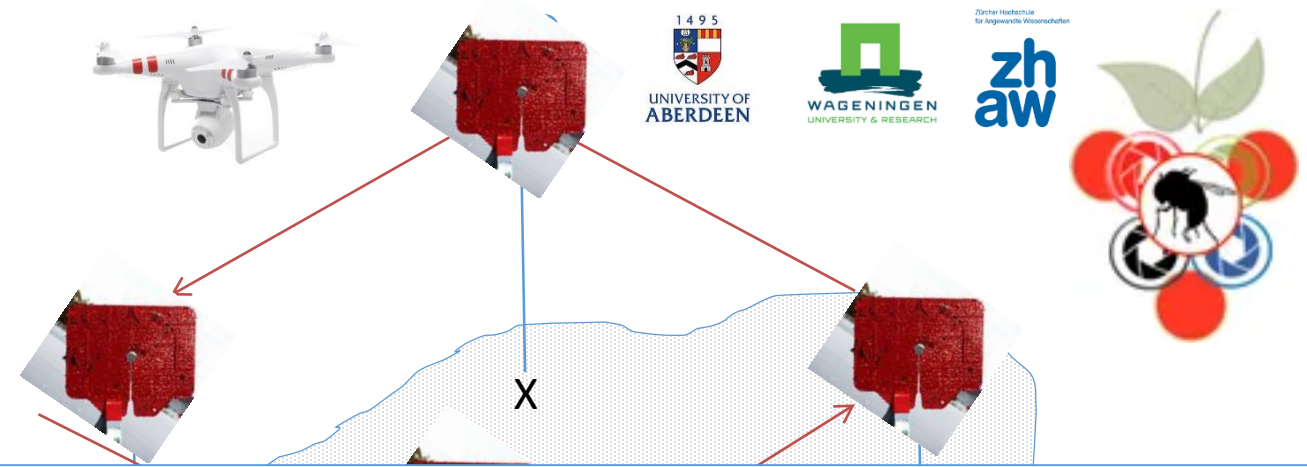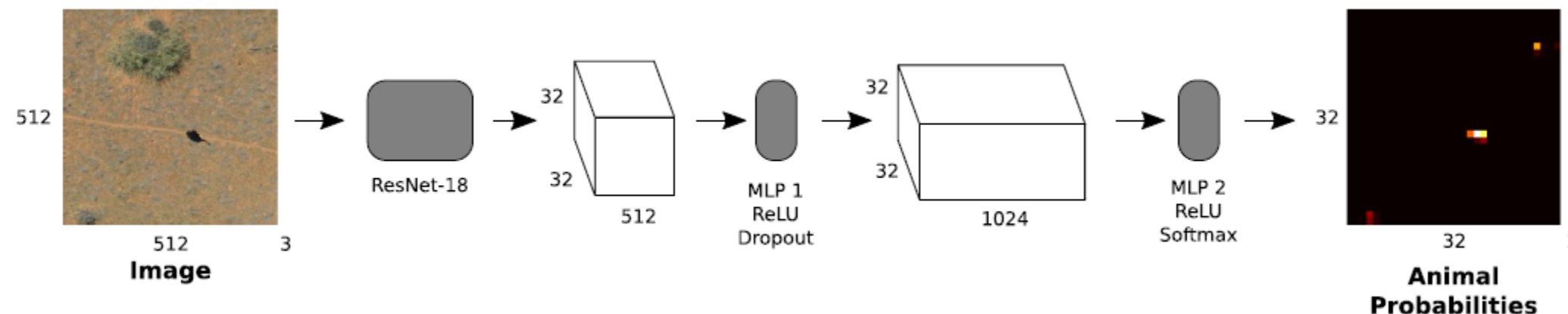
Training data

- 249 labelled images

- 4,753 DS labels
  - 2,396 male
  - 2,357 female

- 16,446 Bycatch labels
  - Different DS species
  - Different insects

- Images randomly split into:
  - 70% Training
  - 20% Validation
  - 10% Test

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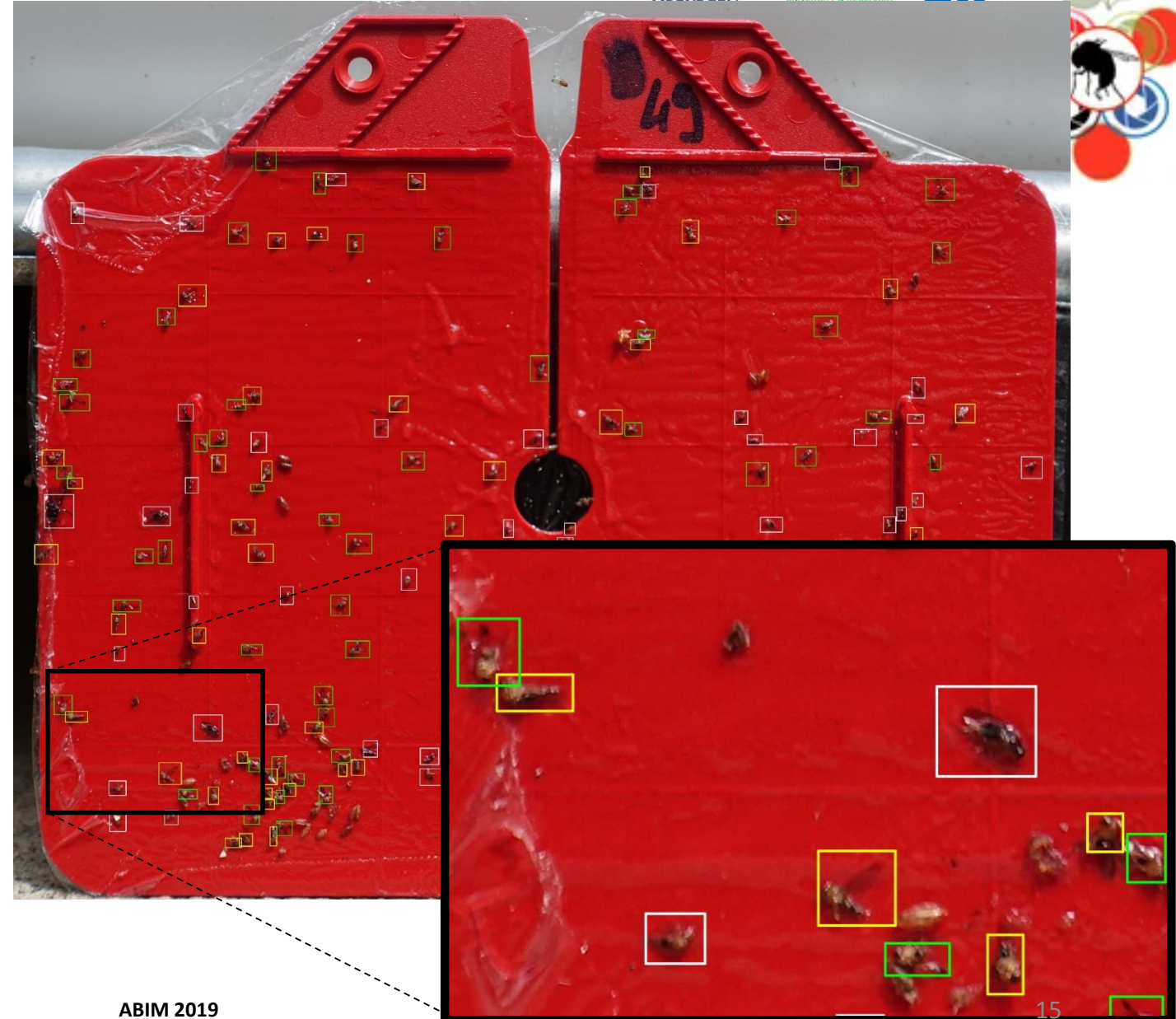
Model

- ResNet-18
  - Kellenberger et al. (2018): Counting animals in UAV images
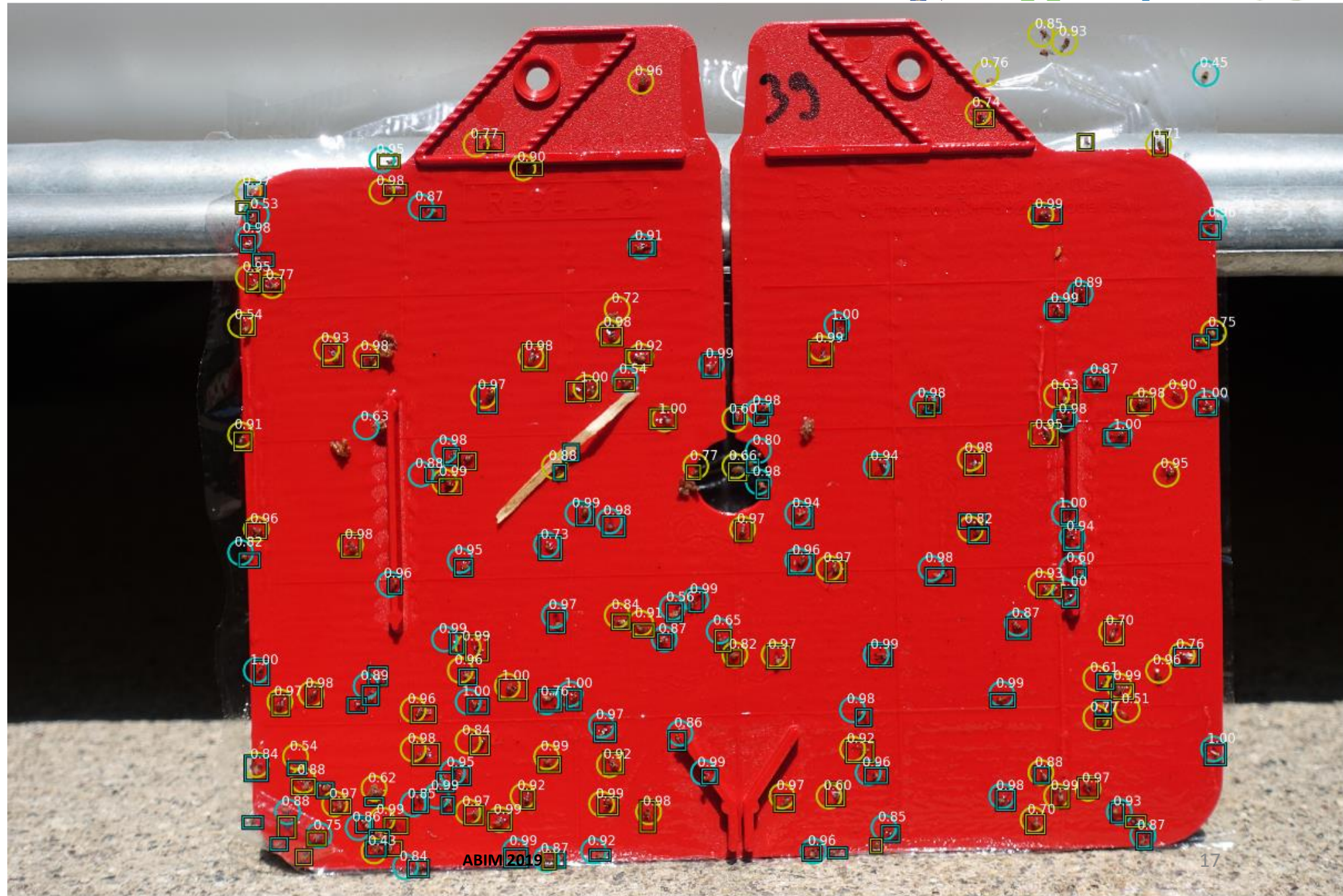 - Original model was trained to detect animals

- We trained it for detection of male and female *D. suzukii* flies
- Training was done on dedicated processing server for 4 days
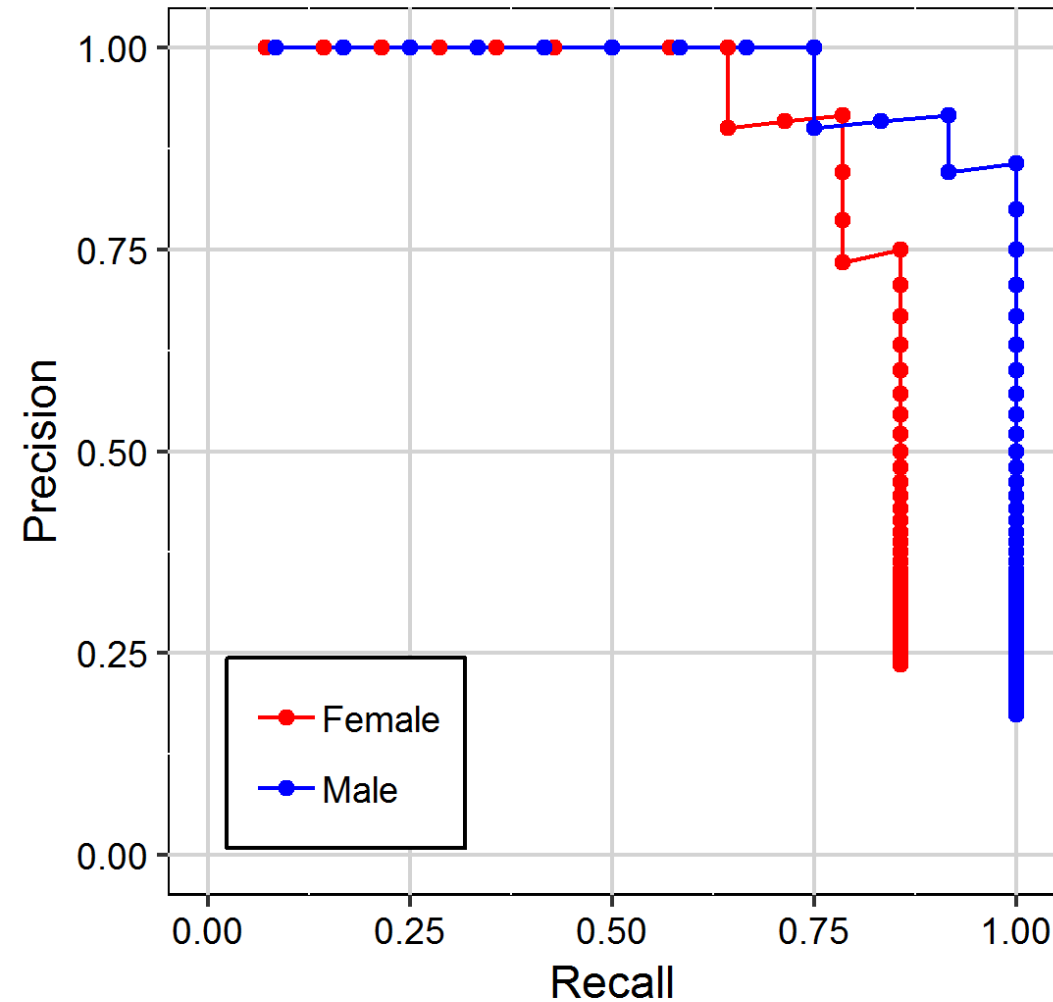
Results

Circles are predictions

Rectangles are labelled ground truth

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Results

- Average precision (AUC)
  - Female: 0.77
  - Male: 0.90

- Males were detected with higher precision

Conclusions

- Trap performance low under field → we'll improve the trap.

- Autonomous positioning in front of trap for image acquisition remains challenging – we'll develop a landing platform.

- Deep learning in combination with high resolution imagery has potential for small insect detection
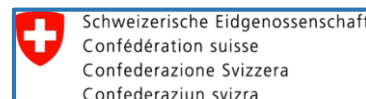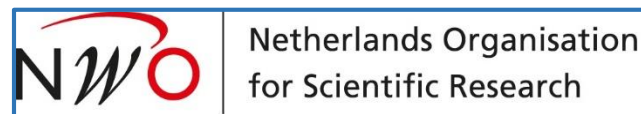
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Thanks for your attention!

Co workers

- David R. Green, UoA, UK
- Billy J. Gregory, UoA, UK
- Lammert Kooistra, WUR, NL
- Peter Roosjen, WUR, NL
- Irene Bühlmann, ZHAW, CH
- Micha Baur, ZHAW, CH
- Alec Handschin, ZHAW, CH
- Julien Kabor-Prieur, ZHAW, CH

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