

# Exploring Challenges in Citizen Image Classification for Mosquito Alert Project



Funded by  
the European Union

Mosquito Alert participates in the following EU funded projects:



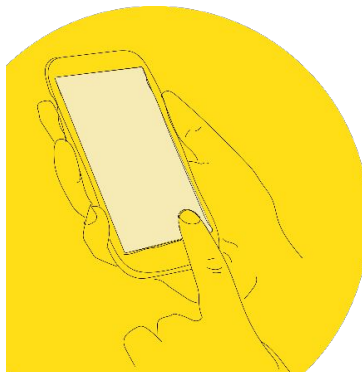
## Mosquito Alert Project

Spain  
regional pilot

2013



*Ae. albopictus*



Spain  
national scale

2014 - 2020



*Ae. albopictus*



*Ae. aegypti*

EU scale

2020 - 2024



*Ae. albopictus*



*Ae. aegypti*



*Ae. japonicus*

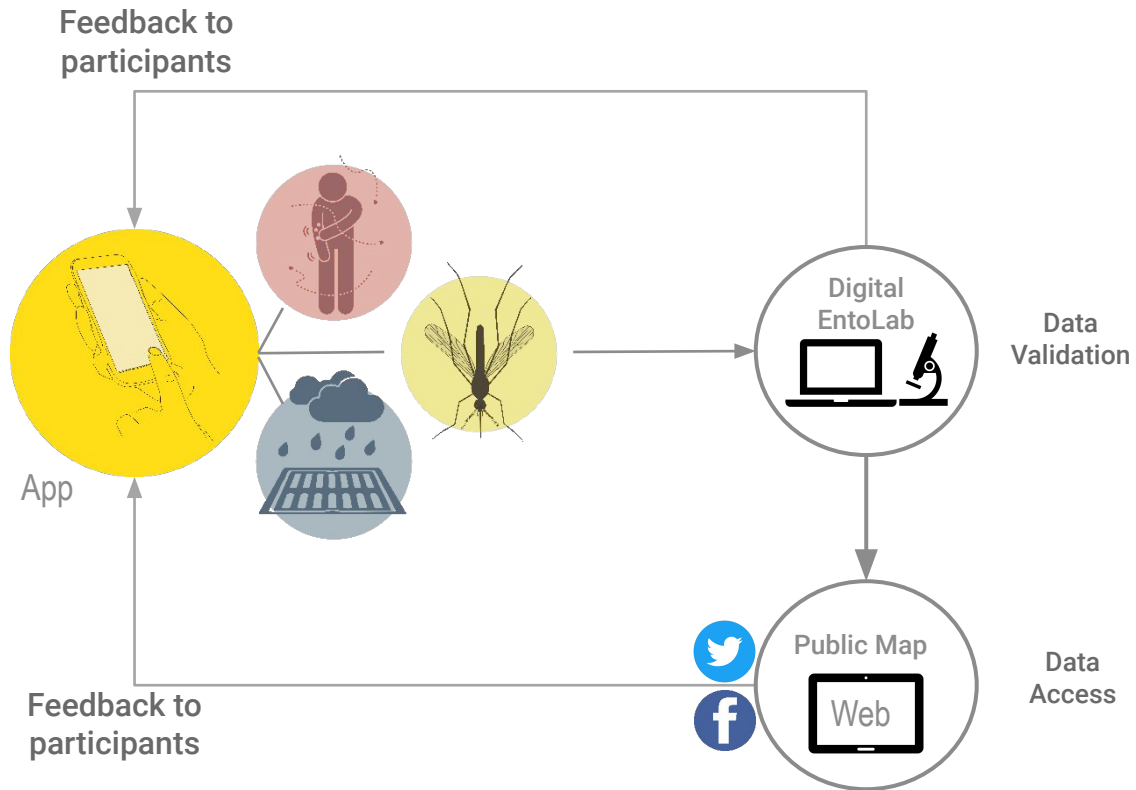


*Ae. koreicus*

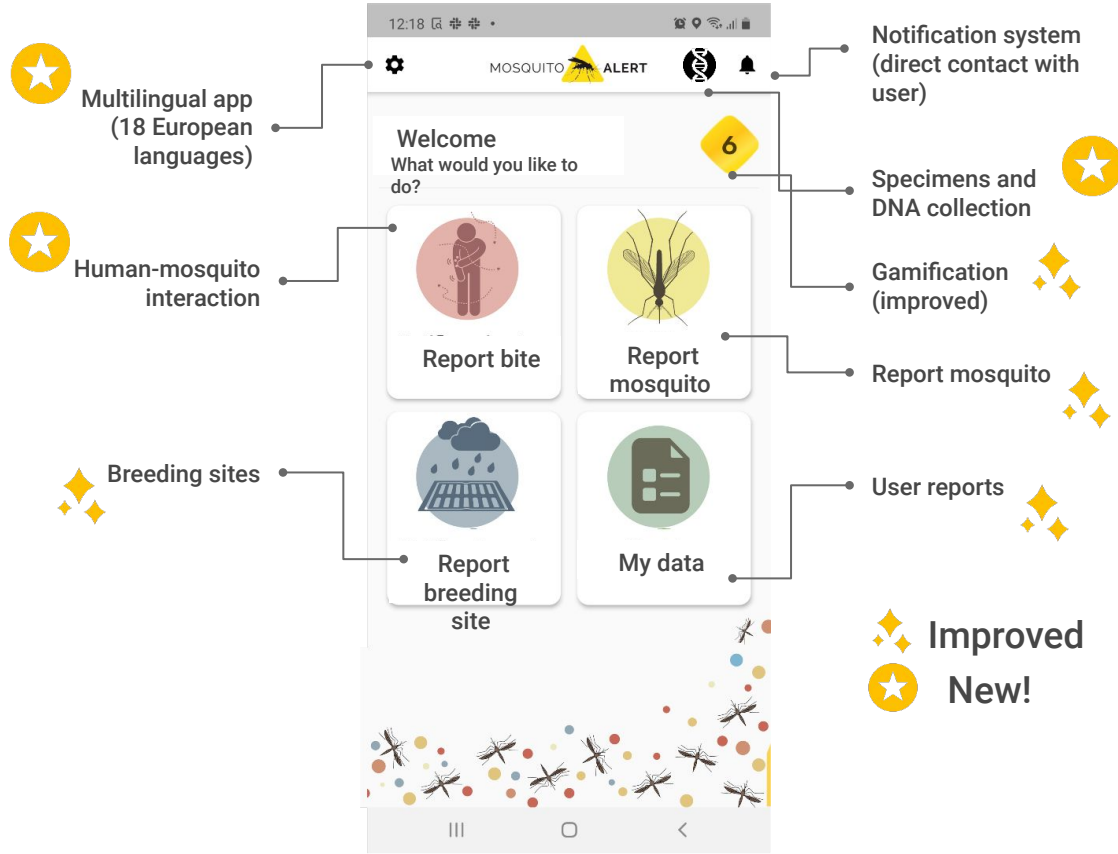


*Culex pipiens*

## Citizen Science loop



## Mosquito Alert App



Improved  
New!



## Public Map: raw data

MOSQUITO ALERT

**Reports**

Select location (city, province, regi...)

Select hashtag

**MOSQUITOES**

- Tiger mosquito
- Yellow fever mosquito
- Asian bush mosquito
- Korean mosquito
- Common mosquito
- Unidentifiable

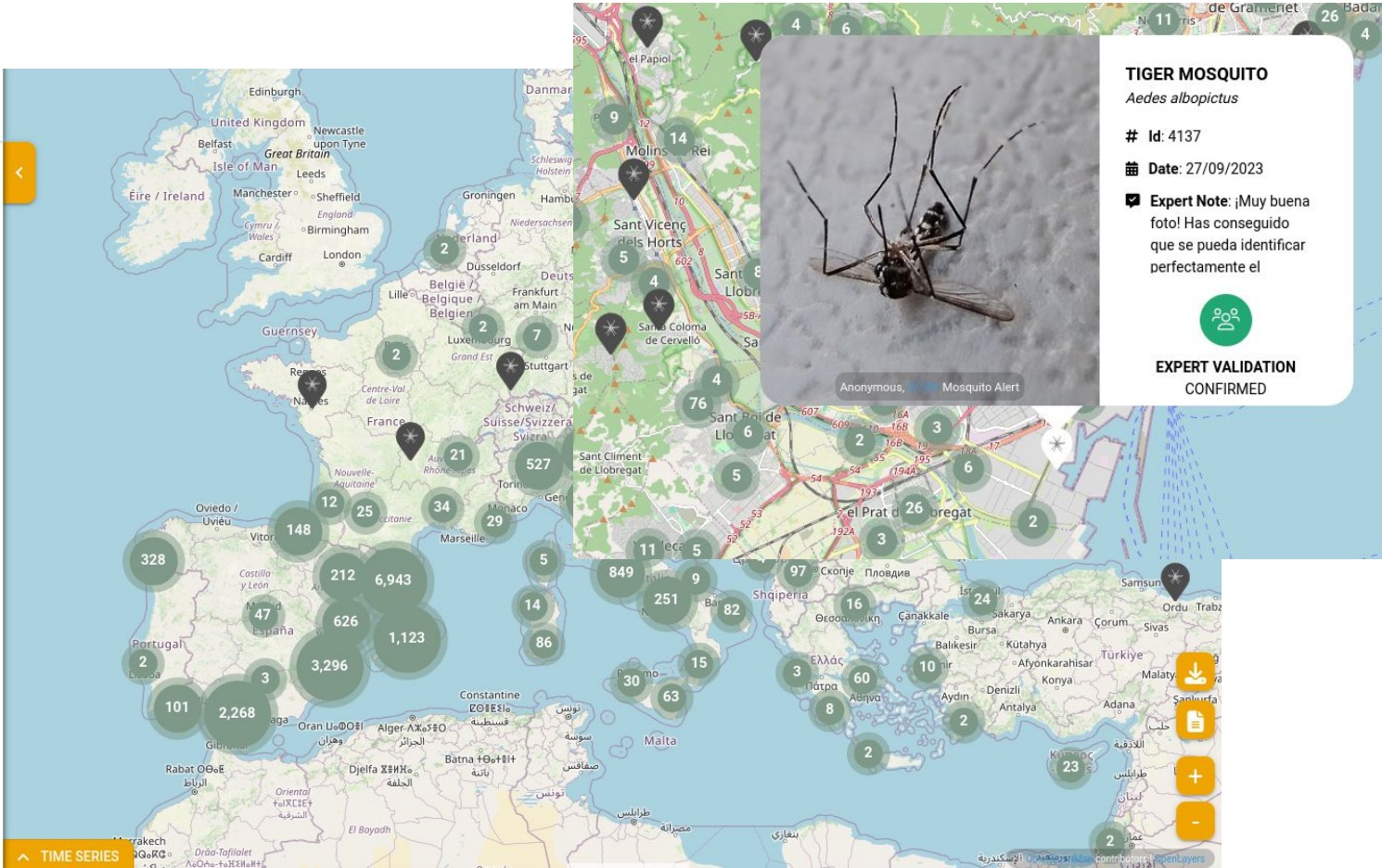
**BREEDING SITES**

- Stormdrain with water
- Stormdrain without water
- Others

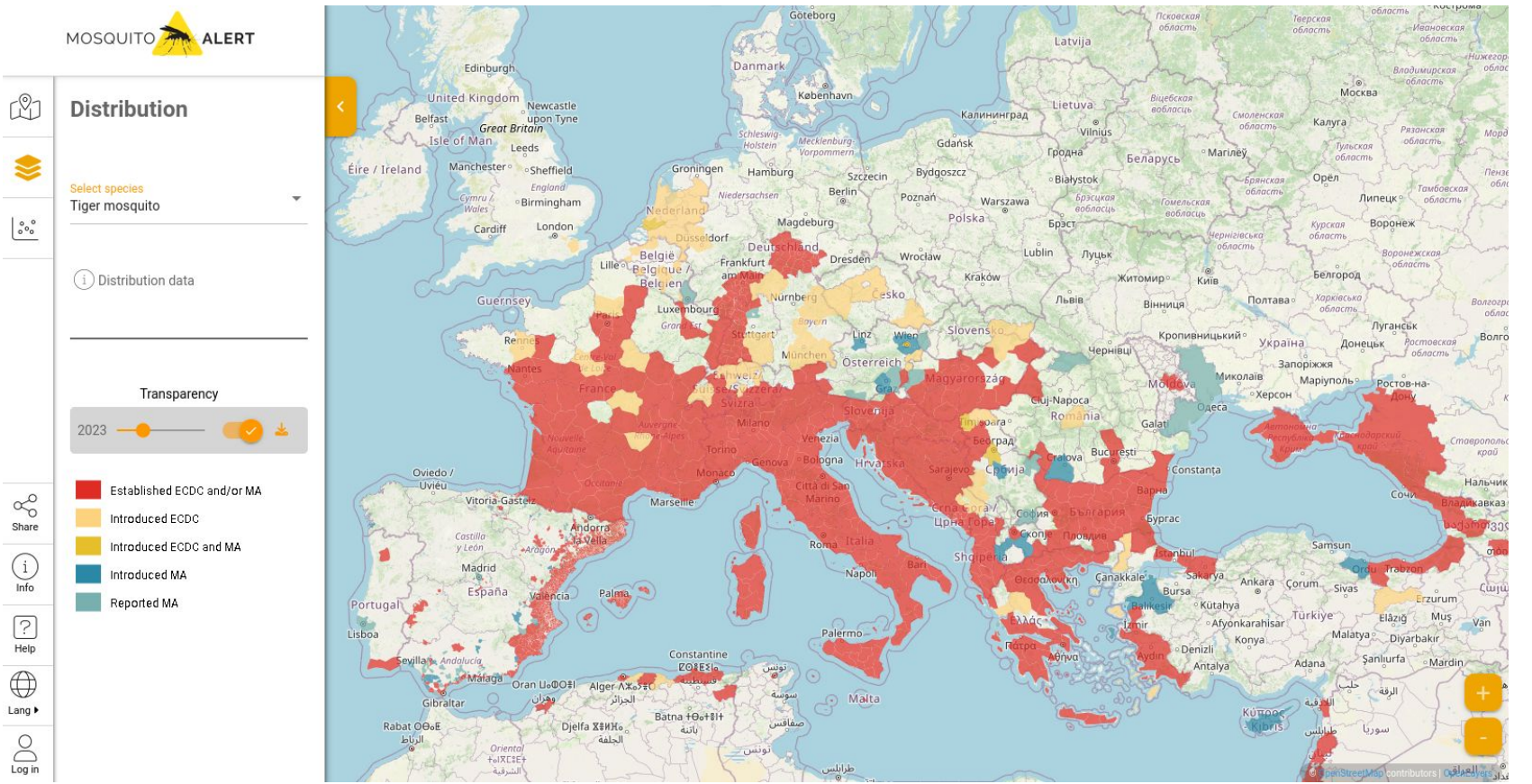
**BITES**

- Bites

**OTHER SPECIES**





## Public Map: presence/absence




## Public Map: modeled data


MOSQUITO  ALERT

 Select species  
 Tiger mosquito


 Month / Year  
 08/2023

 Modeled data

---


**PROBABILITY** 

Low  Medium  High




Transparency






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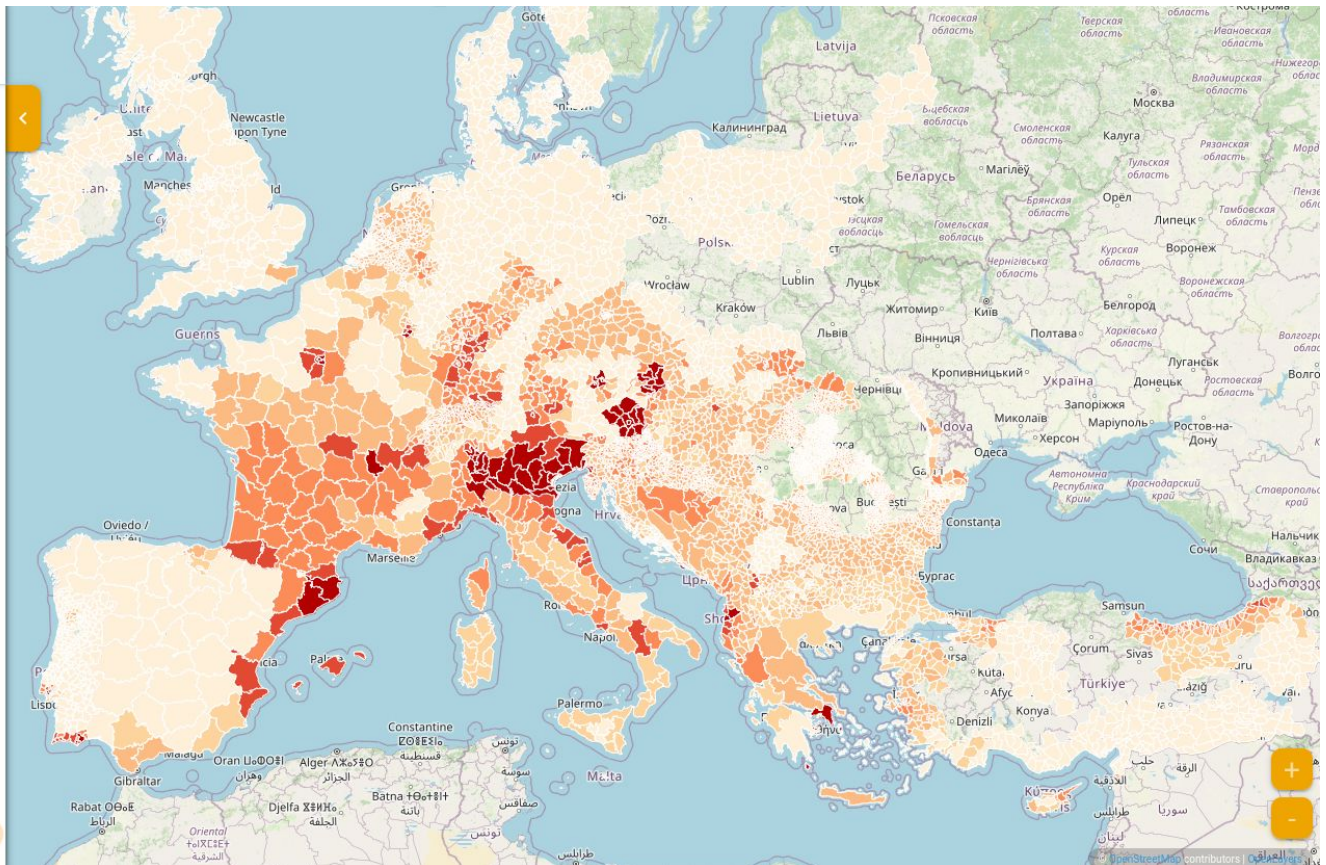
**UNCERTAINTY** 

Very low  Low  Medium  High

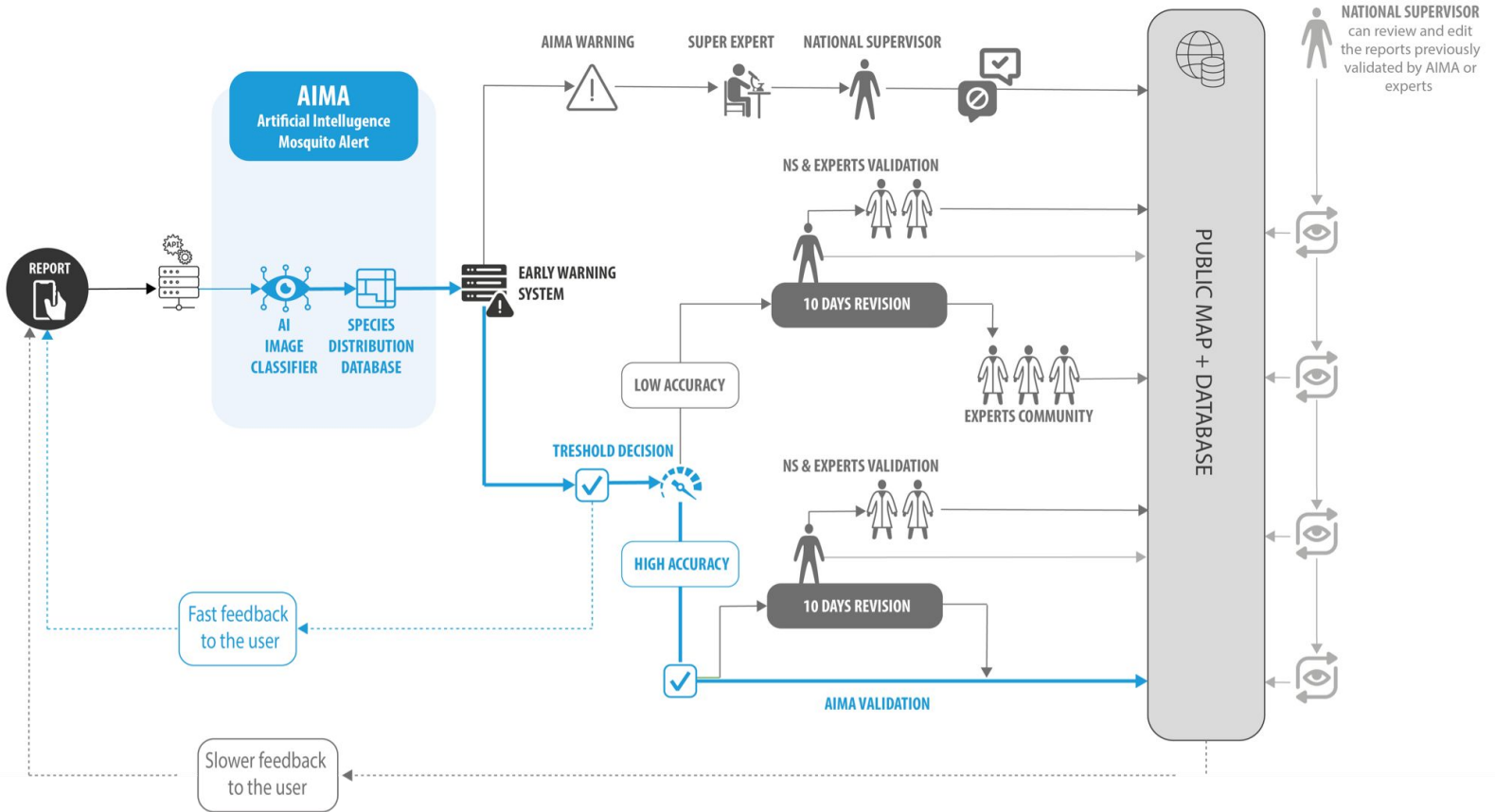


Transparency

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## Towards a real-time system: AI and human-in-the-loop





# AIMA: Artificial Intelligence Mosquito Alert



## early warning system

Dear Roger Eritja,

This message has been automatically generated by the Artificial Intelligence Mosquito Alert System (AIMA). The system has detected the following report, suggesting that one of our targeted species may be present in an area that had not been previously known. We recommend that you follow up on this report.

Report: c5611111-b941-47fb-8532-9955a5098be9  
UserId: [REDACTED] EDITED FOR PRIVACY  
Report datetime: 2023-08-06 17:05:39.106310+02:00  
Identified species: albopictus  
Identification score: 0.5679

AIMA\_scores: [0. 1. 0. 0. 0. 0. 0. 0.]

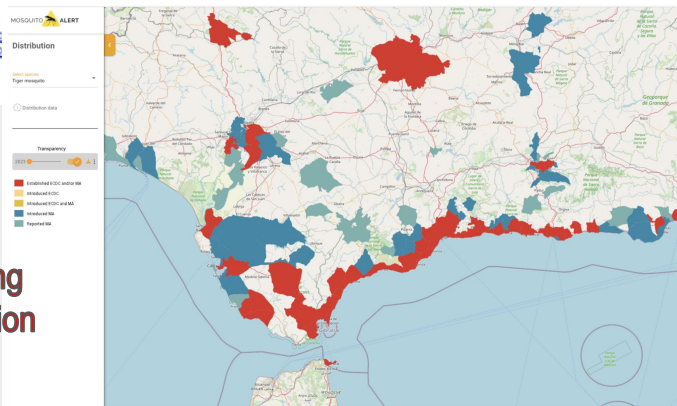
Report zone: ES114\_34123636029 Moaña Pontevedra Spain  
Current status: absent

Image: <http://webserver.mosquitoalert.com/spa/distribution/en/29a3-4723-b7dc-8db64be3bd89.jpg>

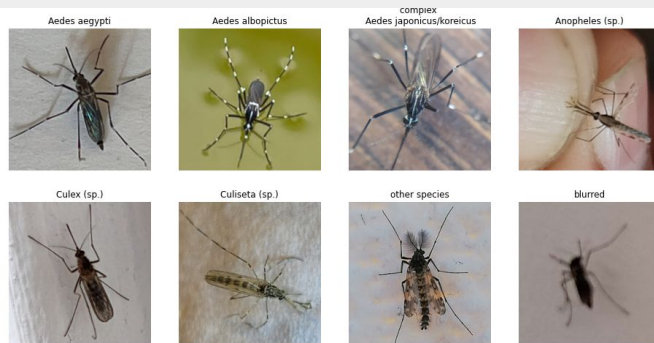
Report:  
<https://webserver.mosquitoalert.com/spa/distribution/en/5611111-b941-47fb-8532-9955a5098be9>

Best regards.

## real time monitoring of species distribution



## species identification



## automatic report validation



--- AI Mosquito Alert ---

Identified species: **Aedes albopictus**

Identification score: **0.9978**

Our AI identified the species in your image as a Tiger mosquito (**Aedes albopictus**). Very good picture! Thanks for participating!



This was an automated classification by the Mosquito Alert Artificial Intelligence system. Additionally, you may soon receive a new notification with the final classification of your report based on the opinion of our entomology experts.

immediate feedback to participants

## targeted species vs. class set

*Aedes aegypti*



*Aedes albopictus*



complex  
*Aedes japonicus/koreicus*



*Anopheles* (sp.)



*Culex* (sp.)



*Culiseta* (sp.)



other species



blurred



## citizen images

*Aedes aegypti*



*Aedes albopictus*



*Aedes koreicus*



*Anopheles (sp.)*



*Culex (sp.)*



*Culiseta (sp.)*



other species



not classified



notclassified



not classified



not classified



not classified



not classified



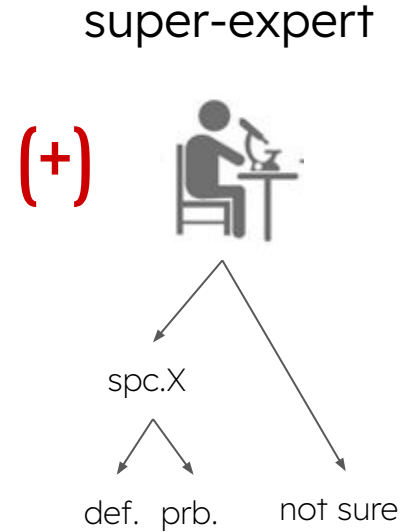
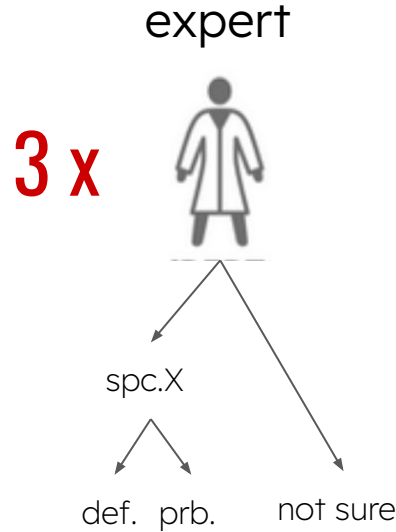
not classified



not\_classified



ground truth

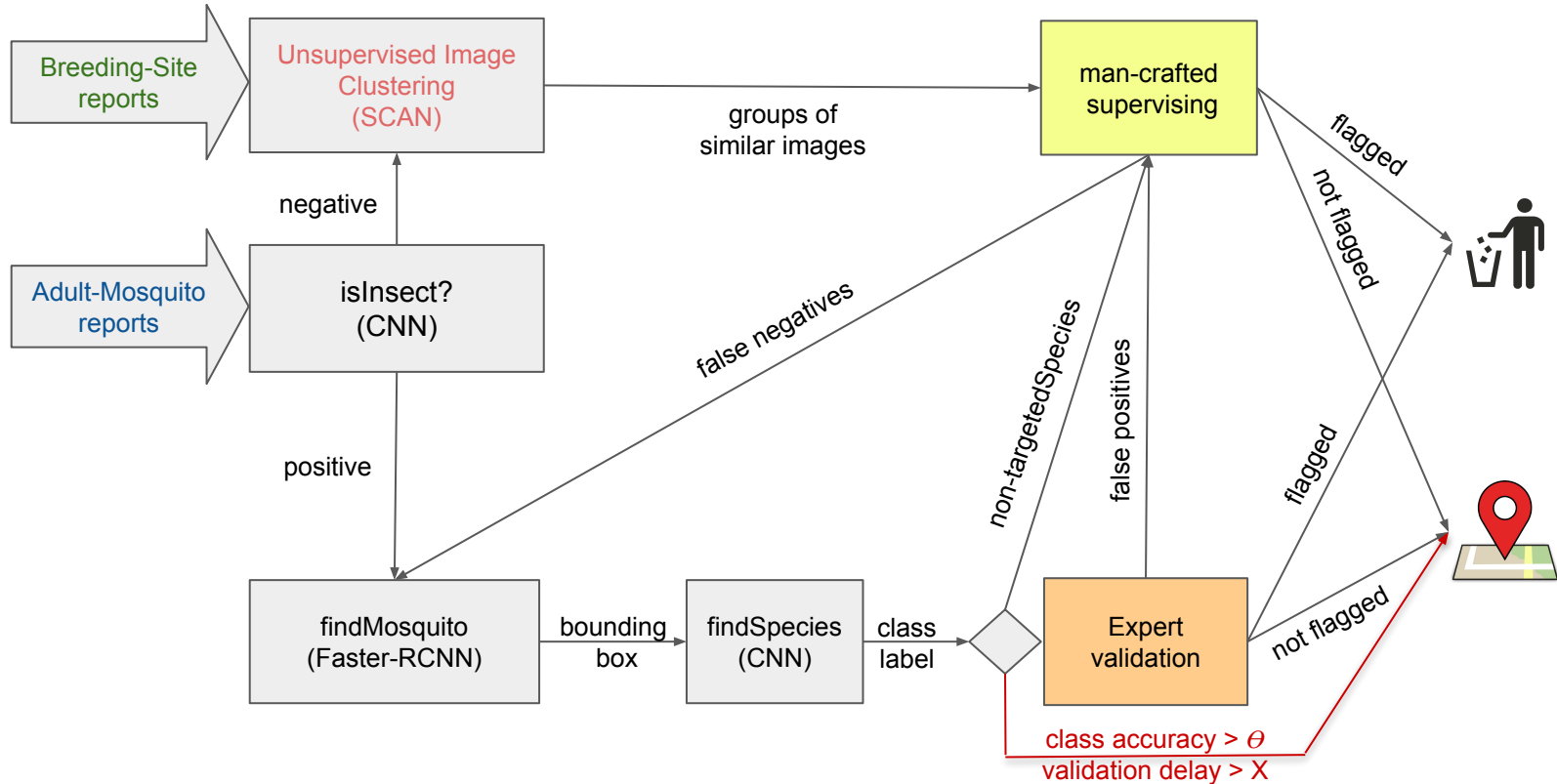


def. = 1.0  
prb. = 0.6  
not sure = 0.0



average class label: spc.X  
average class score (0.0 ≤ S ≤ 1.0)  
average image quality score (0.0 ≤ Q ≤ 1.0)

## Automatic classification pipeline

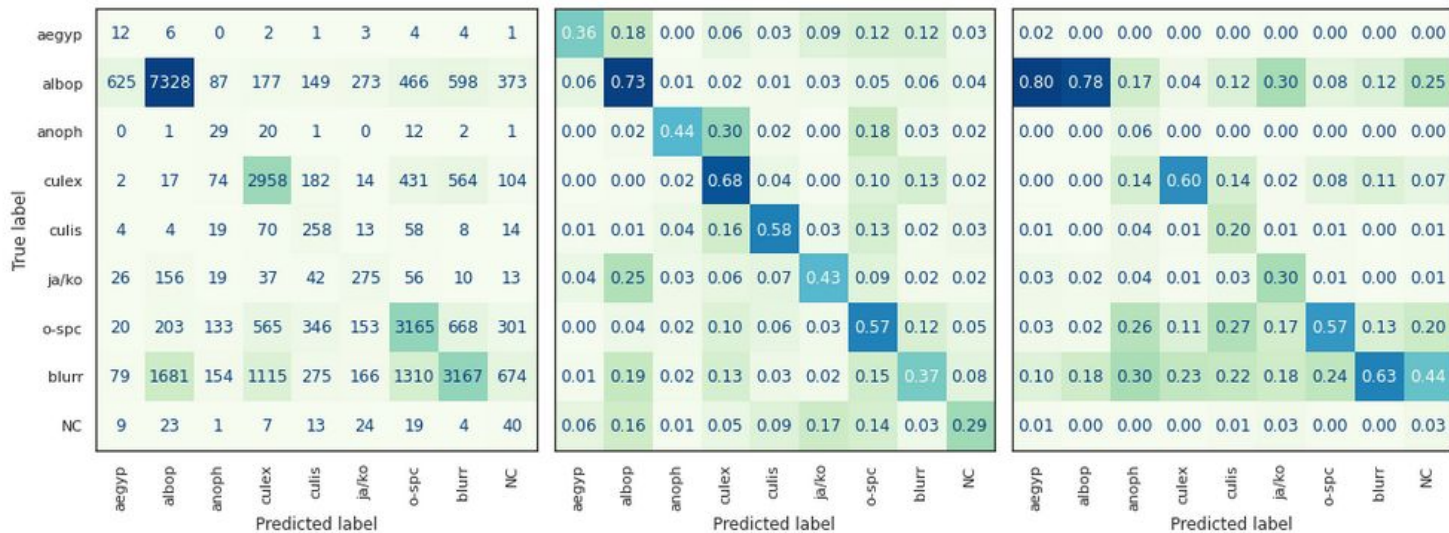


## 3-stage system

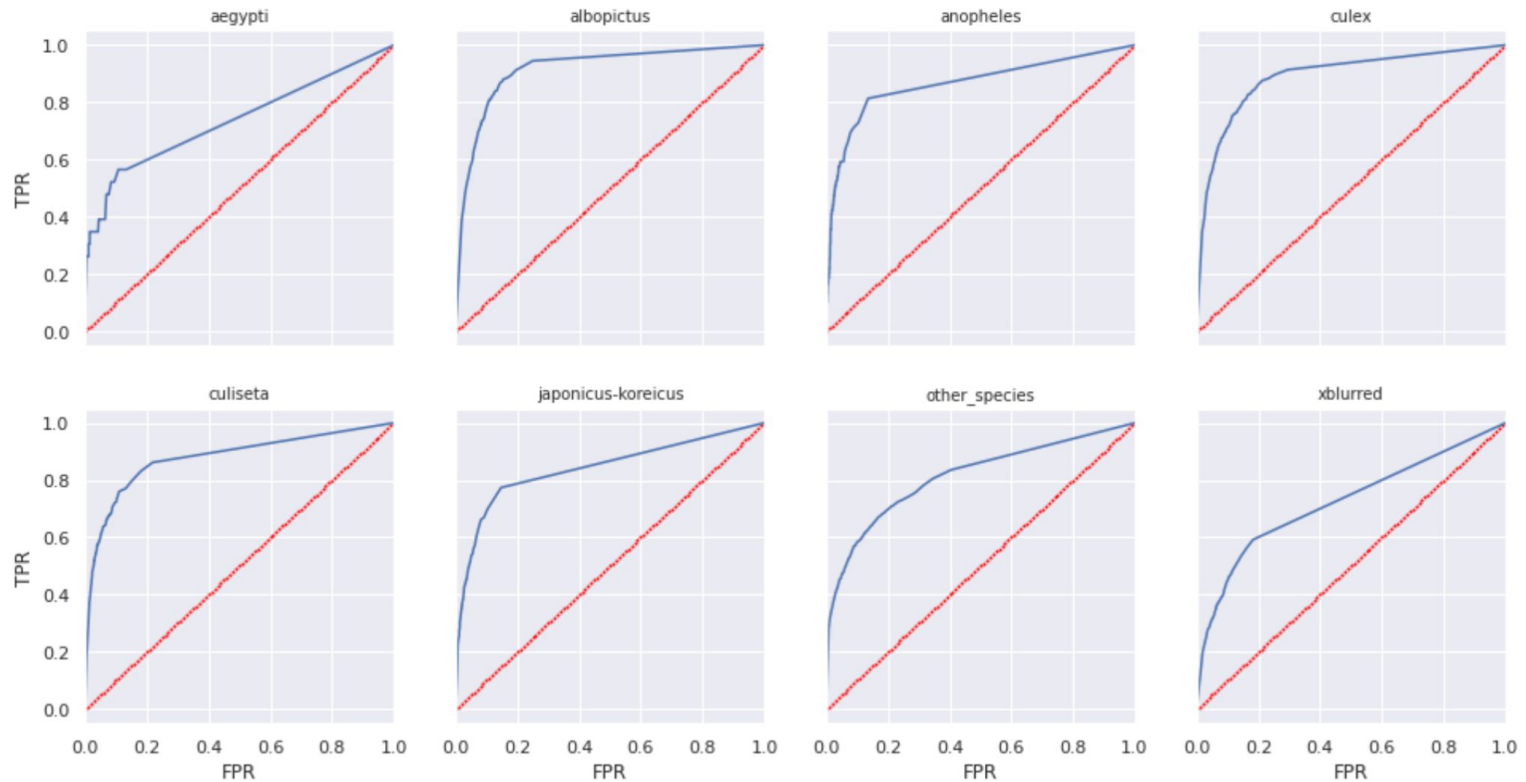
isInsect?	findMosquito	findSpecies
<ul style="list-style-type: none"><li>● binary classifier</li><li>● ResNet 18</li><li>● Accuracy ~98%</li></ul>	<ul style="list-style-type: none"><li>● computes bounding box around ROI</li><li>● single object detector</li><li>● Fast-RCNN (old)</li><li>● Accuracy ~96%</li></ul>	<ul style="list-style-type: none"><li>● multi-class classifier</li><li>● MobileNet_v2<ul style="list-style-type: none"><li>- pretrained</li><li>- fine tuning with layer freezing strategy</li></ul></li><li>● 8-classes<ul style="list-style-type: none"><li>- 3 targeted species</li><li>- 1 complex (jap/kor)</li><li>- 2 future targets</li><li>- other species</li><li>- blurred images</li></ul></li><li>● accuracy<ul style="list-style-type: none"><li>- ~74% (~50% recall)</li></ul></li></ul>

## system performance: confusion matrix

proportion classified = 0.95  
 weighted average precision = 0.65  
 weighted average recall = 0.61  
 weighted average f score = 0.62



## ROC curves: recall-precision trade-off



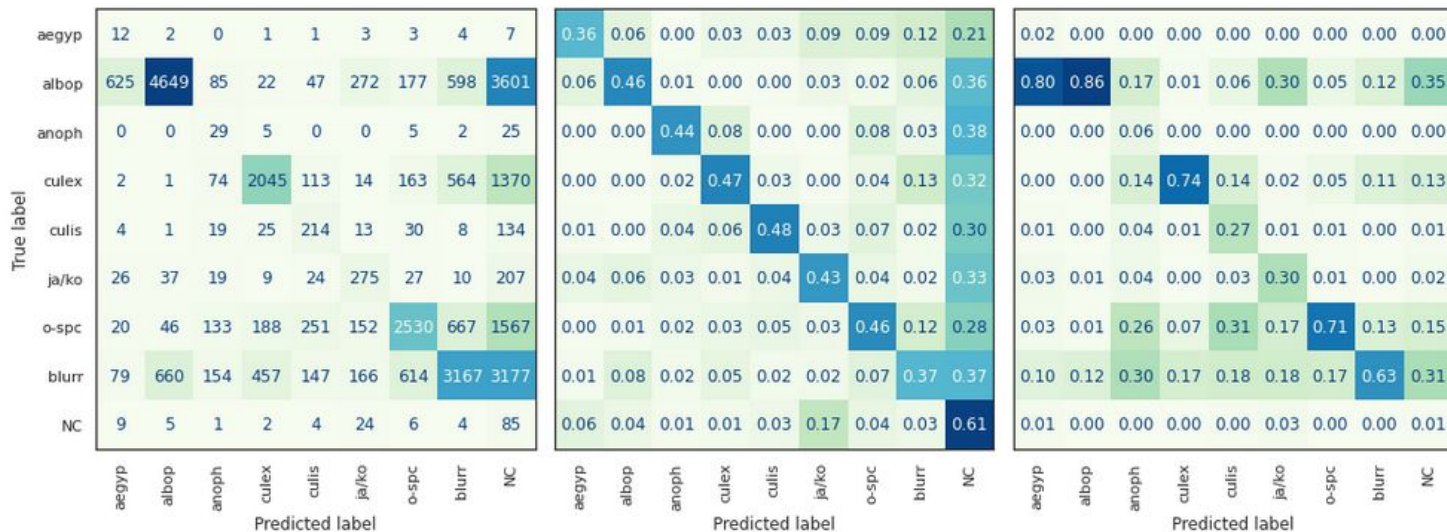


## system performance: confusion matrix (false-positive-rate ~ .05)

proportion classified = 0.66  
 weighted average precision = 0.72  
 weighted average recall = 0.65  
 weighted average f score = 0.68

```

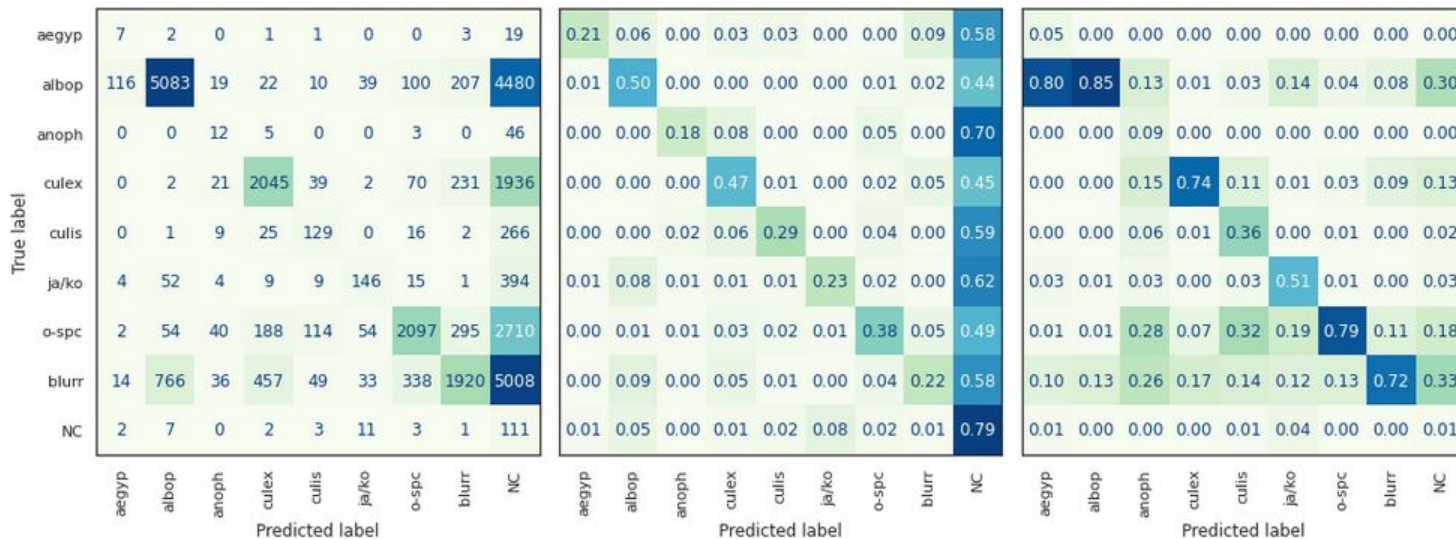
+++ aegypti      ... 0.15, FPR:0.05, TPR:0.42, OPR:0.47
+++ albopictus  ... 0.93, FPR:0.05, TPR:0.53, OPR:0.58
+++ anopheles   ... 0.08, FPR:0.05, TPR:0.62, OPR:0.67
+++ culex       ... 0.76, FPR:0.05, TPR:0.59, OPR:0.64
+++ culiseta    ... 0.24, FPR:0.05, TPR:0.63, OPR:0.68
+++ japonicus-koreicus ... 0.11, FPR:0.05, TPR:0.55, OPR:0.60
+++ other_species ... 0.79, FPR:0.05, TPR:0.48, OPR:0.53
+++ xblurred    ... 0.91, FPR:0.05, TPR:0.27, OPR:0.32
  
```



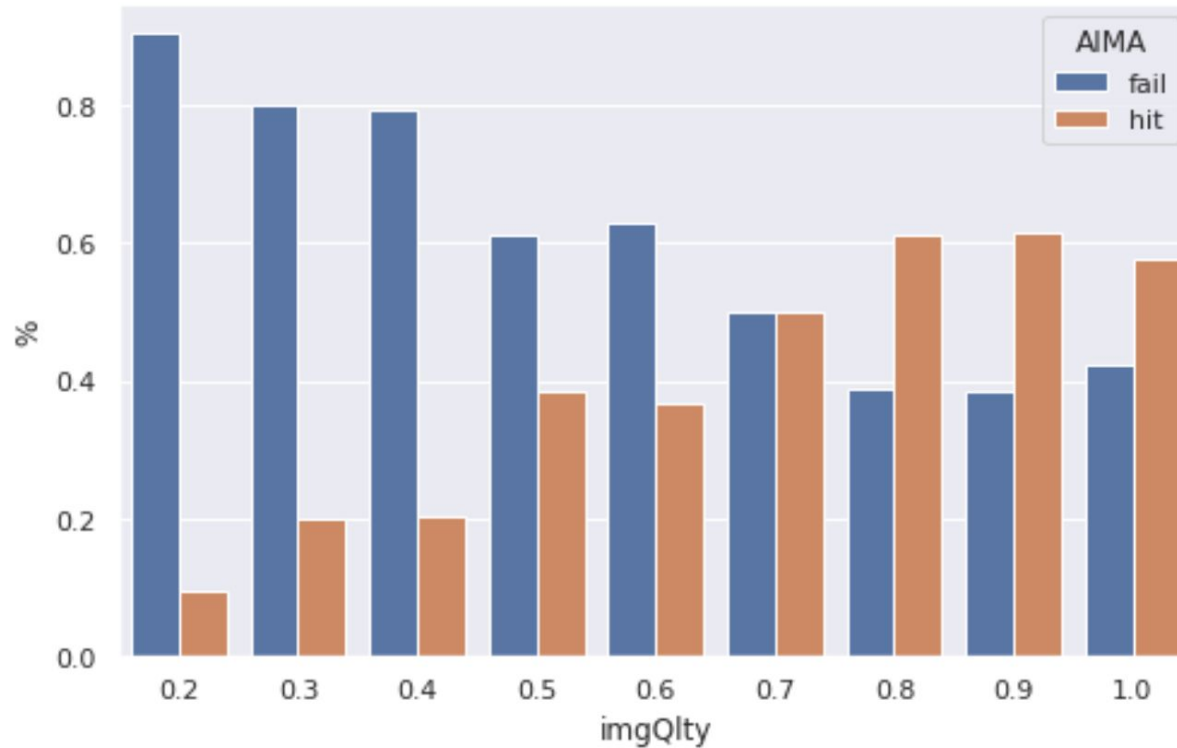
## system performance: confusion matrix (fine tuning)

proportion classified = 0.50  
 weighted average precision = 0.78  
 weighted average recall = 0.77  
 weighted average f score = 0.77

```
+++ aegypti      ... 0.95, FPR:0.00, TPR:0.21, OPR:0.21
+++ albopictus  ... 0.95, FPR:0.04, TPR:0.50, OPR:0.54
+++ anopheles   ... 0.90, FPR:0.00, TPR:0.18, OPR:0.18
+++ culex       ... 0.95, FPR:0.03, TPR:0.47, OPR:0.50
+++ culiseta    ... 0.95, FPR:0.01, TPR:0.29, OPR:0.30
+++ japonicus-koreicus ... 0.95, FPR:0.00, TPR:0.23, OPR:0.23
+++ other_species ... 0.95, FPR:0.02, TPR:0.38, OPR:0.40
+++ xblurred    ... 0.97, FPR:0.03, TPR:0.22, OPR:0.25
```



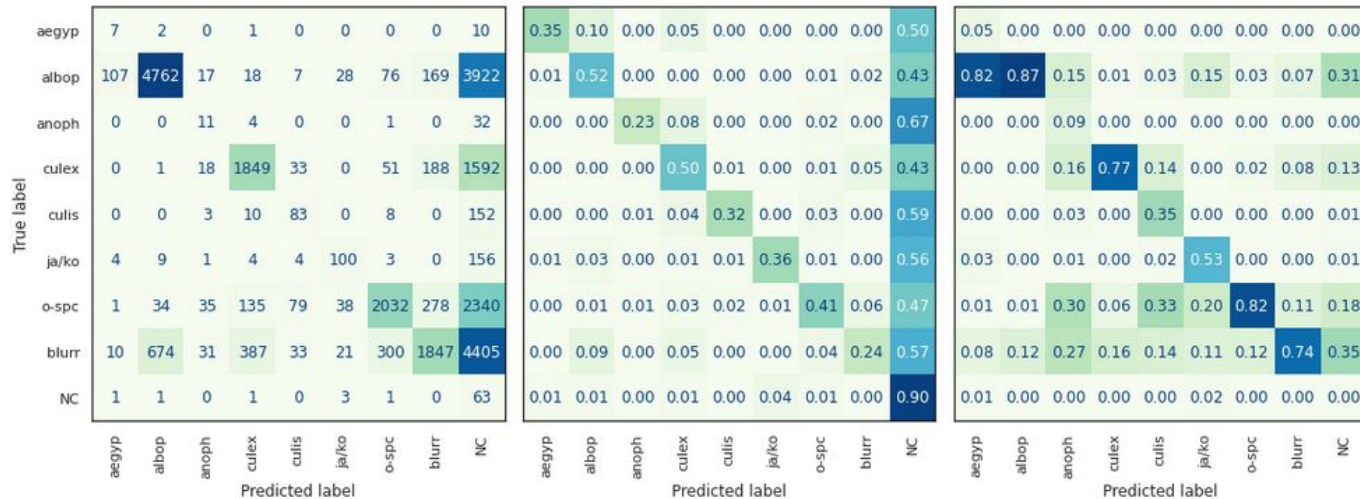
## classification correlates with image quality



## system performance: confusion matrix (fine tuning, image quality > 0.5)

proportion classified = 0.52  
 weighted average precision = 0.80  
 weighted average recall = 0.79  
 weighted average f score = 0.79

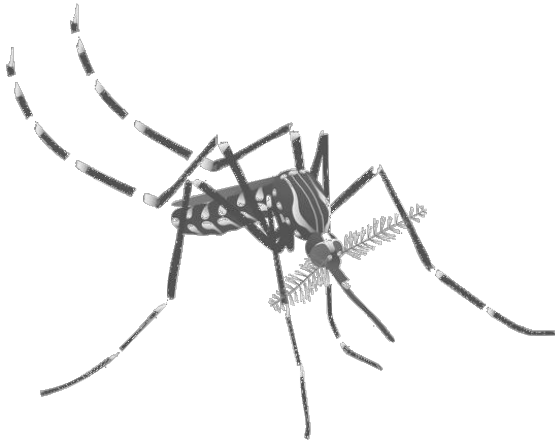
+++ aegypti ... 0.95, FPR:0.00, TPR:0.60, OPR:0.60  
 +++ albopictus ... 0.95, FPR:0.03, TPR:0.57, OPR:0.60  
 +++ anopheles ... 0.90, FPR:0.01, TPR:0.21, OPR:0.22  
 +++ culex ... 0.95, FPR:0.03, TPR:0.52, OPR:0.55  
 +++ culiseta ... 0.95, FPR:0.01, TPR:0.34, OPR:0.35  
 +++ japonicus-koreicus ... 0.95, FPR:0.00, TPR:0.37, OPR:0.37  
 +++ other\_species ... 0.95, FPR:0.02, TPR:0.40, OPR:0.42  
 +++ xblurred ... 0.97, FPR:0.04, TPR:0.29, OPR:0.33



## big picture

2022/2023	# images	% images	correct	incorrect	not-classified	recall (*) all, weighted	precision (*) all, weighted	threshold
all classes	29918	—	11550	3509	14859	0.38*	0.76 *	—
albopictus	10076	33.67	5083	513	4480	0.50	0.85	0.95
not-sure	8621	28.81	1920	1693	5008	0.22	0.72	0.97
other-species	5554	18.56	2097	747	2710	0.38	0.79	0.95
culex	4346	14.52	2045	365	1936	0.47	0.74	0.95
japonicus/koreicus complex	635	2.12	147	94	394	0.23	0.51	0.95
culiseta	448	1.49	129	53	266	0.29	0.36	0.95
anopheles	66	0.22	12	8	46	0.18	0.09	0.90
aegypti	33	0.11	7	7	19	0.21	0.05	0.95
not-classified	139	0.47	111	29	0	0.79	0.01	—

# Thank you!



# Questions?