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Aedes Invasive Mosquitoes

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EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

A questionnaire-based survey of surveillance and management of *Aedes* invasive mosquitoes in Europe

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Acknowledgements: …
The authors particularly thank all participants of this questionnaire survey, and gratefully acknowledge the help received from the European Centre for Disease Prevention and Control, the European Mosquito Control Association and the International Atomic Energy Agency for providing access to collaborators or dedicated workshops. We are also grateful for the help and advice of Frederic Jourdain, Frederic Simard and Adolfo Ibáñez-Justicia during the planning stages of the study. The mosquito drawings in the title graphic are the work of Ana Ramirez and are detailed in the references.

Suggested citation: AIM COST (2020). A questionnaire-based survey of surveillance and integrated management of *Aedes* invasive mosquito species. Technical Report. AIM-COST Action CA 17108. Rome: University La Sapienza.

Date of posting: 25.08.2020. This is AIMCOST deliverable DL 3.2 **Report on results from Delphi and specialised questionnaires**

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SUMMARY

The *Aedes* invasive mosquitoes COST Action (AIM–COST)[1] is a gender, age and geographically balanced network of members from critical stakeholder sectors in EU and neighbouring countries. The Action assesses and reviews current *Aedes* mosquito surveillance, control and analysis practices, and aims to 1) harmonise best practice guidelines, surveillance control protocols to improve consistency across Europe, 2) facilitate the development of new tools and 3) identify priority research topics. This report summarises the results of the first European-wide questionnaire-based survey of surveillance and integrated management of *Aedes* invasive species and represents one of AIM-COST's priorities.

The survey was designed to find out 1) what monitoring, surveillance and control activities for AIM species are happening in Europe and its neighbours; 2) who is responsible for funding, planning and implementing these activities and at what geographical scale; 3) what are the perceived constraints and gaps; 4) what guidelines are used and how they might be improved; and 5) what role citizen science plays in these activities.

The questionnaire was designed and compiled entirely using the EUSURVEY tool[2] as an online survey, with hard copy as an alternative. To facilitate the engagement of the moderators with the participants and to better clarify the questions, the questionnaire was conducted mainly at dedicated workshop sessions rather than by simple invitation. As a result, 154 responses from 36 countries were obtained with a return rate of around 77%.

The survey revealed that both surveillance and control activities are most constrained by the lack of political will, limitations of funding, and availability of trained personnel. There is strong evidence on the lack of integration between national, regional and local planning and implementation activities exacerbating the existing vulnerabilities. The results of entomological surveillance are used to plan control interventions in only about half the cases and are especially underutilised in the planning of pathogen transmission risk mitigation. This highlights the need for better definition of the goals of monitoring and surveillance plans, stronger links between public health officers in charge of mosquito control plans and pest-control companies in charge of implementing them, and better reporting of surveillance/monitoring impact and costs. To improve uptake and effectiveness, surveillance methods should be better harmonized within and between countries. Together with Mosquito Alert, the Action has itself drawn up recommendations for standardised sampling protocols which are being implemented in 27 countries by the AIMSurv Initiative[3] during the 2020 summer.

Questionnaire results highlight the widespread use of pyrethroid adulticides not only to control arbovirus autochthonous transmission, but also to reduce AIM abundance/nuisance. This emphasises the urgent need to widely promote innovative and less environmentally damaging methods and to rectify weaknesses in international/national regulation on the use of biocides which are currently seen as major constraints to control. Control activities should include external quality assessments of control programmes, linked to the contract.

The international agency sponsored surveillance and control guidelines are by far the most widely used (primarily from ECDC and to a lesser extent WHO). These are the most comprehensive and wide ranging, but are less well tailored for local conditions than are locally produced guidelines. They need to be updated to include the latest methods and harmonised to reduce contradictions. They should also either provide additional local guidance or to identify documents that are adapted to national/local scales, and incorporate the relevant parts of the international recommendations. To help those with limited funding target their activities most effectively, guidelines could be prioritised into a minimal set of essential activities and an additional set of activities required to optimise surveillance and control programmes.

The need for training in all aspects of AIM management is acknowledged by all participants. A major focus of AIM-COST is to fill in this gap by providing technical information and training courses in surveillance, control, and analysis, and funding placements for young researchers in expert laboratories.

[1] https://www.aedescost.eu

[2] http://www.ec.europa.eu/eusurvey

[3] https://www.aedescost.eu/sites/default/files/2020-07/AIMCOSTPressRelease_AIMSurv29072020.pdf

1 Foreword

In tropical areas, *Aedes* mosquitoes cause over 100 million symptomatic cases/year of viral diseases, such as chikungunya, dengue, yellow fever and Zika, and thousands of deaths. With increasing trade and travel, several *Aedes* species have been introduced into Europe and are now spreading rapidly becoming a significant public health risk which needs to be effectively addressed, as testified by recent local chikungunya, dengue and Zika virus transmission.

Transboundary risks necessitate effective surveillance, risk assessment, and vector control, with efficient dissemination of information and guidance to stakeholders. This requires collaboration between the normative, research, public health, commercial and civil society sectors at international, national and local scales. This is not currently the case. Despite the range of available institutional guidelines, current mitigation activities are largely un-coordinated and implemented piecemeal nationally or locally, reducing cost-effectiveness and impact.

The *Aedes* invasive mosquitoes COST Action (AIM–COST)[4] is a gender, age and geographically balanced network from critical stakeholder sectors. The Action assesses and reviews current surveillance, control and analysis practices, and aims to 1) harmonise best practice guidelines, surveillance and control protocols ensuring consistency across Europe, 2) facilitate the development of new tools and 3) identify priority research topics. Recommendations to standardise and streamline entomological and spatial analysis are expected to promote enhanced risk assessments needed for reliable targeting and planning. Critical elements maximising impact are the involvement of civil society and citizen scientists, as well as collaborative dissemination ensuring that technical outputs and guidelines are customised at different geographical scales for each operational stakeholder group. Lessons learnt will be transferable to other emerging vector-borne diseases worldwide. This report summarises the results of the first European-wide survey of surveillance and integrated management of Aedes invasive species and represents one of AIM-COST's early priorities.

2 Introduction and Objectives

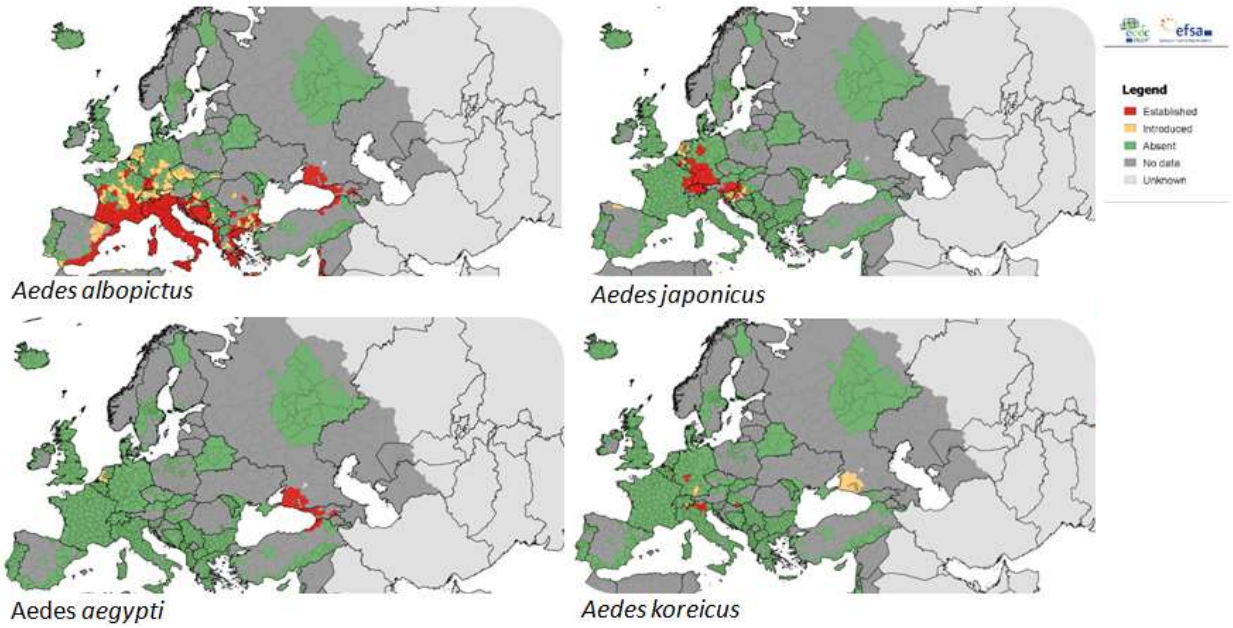

Figure 1: Current known distribution of four AIM species in Europe, by August 2019 (Source: ECDC, 2019)

Besides the historical presence of *Aedes aegypti* around the Mediterranean Basin (Schaffner & Mathis 2014), the modern story of *Aedes* invasive mosquito (AIM) species in the European Continent started with the

[4] http://www.aedescost.eu

introduction of *Aedes albopictus* in Albania during the1970s (Adhami and Reiter 1998). Subsequently the species rapidly and successfully invaded many countries of Europe. To date, other reported AIM species in Europe are *Aedes aegypti, Aedes japonicus, Aedes koreicus, Aedes atropalpus* and *Aedes triseriatus* (ECDC 2012). The reasons for AIM great invasive success are the long-range transportation of drought-resistant eggs mostly via used-tyre trade and the short-range transportation of adults by vehicles. Once transported into a new region, these species readily become established thanks to their ecological flexibility and capacity to exploit artificial water containers for larval development.

The first four of the AIM species listed above are considered the most significant from the public health perspective due to their widespread distribution and vector competence for many pathogenic agents to humans and/or animals (Figure 1). They are able to transmit several vector-borne diseases (VBD): to date, a significant number of autochthonous cases (local transmission) of chikungunya, dengue, and more recently Zika fever have been notified in Europe (Angelini et al. 2007; Rezza et al. 2007; Schilling et al. 2009; Gould et al. 2010; La Ruche et al. 2010; Nisii et al. 2010; Gjenero-Margan et al. 2011; Schmidt-Chanasit et al. 2012; Alves et al. 2013; Petrović et al. 2016; Aranda et al. 2018; Rahden et al. 2019).

When vaccines are not available for VBD, vector control is an important tool for decreasing local transmission. AIM mosquitoes are mostly container breeders, that are difficult to control since private properties play an important role in keeping breeding sites. Therefore, citizen actions are relevant for the control of AIM species. Early detection, monitoring and surveillance of AIM species at local/country level is also of key importance, since control strategies and risk of transmission of VBD is linked to the presence of AIM species and the abundance.

Coordination and methods used for detecting, monitoring, surveying and controlling AIM species at local, regional and/or national level are important to identify the actual situation regarding the current AIM species in Europe and any possible gaps. For this, in an effort to better understand AIM surveillance and control at the European level, a questionnaire survey was distributed to experts in public health, medical entomology, veterinary science and pest control (Box 1).

Highlights Box 1: Survey Objectives

- Identify the monitoring, surveillance and control activities for AIM species in Europe and its Neighbouring Regions.
- Find out who is planning, funding, and implementing these activities.
- Identify the geographical scale that these activities are implemented.
- Record the perceived gaps and constraints in AIM-related activities.
- Identify which guidelines for surveillance and control of AIM are currently available and used.
- Record any gaps in the available guidelines and whether they should be rationalised/standardised.
- Find out the role that citizen science plays in AIM-related activities.

3 Methods

The survey was implemented in three essential steps: development, administration, and validation. As part of the development step, a draft questionnaire was developed and sent to a subset of 15 specialists in the field of mosquito monitoring, surveillance or control (MMSC), hereafter referred to as ‘super users’. Each was asked to complete the draft Questionnaire and to identify errors, gaps and potential sources of confusion and to suggest any changes they thought necessary. The super user responses were then collated, assessed, and the Questionnaire was revised accordingly.

The full revised questionnaire (Appendix 2) was designed and compiled using the EUSURVEY tool (*http://www.ec.europa.eu/eusurvey*). This tool not only provides the means of survey design and construction, it also performs basic automated analyses of the results either on the entire dataset or on subsets filtered by up to three answers. Most importantly it provides the means to administer the surveys online.

The Questionnaire was then prepared in three formats – hardcopy, a digital document, and online through EUSURVEY. The Questionnaire could be completed on any platform with a browser – automatically formatted for Mac, Windows or Android operating systems, and for desktop and smartphone platforms.

Given its complexity (with 27 questions, the majority being multi part, and most with text - based comments), it was decided to administer it online, but primarily at dedicated workshop sessions rather than by simple invitation. Through this strategy, it was possible to explain and clarify the rationale behind each question directly to the participants as the Questionnaire was completed.

Again, because of its complexity, it seemed likely that respondents would need some time to locate the required information, before attending the questionnaire workshops. Participants therefore received the Questionnaire in advance of the workshops, so that they had time to gather any information needed. One dedicated workshop was held at the first AIM-COST Annual Conference, Athens, 14/02/2019: 110 responders), and a second at the EMCA conference (Annual Meeting, La Rochelle, 12/03/2019: 30 responders). Additional potential respondents were identified from one f the survey questions, which yielded approximately 80 additional contacts who were then emailed and asked to complete the online Questionnaire. A final tranche of 30 ECDC national focal points were also asked to complete the survey.

Preliminary analyses were performed using the EUSURVEY tool and detailed reports on selected questions were performed manually at a series of analysis workshops held in Brussels (1-2/04/2019) and Novi Sad (23-24/10/2019). By default, all responses were included in the frequency counts. In some instances, however, efforts were made to correct biases pertaining to geography or respondent type, and these adjustments are reported with the results. Some answers consisted of textual answers or text comments. These were interpreted manually, as required.

An anonymised dataset is available from the project directorate on request to info@aedescost.eu.

4 Results

The results are presented in four sections presenting information collected about: 1- types of respondents involved, 2- surveillance and monitoring activities; 3- control activities; and 4 -use of guidelines for both surveillance and control. Each section presents a text box with the highlights, and summarises the main findings.

4.1 Types of Respondents

A final total of 154 respondents from EU and Neighbouring countries completed the Questionnaire (Table 1).

Highlights Box 2: Respondents

- Most of the 154 respondents had a background of entomology and epidemiology, and came from Western European countries where invasive mosquitoes were well established or in the process of establishing.
- The respondents were clearly well qualified to provide the detailed technical information requested in the Questionnaire.

Most were either academics or worked in public institutions. Few were from the private sector. A wide range of professions were represented, though by far the most frequent were entomologists and epidemiologists.

The majority of respondents had more than 10 years of experience in their fields, leaving about 20% with less than 10 years in their profession.

Experience (yrs)	Institution Type		
	Academic	Private	Public
<10	11.7	1.9	5.8
10 – 20	18.8	1.3	7.8
> 20	22.1	4.5	25.3
Skill set	**Academic**	**Private**	**Public**
Agronomy	0.6	0.0	0.0
Biology	0.6	0.0	0.0
Control	0.6	1.3	0.0
Ecology	0.6	0.0	0.0
Entomology	36.4	6.5	25.3
Epidemiology	7.1	0.0	8.4
Mapping	1.9	0.0	0.0
Modelling	1.9	0.0	0.0
Public Health	0.6	0.0	3.9
Planning	1.3	0.0	0.0
Veterinary	0.6	0.0	1.3
Total	**52.6**	**7.8**	**39.0**

Table 1: Respondent professional experience and skill sets. Values are %.

Thirty six countries were represented, which means that the answers provided applied to a large part of the EU and its neighbours to the east and south. The number of the respondents was however rather heterogeneous, with more respondents from countries where invasive mosquitoes are well established or in the process of establishing, and relatively few from Central and Eastern Europe (Figure 2). Given this geographical and professional composition, the respondents were clearly well qualified to provide the detailed technical information requested in the Questionnaire and could provide perspectives for a wide geographical area.

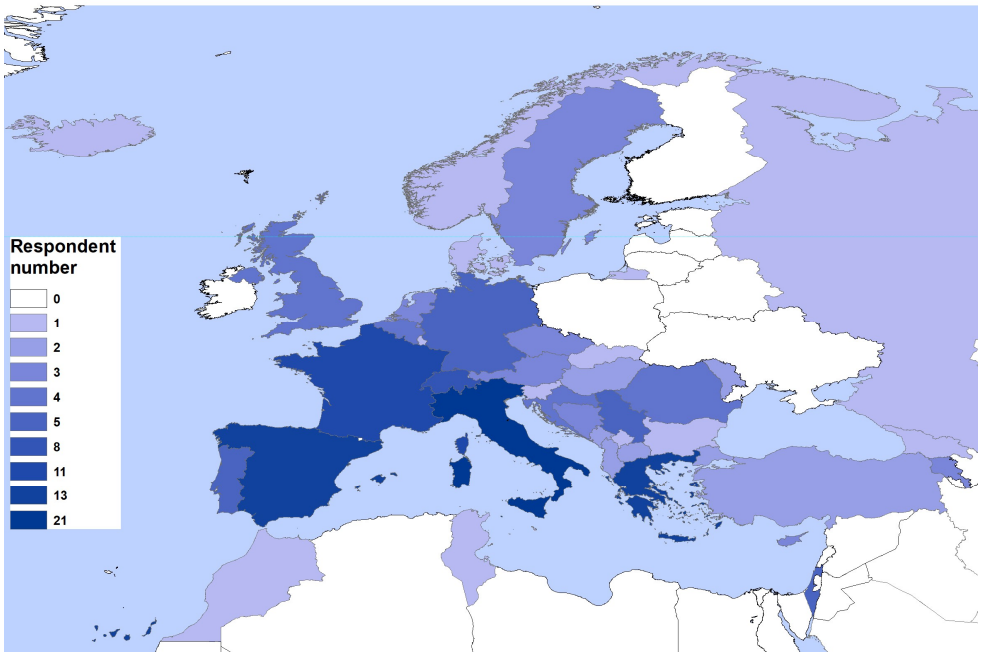

Figure 2: Number of respondents per country.

4.2 Surveillance and Monitoring

Highlights Box 3: Surveillance

- Highest surveillance priorities are to monitor introduction, spread and early warning of AIM species.
- Planning is largely done by public authorities, at all geographic scales. Funding is provided by a combination of national, regional and local authorities, Implementation at national level is mostly by national authorities, and at regional and local levels by public/private partnerships. research institutes and veterinary institutes.
- Private companies are most involved at local level.
- Ovitraps are the most widely used surveillance method, but BG Sentinel traps, larval sampling and CO_2 baited traps are also extensively used. Most countries use a combination of trap types (mostly combining ovitraps and BG Sentinel traps).
- Only about 50% of respondents replied that surveillance results are actually used to plan AIM control activities
- Less than half of the respondents were aware of Citizen Science surveillance programmes, which were considered to increase geographic coverage and to improve early warning capability, followed by cost reduction and increased sensitivity.

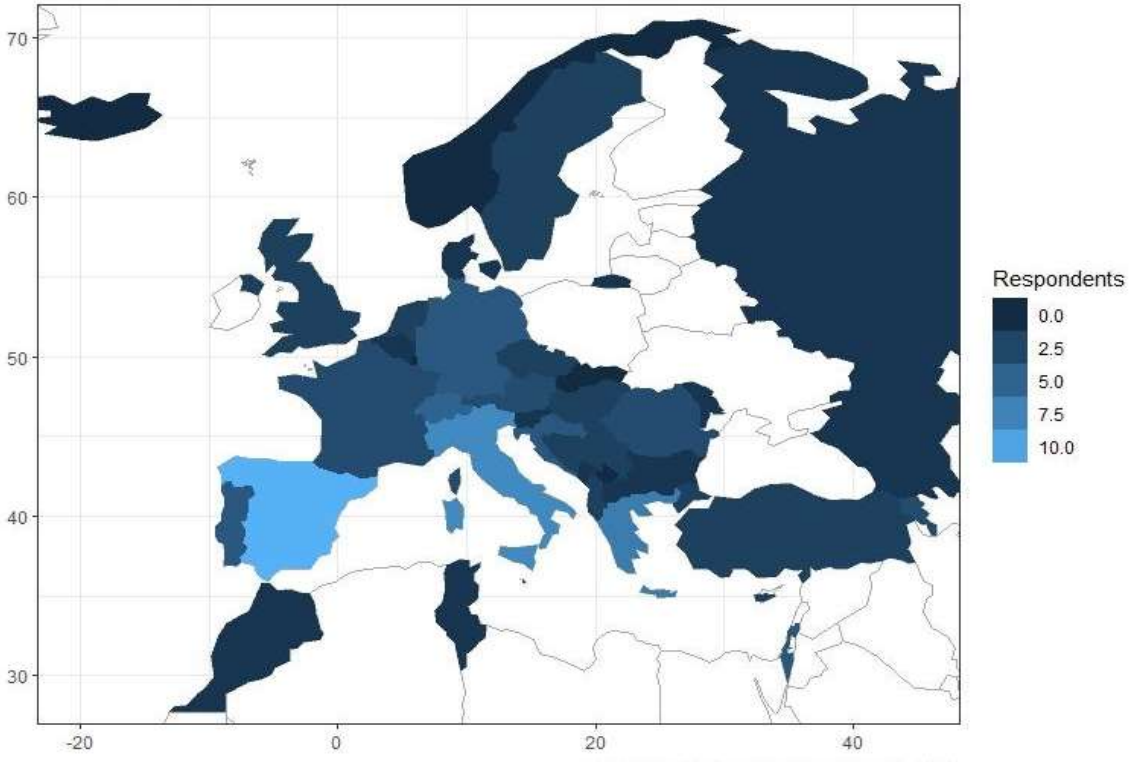

Figure 3: Number of respondents involved in surveillance per country.

Questions related to surveillance aimed at finding out what and how is it being implemented and by whom, who is funding surveillance activities, and how the results are used. In most questions, the answers were required for 3 epidemiological scenarios:- vector present but not established, vector population established,

and risk of arbovirus transmission present - as well as for different geographic scales (i.e. national, regional, local).

Respondents were asked whether they were aware of any surveillance programmes in their country (Q2), and, if existing, at what geographical scale and by what types of institution the main types of surveillance were planned (Q3), funded (Q4), and implemented (Q5) in the field. They were also asked what the main objectives of the surveillance programmes were (Q6), and what methods were used (Q7). Citizen Science involvement was addressed (Q8), as well as whether the surveillance programmes led to any action in the field (Q9). The questions are shown in full in the Appendix

A very high proportion (>90%) of respondents stated that AIM had been reported as either sporadically occurring or established in their country. *Aedes albopictus (~90%)* and *Ae. japonicus (*~50%*)* were the most widely reported species. More than a quarter of the participants reported *Ae. koreicus (*mostly Central Europe*)* or *Ae. aegypti* (mostly neighbouring countries to the South and East).

Around 60% of the participants were involved in monitoring or surveillance in their countries. The number to a large extent reflects the geographic distribution of the respondents shown in Figure 3, and demonstrates enough expertise to be able to describe surveillance activities in their countries.

4.2.1 Surveillance Objectives (Q6)

Reported surveillance objectives and priorities present a fairly straightforward picture (Figure 4): surveillance for introduction, spread and early warning are the highest priorities; surveillance for resistance and to assess efficacy of control activities are low priority, and everything else is of intermediate priority.

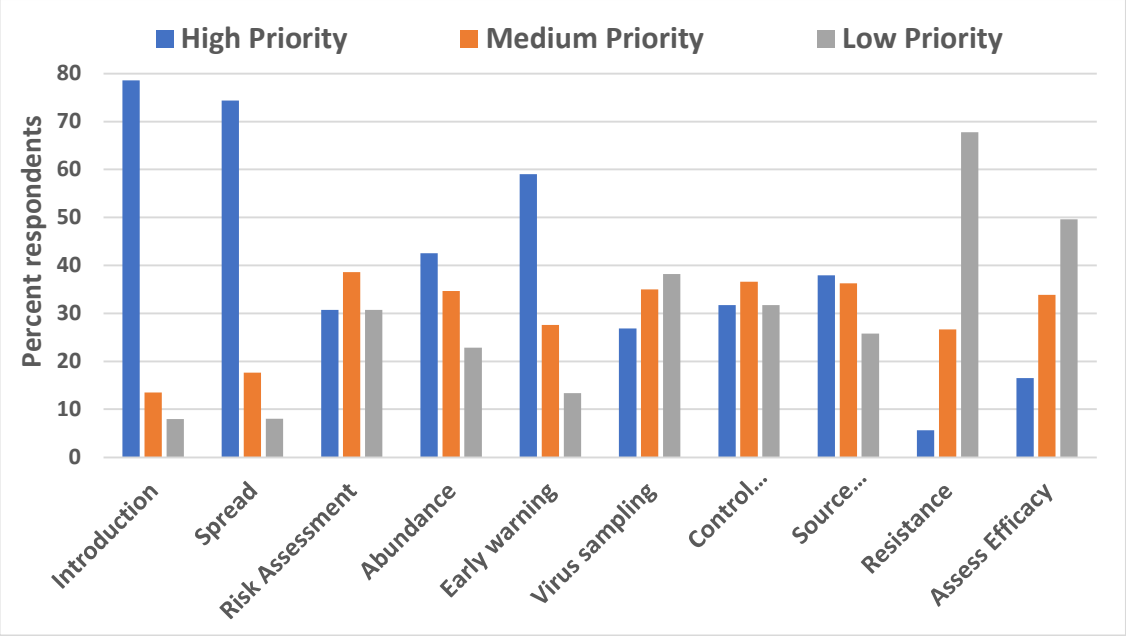

Figure 4: Surveillance priorities.

4.2.2 Planning, funding and implementation

4.2.2.1 Planning (Q3)

Participants were asked to state who is actually responsible of the planning of surveillance activities in their countries at national, regional and local level.

Participants were asked if they were aware of any national, regional or local monitoring or surveillance plans for AIM in their country (Q2). While the majority of the participants (83%) responded positively, a small fraction (17%) reported that they were not aware ('No' + 'I don't know') of such plans.

Respondents were largely uncertain which institutions are responsible for planning at the national and local level, independently from the epidemiological scenario, but they were better informed about who is responsible of planning regional surveillance (Figure 5). The majority of those who answered indicated that public institutions do most of the planning at all geographic scales, with a small contribution from academic bodies and private companies. Private companies are seen to be mostly involved in planning regional surveillance for spread and disease monitoring.

Respondents were also asked to list the competent authorities. Publishing names of institutions is restricted by EU privacy regulations, and so they not provided here. Further information may be obtained by contacting the authors.

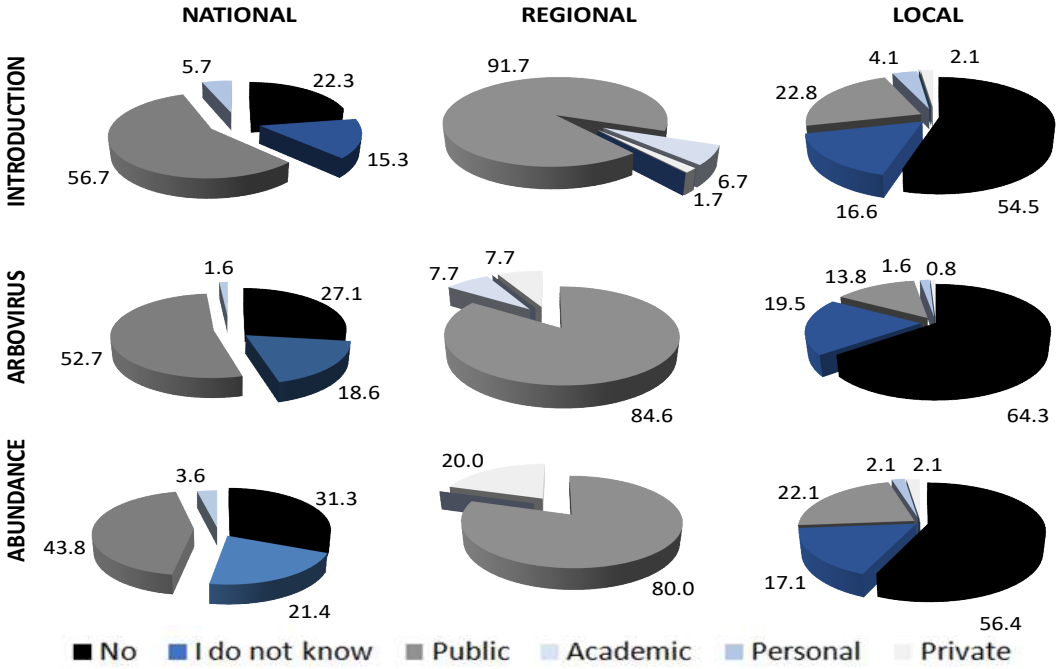

Figure 5: Types of institution responsible for planning different types of surveillance at different geographic scales. Values are % of respondents.

4.2.2.2 Funding (Q4)

Figure 6: Types of institution responsible for funding surveillance at different geographic scales. Values are % of respondents.

Participants were asked to state who is funding surveillance activities in their countries at national, regional and local level. They reported that funding for surveillance in general is provided by a combination of public authorities at national, regional and local (42%) or at regional and local levels (15%). Funding from local and international sources was stated to be comparatively rare (3 – 4% each), with the latter being mostly in the form of research projects.

Respondents felt confident to answer the question with reference to the regional and local level, while up to a third felt unable to answer with reference to the national level (Figure 6). Government funding predominates both national and regional levels in all epidemiological scenarios and at local scale in the case of abundance surveillance. Funding of local surveillance also includes a substantial (25-50%) element of 'other' funding i.e. neither government, research or private, most especially for monitoring introduction and spread, and for disease related surveillance. Research funding is better represented at regional and local levels – being ascribed to 15-22% of surveillance Table 2 shows the results, excluding those respondents who did not answer or did not know (~40%).

At national level surveillance activities are most often implemented by national Authorities (30-40%), research institutions (20-30%) and academics (up to 20%). National organisations are not, however, involved in regional or local surveillance, in which public/private partnerships research institutes and to a lesser extent, veterinary institutes, play a greater role in implementing surveillance.

Though veterinary and research institutions are the most frequent implementers of surveillance at a local level, it is notable that private companies also play a major role at this level, either alone (28%) or as part of public private partnerships (14%) agents. Another clear pattern is the increasing role of public-private partnerships, veterinary institutes and private companies at regional and local level, contrasting with surveillance by mixed funding and academic bodies which is most frequent at national level. No such geographical trend is apparent for surveillance by research institutes which is similar at all scales, and only slightly more frequent at regional level (28-38%) than elsewhere (18-33%)

		Implementing Institution Type						
Level	**Surveillance**	**National**	**Academic**	**Research Inst**	**Mixed funding**	**Public PCO**	**Veterinary R Inst**	**Private PCO**
National	**Introduction**	40.5	13.9	26.6	10.1	1.3	6.3	1.3
	Arborvirus	40.5	14.5	18.2	16.4	1.8	7.3	1.8
	Abundance	31.5	20.4	33.3	7.4	1.9	3.7	1.9
Regional	**Introduction**	0.0	17.3	38.2	2.7	18.2	15.5	8.2
	Arborvirus	0.0	13.0	27.8	7.4	29.6	16.7	5.6
	Abundance	0.0	12.9	37.6	2.4	17.6	18.8	10.6
Local	**Introduction**	0.0	1.8	23.6	1.8	23.6	25.5	23.6
	Arborvirus	0.0	0.0	21.2	0.0	33.3	24.2	21.2
	Abundance	0.0	1.7	27.6	0.0	13.8	29.3	27.6

Table 2: Types of institution responsible for implementing surveillance at different geographic scales. Values are % of respondents excluding the don't knows.

4.2.3 Surveillance Methods and Training (Q7, Q23)

Participants were asked to state which surveillance methods are used in AIM surveillance and monitoring. Overall, ovitraps are reported to be the most widely used (~ 80%), but not by a large margin: BG Sentinel traps, larval sampling and CO_2 baited traps all scored 50% or higher. Human landing, sticky traps and GAT methods were all comparatively uncommon (reported by 30% or less).

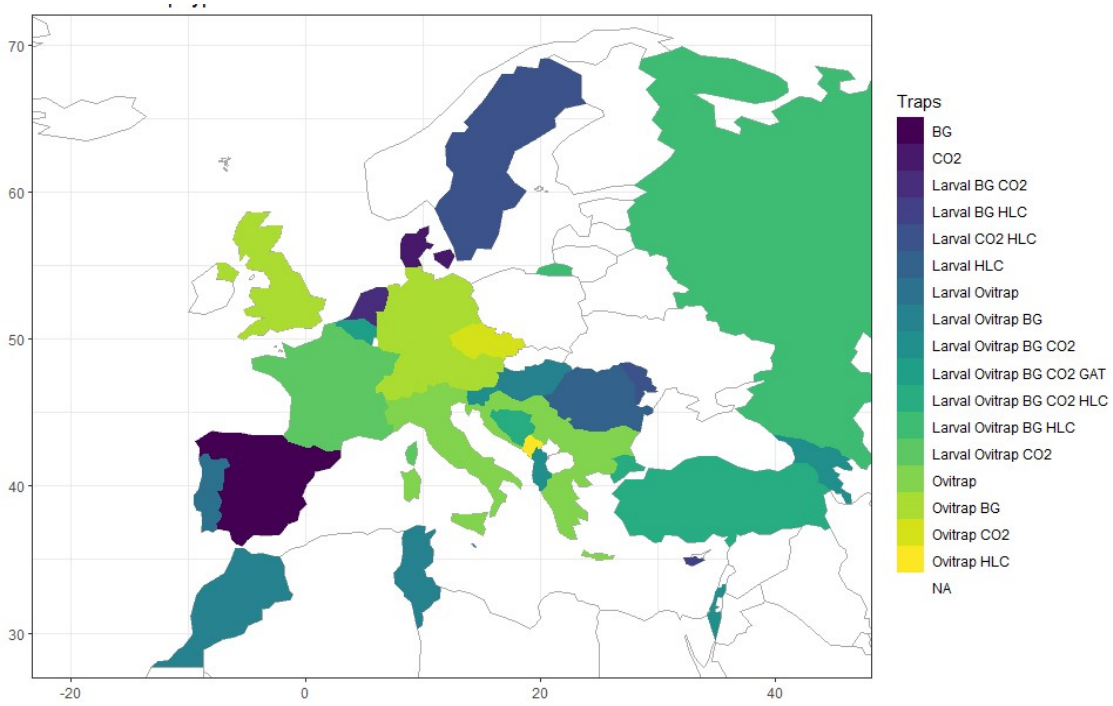

Figure 7: Combinations of type traps uses in different countries.

When examined by country, the patterns are somewhat heterogeneous and show some geographic patterns, mapped in Figure 7. Most countries use a combination of trap types, though ovitraps are the most frequently used methods in Italy and Greece, whilst in Spain, the Netherland and Denmark, it is the BG Sentinel trap that is used most often. Reported trapping density per square kilometre was relatively evenly split by category (< 1, 1-3, 4-10 and >10), with each reported by 10-15% of respondents.

Training in surveillance methods was considered by a large majority (87%) of respondents to be required.

4.2.4 Reporting and Use of Surveillance (Q7 & Q9)

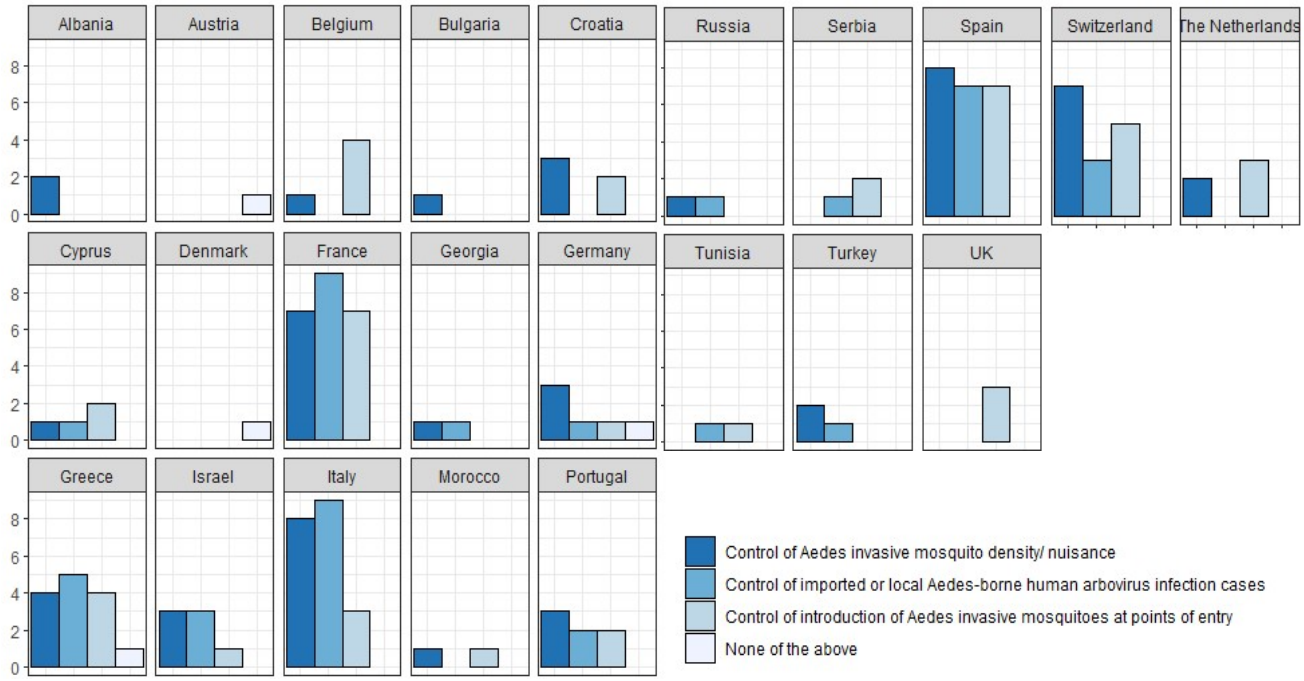

Figure 8: Actions taken in each country as a result of surveillance. Values are respondent number.

Participants reported that surveillance reporting methods are also rather variable but largely traditional. Tables and maps are the preferred reporting tools (>60%), with graphs and notes less commonly used (35-40%). Rather few surveillance results are, as yet, provided through dedicated information systems.

Just over half of respondents replied that surveillance results were used to plan subsequent activities – of which the most commonly identified was density and nuisance control (70%) with a little less(54-58%) confirming the use of surveillance data in control operations at points of entry or to control the spread of arboviruses. These percentages varied, however, from country to country (Figure 8), and no clear geographic pattern is evident

4.3 Control Activities

Highlights Box 4: Control

- Control priorities are nuisance or density reduction primarily at local or regional scale, followed by prevention of disease spread and control at points of introduction at all scales
- National institutions are more involved in control for disease and at points of introduction, but rarely in abundance and nuisance reduction control; Regional authorities, local authorities and health authorities are involved in all types of control; Private companies and citizen groups are more frequently active in abundance and nuisance reduction.
- A third of respondents agreed there should be an external quality assessment for mosquito control interventions.
- Adulticides and biological larvicide (Bti) were commonly used for all control types (abundance, arbovirus reduction, point of entry), followed by source reduction and door to door education programmes. Non-chemical larvicides (surface layer) and insect growth regulators were reported to be less widely used, and other methods such as copepods or fish were consistently rare.
- Control activities were constrained by financial, operational and regulatory factors. Financial constraints were ranked highest, followed by political willingness and awareness of responsible authorities. Operational constraints were lack of operational capacity followed by health priority, cost effectiveness and effectiveness of collaboration between stakeholders. Regulatory constraints comprised environmental regulations followed by regulations on the use of biocides.

4.3.1 Objectives, Implementation and Assessment of Control

4.3.1.1 Objectives and scale of implementation (Q10 & Q11)

Over 85% of the respondents stated that AIM control activities are implemented in their country. When asked why control was being carried out, the most frequently reported objectives were nuisance or density reduction (60%), then prevention of disease spread (50%), with point of introduction control the least frequent (40%). As some 50% of the replies indicated that control for each objective was not carried out, it seems that not all control types were implemented in all areas, so the focus of control objectives varies with region or geographic scale. Figure 9 explores this further and shows that control for abundance (and nuisance) was reported most often for local scale operations, and rather rarely at national scale (8%). The other types of control were more or less equally distributed at all geographic scales, and regional operations consisted equally of all three control activity types.

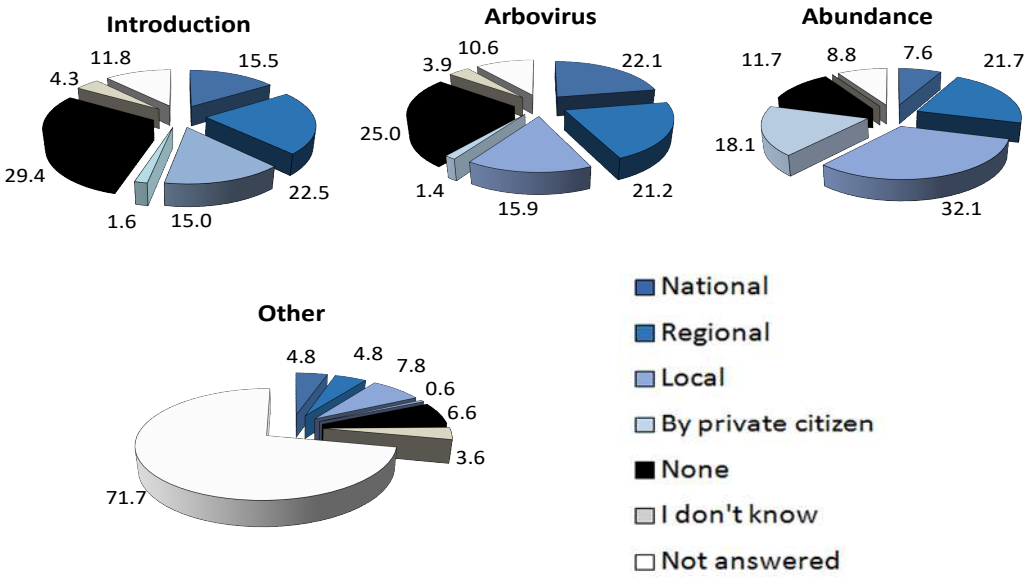

Figure 9: Control objectives at different geographic scales. Values are % respondents.

4.3.1.2 Implementing Institutions (Q12)

These results are largely reflected in the types of institution that implement the various control activities (Figure 10). National institutions rarely implement abundance and nuisance reduction control but are reported to be more involved in control for disease and at points of introduction. Regional authorities are involved in all types of control. Local authorities and health authorities are also involved in all control types. Local authorities more so in abundance and nuisance reduction, with health departments more focused on disease reduction efforts. Private companies and citizen groups are more frequently active in abundance and nuisance reduction and rarely in disease mitigation. A specific question intended to establish details of citizen science involvement in control activities was answered by too few respondents (30%) to provide reliable information which suggests that citizens are somewhat less involved in organised control activities than they are in surveillance programmes.

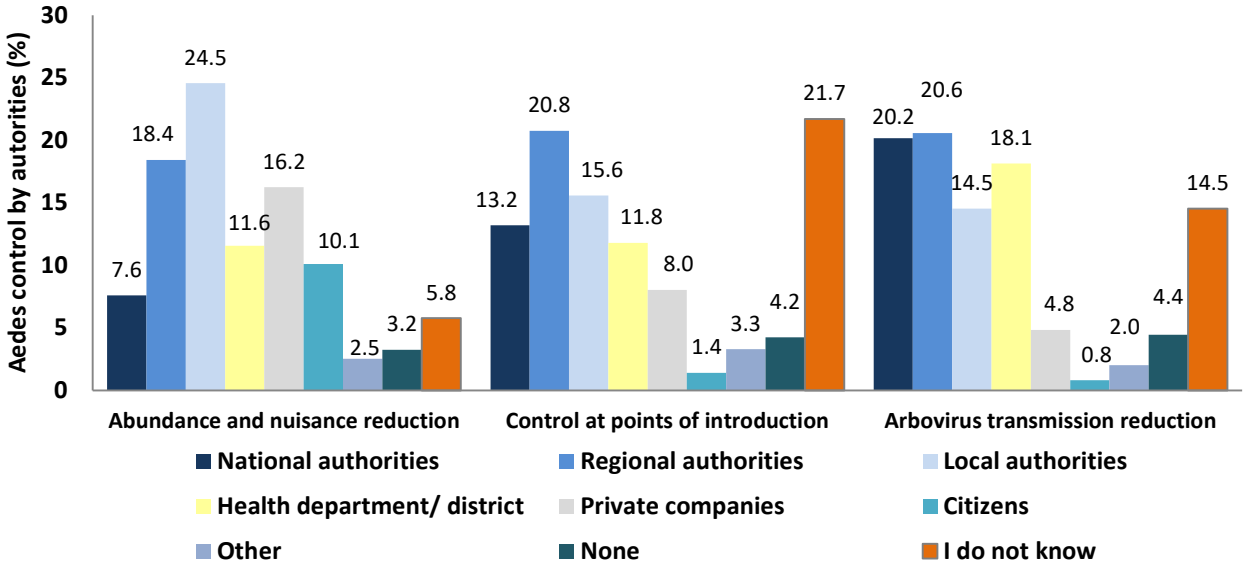

Figure 10: Implementing institutions for different control objectives. Values are % respondents.

4.3.1.3 Assessment of Control Activities (Q16)

Participants were asked if there should be an external quality assessment for mosquito control interventions which will be systematically included in mosquito control programmes and linked to contract obligation. Though only about a third of respondents answered this question, those that responded were strongly in agreement.

	Control objective			
Response	**Points of entry**	**Nuisance**	**Disease**	**Other**
Strongly agree	18.1	14.2	18.1	4.5
Agree	8.4	12.3	9.7	1.3
I don't know	7.1	5.2	5.2	29.0
Disagree	1.9	3.9	2.6	0.6
Strongly disagree	0.6	0.6	0.6	0.6
No Answer	63.9	63.9	63.9	63.9

Table 3: Opinion of need for external assessment of control activities (%).

4.3.2 Methods used in Control (Q13 & Q17)

The most common control methods reported by those with the specialist knowledge required varied substantially according to the objective of the control activities (

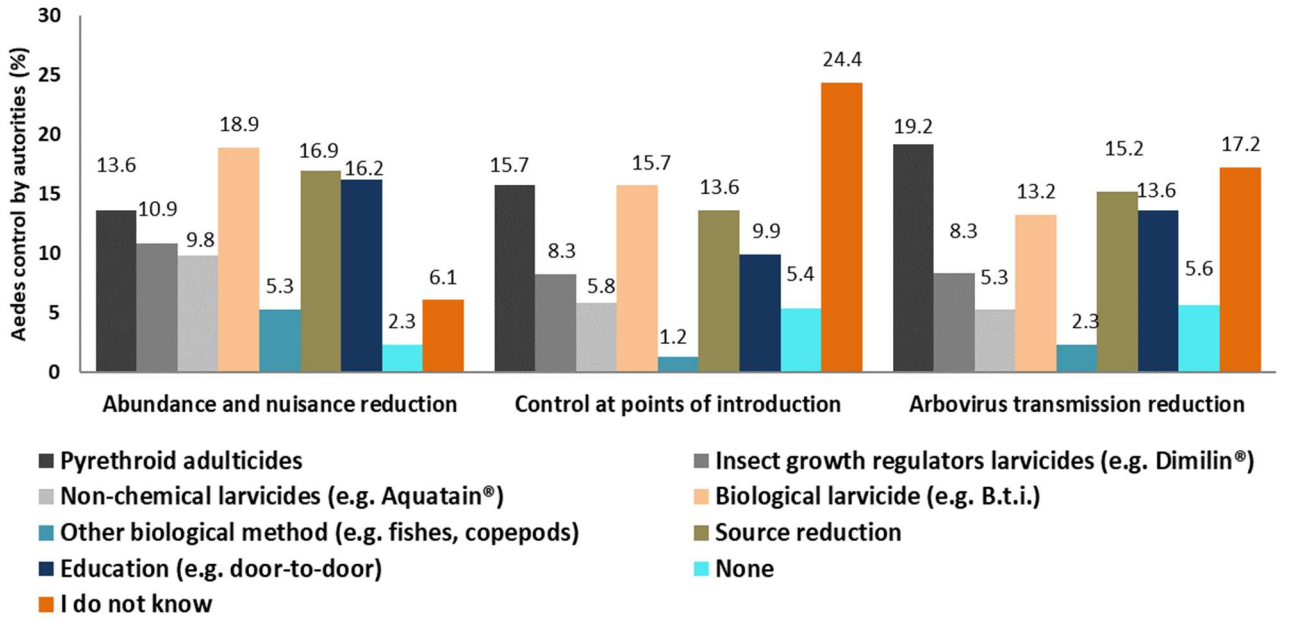

Figure 11). Adulticides and larvicides were commonly used (14-19%) for all types of control, as to a slightly lesser degree were source reduction and door to door education programmes (11-15%). Non-chemical larvicides and insect growth regulators were reported to be less widely used (5 –10%), and other methods such as copepods or fish were consistently rare. The methods used for other control objectives were relied mainly on the use of biocides; pyrethroid adulticides (23%) and larvicides (18%). Note that quite a high percentage (17-24%) of respondents were unable to specify control methods at points of introduction or for arbovirus reduction, though this has little effect on the relative proportions of each answer.

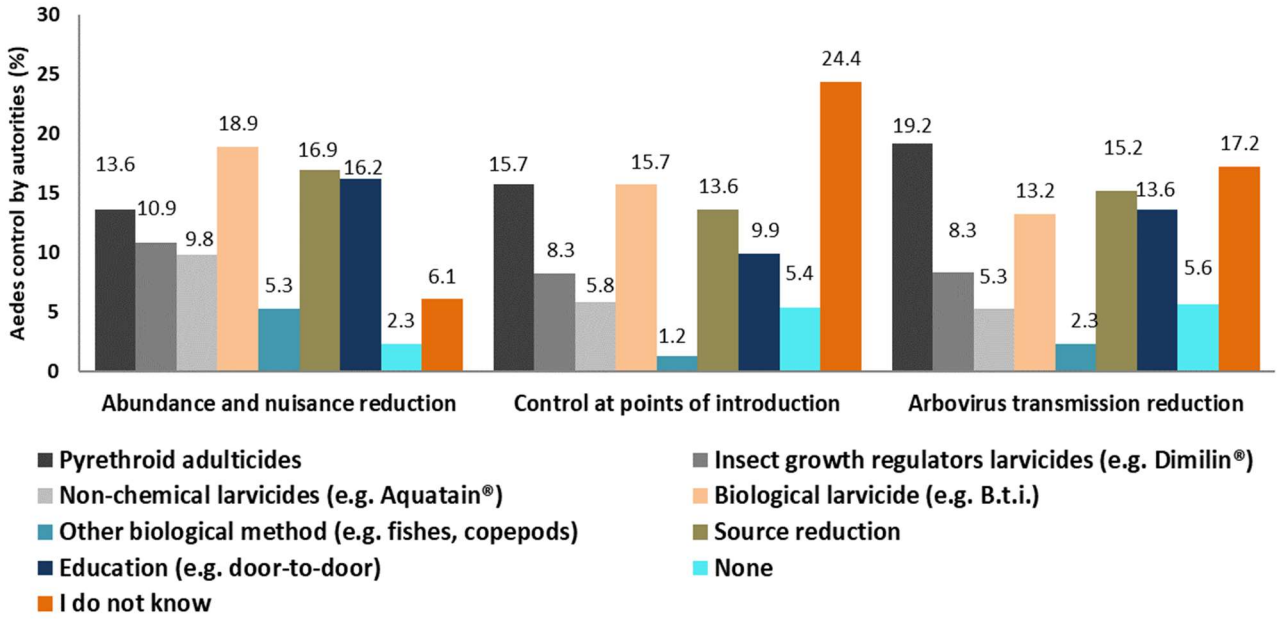

Figure 11: Methods used in control activities. Values are % respondents.

These questions were also focused on traditional and familiar control methods. Only half of respondents were aware of examples of recent use other, novel, methods of control. Amongst those who knew of such activities, the most well-known were irradiated sterile male release (>90%) and autodissemination of biocides (25%). Other novel methods such as *Wolbachia* based suppression, mass-trapping, or transgenic approaches were almost completely unknown.

4.3.3 Constraints on Control (Q14, Q18)

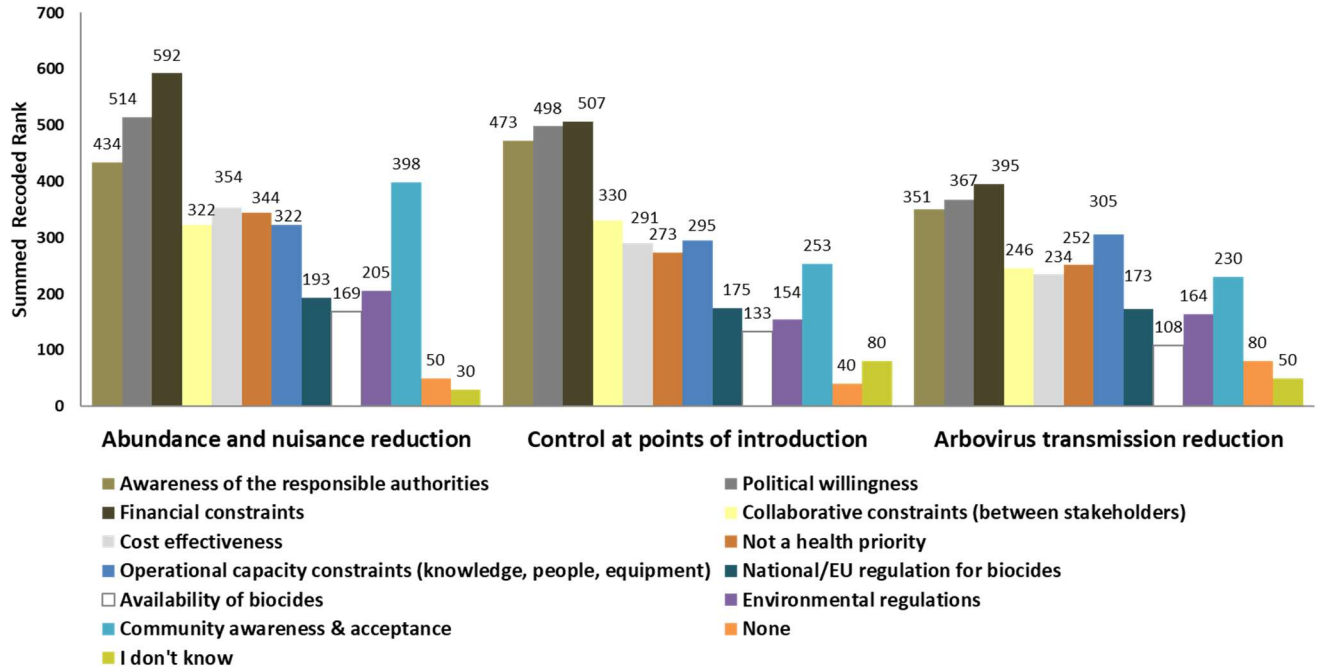

Figure 12: Reported constraints to control activities. Values are summed ranks, recoded as 1st =10 points, 2nd=5 points and 3rd=1 point.

The participants were asked to rank the most common problems or constraints affecting the implementation of the three different types of control. For all types of control, financial constraints were ranked highest,

though political willingness and awareness of responsible authorities followed close behind (Figure 12). These three are related to national politics and are likely to be closely linked: institutional awareness leads to political willingness which provide financial resources.

A second group of more operational constraints were ranked less highly though were still identified as significant problems – namely lack of operational capacity, health priority, (perceived) cost effectiveness, and effectiveness of collaboration between stakeholders. This last factor may be compounded by lack of community awareness and acceptance, which was a particular concern for density reduction and nuisance control. The third and least supported group of regulatory constraints comprised environmental regulations, and the both the availability of and regulatory constraints to use of biocides. When combined the two biocides related constraints joined the second intermediate group.

Insecticide resistance can also be a severe constraint on the success of control activities. About half the respondents were unable to say whether resistance had been reported in their regions, and those that did answer were evenly split between reporting the phenomenon to be reported or not.

Training was also seen to be necessary: a large majority of respondents (87%) reported a need for training in AIM control.

4.4 Involvement of Citizen Scientists (Q8, Q24)

Though less than half of the respondents were aware of surveillance programmes based on Citizen Science, the proportion varied quite substantially between respondents from different countries (Figure 13). It was generally higher (> 60%) in Western Europe than the UK and the Balkans. This contrasts with the countries where Citizen Science data are incorporated into official information, for which the UK and the Balkan score highly. Finally, Norway and Tunisia scored well for both criteria.

Of those that were aware, the greatest contribution made by citizen science surveillance was considered to be increasing geographic coverage and improving early warning capability (70-85%), with rather less support for cost reduction and increased sensitivity to implement control actions (40-60%).

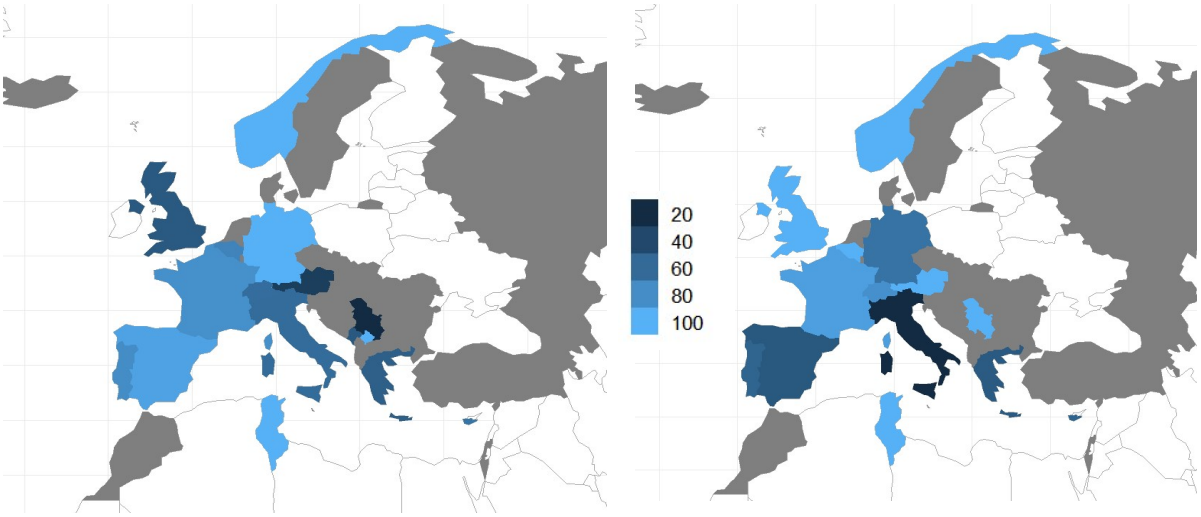

Figure 13 The percentage of respondents aware of Citizen Science initiatives (left) and reporting that citizen science data are incorporated in official surveillance information (right).

The respondents also assessed the importance of having citizens involved in mosquito monitoring surveillance and control activities (source reduction, larval control, biological control, mass trapping). Most participants thought that citizen scientists should be involved in all these activities but mostly on surveillance and source reduction (93%) and monitoring/surveillance (83%) and to a lesser extend with activities that had to do with larval control and biological control (49 %) or mass trapping (41 %).

4.5 Guidelines

Highlights Box 5: Guidelines

- Guidelines for monitoring/surveillance and/or for control are known/used for 37 countries (Europe and beyond). A total of 62 different guidelines documents are cited (of which 27 are scaled for international level, 27 for national level, and 8 for local level).
- The most frequently used guidelines are those from ECDC for AIMs, which are seen to be the best in terms of usefulness, which vectors & VBDS are targeted, scale, strategy & methods.
- Guideline implementation is most constrained by lack of funding and human resources.
- The major gaps & needs appear to be first "Adaptation to the context and/or sector" for the monitoring/surveillance guidelines and "Updating" for the control guidelines.
- Most of the respondents thought that guidelines should be tailored for each target group (planners, technicians, researchers and citizen scientists).
- The best type of guideline dissemination is seen as training seminars for control companies and technicians; awareness campaigns for the general public; public presentations, training seminars, digital documents and awareness campaigns for decision makers; and digital documents or training seminar for researchers.

The success of an AIM management plan relies to its efficiency and sustainability, for both surveillance and control activities. Designing, planning and implementing these activities requires understanding of AIM species' biology, VBD pathogen transmission risk, and surveillance and control methods and techniques, in order to combine and adjust them in a local context and in a cost-efficient approach. Hence many protagonists can intervene in the decision-making process as well as in the operational process of the AIM management programme. Therefore, guidance is crucial to build up the understanding of every protagonist, and several supporting guidance documents are available in Europe and beyond.

Here we aim at: (1) Identifying the various guidelines documents that are used in the perspective of monitoring/surveillance and control of AIMs in Europe and neighbouring countries; (2) Assessing the perception of their usefulness, limitations, gaps and needs; (3) Gauging the appropriateness of dissemination tools and document versions for different audiences.

4.5.1 What Guidelines are used (Q19)

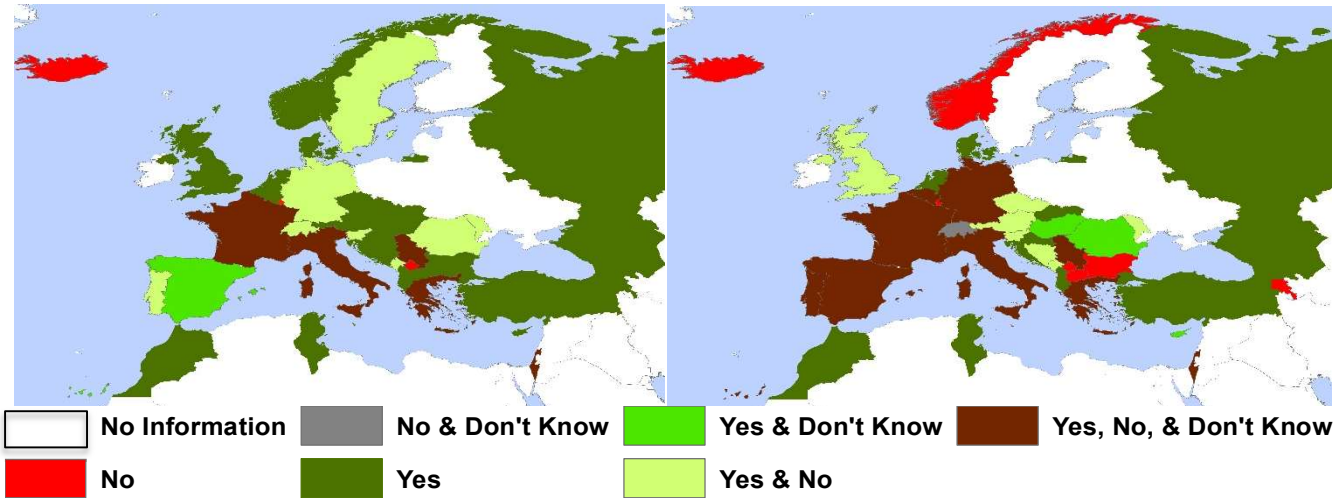

Figure 14: Awareness about and use of guidelines according to the country: Left= Guidelines for monitoring/surveillance; Right=- Guidelines for control.

Responses were obtained for 41 countries, sometimes with contradictory answers ("Yes" and "No" for same country) (Figure 14), which indicates some difference in awareness between participants. Answers refer to guidelines for AIMs but also occasionally for native mosquito species (NMS). Guidelines are known/used for 37 countries (Appendix Table 4).

Respondents are shown to more frequently know/use guidelines for monitoring/surveillance (74.8%) than those for control (52.3%). These frequencies increase for countries where AIM have been reported (76.6% and 54.6%, respectively).

Respondents reported a total of 62 different guidelines documents (Appendix Table 5). Among these, 27 are scaled for international level, 27 for national level, and 8 for local level (*i.e.* part of a country only).

Respondents were asked to list up to 7 guidelines documents. For a first analysis, those listed are gathered into 3 categories: "ECDC" which consists of the 2 guidelines for the surveillance of invasive (ECDCINV) and native (ECDCNAT) mosquitoes [#4 and #5 in Appendix Table 5, respectively]; "WHO" which comprises 15 WHO documents edited by WHO [from #48 to #62 in Appendix Table 5]; "Others" which encompasses 45 other documents, either international (from Europe, including other documents edited in collaboration with ECDC or WHO, or from USA), national and/or local (i.e. sub-national) documents (Figure 15). Most respondents were able to list three guidelines, and relatively few, four or more.

The most frequently cited as highest ranked is "ECDC" (66.4%), while "Others" are cited second (25.2%) and WHO last (8.4%). Overall, "Others" is ranked first (40.8%), while "ECDC" is second (37.0%) followed by "WHO" (22.3%). When guidelines are taken individually this pattern also holds true: the ECDC guidelines for AIMs [#4, ECDCINV in Appendix Table 5] is not only ranked highest most often, (63.6%) but also most frequently cited at any rank (30.5%).

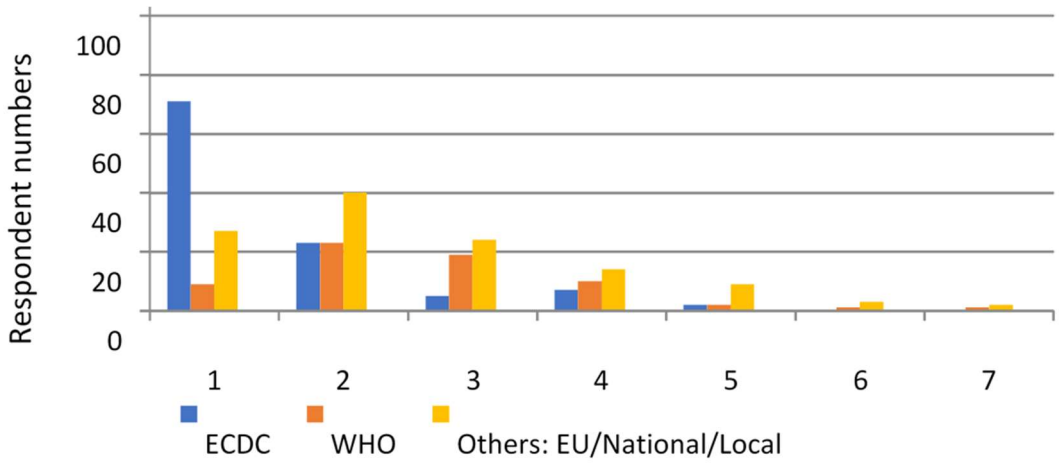

Figure 15: Categories of guidelines ranked 1-7 by respondents.

4.5.2 Assessing usefulness, limitations, gaps & needs

Guidelines were ranked by the respondents for different geographical scales according to four criteria: usefulness, targeted vectors & VBDS, scale, and strategy & methods. In a first step, ranking was analysed by combining the documents into 5 categories: "ECDC" with ECDCINV and ECDCNAT; "WHO" for all WHO-edited documents; "Other International"; "national"; and "local" *i.e.* sub-national.

This showed that "ECDC" guidelines are largely cited at the first place (rank 1) for all four criteria, the "National" ones being considered second also for all criteria. Considering the guidelines individually, ECDCINV guidelines were overall ranked first for all four criteria, while ECDCNAT guidelines is second for usefulness, and EMCAWHO (Guidelines for the control of mosquitoes of public health importance in Europe, edited by EMCA and WHO EURO, Appendix Table 5) is second for targeted vectors, scale, and strategy & methods.

4.5.2.1 Usefulness (Q19)

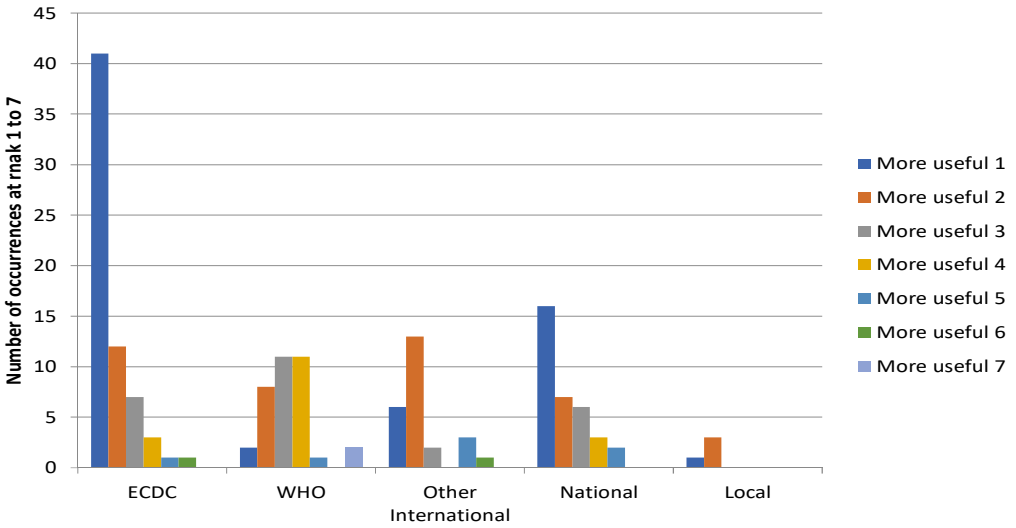

Figure 16: Guidelines categories ranked in terms of usefulness.

Considering the four criteria separately, "ECDC" guidelines in general were ranked in terms of usefulness most useful while "National" guidelines were ranked second, followed by "Other International", "WHO" and "Local" (**Error! Reference source not found.**). When considering guidelines individually, ECDCINV (57.6%) is largely ranked first, while ECDCNAT is cited second (7.4%) Figure 19, Appendix 1). When ranks 1 to 3 are combined together, ECDCINV is again cited first (37.0%), while ECDCNAT is cited second (7.4%), EMCAWHO (6.7%) and the WHO Regional framework for invasive mosquitoes document [WHOINV, #55 in Appendix Table 5] fourth (4.4%).

4.5.2.2 Target vector species & VBDs, scale, and strategy & methods (Q19)

In terms of target vector species and VBDs, scale (national vs. local), and strategy & methods, "ECDC" guidelines are always mentioned as first choice, followed by the "National" guidelines (Figure 20, Guidelines rank for Target vector species & VBDs

In terms of target vector species & VBDs (59 answers), "ECDC" guidelines are mentioned as first choice, followed by the "National" guidelines (Figure 20). Taken individually, the ECDCINV arrives largely first at rank 1 (N=38, 64%). For ranks 1 to 3, ECDCINV is still first (N=51, 38.6%), followed by and EMCAWHO (N=12, 9.1%) and ECDCNAT (N=10, 7.6%) (Figure 21).

, Figure 24**,** Appendix 1). Taken individually, the ECDCINV is most often at rank 1 (Figure 21, Figure 23**,** Figure 25**,** Appendix 1). For ranks 1 to 3 combined, ECDCINV is still first and EMCAWHO is second for all three criteria.

4.5.2.3 Constraints, gaps & needs (Q19c)

Respondents were asked to report constraints and limitations that they face in implementing the surveillance and control guidelines they used. A list of possible limitations was suggested, with multiple choices possible and additional suggestions permitted. The answers (shown in Figure 17) are similar for both surveillance and control guidelines and identify "lack of funding" as the primary (40- 60%) obstacle to guideline implementation and "Limited human resources" as the second (40-50%). Lack of qualified professionals, low public awareness and organisational context were the other main constraints again for implementation of both surveillance and control guidelines.

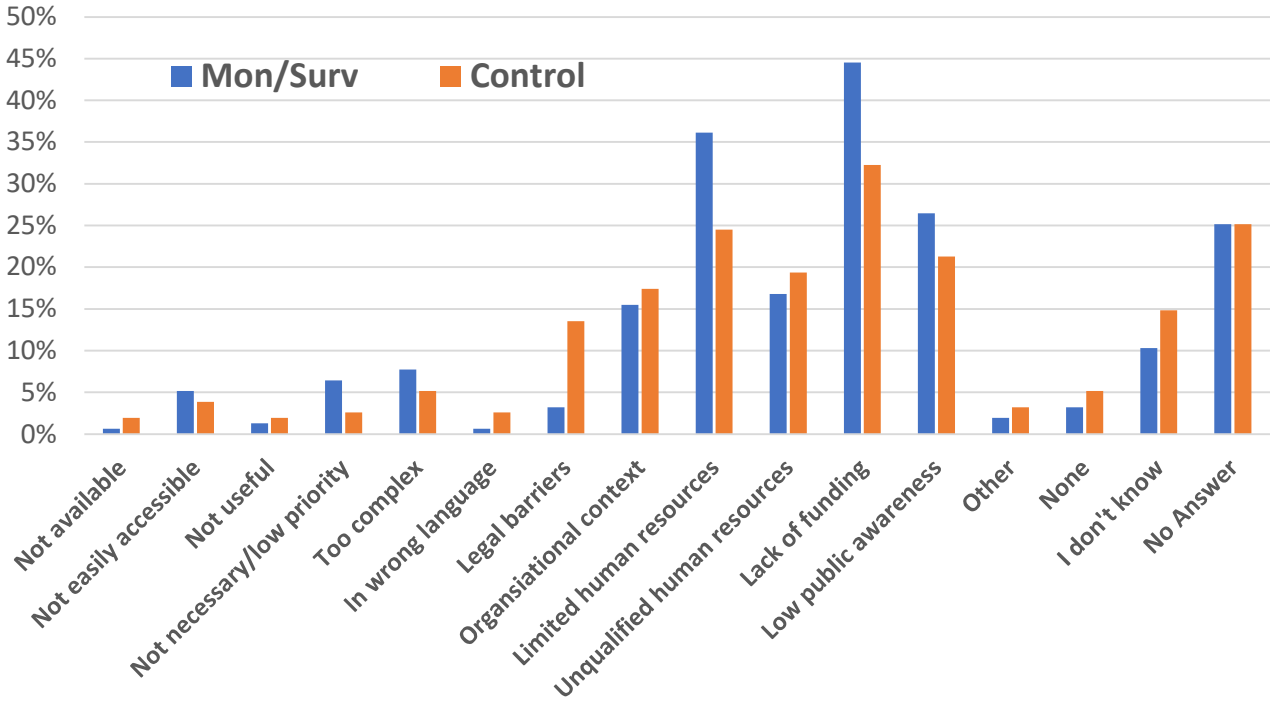

Figure 17: Constraints to use guidelines while implementing AIM surveillance and control.

When asked whether there are gaps or needs in the currently available guidelines, less than half provided definitive "Yes" or "No" answers, but of those who did about two thirds (63%) answered "Yes". A wide range of comments were made in response to this question, - 22 related to monitoring/surveillance guidelines and 27 to control guidelines. All comments were grouped in the following categories:

- Updating: means that the respondent identified the gap/need of updating the guidelines, including new information about new methods, new species, approved products, insecticide resistance, etc.
- Adapt to context or sector: means that the respondent identified the gap/need to adapt the current guidelines, for example to local and/or national scenario.
- QC Needed: means that the respondent identified the gap/need of Quality Management procedures (Quality Assurance and Quality Control), for examples to assess the efficacy of larvicide and /or adulticide treatments.
- Public Engagement: means that the respondent identified the gap/need of involve public in the process of control and/or surveillance, for example by increasing awareness of public to the AIM problem.

Based on these categories, "Adaptation to the context and/or sector" was the most frequent comment for the monitoring/surveillance guidelines (almost 60%), while for the control guidelines, "Updating" was the most frequent comment (Figure 26, Appendix 1).

4.5.3 Appropriateness of dissemination tools and document versions

Only about a third of the participants responded to the question and most of them (71 %) thought that there should be different versions of guidelines for the different groups (planners, technicians, researchers and citizen scientists). Respondents did comment on the dissemination tools available (e.g. printed brochures and leaflets, digital documents, web tools, mobile applications, awareness campaigns, public presentations and training seminars) for guiding different stakeholder groups e.g. decision makers, pest control companies, technicians, researchers and the general public and to rank or prioritise their answers (Figure 18).

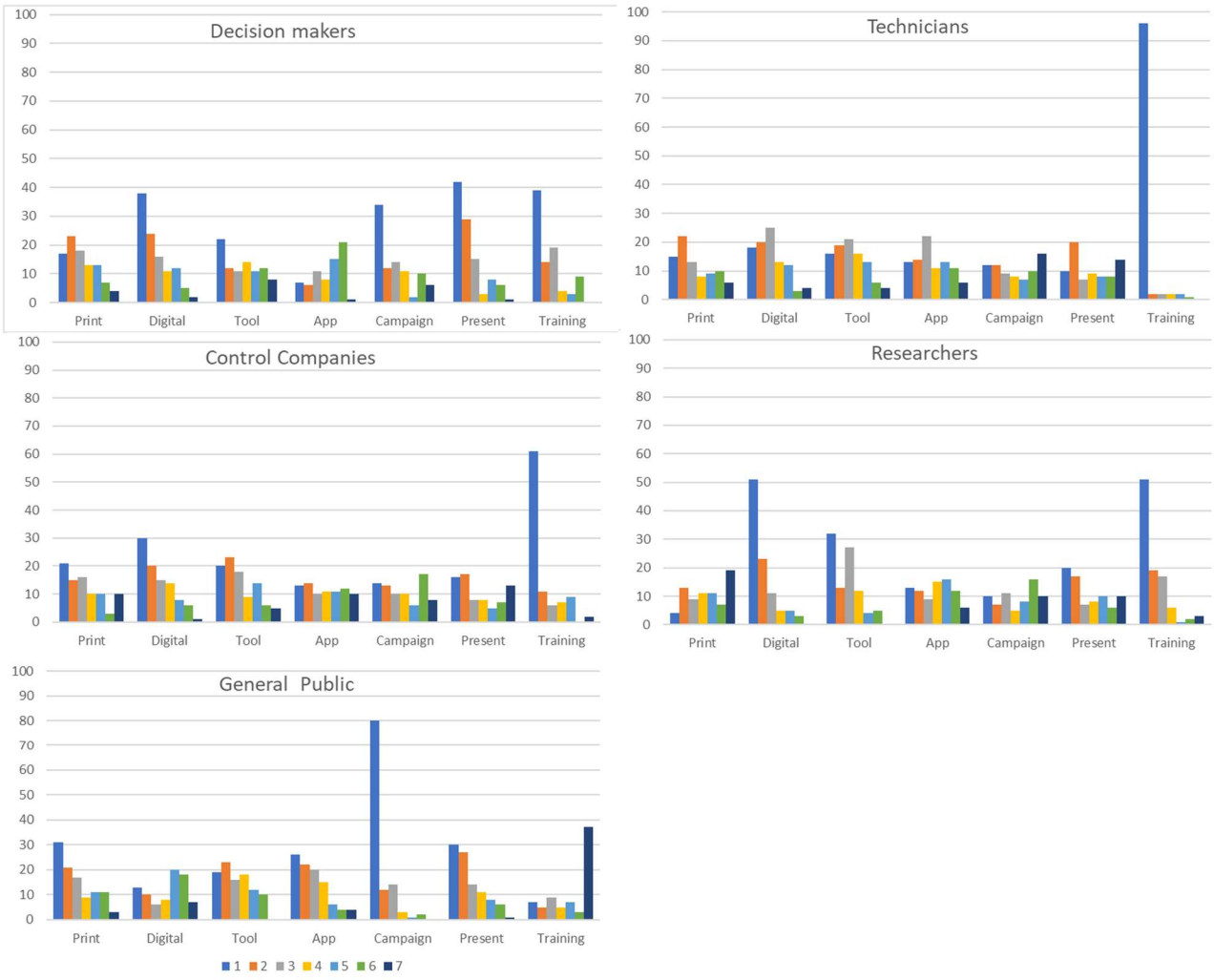

Figure 18: Most appropriate tools for dissemination of Guidelines to different user groups.

For decision makers, the best dissemination tools were considered to be public presentation closely followed by training seminars, digital documents and awareness campaigns. For control companies, best dissemination tool was considered to be the training seminars. For technicians, best dissemination tool was considered to be the training seminars. For the general public, best dissemination tool was considered to be awareness campaigns. For researchers, the best dissemination tools were the digital documents, followed by the training seminars and web tools.

5 Discussion

The questionnaire respondents provided opinions from a wide geographical coverage of 36 European and neighbouring countries, and represents a highly experienced body of expertise, a high proportion of which are from areas where AIM species are present. It should, however, be acknowledged that there is a bias towards academic and institutional professionals from western countries, and that the private sector is poorly represented

Respondents are therefore well placed to assist AIM COST's major objectives of enhancing multidisciplinary collaboration to provide advocacy, technical guidance and training in the management of these vectors, and to promote these activities as a Public Health priority. They largely agree on the main priorities for AIM surveillance - *i.e*. to monitor introduction, spread and early warning - and control - *i.e.* to reduce nuisance or density primarily at local or regional scale, followed by prevention of disease spread and of new introductions at all geographical scales. Different institutions in charge of planning surveillance and control interventions are identified at different scales depending on the objective. Lack of political will and the resulting negative

impacts on funding and availability of qualified personnel are implicated as major impediments to both surveillance and control policies.

Surveillance and Monitoring

Only about half the respondents reported that surveillance/monitoring data are actually used to plan AIM control activities, though limited feedback by private companies (which usually carry out control interventions) prevent a more detailed assessment of what share of control interventions are indeed planned from actual data. Unfortunately, the use of surveillance data specifically to manage transmission risk is even lower. This suggests either that the risk of pathogen transmission is not perceived as a priority or that the cost-benefit of entomological surveillance for AIM species is seen to be lower than that other strategies (*e.g.* surveillance of pathogen circulation in hosts). This highlights the need for better definition of the goals of monitoring and surveillance plans, stronger links between public health officers in charge of mosquito control plans and pest-control companies in charge of implementing them and better reporting of surveillance/monitoring impact and cost. It is also essential that the effectiveness of properly planned surveillance in planning control is better communicated to planners and funding sources. This is especially critical at national and local levels. **AIM-COST contributes to this goal by reinforcing the concept that funding monitoring and surveillance activity is cost-effective only if it provides evidence for improved (e.g. better targeted) control interventions. Advocacy should be better tailored by academics and experts to reach all stakeholders from decision makers, to pest-control companies to citizens. This report is a first step toward this goal. Citizen-science initiatives such as Mosquito Alert could also contribute to this goal, as fully recognised by the respondents to questionnaires.**

Although most respondents use ovitraps for surveillance, many other methods are currently applied. This may be an indication that stakeholders have tailored their monitoring/surveillance scheme to local conditions, as suggested by ECDC guidelines (see below), or more likely that there is no consensus on how to monitor *Aedes* species. **AIM-COST has itself drawn up recommendations for standardised sampling protocols which are being implemented in the summer of 2020 by the AIMSurv 2020 Initiative[5]. This involves 47 AIM-COST partners across 27 countries in Europe and in the Mediterranean Basin and aims to standardize monitoring approaches, improve exploitation and to produce baseline data valuable for continent wide preparedness in collaboration with the VectorNet project funded by ECDC and EFSA. Appropriate dissemination of AIMSurv activities and results to stakeholders is expected to increase awareness at both the political and citizen level. Sharing the variety of experiences could greatly improve the use of surveillance data in the planning of subsequent activities both within and between countries.**

Control

Questionnaire results highlight the widespread use of pyrethroid adulticides not only to control arbovirus autochthonous transmission, but also to reduce AIM abundance/nuisance. pyrethroid spraying is not recommended due to reduced effectiveness caused by resistance and its widespread collateral ecological damage. Only half of the respondents are aware of insecticide resistance in their region, which strongly highlights the need for better dissemination to citizens and professionals of risks associated with insecticide use, and the availability of alternative control strategies with higher long-term efficacy and lower environmental impact. The questionnaire results also highlight weaknesses in international/national regulation on the use of biocides which are currently seen as major constraints to control. **Actions to improve these situations should become priorities of AIM-COST in the next years.**

Respondents who expressed an opinion on the subject, stressed the relevance of the need of an external quality assessment for mosquito control interventions, highlighting once again the need for stronger links between different actors involved in AIM prevention and control. **In this context AIM-COST has held a Workshop on control methods and produced a perspective paper summarizing experts' opinions on different components of Quality Management system (i.e. Quality Assurance and Quality Control) for mosquito control programs with special emphasis on.**

Guidelines

[5] **https://www.aedescost.eu/sites/default/files/2020-07/AIMCOSTPressRelease_AIMSurv29072020.pdf/.**

This is the first continent-wide survey about the use of AIM control and surveillance guidelines. Guidelines are widely available and often used in monitoring and surveillance, especially at regional or national scale and but much less often for control, for which guidelines are less widely available and for which implementation is more often a local responsibility. The Agency sponsored guidelines are by far the most widely used (primarily from ECDC and WHO). WHO guidelines are less widely adopted, probably because they are less focussed on AIM species and are written for a global rather than European context.

International guidelines are the most comprehensive and wide ranging, are in English and are written for all EU countries. They are, however less well tailored for local conditions, which are more often covered by more specialist documents (e.g. EMCAWHO) or locally produced guidelines with a more focussed subject matter and more often in national languages. They also have yet to include the latest information (on new target species, approved control products, insecticide resistance, or new methods), and do not address details of Quality Management procedures within control guidelines and on Public Engagement

International guidelines therefore need to be updated and harmonised to reduce contradictions. in order to give more straightforward and clear messages to the stakeholders. It would also be advisable for the major international guidelines to either provide additional local guidance or to identify documents that are adapted to national/local scales, and incorporate the relevant parts of the international recommendations.

Most guidelines are very detailed, and the lack of funding and human resources often preclude their proper implementation. International guidance should recognise and adapt to this reality by prioritising guideline content into a minimal set of essential activities and an additional set of activities required to optimise surveillance and control programmes. This would help ensure that those with limited funding targeted their activities most effectively.

The AIM COST Action intends to address this need for customisation for each operational stakeholder group by producing a range of information documents and media relevant to the management of monitoring, surveillance and control planning and implementation. These will provide 'baseline' content that can be customised (and translated) for particular target groups and epidemiological situations, and will be complemented by video presentations illustrating the appropriate operational steps. This blended material is expected promote dissemination and harmonisation of best practices, enhance stakeholder engagement and the expansion of multidisciplinary collaboration, improve advocacy at national and international level to attract more resources and better trained professionals.

Training

Training needs are widely acknowledged by respondents. **AIM-COST devotes much of its resources to training and information, both by providing technical information as described above, and by providing training courses in surveillance, control, and analysis, and by funding placements for young researchers in expert laboratories.**

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7 Appendices

Appendix 1: Additional Tables and Figures

Table 4: Awareness about and use of guidelines according to the country of working place of respondent.

Country	Guidelines for monitoring/surveillance			Guidelines for control		
Albania	Yes			Yes		
Armenia	Yes				No	
Austria	Yes			Yes	No	
Belgium	Yes			Yes	No	I don't know
Bosnia and Herzegovina	Yes			Yes	No	
Bulgaria	Yes				No	
Croatia	Yes			Yes		
Cyprus	Yes			Yes		I don't know
Czech Republic	Yes			Yes	No	
Denmark	Yes			Yes		
France	Yes	No	I don't know	Yes	No	I don't know
France OCTs	Yes		I don't know	Yes		
Georgia	Yes			Yes		
Germany	Yes	No		Yes	No	I don't know
Greece	Yes	No	I don't know	Yes	No	I don't know
Hungary	Yes			Yes		I don't know
Iceland		No			No	
Israel	Yes	No	I don't know	Yes	No	I don't know
Italy	Yes	No	I don't know	Yes	No	I don't know
Liechtenstein		No			No	
Luxembourg			I don't know		No	
Kosovo		No				I don't know
Malta	Yes				No	
Moldova	Yes	No		Yes	No	
Montenegro	Yes	No		Yes	No	
Morocco	Yes			Yes		
North Macedonia	Yes			No		
Netherlands	Yes			Yes		
Norway	Yes				No	
Portugal	Yes	No		Yes	No	I don't know
Romania	Yes	No		Yes		I don't know
Russia	Yes			Yes		
Serbia	Yes	No	I don't know	Yes	No	I don't know
Slovakia	Yes			Yes		
Slovenia	Yes	No		Yes	No	
Spain	Yes		I don't know	Yes	No	I don't know
Sweden	Yes	No		Yes	No	
Switzerland	Yes	No			No	I don't know
Tunisia	Yes			Yes		
Turkey	Yes			Yes		
United Kingdom	Yes	No		Yes	No	

Table 5 lists all different guideline documents which were cited by the respondents. For many of them, the answer was not precise enough to identify the exact document, in particular when several are published by the same agency (e.g. WHO). Thus, some respondent (n=52) where contacted in order to get further specifications about the precise document they refer to, and also to get a link to or a pdf of the cited document if needed. Where 'ECDC' was entered without specifying 'invasive' or 'native', we did consider that refers to guidelines for invasive mosquitoes (ECDCINV). When several editions were available for a document title, we listed only the most recent one.

Table 5: List of guideline documents mentioned by respondents, according to their attributed code (in alphabetical order) and their scale category. INT = international; NAT = national; LOC = local.

#	Guide ID Code	Title	Agency or Author	Scale	Ed. date
1	ACADCLE	The biology of mosquitoes. Vol 1 - Development, Nutrition and Reproduction; Vol 2 - Sensory Reception and Behaviour: Vol 3 - Transmission of Viruses and Interactions with Bacteria	Clements A.N.	INT	1992-1999-2011
2	ACADSER	Mosquito ecology. Field sampling methods	Service M.W.	INT	1993
3	ALBNAT	Udhëzues mbi kontrollin e vektorëve dhe brejtësve në Shqipëri [Vector and rodent control in Albania]	Institute of Public Health	NAT: Albania	2013
4	ECDCINV	Guidelines for the surveillance of invasive mosquitoes in Europe	ECDC	INT	2012
5	ECDCNAT	Guidelines for the surveillance of native mosquitoes in Europe	ECDC	INT	2014
6	ECDCVC	Vector control with a focus on *Aedes aegypti* and *Aedes albopictus* mosquitoes: Literature review and analysis	ECDC	INT	2017
7	EMCAWHO	Guidelines for the control of mosquitoes of public health importance in Europe	EMCA & WHO Regional Office for Europe	INT	2013
8	FRANSES	Avis révisé de l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail relatif à « l'analyse de la stratégie de lutte anti-vectorielle (LAV) mise en œuvre à La Réunion depuis 2017 »	Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (ANSES)	NAT: France	2018
9	FRCNEV	Guide à l'attention des collectivités souhaitant mettre en œuvre une lutte contre les moustiques urbains vecteurs de dengue, de chikungunya et de Zika	Centre national d'expertise sur les vecteurs (CNEV)	NAT: France	2016
10	FRDENCHIK	Guide relatif aux modalités de mise en œuvre du plan anti-dissémination du chikungunya et de la dengue en métropole	French Ministry in charge of Health	NAT: France	2015
11	GERNATACT	*Aedes albopictus* in Deutschland - Aktionsplan für den Umgang mit der Asiatischen Tigermücke [*Aedes albopictus* in Germany - Action plan for dealing with the Asian tiger mosquito]	Nat. Expertenkommission „Stechmücken als Überträger von Krankheitserregern", Friedrich-Loeffler-Institut	NAT: Germany	2016
12	GERNATPLA	*Aedes albopictus* in Deutschland - Handlungsbedarf und -optionen im Umgang mit der Asiatischen Tigermücke [*Aedes albopictus* in Germany – Call for action and options regarding Asian tiger mosquitoes]	Nat. Expertenkommission „Stechmücken als Überträger von Krankheitserregern", Friedrich-Loeffler-Institut	NAT: Germany	2016
13	GREDEN	Σχέδιο διαχείρισης των διαβιβαστών σε περίπτωση κρούσματος Δάγκειου πυρετού, λοίμωξης από ιό Chikungunya ή Zika [Response vector management plan in case of dengue fever, chikungunya or Zika virus infection]	Hellenic Ministry of Health	NAT: Greece	2016
14	GREMOSCON	Προγράμματα καταπολέμησης των κουνουπιών, σχέδιο δράσης, σχετική ενημέρωση και προφύλαξη του κοινού για το έτος 2019. [Mosquito control programme, action plan and relevant public awarness and precaution for 2019]	Hellenic Ministry of Health	NAT: Greece	2019
15	HUNMOSCON	Módszertani Levele – A Szúnyogok Elleni Védekezésröl [Methodological letter – On the control of mosquitoes]	Béla Johan National Centre for Epidemiology	NAT: Hungary	2005
16	ISRLOCAL			NAT: Israel	

#	Guide ID Code	Title	Agency or Author	Scale	Ed. date
17	ITAALBO	Linee guida per la sorveglianza e il controllo di *Aedes albopictus* in Italia	Istituto Superiore di Sanità	NAT: Italy	1996
18	ITAARBOV	Piano nazionale di prevenzione, sorveglianza e risposta alle arbovirosi (PNA) 2020-2025	Ministerio della Salute	NAT: Italy	2019
19	ITAEMROM	Piano Regionale di Sorveglianza e Controllo delle Arbovirosi - Anno 2019 [Emilia-Romagna regional plan for the surveillance and control of arboviruses]	Regione Emilia-Romagna	LOC: Emilia-Romagna, IT	2019
20	ITAERIMC	Zanzare e altri insetti: impara a difenderti - Per una strategia integrata di lotta alle zanzare, 2019 - Linee guida per gli operatori dell'Emilia-Romagna. [Integrated mosquito control startegy, 2019 - Guidelines for operators in the Emilia-Romagna region]	Regione Emilia-Romagna	LOC: Emilia-Romagna, IT	2019
21	ITAINV	Piano Nazionale di sorveglianza e risposta alle arbovirosi trasmesse da zanzare invasive (*Aedes* sp.) con particolare riferimento ai virus Chikungunya, Dengue e Zika - 2018	Ministero della Salute	NAT: Italy	2018
22	ITAINVTREN	Piano per il controllo della zanzara tigre in provencia di Trento	Provincia Autonoma di Trento	LOC: Trento, IT	2018
23	ITAISSVEC	Linee guida per il controllo di Culicidi potenziali vettori di arbovirus in Italia [Guidelines for control of potential arbovirus mosquito vectors in Italy]	Istituto Superiore di Sanità	NAT: Italy	2009
24	ITAWNLAZ	Piano di Sorveglianza e risposta al virus della West Nile e Usutu. Regione Lazio, 2019	Regione Lazio	LOC: Lazio, IT	2019
25	ITAWNV	Piano di Sorveglianza e risposta al virus della West Nile e Usutu - Regione Lazio - 2019 [Surveillance and response plan for West Nile and Usutu – Lazio Region – 2019]	Ministerio della Salute	NAT: Italy	2018
26	LIFECON	Practical management plan for invasive mosquito species in Europe: I. Asian tiger mosquito (*Aedes albopictus*)	LIFE CONOPS	INT	2020
27	MORIBM	Manuel de la gestion intégrée de la lutte antivectorielle. 1-Processus d'implantation. 2- Outils techniques de la lutte antivectorielle.	Direction de l'Epidémio-logie et de Lutte contre les Maladies, Ministère de la Santé	NAT: Morocco	2012
28	NLIMS	Beleid bij exotische steekmuggen in Nederland	Rijksinstituut voor Volks-gezondheid en Milieu (RIVM)	NAT: Netherlands	2013
29	NLINV	Vondst exotische mug: Wat nu?	Netherlands Food and Consumer Product Safety Authority, Nederlandse Voedsel- en Warenautoriteit (NVWA)	NAT: Netherlands	2014
30	NLNMS	Bestrijding van inheemse muggen in Nederland [The control of native mosquitoes in the Netherlands]	Rijksinstituut voor Volks-gezondheid en Milieu (RIVM)	NAT: Netherlands	2016
31	PORVEC	Plano nacional de prevenção e controlo de doenças transmitidas por vetores	Direçao-Geral da Saúde	NAT: Portugal	2016
32	RUSCUL	Контроль численности кровососущих комаров р. Culex, места выплода которых находятся в населенных пунктах [Control of the abundance of blood-sucking mosquitoes of the genus *Culex*, of which the breeding sites are located in settlements]	Federal Service for Surveillance on Consumer Right Protection and Human Wellbeing	NAT: Russia	2009

#	Guide ID Code	Title	Agency or Author	Scale	Ed. date
33	RUSINV	Организация и проведение мероприятий по энтомологическому мониторингу и регуляции численности кровососущих комаров *Aedes aegypti* и *Aedes albopictus* [Organising and conducting activities for the entomological monitoring and regulation of the number of blood-sucking mosquitoes *Aedes aegypti* and *Aedes albopictus*]	Federal Service for Surveillance on Consumer Right Protection and Human Wellbeing	NAT: Russia	2016
34	RUSMAL	Малярийные комары и борьба с ними на территории Российской Федерации. [Malaria mosquitoes and their control in the Russian Federation.]	Federal Service for Surveillance on Consumer Right Protection and Human Wellbeing	NAT: Russia	2000
35	RUSWNV	Мероприятия по борьбе с лихорадкой Западного Нила на территории Российской Федерации [Activities to control West Nile fever in the Russian Federation]	Federal Service for Surveillance on Consumer Right Protection and Human Wellbeing	NAT: Russia	2010
36	SPANECPLA	Guía uía para la gestión de mosquitos y simúlidos	Asociación Nacional de Empresas de Sanidad Ambiental (ANECPLA)	NAT: Spain	2018
37	SPCATARB	Protocol per a la vigilància i el control de les arbovirosis importades transmeses per mosquits a Catalunya	Agència de Salut Pública de Catalunya (ASPCAT)	LOC: Catalonia, SP	2019
38	SPCATINV	Estratègia per a la prevenció i el control del mosquit tigre a Catalunya	Comissió Interinstitucio-nal per a la Prevenció i Control del Mosquit Tigre a Catalunya	LOC: Catalonia, SP	2011
39	SPMOH	Plan nacional de preparación y respuesta frente a enfermedades transmitidas por vectores - Parte I: Dengue, Chikungunya y Zika	Ministerio de Sanidad, Servicios Sociales e Igualdad	NAT: Spain	2016
40	SPMOSAND	Control integral de mosquitos en Huelva	López Sánchez S.	LOC: Andalucia, SP	1989
41	SWISSINV	Koordination der Überwachung und Bekämpfung der Asiatischen Tigermücke und anderer invasiver gebietsfremder Mücken in der Schweiz / Coordination du contrôle et de la lutte contre le moustique tigre asiatique et d'autres moustiques exotiques invasifs présents en Suisse	Federal Office for the Environment	NAT: Switzerland	2019
42	USCALAIM	Guidance for surveillance of and response to invasive *Aedes* mosquitoes and dengue, chikungunya, and Zika in California	California Department of Public Health	LOC: California, USA	2019
43	USCDCIMM	Integrated Mosquito Management for *Aedes aegypti* and *Aedes albopictus* mosquitoes	Centers for Disease Control and Prevention	INT	2019
44	USCDCINV	Surveillance and Control of *Aedes aegypti* and *Aedes albopictus* in the United States	Centers for Disease Control and Prevention	INT	2017
45	USCDCINVIR	Guidelines for *Aedes aegypti* and *Aedes albopictus* Surveillance and Insecticide Resistance Testing in the United States	Centers for Disease Control and Prevention	INT	2016
46	VNETECDC	Field sampling methods for mosquitoes, sandflies, biting midges and ticks – VectorNet project 2014–2018	ECDC & EFSA	INT	2018
47	VNETEFSA	Field sampling methods for mosquitoes, sandflies, biting midges and ticks – VectorNet project 2014–2018	EFSA & ECDC	INT	2018
48	WHOCOMBI	Communication for behavioural impact (COMBI): a toolkit for behavioural and social communication in outbreak response	WHO/FAO/UNICEF	INT	2012

#	Guide ID Code	Title	Agency or Author	Scale	Ed. date
49	WHODENCON	Guidelines for dengue surveillance and mosquito control	WHO Regional Office for the Western Pacific	INT	2003
50	WHODENDIAG	Dengue: guidelines for diagnosis, treatment, prevention and control	WHO/TDR	INT	2009
51	WHODENGUE	Comprehensive guidelines for prevention and control of dengue and dengue haemorrhagic fever	WHO Regional Office for South-East Asia	INT	2011
52	WHOEUTC	Training curriculum on invasive mosquitoes and (re-)emerging vector-borne diseases in the WHO European Region	WHO Regional Office for Europe	INT	2016
53	WHOEUVEC	Manual on prevention of establishment and control of mosquitoes of public health importance in the WHO European Region (with special reference to invasive mosquitoes)	WHO Regional Office for Europe	INT	2019
54	WHOIHR	International health regulations (2005)	WHO	INT	2016
55	WHOINV	Regional framework for surveillance and control of invasive mosquito vectors and re-emerging vector-borne diseases 2014–2020	WHO Regional Office for Europe	INT	2013
56	WHOIVM	Handbook for integrated vector management	WHO	INT	2012
57	WHOPAG	Vector surveillance and control at ports, airports, and ground crossings	WHO	INT	2016
58	WHOPEST	Space spray application of insecticides for vector and public health pest control - A practitioner's guide	WHOPES	INT	2003
59	WHOTDR	A review of entomological sampling methods and indicators for dengue vectors	UNICEF/UNDP/WORLD BANK/WHO - Special Programme for Research and Training in Tropical Diseases (TDR)	INT	3003
60	WHOURB	Public health significance of urban pests	WHO Regional Office for Europe	INT	2008
61	WHOVEC	Global vector control response 2017–2030	WHO/TDR	INT	2017
62	WHOZIKEU	Zika virus - Technical Report	WHO Regional Office for Europe	INT	2016

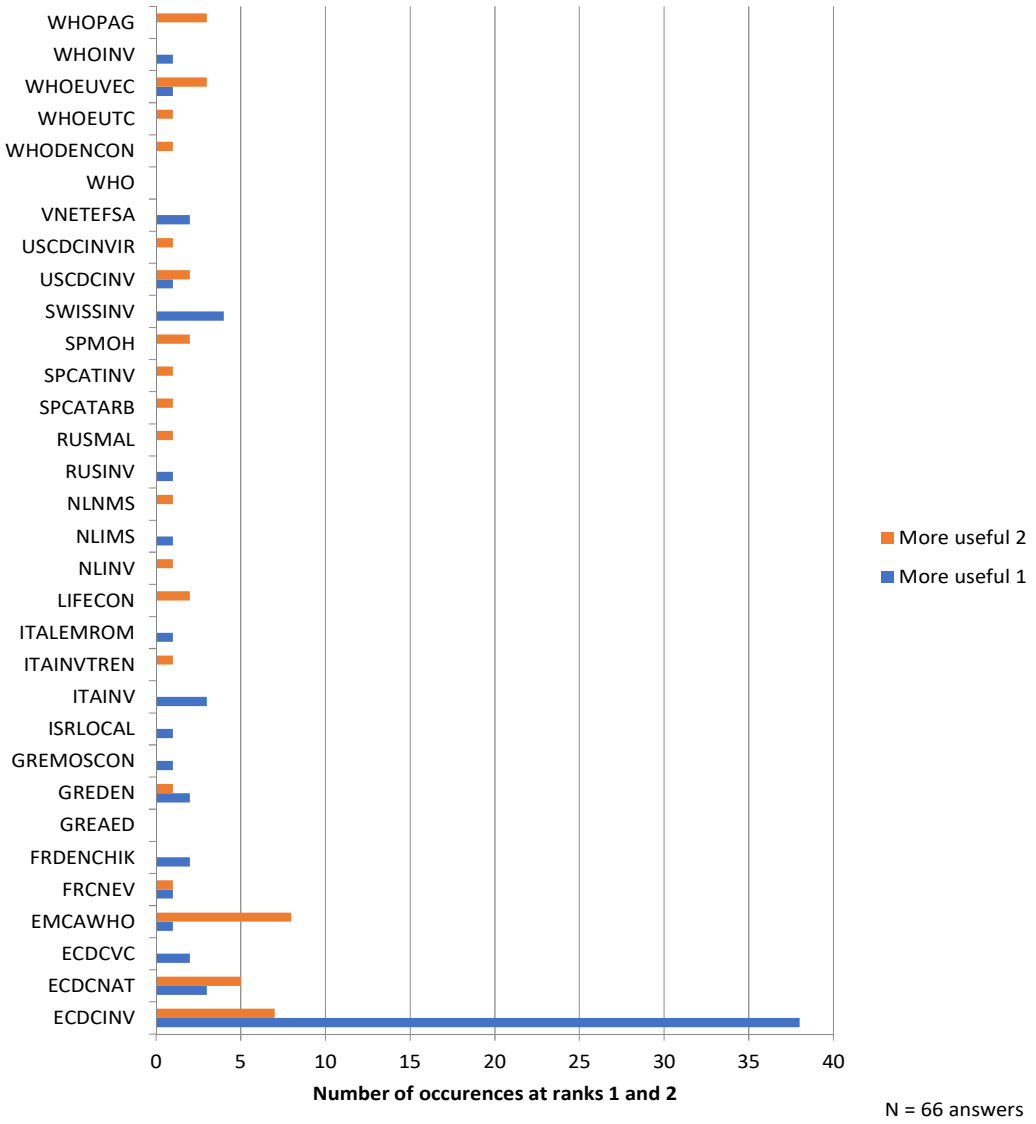

Figure 19: Guidelines ranked at 1st and 2nd place by the respondent in terms of usefulness, in the respondent's local context.

Guidelines rank for Target vector species & VBDs

In terms of target vector species & VBDs (59 answers), "ECDC" guidelines are mentioned as first choice, followed by the "National" guidelines (Figure 20). Taken individually, the ECDCINV arrives largely first at rank 1 (N=38, 64%). For ranks 1 to 3, ECDCINV is still first (N=51, 38.6%), followed by and EMCAWHO (N=12, 9.1%) and ECDCNAT (N=10, 7.6%) (Figure 21).

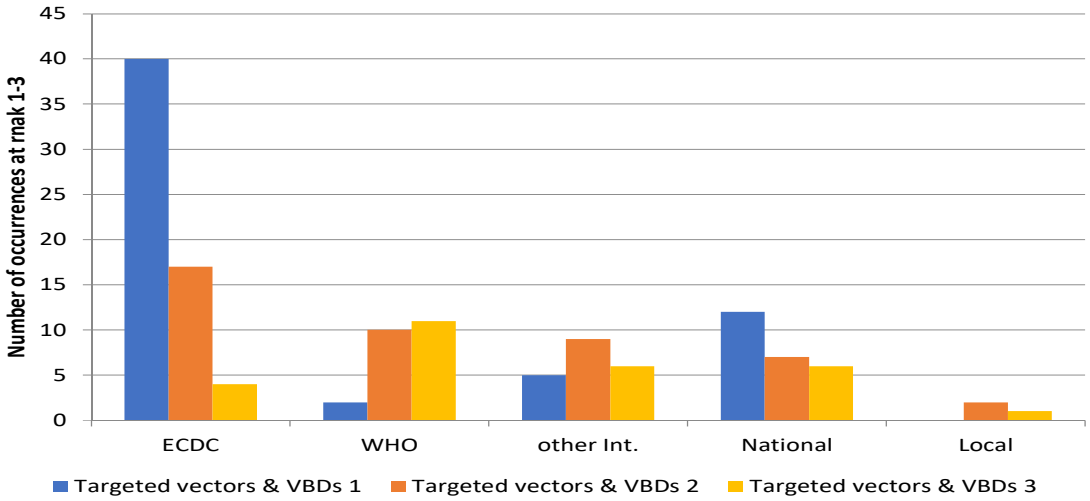

Figure 20: The best guidelines categories ranked from 1 to 3 by the respondent in terms of target vector species, in the respondent's local context.

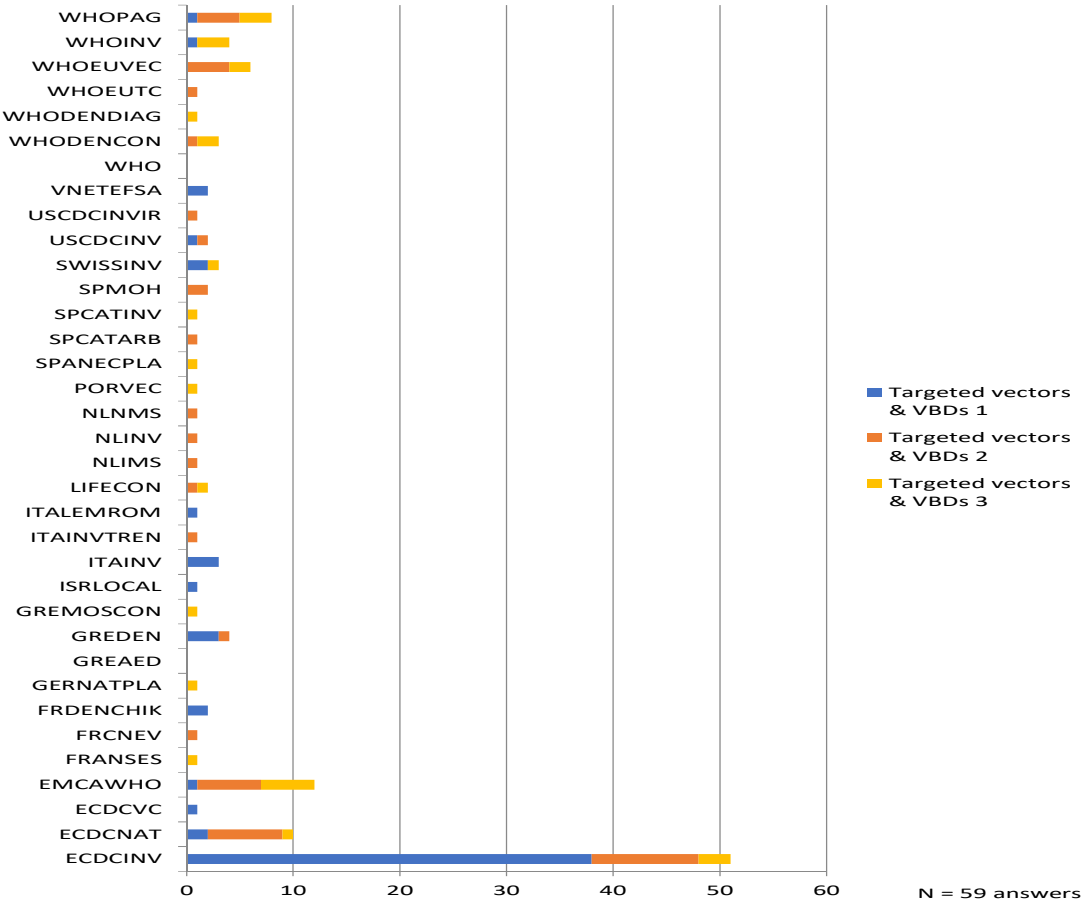

Figure 21:. The best guidelines categories ranked from 1 to 3 by the respondent in terms of target vector species, in the respondent's local context

Guidelines rank for scale

In terms of scale (national vs. local) (54 answers), again "ECDC" guidelines are mentioned as first choice, the "National" guidelines as second (Figure 22). Taken individually (Figure 23), the ECDCINV arrives largely first (N=30, 56.6%). Over ranks 1 to 3, ECDCINV is first (N=45, 38.8%), EMCAWHO second (N=11, 9.5%) and third the WHOEUVEC (N=7, 6.0%).

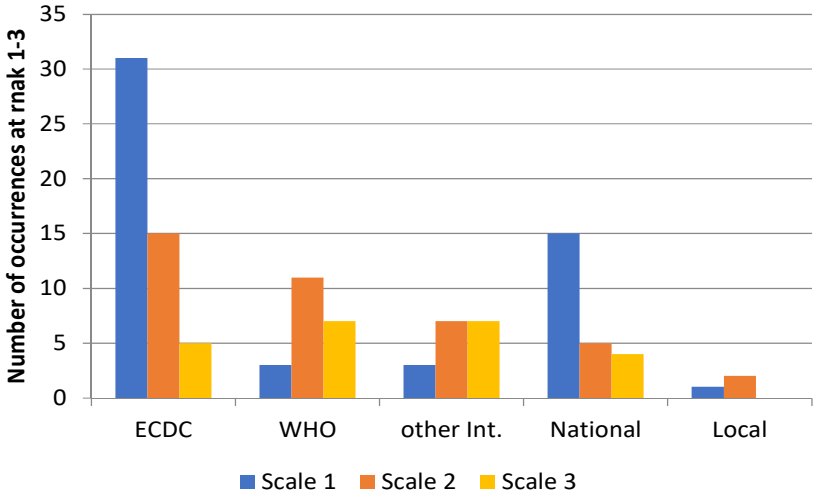

Figure 22: The best guidelines categories ranked from 1 to 3 by the respondent in terms of scale, in the respondent's local context.

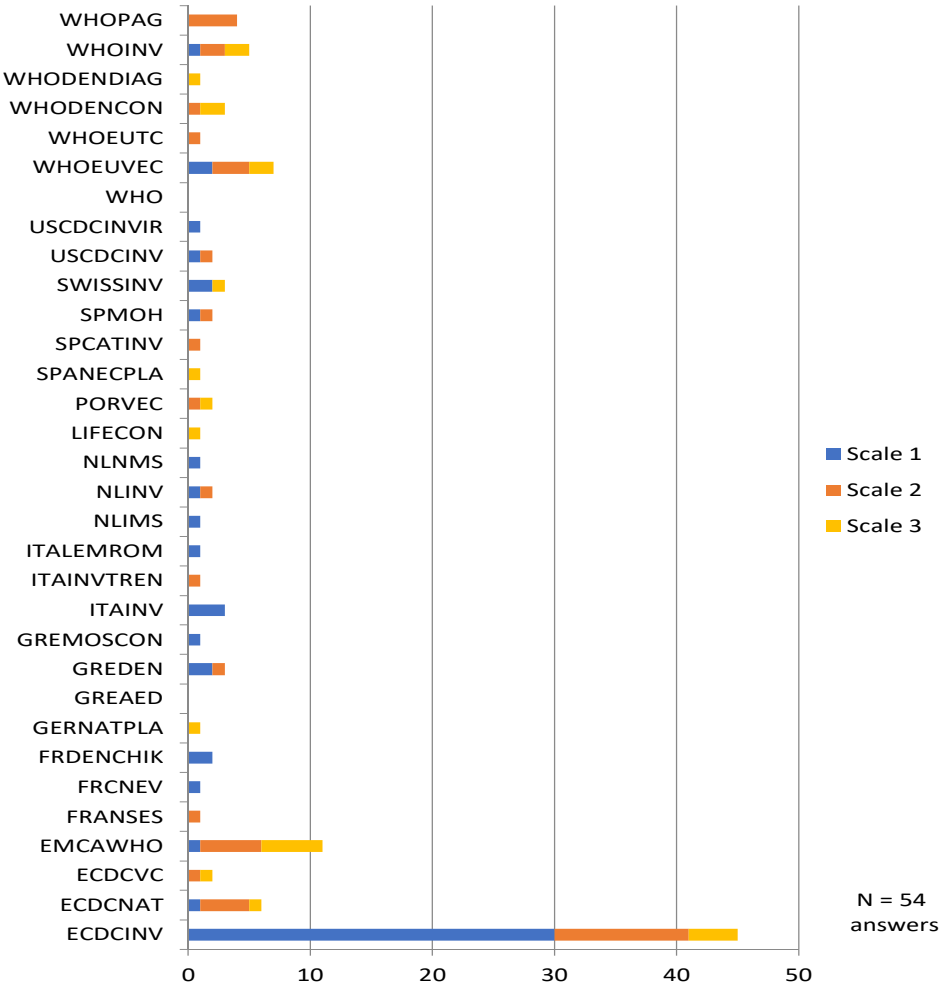

Figure 23: The best guidelines categories ranked from 1 to 3 by the respondent in terms of scale, in the respondent's local context.

Strategy & methods

In terms of strategy & methods (51 answers), again "ECDC" guidelines are mentioned as first choice, the "National" guidelines as second (Figure 24). Taken individually, the ECDCINV arrives largely first at rank 1 (N=33, 64.7%). Over rank 1 to 3, ECDCINV is first (N=44, 38.3%), EMCAWHO second (N=11, 9.6%), and both ECDCNAT and WHOEUVEC third (N=6, 5.2%) (Figure 24).

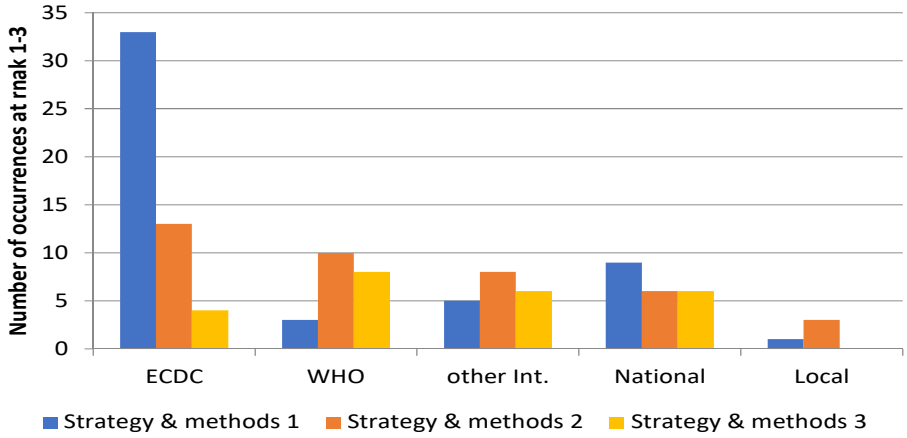

Figure 24: The best guidelines categories ranked from 1 to 3 by the respondent in terms of strategy and methods, in the respondent's local context.

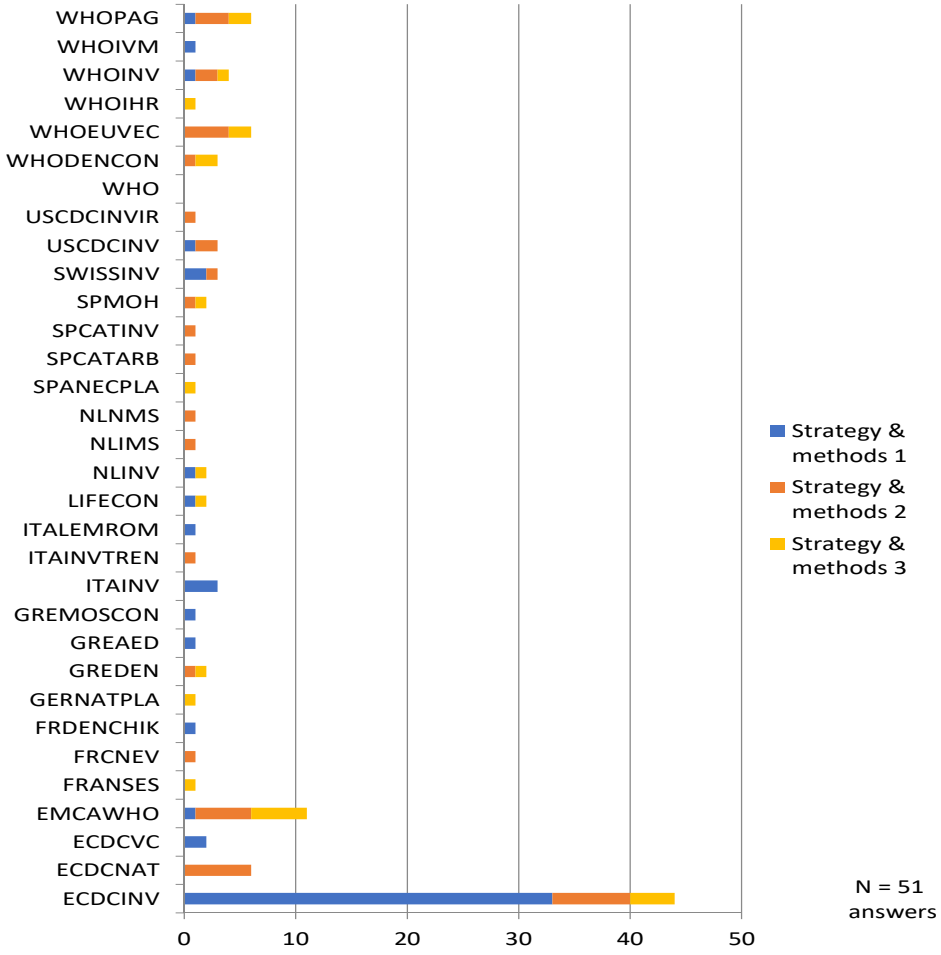

Figure 25:. The best guidelines categories ranked from 1 to 3 by the respondent in terms of strategy and methods, in the respondent's local context

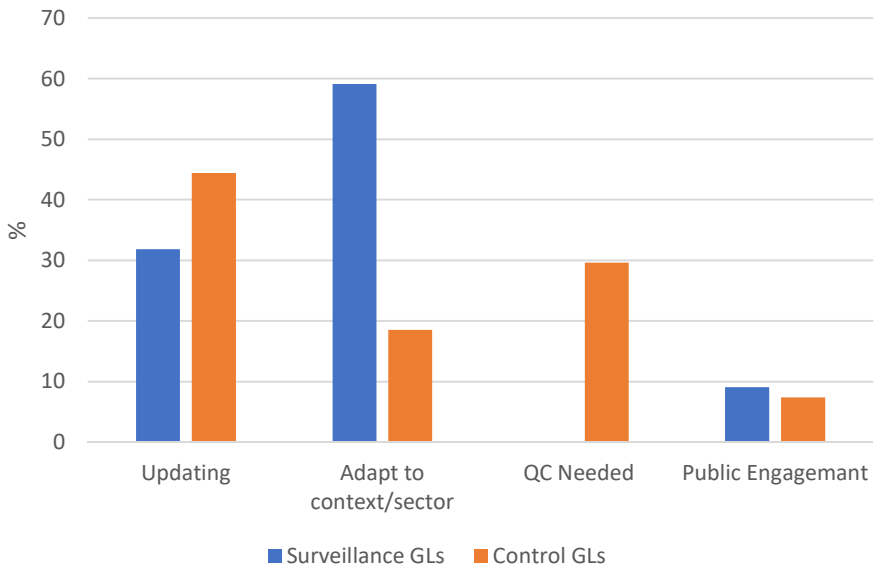

Figure 26: Categories of gaps/needs in the current monitoring/surveillance and/or control guidelines reported by respondents. QC = Quality check; GLs = Guidelines. ($N_{surveillance}$= 22; $N_{control}$= 27).

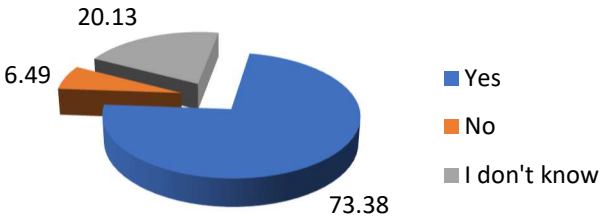

Figure 27: Respondents' agreement to participate in a standardised surveillance system and protocol developed through AIM-COST (in %).

More than two-thirds of the participants agreed to participate in a standardized surveillance system and using the protocol developed through AIM-COST at least as a part of their monitoring/surveillance programme (Figure 27).

Appendix 2: Questionnaire document

The hardcopy questionnaire is provided here as an embedded document in order to save space.

Click on the link below to open

AIM-COST pilot questionnaire final v

Appendix 3: Author details and contacts

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