FRAMEWORK FOR NATIONAL SURVEILLANCE & CONTROL PLANS FOR *AEDES* VECTORS IN THE PACIFIC

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Representative Office for the South Pacific

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Empty tin cans in a farmhouse in Kiribati. These cans collect rainwater and attract *Aedes* mosquitoes to lay their eggs.

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Acknowledgements

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Abbreviations and acronyms

GVCR	Global Vector Control Response 2017–2030
IRS	indoor residual spraying
MoH	Ministry of Health
PIC	Pacific island country and area
IRS-*Aedes*	targeted indoor residual spraying for *Aedes*
ORS-*Aedes*	targeted outdoor residual spraying for *Aedes*
VBDCP	vector-borne disease control programme
VSCP	vector surveillance and control plan
WHO	World Health Organization

Summary

Why?

Populations in Pacific island countries and areas (PICs) remain vulnerable to *Aedes*-borne diseases for which there are no available vaccines or specific treatments e.g. dengue, chikungunya, and Zika virus disease. Prevention of outbreaks through effective vector surveillance and control is important. However, many PICs do not have plans in place to ensure preparedness and have limited local capacity to mount an effective response.

Who?

This framework is designed to assist vector-borne disease control programmes in PICs to plan for the prevention and response to outbreaks of diseases carried by *Aedes* mosquitoes.

What?

It outlines information to be included in national vector surveillance and control plans (VSCPs) and provides guidance on implementing these plans.

Where?

The framework is intended to guide the development of VSCPs that are adapted to the specific needs of PICs considering the local situation, health priorities and resource availability. Since these all vary between and within PICs, this framework provides guidance on aspects of vector surveillance and control that can be considered across different Pacific settings.

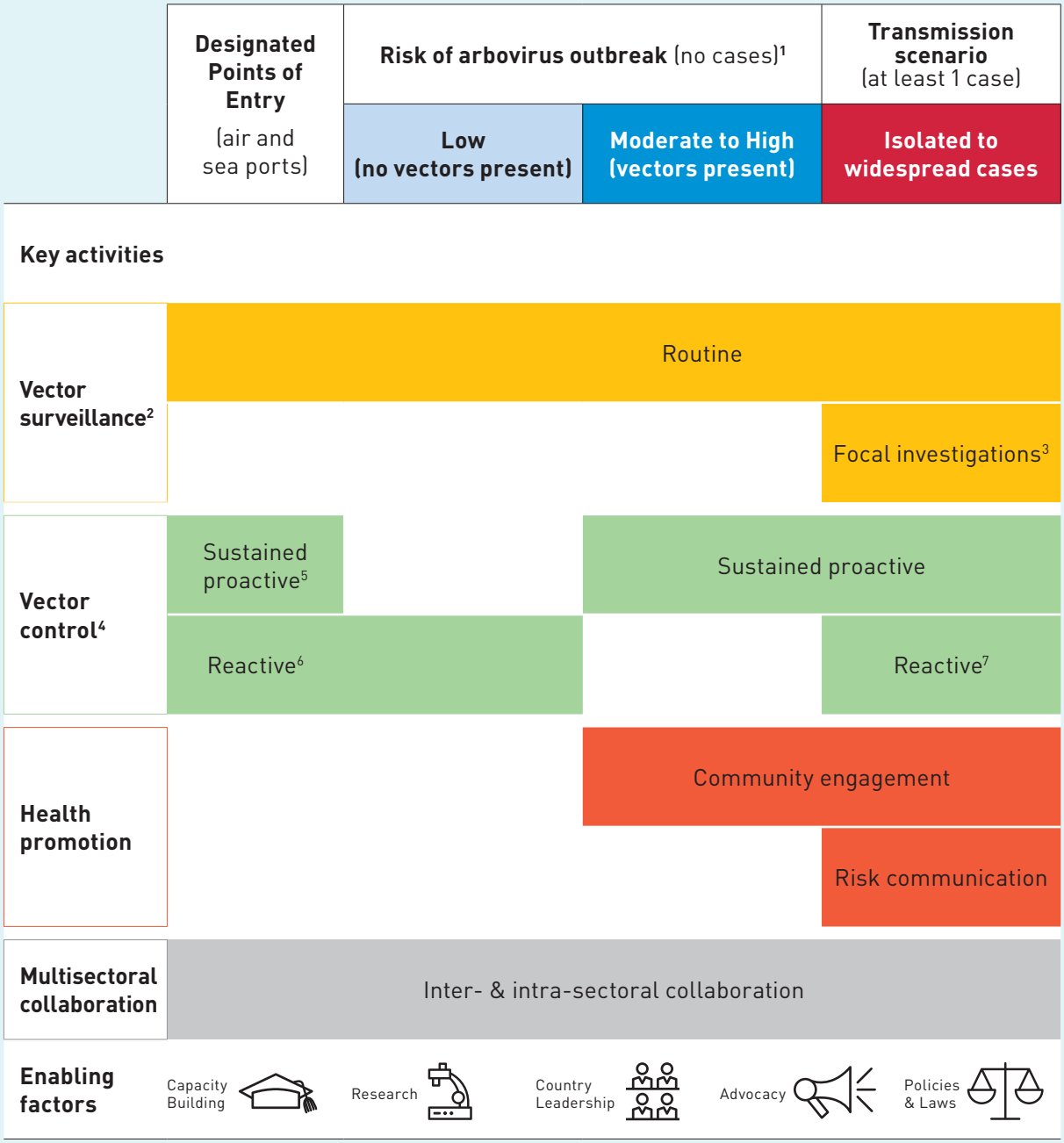
How?

Priority activities will differ within and between countries, and must be adapted when levels of transmission risk change. For example:

- In a country with no *Aedes* vectors and no endemic arboviruses, efforts should focus on points of entry (airports, seaports) for rapid detection and response to incursive species.
- In a country with endemic arboviral disease, ongoing routine vector surveillance is essential to guide prioritized action in the event of a significant increase in cases – tailored to local *Aedes* distribution and risk of virus transmission.
- Sustained proactive vector control to reduce vector breeding should be the mainstay of control programmes.
- Where a reactive response is required (to an outbreak), interventions should be targeted to the highest risk areas.

At a minimum, capacity to conduct essential vector surveillance and control activities is required for all PICs. To be effective, activities should include engagement with communities, leaders and sectors beyond health to ensure coordination. Key considerations for integrated *Aedes*-borne disease management are shown in the figure on the next page, which can be used as a guide on elements to be considered in developing an *Aedes* VSCP. Importantly, VSCPs should ensure that *Aedes*-borne disease management is well integrated within vector-borne disease control programmes, and enable PICs to effectively prevent and respond to ongoing *Aedes*-borne disease threats.

Key elements of effective *Aedes* vector surveillance and control



1. Risk is determined by a combination of factors that include occurrence of competent vectors, human immunity, virus presence or likelihood of importation.
2. During outbreaks, vector control may take priority over surveillance activities, depending on available capacity.
3. Focal investigations are small-scale and occur at and around case houses to inform reactive vector control operations.
4. Specific activities are dependent on the risk of outbreaks, and/or transmission scenario and available capacity.
5. Sustained proactive vector control includes periodic activities carried out at planned times throughout the year. These may be focal (small-scale) or broad-scale.
6. If exotic species are detected.
7. May be focal or broad scale. Specific activities are dependent on the current transmission scenario, outcome of focal investigations and available capacity. See Annexes 4 and 5 for further information.

1. Introduction

Infectious disease outbreaks due to *Aedes* mosquitoes have become increasingly common globally, including in Pacific island countries and areas (PICs), where outbreaks caused by arboviruses such as dengue, Zika and chikungunya viruses are increasing in frequency and scale. Since 2014, 20 of the 22 PICs reported arboviral disease outbreaks, with a total of 104 outbreaks identified through either the Pacific syndromic surveillance system or from a literature review between 1 October 2014 and 30 June 2020 (Mathews RJ et al., 2022). The increasing trend in outbreaks is a concern, as many small PICs have fragile health systems that can easily be overwhelmed.

Mosquitoes of the *Aedes (Ae.)* genus, of which *Ae. aegypti* is the most common vector throughout PICs, transmit arboviruses such as dengue, Zika and chikungunya viruses. For most arboviral diseases, there is no specific treatment, and vaccines are available against only a few of these viruses. Vector control can, however, prevent many infections if it is well coordinated and implemented. Vector control has contributed to major reductions in vector-borne diseases globally, despite some challenges to coverage (WHO, 2017a).

Although integrated vector control remains pivotal to the prevention and control of all arboviruses, programmes and activities are frequently segmented by disease instead of leveraging capacity to address these related public health threats. An integrated approach will ensure optimal use of limited resources, particularly where arboviral disease burden is greatest, and where areas are at risk of arboviral disease emergence. Combining disease-specific interventions known to be effective against several arboviral diseases will be the most cost-effective, sustainable strategy for reducing disease while addressing the unique aspects of each virus separately.

Proactive and integrated use of interventions in advance of outbreaks is particularly important in resource-constrained settings, to ensure efficient preparedness, prevention, response and control of *Aedes*-borne disease threats. Such a strategy would ideally include comprehensive risk monitoring, rapid detection and response to outbreaks to prevent epidemics, strengthening of integrated vector management, development of systems and strategies to monitor and reduce risk and better collaboration of stakeholders in various disciplines. In areas lacking resources to implement a comprehensive strategy, a scaled-back approach can ensure essential baseline surveillance activities and response measures are maintained.

To promote the full potential of vector surveillance and control to reduce the disease burden, WHO published the Global vector control response 2017–2030 (GVCR) (WHO, 2017a) in response to World Health Assembly resolution 70.16. Since then, WHO has issued several high-level guidance documents to assist in planning and implementation of the GVCR, including the Framework for a national vector control needs assessment (WHO, TDR, 2017), the Framework for a national plan for monitoring and management of insecticide resistance in malaria vectors (WHO, 2017b) and, more recently, the **Manual for surveillance and control of *Aedes* vectors in the Pacific (Pacific Community, WHO Division of Pacific Technical Support, 2020)**. However, standardized guidance for practical, actionable vector surveillance and control plans (VSCP) for *Aedes* spp. in PICs was required, as consistent with the objectives and recommendations of the GVCR and WHO evidence-based recommendations.

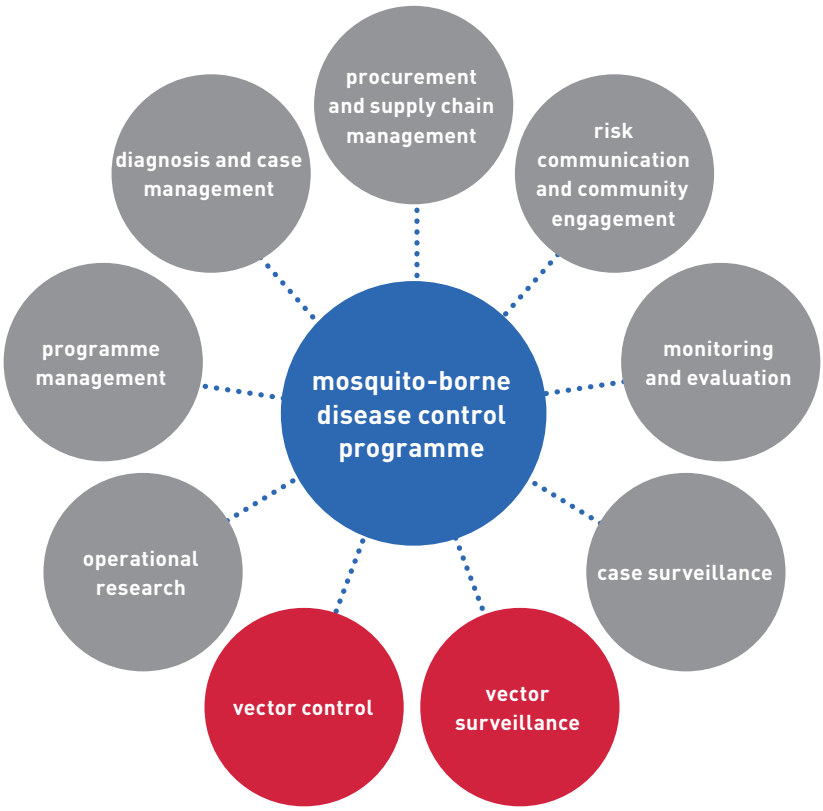
This framework therefore offers PICs a basis for developing *Aedes* vector surveillance and control plans (VSCPs) to prevent and/or contain most arboviruses and thereby reduce the burden of *Aedes*-borne diseases of Pacific island populations and communities. The document provides strategic guidance to ministries of health in developing national VSCPs for *Aedes*-borne diseases that are appropriate for PIC transmission settings and their health system resources. The intention is to facilitate implementation of WHO recommendations for *Aedes* vector surveillance and control that complement and are integrated with broader strategies to address vector-borne diseases. The ultimate objective is to reverse the rising incidence of *Aedes*-borne diseases in the region and to prevent the spread of both arboviruses and their vectors to new areas.

The framework is primarily for programme managers and operational staff responsible for planning, implementing, monitoring and evaluating *Aedes* VSCPs and for collaborating and community partners in vector-borne disease surveillance and control. The framework is intended to be used in conjunction with the **Manual for surveillance and control of *Aedes* vectors in the Pacific** that is regularly cross-referenced throughout this document. Together, these documents provide detailed guidance to adapt broader guidelines into practical, action plans, tailored to the context of each PIC. Both documents focus on medically important *Aedes*-transmitted arboviruses, namely dengue, Zika and chikungunya viruses, for which there is limited guidance for PICs.

According to the context of each country, VSCPs based on this framework could be individual plans (i.e. for *Aedes* only), integrated into national vector-borne disease control plans (e.g. for *Anopheles*) or part of a larger disease control plan that covers many vector-borne and arboviral diseases (Fig. 1). The framework outlines the content to be included and the key considerations in developing a national *Aedes* VSCP. The annexes provide further information and references for planning and implementing *Aedes* VSCPs.

An *Aedes* VSCP is an integral component of the response to mosquito-borne disease threats. It should be used together with guidance on other essential aspects of vector-borne disease prevention and control, such as diagnosis and case management, programme management, monitoring and evaluation, operational research and community mobilization. This framework offers PICs guidance that is adaptable to the unique situation of each country or area, while also adhering to the objectives and recommendations of the GVCR.

Fig. 1. Key elements of a national vector-borne disease control programme



The two elements of a mosquito-borne disease control programme shown in red can be articulated in a separate strategic plan (e.g. a VSCP for *Aedes* or *Anopheles*) or they could be incorporated into a broader national strategy for single or multiple vector-borne diseases, in which all the elements are represented.

2. Guiding principles and elements of strategic planning

The guiding principles of an effective national strategic plan are:

- country ownership and leadership;
- inclusive, coordinated partnerships;
- accountability;
- evidence-based, results-oriented management; and
- socio-economic inclusivity and equity.

The four main components of a VSCP are:

- a situation analysis to gather the epidemiological and entomological information to inform development of the VSCP;
- a strategic plan outlining the objectives, goals and desired outcomes, usually covering 3–5 years;
- a costed implementation plan for vector surveillance and control activities; and
- a detailed annual workplan aligned with the national annual budgeting cycle for each activity in the VSCP.

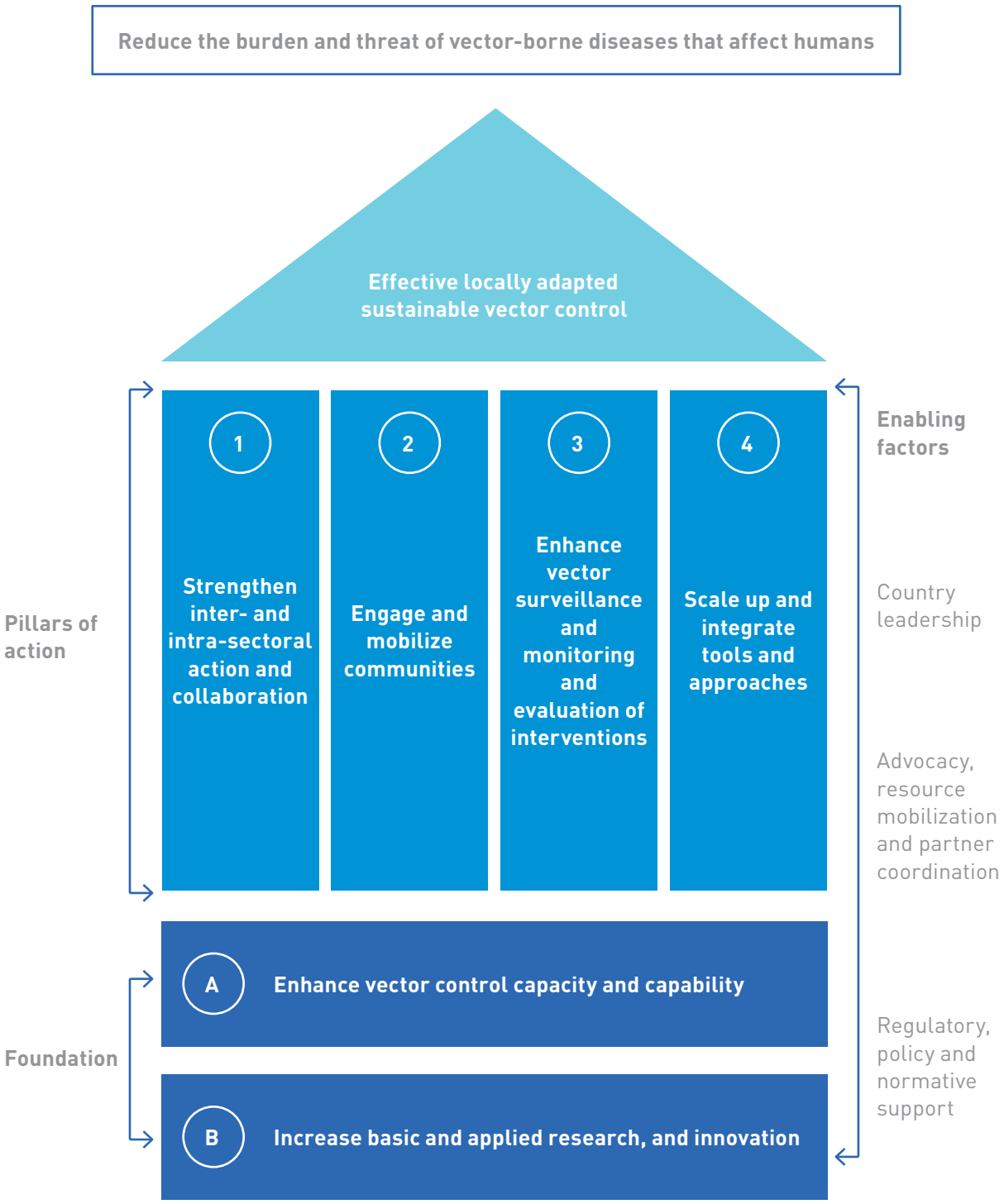
Development of these components requires consideration of the factors that will affect implementation, such as the current burden of disease and the human, infrastructural and institutional resources available to prevent and control outbreaks. Development of the *Aedes* VSCP must be led by the country to ensure that the strategies and plans are aligned with national planning and financial cycles. The content should be aligned with relevant regional guidance and with the global guidance and goals of the GVCR, which outlines the basic elements and pillars for effective, locally adapted, sustainable vector control systems, as summarized in Fig. 2. The GVCR advocates for enhancing overall vector control capacity and capability and closer integration of programmes that address different vector-borne diseases. It lists considerations for strategic planning, such as a review of planned or active vector control interventions to ensure they are evidence-based, and that any gaps or ineffectiveness of interventions can be addressed through the strategic plan.

Increased infrastructure and human resource capacity will be required to conduct all the activities. However, where this is not available, existing resources can be adapted to ensure that the minimum requirements for vector surveillance and control are maintained. When human resources are inadequate, staff may be recruited from other sectors. Ideally, technical staff should have access to a functioning insectary and an entomological laboratory for assessment of vector species, susceptibility to insecticides and intervention efficacy. Where this is not possible, arrangements can be made to access the capacity of regional facilities. Steps should be taken to integrate entomological surveillance data collection into health data collection systems, and to ensure data are used to inform decision-making.

Integration of these elements of the GVCR into *Aedes* VSCPs in PICs will involve assessing vector surveillance and control needs, planning resource mobilization and considering ways to streamline or increase overall capacity for *Aedes* vector surveillance and control. This will require cooperation among sectors, especially for activities such as community engagement and mobilization. Countries may also refer to, and integrate in whole or part, relevant national plans that overlap with the *Aedes* VSCP to ensure coordinated action and reduce fragmentation or duplication of efforts. These plans might include environmental health plans, and/or the national health sector investment framework.

Where feasible, existing vector-borne disease plans can be updated to incorporate *Aedes*-borne diseases, rather than developing new *Aedes* VSCPs from scratch. Key considerations for integrated *Aedes*-borne disease management are shown in Fig. 3, which can be used as an additional guide for elements to reflect in an *Aedes* VSCP. The key activities and enabling factors shown in Fig. 3 are aligned with those recommended in the GVCR and the **Manual for surveillance and control of *Aedes* vectors in the Pacific.** The strategy or approach used should also consider broader factors influencing management of *Aedes*-borne diseases such as case management and overall health systems capacity.

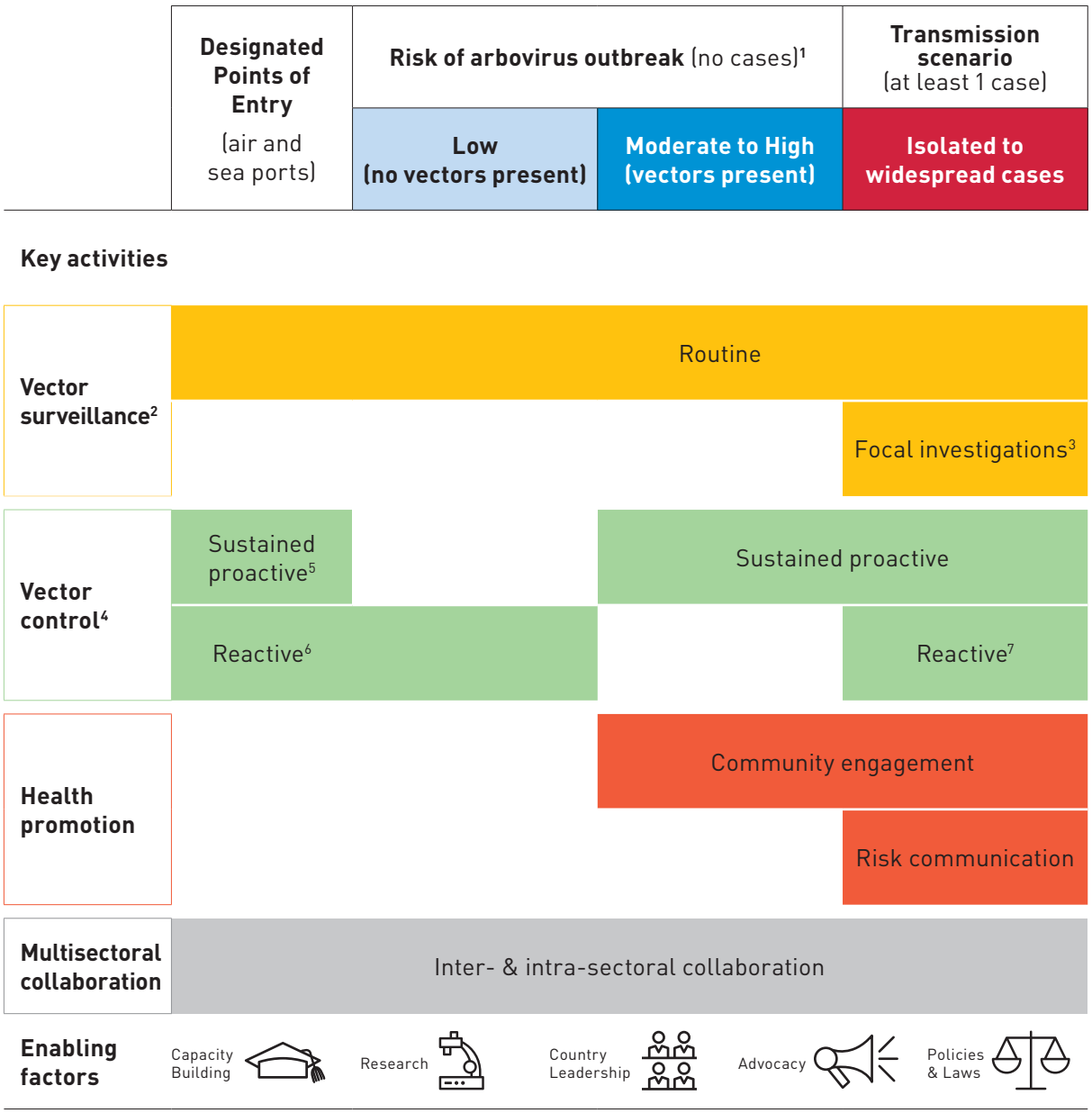
Fig. 2. Elements of the GVCR that should guide development of VCSPs



The global framework for effective, locally adapted, sustainable vector control is built on two elements (A and B) that support the actions in four main pillars, enabled by factors summarized on the right.

Source: WHO (2017a)

Fig. 3. Key elements of effective *Aedes* vector surveillance and control



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A conceptual framework for integrated *Aedes* vector surveillance and control, based on four activities – integrated surveillance, vector control, health promotion and multisectoral collaboration – and five supporting activities – capacity-building, research, leadership, advocacy, policies and laws, tailored to local *Aedes* distribution and risk of virus transmission.

Other WHO guidance documents include:

- Managing pesticides in agriculture and public health (WHO & Food and Agriculture Organization of the United Nations, 2021);
- Manual for surveillance and control of Aedes vectors in the Pacific (Pacific Community & WHO Division of Pacific Technical Support, 2020);
- Western Pacific regional action plan for dengue prevention and control (WHO Regional Office for the Western Pacific, 2016); and
- Global strategy for dengue prevention and control 2012–2020 (WHO, 2012).

If specific guidance for *Aedes* species is not yet available, reference can be made to guidance on malaria and other vector-borne diseases, such as the Manual for developing national malaria strategic plans (WHO Regional Office for Africa, 2018) and the Framework for a national plan for monitoring and management of insecticide resistance in malaria vectors (WHO, 2017b). Additional guidance documents relevant to formulating *Aedes* VSCPs are listed in Annex 1. See also the WHO website for new guidance documents.

3. Processes and steps for developing an *Aedes* VSCP

The process and principles outlined in this framework are applicable to strategic planning for both *Aedes*-borne and other vector-borne diseases. Whether developing an entirely new plan, or updating an existing plan, the steps shown in Fig. 4 can be followed as a guide to the process of planning, developing and adopting new plans. These steps are described in the following sections. This framework focuses on steps 2–5, which together comprise the key components of a VSCP; however, all steps in the planning process should be followed and adapted to the situation, disease focus and departmental organization for each country. Additional guidance on each step can be found in the Manual for developing national malaria strategic plans (WHO Regional Office for Africa, 2018). While distinct steps are outlined, activities can be planned and initiated in parallel, such as early engagement with development partners for resource mobilization.

3.1 Step 1: Organize and prepare the planning process

The first step is to seek agreement within the relevant ministry or department that a new or updated strategic plan is needed. A steering committee or working group should be established, comprised of the relevant staff required to contribute to the plan. For example, health programme managers, technical officers, field staff, and/or implementing partners. Where possible, the *Aedes* VSCP should be integrated within existing vector-borne disease control plans, rather than creating duplicate plans between sections or departments.

3.2 Step 2: Conduct a situation analysis

Conducting a situation analysis is a useful way to provide context for, and guide the content of, the VSCP. It is a preliminary step to gather information that will guide the development of the VSCP by providing brief overviews of:

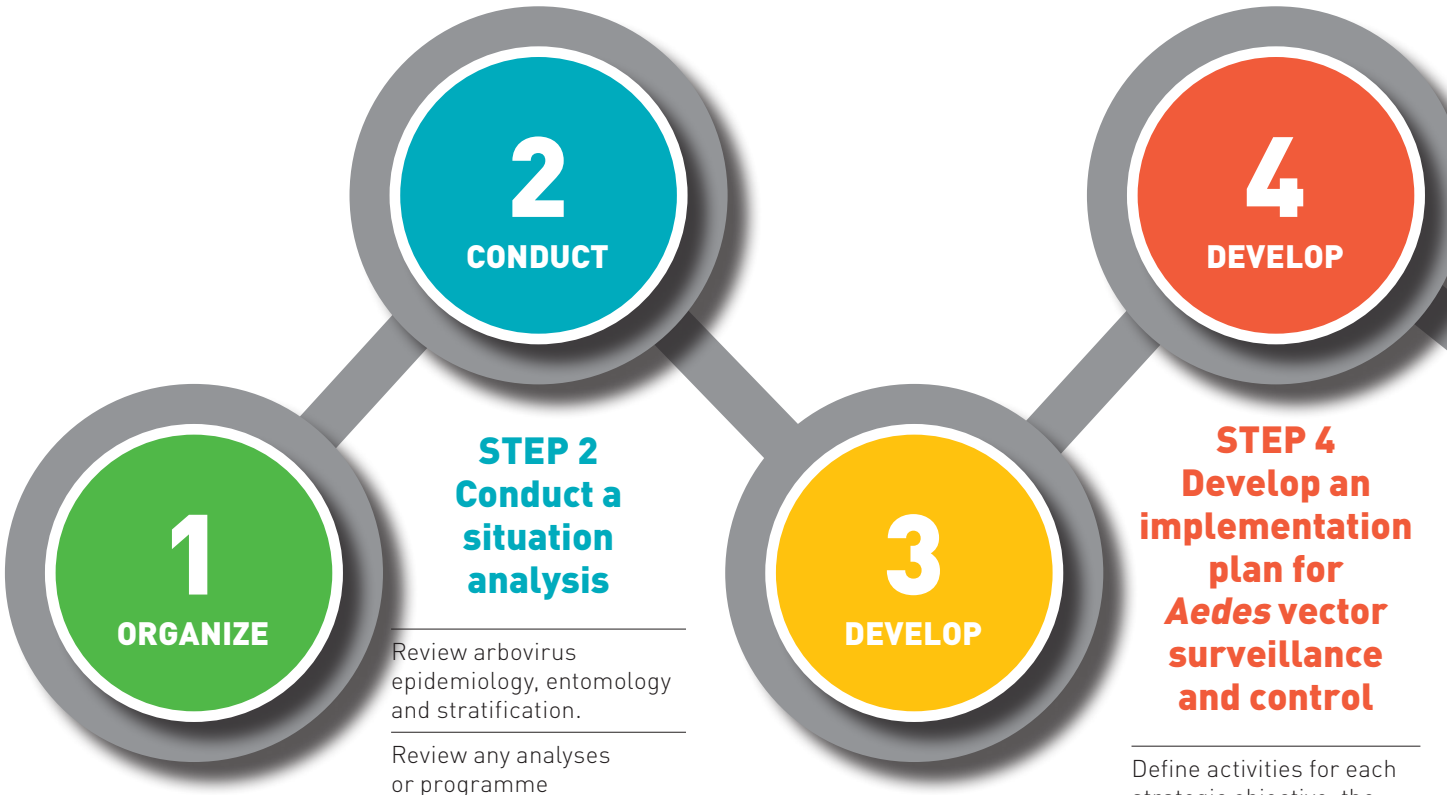
- the epidemiology and risk of significant *Aedes*-borne diseases in the country and, if possible, an estimate of the national burden of disease, including asymptomatic infections (see Annex 2);
- the *Aedes* species present in the country and incriminated in any disease transmission;
- vector surveillance and control strategies used currently or recently in the country for each of the diseases;
- the impact of vector management programmes on disease prevalence;
- identified limitations and risks, including financial, human and other resource constraints that might impede effective implementation of a national *Aedes* VSCP; and
- measures in place or proposed to address any challenges.

The situation analysis may involve:

- a needs assessment for a *Aedes* VSCP, conducted in accordance with the WHO framework (WHO & TDR, 2017) (see simplified version at https://pacmossi.org);
- a review of any national, regional or global disease control goals and targets; and
- an analysis of strengths, weaknesses, opportunities and threats of the existing programme(s). Guidelines are available in section 4.2.4 of the Manual for developing national malaria strategic plans (WHO Regional Office for Africa, 2018).

This information can then be used to document the lessons learned from previous strategies, and serve as a basis for defining a new programme vision, goals, objectives and activities to be outlined in the VSCP. Some specific components of the situation analysis that may be informative to include in the VSCP are outlined below.

Fig. 4. Overview of steps in strategic planning



STEP 1 Organize and prepare the planning process

- Seek ministry or departmental approval to develop an *Aedes* VSCP.
- Establish an *Aedes* VSCP steering committee and technical working groups (comprising management representatives in the ministry or department, technical officers from the vector control programme, implementing partners and others).
- The steering committee should develop a road map for developing a strategic plan according to the following steps.

STEP 2 Conduct a situation analysis

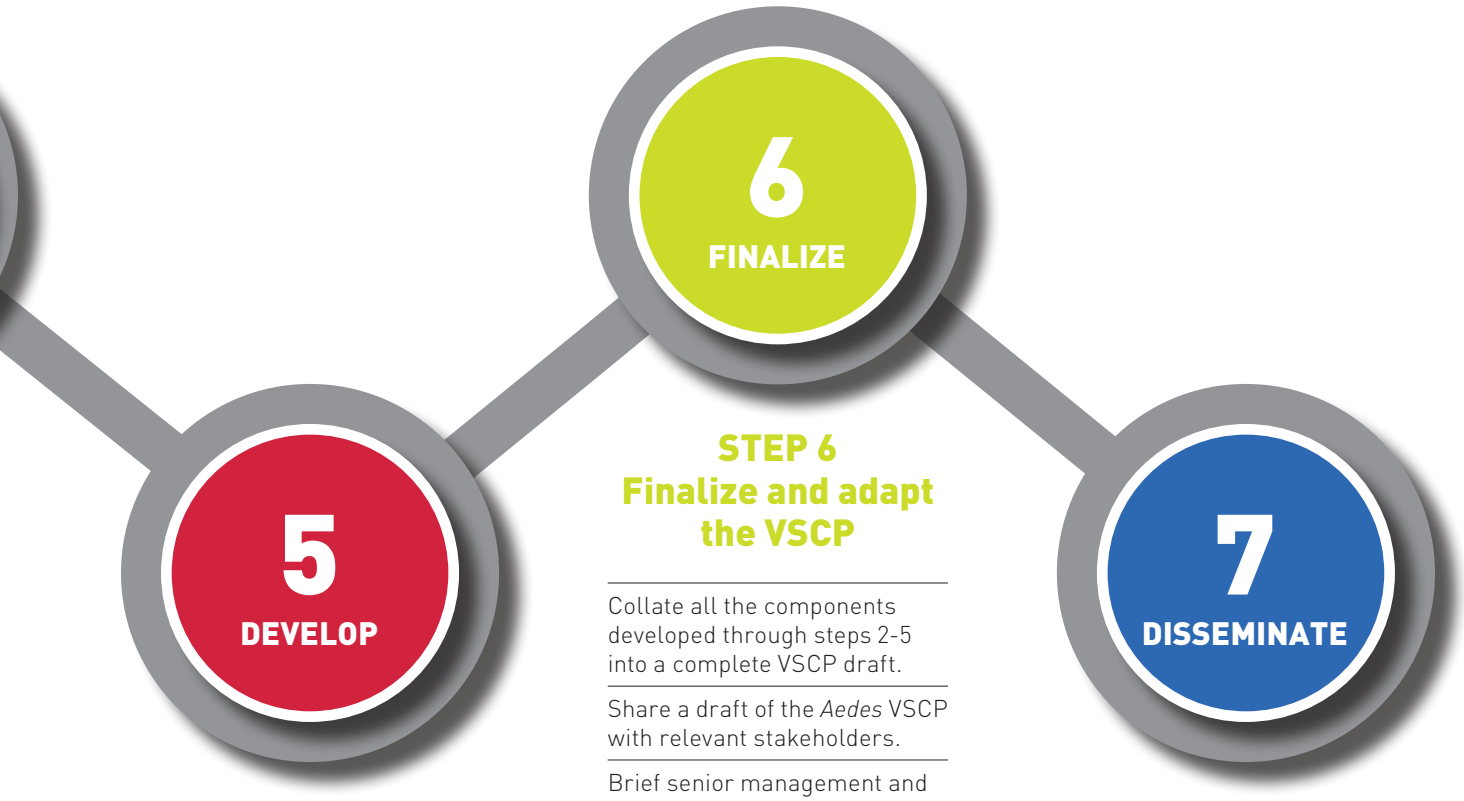
- Review arbovirus epidemiology, entomology and stratification.
- Review any analyses or programme reviews, including recommendations.
- Review the policy and management framework.
- Assess progress towards national, regional and global targets.
- Analyse the programme's strengths, weaknesses, opportunities and threats.
- Estimate the burden of arboviral diseases, ideally at least every 3 years.
- Document lessons learnt from previous or current *Aedes* vector control programmes.

STEP 3 Develop a strategic plan for *Aedes* vector surveillance and control

- State the programme vision, goals and objectives.
- Define the strategies and targets for the strategic plan.
- Define the desired outcomes and impacts.
- Identify data required for monitoring programme progress, such as entomological surveillance indicators and data on coverage, access and use of vector control interventions.

STEP 4 Develop an implementation plan for *Aedes* vector surveillance and control

- Define activities for each strategic objective, the people responsible and the time frame.
- Define implementation arrangements, i.e. a budget and resource mobilization plan.
- Identify any action necessary for implementation, such as coordination of partnerships, procurement and supply management, financial resource management and risk management.
- Outline any quality assurance methods and coordination mechanisms that will be used to inform or evaluate programme progress, e.g. monitoring of insecticide resistance status, talking to health staff or community leaders, household surveys, supervisory visits and review of health information and surveillance systems.
- Consider any gaps in resources or knowledge, and priority actions to address these.



STEP 5
Develop an annual workplan for programme activities

Outline a plan for proposed annual activities to be conducted, who will be responsible for specific tasks, and the timeframe for each.

Outline the annual budget necessary to support all vector surveillance and control activities e.g. quantities and cost of vector control supplies, insectary or equipment maintenance, staff trainings or any technical support required.

STEP 6
Finalize and adapt the VSCP

Collate all the components developed through steps 2-5 into a complete VSCP draft.

Share a draft of the *Aedes* VSCP with relevant stakeholders.

Brief senior management and heads of partner agencies.

Incorporate all relevant feedback into the final version, and consider organizing a stakeholder meeting to endorse the strategy.

STEP 7
Disseminate the strategic plan and mobilize resources

Produce and share a summary of the plan with partners and stakeholders.

Plan a launch event to promote the strategy and seek the support of senior management, partners and stakeholders who will assist in delivering the plan, e.g. ministry of health, ministry of finance, development partners

Distribute the full final version to all stakeholders and interested parties, and plan follow-up meetings to discuss resource mobilization as necessary.

Source: Adapted from WHO Regional Office for Africa (2018)

General steps in developing or updating a strategic plan for any health programme, covering either several diseases (e.g. all vector-borne diseases) or a single group of diseases, such as *Aedes*-borne diseases.

Epidemiology and risk of vector-borne diseases

The situation analysis should provide a brief overview of the current and past situation of *Aedes* mosquito-borne diseases, such as dengue, chikungunya and Zika virus disease, in the country.

For each of the relevant diseases, indicate:

- morbidity and mortality rates, case distribution by e.g. location, age, sex, and trends over time, with maps or figures showing distribution when possible or relevant;
- estimates of incidence and burden, if available (see Annex 2), noting that up to 80% of infections with some arboviruses are asymptomatic;
- transmission and risk scenarios according to whether disease outbreaks are suspected or confirmed and whether the risks in specific geographical areas are low, moderate or high **(see section 3 of Manual for surveillance and control of *Aedes* vectors in the Pacific);**
- other relevant drivers of *Aedes*-borne disease transmission, such as current or anticipated climate change;
- implications for health systems resources and other factors that affect access to diagnosis, prevention or treatment, such as different health facility infrastructure in urban and rural areas; and
- relevant challenges or gaps in information, such as the difficulty of conducting vector surveillance on many islands.

This section should provide references to sources of detailed, up-to-date information on disease outbreaks, such as the Pacific Public Health Surveillance Network or PacNet, which is the Network's communication forum.

Vector profiles

Provide an overview of mosquito species that are known vectors of dengue, chikungunya and Zika viruses in the country and elsewhere. Vector profiles may be summarized in a table (see e.g. Table 1).

Table 1. Example from Wallis and Futuna showing arbovirus vectors present, their geographical distribution and key characteristics

Species	Vector status	Geographical distribution	Key larval habitat characteristics	Adult feeding behaviour	Adult resting behaviour
Aedes aegypti	Dengue virus (primary vector)	Wallis Island only; north-eastern section, coastal to inland	Mainly artificial containers, few natural containers; confined to peri-domestic areas	Tends to feed more commonly indoors and peri-domestic settings, e.g. veranda	Dark, shady surfaces below 1.5m, inside and immediately outside houses
Aedes polynesiensis	*Wuchereria bancrofti* (primary vector), dengue virus (secondary vector)'.	Countrywide, coastal to inland (Wallis, Futuna, and Alofi islands)	Artificial and natural containers; peri-domestic and wild environments	Typically feeds outdoors during the daytime	Mainly outdoors on shady vegetation

Information specific to the country must be included, such as whether a species generally feeds outdoors during the day, peaks at a certain time or feeds indoors less frequently, and when these characteristics were last measured, as vector behaviour changes.

For each of the principal vector species, the profile should include:

- Species distribution – information on endemic or exotic species in different regions of the country and possible determinants of the distribution pattern when known, e.g. landscape, climatic conditions, human activities.
- Recent survey data – specify when the last comprehensive vector surveys were conducted.
- Biology – information on mosquito behaviour relevant to disease transmission and control, e.g. propensity to feed or rest indoors or outdoors, propensity to feed on humans or other animals, activity and biting times, relative dispersal distances, citing local data when possible.
- Habitat characteristics – such as types of larval habitats and the most productive local larval habitats, when known.
- Insecticide susceptibility – information about physiological and biological resistance to insecticides in any part of the country.

This section should also provide references to other sources of detailed or up-to-date information, such as national strategic plans, guidance manuals and annual reports. For general behavioural and ecological (bionomic) parameters of *Aedes* vectors common in the Pacific, refer to **section 2, Table 2 of Manual for surveillance and control of *Aedes* vectors in the Pacific.** As certain behavioural characteristics of the same vector species may differ by geographical location, include any unique characteristics observed in studies in the country and consider how they may affect vector control strategies.

Vector surveillance strategies

This section should provide details of the strategies that have been used recently to monitor *Aedes* vectors in relation to the arboviral diseases experienced or anticipated. The location, purpose and rationale of each surveillance strategy should be stated and outcomes briefly discussed. An overview of survey areas and the distribution of sampling sites may be presented on a map, noting the time of the surveys. See Box 2 for considerations for planning vector surveillance.

Box 2. Considerations for vector surveillance

- Surveillance, including vector surveillance, is a core control strategy.
- Community surveillance should be combined with social mobilization and integrated action.
- Planning, implementing and monitoring targeted vector control should be guided by mapping of entomological, environmental and epidemiological data.
- Indices for adult female *Ae. aegypti*, the most direct measure of dengue virus transmission, should be monitored routinely, including movements from urban to rural areas or from island to island. Additional species that might be involved in local transmission should also be monitored, such as *Ae. albopictus* and *Ae. polynesiensis*.
- Indices of immature vectors (Breteau, container, house, pupal) are useful for monitoring the impact of vector control programmes, but there is limited evidence for linking immature *Aedes* indices to the risk of dengue virus infection.
- Insecticide resistance should be monitored routinely and managed. See WHO (2017).

Vector control interventions

The situation analysis should specify:

- vector control interventions used in the country currently and recently, with evidence for their effectiveness or lack of effectiveness;
- approaches available for both proactive and reactive vector control; and
- insecticides used or registered for use in the country.

List the vector control interventions currently or recently used for the major mosquito-borne arboviral diseases, with an indication of the geographical areas involved and the vectors targeted (see example in Table 2). Notes on the effectiveness of the interventions derived from local or regional monitoring and evaluation or other published literature and guidelines may be included. Potential interactions among different control strategies must be considered when relevant (e.g. impact of insecticide treatments on populations of *Wolbachia*-infected *Ae. aegypti*).

A health official shows *Aedes* mosquito larvae collected during a survey.

Table 2. Sample approach to summarizing vector control methods used for dengue prevention and control in a province or a country in the previous 12 months

Vector control intervention[a]	Routinely	During outbreaks	Pesticide used	Target vectors
Larval source reduction (e.g. community clean-up)	Areas A, B, C, D, E, F	Areas C, D, E	–	*Ae. aegypti* and *Ae. albopictus*
Larviciding	Areas A, B, C, D	Areas C, D, E	Temephos and *B. thuringiensis israelensis*	*Ae. aegypti* and *Ae. albopictus*
Targeted indoor residual spraying for *Aedes*	Area C	Area C, D	Bendiocarb	*Ae. aegypti*
Targeted outdoor residual spraying for *Aedes*	–	Area E	λ-Cyhalothrin	*Ae. albopictus*
Issuance of bednets to febrile patients	–	Area C	Deltamethrin	*Ae. aegypti*
Issuance of repellents to febrile patients	–	Area E	Diethyltoluamide	*Ae. albopictus*
Indoor space spraying	–	–	–	–
Outdoor space spraying	–	–	–	–
Wolbachia	–	–	–	–

[a] Note that the interventions listed here are examples only

Vector control interventions against immature vectors

Source reduction with active community support should be the mainstay of control of immature stages of mosquitoes (larvae and pupae). Application of chemical and biological larvicides to water storage containers and other larval habitats is also effective in reducing immature vector populations. Use of larvicides is supplementary to source reduction, to kill larvae in water bodies that cannot be drained, filled or otherwise modified.

The determinants of success in control of immature stages are high coverage rates and frequent reapplication, often in combination with environmental management. The choice of larvicide depends on the habitat to be treated, the seasonality of the *Aedes* vectors present and the residual activity of the insecticide product; for example, the larvicide formulations and cycles of application differ for treating peri-domestic water containers for periodic storage of drinking-water and for treating permanent or larger water bodies that are not suitable for human consumption.

Vector control interventions against adult vectors

Targeted indoor residual spraying for *Aedes* (IRS-*Aedes*) at high coverage can be used as a preventive or reactive intervention. IRS-*Aedes* can be scaled up and adapted for indoor-resting *Aedes* vectors, while targeted outdoor residual spraying (ORS-*Aedes*) in peri-domestic areas may be suitable for some vectors. The choice of insecticide should be based on understanding of local insecticide resistance and on global and regional WHO recommendations. Use of insecticide-treated materials (screens or curtains) has been shown to be effective for control of adult vectors, as have fixed window screens fitted with insecticide-treated netting.

Untargeted, sporadic space-spraying of insecticides is usually ineffective for routine control of dengue virus transmission. Space spraying may be useful in an emergency, such as an outbreak, if repeated at high coverage in targeted sites identified as at high risk; however, it is not recommended as a routine or proactive intervention. There is no single most effective intervention applicable to all ecosystems; therefore, programmes should select locally appropriate interventions, and avoid relying on any single intervention.

Use of personal protective measures and topical repellents, with advice on their use, should be encouraged to provide protection from mosquito bites. This can be part of routine case management, such that suspected or confirmed cases of arboviral illness are not admitted to hospital but remain in the community. See **Section 4 of Manual for surveillance and control of *Aedes* vectors in the Pacific** for further details on vector surveillance.

Insecticides

List the insecticides currently registered for use in public health and agriculture in the country (see examples in Table 3), specifying details such as:

- the classes of insecticide
- insecticide type (active ingredient)
- product name (or trade name) and manufacturer
- registered uses and formulations.

This information should be available from regional or national institutions responsible for pesticide registration and regulation. Pesticides widely used in agriculture may affect mosquito habitats in the area, potentially increasing selection pressure for insecticide resistance in the mosquito population. Intensive use of named pesticides on certain crops or in certain locations could be included. Registration could be sought of insecticide products that are not currently registered for use, particularly if suitable products against *Aedes* are not available or where alternative products are necessary to manage insecticide resistance. Interventions are reviewed by WHO and the Vector Control Advisory Group, and products are added to the WHO prequalified vector control product list as appropriate.

Community health workers spraying insecticide to control mosquitoes in the communities of Tuvalu.

Table 3. Sample summary of insecticides registered in a country for public health vector control and agriculture

Insecticide class	Insecticide type (active ingredient)	Product name and manufacturer	Use	Formulation	Date of registration
Pyrethroid	Permethrin	xx	Long-lasting insecticidal net	Incorporated polyethylene	01/01/2009
Pyrethroid	Deltamethrin	xx	Long-lasting insecticidal net	Coated polyester	01/01/2009
Pyrethroid	Deltamethrin	xx	IRS	WP	01/01/2010
Organochlorine	DDT	xx	IRS	WP	01/01/2011
Organophosphate	Pirimiphos-methyl	xx	IRS	EC	01/01/2012
Organophosphate	Temephos	xx	Larvicide	GR	01/01/2013
Carbamate	Bendiocarb	xx	IRS	WP	01/01/2016
Pyrethroid	Deltamethrin	xx	Agriculture	EC	01/01/2009
Organophosphate	Pirimi-phos-methyl	xx	Agriculture	EC	01/01/2010
Biological	Pyriproxyfen	xx	Larvicide	GR	Expected 01/12/2021
Biological	B. thuringien-sis israelensis	xx	Larvicide	GR	01/01/2013

Source: Adapted from WHO (2017b)

Programme management and operational considerations

Most vector control interventions used in dengue control programmes have some demonstrated entomological efficacy against *Aedes*. No single intervention is applicable to all ecosystems and epidemiological contexts. Vector-borne disease programmes should select interventions that are appropriate to the local context according to local data when possible. Ideally, programmes should integrate entomological and epidemiological end-points, and both should be measured and analysed.

Approaches should target both immature and adult vector populations, not with a single intervention. In order to prevent outbreaks or interrupt transmission, interventions must be sustainable and result in high coverage. Sustainability often requires intra- and inter-sectoral collaboration, community involvement and programmatic continuity, which present both challenges and opportunities in PICs. Improvements to the built environment are also recommended to control dengue and other vector-borne diseases, highlighting the importance of inter-sectoral collaboration and/or the establishment of a national multisectoral taskforce, as recommended in the GVCR.

The cooperation of various departments involved in disease control can result in successful control of *Aedes* mosquitoes with integrated approaches involving available health staff and resources. For example, staff from community engagement programmes and/or public health or vaccination programmes could work with vector control field staff to collect and distribute information on vector control from or to communities. Support from local and national governments (e.g. policy, funding, management, logistics, capacity-building, staffing), including intersectoral collaboration, will improve the chances of success and the sustainability of *Aedes* control programmes.

Additional programme management considerations that may affect strategic planning and could be discussed in the strategic plan include:

- policy and regulatory landscape
- planning and implementation
- human resources
- budget landscape
- budget coordination
- sustainability and operational constraints
- gaps in evidence and knowledge.

An outline of the content to consider including under each of these headings is below.

Policy and regulatory landscape

Briefly describe the governance system for addressing *Aedes*-borne diseases. including:

- prioritization of arboviral disease control in the health sector;
- whether the vector control programme is centralized or decentralized, the decision-making process and how this affects the availability of resources;
- whether vector-borne diseases are notifiable in all relevant sectors of the health system and the systems that are in place for reporting and responding to notifiable diseases; and
- the regulatory guidelines that should be considered or followed to implement interventions, e.g. nationally approved insecticides, use of genetically modified organisms.

Planning and implementation

Indicate whether the country has strategic plans and guidelines for implementation of *Aedes* control according to the country's needs and WHO recommendations. List the relevant documents or related programmes that could be leveraged, such as a malaria control strategy or programme on neglected tropical diseases. Mention whether planning is participatory, with clear roles and responsibilities for all

partners. Comment on the flexibility of programme implementation with changes in the epidemiology of *Aedes*.

Human resources

Summarize current national and subnational human resource capacity for vector surveillance and control, perhaps in a table, specifying the existing positions and the responsibilities and activities undertaken in each role in the previous year. Later in planning, human resources should be compared with the programme objectives and activities planned for the coming year, including options for community surveillance through established mechanisms, such as village health workers. Training requirements and associated plans should also be identified.

Budget landscape

Provide an overview of the recent or current budget allocation for vector control operations, and indicate whether the budget is sufficient, less than sufficient or severely limiting. Describe whether the primary sources of funds are domestic or from donors, such as development partners. Indicate any anticipated funding in order to determine whether resource mobilization is required.

Budget coordination

This section should provide an overview of all the local and international partners active in implementation and management of the national *Aedes* VSCP**.** These include partners in all sectors working in infectious disease prevention and control, also beyond the health sector, such as:

- research and academic institutions;
- the private sector, including local businesses;
- public–private partnerships;
- nongovernmental and community service organizations, such as church and women's groups; and
- agencies of the United Nations and other development partners.

For each partner, indicate the specific field of activities, which may include initiatives to improve human and infrastructural capacity and support implementation of vector management programmes, community engagement programmes and/or insecticide resistance monitoring and management strategies.

Sustainability and operational constraints

This section should identify the current risks to sustaining planned vector surveillance and control operations, including financial, human and other resource constraints that could impede implementation of an effective vector control programme. Indicate any measures planned, in place or necessary to address any identified challenges.

Gaps in evidence and knowledge

Knowledge may be lacking on the best-practice interventions for a given country or transmission setting, in areas such as vector species distribution, behaviour and insecticide susceptibility. Some of the information on vector profiles may already have indicated what is known and not known about local vectors and when it was last assessed.

3.3 Step 3: Develop a strategic plan for *Aedes* vector surveillance and control

The core elements of a national *Aedes* strategic plan are outlined below, in the order in which they might be presented in the VSCP. They can be adapted to the requirements of each country or type of plan, e.g. an individual plan for one vector or a combined strategic plan for all vector-borne diseases. The sections below are adapted from the Manual for developing national malaria strategic plans (WHO Regional Office for Africa, 2018).

Summary

The executive summary of the *Aedes* VSCP should include enough detail to provide a senior manager with a concise overview of the plan's objectives, rationale, methods for vector surveillance and control and decision-making and of the resources necessary for implementation. Key points to be included are:

- a brief description of the epidemiology of significant vector-borne diseases in the country and the principal vector species involved;
- an overview of the vector control strategies used currently or recently in the country and their effectiveness for public health;
- the main findings of the situation analysis, such as whether entomological monitoring should be enhanced, whether the vector control policy should be reviewed or critical gaps in knowledge;
- the objectives, rationale and key elements of the proposed *Aedes* VSCP; and
- the resources available for *Aedes* surveillance and control, including staff and budget.

Overall vision and goals

This section should state the vision, goals and objectives of the *Aedes* VSCP and the targets and indicators required for monitoring the programme. The "vision" is a statement of a desired better future. This can be expressed as a strategic statement of intent to impel the programme towards the desired future. The statement encompasses the overarching vision of disease reduction and the broad purpose of the strategy. Examples include:

- to reduce the burden and threat of *Aedes*-borne diseases by effective, locally adapted, sustainable vector control; and
- to establish sufficient vector surveillance and control capacity to effectively monitor, prevent and respond to *Aedes*-borne disease threats.

Programme goals – the desired results of the programme – are related to the programme vision and are based on the intended reduction or elimination of the disease burden. A "goal" is a general objective for the impact on the numbers of cases or deaths or on transmission. Examples include:

- to prevent local transmission of arboviruses in all non-endemic districts or provinces by 2023;
- to prevent the incidence of arbovirus disease from reaching outbreak thresholds in all endemic districts or provinces by 2023; or
- to reduce the number of districts or provinces endemic for arboviruses by 75% by 2025 as compared with 2020.

The Manual for developing national malaria strategic plans (WHO Regional Office for Africa, 2018) and the **Manual for surveillance and control of *Aedes* vectors in the Pacific** also contain detailed guidance on formulation of a programme vision, goals, objectives, strategies and indicators. Points and examples relevant for *Aedes* vector surveillance and control are summarized below.

Specific objectives

Specific objectives are set to achieve the goals (or general objectives) and are therefore directly linked to the goals (Table 4). Examples include:

- to reduce the incidence of arbovirus diseases in endemic districts or provinces by at least 50% in at least five of the nine endemic districts or provinces by December 2022; or
- to prevent incursion and/or establishment of the exotic vector *Ae. albopictus* at all points of entry (airport and seaports) throughout 2022–2023.

Table 4. Sample indicators for monitoring achievement of specific objectives

Specific objective	Activities (tasks) and targets	Progress Indicators
To achieve optimal coverage of adult and larval vector control by December 2022 in at least five of the nine target districts	Review and update *Aedes* VSCP by October 2021.	Updated national *Aedes* VSCP covering 2022–2024 in place
	Increase coverage of preventive IRS-*Aedes* by 50% in endemic districts by 2022 over that in 2020.	No. of households sprayed
	Extend coverage of community engagement to 80% of endemic villages by December 2022.	No. of villages in which vector control behavioural change campaigns were conducted
To prevent incursion and establishment of *Ae. albopictus* at all three points of entry (air- and seaports) throughout 2022–2024	Conduct weekly surveys of adult mosquitoes at sentinel trap sites within a 400-m radius of port areas.	No. of sentinel sites in which routine adult surveillance was conducted
	Conduct quarterly larval surveys of aquatic habitats, and apply source reduction treatment at 90% of properties within a 400-m radius of points of entry.	No. of properties inspected and number of aquatic habitats treated
	Inspect at least 75% of international ships and cargo within 48 h of arrival at a port of entry, and treat as necessary.	No. of ships inspected and treated
	Conduct ORS-*Aedes* within 3 days of detection of *Ae. albopictus* within a 400-m radius of a point of entry.	No. of areas sprayed and number of days after detection
To map distribution of all arbovirus vector species in all districts by December 2023	Increase the number of field staff trained in vector surveillance in each district from two to six by December 2022.	No. of trained staff per district
	Establish functional sentinel surveillance sites in at least 50% of villages in each district by December 2022.	No. of sentinel surveillance sites in which routine surveillance is established

Only a selection of the strategies and targets required for each objective are listed in the table. Additional strategies will be required to achieve each objective.

Activities and targets

"Activities" indicate how each (specific) objective can be achieved. They are specific tasks for achieving objectives. Each specific objective can be achieved only if several activities are used. Therefore, the VSCP team must identify all the activities required to achieve a specific objective. For each identified activity, targets must be specified at the planning stage to facilitate programme monitoring. A "target" is an intermediate result intended to further an objective of a programme. Targets should be comparable with baseline data and be "SMART": specific, measurable, achievable, realistic and time-bound. For example:

- An absolute target is a specific number for an increase over a baseline value, e.g. larval source management coverage increased from 20% to 50% in 5 years.
- A relative target is a relative change that is independent of the initial value, such as a reduction by half in the number of dengue cases. Relative targets are often set when the baseline is uncertain.
- Annual rates of change describe the pace of change expected, especially during a period of increasing services, e.g. increase in coverage from 2% to 4% per year.

Programme indicators

An "indicator" is a measurable or tangible variable for assessing the goals, objectives, targets and changes over time. See **Annex 4 of Manual for surveillance and control of *Aedes* vectors in the Pacific** for examples of Indicators in an arbovirus vector control programme. The five main types of indicator are inputs, processes, outputs, outcomes and impact. For examples, see Table 4.

- Impact indicators are used in monitoring achievement of goals.
- Outcome indicators are used in monitoring achievement of objectives.
- Output indicators are used in monitoring implementation of strategies.

Appropriate indicators must be allocated to the goals, objectives and strategies. The sources of information for each indicator should also be stated; for example, data on the impact of the programme (achievement of the goals) could be obtained from epidemiological reports.

Performance monitoring and reporting

"Monitoring" is routine observation, collection and use of data and reporting on programme implementation (weekly, monthly, quarterly or annually); its aim is to ensure that programmes are working satisfactorily and to determine whether adjustments are necessary. This section should briefly describe the agreed monitoring process and reporting frequency and the people who will compile and collate the required information. See **section 6 of Manual for surveillance and control of *Aedes* vectors in the Pacific** for a description and examples of a framework for monitoring and evaluating an arbovirus vector control programme.

3.4 Step 4: Develop an implementation plan for *Aedes* vector surveillance and control

The core elements of an implementation plan for *Aedes* vector surveillance and control are outlined below, in the order in which they might be presented. They can be adapted to the requirements of each country or scope of the plan, e.g. an individual plan for one vector or a combined strategic plan for all vector-borne diseases.

Vector surveillance

The purposes of different types of entomological surveys for *Aedes* vector species are described in **section 4 of Manual for surveillance and control of *Aedes* vectors in the Pacific**. The purpose and priority of *Aedes* vector surveillance is usually determined by the questions to be addressed by each PIC. In general, surveillance is conducted to understand:

- adult vector occurrence, species composition and behaviour;
- resistance to insecticides;
- aquatic habitats of immature vectors;
- incursions of invasive species; and
- receptivity and risk assessments.

Annex 3 gives some examples of strategic operational decisions that can be made from *Aedes* surveillance information. The key components of the vector surveillance section of a VCSP are described below.

Disease risk stratification for vector surveillance

This section should list areas of the country that would be classified as at high, moderate or low risk of an arbovirus outbreak according to the criteria given in **Table 3 of Manual for surveillance and control of *Aedes* vectors in the Pacific**. The aim is to inform decisions about the surveillance strategy and targeting of routine vector control activities. Vector sampling, including the number of sampling sites and frequency of sampling, depends on, among other factors, the risk of an arbovirus outbreak in the area and available capacity.

Transmission risk varies geographically and over time and is highly dependent on the risk of importation of viruses. Surveillance strategies should be adapted accordingly. For example, areas classified as at low risk for an arbovirus outbreak may have no competent vector species but a risk of their introduction and establishment. In these areas, the aim of routine vector surveillance is to detect introduced *Aedes* vector species. Such surveys could be done periodically, for example once or twice a year. An area classified as at high risk has at least one competent vector species and either known circulation of arboviruses or a high risk of importation of viruses. In these areas, surveys would be conducted in more sites and repeated several times a year (see examples in tables 5 and 6).

The scale of risk stratification may differ subnationally (provinces, islands, health zones, cities, suburbs of cities, villages), according to the geographical or administrative divisions relevant to vector control operations. Prioritization of vector surveillance strategies (and key entomological indicators) according to risk of arbovirus outbreak is further discussed in **section 3 of Manual for surveillance and control of *Aedes* vectors in the Pacific.**

Table 5. Sample routine surveillance plan for *Aedes* vectors in the absence of arbovirus transmission

Name of area or zone to be surveyed	Level of risk for an arbovirus outbreak	Type and purpose of survey	Target species	Trapping or sampling method	Size of sampling area (estimated km2)	Total no. of sampling sites	Trapping duration per month	Proposed months of sampling
A	Low	Routine; adult occurrence	Incursions of *Ae. aegypti*, *Ae. albopictus*, *Ae. polynesiensis*	Biogents Sentinel traps	12 km^2	48 sentinel sites	1 week	Apr, Nov
B	Moderate	Routine; adult occurrence	*Ae. polynesiensis*	Biogents Sentinel traps, ovitraps	10 km^2 (600 houses)	200 houses	2 weeks	Mar
C	High	Routine; adult occurrence, Resistance, key larval habitats	*Ae. aegypti*	Biogents Sentinel traps, Ovitraps, Sweep net collections, Larval and pupal surveys	5 km^2	40 sentinel sites	1 week	May

Table 6. Simplified general plan for routine vector control according to risk stratification of areas and entomological profile of vectors

Area	Transmission risk level	Known *Aedes* vectors present	Transmission period (months)		Larval source management				Adulticiding		Community engagement	
			Typical start and end	Peak	Inter-vention	Months	Insecticide or product	Inter-vention	Months	Insecticide/ product (if any) *	Intervention	Months
1	High	*Ae. aegypti*	All	Feb, Mar, Apr	Larviciding, source reduction	All	*B. thuringiensis israelensis*	IRS-*Aedes*	Apr, Nov	Bendiocarb	Community education and clean-up campaigns	All
2	High	*Ae. polynesiensis*	All	Feb, Mar, Apr	Larviciding	All	*B. thuringiensis israelensis*	ORS-*Aedes*	Dec, Jan	Lambda-cyhalothrin	Community education and clean-up campaigns	All
3	High	*Ae. aegypti*	All	None	Larviciding, source reduction	All	Temephos	None	None	None	Community education and clean-up campaigns	All
4	Moderate	*Ae. aegypti*	Oct - May	Oct, Feb, May	Larviciding	Oct, Feb, May	Temephos	None	None	None	Community education and clean-up campaigns	Oct, Feb, May
5	Low	None	None	None	Larviciding Source reduction	None	None	None	None	None	Community education and clean-up campaigns	Oct, Feb, May

* This activity plan should take into account the entomological profile of the vectors present and their resistance to insecticides.

Surveillance tools

This section should give an overview of the tools that have been chosen for surveillance in the country's vector management programme within the next 12 months, with some justification for the selection. Descriptions of various traps and other surveillance strategies for *Aedes* species (e.g. Biogents Sentinel trap, gravid *Aedes* trap, ovitraps, resting collections, sweep-net collections) are provided in **Manual for surveillance and control of *Aedes* vectors in the Pacific**, with information on their advantages, disadvantages and operational guidelines. Recommended sampling methods are given in **Table 4 of that document** according to vector composition and behaviour, insecticide resistance and aquatic habitats of immature vectors. After a sampling method has been chosen, the following should also be considered during planning and implementation, as they may have implications for interpreting the results of surveillance and on budgetary requirements.

Seasonal conditions

Populations of container-breeding *Aedes* mosquitoes may decline to very low densities in the dry season or the cold season in some countries and may therefore be difficult to detect with any method. Nil catches at such times do not necessarily imply the absence of the vector. Good understanding of seasonal fluctuations in vector density in an area can be gained by conducting monthly baseline surveys across multiple sites when possible. The information is useful for determining the optimal timing of future surveillance and of proactive vector control activities.

The effectiveness of outdoor adult sampling can be reduced by very windy or rainy conditions. For example, peri-domestic *Aedes* mosquitoes may rest in sheltered sites and not fly readily towards the host in strong winds during sweep-netting (see description in **section 4.4.4 of Manual for surveillance and control of *Aedes* vectors in the Pacific**.

Density and distribution of trap sites

The density of peri-domestic *Aedes* mosquitoes often varies within a relatively small area. Therefore, reliable conclusions about a wide area cannot be drawn from just one or two trap sites. The density and distribution of traps or sampling sites should be representative of the whole area targeted for surveillance. The mosquito specimens collected must be identified. Details and links to morphological identification keys are available in **Manual for surveillance and control of *Aedes* vectors in the Pacific**. Staff trained in mosquito identification can distinguish the different *Aedes* species present in PICs as well as any exotic species.

A community health worker conducts a field sampling of mosquitoes in Tuvalu.

Routine vector surveillance activities

Strong vector surveillance programmes are necessary in PICs to guide both proactive and reactive vector control. The capacity to prevent and respond to disease transmission with appropriate vector control requires the necessary entomological information, i.e. distribution of vector species, susceptibility of vectors to insecticides, as well as their biting and resting preferences. Routine vector surveillance is part of preparedness and should be conducted before planning vector control activities, during transmission, before outbreaks, before arboviruses are introduced into receptive areas and after vector control.

This section should specify the types of routine vector surveillance to be conducted:

- in areas with no confirmed (or suspected) arbovirus cases (see **Fig. 3 in Manual for surveillance and control of *Aedes* vectors in the Pacific**;
- during investigation of isolated cases, either imported or acquired in the area (see **Fig. 4 in Manual for surveillance and control of *Aedes* vectors in the Pacific**;
- during investigation of several local arbovirus cases that do not constitute an outbreak (see Annex 4);
- at points of entry; and
- in various selected areas to monitor insecticide resistance.

The following information could be included in the plan:

- surveillance methods for areas of low, moderate or high risk of arbovirus outbreaks (See **Fig. 3 in Manual for surveillance and control of *Aedes* vectors in the Pacific** and Annex 4 of this framework);
- the general size of each area (e.g. radius, surface area, number of premises) and the number of sampling sites used in each routine survey;
- the frequency of surveys (monthly, quarterly, seasonally or periodically); and
- whether insecticide resistance monitoring will be conducted regularly (e.g. annually) or ad hoc.

Guidance is given in WHO (2017b), which was developed for malaria vectors but can be adapted for *Aedes* vectors. An example of a routine vector surveillance plan is shown in Table 5.

Outbreak vector surveillance

During widespread outbreaks, routine vector surveillance may be a lower priority than vector control. Decisions on vector control in an outbreak are usually based on an established, routine vector surveillance system, in which the vector species present in the area should already have been identified. If cases of arbovirus disease are detected in areas where local vector species have not been recorded, an intensive survey must be launched immediately at the houses of cases, contacts and neighbouring properties (see **Table 6 in Manual for surveillance and control of *Aedes* vectors in the Pacific**.

This section should list areas for which there is no reliable information on local *Aedes* vector species, and a general plan of action should be drafted, to be implemented immediately if cases are reported from those areas. The information in the plan could include the method of choice for collecting adult *Aedes* (e.g. sweep-net sampling, Biogents Sentinel traps), the number of traps to be deployed in relation to the case house and contact locations, the intended duration of trapping and the number of properties to be covered in the neighbourhood of the case or of key contacts.

Vector control

Vector control may be either proactive (routine control in the absence of an outbreak to prevent disease outbreaks or incursion of exotic vectors) or reactive (in response to an outbreak). Both are guided by data from routine vector and case surveillance, which together ensure the most rapid, effective response. VCSPs should consider the resources required for both proactive and reactive vector control throughout the term of the plan. Ideally, proactive activities will be carried out periodically, at planned times throughout the year (sustained proactive control). Some interventions can be used for both proactive and reactive control.

Approaches should target both immature and adult vector populations, and not rely on a single intervention only. The key interventions are summarized below; however, a number of new tools are under development that are not discussed in detail here. Some newer technologies, such as *Wolbachia* transmission blocking technique, have also been deployed successfully in PICs though are usually used in a time-limited manner.

Routine vector control activities (proactive)

Proactive control is defined as routine vector control activities that are implemented in the absence of an outbreak. In some PICs, this may mean in the absence of any arbovirus transmission, while in others it may mean during periods of endemic transmission that is below the threshold for an outbreak. The aim of proactive vector control is to reduce the frequency and scale of arbovirus outbreaks. Proactive control is an important prevention tool, particularly if conducted prior to and during the typical outbreak season, and can be sustainably implemented with effective engagement of communities.

Various vector control intervention methods applicable to *Aedes* species are described in **section 5 of Manual for surveillance and control of *Aedes* vectors in the Pacific**, with information on the advantages and disadvantages of each. Routine vector control is conducted only in areas of moderate or high risk of arbovirus transmission, which must be listed in the plans for routine vector surveillance.

Vector populations in all high-risk areas can be suppressed consistently through activities such as larval source management with strong community engagement. Such activities can be conducted on their own or in addition to supplementary or novel vector control measures such as the *Wolbachia* transmission blocking technique. Larval source management includes source reduction (e.g. community clean-up campaigns) and larviciding, which can be undertaken throughout the year, including in the dry season when possible. These and other interventions often require intersectoral cooperation to ensure that activities are sustained.

High-risk areas with a recent history of arbovirus outbreaks should be marked for proactive IRS-*Aedes* or ORS-*Aedes* just before peak transmission (see an example in Table 6 and Annex 5). For detailed guidelines on the type of equipment, insecticides and procedures for conducting IRS against *Ae. aegypti*, see the Manual for indoor residual spraying in urban areas for *Aedes aegypti* control (Pan American Health Organization, 2019). Untargeted and sporadic space-spraying is mostly ineffective for routine operations in controlling dengue virus transmission.

Outbreak vector control activities (reactive)

Reactive control is defined as activities that are initiated in response to an outbreak in disease cases or the detection of exotic vectors. In outbreak response situations, the primary aim of reactive vector control is to rapidly reduce the number of potentially infectious adult vector mosquitoes in the area. In response to an exotic vector, the primary aim is to rapidly contain the vector, reduce its spread to other areas, and if possible attempt elimination. This section of the plan should specify the actions to be taken for various scenarios in which confirmed arbovirus cases may arise. The key to successful containment of outbreaks is preparedness for vector control, with the aim of a rapid reduction in the density of adult mosquitoes before they can transmit a virus to other people (e.g. for dengue virus, the extrinsic incubation period is typically 8–12 days).

Reactive vector control may be undertaken either in a small geographic area at risk (focal), a wide geographic area (broad-scale), or be targeted to one or more high-risk areas. If transmission is already widespread, interventions should be prioritized in the areas with the highest transmission (as identified

during epidemiological surveillance). Communication between epidemiology teams and vector control managers is therefore essential. Outbreak vector control should comprise:

- IRS-*Aedes* or ORS-*Aedes* (depending on the species);
- personal protection (topical repellent; mosquito net);
- risk communication (to avoid bites and reduce mosquito habitats);
- source reduction (e.g. community clean-up campaigns targeting larval containers);
- larviciding (treating, modifying or removing mosquito-resting containers); and
- indoor space spraying (only as a secondary activity in areas of widespread arbovirus transmission and dense human population).

See **Manual for surveillance and control of *Aedes* vectors in the Pacific** for further details.

Vector control programmes should maintain enough capacity to conduct at least the first five activities in all high-risk areas within a relatively short time. A checklist should be drawn up for each province or area that has high-risk areas to ensure that there are enough skilled staff, equipment, transport, insecticides, pamphlets and data collection system (see example in Annex 6).

Periods of little or no transmission should be used for mobilizing and training staff at all operational levels, holding workshops on planning, procuring equipment and chemicals and other preparatory activities. If provinces plan together, they can assist each other in responses when necessary.

Quality assurance for vector control interventions

Quality assurance of field application of vector control should be an integral part of the national programme strategy and should include:

- high-quality training for all staff conducting vector control interventions in the field;
- regular supervision, monitoring and follow-up of field operations;
- periodic testing of the quality of IRS-*Aedes* operations with the WHO cone bioassay of sprayed surfaces; and
- where larval source management is used, determination of its impact by monitoring changes in vector density before and after implementation.

Recommendations on procedures and the frequency of monitoring are given in **Manual for surveillance and control of *Aedes* vectors in the Pacific**.

Community engagement

Community engagement is a key component of any vector control programme. Community understanding of arborviral diseases and their spread, however, differs by context and culture, and no approach is suitable for all situations. Decision-makers, service providers and communities must determine the most appropriate approach for collaboration in a given context and situation according to their interests and purpose. This framework does not, therefore, prescribe means for engaging with communities. WHO guidelines and recommendations for community engagement and risk communication are listed in **Manual for surveillance and control of *Aedes* vectors in the Pacific**.

In any vector control programme, community engagement must be continuous, with consistent communication among stakeholders, timely dissemination of honest information and effective management of misinformation.

Programme management

Planning and implementation

This section should outline the process for developing the *Aedes* VSCP, including:

- the people involved;
- the duration of the plan, e.g. 3–5 years or annual;
- the people to be consulted at national and subnational levels;
- how decisions are taken for technical operational activities; and
- a schedule of meetings, updates and reviews.

Planning may include reassessment of the strengths and weaknesses identified in the existing vector control programme, with practical solutions to address issues such as lack of a clear policy and guidelines, inefficient communication within or among sectors and insufficient planning of routine operations and preparedness for emergency responses.

Advocacy to ensure continued high-level national political commitment and partner commitment should be a priority.

Human resources

In this section, the human resources required for planned activities should be listed, with the human resources already available nationally and subnationally as identified in the situation analysis. The existing human resources should be used for priority activities while additional resources are being mobilized. The recruitment process should be clearly outlined, with a time frame for recruitment to different positions and the people responsible for implementing the recruitment plan.

Both existing and new staff should follow a comprehensive training programme in areas such as:

- the principles of vector biology and disease transmission;
- vector surveillance techniques and mosquito identification;
- management of insectary facilities and rearing;
- vector control procedures;
- pesticide storage and handling
- data collection, management and interpretation;
- engagement of communities and other stakeholders; and
- project management, monitoring and evaluation.

Infrastructure

The infrastructure for vector surveillance and control should be organized at national and subnational levels. It may include:

- identification of warehouses for storage of equipment, pesticides, vehicles, etc.
- laboratory and insectary facilities and consumables;
- maintenance of vehicles, equipment and other supplies required at each level; and
- data management tools and communication technologies.

The infrastructural requirements should be included in the strategic plan, and options explored for construction, renting or extending suitable spaces.

Technical assistance

This section should state areas of the programme in which technical assistance will be required and when. These may include development of training modules, providing training and planning and implementing operational research. Plans for engagement with relevant institutions or organizations should be specified.

Budget and potential sources of funding

This section should describe the overall budget for implementation of the proposed *Aedes* VSCP and the budget for an annual workplan. Budgets should include all the requirements for implementation of the annual workplan (see section 6). The budget should cover scheduled routine surveillance, proactive vector control and projected costs of reactive vector control and the annual costs of human resources (e.g. salaries and allowances); field and laboratory equipment and consumables; transport and overheads; meetings, workshops and training courses.

If necessary, additional funding allocations should be sought from the government and/or external partners, with justification based on specific objectives and budget estimates.

Partner coordination

Programme managers should use information on the involvement of and support from the funding and/or implementing partners identified in the situation analysis to schedule regular meetings, separately or collectively, throughout planning and implementation of the *Aedes* VSCP.

Procurement, supply chain management and logistics

This section should briefly describe how stocks are monitored and maintained, including the procurement process, from requests to approvals, ordering and delivery of operational resources such equipment and consumables, with realistic time frames for each stage. This could be presented as a flow diagram. The efficiency of the process could be described, and, as necessary, practical solutions to improve the supply chain to ensure timely implementation of plans in the field.

Information systems and data management

This section outlines current processes for collating and reporting data from all surveillance and control activities in the country, with a brief description of the management and maintenance of a full national database; how data are shared with and reviewed by the decision-making bodies responsible for vector control; a brief indication of the issues and challenges encountered at any step of the process; and potential mitigating measures.

Programme monitoring and evaluation

Monitoring and evaluation are essential to ensure that priority actions are implemented as planned to meet the stated objectives and achieve the desired results. Managers at national and district levels and in health facilities should review indicators at least every quarter and undertake annual reviews before budgets are prepared.

The programme should be reviewed before the next strategic plan is developed, with time frames for monitoring and evaluation and cost estimates. Liaison with external partners will be required during planning if they are required to assist in monitoring and evaluation.

Risks and mitigating measures

This section should identify the risks to achievement of effective, successful implementation of the national VSCP and possible measures to address issues. The risks may include:

- insufficient financial, human or logistical resources;
- limited availability or stock-outs of operational equipment and consumables; and
- lack of awareness of or support for the national *Aedes* VSCP by senior management or national and international development partners.

The plan should also outline measures to mitigate any identified constraints and risks, with the associated budget (if necessary) for implementing such measures.

Gaps in evidence and knowledge

This section should highlight any gaps in information that must be addressed to strengthen the *Aedes* VSCP in the short, medium and long term, with a strategy for addressing the gaps. Priorities should be identified rather than a list of desired research or knowledge. This section may also include an operational research plan to fill the knowledge gaps. Where capacity allows, operational research may be conducted to ensure that accurate, locally-relevant information is gathered and used to improve preparedness and response. Ideally, development of the operational research plan will be consultative and involve at least one person with the appropriate scientific qualifications and experience. When possible, collaboration with research institutions or other organizations in PICs should be explored.

3.5 Step 5: Develop an annual workplan for programme activities

Tasks, activities and timeline

The timelines for the proposed activities and the institutions (or individuals) responsible for each action to be undertaken in the current year should be identified. Most of the proposed tasks for the coming year will have been identified earlier, during formulation of specific objectives, strategies and targets. A detailed Gantt chart can be used to illustrate activities and timelines (see Table 7).

Budget

The annual budget necessary for implementation of all vector surveillance and control activities should be outlined, including human resources, field equipment, laboratory equipment and consumables, insectary maintenance, data management and dissemination. (See example in Annex 7.) Training, meetings and any additional technical support required should also be listed, with their costs. The budget should be structured to align with national financial and planning cycles.

The quantity of resources required to complete an activity such as IRS-*Aedes* in a specific area should be known, as this is essential for budgeting. The quantities of insecticide required and the time necessary to cover a known number of properties can be estimated in a rehearsed, practical exercise, such as simulating a normal working day in a typical residential setting. (See an example in Annex 8.) Detailed means for estimating the cost of insecticides to be procured is provided in the Guidelines for procuring public health pesticides (Yadav, 2012).

3.6 Steps 6&7: Finalize and disseminate the *Aedes* VSCP

The draft *Aedes* VSCP should be shared with stakeholders, and a stakeholder meeting planned to review the draft and provide feedback. It may also be useful to hold a briefing to senior management and partner agencies to provide an overview of the plan, along with follow-up meetings as necessary to discuss resource mobilization. After integrating feedback received from key stakeholders and senior management, the plan can be finalized. When reviewing the final plan, it is useful to ensure that the following aspects are clear:

- **Inputs:** What are the human, equipment and funding resources invested in the plan?
- **Process:** What is the work being done? e.g. staff training, procurement of surveillance and control supplies, community education campaigns.
- **Outputs:** What is being produced? e.g. staff trained, data generated.
- **Outcomes:** What is the immediate impact on the population? e.g. community knowledge and attitudes, outbreaks prevented.
- **Impact:** What is the long-term impact? e.g. morbidity, mortality, economic and social status.

It may also be useful to produce a short summary of the plan (less than 10 pages) to share with stakeholders which highlights the goals, objectives, key activities, expected impact, outcomes and overall cost of the VSCP. This can assist with securing buy-in from management and partners and support discussions on resource mobilization. Once the final and summary versions of the VSCP are ready, a launch event can be held to present and raise awareness of the plan, and to distribute either electronic and/or hard copies among stakeholders and partners.

Table 7. Example of a chart for planning tasks, activities and timelines over 1 year

Task	Activity	Responsible body	Month											
			J	F	M	A	M	J	J	A	S	O	N	D
Development of national workplans	Conduct needs assessment Set objectives, targets, activities and timelines	MoH, VBDCP, partners	x	x										
	Identify requirements, and develop appropriate budget	MoH, VBDCP, partners		x	x	x								
	Compile, review and finalize national workplans	MoH, VBDCP, partners		x	x	x								
Preventive IRS-*Aedes* in selected high-risk areas	Recruit additional operational staff as required	MoH, VBDCP		x	x	x								
	Plan and conduct technical training workshops	MoH, VBDCP			x	x	x							
	Mobilize equipment, insecticides, data management system and other resources	MoH, VBDCP			x	x	x	x						
	Spray targeted houses	MoH, VBDCP					x	x	x	x	x			
Community engagement in targeted areas	Identify and consult key stakeholder representatives from target districts	MoH, VBDCP				x	x	x	x	x	x			
	Hold information and consultative meetings with communities	MoH, VBDCP, stakeholders					x	x	x	x	x	x	x	x
	Implement and monitor agreed engagement plans with communities	MoH, VBDCP, community stakeholders						x	x	x	x	x	x	x

Adult mosquito surveys at and around points of entry	Map distribution and locations of sentinel surveillance sites	MoH, VBDCP	x	x	x										
	Train staff in surveillance techniques	MoH, VBDCP		x	x	x									
	Procure traps and other surveillance resources	MoH, VBDCP	x	x											
	Deploy traps; and monitor weekly as required	MoH, VBDCP			x	x	x	x	x	x	x	x	x	x	
Data input, analysis and reporting	Establish data collection system	MoH, VBDCP	x	x	x										
	Regularly report vector species distribution and density	MoH, VBDCP			x			x			x				x

IRS-*Aedes*, targeted indoor residual spraying for *Aedes*; MoH, ministry of health; VBDCP, vector-borne disease control programme

4. References

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Yadav RS, editor (2012). Guidelines for procuring public health pesticides. Geneva: WHO; 2012.

5. Annexes

Annex 1. Additional guidance on control of *Aedes*-borne disease

In addition to the reference list above, the list below provides some additional guidance documents of relevance to surveillance and control of Aedes-borne diseases. This list was current at the time of publication; however, please visit the WHO Global (https://www.who.int/publications) and regional (https://www.who.int/Westernpacific) websites regularly for updates. See also the list of WHO documents in Annex 3 of the GVCR.

Food and Agriculture Organization & WHO (2011) International code of conduct on the distribution and use of pesticides: Guidelines for quality control of pesticides. Rome.

Insecticide Resistance Action Committee (2011) Prevention and management of insecticide resistance in vectors of public health importance, 2nd edition.

Pacific Public Health Surveillance Network (2016) Pacific outbreak manual.

WHO (2005) International Health Regulations – 3rd edition. Geneva.

WHO (2016) Technical handbook for dengue surveillance, dengue outbreak prediction/detection and outbreak response ("model contingency plan").

WHO (2016) Entomological surveillance for Aedes spp. in the context of Zika virus. Interim guidance for entomologists. Geneva.

WHO (2016) Vector control operations framework for Zika virus. Geneva.

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WHO (2021) WHO aircraft disinsection methods and procedures. Geneva. Licence: CC BY-NC-SA 3.0 IGO.

WHO (2022) Manual for monitoring insecticide resistance in mosquito vectors and selecting appropriate interventions. Geneva. Licence: CC BY-NC-SA 3.0 IGO.

WHO & the International Atomic Energy Agency (2020) Guidance framework for testing the sterile insect technique as a vector control tool against Aedes-borne diseases. Geneva. Licence: CC BY-NC SA 3.0 IGO

Annex 2.
Steps in estimating the burden of dengue

The steps below summarize those in the WHO Toolkit for national dengue burden estimation (2018). This tool includes guidance and templates for analysing data to estimate the national dengue burden. The aim is to understand how different burdens of disease are distributed over time and space in a particular country and to guide optimal allocation of limited resources for dengue prevention and control. Detailed instructions on completion of each step are provided in the full toolkit.

Step 1. Identify sources of data, such as from sentinel surveillance, national notification, hospital records and research reports.

Step 2. Calculate the clinical burden of dengue from national surveillance data, and assess the probable completeness of thie data, such as the estimated levels of over- or under-diagnosis of dengue and any gaps in diagnostic coverage.

Step 3. Calculate the probable community burden of dengue from the results of community surveys or published research on febrile illness and seroprevalence surveys.

Step 4. Make a realistic estimate of the national, clinical and community burden of dengue (using the spreadsheets and tables in the toolkit) and any potential gaps in surveillance.

Step 5. Consider conducting further analyses for more detailed understanding of the distribution of the burden, such as assessment of spatial and/or economic variation, comparison of the national estimates with those from global modelling, or join researchers in conducting new surveys.

Step 6. Countries are encouraged to document burden estimates in a publicly available report and to re-evaluate the national burden regularly, ideally every 3 years. The burden might increase suddenly if a new dengue serotype is introduced that can cause much higher morbidity and mortality.

Estimation of burden is important for understanding the true rates of infections in a population, as > 80% of arboviral infections are mild or asymptomatic and are not diagnosed. An estimate of the true burden of dengue may also be useful for making a case for investment in surveillance and control measures.

Reference

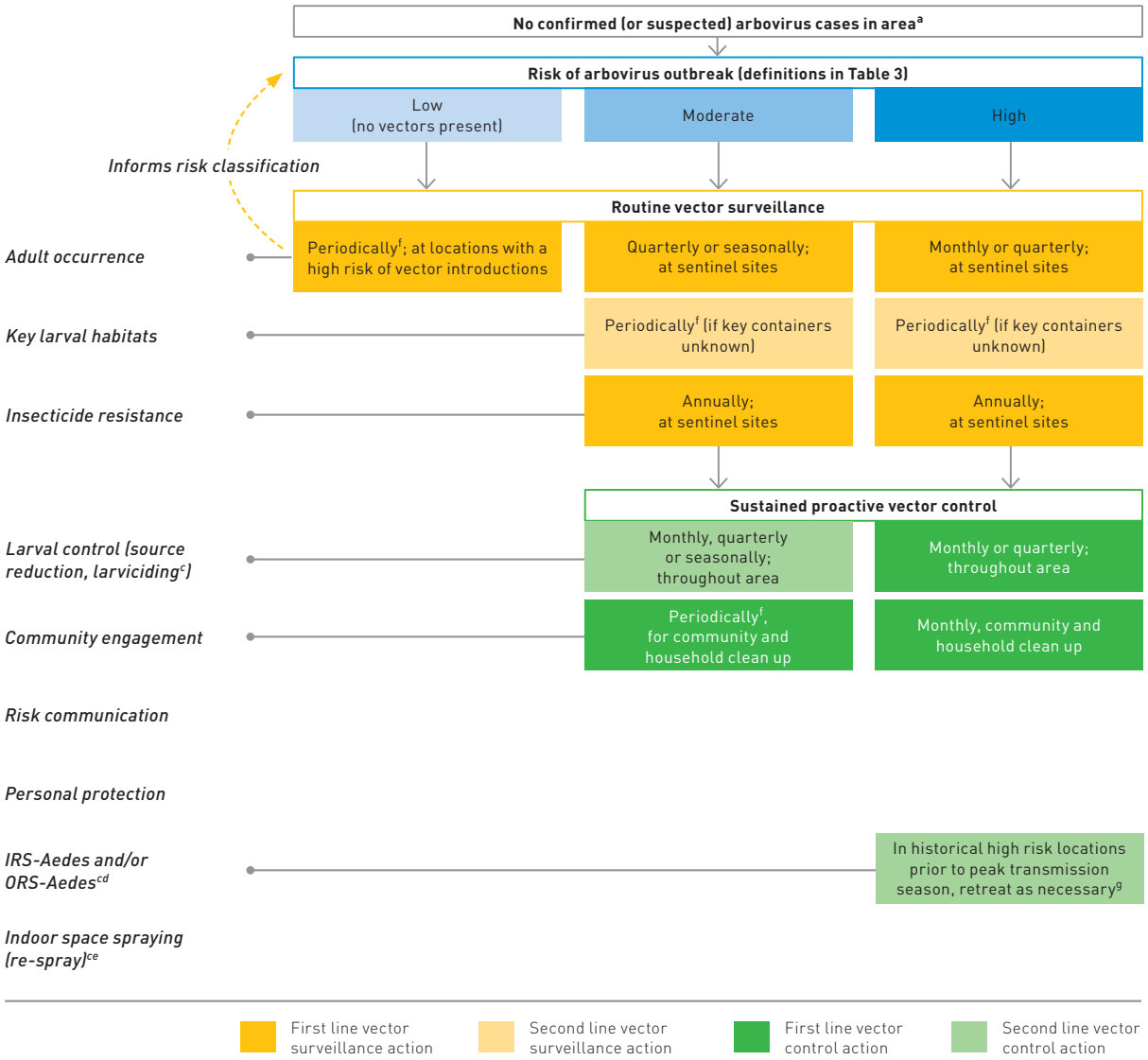
WHO (2018) A toolkit for national dengue burden estimation

Annex 3.
Examples of strategic decisions based on entomological surveillance of *Aedes* spp.

Entomological indicator	Information obtained	Operational decision	Example
Species occurrence	*Aedes* vector species present or absent in an area Survey methods may target adult mosquitoes or immature stages	Appropriate vector control methods based on typical behaviour of species, e.g. indoor- or outdoor-resting	*Ae. aegypti:* main adulticide treatment indoors, i.e. IRS-*Aedes* *Ae. albopictus:* main adulticide treatment outdoors on fringing vegetation, i.e. ORS-*Aedes*
		Classification of areas by risk of arbovirus outbreak. Occurrence of at least one competent vector species in an area makes it moderate or high risk, which determines priority of routine vector control activities	Identification of established *Aedes* vector population in an area for the first time can change the risk status of the area from low to high, with other factors considered, such as human population and arbovirus circulation
Species population density	No. of adult female vectors collected per sampling method per unit time in an area (e.g. number of females per trap per week) Can identify spatial differences in *Aedes* vector species density Survey methods target adult female mosquitoes	Prioritization of interventions if arbovirus cases detected in several locations at the same time Rationale: Arbovirus transmission likely to spread faster in areas of higher adult mosquito density, with other factors considered	Deploy vector control team immediately to an area in which the average density of *Ae. aegypti* is 80 females per Biogents Sentinel trap per week, and mobilize additional resources to respond a few days later to an area with an average density of *Ae. aegypti* of 4 females per trap per week.
	Changes in *Aedes* species density at same location at different times of the year Survey methods to target adult female mosquitoes	Can predict optimal timing of surveys in subsequent years for optimal use of resources, focusing only on times of highest densities of female mosquitoes	Conduct surveys in selected locations only in February–March to identify spatial differences in vector population densities

Adult vector insecticide resistance	Proportion of adult female vectors alive after exposure to insecticide in standard bioassay Adult females usually reared from eggs, larvae or pupae collected from targeted area	Insecticide resistance management strategies adopted in areas of confirmed resistance, e.g. change in class of insecticide used in the area	Switch from pyrethroid insecticides to carbamates for IRS-*Aedes* in the affected area
		Intensify surveillance in areas surrounding confirmed site of resistance to identify extent of insecticide resistance	Deploy ovitraps in four villages adjacent to the village in which insecticide resistance was detected to collect eggs for testing a broader geographical area

Annex 4.
Operational priorities for vector surveillance and control according to risk of an arbovirus outbreak

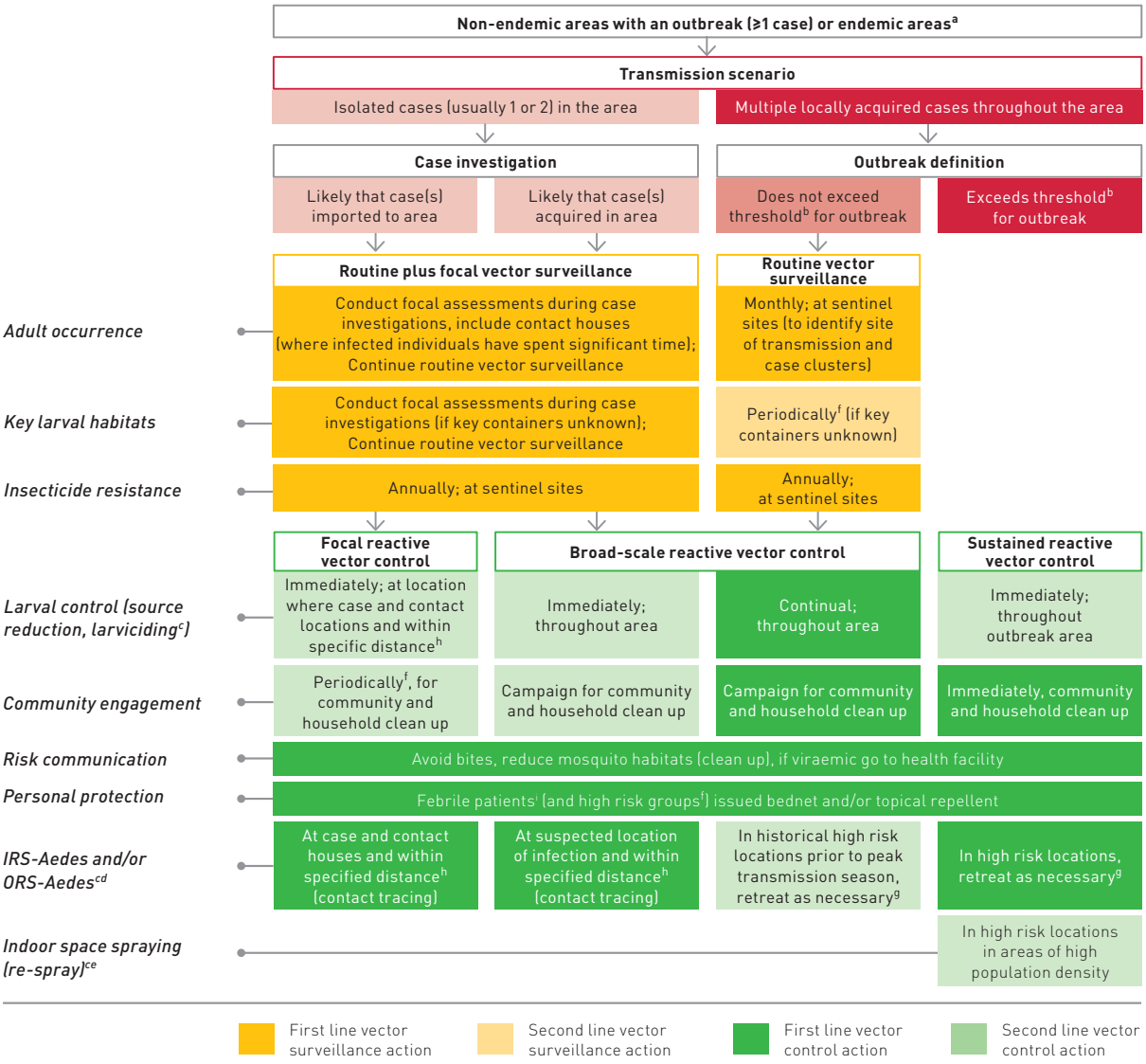


Reference

Pacific Community and WHO Division of Pacific Technical Support (2020) Manual for surveillance and control of *Aedes* vectors in the Pacific. Suva: Licence: CC BY-NC-SA 3.0 IGO.

a The minimum size of an area is determined by availability of reliable disaggregated disease surveillance data and feasibility for decisions on vector control implementation. The area is not necessarily based on administrative boundaries.
b Outbreak thresholds should be adjusted to suit the local conditions by each country
c Use insecticide class to which there is no known resistance in local *Aedes* vectors, see Section 5.6.2
d Frequency of re-spraying will depend on the residual efficacy of the formulation and application type as well as other factors such as the surface type
e Indoor space spraying should be done at least once per week for a minimum of four weeks when there is an outbreak
f Generally means 2 or fewer times per year, depending on need
g If surveillance system is sensitive enough to identify clusters in a timely manner, can use as a response measure
h Distance from cases for focal activities will depend on the environment and vectors (eg. 100-200m radius)
i With suspected or confirmed *Aedes*-transmitted arbovirus infections

Annex 5.
Operational priorities for vector surveillance and control when at least one case of arboviral disease been detected



Reference

Pacific Community and WHO Division of Pacific Technical Support (2020) Manual for surveillance and control of *Aedes* vectors in the Pacific. Suva: Licence: CC BY-NC-SA 3.0 IGO.

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h Distance from cases for focal activities will depend on the environment and vectors (eg. 100-200m radius)
i With suspected or confirmed *Aedes*-transmitted arbovirus infections

Annex 6.
Sample checklist for outbreak preparedness and response in a high-risk area of a province or district

The checklist can be used as a basis for discussions in departmental planning meetings about requirements and level of readiness and how to address any lack of staff or equipment. Columns may be filled in with quantities or brief notes, as applicable.

	Trained operational staff		PPE for field staff		Vehicles		Spraying equipment
Outbreak response activity	No. required	No. available	No. and type required	No. available	No. and type required	No. available	No. and type required
IRS-*Aedes*							
ORS-*Aedes*							
Larviciding							
Source reduction							
Personal protection measures							
Risk communication							
Indoor space spraying							

PPE, personal protective equipment; IRS-*Aedes*, targeted indoor residual spraying for *Aedes*; ORS-*Aedes*, targeted outdoor residual spraying for *Aedes*

	Insecticides and larvicides		Repellents or nets for patients		Communication strategies and materials		Information and data management systems	
No. available	Quantity and type required	Quantity available	No. and type required	No. available	No. and type required	No. available	No. and type required	No. available

Annex 7.
Sample budget for an annual vector control plan

The table below shows a budget based on activities. The listed budget items can be broken down into specific quantities on a separate spreadsheet according to the requirements for achieving desired targets.

Specific objective	Task (strategy)	Activity	Budget items	Amount		
				Year 1	Year 2	Year 3
Reduction by 50% of *Aedes* vector density in endemic districts by December 2022	Development of national workplans	Conduct needs assessment. Set objectives, targets, activities, and timelines.	Steering committee meetings (travel, accommodation, allowances)			
		Identify requirements and establish appropriate budget	Stakeholder meetings; financial advisor or consultant			
		Compile, review and finalize national workplans	Meetings, graphic designing, printing			
	Preventive IRS-*Aedes* in selected high-risk areas	Recruit additional operational staff as required.	Advertising, interviews, salaries			
		Plan and conduct technical training workshops.	Venue, facilitators, accommodation, travel, allowances			
		Mobilize equipment, insecticides, data management system and other resources.	Pneumatic sprayers, PPE, insecticides, vehicles, computers			
		Spray targeted houses	Fuel, staff allowances			

	Community engagement in targeted areas	Identify and consult key stakeholders from target districts.	E-mails, telephone, meetings, coordination
		Hold informative and consultative meetings with communities.	Meeting venues, travel costs, allowances, refreshments
		Implement and monitor agreed plans for engagement with communities.	Design messaging strategies, pamphlets, media statements, community meetings.
Prevent incursion and establishment of *Aedes* vectors through points of entry	Adult mosquito surveys at and around points of entry	Train staff in surveillance techniques.	Venue, facilitators, accommodation, travel, allowances
		Map distribution and locations of sentinel surveillance sites.	Mapping software, travel
		Procure and deploy traps; monitor traps weekly; identify mosquitoes.	Traps and accessories, transport, laboratory, reagents, microscopes

IRS-*Aedes*, targeted indoor residual spraying for *Aedes*; PPE, personal protective equipment

Annex 8.
Projection of requirements for targeted indoor residual spraying for budgeting

Detailed guidelines on the type of equipment, insecticides and procedures for conducting IRS-*Aedes* against *Ae. aegypti* were provided by the Pan American Health Organization (2019). The amount of insecticide required to treat an area depends on the number of houses to be sprayed and the average amount of insecticide applied per house, which depends on the type and size of the houses and the types of materials and furniture in the house that are used by *Ae. aegypti* as resting sites. These parameters will differ by country and community.

The average amount of insecticide and the time required for spraying an area can be determined in a test run in which a selected number of houses are treated. For example, three teams of two people can be allocated 20 houses per team and spray under supervision (see table). The average time and insecticide to be applied can then be used to make estimates for areas with similar types of housing.

Team	Time to spray 20 houses (h)	No. of refills of spray tank	Amount of insecticide (mL) per 5-L tank refill (from label mix rate)	Total insecticide used (mL)
A (2 people)	3	9	100	900
B (2 people)	5	11	100	1100
C (2 people)	4	10	100	1000
Average	4			1000

Thus, a team of two people is estimated to take an average of 4 h to conduct IRS-*Aedes* in 20 houses and will use 1 L of insecticide. This information can be used to plan the number of teams to be deployed to spray targeted areas within a specified time. The proposed number of teams and specified time can be used be used further to estimate other resources, such as transport and fuel.

Reference

Pan American Health Organization (2019) Manual for indoor residual spraying in urban areas for *Aedes aegypti* control. Washington DC.

A mother and child under a mosquito net in a typical house, Savai'i Island, Samoa.


Family first

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