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# Guide to forest biosecurity



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# Abbreviations

|      |                                                         |
|------|---------------------------------------------------------|
| DNA  | deoxyribonucleic acid                                   |
| FAO  | Food and Agriculture Organization of the United Nations |
| ISPM | International Standard for Phytosanitary Measures       |
| NPPO | national plant protection organization                  |
| NWFP | non-wood forest product                                 |
| RNA  | ribonucleic acid                                        |
| SFM  | sustainable forest management                           |
| SWOT | strengths, weaknesses, opportunities and threats        |

# Foreword

Healthy forests are essential for the health of the planet and the well-being of people. They support biodiversity, regulate climate, protect soils and water resources, and sustain the livelihoods of millions of people worldwide. Although deforestation continues to decline globally, forests are increasingly threatened by wildfires and pest outbreaks. Climate change, global trade and the movement of goods and people facilitate the introduction and spread of pests, increasing risks to forest health. Together, these pressures highlight the need for robust national forest biosecurity systems that can anticipate, prevent, detect and respond to emerging threats.

Effective forest biosecurity depends on strong collaboration across sectors, including forestry, agriculture, environment, trade and border control, as well as engagement with research institutions, the private sector and local communities. Prevention and early intervention are crucial for reducing the economic, social and environmental impacts of pests and other threats that can undermine forest resilience.

This publication aligns with the 2030 Agenda for Sustainable Development and contributes directly to several Sustainable Development Goals (SDGs), including SDG 2 (zero hunger), SDG 3 (good health and well-being), SDG 13 (climate action) and SDG 15 (life on land). Healthy forests are fundamental for achieving climate-change mitigation and adaptation objectives, conserving biodiversity and supporting sustainable land management. Strengthening national forest health systems also contributes to SDG 1 (no poverty) and SDG 8 (decent work and economic growth) by safeguarding forest-based livelihoods and industries. Aligned with the One Health approach, forest biosecurity safeguards ecosystem integrity while protecting human and animal health from the transboundary spread of pests.

Strengthening national systems requires investment in institutional coordination, technical capacity, awareness-raising and the development of enabling policies and legislation. Equally important is fostering regional and international cooperation to address transboundary risks and share knowledge and experience.

This publication provides practical guidance for strengthening forest health governance and biosecurity preparedness. By promoting coherent, integrated and forward-looking approaches, the aim is to support countries in protecting forest ecosystems as vital natural assets for the present and future generations. With stronger biosecurity systems, countries can better anticipate emerging risks, reduce vulnerabilities and ensure that forests continue to provide essential goods and services in an increasingly interconnected and changing world.

**Zhimin Wu**

Assistant Director-General and Director of the Forestry Division, FAO

## Key messages

- ▶ **Forests are vital for sustainable development but face growing pest risks.** Invasive species and native pest outbreaks increasingly threaten forest ecosystems and the economic, social and environmental benefits they provide, with risks intensified by climate change, global trade and human movement.
- ▶ **Forest biosecurity must be addressed through integrated systems.** Effective forest biosecurity depends on coherent, system-based approaches that combine prevention, early detection and long-term management, supported by appropriate policies, legislation, institutions and resources.
- ▶ **Prevention and early response are the most cost-effective interventions.** Investing in measures that reduce the likelihood of pest introduction and enable rapid detection and response delivers the greatest returns and minimizes long-term economic and ecological impacts.
- ▶ **Biosecurity is a shared responsibility across society.** Governments, forest owners and managers, industry, research institutions, Indigenous Peoples, local communities and the public all have important and complementary roles to play in reducing pest risks and strengthening forest biosecurity outcomes.
- ▶ **Resilient forest ecosystems underpin effective biosecurity.** Sustainable forest management practices that enhance the health, vitality and resilience of forests reduce vulnerability to pests and should be embedded across all forest biosecurity activities.
- ▶ **Forest biosecurity systems must be adaptive and forward-looking.** Continuous monitoring, evaluation and learning, supported by research, innovation and international cooperation, are essential for ensuring the ongoing effectiveness of forest biosecurity systems in a changing and increasingly interconnected world.



# 1 Introduction

Forests cover nearly one-third of the Earth's land surface, with a total area of 4.14 billion hectares. Ninety-three percent (3.8 billion hectares) of these forests have regenerated naturally, and 8 percent (303 million hectares) are planted (FAO, 2025).

Forests play invaluable roles in sustaining the planet. They are essential for maintaining biodiversity, regulating climate, filtering noise and chemical pollution, providing food and shelter, supporting local economies (such as through ecotourism and industries based on wood and non-wood products), and supplying essential ecosystem services that help ensure food security and enhance resilience in the face of disasters.

Forests and trees are under increasing threat from pests,<sup>1</sup> a threat exacerbated by climate change. Pest outbreaks can devastate entire forest ecosystems, and they have serious implications for many tree species. Pests – both native and non-native – can invade forests through diverse pathways, such as natural spread, domestic and global trade, inadvertent transport via tourism, vehicles and equipment, and intentional introductions. Maintaining the health and vitality of trees is an important way of minimizing the impacts of pest outbreaks because stressed trees are more vulnerable to pest attack.

Ensuring that forests and trees continue to provide their essential economic, social and environmental benefits requires concerted efforts to understand, monitor and manage pest threats. Forest health and biosecurity practices can help protect and maintain healthy, resilient forests and trees and safeguard biodiversity.

Biosecurity is a strategic and integrated approach to analysing and managing risks to human, animal and plant health, including associated risks to the environment (FAO, 2007). In the context of this guide, we define forest biosecurity as the policies and regulatory frameworks (including tools and activities) aimed at protecting the health and vitality of forests and trees from the risks posed by pests.

Many countries have implemented biosecurity systems with a focus on plants and animals for production. Forests, which play both production and conservation roles, are usually included in plant biosecurity, but they often receive little – if any – attention compared with agricultural and horticultural crops. This lack of focus on forest biosecurity is due largely to economic factors, but the wide range of forest types, purposes and scales also plays a role. Forests are designated and used for diverse purposes, such as protection, conservation, amenity, production (planted and natural, smallholder and industrial), climate-change mitigation (e.g. carbon credits), urban and roadside amenity, and agroforestry; each provides a

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<sup>1</sup> “Pest” is defined as any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products (ISPM No. 5; IPPC Secretariat, 2024).

challenge because of differences in pest risk and how best to manage this.

“Forest biosecurity” is defined here as a system to prevent and manage forest pests, diseases and invasive species (in this guide, these threats are generally referred to collectively as “forest pests”). It encompasses comprehensive approaches designed to maintain forest health, vitality and resilience and to protect against and manage biological threats. Forest biosecurity can involve a complex mix of issues and actors, but a shared-responsibility approach can encourage collective efforts. Key for the implementation of an effective and sustainable forest biosecurity system in a country is active and ongoing actor engagement at multiple levels – across and within government departments, regional and international collaborators and partners, industry bodies, non-governmental organizations, natural-resource managers, landowners, and local communities.

### 1.1 PURPOSE, SCOPE AND TARGET AUDIENCE

This guide is a resource for policymakers and decision-makers. It emphasizes the need for comprehensive forest biosecurity systems at the regional, national and local levels that enable quick, effective decision-making to minimize the impacts of pests on forests and their associated economic, sociocultural and environmental values. The guide acknowledges the inevitability of pest risks and stresses the importance of measures aimed at preventing pest introductions, containing their spread if introduced, and minimizing the impacts of established pests. It also provides guidance for foresters and communities on their potential roles and responsibilities, alongside those of national agencies and national plant protection organizations (NPPOs).

The guide will be helpful for countries that have:

- no national forest biosecurity strategy, plan, legislation or policy;
- a national biosecurity strategy, plan, legislation or policy but no focus on forest biosecurity; or
- a national forest biosecurity strategy, plan, legislation or policy that is not yet fully implemented.

Chapter 2 elaborates on the concepts of biosecurity and forest biosecurity and outlines the actors and activities involved in an effective forest biosecurity system. Chapter 3 discusses the importance of inclusivity for success when developing and implementing activities associated with a biosecurity system. Chapter 4 provides general guidance on the preparation of an effective forest biosecurity system. Chapter 5 focuses on tools to support the preparation and implementation of a forest biosecurity system, and Chapter 6 offers a brief conclusion.

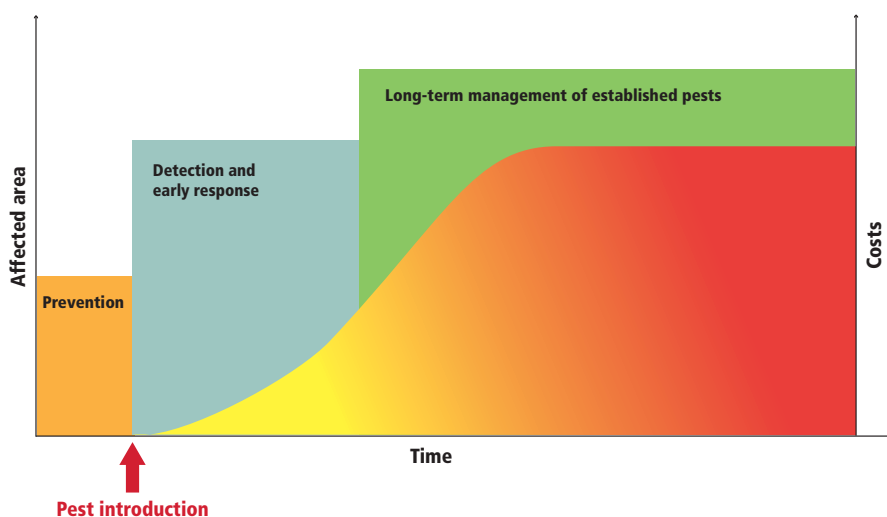
## 2 Structure of forest biosecurity systems

A main aim of biosecurity is to prevent or minimize exposure to pest threats and ultimately to avoid the threats becoming issues that require management – with associated costs and impacts. For example, Dodd *et al.* (2020) compared the cost of pest prevention in Australia with the cost of control and estimated that the benefit-to-cost ratio of the country's biosecurity system was 30:1.

Figure 1 illustrates the pest invasion process and depicts impacts and costs incurred during the establishment and spread of a pest or pathogen in a new environment. The pest invasion curve can be useful for understanding the progression of a pest invasion, identifying effective points of intervention, and developing strategies for preventing or managing spread. The highest returns on investment occur early in the curve (i.e. in the prevention phase).

FIGURE 1.

The pest invasion curve, showing the corresponding change in the area affected and costs



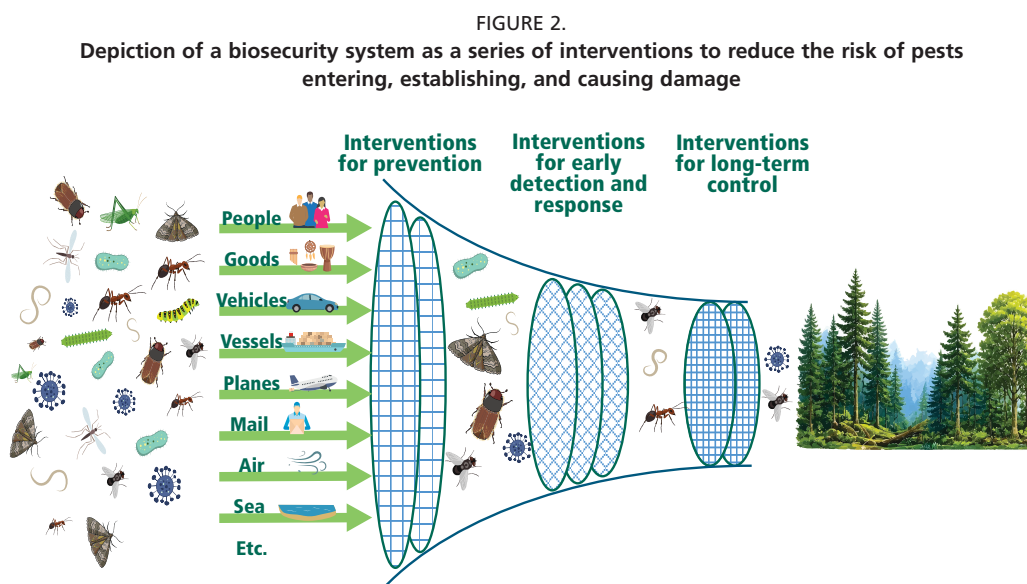
Source: Adapted from Victorian Government. 2010. Invasive Plants and Animals Policy Framework. Melbourne, Australia, Department of Primary Industries. <https://agriculture.vic.gov.au/biosecurity/protecting-victoria/legislation-policy-and-permits/invasive-plants-and-animals-policy-framework/Invasive-Plants-and-Animals-Framework-Sep-22.pdf>

Pest invasions typically have four stages:

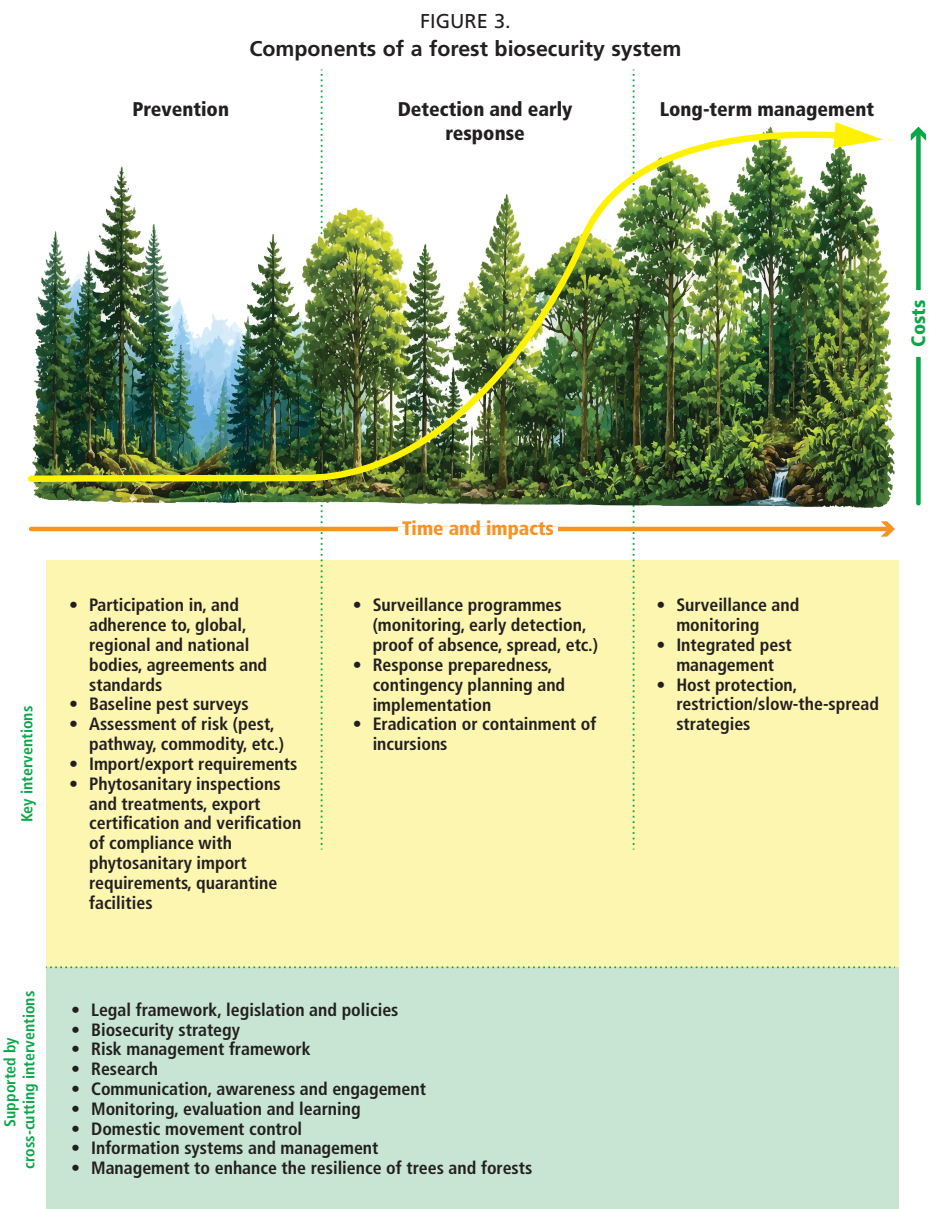
1. **Introduction.** A pest is introduced to the new environment. This can happen through intentional or unintentional human activity, such as shipping, trade or accidental release, or via natural pathways (e.g. wind, extreme weather events, host jumping, and animal vectors).
2. **Establishment.** The pest establishes a breeding population in the new environment (although not every introduction results in establishment).
3. **Spread.** The pest starts spreading in its new environment. This can happen through various mechanisms, such as natural dispersal (e.g. via wind, water or animal vectors) or human activities.
4. **Impact.** The pest starts having undesired impacts – such as on ecosystems, production systems and hosts. Impacts may include outcompeting native species, reducing production, increasing management costs, and altering ecosystem processes. The latter may be exacerbated by a lack of co-evolved resistance and natural predators.

## 2.1 FOREST BIOSECURITY SYSTEMS

Biosecurity, including forest biosecurity, comprises a series of key risk-management interventions; taken together, these interventions constitute a biosecurity system. A system-based approach recognizes that no single intervention will address all biosecurity risks and that multiple layers of protection will maximize the likelihood that, if a threat evades one type of intervention, it will be addressed by others (Figure 2). The potential interventions in a biosecurity system can be applied to threats posed by both native and non-native pests.



Biosecurity systems have three pillars: (1) prevention; (2) detection and early response; and (3) long-term management (Figure 3). Interventions under the prevention pillar help reduce the risk of introduction, establishment and spread. If a pest establishes, control measures under pillar 2 – detection and early response – would ideally remove the pest from the environment. If eradication is unsuccessful or unachievable, containment measures under pillar 3 can minimize further spread.



Note: The key interventions apply to both native and non-native pests, although some (e.g. eradication) are not relevant to native pests.

## 2.2 PILLAR 1. PREVENTION

Prevention activities (Table 1) are aimed at reducing the risk of pests entering and establishing in a country or region. Prevention is usually more cost-effective in reducing losses and enabling trade than managing an already introduced or established pest.

TABLE 1.

**Prevention: Responsible actors and detailed activities for the prevention pillar in a forest biosecurity system, by intervention**

| Intervention                                                                                       | Actor(s) responsible                                                                                          | Detailed activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Participation in, and adherence to, global, regional and national bodies, agreements and standards | Government                                                                                                    | <ul style="list-style-type: none"> <li>• Review national or other jurisdictional policies, legislation and legal frameworks</li> <li>• Provide clear roles and responsibilities for institutions to support accountability and enable swift, coordinated action</li> <li>• Participate in multilateral forums and global sanitary and phytosanitary organizations (e.g. World Trade Organization, International Plant Protection Convention, Convention on Biological Diversity, Codex Alimentarius Commission)</li> <li>• Participate in regional plant protection organizations, regional trade agreements, etc.</li> <li>• Engage with importing/exporting countries</li> <li>• Develop an effective system for communication and information exchange, including with the public</li> </ul> |
| Baseline pest surveys                                                                              | Government, in collaboration with scientific experts and industry <sup>a</sup>                                | <ul style="list-style-type: none"> <li>• Conduct field surveys, data collection, analysis and reporting to establish the initial status of pest populations in the area</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Assessment of risk (pest, pathway, commodity, etc.)                                                | Government, in collaboration with scientific experts and industry, in compliance with international standards | <ul style="list-style-type: none"> <li>• Conduct risk profiling and assessment               <ul style="list-style-type: none"> <li>○ Identify and prioritize pest risk (economic, social and environmental), introduction pathways, and at-risk commodities and environments</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

Table 1 (continued)

| Intervention                                                                                                                                                | Actor(s) responsible                                              | Detailed activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Import/export requirements                                                                                                                                  | Government, in collaboration with scientific and industry experts | <ul style="list-style-type: none"><li>• Develop import/export requirements based on risk assessment</li><li>• Ensure compliance with importing-country requirements and verification</li></ul>                                                                                                                                                                                                                                                                                                                                        |
| Phytosanitary inspections and treatments; export certification and verification of compliance with phytosanitary import requirements; quarantine facilities | Government, in collaboration with industry                        | <ul style="list-style-type: none"><li>• Develop capacity to inspect export/import commodities (e.g. live plants, seeds, machinery, vehicles, containers, packaging materials, e-commerce/postal goods, and ship ballast)</li><li>• Develop capacity to audit biosecurity systems and quarantine activities</li><li>• Ensure appropriately trained personnel at points of entry</li><li>• Establish holding and monitoring facilities for live-plant imports</li><li>• Provide diagnostic facilities, resources and training</li></ul> |

Note: <sup>a</sup> The term “industry” comprises a wide range of commercial actors, such as importers, exporters, primary producers of forestry, horticulture and agriculture, and those involved in tourism, trade and transport.

2.3 PILLAR 2. DETECTION AND EARLY RESPONSE

This pillar focuses on the use of surveillance and reporting to detect biosecurity threats as soon as possible after they arrive or re-emerge in an area. The aim is to contain or eradicate the threats and thereby prevent them from establishing and spreading. For a new pest incursion,<sup>2</sup> as well as for outbreaks of established and native pests, control activities are used to prevent or eliminate the threat or reduce it to an acceptable level. Detection and early-response activities (Table 2) are aimed at detecting and managing pest incursions before they have unacceptable impacts.

<sup>2</sup> An incursion is defined as “an isolated population of a pest recently detected in an area, not known to be established, but expected to survive for the immediate future” (ISPM No. 5; IPPC Secretariat, 2024).

TABLE 2.

**Detection and early response: Responsible actors and detailed activities for the detection and early response pillar of a forest biosecurity system, by intervention**

| Intervention                                                                                           | Actor(s) responsible                                                                                                             | Detailed activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Surveillance programmes (e.g. monitoring, early detection, proof of absence, and monitoring of spread) | Governments (national, subnational and local), in collaboration with scientific and industry experts, communities and the public | <ul style="list-style-type: none"> <li>• Develop national surveillance and monitoring systems</li> <li>• Determine the type of surveillance – targeted or general – to implement in different contexts: <ul style="list-style-type: none"> <li>○ targeted – specific objectives (e.g. early detection for specific species, and high-risk-site surveillance to detect changes in health status or symptoms for a range of tree species that might be indicative of a new pest or pathogen)</li> <li>○ general – drawing on a wide range of data sources and observations and reporting by industry participants, the public and communities</li> </ul> </li> <li>• Increase public involvement in surveillance through dissemination campaigns, citizen science and other activities</li> <li>• Engage and partner with local actors, including Indigenous and ethnic communities, to identify surveillance needs and approaches</li> <li>• Provide training in pest recognition and reporting channels</li> <li>• Develop diagnostic capacity and resources</li> </ul> |
| Response preparedness and contingency planning and implementation                                      | Government, in collaboration with scientific experts and industry                                                                | <ul style="list-style-type: none"> <li>• Conduct contingency planning for response to incursions of priority pest threats, including identifying key responsible/accountable actors</li> <li>• Develop preparedness and response plans</li> <li>• Promote membership of certification or assurance schemes</li> <li>• Cultivate collective responsibility – requiring partnerships between government and all sectors related to biosecurity (e.g. animal and plant health, the environment, and human health), industry, research and the public</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Eradication or containment of incursions                                                               | Government/industry/the public                                                                                                   | <ul style="list-style-type: none"> <li>• Develop capability and systems to take urgent action to eradicate or contain the pest</li> <li>• Establish partnerships between government (across biosecurity sectors), industry and the public</li> <li>• Assess cost-effective options</li> <li>• Consider establishing agreements and structures for sharing the costs of control, containment or eradication between government and industry</li> <li>• Institute domestic movement control</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

## 2.4 PILLAR 3. LONG-TERM MANAGEMENT

If pests have established in a new area or the existing population is increasing, biosecurity activities should shift towards managing the organisms (both pest and host(s)), with objectives such as slowing or containing the spread, long-term eradication, and host protection (Table 3). Knowledge of the status of a given pest and how it is being managed will help in meeting international phytosanitary requirements.

TABLE 3.

**Long-term management: Responsible actors and detailed activities for the long-term management pillar of a forest biosecurity system, by intervention**

| Intervention                | Actor(s) responsible                                                                                                             | Detailed activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Surveillance and monitoring | Governments (national, subnational and local), in collaboration with scientific and industry experts, communities and the public | <ul style="list-style-type: none"> <li>Continue the activities described in Table 2 (i.e. those indicated for the detection and early response pillar)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                      |
| Integrated pest management  | All actors managing trees and forests                                                                                            | <ul style="list-style-type: none"> <li>Focus on long-term pest suppression</li> <li>Establish acceptable economic/ecological threshold levels of pest populations in response to forest management goals (wood production, conservation, etc.)</li> <li>Analyse monitoring data and thresholds to determine best pest management measures</li> <li>Use combinations of biological, cultural, mechanical and chemical control measures, ensuring their environmental safety</li> <li>Put in place strategies for host protection to restrict/slow the spread</li> </ul> |

## 2.5 CROSS-CUTTING INTERVENTIONS

The interventions listed in Table 4 are relevant to all three pillars of a forest biosecurity system.

TABLE 4.

**Cross-cutting: Responsible actors and detailed activities for the cross-cutting interventions of a forest biosecurity system**

| Intervention                              | Actor(s) responsible                                      | Detailed activities                                                                                                                                                                                                  |
|-------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Legal framework, legislation and policies | Government                                                | <ul style="list-style-type: none"> <li>Harmonize policies across sectors to allow the sharing of resources and expertise</li> <li>Harmonize legal frameworks (global, regional, national and subnational)</li> </ul> |
| Biosecurity strategy                      | Government, in collaboration with industry and the public | <ul style="list-style-type: none"> <li>Develop an overarching national biosecurity system harmonized between and across sectors<sup>a</sup></li> </ul>                                                               |

Table 4 (continued)

| Intervention                            | Actor(s) responsible                                                                                                                                                                                                                                         | Detailed activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Risk management framework               | Governments, industry, the scientific community and other appropriate actors                                                                                                                                                                                 | <ul style="list-style-type: none"> <li>• Appoint an appropriate institution to act as the national plant protection organization</li> <li>• Make clear organizational arrangements (e.g. by defining capacity, developing mandates, identifying and assigning roles and responsibilities, and deciding core forest biosecurity functions, principles and procedures)</li> <li>• Develop and implement standards and guidelines</li> <li>• Identify and allocate resources to enhance capability and capacity (human, technical, financial and infrastructural)</li> <li>• Establish contingency plans and response agreements with relevant actors</li> <li>• Ensure clear decision-making processes, with identified roles, responsibilities and accountability</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Research                                | Government, industry, academia and research organizations                                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>• Invest in research that informs and improves pest prevention activities, diagnostic techniques, surveillance, response, management, and access to, and availability of, technical capability and capacity</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Communication, awareness and engagement | Governments, research institutes, academia, non-governmental organizations, specialist interest groups, the public, Indigenous and local communities, and government departments of agriculture, environment, tourism, trade, transport, finance and customs | <ul style="list-style-type: none"> <li>• Share pest information               <ul style="list-style-type: none"> <li>○ Provide information at points of entry (e.g. airports, land borders and seaports) on the risk of bringing in certain items</li> <li>○ Use a variety of communication media (e.g. television, radio, print and social) to reach target actors</li> <li>○ Consider the compulsory screening of video clips on aircraft and ships prior to landing or docking</li> </ul> </li> <li>• Encourage all actors to be familiar with forest biosecurity, such as relevant legislation and policies, pest threats and impacts, and the consequences of introductions</li> <li>• Ensure that government officers have clear operational roles and actively promote biosecurity</li> <li>• Build capacity for pest reporting to enhance the chances of effective control and eradication</li> <li>• Provide accessible means (e.g. apps, websites and phone numbers) to the public, industry actors and others for reporting pest sightings and outbreaks</li> <li>• Where possible, provide biosecurity equipment and information at entry points to forest areas</li> <li>• Identify barriers to participation in biosecurity, and consider providing incentives for participation</li> <li>• Promote the engagement of actors in biosecurity actions so they better understand their roles and responsibilities</li> <li>• Engage the public (e.g. through citizen science, media campaigns and participation networks)</li> </ul> |

Table 4 (continued)

| Intervention                                  | Actor(s) responsible                                      | Detailed activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitoring, evaluation and learning           | All actors                                                | <ul style="list-style-type: none"> <li>• Develop performance indicators for all outputs and outcomes</li> <li>• Implement monitoring systems</li> <li>• Collect and analyse data</li> <li>• Evaluate analyses and provide feedback</li> <li>• Use the results of monitoring, evaluation and learning to improve the biosecurity system</li> </ul>                                                                                                                                                                                                                                                                                                                                                                          |
| Information systems and management            | Government, in collaboration with industry and the public | <ul style="list-style-type: none"> <li>• Establish a secure, centralized system for storing and disseminating information</li> <li>• Use the information system to develop knowledge products and ensure compliance and required reporting</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Enhancing the resilience of trees and forests | All actors managing trees and forests                     | <ul style="list-style-type: none"> <li>• Put in place sustainable forest management measures to increase forest and tree resilience, such as the following:               <ul style="list-style-type: none"> <li>○ choosing tree species and provenances that are suitable for the site under likely changes in climate</li> <li>○ soil enhancement</li> <li>○ water harvesting</li> <li>○ reduced impact logging</li> <li>○ silviculture</li> <li>○ ensuring that livestock grazing and the harvesting of non-wood forest products are sustainable</li> <li>○ integrated pest management (potentially including biological control<sup>b</sup>)</li> <li>○ enforcement of relevant forest policies</li> </ul> </li> </ul> |

Note: <sup>a</sup> One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems (FAO, UNEP, WHO and WOA, 2022); <sup>b</sup> See Kenis *et al.* (2019) for guidance on classical biological control.

Sources: FAO, UNEP, WHO & WOA. 2022. *One Health Joint Plan of Action (2022–2026). Working together for the health of humans, animals, plants and the environment*. Rome, Food and Agriculture Organization of the United Nations (FAO), United Nations Environment Programme (UNEP), World Health Organization (WHO) and World Organisation for Animal Health (WOAH). <https://doi.org/10.4060/cc2289en>; Kenis, M., Hurley, B.P., Colombari, F., Lawson, S., Sun, J., Wilcken, C., Weeks, R. & Sathyapala, S. 2019. *Guide to the classical biological control of insect pests in planted and natural forests*. FAO Forestry Paper No. 182. Rome, FAO.



## 3 Collaboration, engagement and shared responsibility

A wide range of individuals and organizations may be implicated in pest introductions and spread, and they all have important roles to play in pest prevention and management. The challenge of preventing the introduction of forest pests is shaped by the values, awareness, risk perceptions, attitudes and behaviours of a broad range of actors, such as those in the nursery and plant industry, landowners and managers, policymakers, researchers, forest users, local communities (including Indigenous and ethnic groups), non-governmental organizations and the public. Collaboration that incorporates close engagement between biosecurity sectors and research disciplines and between research, policy and practice requires careful planning and the investment of time and resources. If done well, such engagement will facilitate knowledge-sharing, build relationships and trust, and support the airing and management of conflicts. It will also enable the development of agreed processes that promote capacity development. Collaborative processes recognize issues around power, equity and inclusion, and greater inclusion and participation can lead to better overall biosecurity outcomes. The existing biosecurity strategies of several countries emphasize the importance of collaboration and shared responsibility.<sup>3</sup>

### 3.1 PARTICIPATION AND ENGAGEMENT

Participation incorporates various types of engagement and empowerment, such as collaboration, co-design and shared decision-making. It often involves collective knowledge creation to decide, develop and implement actions, thus increasing accountability. Participation in actions associated with forest health and biosecurity will support awareness-raising, knowledge exchange and capacity building. Inclusive approaches will also likely improve the social acceptability of management approaches, which may include actions with negative connotations, such as chemical spraying and the removal of vulnerable trees. Awareness about forest biosecurity among the public and industry can reduce risky behaviours, such as bringing plant products into an area and moving diseased materials between jurisdictions.

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<sup>3</sup> Two examples are the Great Britain Plant Biosecurity Strategy and New Zealand's Tiakina Kauri | Kauri Protection programme and the Kotatou This Is Us campaign and Biosecurity Business Pledge.

A participatory approach to forest biosecurity may include the following functions:

- Mapping key stakeholders early, identifying those with less interest/influence, and preparing a plan for broader engagement accordingly.
- Empowering a broad set of individuals, organizations and enterprises that would not normally be considered key actors in forest health and biosecurity (e.g. officials and industry) to be involved.
- Acknowledging the multiple economic, social and environmental values and perspectives associated with forest species and landscapes and, where possible, incorporating these into decision-making. There are also diverse perceptions of risk related to the introduction and impacts of forest pests and how to address these. Different ways of communicating – based on building relationships and trust – need to be considered.
- Inclusive approaches that embrace diverse communities (e.g. in terms of ethnicity, gender and age). Participation will promote a plurality of perspectives and experiences that will empower those who normally feel excluded but who can have a significant impact on forest biosecurity or be affected by the consequences of a pest introduction or outbreak. Inclusive participation can also help in identifying opportunities to include biosecurity practices in existing processes.

### 3.2 OUTCOMES AND CHALLENGES

Collaboration, participation and shared responsibility can all contribute to positive forest biosecurity outcomes. One such outcome is increased awareness about the risk pathways for pest introductions and the impacts of pest outbreaks. Another potential outcome is a greater understanding of the role each actor can play in a holistic biosecurity system, as well as an increase in their capacity and motivation to perform that role. More-inclusive approaches also have challenges, such as the following:

- Participation takes time and resources – these might be lacking in an outbreak, which could require an emergency response.
- The development of harmonious relationships among actors requires managing competing priorities and vested interests.
- Knowledge transfer to retain institutional memory in the face of staff turnover is time-consuming and costly.

### 3.3 GUIDANCE ON COLLABORATIVE APPROACHES

One size does not fit all, but organizations can take steps to co-develop more-inclusive approaches to biosecurity, as follows:

- Identify budget-holders and secure and allocate resources for biosecurity engagement and capacity development.
- Conduct stakeholder mapping and analysis of all individuals, communities and organizations that may contribute to, or be affected by, threats to forest biosecurity. Ensure that the mapping encompasses gender, age, ethnicity,

resource ownership, stewardship and other factors important for developing an adequate map.

- Stakeholder mapping and analysis should ascertain why and where different actors are important along the pest invasion curve; identify interests and needs for biosecurity learning and action; highlight potential conflicts of interest; and canvass the likely impacts of different management approaches. The mapping and analysis should also help identify actors that are missing from the collaborative process.
- Develop a roadmap for shared responsibility – the whom, what (e.g. required resources, data and decisions), when and how (e.g. information, consultation, participation, partnerships, and empowerment through capacity building), and the behaviours required of the various actors.
- Engage with stakeholders – through consultation, research and collaboration with networks – to understand the level of knowledge held by each group and the extent of support and collaboration needed to engage in biosecurity discussions and develop capacity.
- Consider the co-development of actions with stakeholder groups at different stages of a pest outbreak. This will help prioritize engagement processes because sufficient resources are unlikely to be available to engage all actors simultaneously. For example, when thinking of public engagement in surveillance, approaches might comprise mass participation (through mobile apps and websites); trained participation;<sup>4</sup> and engaging with online communities. As with any actor group, thought is needed on what might be the right approach for any biosecurity intervention or campaign.
- Evaluate the process. Co-development will benefit from periodic evaluation, with the aim of reinforcing aspects that are working well and modifying those that are not. Ideally, the evaluation framework is established at the beginning and linked to the overall purpose and objectives of the participatory approach.

Mapping out forest biosecurity stakeholders and identifying collaborative approaches contribute to building a biosecurity system.

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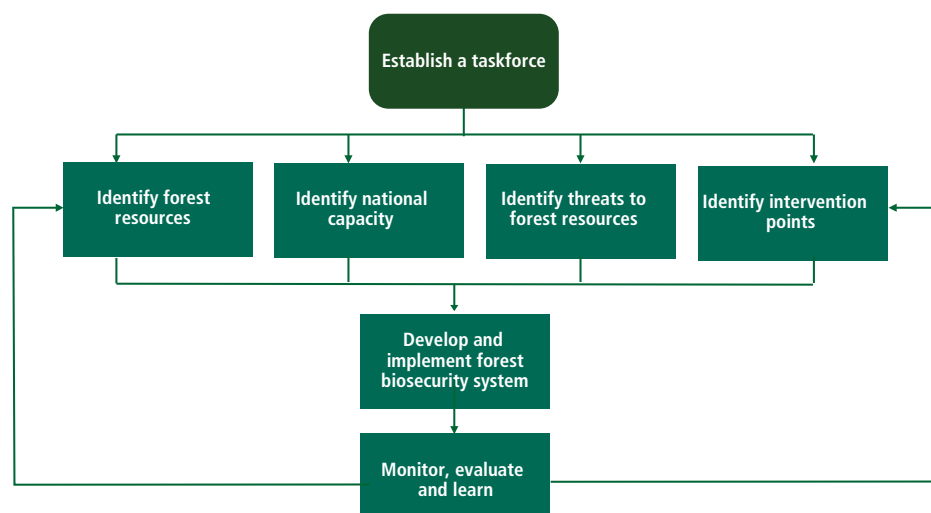
<sup>4</sup> For example, Observatree ([www.observatree.org.uk](http://www.observatree.org.uk)) is a United Kingdom of Great Britain and Northern Ireland-wide early-warning system using trained citizen-science volunteers to survey and report on priority pests.



## 4 Developing a forest biosecurity system

Several actions will assist the formulation of a forest biosecurity system. Figure 4 presents these and their linkages.

FIGURE 4.  
Actions for the development of a forest biosecurity system



### 4.1 ESTABLISH A TASKFORCE

A taskforce provides crucial coordination for creating and implementing a forest biosecurity system. The government, or its delegated authority, should lead establishment of the taskforce by identifying the authority or authorities for forestry and biosecurity issues, determining who will serve on taskforce, and setting out its responsibilities and mandate.

The work of the taskforce could include:

- agreeing on the taskforce's supporting structure and its location, role, vision and mission;
- identifying objectives of the forest biosecurity system;
- deciding on the approach, deliverables, timeframes and deadlines to inform development of the forest biosecurity system; and
- identifying affected actors (e.g. through focus groups). Who might be affected by a pest incursion? Who will benefit from or be adversely affected by the interventions?

## 4.2 IDENTIFY FOREST RESOURCES AND THEIR VALUE

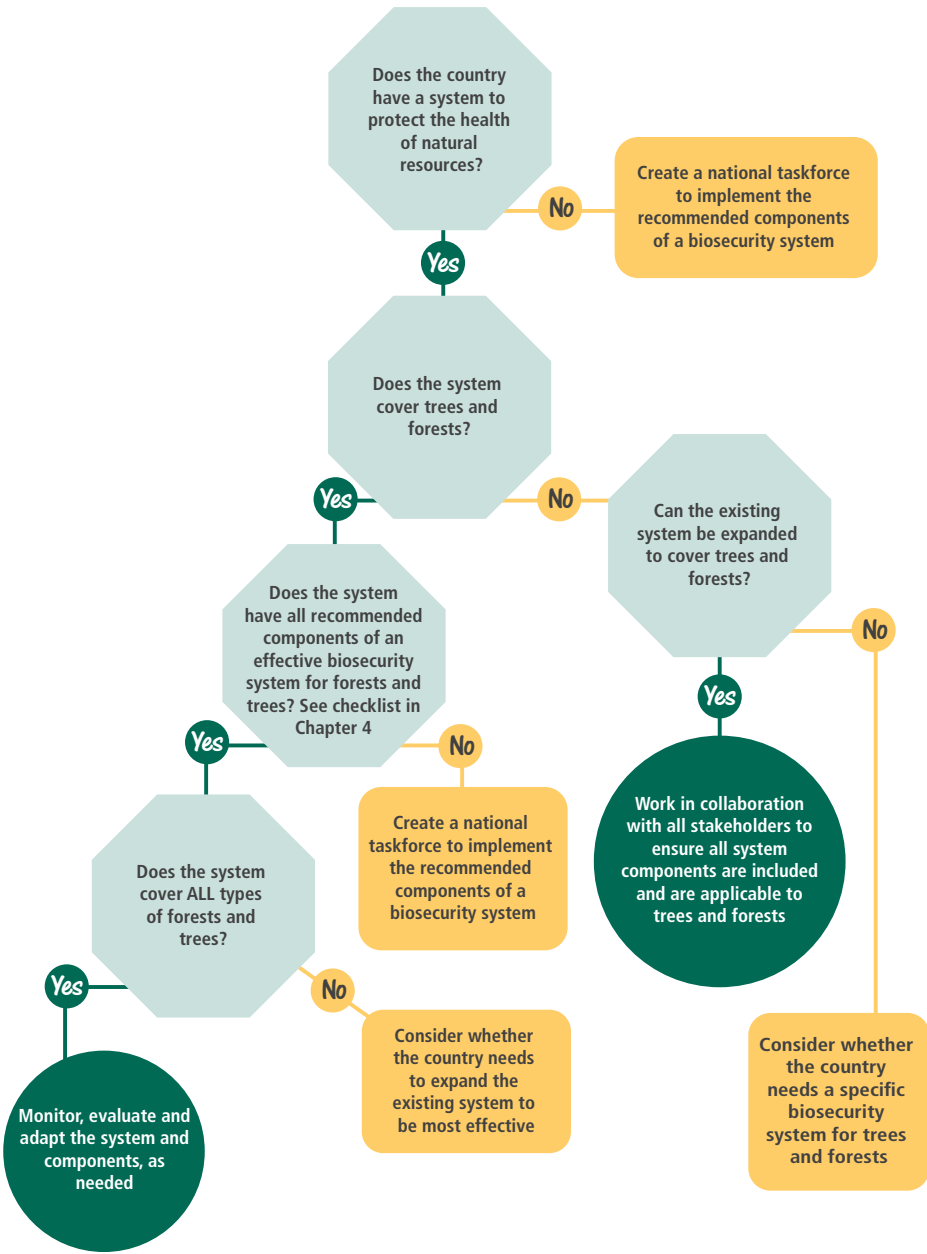
Understanding the following will help ensure the efficient allocation of human and financial resources:

- the forest resources – such as their types, purposes, species and actors – and their interactions with other ecosystems, including agroecosystems;
- the economic, social, cultural and environmental values of the forest resources;
- the distribution of the forest resources by reviewing inventories (e.g. national or subnational inventories or submissions to FAO's Global Forest Resources Assessment); and
- the geography of the country or area, including any geographical barriers that might help prevent pest introduction and spread.

## 4.3 ASSESS THE STATUS OF FOREST BIOSECURITY AND NATIONAL CAPACITY

An assessment of the country's current capacity in biosecurity will help guide the actions needed to strengthen it. A decision tree, such as that presented in Figure 5, can help in conducting such an assessment and identifying where the biggest needs are.

FIGURE 5.  
Decision tree to guide the strengthening of forest biosecurity capacity



Important factors to consider when determining national forest biosecurity capacity include the following:

- **Governance** – specifically, the levels of government (e.g. national, subnational or autonomous community) at which forest health and biosecurity are managed.
- **Organizational structure** –
  - How are the various departments or sectors related to biosecurity (e.g. environment, silviculture, phytosanitary and industry) arranged within the government?
  - Where does forestry lie within the structure?
  - Are forestry and biosecurity covered by the same government authority?
  - If forestry and biosecurity are under different authorities, is there a means for coordination (such as a liaison officer or a committee) between them?
  - How strong is the understanding within government of the value of the forests and the threats to them?
  - What priority is afforded forest biosecurity within government? If low, consider elevating it.
- **Adherence to instruments** – what obligations does the country have under national and international mechanisms?
- **Forest ownership and management** – who owns and manages the forests and trees? Are they located on private, public, tribal or sacred land or in community forests? What authority does the government have to implement biosecurity measures on these lands?
- **Funding** – are systems in place to determine which interventions can be funded by government or private entities, or a combination of both? For private entities, do mechanisms exist to deal with potential conflicts of interest?
- **Gaps** – what is the national capacity for forest biosecurity? Carry out a strengths, weaknesses, opportunities and threats (SWOT) analysis of national capacity and existing groups, systems and expertise. Strengths and weaknesses are internal factors that can be influenced or changed; in contrast, opportunities and threats are external and usually beyond the influence of a single actor. A useful next step after a SWOT analysis is to think of solutions by considering synergies between strengths and opportunities that will enable solutions to threats and weaknesses. What main lines of action does the SWOT analysis suggest?

#### 4.4 IDENTIFY THREATS TO RESOURCES

Conduct risk assessments for native and non-native pests. Consider the following:

- Which organisms are known to affect the tree species present?
- Are these pests native or non-native?
- What emerging pests (native and non-native) pose a threat to forests and trees?
- What are the causes or drivers of their emergence?

- Which processes in the forest sector carry risk for the spread of pests – that is, what are the pest risk pathways?
- Which production systems and forest types bear most overall risk and therefore require more regulation or intervention to optimize investment and the deployment of resources?
- How can the country or forest sector support forest practices that reduce pest risk?
- Which abiotic threats are affecting forests and trees, and where are the most vulnerable areas?
- Where are the risk hotspots (that is, high-risk sites for introductions, or where outbreaks of native or established exotic pests are already occurring)?
- What are the high-risk times of year?
- What forest resilience activities should be conducted, and where?
- Where and when should surveillance programmes be implemented?

#### 4.5 IDENTIFY INTERVENTION POINTS

Forest biosecurity risk should be considered along all forest value chains, and all actors in each value chain should be aware of the role they play. Various intervention points – that is, stages of the value chain where the implementation of biosecurity measures could prevent the introduction or spread of pests – should be identified. Box 1 describes potential intervention points, as well as key actors.

##### BOX 1.

##### Forest biosecurity intervention points and key actors

###### Intervention points

The relevance of the intervention points given below will vary, depending on the type of forest (e.g. its designated purpose).

- **Germplasm/propagation material (e.g. seeds, tissue culture, seedlings and cuttings).** Species selection should be considered carefully for possible pest threats, especially in a changing climate. Biosecurity measures in germplasm production and distribution are crucial for minimizing the risk of pest movement. Stringent risk management and biosecurity measures should be applied in clonal propagation facilities and forest tree-seed collection to prevent contamination and maintain genetic integrity.
- **Nurseries.** Forest nurseries should adopt biosecurity measures such as appropriate site selection, sanitation procedures, pest monitoring and control, staff training, reporting, and compliance with regulatory standards.
- **Sustainable forest management (SFM).** All SFM practices should enhance the resilience of trees and forests to biotic and abiotic disturbances (e.g. pests, fires, drought and climate change). SFM practices such as appropriate

## Box 1 (continued)

tree species selection, proactive silviculture, silviculture waste management, integrated pest management, forest health surveillance and monitoring, and training and capacity building can help prevent the introduction and spread of pests in both plantations and naturally regenerating forests and ensure the early detection of symptoms.

- **Harvesting.** Harvesting operations in both planted and naturally regenerating forests require strict biosecurity measures, including equipment sanitation, silvicultural waste management and monitoring, to mitigate environmental impacts and prevent the spread of pests, particularly via machinery.
- **Harvest of non-wood forest products (NWFPs).** Biosecurity measures are important for minimizing the risk that NWFP harvesting has negative impacts on tree health and spreads pests to new areas. Compliance with regulations, and community engagement, are also crucial.
- **Processing.** Wood-processing facilities must comply with strict biosecurity measures, such as sanitation and pest control, to ensure product safety and quality and meet regulatory standards.
- **Trade.** Biosecurity measures are necessary to ensure the compliance of exports and imports of wood and NWFPs with international protocols and thereby for maintaining the integrity of wood and NWFP supply chains and safeguarding forest health worldwide. Measures include implementing pest management in the forest of origin, obtaining phytosanitary certification, conducting pre-shipment inspections, and establishing collaboration between exporting and importing countries to prevent the spread of pests.
- **Other forest uses.** A wide range of forest uses, such as those associated with recreation, tourism, woodfuel collection, fishing, hunting and trapping, can result in pest introduction and spread in forests, but they also provide opportunities to increase the awareness of forest users about forest health protection and biosecurity. An informed and engaged public will result in more-responsible forest use.

#### Key actors and their roles

The key actors involved will vary depending on the national context. See Chapter 3 for further guidance on stakeholder mapping.

- **Government agencies** – develop regulatory frameworks and phytosanitary regulations; conduct forest health monitoring; promote and support good forest health and biosecurity practice and fund research; promote and support good biosecurity practices; in collaboration and partnership with other actors, put in place the systems and infrastructure needed to ensure that forest biosecurity works effectively and can be delivered; provide expertise, guidance, support and resources for the effective implementation of the forest biosecurity system; empower stakeholder groups through

## Box 1 (continued)

forums for collaborative and shared responsibility approaches and by involving them in decision-making and the development and implementation of biosecurity actions; and implement a financing framework.

- **Forest owners and managers** – implement site selection, surveillance and integrated pest management strategies; and ensure biosecurity through supply chains.
- **Research institutions and academia** – conduct scientific studies on forest health, pest management and biosecurity strategies to support improved biosecurity practice; and provide data-driven recommendations that guide policies, management practices and decision-making.
- **Industry associations and trade organizations** – advocate for balanced biosecurity policies; develop guidelines; train members; and support technical assistance, research collaboration, and certification programmes.
- **Forest workers and contractors** – implement biosecurity measures during planting, harvesting and processing; and ensure compliance with sanitation practices and pest identification protocols.
- **Community groups, Indigenous Peoples and ethnic groups** – contribute traditional ecological knowledge to detect and respond to forest changes; engage in monitoring, awareness-raising and decision-making; and implement good forest health and biosecurity practices.
- **Certification bodies and standards organizations** – develop biosecurity criteria in certification schemes that promote SFM; conduct audits; encourage continuous improvement; and facilitate market access.
- **Consumers and end-users** – influence corporate social responsibility by demanding assurances for sustainable and biosafe products; seek transparency and traceability in supply chains; and support certification programmes.
- **International organizations and agreements** – facilitate collaboration through networks and ensure compliance with relevant international standards.
- **Non-governmental organizations** – advocate for effective policies on forest health and biosecurity; engage communities and memberships in biosecurity management; ensure awareness of and compliance with good biosecurity practices, especially when implementing initiatives related to tree-planting and forest activities; fund research; and promote innovation through collaborative initiatives.

## 4.6 IMPLEMENT THE FOREST BIOSECURITY SYSTEM

Key considerations for the development and implementation of a forest biosecurity system include the following:

- Prioritize action based on the knowledge gathered from previous activities.
- Identify what can be done with the available resources.
- Identify the actions that could be taken if additional resources were available and determine where those resources could be sourced (e.g. industry body, industry levy or official development assistance).
- Identify and foster cross-sector opportunities.
- Seek opportunities for sharing resources and institutional capacity and establish formal partnerships and agreements (while ensuring confidentiality and addressing potential conflicts of interest).
- Identify roles and responsibilities and deadlines for implementation.
- Ensure a participatory approach that includes all actors.

## 4.7 MONITOR, EVALUATE AND LEARN

Monitoring, evaluation and learning frameworks should be flexible, and they should evolve over time and align with best practices, as described below.

### Monitoring

- Establish clear indicators for system performance (e.g. detection time, response speed and containment success rate).
- Use integrated data collection systems that combine field observations, diagnostics, remote sensing and other sources of information.
- Focus monitoring resources on high-priority threats and vulnerable areas.
- Ensure timely and transparent reporting mechanisms between local, national and international actors.
- Maintain data quality standards and protocols for validation and verification.

### Learning

- Conduct regular reviews of response actions following pest detections.
- Facilitate cross-sectoral knowledge-sharing between forestry, agriculture, customs and public-health sectors.
- Document lessons learned in an accessible central repository.
- Promote peer-to-peer learning through exchanges, joint field exercises and workshops.
- Integrate new scientific findings and emerging technologies into operational practices.

**Evaluation**

- Conduct periodic independent evaluations to assess system effectiveness and efficiency and inform policy and operational changes.
- Use simulation exercises to test preparedness and identify weaknesses.
- Evaluate the cost-effectiveness of interventions relative to the value of the resources protected.
- Incorporate stakeholder feedback.
- Track long-term trends in threat occurrence and system performance to guide strategic adjustments.

The assessment checklist in Chapter 5 can be customized for monitoring purposes.



## 5 Tools and guidance

This chapter contains three tools for use by countries and actors in developing and improving forest biosecurity systems. Table 5 presents a checklist for assessing an existing system and identifying the need for improvement, Figure 6 sets out the steps that can be taken before and after the detection of a pest, and Figure 7 provides guidance on the design of a pest surveillance programme.

TABLE 5.

**Self-assessment: does my system have the following components?**

| Focus                                              | Component                                                                                                                    | Yes | No | Is updating or improvement required? |
|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|-----|----|--------------------------------------|
| <b>Guiding mechanisms (strategy, system, plan)</b> | A strategy exists for the management of forest pests                                                                         |     |    |                                      |
|                                                    | The strategy has clearly defined goals and objectives for the forest biosecurity system in the short, medium and long terms  |     |    |                                      |
|                                                    | A system exists for the management of forest pests                                                                           |     |    |                                      |
|                                                    | The system provides the necessary structure, processes, roles and responsibilities and funding plan to implement effectively |     |    |                                      |
|                                                    | A plan exists for the management of forest pests                                                                             |     |    |                                      |
|                                                    | The plan includes an implementation plan with clearly defined roles and responsibilities and an evaluation mechanism         |     |    |                                      |
| <b>Legal considerations</b>                        | Legislation exists for biosecurity activities involving trees and forests                                                    |     |    |                                      |
|                                                    | The legislation is comprehensive                                                                                             |     |    |                                      |
|                                                    | The legislation is consistent                                                                                                |     |    |                                      |
|                                                    | The legislation is up to date                                                                                                |     |    |                                      |
|                                                    | Those involved in delivering biosecurity functions have adequate powers to perform these functions successfully              |     |    |                                      |
|                                                    | Relevant national regulations are harmonized with regional and international norms, guidelines and recommendations           |     |    |                                      |
| <b>Governance</b>                                  | A national group or agency is accountable for trees and forests                                                              |     |    |                                      |
|                                                    | A national group or agency is accountable for biosecurity                                                                    |     |    |                                      |
|                                                    | A taskforce exists for biosecurity                                                                                           |     |    |                                      |
|                                                    | A forest biosecurity taskforce exists that includes all relevant government or designated authorities, including finance     |     |    |                                      |

Table 5 (continued)

| Focus                                                                                                              | Component                                                                                                                                                            | Yes | No | Is updating or improvement required? |
|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----|--------------------------------------|
| <b>Partnerships (who is involved?)</b>                                                                             | National actors are engaged in the forest biosecurity system, including:                                                                                             |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>government agencies (national, subnational and local)</li> </ul>                                                              |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>the private sector (forest managers, wood processors, enterprises, importers/exporters, community foresters, etc.)</li> </ul> |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>the scientific and research community</li> </ul>                                                                              |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>local and Indigenous communities</li> </ul>                                                                                   |     |    |                                      |
| <b>Communication</b>                                                                                               | Systems and tools are in place to communicate effectively with all actors                                                                                            |     |    |                                      |
| <b>Engagement</b>                                                                                                  | Tools have been developed to engage actors in forest health and biosecurity activities and empower local communities                                                 |     |    |                                      |
| <b>National capacity and resources</b>                                                                             | Competent authorities exist nationally with adequate technical and scientific capability and the required infrastructure                                             |     |    |                                      |
| <b>Core biosecurity activities/functions</b>                                                                       | For <b>prevention</b> , the forest biosecurity system includes:                                                                                                      |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>adherence to International Standards for Phytosanitary Measures</li> </ul>                                                    |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>import and export requirements</li> </ul>                                                                                     |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>border activities</li> </ul>                                                                                                  |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>surveillance</li> </ul>                                                                                                       |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>pest diagnostics</li> </ul>                                                                                                   |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>risk assessment and mechanisms for establishing risk-based priorities</li> </ul>                                              |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>training</li> </ul>                                                                                                           |     |    |                                      |
|                                                                                                                    | For <b>emergency preparedness and response</b> , the forest biosecurity system includes:                                                                             |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>generic contingency plans</li> </ul>                                                                                          |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>pest-specific contingency plans</li> </ul>                                                                                    |     |    |                                      |
|                                                                                                                    | <ul style="list-style-type: none"> <li>response mechanisms – including decision-making and funding/cost-sharing arrangements</li> </ul>                              |     |    |                                      |
|                                                                                                                    | For <b>long-term management</b> , the forest biosecurity system includes integrated pest management                                                                  |     |    |                                      |
|                                                                                                                    | Tools and resources – such as guidelines, manuals and standard operating procedures – exist to support the functioning of the forest biosecurity system              |     |    |                                      |
| <b>Resilience</b>                                                                                                  | The forest biosecurity system considers the implementation of sustainable forest management practices                                                                |     |    |                                      |
| <b>Contribution to international standards-setting organizations and bodies on forest-health-related standards</b> | Forest-relevant authorities participate actively in national and regional plant protection organizations                                                             |     |    |                                      |

FIGURE 6.  
Decision tree to guide action before and after a pest has been detected

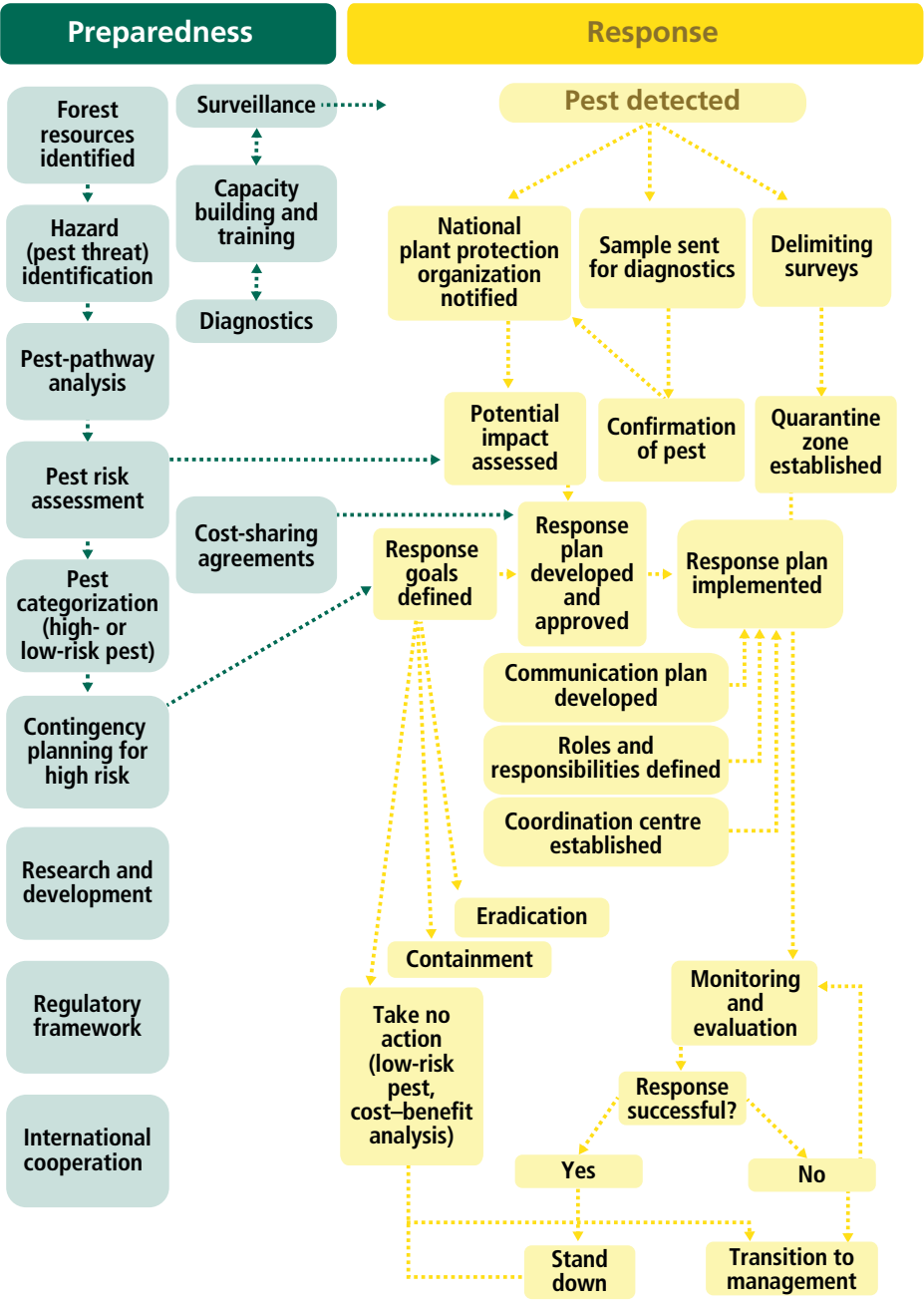
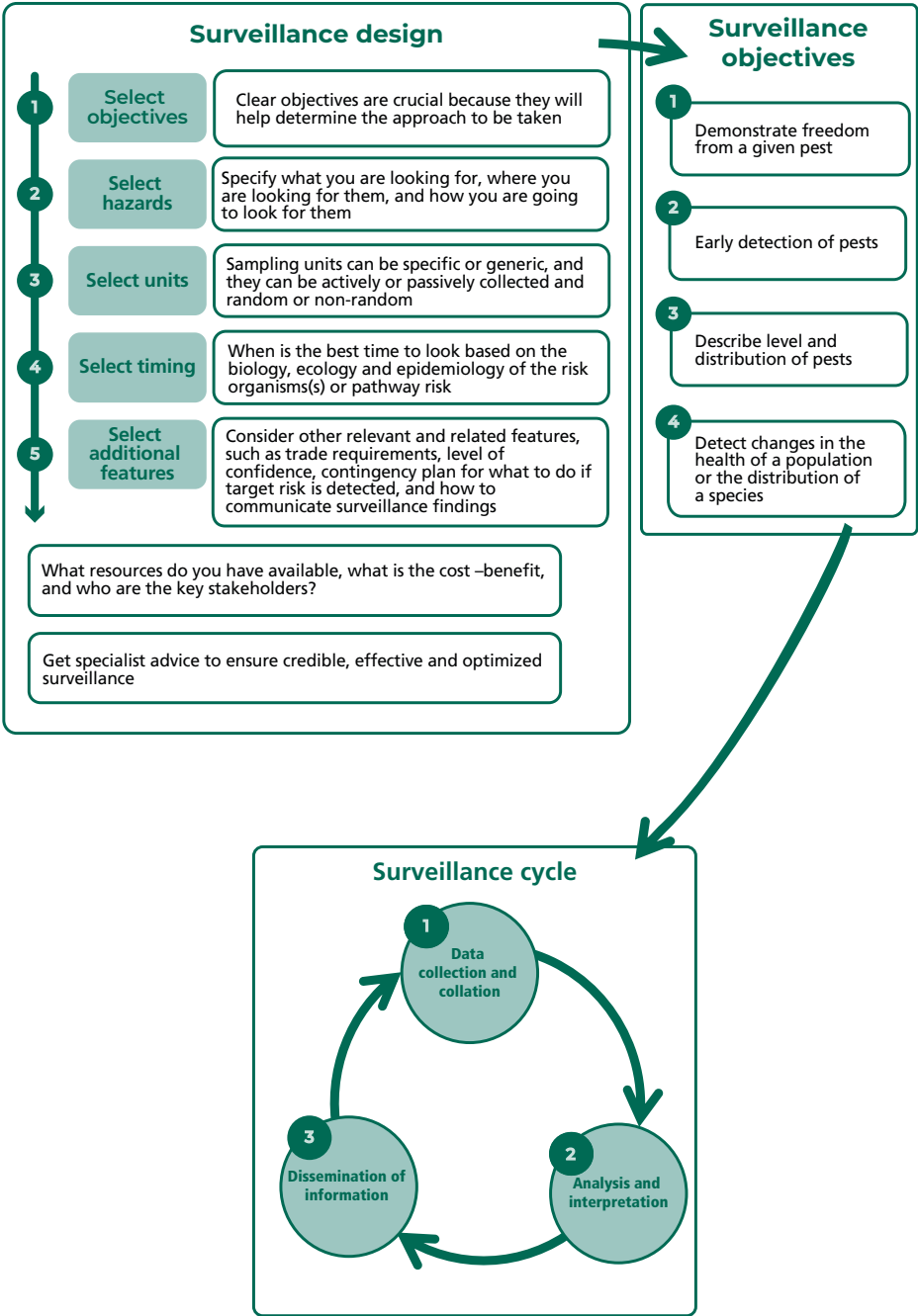


FIGURE 7.  
Guidance on the design of a pest surveillance programme



Source: Adapted from: New Zealand Ministry for Primary Industries. Undated. [www.mpi.govt.nz/mpi-surveillance-guide](http://www.mpi.govt.nz/mpi-surveillance-guide). Wellington. Accessed 5 July 2024.

## 6 The way forward

Nations increasingly recognize the need for comprehensive forest biosecurity systems to protect forests and trees from pests and other threats and their potentially devastating economic, social and environmental impacts. As shown in this guide, effective systems have the following six ingredients:

- 1. Integrated and tailored.** National forest biosecurity systems should be integrated into national policies, regulations and guidelines. They should be tailored to the specific needs and vulnerabilities of the country's forest ecosystems to ensure that each ecosystem is resilient to current and emerging threats.
- 2. Engagement of all actors.** Successful forest biosecurity systems actively engage a diverse range of actors, such as government agencies, private-sector entities, environmental bodies, researchers and local communities. Collaborative efforts at all levels of society are necessary to ensure that biosecurity measures are well implemented and maintained.
- 3. Monitoring, learning and adaptation.** By regularly assessing the effectiveness of biosecurity measures and adapting them as needed, countries can respond swiftly to new threats and challenges. This adaptive management approach can ensure that forest biosecurity systems stay relevant and effective in a dynamic global environment.
- 4. Research and innovation.** Innovative solutions and emerging technologies are transforming forest biosecurity. Cutting-edge tools such as artificial intelligence, remote sensing, molecular diagnostics, environmental DNA (eDNA) detection, RNA interference (RNAi) and CRISPR/Cas9 gene drives are providing new avenues for the early detection of, rapid response to, and effective management of forest pests. Continued investment in research and innovation is essential, and there are also significant opportunities to enhance biosecurity efforts through the integration of traditional knowledge and modern science.
- 5. Future challenges and opportunities.** Countries need to prepare for future challenges in forest biosecurity, such as those posed by climate change, trade and the emergence of new pests.
- 6. Collaboration at multiple levels.** Effective forest biosecurity cannot be achieved in isolation. Collaboration is needed among neighbouring nations, in regional bodies, and with global trading partners through NPPOs and regional plant protection organizations. These partnerships are crucial for sharing information, coordinating responses to transboundary threats, and harmonizing biosecurity standards and practices.

The development of forest biosecurity systems at the national level is a multifaceted endeavour that requires a holistic and collaborative approach. By recognizing the importance of biosecurity, engaging all relevant actors, leveraging innovative technologies, and fostering international cooperation, countries can safeguard their forests for future generations.

## 7 Glossary

**Biosecurity.** A strategic and integrated approach to analysing and managing relevant risks to human, animal and plant life and health, including associated risks to the environment (FAO, 2007).

**Incursion.** An isolated population of a pest recently detected in an area, not known to be established but expected to survive for the immediate future (ISPM No. 5 – IPPC Secretariat, 2024).

**National plant protection organization.** An official service established by a government to discharge the functions specified by the International Plant Protection Convention (ISPM No. 5 – IPPC Secretariat, 2024).

**Non-wood forest products.** Goods derived from forests that are tangible and physical objects of biological origin other than wood (FAO, 2023). Examples include products used as food and food additives (e.g. edible nuts, vegetables, mushrooms, fruits, herbs, spices and condiments, aromatic plants, game and insects), fibre (e.g. used in construction and for the manufacture of furniture, clothing and utensils), resins, gums, and plant and animal products used for medicinal, cosmetic or cultural purposes.

**Pest.** Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products (ISPM No. 5 – IPPC Secretariat, 2024).



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## Guide to forest biosecurity

Healthy forests are vital for planetary health and the well-being of people. But they are under growing pressure: climate change, global trade and the movement of people and goods are making it easier for pests and pathogens to move across borders and establish where they never could before. Robust national forest biosecurity systems are essential for anticipating, preventing, detecting and responding to these emerging threats.

*Guide to Forest Biosecurity* provides practical guidance for strengthening forest health governance and biosecurity preparedness in countries. By promoting integrated approaches, this resource for policymakers and decision-makers supports countries in protecting forests as vital natural assets. With stronger forest biosecurity systems, countries will better anticipate emerging pest risks, reduce vulnerabilities, and ensure that forests continue to provide essential goods and services in an increasingly interconnected and changing world.

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