**Table 5.11.** A summary of gaps in knowledge and implementation impeding management of biological invasions.

The gaps were developed through an expert elicitation process with authors of Chapter 5.

|  | **Gap type**  **and category** | **Gap description** | **Why is it important?** | **Cross-reference** |
| --- | --- | --- | --- | --- |
| **Pathway Management** | Knowledge and implementation; potential instruments, including policy and enabling approaches | Eradication strategies and guidelines for generalist invasive alien invertebrates, diseases and hard to detect freshwater and marine invasive alien species (not restricted to defined hosts). | These groups have been understudied. Even where information is available, developing and implementing guidelines remains difficult and is seldom done. | 5.2.2.1, 5.2.2.2, 5.5.3 |
| Knowledge; gaps on biomes, units of analysis or taxonomic gaps | Risk management, cost-effective species-based surveillance and detection strategies for multiple invasive alien species groups, e.g., fungi and other microbes. | Species-based approaches are limited by taxonomic un- certainty, e.g., microbes. Strategies are needed at a higher taxonomic level than species in such cases. | 5.2.2.1, 5.3.1.2, 5.4.3.2 |
| Implementation; potential instruments, including policy and enabling approaches | Risk analysis for movement of marine invasive alien species. | Risk analysis tools are available but not consistently applied. Pathway management is the highest priority for marine species. | 5.2.2.1, Figure 5.4 |
| Implementation; potential instruments, including policy and enabling approaches and management | Managing alien species movements and biosecurity risks along trade supply chains, e.g., via shipping containers. | Trade based pathways such as shipping containers and illegal mail order remain poorly managed, particularly for contaminating pests and diseases. | 5.3.1.1,  5.4.3.1,  Box 5.2 |
| Implementation; potential instruments, including policy and enabling approaches and management | Effective management and compliance of biofouling policy. | International (and national) policy instruments are available but not consistently applied. New biofouling treatments are needed. | 5.5.1,  Chapter 6, section 6.2.1(5) |
| Implementation; management | Management of deliberate movements of species across jurisdictional land-borders. Domestic quarantine is poorly implemented in several developing countries. | Needs better policy to support management. Natural pathways cannot be prevented, but may benefit from improved surveillance. | 5.6.2.1, Table 5.10 |
| Knowledge; integrated scenarios and models; technical development | Understanding of direct and indirect non-target impacts of chemical, manual, mechanical and biological control of an invasive alien species on other species and ecosystems. | Non-target impacts can be substantial and are important therefore data need to be collected and included in risk analysis. | 5.5.5 |
| **Species-based Management** | Knowledge; gaps on biomes, units of analysis or taxonomic gaps | Incorrect taxonomic species identification (or varieties) impeding management. | Access to strong taxonomic capability for invasive alien species in all key groups is critical. | 5.4.3.2, 5.6.2.1,  Table 5.4,  Table 5.12 |
| Knowledge and implementation; integrated scenarios and models; technical development | Prioritizing invasive alien species management and developing the necessary strategies under climate change and habitat or land-use change. | Considering climate change effects on invasive alien species and their management is rare but will be critical in the future. | 5.6.1.3, Figure 5.27; Chapter 6, section 6.7.2.2 |
| Knowledge and implementation; integrated scenarios and models; technical development | Prioritizing management of biological invasions over other actions (e.g., threatened and endangered species protection and management). | Protecting threatened species and communities may be improved by understanding cost-effectiveness of different actions including management of biological invasions to prioritize investments. | 5.2.2.2, 5.3.1.4 |
| Implementation; management | Containment of slow spreading pervasive invasive alien invertebrates and plants. | Slow spreading invasive alien species are often a lower priority for management but they may be harder to control later and have greater long-term impacts. | 5.5.4 |
| Implementation; technical development | Humane management approaches for invasive alien species subject to animal ethics. | Humane management approaches for invasive alien species often increases social acceptability | 5.4.3.2, 5.5.5.2 |
| Implementation; integrated scenarios and models; technical development | Management of invasive alien invertebrates and plants under increasingly restrictive chemical control options. | With the preference to alternative management options, it is important to proactively consider and develop better integrated management approaches including biological options. | 5.4.3.2,  5.4.3.3 |
| Implementation; management | Management of marine invasive alien species for population suppression. | All current marine invasive alien species management programmes have been unsuccessful in the long-term as a means of control. | 5.6.1.1,  Box 5.3 |
| Implementation; management | Management approaches for widespread established invasive alien species using available and novel tools and methods. | Once prevention has been optimized there is a need to consider and develop better technologies for control of widespread species. | 5.5.5 |
| Implementation; integrated scenarios and models | Management decision-making approaches for invasive alien species with benefits in some contexts (i.e., conflict species). | Policy and collective decision- making approaches need to better address conflict species to prevent management being stalled. | 5.6.1.2, Table 5.9; Chapter 6, section 6.4.1 |
| Knowledge; integrated scenarios and models | Prioritizing site-based management under multiple management contexts (i.e., nature, nature’s contributions to people and good quality of life). | Site-based, ecosystem-based and restoration generally focuses on biodiversity protection but needs to include impacts on Indigenous Peoples and local communities. | 5.3.1 |
| **Site/ecosystem-based Management** | Knowledge; integrated scenarios and models; technical development | Cost-effective scenarios and modelling for invasive alien species management and evaluation use. | Scenarios and modelling are generally underutilized for invasive alien species management planning. | 5.2.2.4, 5.6.3.2,  Table 5.14, Table 5.15 |
| Knowledge; potential instruments, including policy and enabling approaches and management | Managing urban and peri-urban areas, including urban-marine linked areas, in the context of impacts on surrounding ecosystems and ecosystem services on which local communities depend. | As urban and peri-urban areas put increasing pressure on native communities through local biodiversity loss, managing this driver of invasive alien species impacts needs to be prioritized and addressed. | 5.6.1.4 |
| Implementation; management | Effective inclusion of Indigenous and local knowledge in management design and decision-making. | Indigenous and local knowledge is critical for long-term, integrated, management of biological invasions. | 5.1.3, 5.5.2,  5.7,  Box 5.15 |
| Implementation; management | Adaptive integrated invasive alien species management with ecosystem restoration to improve ecosystem resilience and broader ecosystem-based management. | Improving adaptive management from governance to implementation is a priority, as it is a proven approach to managing dynamic ecosystems. | 5.4.3.3, 5.5.6,  5.6.2.5;  Chapter 6., Box 6.14 and Box 6.16 |
| **Other implementation gaps** | Essential supporting processes as impediments to invasive alien species management; potential instruments, including policy and enabling approaches and management | Procedural (policy, cross-jurisdictional, stakeholder engagement).  Capacity-related (capability, lack of knowledge on modern tools and techniques, resourcing and communication).  Societal (lack of awareness, resistance) challenges will need to be addressed. | Biosecurity and invasive alien species have a human cause, are a function of human values and endeavour, and therefore need greater cooperation and social and societal analysis and solutions. | 5.6.3.3, Table 5.10; Chapter 6, sections 6.4 and 6.7 |
| Uncertainty; integrated scenarios and models; technical development | Decision-making in the context of uncertainty. | The precautionary approach argues that actions should not be hampered by incomplete knowledge where doing nothing is not an option. | 5.2.2.3, 5.6.2.5 |