Tackling invasive non-native species in the UK Overseas Territories

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Abstract The 16 UK Overseas Territories (OTs) together account for 94% of the UK's unique biodiversity and make a significant contribution to global biodiversity. Being predominantly islands, the OTs are very vulnerable to the introduction of potentially harmful invasive non-native species, and pressures are increasing with the continual growth of international trade and impact of climate change. Biosecurity is acknowledged as the most cost-effective means of addressing invasive species threats for small islands, and yet the OTs face many challenges in the implementation of biosecurity controls. In 2016 a UK Government funded project "Tackling Invasive Non-Native Species in the UK Overseas Territories" was initiated to improve the biosecurity of the OTs against non-native species in order to improve their environmental resilience and food security through technical assistance and capacity building. A gap analysis carried out in early 2017 assessed the strengths and weaknesses for all 16 OTs along the biosecurity continuum in three areas: (1) prevention (2) early warning and rapid response, and (3) long-term management. Overall, capacity is weakest in the area of prevention and greatest in that of long-term management. Border activities, where implemented, are primarily linked to agricultural production and animal health. Few OTs have carried out horizon scanning or comprehensive pathway analysis or have the capacity to carry out pest risk analysis. Greatest capacity is seen in the relatively well resourced Antarctic and sub-Antarctic territories, and in St Helena Island which was the subject of a 4-year project in anticipation of air access. Legislation is generally weak, and few OTs have developed territorial biosecurity policies or strategies. Officers responsible for biosecurity often have a range of functions in addition to their biosecurity roles, lack access to specialist expertise and diagnostic facilities, and may also lack access to appropriate training. This compromises their ability to deliver effective biosecurity. This situation is common to many small island states.

Keywords: biosecurity, capacity, gap analysis, horizon-scanning, pathway-analysis, prevention

INTRODUCTION

The 16 UK Overseas Territories (OTs) together account for 94% of the UK's unique biodiversity and as such make a significant contribution to global biodiversity (Churchyard, et al., 2014). Despite this, involvement of the UK government in the OTs with regards provision of financial and other resources is minimal, with the OTs receiving only project funding from the UK (e.g. Vaas, et al., 2017). Being predominantly islands, the OTs are very vulnerable to the introduction of potentially harmful invasive non-native species, recognised as the biggest threat to island biodiversity, as well as to food security and sustainable development (Copsey, et al., 2018). Pressures are increasing with the continual growth of international trade, the main driver of the spread of invasive species, resulting in higher numbers of individuals of more species being moved around the world, both deliberately and accidentally. The chances of a new potentially harmful species arriving and establishing in a new area are therefore greater. The implementation of biosecurity measures is aimed at minimising this risk (Copsey, et al, 2018), and contributes towards achievement of Strategic Goal B of the Convention on Biological Diversity, *Reduce the direct pressures on biodiversity and promote sustainable use*, and specifically Aichi Target 9 (UNEP, 2011).

Biosecurity, defined as measures to reduce the risk of introducing or spreading invasive non-native species (and other harmful organisms such as diseases) in the wild, has long been acknowledged as the most cost-effective means of addressing invasive species threats for small islands (for example Tye, 2009). To be effective, actions need to be implemented across the biosecurity continuum, with pre-border controls at the country of origin, inspections and interceptions at the border, and post-border surveillance and interventions in the wider environment, all applied to both deliberate (legal and illegal) and accidental introductions. Once implemented, biosecurity actions must be maintained as part of normal government practice.

The IUCN announced the Honolulu Challenge at the World Conservation Congress 2016, calling for greater action to tackle the issue of invasive non-native species across the globe, with particular attention to preventative action and the development of effective biosecurity policies (IUCN, 2017).

As part of the UK Government's response the 3-year project *Tackling Invasive Non-Native Species in the UK Overseas Territories* was initiated. Its objective is "to improve the biosecurity of the OTs against invasive non-native species to improve their environmental resilience and food security; achieved through reducing the risk and impact of invasion and natural hazards via technical assistance and capacity building".

In order to plan the appropriate capacity building activities, a gap analysis was carried out in January 2017 on biosecurity practices and capacity in all 16 UK OTs (Fig. 1) (information from McPherson, 2016):

Anguilla: one main and a number of smaller islands in the Caribbean region with a total area of 90 km^2 and population of 13,572.

Ascension Island: a single main island in the South Atlantic, with an area of 87 km^2 and population of 1,000.

Bermuda: eight connected islands and over 190 smaller islands in the wider Caribbean with a total area of 53.7 km^2 and population of 65,038.

British Antarctic Territory (BAT): the Antarctic Peninsula and two groups of nearby islands, with a total area of 1,709,400 km^2 and no permanent population.

British Indian Ocean Territory (BIOT); archipelago of over 50 small low-lying islands in the Indian Ocean, with a total area of 50 km^2 and no permanent population, but a large permanent military presence.

British Virgin Islands (BVI): Four main islands and over 50 small islets and cays in the Caribbean, with a total area of 151 km² and population of 28,882.

Cayman Islands: three islands in the Caribbean, with a total area of 264 km² and population of 54,397.

Cyprus Sovereign Base Areas (CSBA): two separate areas, Akrotiri-Episkopi (the Western SBA) and Dhekelia (the Eastern SBA), on the island of Cyprus in the Mediterranean, with a total area of 254 km² and population of 15,700.

Falkland Islands: two main islands and over 770 smaller islands in the South Atlantic, with a total area of 12,173 km² and population of 2,841.

Gibraltar: a peninsula at the southern coast of Spain, with an area of 6.8 km² and population of 31,465.

Montserrat: a single island in the Eastern Caribbean, with an area of 102 km² and population of 4,922.

Pitcairn Islands: four islands in the South Pacific, with a total area of 48.7 km² and population of 47, all resident on the main island.

St Helena Island: a single main island in the South Atlantic, with an area of 121 km² and population of 4,534.

South Georgia and South Sandwich Islands (SGSSI): one main island and several small ones in the South Georgia group and a group of 11 small islands in the South Sandwich Islands Group, all in the sub-Antarctic. Total area is 3,903 km² with no permanent population.

Tristan da Cunha: four islands in the South Atlantic, with a total area of 207 km² and population of 268.

Turks and Caicos Islands: two island groups of over 120 small islands in the Caribbean, with a total area of 417 km² and population of 49,000.

METHODS

A questionnaire was designed, identifying the components required for an effective biosecurity programme along the biosecurity continuum. Emphasis was given to the pre-border and post-border activities targeted
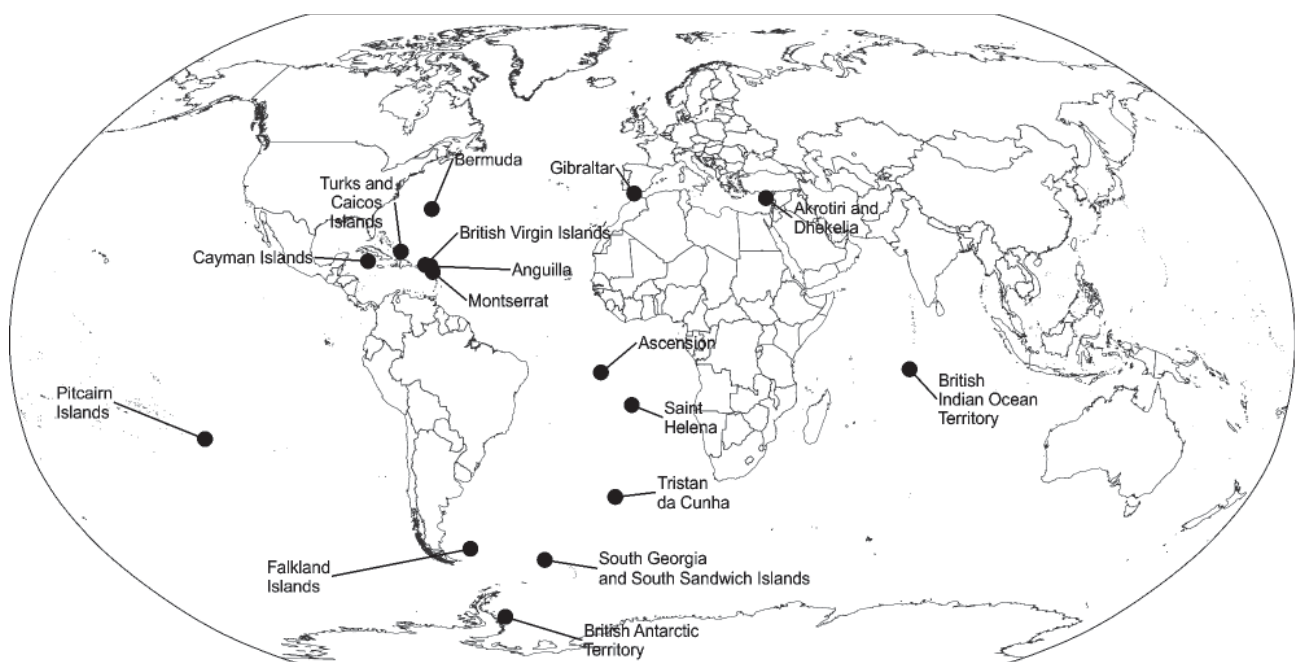
by the project, grouped in three areas: 1) Prevention; 2) Early Warning and Rapid Response (EWRR); and (3) Management, Prioritisation and Frameworks (MPF) in the components defined as follows:

Prevention

Pest Risk Analysis (PRA): system established and in use to evaluate the likelihood of the entry, establishment, or spread of a pest or disease, and the associated potential biological and economic consequences. Both phytosanitary and zoosanitary risks covered.

Non-Native Species Risk Analysis (NNRA): comprehensive risk assessment frameworks exist to assess the risk of non-native species (plant and animal) becoming invasive.

Pathway Analysis: prioritised pathways of entry identified, and results used as the basis for procedures.

Horizon Scanning: horizon scanning exercise carried out to identify invasive species most likely to invade via identified pathways.

Contingency Planning: formalised generic contingency plan or plans in place to deal with priority invasive species that are likely to arrive. This is divided into (i) Plants, including both plants and plant health risks (non-native plant pests and diseases); (ii) Animals, including both vertebrates and animal health risks (non-native vertebrates, animal diseases and parasites); and (iii) Other risks (invertebrates other than plant pests, and marine species).

Border Operations: in-place and operational, considering staffing, provision of dedicated facilities, procedures and protocols in place, public awareness, and levels of compliance. Both phytosanitary and zoosanitary risks covered.

Early warning and rapid response

Alert System: clear system in place for reporting incursions or new species, for both plant and animal (vertebrate and invertebrate) risks.

Surveillance: generic and/or incursion specific programmes in place for surveillance of priority invasive

Fig. 1 The 16 UK Overseas Territories.

species. This is divided into (i) Plants, including both plants and plant health risks (non-native plant pests and diseases); (ii) Animals, including both vertebrates and animal health risks (non-native vertebrates, animal diseases and parasites); and (iii) Other risks (invertebrates other than plant pests, and marine species).

Monitoring: generic and/or incursion specific programmes in place for monitoring established priority invasive species.

Rapid Response Capacity: capacity (capability and resources) to provide rapid response to incursions. This is divided into (i) Plants, including both plants and plant health risks (non-native plant pests and diseases); (ii) Animals, including both vertebrates and animal health risks (non-native vertebrates, animal diseases and parasites); and (iii) Other risks (invertebrates other than plant pests, and marine species).

Management, prioritisation and frameworks

Prioritisation: prioritised established invasive species for control/eradication based on global risk management best practice, such as the *Guidelines for invasive species management in the Pacific* (Tye, 2009).

Baseline Data: baseline inventories available for plants (native and non-native), animals (terrestrial vertebrates and invertebrates), and other (marine species).

Territorial Framework: biosecurity legislation in place and enforced; biosecurity strategy or policy in place or endorsed, and being implemented.

Contacts were established in each OT for both agriculture and environment sectors, and territory capacity assessed though a combination of email, telephone interviews and face to face interviews. At least two people were involved in each territory, with the exception of BAT where there was only one. Capacity for each component was rated and scored as follows:

None - No action taken / Nothing in place. Score of 0

Basic - Some actions taken / Basic framework or actions in place / Actions planned in near future and expected to take place. Score of 1.

Some - Some substantial advances while other actions remain to be done / Actions being actively implemented along a planned timeframe. Score of 2.

Good - Substantive actions taken / Substantial framework or actions in place / Action being implemented / Action achieved. Score of 3.

Scores were summed across the components and territories to provide a simple index for comparison purposes. The text and ratings assigned to the components were in all cases agreed and approved by the contacts in-country for each territory. The resulting scores were then cross-checked by Dr Niall Moore of the GB Non-Native Species Secretariat to ensure that the ratings matched the comments; any adjustments were then discussed and agreed by the relevant contacts.

Final scores were checked by visitors from the RSPB, IUCN, Animal and Plant Health Agency (APHA), UK, and South Georgia Heritage Trust with recent experience of the relevant territory. Again, any discrepancies were then discussed and agreed by the relevant contacts before the scores were finalised.

RESULTS

Responses were obtained from all 16 OTs. Overall, respondents welcomed the project and expressed frustration where they identified gaps in their territory.

Table 1 Overall scores in the areas of Prevention, Early Warning and Rapid Response (EWRR) and Management, Prioritisation and Frameworks (MPF) and total scores for each of the 16 OTs and the UK in ascending order, out of a maximum overall score of 66. Maximum possible scores per area are 24 (Prevention and EWRR) and 18 (MPF). Overall mean score excludes that for the UK.

Territory	Prevention	EWRR	MPF	Overall score
Turks and Caicos	4	8	7	19
BIOT	3	5	12	20
CSBA	3	7	11	21
Montserrat	5	8	9	22
Ascension	5	8	10	23
Anguilla	8	4	12	24
Bermuda	5	9	12	26
Tristan da Cunha	7	7	12	26
Pitcairn	9	10	7	26
Falkland Islands	11	10	10	31
Cayman	11	9	13	33
BVI	10	14	10	34
Gibraltar	3	17	17	37
BAT	17	11	17	45
St Helena	14	18	13	45
SGSSI	14	19	18	51
UK	21	20	17	58
Overall mean score for the OTs	8.1	10.3	11.9	

Differences between territories

Scores for each territory in the three categories of Prevention, EWRR and MPF are shown in Table 1, with the territories listed from the lowest overall score (weakest capacity) to the highest (most capacity). The estimated score for the UK is given for comparison.

The three highest scoring territories are the two Antarctic and sub-Antarctic territories, and St Helena. BAT and SGSSI (with total scores of 45 and 51 respectively) benefit from their unique environmental status and considerable research input. St Helena (with a total score of 45) has been the subject of a 4-year project to strengthen biosecurity in anticipation of air access. The total score for SGSSI (51) is closest to that estimated for the UK (58).

A group of four territories have total scores between 31 and 36, comprising in ascending order: Falkland Islands, Cayman Islands, BVI and Gibraltar; Gibraltar has a score accounting for less than 20% of their overall score in the area of Prevention, but scores highly in the other areas.

A group of nine territories have the lowest totals, with scores between 19 and 26 and only one or two points between each, comprising in ascending order: Turks and Caicos Islands, BIOT, CSBA, Montserrat, Ascension Island, Anguilla, Bermuda, Tristan da Cunha and Pitcairn. Three territories are particularly weak in the area of Prevention, with scores accounting for less than 20% of their overall score: BIOT, CBSA and Bermuda. All four have ratings of Basic or None for all components in this area with only two exceptions: Bermuda with a rating of Some for border operations, and CBSA with a rating of Some for contingency planning for animals and animal health risks. Anguilla has a total score accounting for less than 20% of overall in EWRR, with all ratings in this area of Basic or None.

Components of biosecurity

The overall capacity is weakest in the area of Prevention, with an average score of 8.1, and strongest in the area of Management, Prioritisation and Frameworks, with an average score of 11.9 (Table 1). Table 2 shows total scores by component out of a maximum possible score of 48.

The highest scoring components are the group encompassing baseline inventories. This is generally good and especially for plants, with a total score of 43. Baseline knowledge for animals (terrestrial vertebrates and invertebrates) and other (marine species) both had a total score of 35.

The next highest scoring component is a group of four with scores of 28 to 30: alert system, prioritisation, legal framework and border operations.

The greatest capacity gaps are those of horizon scanning and contingency planning for other risks, both with total scores of 8. The second greatest gap is a group of three components: rapid response for other risks, surveillance of other risks and non-native risk analysis, all with scores of 12. Only five OTs have carried out horizon scanning, rated as Good only for BAT which has benefitted from considerable research input. The other OTs did not

Table 2 Total scores for each component: the maximum possible score is 48.

Component		Total score
Prevention		
Risk Analysis (PRA)		16
Risk Analysis (NNRA)		12
Pathway Analysis		17
Horizon scanning		8
Contingency Planning	Plants and plant health risks	15
	Animals and animal health risks	23
	Other risks	8
Border operations		30
Early Warning and Rapid Response		
Alert System in Place		30
Surveillance	Plants and plant health risks	23
	Animals and animal health risks	17
	Other risks	12
Monitoring		23
Rapid response Capacity	Plants and plant health risks	23
	Animals and animal health risks	24
	Other risks	12
Long-term management		
Prioritisation		29
Baseline	Plants	43
	Animals	35
	Other	35
Framework	Legal	28
	Territorial policy or strategy	20

understand what horizon scanning was. "Other risks" comprises non-crop pest invertebrates and marine species, for which capacity is clearly weaker than for crop pests or plants; even for the UK where surveillance for other risks was the only component which was rated Basic, all the other components being rated as Some or Good.

DISCUSSION

The relatively small population size of the OTs means that biosecurity officers often have a range of functions and responsibilities in addition to their biosecurity roles, lack access to specialist expertise and diagnostic facilities, and may also lack access to appropriate training. This compromises their ability to deliver effective biosecurity. There is a dependence on community support, itself dependant on good levels of awareness and understanding. Officers carrying out biosecurity functions work closely with customs, and this is clearly an important partnership.

Biosecurity practices tend to be based on historic legislation inherited from their colonial pasts and not updated, with procedures aimed at protecting agriculture and production, focusing primarily on managing deliberate introductions to reduce the introduction of crop pests and livestock diseases, with a few exceptions (e.g. BAT and SGSSI). Legislation is weak and scattered across a number of regulations relating to customs, plant health and animal health. The broader threat posed by non-native invasive species to the environment is not being recognised, and extension of biosecurity approaches to species, which are not crop pests or livestock diseases, is generally poor or non-existent.

For many OTs, actions such as border operations and post-border surveillance are focused on easily-identifiable species such as Pacific lionfish *Pterois volitans*, brown tree snake *Boiga irregularis* and Tephritid fruit flies (Diptera: Tephritidae). While this is a good starting point for biosecurity teams, actions need to go further, and target more cryptic species identified as priority, as well as taking a generic approach to detect the unexpected. Biosecurity actions across the continuum are particularly weak for non-crop pest invertebrates, except where there has been a historic incident of note, such as the jacaranda bug (*Orthesia insignis*) outbreak on endangered endemic gumwood trees (*Commidendrum robustum*) in St Helena in the mid-1990s, which raised attention within the Territory to the issue of invasive non-native species.

BAT is distinct in being one of the few OTs which is not an island but one of 29 national Antarctic programmes. As such, BAT has no control over what is done on other stations, or what the tourism industry does with regard to biosecurity unless they come to BAT stations, rendering it vulnerable to intra-Antarctic transfer of non-native species. This issue is recognised as a concern in the Antarctic and included by the Antarctic Treaty Committee for Environmental Protection (CEP) in the 2016 CEP Non-native Species Manual (Anon., 2016a).

CSBA and Gibraltar are also not islands and consist of enclaves adjacent to EU countries (Spain and Cyprus). CSBA has relatively few resources dedicated to biosecurity, and with relatively long leaky land borders with the Republic of Cyprus this is to be expected. Gibraltar puts most attention into actions in the areas of Early Warning and Rapid Response, and Management, Prioritisation and Frameworks, with comprehensive monitoring programmes for existing invasive species, and surveillance programmes and rapid response capability in the event of an incursion. Actions are detailed in the Biodiversity Action Plan (Perez, 2006).

Where OTs have rated capacity as Basic or above in these components it is primarily due to the outcome of a specific research project, usually UK-funded by a competitive research grant such as a Darwin Plus award, or builds on a topical invasive species issue such as the Pacific lionfish (*Pterois volitans*) and pink hibiscus mealybug (*Maconellicoccus hirsutus*) invasions in the wider Caribbean (Morris & Whitfield, 2009; <http://www.cabi.org/isc/datasheet/40171>).

Risk Analysis (PRA and NNRA) comes quite low, with scores of 16 and 12 for PRA and NNRA respectively. Risk analysis, when done correctly, is a time-consuming and complex procedure which requires access to taxonomic and other expertise and, in most cases, funding to bring experts together. The small, resource-limited OTs are challenged to achieve this, and most carry out simplified forms of risk analysis as well as they can, on an ad-hoc basis, with heavy reliance on published databases such as the CABI Invasive Species Compendium and Global Invasive Species Database, and on assessments carried out for Florida, Hawaii and the Pacific Islands for plant species (<http://www.hear.org/pier/wra.htm>). While these make a good match for Pitcairn, their suitability to the other OTs is less certain. Comprehensive, published assessments specifically for the island groups in the Caribbean and South Atlantic would be very helpful.

The introduction of new exotic species as pets is of concern, particularly to the Caribbean territories, due to the risk of escapes or deliberate dumping of potentially invasive species in the wild. In the Caribbean, at least some introductions are linked to hurricanes: in Anguilla it is known that at least two monkeys escaped from an individual, who had them as pets, after a hurricane in 1999, and the green iguana was first introduced on logs of wood during a hurricane in 1995 (R. Connor, Government of Anguilla, pers. comm.). Escapes of exotic fish are not considered a big problem, probably due to the lack of large bodies of fresh water inland in the OTs. Escapes of exotic birds are also not considered a big issue. Currently, one of the commonest domestic species of concern is the cat (*Felis catus*) (R. Connor. pers. comm.). Unwanted kittens are frequently dumped in the wild and form feral populations, threatening wildlife such as the native Anguilla racer snake (*Alsophis rijgersmae*), endemic Antillean iguana (*Iguana delicatissima*), or endemic St Helena wirebird (*Charadrius sanctaehelenae*) (Varnham, 2006).

With the exception of CSBA, all the OTs carry out biosecurity border operations to a greater or lesser extent, and 12 out of the 16 rated this as "Some" or "Good". Focusing limited resources on border inspections and interceptions is cost-effective for islands where the border is clearly defined and defendable. However, in a continental context with leaky borders which cannot be readily defended, an alternative strategic approach is to identify the priority species or pathways of concern and work more widely across the biosecurity continuum, particularly post-border. Tactics adopted are based on the results of pathway analysis and horizon scanning. In this context, high scores across the board for all components aren't necessarily appropriate, instead a package of activities is adopted designed to minimise the identified risks. CSBA and Gibraltar are not island territories and have different priorities. In CSBA, the focus is on the zoosanitary risks of new animal disease outbreaks and public health issues, routine monitoring is of aerial insect vectors, specifically mosquitoes, and rapid response capacity exists to respond in the event of human or animal health outbreak. Gibraltar benefits from strong post-border monitoring, surveillance and prioritisation actions to protect its unique biodiversity, as laid out in the Gibraltar Biodiversity Action Plan and Reserve Management Plan (Anon., 2016b; Perez, 2006).

Ascension Island and BIOT also rated border operations as "Basic". Both territories have limited or no agricultural production and consequently little political incentive in the past to invest in biosecurity border controls. The limited resources available to biosecurity are targeted at post-border actions directed towards the highest risk species, namely mosquitoes of human health concern and fire ants in Ascension Island, and brown tree snake in BIOT. This approach emphasises the importance of horizon scanning, pathway analysis and accurate assessment of risks in the first place, and the need to build capacity in these areas to provide information on where to target resources.

PRIORITIES AND RECOMMENDATIONS

Aiming to build capacity for all OTs so that they have high scores across the board is neither realistic nor suitable. Whereas for many OTs an appropriate strategy would be to devote a substantial proportion of available resources to border operations, for others, such as CSBA or Ascension Island, a more cost-effective strategy instead would be to establish post-border surveillance programmes targeted at identified priority species or pathways. In all the OTs resources are limited, and officers must be very focused in their activities. To do this effectively, each OT needs basic information on the range of potential invasive species (horizon scanning), how they might arrive (pathway analysis) and how to assess risk (PRA and NNRA). Capacity in these fundamentals was found to be lowest in this gap analysis, and initial activities will concentrate in this area:

Building fundamentals:

- Horizon scanning linked with pathway analysis: to determine what potential invasive species are out there and the different ways they can arrive. The information is used to design an appropriate package of responses which guides how the available resources should be best divided up between preventative actions, such as pathway or border operations, and reactive actions, such as surveillance and rapid response.
- Risk analysis: the process of assessing biosecurity risks. OTs need access to support for risk analysis, and a harmonised approach across the OTs to guide practices on-island for:
- Assessment of plant or animal species for potentially invasive characteristics;
- Assessment of the risks of a plant or animal species carrying potentially harmful pests, parasites or diseases.

Establishing the framework:

- Territorial policy or strategy: agreed actions to achieve the appropriate package of response, including a communications strategy for awareness to improve compliance and internal advocacy to promote government support.
- Legislation: regulate across the biosecurity continuum, including actions to contain, control and eradicate established invasive species. Provision of model legislation would allow a harmonised approach across OTs; assistance with drafting to apply it at the territory level is also required.

Delivery:

- Training: on all aspects of biosecurity, with specific needs varying with the Territory. This provides essential underpinning to deliver the fundamentals and framework outlined above.

Adding value:

- Regional coordination: use regional coordination bodies where they exist and are active, linking among the UKOTs and also to appropriate independent countries and other territories.
- Build networks, either strengthening existing or developing new ones, to promote sharing and exchanges, and promote the confidence and inspiration which result from peer-learning networks.

Building capacity in the activities outlined above will equip the officers responsible for biosecurity in the OTs with the capacity to develop other actions such as contingency and rapid response planning.

ACKNOWLEDGEMENTS

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