

Proposed attributes of national wildlife health programmes

This paper (No. 24072018-00125-EN) has been peer-reviewed, accepted, edited, and corrected by authors. It has not yet been formatted for printing. It will be published in December 2018 in issue 37 (3) of the *Scientific and Technical Review*

C. Stephen ^{(1, 2)*}, J. Sleeman ^(3, 4, 5), N. Nguyen ⁽³⁾, P. Zimmer ⁽¹⁾, J.P. Duff ⁽⁶⁾, D. Gavier-Widén ⁽⁷⁾, T. Grillo ⁽⁸⁾, H. Lee ⁽⁹⁾, J. Rijks ⁽¹⁰⁾, M.-P. Ryser-Degiorgis ^(5, 11), T. Tana ⁽¹²⁾ & M. Uhart ⁽¹³⁾

- (1) Canadian Wildlife Health Cooperative, 52 Campus Drive, Saskatoon, Saskatchewan S7N 5B4, Canada
- (2) World Organisation for Animal Health (OIE) Collaborating Centre on Research, Diagnosis and Surveillance of Wildlife Diseases, Saskatoon, Canada
- (3) USGS National Wildlife Health Center, 6006 Schroeder Road, Madison, Wisconsin 53711-6223, United States of America
- (4) World Organisation for Animal Health (OIE) Collaborating Centre on Research, Diagnosis and Surveillance of Wildlife Diseases, Madison, United States of America
- (5) World Organisation for Animal Health (OIE) Working Group on Wildlife
- (6) Animal and Plant Health Agency Diseases of Wildlife Scheme, Penrith Veterinary Investigation Centre, Penrith, Cumbria CA11 9RR, United Kingdom
- (7) Department of Pathology and Wildlife Disease, National Veterinary Institute, SE-751 89 Uppsala, Sweden
- (8) Wildlife Health Australia, Suite E, 34 Suakin Drive, Mosman, New South Wales 2088, Australia

- (9) Conservation Genome Resource Bank for Korean Wildlife, Seoul National University College of Veterinary Medicine, Seoul 08826, Republic of Korea
- (10) Dutch Wildlife Health Centre, Utrecht University, Yalelaan 1, 3584 CL Utrecht, the Netherlands
- (11) Centre for Fish and Wildlife Health, Vetsuisse Faculty, University of Bern, Länggass-Str. 122, Postfach, 3001 Bern, Switzerland
- (12) Ministry for Primary Industries, 25 The Terrace, Wellington 6011, New Zealand
- (13) Latin America Program, One Health Institute, School of Veterinary Medicine, University of California, 1089 Veterinary Medicine Drive, Davis, CA 95616, United States of America

*Corresponding author: cstephen@cwhc-rcsf.ca

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Summary

Wildlife health is important for conservation, healthy ecosystems, sustainable development and biosecurity. It presents unique challenges for national programme governance and delivery because wildlife health not only crosses jurisdictional responsibilities and authorities but also inherently spans multiple sectors of expertise. The World Organisation for Animal Health (OIE) encourages its Members to have wildlife disease monitoring and notification systems. Where national wildlife health surveillance programmes do exist, they vary in scope and size. Evidence-based guidance is lacking on the critical functions and roles needed to meet the OIE's recommendations and other expectations of a national programme. A literature review and consultation with national wildlife health programme leaders

identified five key attributes of national programmes: 1) being knowledge and science based; 2) fostering cross-nation equivalence and harmonisation; 3) developing partnerships and national coordination; 4) providing leadership and administration of national efforts; and 5) capacity development. Proposed core purposes include: 1) establishment and communication of the national wildlife health status; 2) leading national planning; 3) centralising information and expertise; 4) developing national networks leading to harmonisation and collaborations; 5) developing wildlife health workforces; and 6) centralising administration and management of national programmes. A national wildlife health programme should aim to identify, effectively communicate and manage the risk to or from a country's wildlife populations. It should generate the appropriate knowledge required to improve the effectiveness of wildlife policies and systems, including identifying and assessing emerging priorities, thus facilitating early warning, preparedness and preventive actions.

Keywords

Design – Disease – Function – Health – National – Programme – Purpose – Surveillance – Wildlife.

Introduction

National wildlife health programmes can help countries meet the obligations of many international conventions and agreements. They are an essential defence against biodiversity loss and the trade restrictions imposed on exports under the guise of trade agreements, such as sanitary and phytosanitary measures of the World Trade Organization (WTO). Wildlife health programmes are an essential component of early warning systems aiming to protect the health of domestic animals, wildlife and human beings. The World Organisation for Animal Health (OIE) strongly encourages its Members to 'put efficient monitoring systems in place and notify outbreaks of diseases in wild, feral or partially domesticated animals, as is the practice for all other animals' (1). The OIE has stated that 'surveillance of wildlife diseases must be considered equally as important as surveillance and control of diseases in domestic

animals' (1). Chapter 2 of the OIE *Tool for the Evaluation of Performance of Veterinary Services* notes that Veterinary Services must have the authority and capability 'to determine, verify and report on the sanitary status of the animal populations, including wildlife, under their mandate' (2). Requirements relating to wildlife are included in the OIE standards and recommendations for international trade. In addition, the OIE has established a system of national focal points for wildlife in its Member Countries, providing a list of their proposed tasks and training for roles aimed at strengthening and improving its Members' national wildlife health programmes (3).

The joint Global Early Warning System (GLEWS) for Emerging Diseases of the OIE, the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) obtains information about wildlife events from regular activities, leading to better disease intelligence and risk assessment at the animal/human/ecosystem interface to improve early warning and support the response. The OIE and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) are working together to develop and disseminate guidelines and recommendations on disease prevention, detection and control as well as measures for safe trade and management of disease risk at the interfaces between wildlife, domestic animals and humans (4). Further, the United Nation's 2030 Agenda for Sustainable Development recognises the importance of protecting life on the land and life underwater as cornerstones of human prosperity. Despite all the needs for and expectations from national wildlife health programmes, to date there are no standards clearly defining attributes of such programmes.

Wildlife health presents unique challenges in governance and programme delivery because its influences fall across conservation, public health, agriculture and environmental management. While many agencies have interests in wildlife health, rarely does a single entity have the authority or expertise to manage all interests. Authority and resources are often disbursed across organisations. Responsibilities can be centralised, distributed across national and

sub-national entities, or unclear. The cross-agency relevance of wildlife health makes it easy for one agency to assume that another agency has programmes in place to address needs and obligations, leading to gaps in national efforts. The overlap and fragmentation in responsibilities expands when wildlife health programmes evolve beyond the traditional focus on detecting and responding to diseases to become programmes capable of preventing diseases and promoting healthy, resilient populations and ecosystems. A well-developed national programme should enable cross-agency collaboration, policies, strategies and plans that define a country's wildlife health vision, priorities and course of action, ensuring it meets society's interests and needs through consistent means throughout a country (5).

There is a long history of wildlife serving as bio-sentinels for the effects and distribution of environmental pollutants and pathogens (6, 7). General scanning surveillance of wildlife can link the detection of new pathogens or pollutants with pathological effects, helping in risk identification, assessment and prioritisation for further investigation. Recent attention has focused on using systematic ways to collect, integrate and communicate the direct and indirect effects of climate change on wildlife health for public health and conservation purposes (8). Through collecting wildlife disease data, discovering and assessing hazards, and integrating these with social and environmental information, a national wildlife health programme can help prioritise risk communication and strategic management decisions.

Wildlife, economies and public health, as well as nations, are rapidly becoming interconnected, creating an era of emerging infectious diseases (9, 10). International and national movements of people and goods coupled with rapidly changing social and environmental conditions have created new avenues for pathogen traffic that cross national or sub-national borders. Few local disease events are without national consequences and few national decisions are unaccompanied by local consequences (11). Countries have responded to the threat of emerging and resurgent diseases by creating or strengthening national strategies for detection and control of emerging risks, but the

proportion of investment in wildlife health programmes to contribute to these strategies has often been small in comparison with investment in domestic animal and public health programmes (12).

Despite the well-known need for and contributions from wildlife health programmes, there is little evidence-based guidance or consensus on the necessary competencies and critical functions of a national wildlife health programme. The functions of both public health and domestic animal health programmes are often well described in policy or legislation. For example, the concept of core competencies heavily influences public health planning and training (13). The OIE's Performance of Veterinary Services (PVS) evaluation tool uses internationally accepted critical competencies for national Veterinary Services. The OIE *Terrestrial Code* and *Aquatic Code* provide basic principles for animal disease surveillance (14, 15). However, such guidance is focused largely on disease surveillance aspects of a national programme, particularly with respect to selected infectious diseases. Other contributions of a national wildlife health programme (e.g. using wildlife as bio-sentinels for climate change effects or impacts of pollution, or assessing effects of landscape change on wildlife and ecosystem productivity and services) generally fall outside existing guidance documents.

There is a wide diversity across nations in terms of their ability to provide a national wildlife health programme. This is in part due to the variation in systems of governance, resources, national priorities, epidemiological situations and diverse histories of programme delivery, including division of authority. In August 2016, 13 people with experience leading national wildlife health programmes came together to consider the question: 'are there shared competencies and critical functions that can define the essential features and scope of practice of a national wildlife health programme?' Combined subsequently with a scoping review of the literature, the goal of this meeting was to begin the process of defining the essential attributes of a national wildlife health programme that could be scalable and adaptable to each nation's needs. This paper addresses a gap in the literature and aims to motivate ongoing conversations and

investigations into the purposes and essential functions of a national wildlife health programme.

Methods

Peer-reviewed literature was searched using PubMed, Web of Science Core Collection, BIOSIS Previews, Current Contents Connect, SciELO Citation Index, and Zoological Record databases. Citations from all databases published from January 1990 to August 2016 were collated. The search terms included 'wildlife national programme'. Based on the title or the abstract of the articles found, only those describing generalisable attributes, functions or competencies for national programmes were selected for further review.

Participants in the one-day workshop were invited on the basis of their roles as leaders or managers of national wildlife health programmes. The 13 participants were affiliated with government agencies, non-profit organisations and academic institutions involved in delivering national wildlife health programmes. This included a representative of a non-profit organisation (Wildlife Disease Association [WDA]) with specialist knowledge of wildlife health programmes in Latin America. Participants were from 11 national programmes, from 12 countries in five continents (Australia, New Zealand, Canada, United States of America, Argentina, United Kingdom, the Netherlands, Sweden, Switzerland, People's Republic of China, Republic of Korea and Thailand). Workshop discussions focused on four questions:

1. What are the essential functions, goals and objectives of a national wild animal health programme?
2. Who are the targeted knowledge users?
3. What are the necessary capabilities and competencies of a national wildlife health programme?
4. What is the necessary level of effort and investment to meet goals and objectives?

A draft paper prepared by four of the authors was shared with all attendees to develop a consensus on the workshop findings and recommendations, which are represented below.

Results

State of practice of national wildlife health programmes

The scoping literature review failed to find publications that provided evidence or consensus on the necessary structure, functions, governance or goals for national wildlife health programmes. A small number of papers, such as that by Ryser-Degiorgis and Segner (16), described tasks and strategies of specific programmes. Others, such as Stallknecht (17), described impediments to wildlife surveillance. The OIE wildlife focal point training manuals on surveillance and international reporting of diseases in wild animals and OIE guidelines for wildlife disease surveillance covered some aspects of national surveillance programme delivery.

The structures of national programmes varied widely among the participating organisations represented at the workshop. All of them were firmly rooted on a foundation of providing or supporting diagnostic services, surveillance capacity and a network of wildlife health experts, but there was diversity in their size, budget, technical capacity, experience, organisational structure and governance. Some had been in existence for over 60 years while others were only a few years old. Some had a staff of over 75 people while others had 1–3 employees. A variety of organisational structures were identified, including centralised, decentralised, governmental and non-governmental models.

There were some commonalities among the programmes and nations represented at the workshop. Common elements of programme mission statements included protection of the health of people, livestock and wildlife from threats originating from wildlife-related disease. In many cases, legislation dealing with wildlife health was dispersed across animal health legislation and nature management legislation protecting biodiversity. Legal authority, and therefore roles

and responsibilities, for dealing with wildlife health issues tended to be fragmented or varied across or within jurisdictions. Exceptions existed such as the European Union-level Animal Health Law, which includes wildlife. Growing expectations for many, but not all, programmes included:

- science-based threat detection for public safety, trade and conservation
- a focus on prevention and protection
- fostering collaboration across agencies, sectors and disciplines (especially for climate change and public health).

Where non-governmental agencies delivered national programmes, these agencies were not assigned regulatory authority. The potential target audience for the output and outcomes of the national wildlife health programmes discussed was wide, and included:

- wildlife health, public health and domestic animal health stakeholders
- sub-national, national and international government agencies concerned with wildlife, natural resources and ecosystems
- agriculture and public health
- the general public
- policy-makers
- the scientific community.

The participants reported that many of their current stakeholders would view a national wildlife health programme to be successful if it could:

- provide early detection of emerging diseases, contributions to risk assessments and proof of disease freedom

- develop diagnostic tools and technology specific to wildlife disease detection
- develop or provide expert input into national disease response plans and multi-agency frameworks
- establish information and sample repositories or biobanks.

Challenges identified included lack of sustainability of the programmes due to uncertain funding, inadequate facilities, personnel turnover and loss of expertise. Additional concerns included competition for limited funding, reliance on multiple funding sources that have different values and priorities, demand exceeding capacity, challenges in communicating the value of wildlife health to sponsors, and insufficient facilities and resources to provide national coverage for the full spectrum of species and issues. Insufficient understanding by stakeholders and decision makers of the goals and objectives of a national wildlife health programme was also a challenge. The lack of a legislative mandate in some countries resulted in overlap and hence competition among entities, fragmentation and lack of coordination on the delivery of services and, in some cases, a lack of a coordinated network. Specific needs identified included better leadership, networking and coordination of activities, as well as data management tools, data sharing agreements and enhanced diagnostic and other scientific capabilities.

Proposed attributes of a national wildlife health programme

A list of five core attributes with associated function and goals were developed from a review of the activities and responsibilities of the programmes represented at the workshop (Table I). No country had every feature or function listed in Table I. Table II categorises some of the critical skills, knowledge and capabilities needed by a national programme to provide these functions. Although Table II is organised by general themes, there is cross-over of skills, knowledge and capacities between themes. For example, requirements for disease management are dependent on the skills and capabilities needed for diagnostic services. Accessing and delivering these skills and

capacities can be done by the national programme itself but often requires partnership with other agencies and organisation of individuals, making partnership development a cross-cutting skill. Table II is not an exhaustive list, but instead illustrates the diversity of capabilities a national programme would need to deliver the proposed goals as well as the purposes and roles identified in Table III.

Insert Tables I, II and III here

Attribute 1 – Being a knowledge- and science-based programme

At their core, national wildlife health programmes are knowledge-based programmes. Their people, infrastructure and resources are directed towards generating, collating, transforming, storing, managing, analysing, using and sharing knowledge outcomes to achieve national goals. By serving as a knowledge-based organisation, a national wildlife health programme can:

- foster interjurisdictional cooperation and collaboration, including exchange and sharing of information and knowledge
- provide credible information, advice and technical support to sub-national, national and international organisations
- collect nationwide information to meet obligations for international reporting or to provide a nationwide awareness of the situations of interest
- support the development of evidence-based national goals or strategies.

There are five main features of this attribute.

1. **Generating data and information.** Surveys, surveillance, research and consultation are four approaches used by wildlife health programmes to produce the information and data needed to describe a wildlife health situation. The proportion of effort dedicated to any one of these four approaches can vary among

national programmes and is influenced by the existence of complementary or competing expertise and resources in a country, the role of government versus non-governmental organisations in research and surveillance, and the ability to coordinate, share and integrate multiple sources of information.

2. **Data and information management and storage.** A data repository should support national expectations for disease reporting and assist in detecting trends in health outcomes over time. Centralisation and standardisation of data help to make credible information, advice and technical support readily available and create a reference centre to support regional, national and sub-national efforts. This function should be extended to bio-banking materials that will be useful for more detailed analysis and retrospective assessments.
3. **Information analysis and assessment.** There are two components to this function. First is the ability to produce explicit knowledge and information from data, such as those which are produced from epidemiological analysis. Second is access to and development of tacit knowledge of members of the national programme and its network. Tacit knowledge of the wildlife health situation can help make programme outputs more accessible and understandable to knowledge users. Connecting knowledge producers with knowledge users can facilitate development of tacit knowledge.
4. **Knowledge mobilisation and communication.** A national programme should maximise the impact of the information and knowledge produced, and document and communicate those impacts as widely as possible. One way to achieve this is to be a knowledge broker, which, in addition to serving as a knowledge source, creates the relationships and networks between producers and users of knowledge. A feature that differentiates national programmes from others is the need to connect and collaborate with sub-national programmes and

other stakeholders. This requires not only relationship development but also the use of multiple means for information exchange and dissemination of information to, with, and between collaborators, stakeholders and partners.

5. **Evaluation.** An important role for a national programme is to lead and coordinate collaborative efforts to critically evaluate the programme's activities, characteristics and outcomes to assess its reliability, value and effectiveness. Ongoing evaluation supports the evolution of specific strategic goals and deliverables to meet changing situations and helps to develop consensus on how to measure and report on progress towards those goals.

Attribute 2 – Supporting cross-nation equivalence and harmonisation

Consensus on basic criteria or standards for programme delivery, shared health goals and/or strategies with accountability mechanisms can guide the development of an equivalent and consistent programme across a country. Through the vantage point of a national perspective, a national programme works with partners to identify strategic priorities and to find partnerships to deliver on programme goals more efficiently. A national network facilitates collaborative processes to develop shared goals and standards. It also facilitates processes to harmonise approaches to diagnosis, surveillance, assessment and management by identifying variability in recognising and assessing wildlife health across a country.

Common subjects for harmonisation include case definitions, protocols for disease investigations, laboratory standards relevant to wildlife, standards for data storage and data sharing agreements. It could also include aspirational, leadership and management elements such as articulating the vision and missions for wildlife health programmes, and metrics for assessing programme impacts and developing management targets for health outcomes. Harmonisation, where it includes data standardisation, can provide benefits in the quality of data analysis and dissemination.

Attribute 3 – Partnerships and national coordination

Coordination of effort can be as important as harmonisation in creating equivalency across a country. There are benefits to having a central body that strives to foster partnerships and/or sharing of information and resources to:

- reduce redundancies in effort by linking capacity between sub-national and regional collaborators
- facilitate rapid information sharing, including overcoming barriers to sharing information
- ensure co-learning across programmes
- develop a single focal point to accumulate a shared perspective on a nation's wildlife health status
- coordinate national-level surveillance and disease response activities.

Because of the shared and distributed responsibilities and interests in wildlife health, this cannot be achieved without attention to developing and supporting effective partnerships and a governance structure among those who detect, assess and respond to wildlife health events. Linkages with other nations provide a country with insights into the global wildlife health situation. Effective collective action requires processes, rules and institutions that enable policy and practice to be agreed and delivered. This, in turn, relies on good partnerships, good governance and organisational perspectives that support collaboration.

Local events influence wildlife health and disease, hence a national programme must be connected from the national, to sub-national, to local level to ensure an effective multi-way flow of information including horizontally across government sectors such as public health, environmental and natural resource management agencies, and agriculture. This creates challenges in collaboration and coordination when enabling legislation does not exist to facilitate information

sharing, response agreements and relationship building as ongoing activities.

Wildlife health programmes require partnerships with a diversity of collaborators and stakeholders because they deal with complex issues that cross disciplinary, species and subject boundaries. As such, time and effort are required to foster trusting relationships among the numerous interests in the wildlife health realm. Because of the diversity of interests and the necessity for partnerships, wildlife health is an exemplar of the need for an integrated, 'One Health' approach. A national wildlife health programme can provide the channel for interactions with other players in the One Health space, providing opportunities for national discussions on domestic animal and human health as well as conservation/biodiversity/ecosystems. A national wildlife health programme should, therefore:

- foster multi-stakeholder cooperation and collaboration, including exchange and sharing of information and knowledge
- support a network of expertise with sufficient credibility, trust and collegial relations to bridge the needs and capacities of multiple parties.

Attribute 4 – Leadership and administration

Many national programmes form a central focal point that provides a voice on wildlife health issues, including risk communication. Coordinating the internal and external information, partners and networks needed to deliver a national programme can consume significant time and funds and could not be achieved without leadership and administrative and operational support. Leaders who integrate, negotiate and evaluate collaborative partnerships and contractual arrangements are needed to manage the broad range of interests in wildlife health. Skilled leaders with aptitude for and experience in building partnerships and teams, organising complex relationships and troubleshooting are critical for effective management of issues that cross disciplinary boundaries and jurisdictions. Although the efficiencies gained through synergistic

partnership can overcome some resource inadequacies, formalised administrative and governance structures greatly help in the design and efficient operation of a national programme.

Because wildlife is generally regulated as a public good, a national wildlife health programme is inherently governmental. It is essential, therefore, that a national programme is given authority, permissions, or an official mandate to deliver on national needs and obligations. A governmental entity can deliver these services, or they can be outsourced to non-governmental entities if that is more efficient for the specific situation. Although there are obligations for governments to invest in a national programme, there are also beneficiaries in the private sector (such as agriculture and hunting organisations) and the civil society sectors (such as conservation organisations) that should be considered when planning governance and funding mechanisms.

Attribute 5 – Capacity development

There are differences between a national wildlife health programme and a nation's wildlife health capacity. While the first of these categories may be delivered by a single, identifiable entity, a nation's wildlife health capacity is the accumulation of sub-national, civil society, academic and other contributors that provide information and action needed to characterise and manage wildlife health. A national wildlife health programme helps fill gaps in expertise, infrastructure and information to ensure a similar level of observation and assessment of wildlife health across a country.

A national programme can supplement or complement sub-national efforts through targeted programmes and development of specialised expertise, tests or equipment, and provide direct assistance when requested. National wildlife health programmes can provide a wide variety of learning experiences to cultivate a competent future workforce and ensure succession of information by maintaining and developing consistent expertise. Access to modern tools, reliable expertise and human resources are also essential for sustainable programme delivery. National programmes can also be a source of

surge capacity to support the response of their own and other programmes to emergency situations.

Conclusions

The capacities and activities of national wildlife health programmes currently vary around the world. By comparing the scope of practice, valued services and core activities of 11 national programmes from North America, Europe, Asia and Australasia, the authors have identified shared roles, functions and competencies for a national programme that can serve the needs of conservation, environmental management, agriculture, trade, sustainable development, biosecurity and public health.

While there are growing expectations to be able to integrate wildlife health into risk management planning and health assessment, evidence-based guidance on the essential attributes of national wildlife health programmes is lacking. There has been no published, systematic evaluation of any wildlife health programme. The authors recognise that not all national wildlife programmes are represented in this paper; there was a lack of representation from Africa, for example. More work is required to specify further the precise competencies and functions and their relative importance, as well as to develop metrics to measure the success of these programmes. The findings outlined in this paper, therefore, should be considered more aspirational than prescriptive. There will be varied needs for investment in the developing capacities and competencies, depending on a country's wildlife animal health structure and epidemiological situation. However, these aspirations set out a roadmap towards developing an international consensus on how a national wildlife health programme can help meet the wildlife conservation, trade, economic, animal and public health needs of each nation in an equivalent fashion.

Some countries have been developing high quality national wildlife surveillance programmes but none of the 11 programmes in this review had completely fulfilled all the expectations of Tables I and II. Countries varied in their fiscal or legislated capacity to meet all the

attributes of a national wildlife health programme identified in literature or in the workshop. Programmes would benefit from support by a national strategy and operating plans that outline roles and responsibilities, including how a national programme relates with local, sub-national and regional organisations.

The inspiration for this paper was the need to operationalise the OIE's encouragement of Member Countries to 'put efficient monitoring systems in place and notify outbreaks of diseases in wild, feral or partially domesticated animals, as is the practice for all other animals'. In the absence of published guidance, many countries or programmes are challenged in defining and defending their essential features to sponsoring organisations. In recent years, most of the focus on national animal health programmes has been on the capacity to detect reportable diseases or emerging infections of concern to agricultural trade and productivity, or to public health. As the impact of emerging infections on wildlife has become more apparent, for example chytridiomycosis in amphibians and white-nose syndrome in bats, there is a growing awareness of the need for international and national standards to also detect and respond to infections significant to wildlife conservation. The authors believe that the programmatic attributes described in this paper can help nations meet the OIE expectations for wildlife health, including performance of surveillance and management of diseases that are primarily concerns for wildlife conservation.

There remains, however, the question of whether the attributes recommended in this paper would support wildlife conservation programmes in protecting biodiversity, regardless of the implications for livestock production, trade or public health. The purpose of a national surveillance system is to collect, analyse and interpret data systematically and continuously, and to disseminate the resulting assessment to those who have the right to know so that action can be taken (18). A national wildlife health programme could be adjusted to address the top threats to global wildlife, such as climate change, species overexploitation, habitat loss and food systems (19). For example, it would need to be as interested in the determinants of

health as in health outcomes. Paying attention to how species sensitivity and exposure to hazards are changing in advance of death or disease will be instrumental in identifying actionable signals that will allow timely conservation action. In addition, recipients of surveillance information could be extended beyond the usual targets. As most of the drivers of wildlife health threats fall outside the traditional government animal health realm, a more comprehensive surveillance network would be required to detect and communicate surveillance signals. Elements of the OIE's sixth strategic plan (such as the goal of understanding the relationships between climate change and ecosystem health, and biodiversity loss) provide hope that expectations for wildlife health programmes can evolve to include an all-hazards approach that can provide signals to motivate action not just for infections but also for those global pressures that present the greatest threat for wildlife conservation (20). The recommended attributes in this paper provide a foundation from which to adapt approaches to wildlife health at a national level by providing a firm foundation of systematic and integrated observations to detect a suite of infectious and non-infectious threats to wildlife populations.

What a national wildlife health programme does is inherently governmental, but much of the information and many situations that inform national programmes are derived from a network of local and regional entities in and out of government, with the resulting knowledge communicated back to this network. A national programme should serve as a catalyst for collaboration, exchange of information and outreach to produce comparable knowledge, technology and skills across jurisdictions. National wildlife health programmes build from a core of disease surveillance to create the capacities to meet the evolving expectations from conservation, public health, natural resource and agriculture partners. National wildlife health programmes, therefore, require infrastructure, staff and partners that cover a wide range of expertise, from traditional diagnostic skills to people with knowledge of species ecology and wildlife management, applied and quantitative epidemiology, bio-informatics, communication and knowledge mobilisation experts, management, leadership skills, and more.

Acknowledgements

The authors would like to thank the Wildlife Disease Association for financial support and Dr P. Ratanakorn (Mahidol University, Faculty of Veterinary Science, Thailand), Rupert Woods (Wildlife Health Australia) and Dr H. He (National Research Center for Wildlife Borne Diseases, Institute of Zoology, Chinese Academy of Sciences, People's Republic of China) for their contributions to this project's workshop.

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Table I
Five attributes and associated functions and goals of national wildlife health programmes derived from a comparison of 11 national programmes

Attributes	Functions	Goals
Knowledge- and science-based programme	Hazard recognition and assessment	Detect aetiologies and threats of concern in a timely fashion Establish national wildlife disease status Support claims of disease freedom Assess success of disease management programmes
	Risk assessment, risk communication, decision support and trend analysis	Provide specialist knowledge to inform risk assessments Provide decision makers with actionable information Help with risk communication
	Health information management	Maintain a historic database to document national disease status Support evidence-based action and advice Support retrospective research and investigations
	Research and development	Understand the ecology of wildlife disease by independent or partnered research Provide special expertise or capacity to support research
	Disease control and management and emergency response planning	Provide information and capacity to support actions to protect human and animal health
	Provide expert advice and expertise	Provide a recognised focal point for coordination of wildlife health expertise
Cross-nation equivalence and harmonisation	Development of and/or expert input into standard operating procedures, policy and practices	Coordinate wildlife health interests to enable a consistent, coordinated and harmonised response across a nation Compare available health data over time and space
	Provide, facilitate and/or augment diagnostic and epidemiological capabilities	Provide equivalent access to modern capabilities to characterise wildlife disease events
Partnerships and national coordination	Develop and maintain a partner network	Enable robust information sharing and nationwide coverage Established and maintain communication frameworks

		Access to and centralisation of sample and data
	Programme coordination	Coordinate wildlife health interests to enable consistent, coordinated and harmonised information sharing
	Communication and outreach	Inform stakeholders, including public and risk managers, of options to reduce risk, prevent/control disease and maintain ecosystem health
Leadership and administration	Advocacy	Inform policy
	Planning and strategy development	Strategic and adaptive management
	Administration	Transparent programme management
Capacity development	Workforce training	Succession planning
	Operate and/or provide access to appropriate facilities	Maintain and develop consistent expertise
		Ensure adaptive and modernised infrastructure to cope with current and emerging issues

Table II
Examples of infrastructure, capabilities, skills and knowledge required of a national wildlife health programme

Theme	Examples of infrastructure and capabilities	Examples of skills and knowledge
Diagnostic	System and partners to plan, access, process and safely dispose of samples	Pathological, microbiological and clinical disciplines
	Diagnostic laboratory system	Field investigation
	Field equipment and vehicles	
Assessment	Data and information management and archive	Epidemiology
	Data analytical tools including capacity for mapping and spatial analysis	Disease and wildlife ecology and allied fields
		Bioinformatics
		Risk analysis and decision support
Harmonisation and coordination	Capacity and partnerships to develop, validate and share expertise and methodologies	Social sciences including economics
		Policy assessment and development
		Clinical epidemiology
		Methods and programme assessment
Communication	Two-way communication networks	Facilitation and conflict resolution
		Risk and science communication
		Knowledge translation and mobilisation
		Cultural competency
Research	Laboratory, animals and field research capacity and infrastructure	Social and interpersonal skills to develop networks with diverse groups of stakeholders
		Research design and implementation
		Specialised disciplinary knowledge
		Statistics and modelling
Disease control	Authority or mandate to coordinate and participate in control efforts	Incident command systems
	Authority or partnerships for border standards and containment	Epidemiology
Programme management and administration	Relationships with decision makers and the public	Logistics
	Governance and authority to support this role	Partnership development, management and evaluation
	Fiscal resources to deliver programmes	Leadership
	Administrative workforce	Fiscal and human resource management
	Office and laboratory space to deliver programmes	Business development
Capacity development	Facilities, abilities and support to teach and train	Education programme development

Table III**Proposed purposes and roles of a national wildlife health programme**

Purpose	Role
Establish and communicate the national wildlife health status	Maintain a network and system to detect, assess, summarise and communicate the types, extent and effects of hazards in wildlife affecting conservation, public health, domestic animals and economic activities at the national level
Lead national planning	Assess risks and develop response plans for threats and issues of national concern Develop national goals or strategies with accountability mechanisms
Provide a recognised focal point for wild animal issues	Direct or delegated national authority to represent the nation in international programmes and negotiations Consistent reporting and messaging Develop and track performance indicators or collect nationwide information to meet obligations for international reporting and/or to provide a nationwide awareness of situations of interest
Centralised information and expertise	Provide credible information, advice, technical support and be a reference centre for sub-national, other national and international organisations, including policy-makers
Promote equivalent and harmonised activities	Encourage and support sub-national entities to deliver equivalent programmes across a nation Develop criteria or standards for programme delivery Fill gaps to harmonise capacity and response across sub-national jurisdictions
Promote cooperation and collaboration	Foster interjurisdictional and agency cooperation and collaboration including exchange and sharing of information and knowledge
Develop and manage a cooperative national network of expertise and information	Support a network of expertise with sufficient credibility, and collegial relations to swiftly bridge inter-jurisdictional arrangements to help in local response Foster collaboration and coordination among government, academia, community and other stakeholders
Centralised programme management	Manage administration of national projects and the programme to ensure uniformity of delivery across a country
Workforce development	Ensuring a skilled workforce through training and education