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Ecology and Evolution of Infectious Diseases: a US-UK Bilateral Funding Initiative

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UK Research and Innovation

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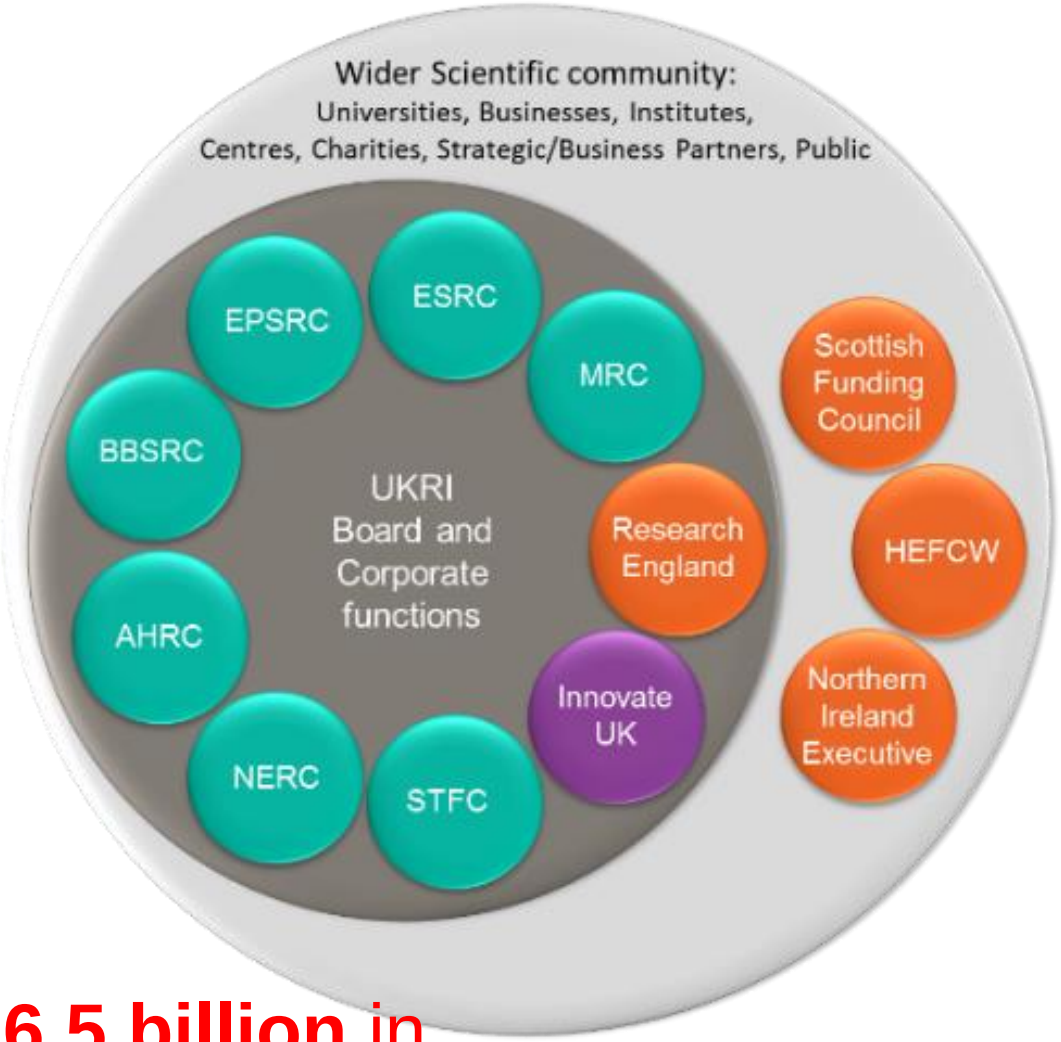
Cover

1. Brief overview of the UK Research and Innovation and BBSRC
2. Ecology and Evolution of Infectious Diseases (EEID) Programme
3. UK-US Partnership
4. Examples of funded science
5. Future

What is UK Research and Innovation?

- UK Research and Innovation launched in April 2018
- UKRI is the new funding organisation for research and innovation in the UK
- It brings together the seven UK research councils, Innovate UK and a new organisation, Research England, working closely with its partner organisations in the devolved administrations



More than £6.5 billion in combined budget per year

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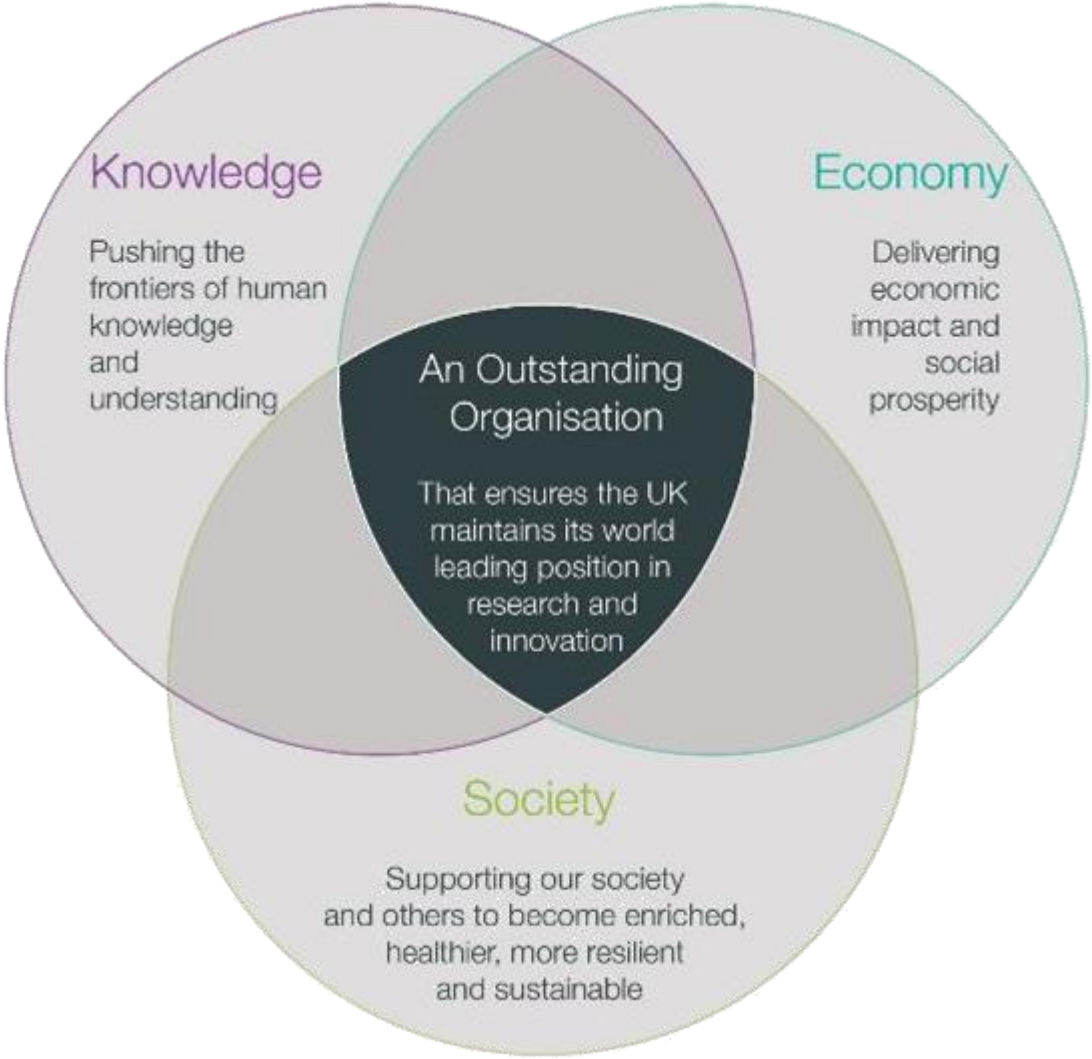
UK Research and Innovation - Mission

To invest every pound of taxpayers' money wisely in a way that maximises impact for citizens, in the UK and across the world.

This will have three elements:

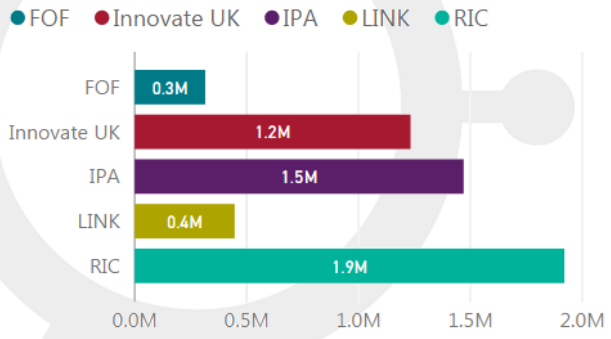


BBSRC – what we do

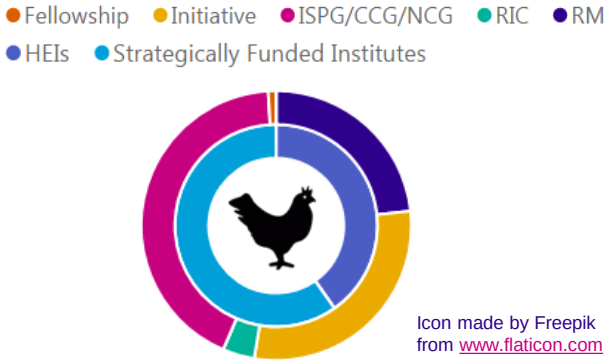
- Invest in **world-class bioscience research** in UK Universities and Institutes
- Invest in **bioscience training and skills** for the next generation of bioscientists
- Drive the widest possible **social and economic impact** from our bioscience in industry, policy and public goods
- Promote **public dialogue** on bioscience

Animal health – Analysis by 2017/18 Spend Year (£50.4m)

Collaborative R&D Schemes - 11% total

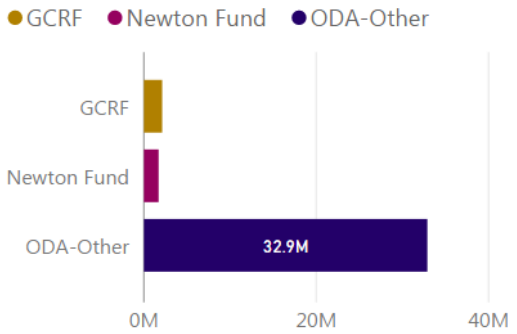


Investment Mechanism & HEI/Institute Split

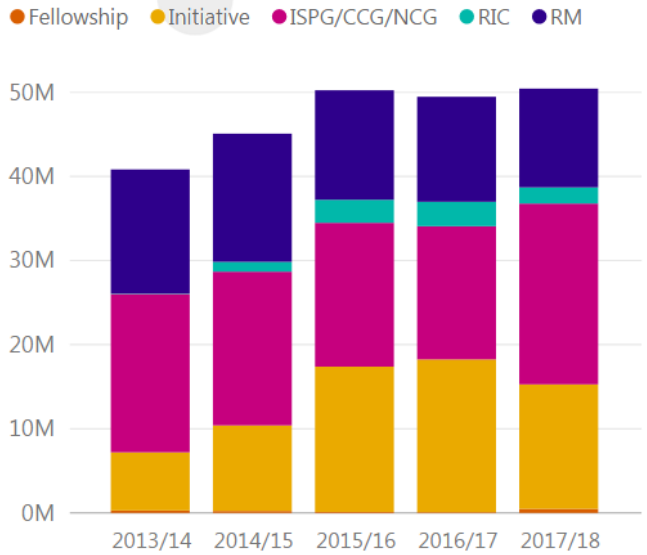


Icon made by Freepik from www.flaticon.com

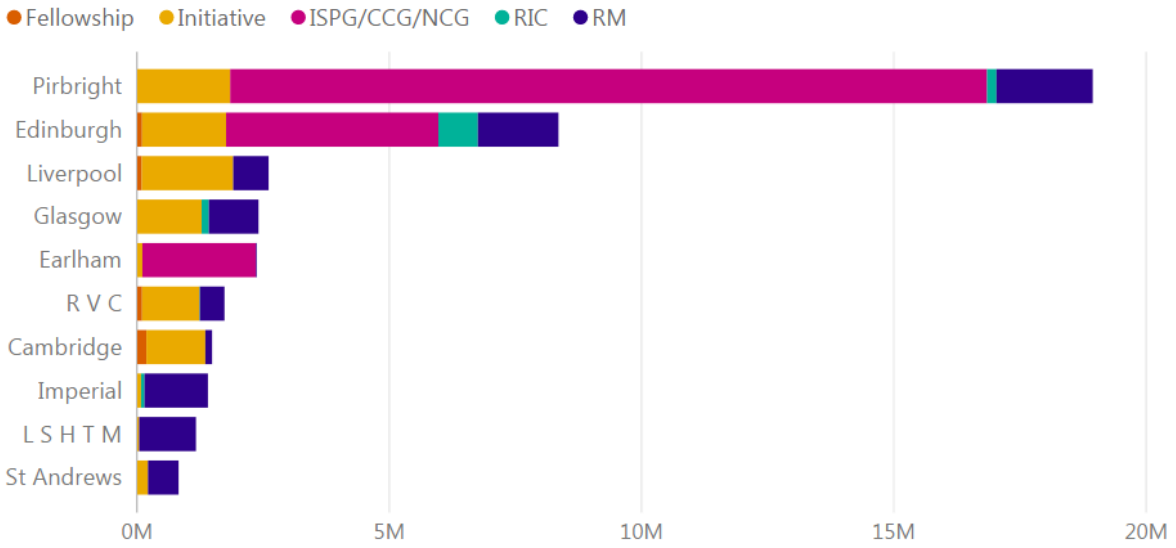
ODA Compliance - 73% total



Analysis by Spend Year (2013/14 - 2017/18)



Top 10 Research Organisations



All figures given in £ millions.

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Data source: ReSOURCe; Policy, Strategy and Evidence. **Last updated:** September 2018.
Note: The contents of this document are for BBSRC SO use only; communication of this information outside of BBSRC SO should be checked with Policy, Strategy and Evidence

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BBSRC Forward Look for UK Bioscience

Advancing the frontiers of bioscience discovery

- Understanding the rules of life
- Transformative technologies

Tackling strategic challenges

- Bioscience for sustainable agriculture and food
- Bioscience for renewable resources and clean growth
- Bioscience for an integrated understanding of health

Building strong foundations

- People and talent
- Infrastructure
- Collaboration, partnerships and KE

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EEID

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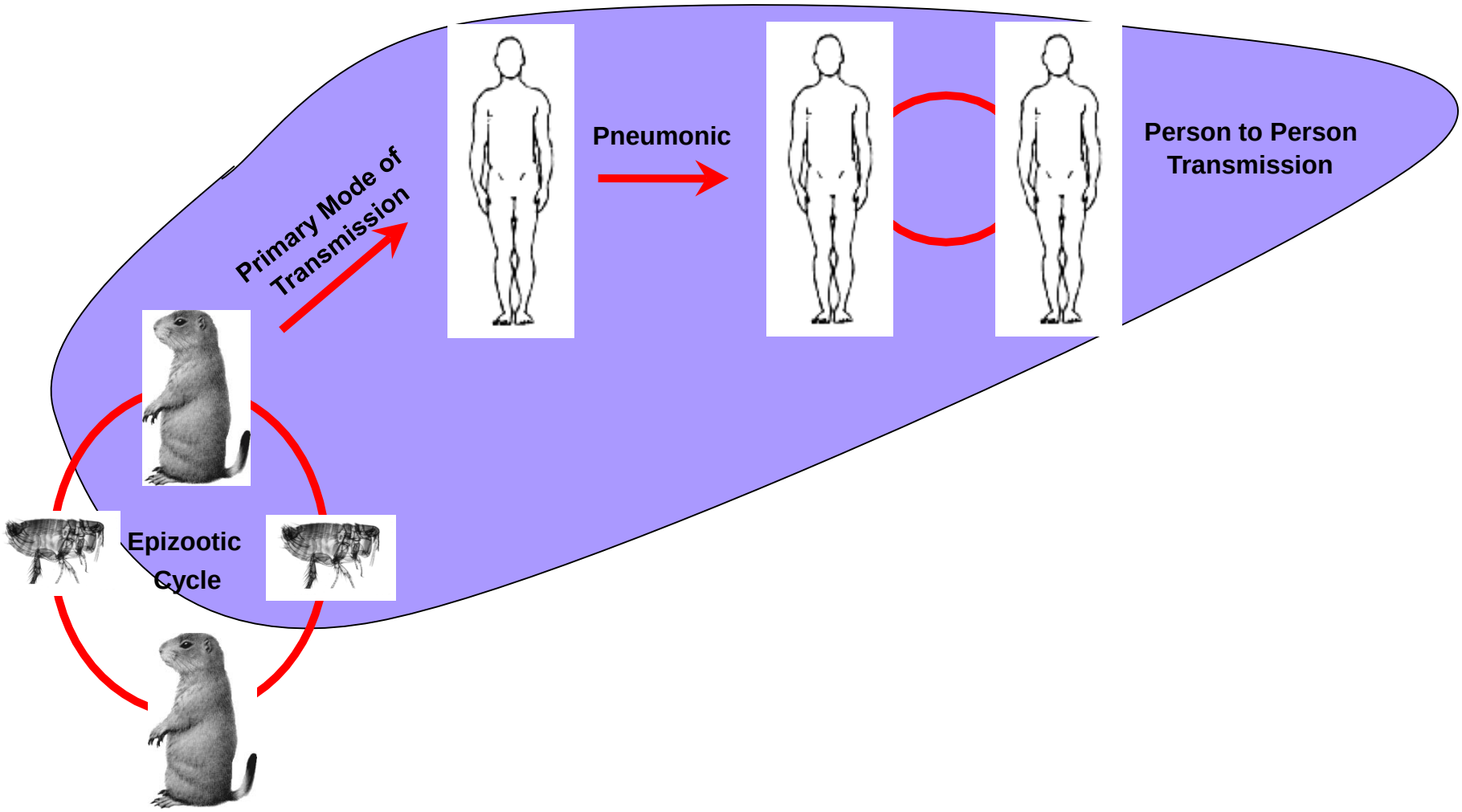
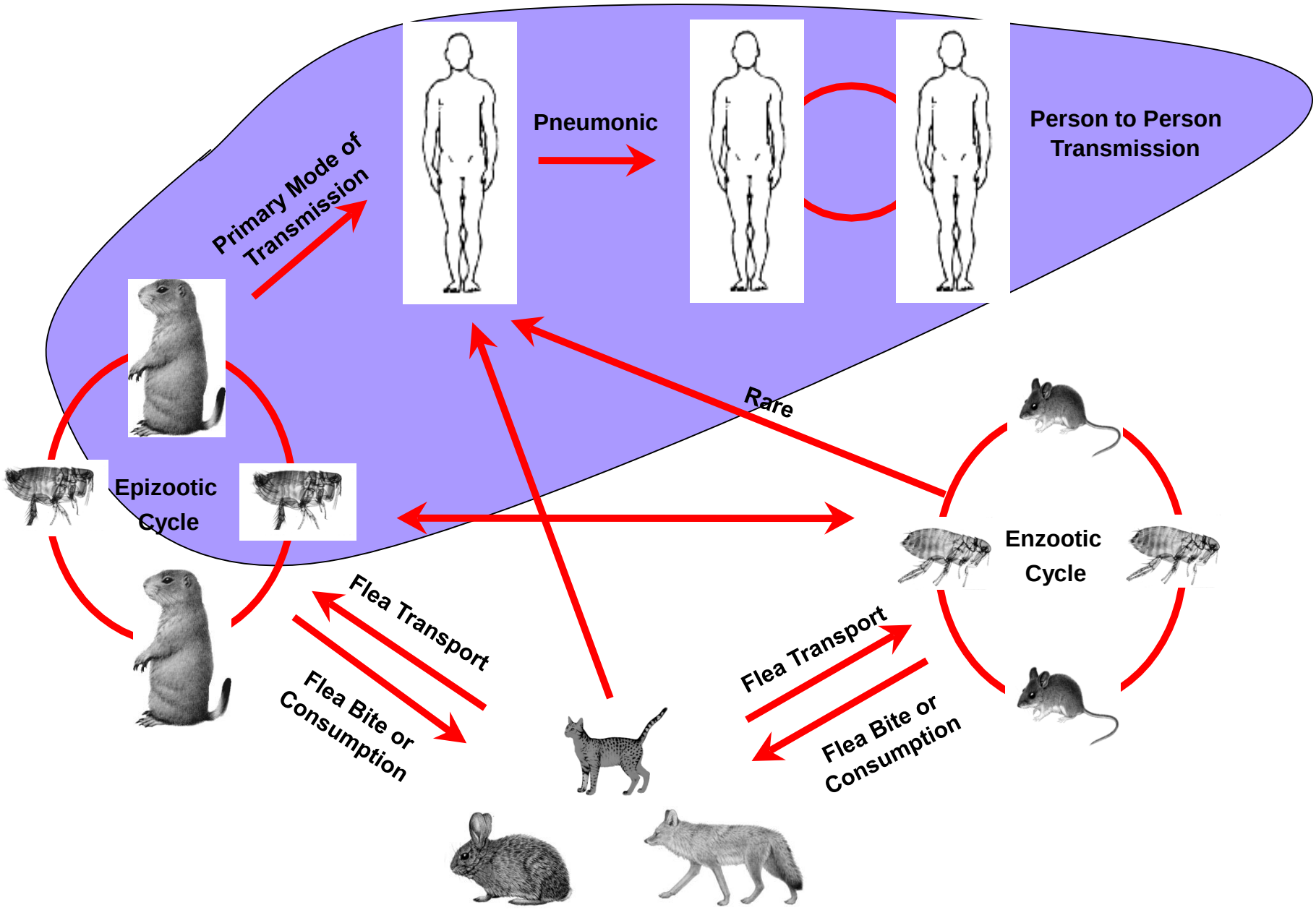


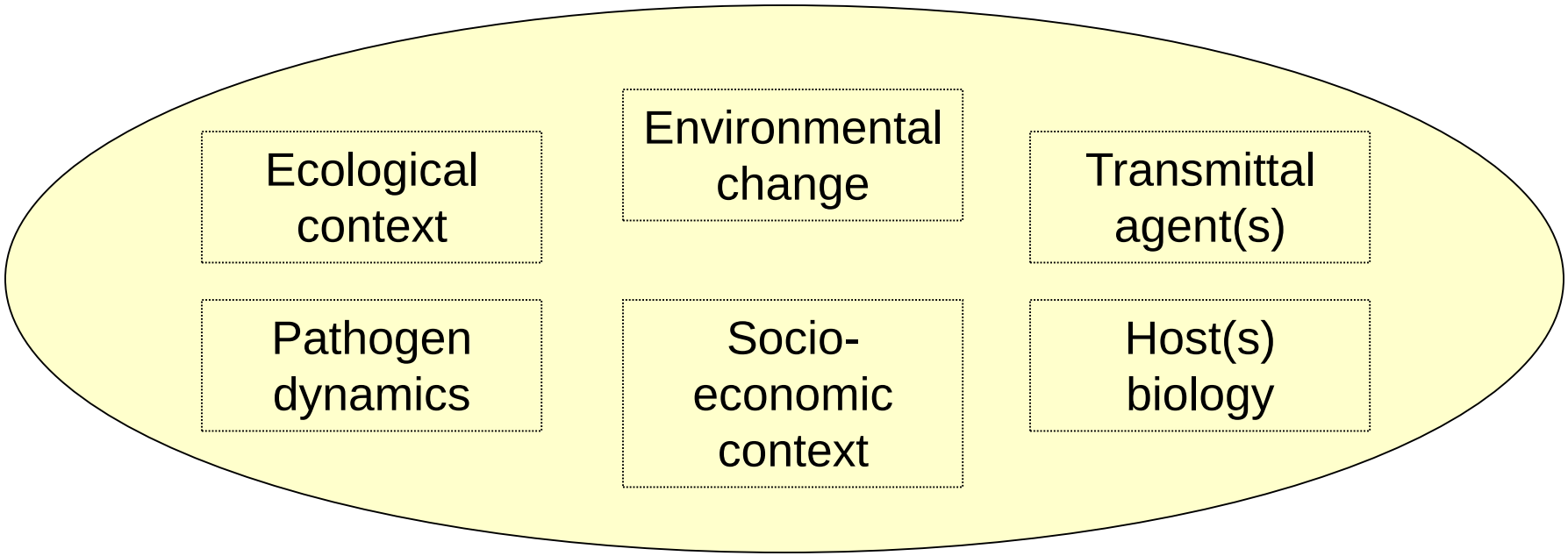
Traditional vector biology and epidemiology studies



Ecology of infectious disease study

Adapted from
S. Collinge and M. Kosoy

Ecology and Evolution of Infectious Diseases



Ecology and Evolution of Infectious Diseases

Mission: To develop predictive principles to enable the prevention of infectious disease transmission

Program: Funding 156 interdisciplinary research projects beginning in 2000

Funded and administered by:

- NSF - Biological Sciences; Social, Behavioral & Economic Sciences; Geosciences
- NIH - Fogarty International Center; General Med. Sci.; Allergy & Infectious Disease; Envir. Health Sci.
- USDA – National Institute of Food & Agriculture

Including collaborations with the **UK Research Innovation**, the United States-Israel Binational Science Foundation, and the National Natural Science Foundation of China

A transdisciplinary approach…

Ecology

➔ interactions between landscape and host population dynamics

Socio-economy

➔ land management, human behaviours, etc…

Medical Sciences

➔ mass-screening of human populations, patient follow-up, epidemiology

Geography

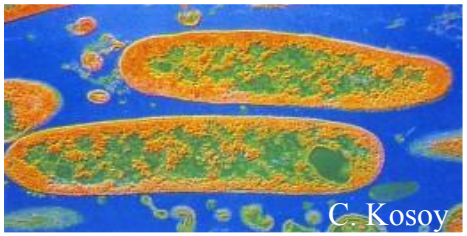
➔ remote sensing, spatial analysis

… towards risk assessment and modeling

EEID - diversity in diseases

- Echinococcus
- Schistosomiasis
- Malaria
- Chagas
- Trematodes
- Hanta virus
- Rabies
- Encephalitis
- Dengue
- West Nile

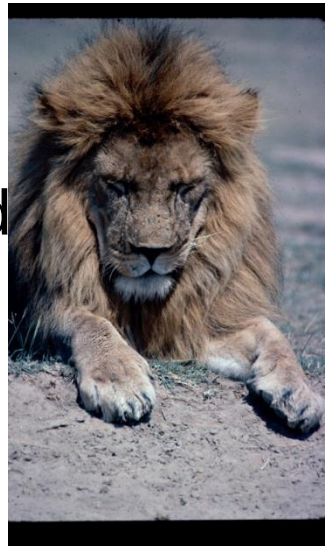
- Herpesvirus
- Canine Distemper
- Prion disease
- Tuberculosis
- Mycoplasma
- Leptospirosis
- E. coli
- Plague
- Cholera
- Chitrid fungi



EEID - Diverse hosts

Humans
Primates
Amphibians
Potatoes
Sea lions
Buffalo
Deer
Bats
Pigs
Wild dogs

Rodents
Racoons
Canaries
Rainforest bird
Prairie dogs
Lions
Tortoises
Corals
Honey bees



EEID – Global Reach

Continent	2000-05	2006-10	2011-15	2016-18	Total	Percent
North America	25	35	20	18	98	57%
Europe	1	1	3	1	6	3%
Australia	0	0	1	1	2	1%
South America	4	4	2	1	11	6%
Africa	7	14	8	12	41	24%
Asia	3	5	0	2	10	6%
Oceania	1	1	0	2	4	2%
Total	41	60	34	37	172	

EEID: UK-US Partnerships

2010 - 2015

Total number of Research Projects funded: 12
Total number of Research Collaboration Network: 1

Investment from
- UK: $9.7M
- US: $75M

Success rates of UK-US Collaborative Projects: 26% than the overall average for the programme (8-15%).

Quality: The output of US-UK projects is benchmarked highly on publications (average 9.8 PA) and training/capacity building, demonstrating the strength of the international collaborations fostered by UK participation

After a gap of few years UK has again partnered in EEID 2018 call

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Funded Research

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Mycobacterial Transmission Dynamics in Agricultural Systems: Integrating Phylogenetics, Epidemiology, Ecology and Economics

Focus is on developing multi-scale methodology for determining transmission dynamics using whole genome sequencing data and phylodynamics using Mycobacterial as a model systems

Cornell University (Yrjo T Grohn, Ynte H Schukken, Michael J Stanhope, Loren W Tauer) ; University of Minnesota (Scott Wells); University of Glasgow (Rowland Kao); Agri-Food and Biosciences Institute, Ireland

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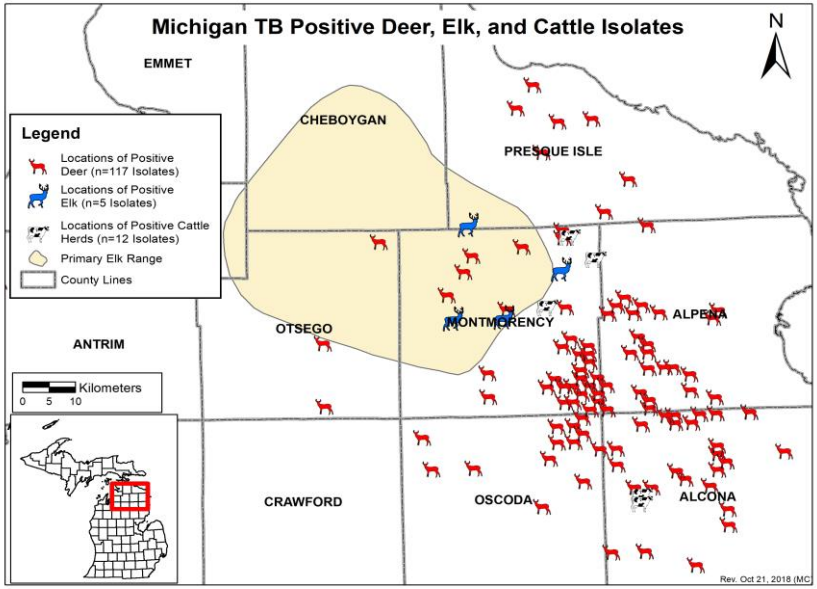
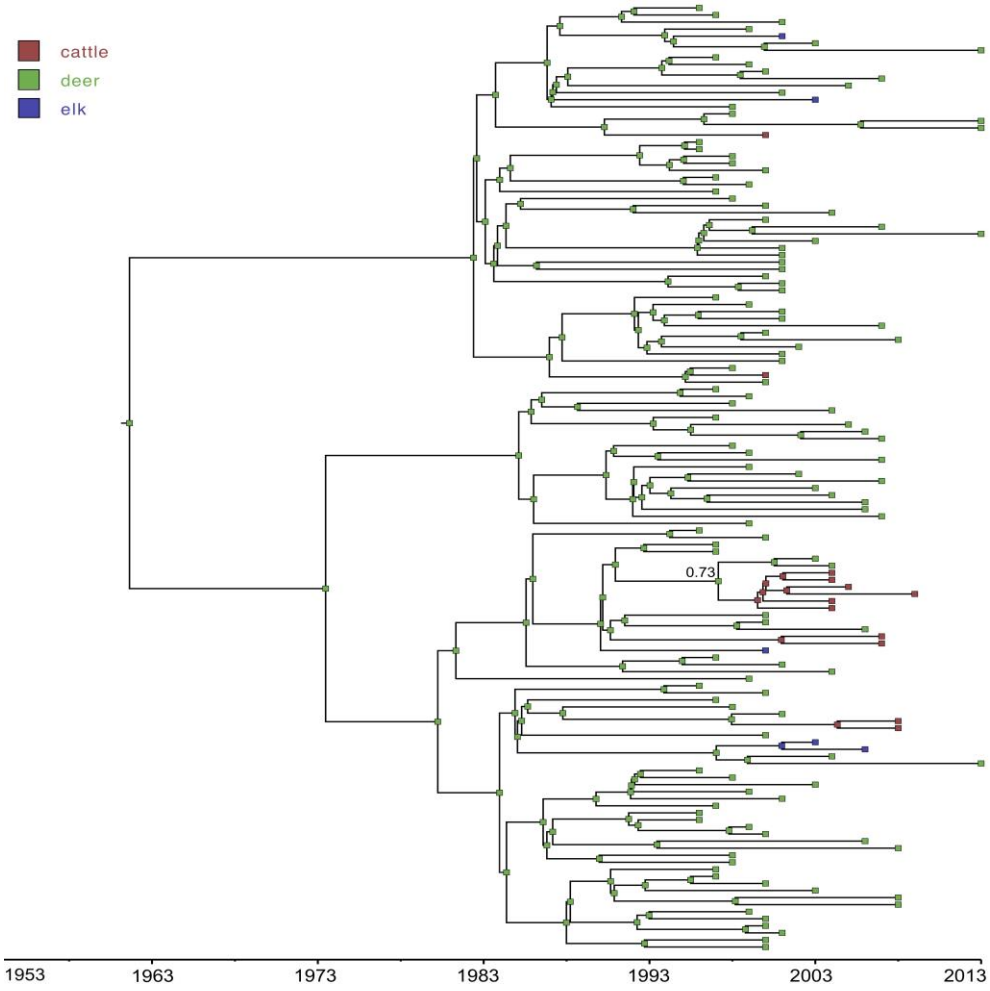
What is driving bTB in Michigan cattle?

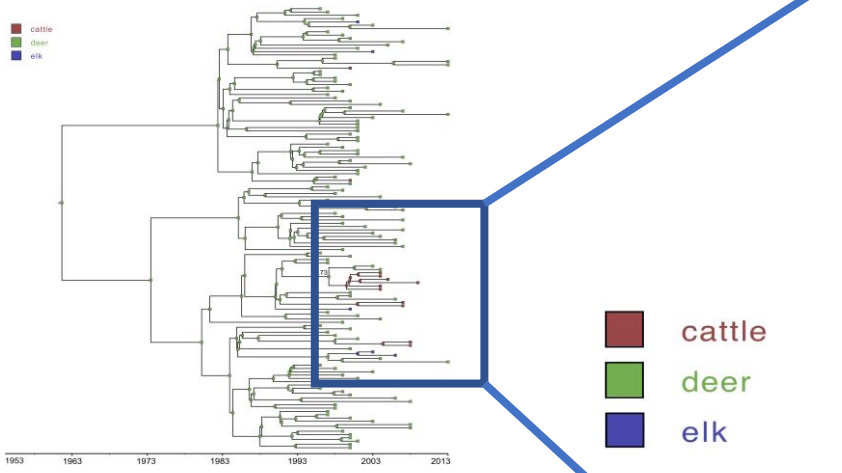




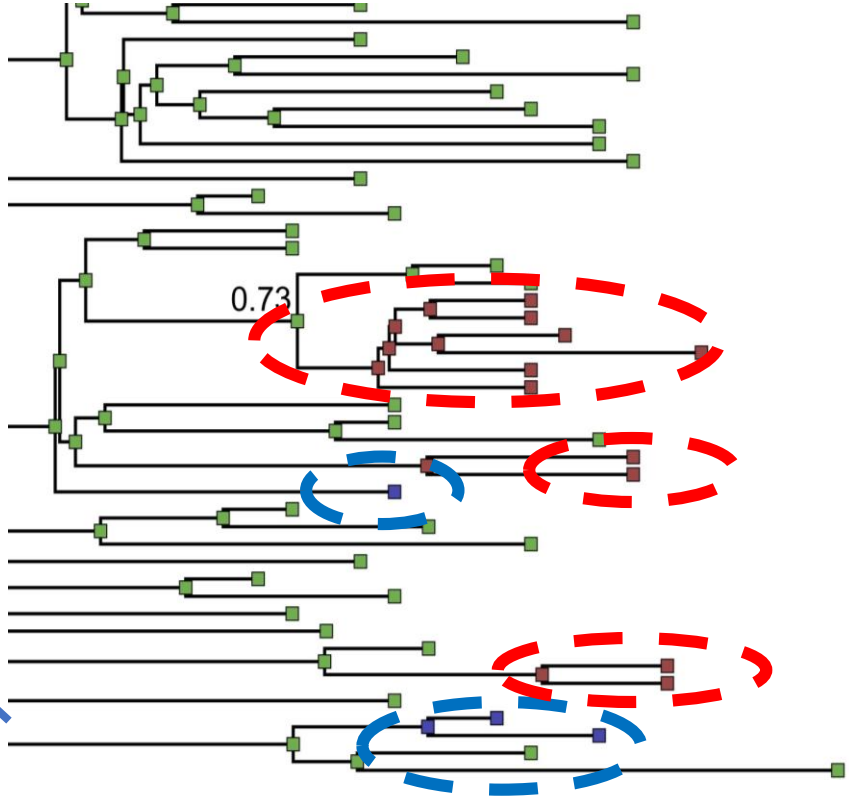
Few elk – but Elk are maintenance hosts in other systems - could elk play a role?

- Greater home ranges than deer
- Larger (more likely to bypass biosecurity on farms?)

Elk Samples Phylogenetically Separate from Cattle



Bayesian Evolutionary Analysis



Host species interaction	Estimated posterior probability of transition between host species (symmetric)	Estimated absolute transition between host species (event/genome/year)	Strength of support by Bayes' factor (BF > 3: well supported BF > 10: very strong support)
Cattle-Deer	**0.996**	**0.012**	**28.37**
Cattle-Elk	0.391	0.011	0.073
Deer-Elk	**0.989**	**0.011**	**10.24**

Discrete ancestral trait mapping in BEAST 2.0 shows weak support for Elk having a direct role in transmission to cattle

Key Messages

- For the system, it confirms the **central role that deer have in maintenance of TB,** with some evidence of cattle-to-cattle transmission having a role, but not likely a central one.

- Our analysis shows that we can **detect statistically robust signatures of inter-species transmission** and quantify how likely they are with bacterial deep sequence data

Mutual Benefits from UK Perspective

- The US link was important because there are very few systems for which we have the kind of **comprehensive data on both wildlife and livestock**, for a pathogen that affects multiple hosts (even for TB in Britain, we mostly know about cows, not badgers).

- The prominence of bovine TB in Britain is known, **this system in the US provides a test bed for asking questions** that are equally relevant for GB

Ecological and socio-economic factors impacting maintenance and dissemination of antibiotic resistance in the Greater Serengeti Ecosystem

Washington State University (Douglas Call, Margaret Davis, Robert J Quinlan); University of Glasgow (Louise Matthews); Jonathan Rushton (Royal Veterinary College)

Lancet Planet Health 2018; 2: e489–97

The Importance of

Tackling Bacterial Transmission as well as Improving Antimicrobial Stewardship

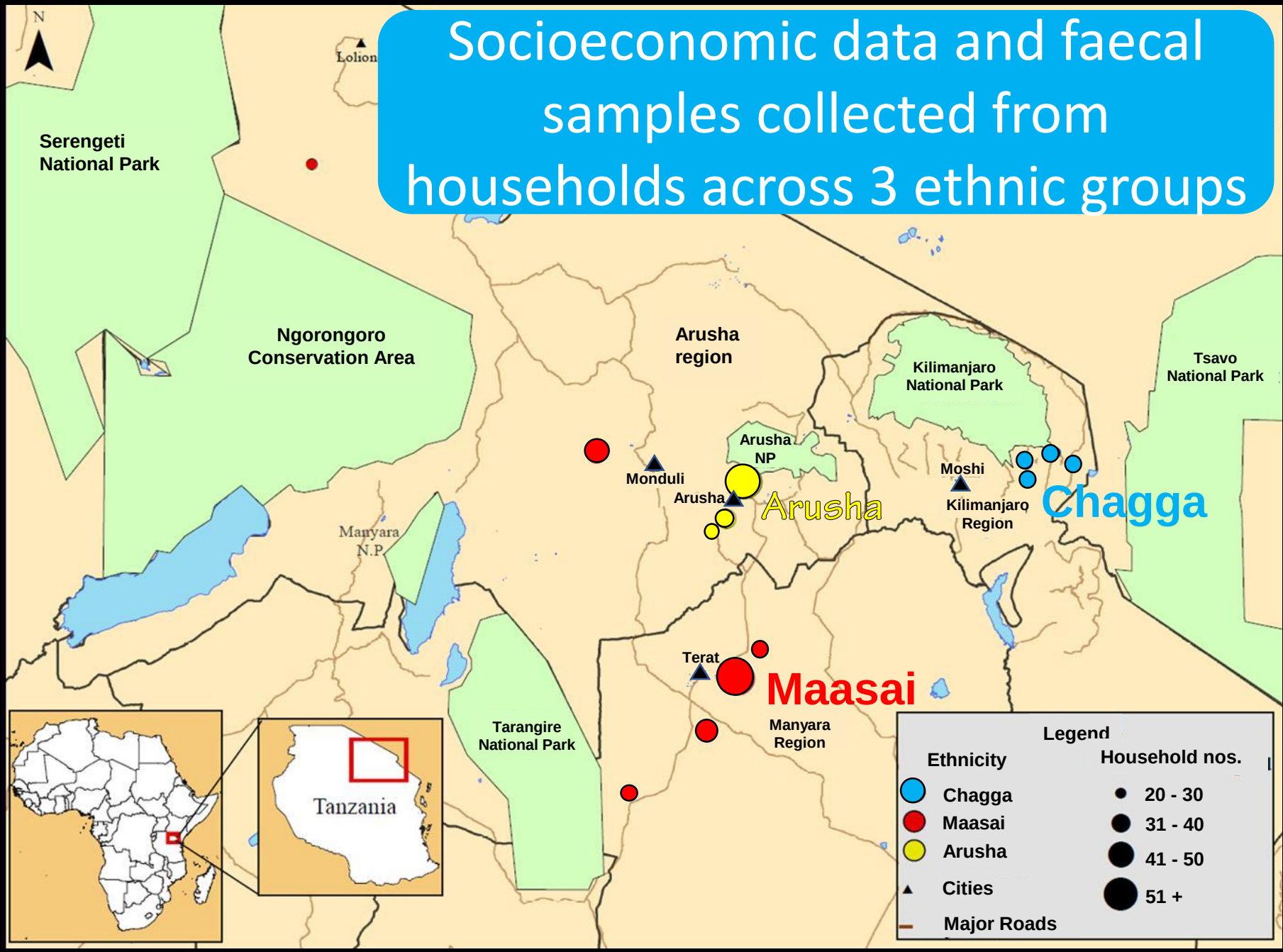
www.thelancet.com/planetary-hea

Identification of risk factors associated with carriage of resistant *Escherichia coli* in three culturally diverse ethnic groups in Tanzania: a biological and socioeconomic analysis

Mark A Caudell, Colette Mair*, Murugan Subbiah*, Louise Matthews, Robert J Quinlan, Marsha B Quinlan, Ruth Zadoks, Julius Keyyu, Douglas R Call*

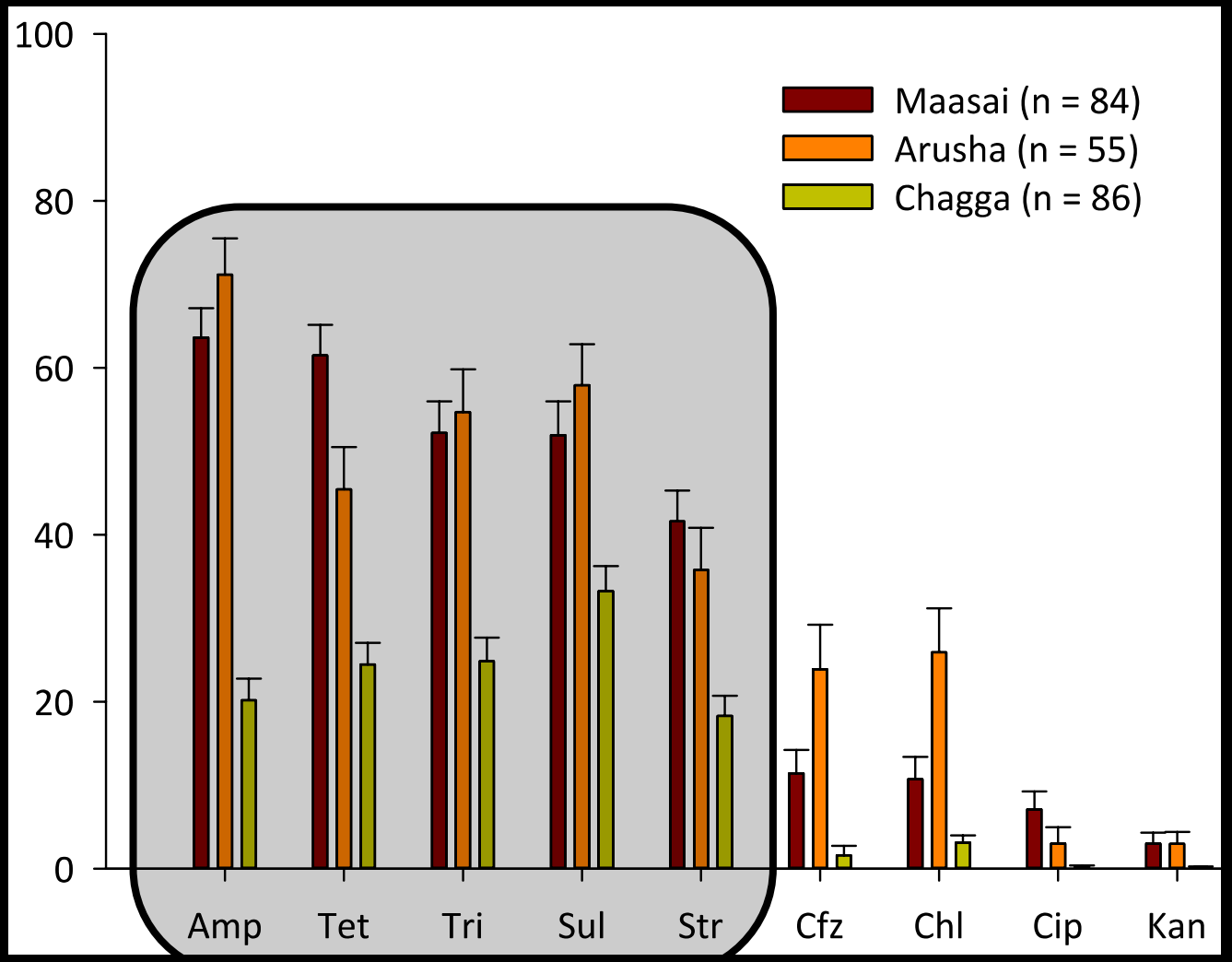
Summary

Backgound Improved antimicrobial stewardship, sanitation, and hygiene are WHO-inspired priorities for restriction of the spread of antimicrobial resistance. Prioritisation among these objectives is essential, particularly in low-income and middle-income countries, but the factors contributing most to antimicrobial resistance are typically unknown and could vary substantially between and within countries. We aimed to identify the biological and socioeconomic risk factors associated with carriage of resistant *Escherichia coli* in three culturally diverse ethnic groups in northern Tanzania. **Joint first author*


Socioeconomic data and faecal samples collected from households across 3 ethnic groups
N
Lolion
Serengeti National Park
Ngorongoro Conservation Area
Arusha region
Kilimanjaro National Park
Tsavo National Park
Arusha NP
Monduli
Arusha
Arusha
Moshi
Kilimanjaro Region
Chagga
Manyara N.P
Terat
Maasai
Manyara Region
Tarangire National Park
Tanzania
Legend
Ethnicity
Chagga
Maasai
Arusha
Cities
Major Roads
Household nos.
20 - 30
31 - 40
41 - 50
51 +

Resistance at household level differs across ethnic groups

Household prevalence of resistance (%)



Lancet Planet Health 2018; 2: e489–97

Key Findings

Antimicrobial use in people and livestock was not associated with prevalence of resistance at the household level. Instead, the factors with the greatest predictive value involved exposure to bacteria, and were intimately connected with fundamental cultural differences across study groups

Key Messages

Informing Policy

Public health interventions to limit antimicrobial resistance need to be tailored to local practices that affect bacterial transmission

Further Funding

£3M funded MRC project on AMR that will exploit findings and isolate collections from the EEID gran

Mutual Benefits

- Complimentary Expertise:
  - UK: brought expertise in molecular ecology, epidemiology and statistics of large data sets.
  - US: brought a unique combination of wet lab expertise in analysis of large scale AMR collections coupled with quantitative approach to anthropology that is not common in the UK.

Vector Behavior in Transmission Ecology

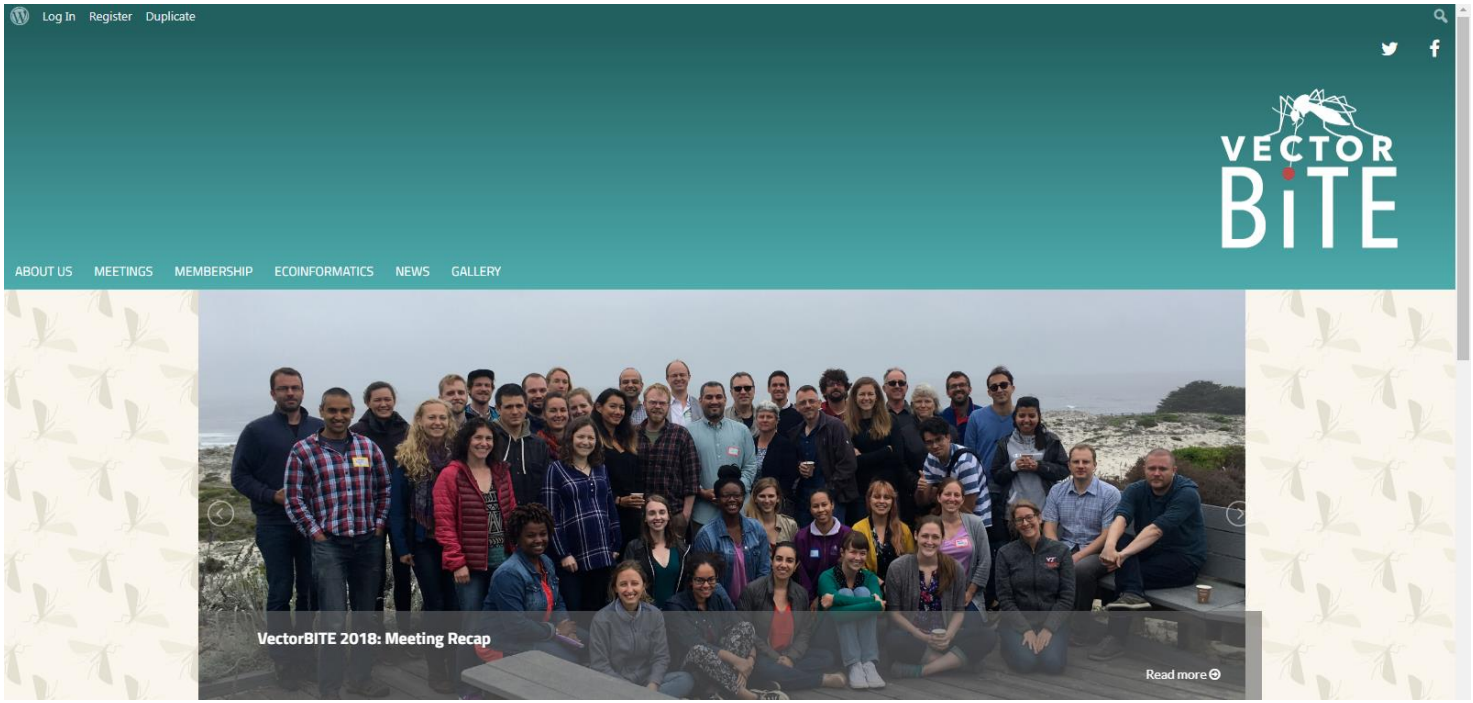
Example of Research Collaboration Network

Aim

Increase **interaction between researchers** in the diverse fields studying VBDs, to encourage **collection and consolidation of key data**, and to encourage **development of analytical tools** to better understand the role of vector behavior in transmission ecology.

Increase Interaction between Researchers

Members: **Over 300 researchers** focusing on either empirical or theoretical aspects of VBD transmission registered to www.vectorbite.org with online profiles, public facing blogs, and meeting information



Asilomar meeting 2018

Annual Meetings

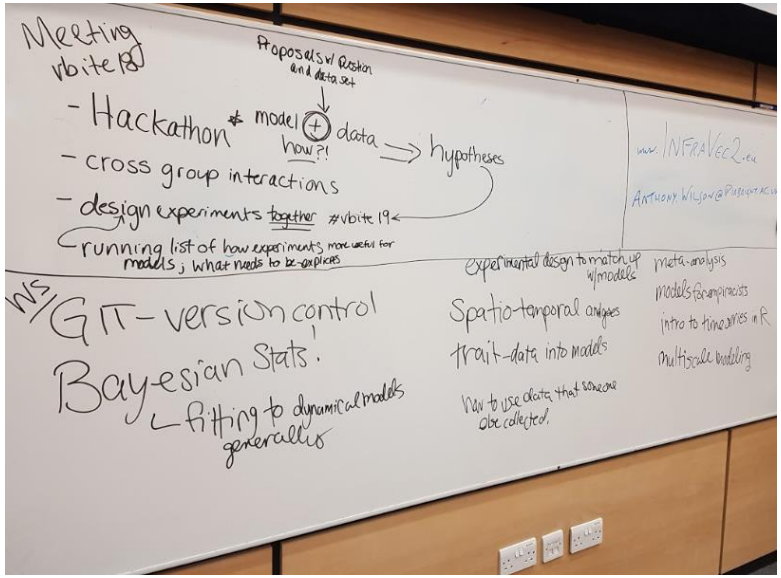
2016 (USA), 2017 (UK @ Imperial College London), 2018 (USA)

Funded ~90 UK researchers to meet with USA and international collaborators in working groups designed by themselves and populated with a mix of proposed and chosen network members

Silwood Park Meeting 2017

Training

Community identified training priorities at 2017 meeting and first training workshop delivered @ VBiTE 2018- All training materials are open source and available online



The VectorBiTE Training Workshop materials

VECTOR BiTE

- The VectorBiTE Training Workshop materials
  - Schedule
  - The Teaching Tools
  - How to prepare for the Workshop
- For Instructors
  - General instructions
  - Planned Topics

Schedule

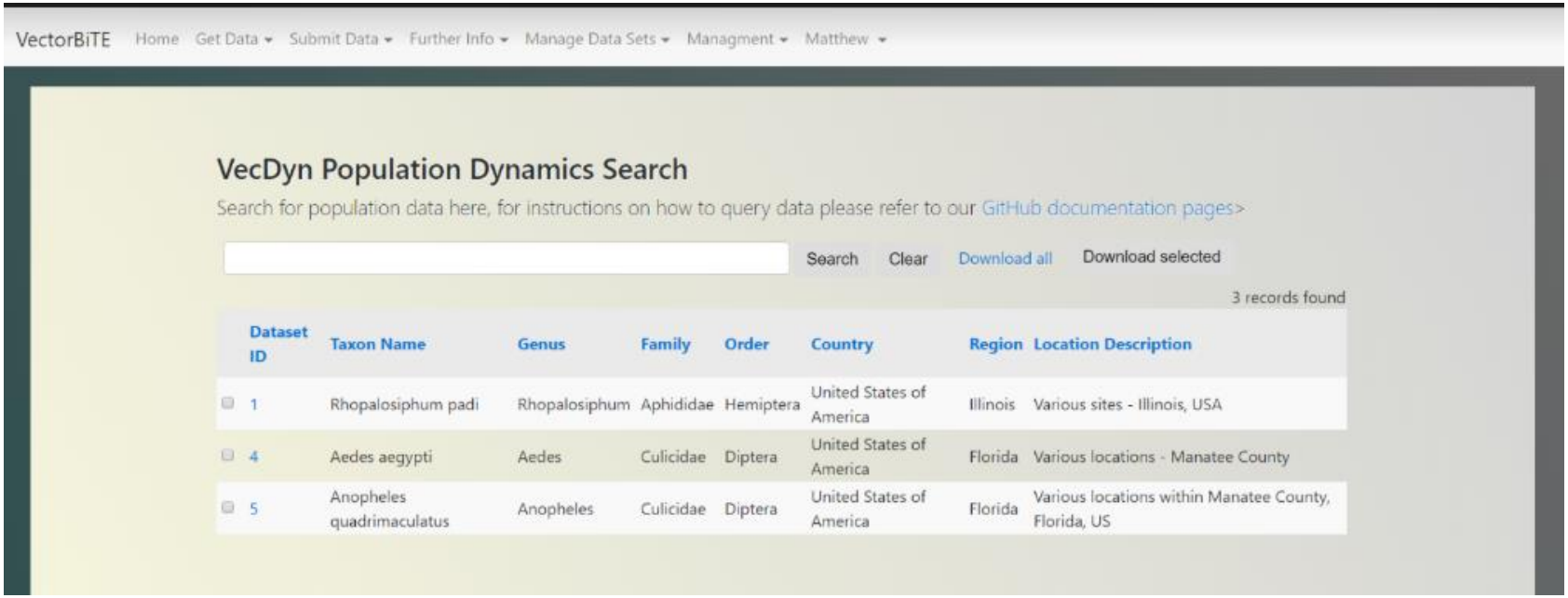
(Training Team: Leah Johnson (LJ); Samraat Pawar (SP): Marta Shocket (MS); Fadoua El Moustaid (FE); Matthew Watts (MW))

Date	Time	Topic	Lead Instructor
Monday, 11th June	08:30 - 09:00	General Intro and Setting up	SP
	09:00 - 10:30	Data principles/wrangling	SP
	10:30 - 11:00	*Break*	--
	11:00 - 12:00	Intro to Model Fitting Lecture	SP
	12:00 - 13:00	*Lunch*	--

Collection and Consolidation of Key Data

2 Large Databases are being launched:

1. VecDyn- Time series of vector population abundances. Currently working with network members to upload existing data. Will eventually be open source of such datasets.
2. VecTraits- In development stage and will house trait data (physical traits, life history, behaviour) of vectors



Added Value of US-UK Partnership

- Maximized number of researchers we are able to fund to attend meeting
- Improved diversity and mixing of researchers from different fields, institutions, study systems, and demographics
- Has allowed RCN to work with both USA and UK partners (Vectorbase, CDC, VectorHub) to increase data sharing across different efforts

Future

- **EEID 2018**
  - Call closed: 21 November
  - Proposals received and undergoing peer review
  - Panel Meeting: February 2019

- **International Transdisciplinary Partnership Building Workshop: 18-19 March 2019, London**
  - To bring together the UK and US EEID researchers and funders to share their experiences of transatlantic collaboration and discuss ways to strengthen the partnership

- **EEID 2019**
  - Making a case for continued participation

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Thank you
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