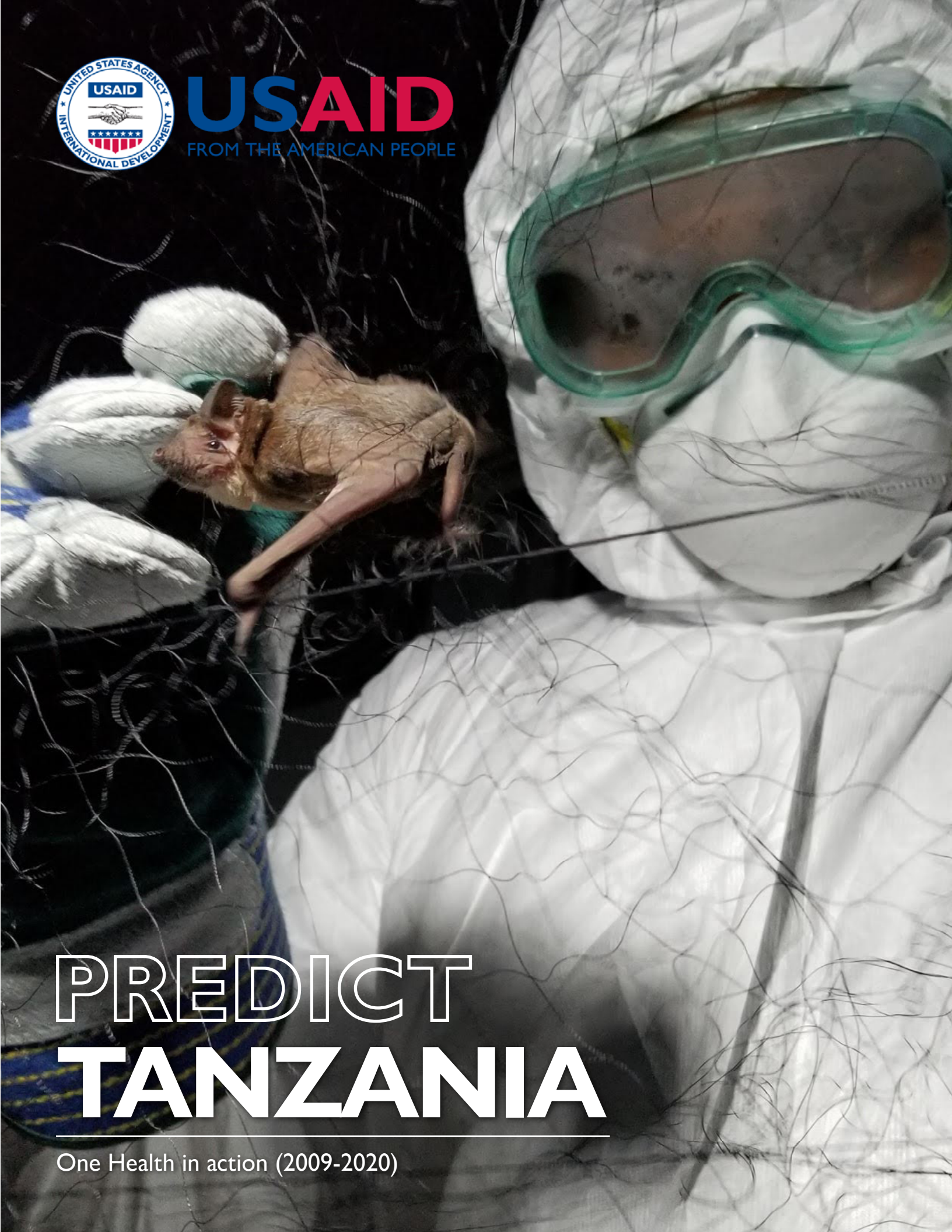

USAID
FROM THE AMERICAN PEOPLE
PREDICT
TANZANIA
One Health in action (2009-2020)

A One Health approach to strengthening national health security

TANZANIA

Since 2009, UC Davis, the Sokoine University of Agriculture (SUA), and government partners, have worked to advance One Health capacity and wildlife laboratory infrastructure in Tanzania. During PREDICT-1, our One Health team targeted high-risk human-wildlife interfaces, collected samples from wildlife, and tested them for viral threats. IIn the first five years, 63 viruses were detected (12 known viruses and 51 new viruses).

Building on these successes, our team partnered with the Ifakara Health Institute (IHI) to launch intensive One Health surveillance of both animal and human populations in Tanzania's Lake Zone; this area is considered a hotspot for viral spillover and spread due to land conversion, human population movement from neighboring Uganda, Rwanda, and Burundi, and intensive livestock development. Our team's work has provided proof of concept for applying the One Health approach in Tanzania, strengthened subnational and district-level One Health platforms by training animal and human health professionals on the frontlines of zoonotic disease transmission, shed light on the viruses and pathogens circulating in animal and human populations in at-risk communities, identified human behaviors and practices that increase risk for zoonotic disease transmission, and delivered critical data and insights for strengthening health security and refining national surveillance plans.

In addition, by putting stakeholder engagement and community outreach at the forefront of our approach, we worked directly with communities at all levels to identify practical and actionable disease prevention and control strategies.

LOCAL PARTNERS

- Ifakara Health Institute
- Sokoine University of Agriculture
- University of California, Davis
- Clinic (Kigoma Rural District)
- Clinic (Kyerwa District)
- Food and Agriculture Organization
- Ministry of Health, Community Development, Gender, Elderly & Children
- Ministry of Livestock, Agriculture & Fisheries
- National Institute of Medical Research
- Tanzania National Parks Authority
- Tanzania Veterinary Laboratory Agency
- Tanzania Wildlife Research Institute

>260

DEVELOPED the One Health Workforce by training more than 260 people in Tanzania.

>5.7K

OPERATIONALIZED One Health surveillance and sampled over 5.7K animals and people, to identify ways to help minimize the spillover of zoonotic disease threats from animals into human populations.

LABORATORY STRENGTHENING

- Ifakara Health Institute
- Sokoine University of Agriculture

34,369
TESTS

60
PREDICT

17
KNOWN

DETECTED 77 unique viruses in both animal and human populations.

HAPPY RAPHAEL MKALI

Laboratory Lead

Ifakara Health Institute

"What I really enjoy about working with PREDICT is the beauty of interacting with teams of different disciplines - from veterinarians to social scientists to public health professionals, who all together have brought different experiences on how to approach zoonoses and other One Health issues around our communities."

MWOKOZI MWANZALILA

Behavior Scientist & Community Engagement Liaison

Sokoine University of Agriculture

"PREDICT project has helped me to create more confidence when talking in front of people. In addition, I have gained new knowledge on zoonotic diseases."

MAJOR ACHIEVEMENTS

- Trained over 260 individuals in One Health skills
- Safely sampled >5,700 individuals (animals and people)
- Interviewed >1,600 people on behaviors and practices associated with viral transmission and spread
- Strengthened 2 research labs essential for supporting the national laboratory system
- Detected 77 viruses (60 new and 17 known) and enhanced national understanding of exposure to priority zoonotic diseases (Rift Valley fever and other viral hemorrhagic fevers)
- In partnership with the One Health Coordination Desk, empowered district-level One Health teams with the skills and knowledge to sustain zoonotic disease surveillance and strengthen multi-sectoral communications
- Contributed to COVID-19 response and SARS-CoV-2 testing capacity in Tanzania

ONE HEALTH SURVEILLANCE

PREDICT's One Health surveillance was designed to train, equip, and enable the workforce to collect data and build the evidence base for priority zoonoses and emerging diseases in vulnerable and high-risk areas. PREDICT engaged local communities in high-risk locations and fostered improved recognition of zoonotic diseases and awareness of transmission pathways including prevention and control options. In addition, by sharing animal and human surveillance findings, PREDICT helped catalyze information and knowledge exchange between animal and human surveillance sectors.

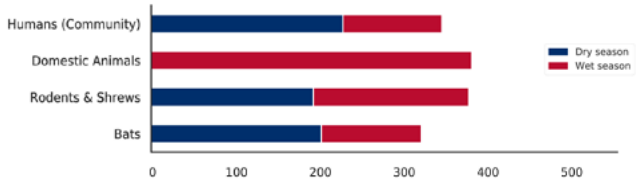
In Tanzania, One Health surveillance sites were located in three distinct areas across the Lake Zone, an area considered a hotspot for viral spillover and spread due to land conversion, intensive livestock development and human migration from neighboring Uganda, Rwanda, Democratic Republic of Congo and Burundi. To enable assessment of potential trends in virus spillover and spread across space and time, we collected samples from animals and people concurrently over a five-year period during both rainy and dry seasons.

HUMAN SURVEILLANCE

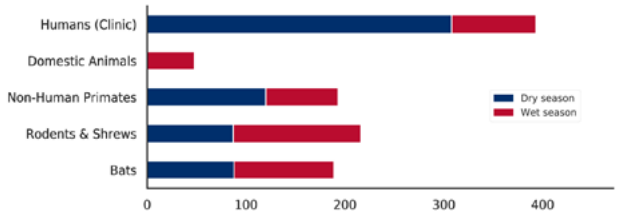
Individuals were enrolled and tested at two local health centers (n = 587, continuous enrollment) and from communities (n = 294, episodic enrollment) where livestock and wildlife were sampled. At the health centers, we targeted patients presenting with fevers, while in community sites, we randomly selected individuals for participation. Children were only enrolled with parent or guardian consent at the health centers. Samples were collected from community members in Kibondo District, a rural area with game reserves and protected forests, where residents farm and raise animals, and where there are large settlements and established camps for refugees from neighboring countries. Sampling was also conducted within the Kigoma Rural District, which is home to both urban and rural communities. In the rural areas, residents largely farm and raise livestock. Febrile patients from both the urban and rural communities that enrolled at a clinic in the urban area were included in the syndromic surveillance.

Syndromic surveillance was also conducted at a clinic that serves rural communities within the Kyerwa District. These communities near the northwestern border of Tanzania engage in farming, the raising of animals, tin mining, logging, and charcoal production.

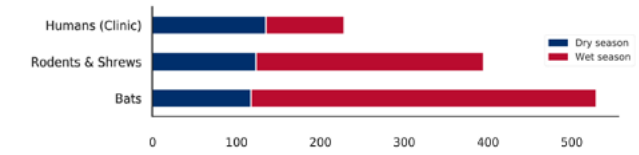
KIBONDO DISTRICT



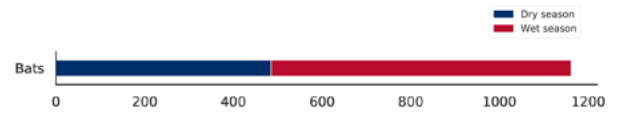
KIGOMA RURAL DISTRICT



KYERWA DISTRICT



MOROGORO



Numbers of individuals sampled by taxa group

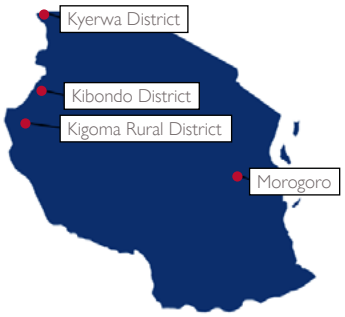
SURVEILLANCE SITES

KIBONDO DISTRICT = bats; cattle/buffalo; dogs; goats/sheep; humans; rodents/shrews; swine

KYERWA DISTRICT = bats; humans; rodents/shrews

KIGOMA RURAL DISTRICT = bats; cattle/buffalo; dogs; goats/sheep; humans; non-human primates; rodents/shrews

MOROGORO = bats



WILDLIFE & DOMESTIC ANIMAL SURVEILLANCE

Wildlife sampling locations were chosen near and adjacent to human surveillance sites. Rodents and bats were sampled at all three sites. In Kibondo, insectivorous bats were sampled from the roofs of domestic dwellings, government office buildings, and health care facilities; rodents were sampled at farms and near human dwellings. In the Kigoma Rural District, insectivorous bats were sampled from the roofs of dwellings, commercial offices, and a primary school. In addition, our team collected samples from baboons and other non-human primates in and around Gombe National Park, which is in the Kigoma Rural District where people were sampled. Livestock and canine samples were collected by the FAO and Government of Tanzania partners at sites within the Kibondo and Kigoma Rural Districts. In the Kyerwa District, frugivorous bats were sampled from an abandoned tin mine extraction cave that is adjacent to farms and orchards; rodents were sampled near dwelling and fields used for banana and maize cultivation. Finally, in Morogoro town, the home of Sokoine University of Agriculture, we conducted a targeted investigation into the seasonality of coronavirus shedding at an urban resident Straw-colored fruit bat (*Eidolon helvum*) colony. At this site, our team collected bat feces from a tarp under the roosting colony each month over a 12-month period.

From 2014-2019, the PREDICT/ Tanzania team safely collected and tested biological samples from a total of 881 people, 120 dogs, 52 cattle, 105 goats/ sheep, 95 pigs, 911 bats, 193 non-human primates and 872 rodents, at the three concurrent surveillance sites in the Lake Zone. In Morogoro, 1,162 samples were non-invasively collected from frugivorous Straw-colored fruit bats. An additional 271 people completed structured behavioral risk questionnaires and 287 individuals were enrolled in focus group discussions and unstructured interviews using ethnographic techniques in Lake Zone communities within the Kibondo, Kyerwa, and Kigoma Rural Districts, where animals were sampled.

VIRUS DETECTION

Samples from wildlife, humans, and domestic animals were safely tested using consensus PCR (cPCR) to screen for priority zoonotic viral diseases and emerging threats such as filoviruses (Ebola and Marbug), Influenzas, coronaviruses, paramyxoviruses and flaviviruses. Virus findings were confirmed through genome sequencing and interpreted to better understand the relationship of the detected sequence to those from known animal and human pathogens.

Between 2014-2019, PREDICT/Tanzania's One Health team established a safe and secure biobank of >23,000 samples from wildlife, domestic animals and people, including whole blood, oral and nasal swabs, urine, feces and serum. Virus testing at PREDICT partner laboratories (SUA and IHI) focused on feces, nasal and oral swabs. Specimens from animals and people were analyzed through >41,800 cPCR tests across the five viral families.

VIRUS TABLE

VIRAL FAMILY	VIRUS	SPECIES	SAMPLING LOCATION	# OF POSITIVE INDIVIDUALS		
				TOTAL	WET SEASON	DRY SEASON
Coronavirus	Betacoronavirus 1 (OC43)	Human	Kibondo District, Clinic (Kigoma Rural District)	3	0	3
	PREDICT_CoV-97	Egyptian Fruit Bat	Kyerwa District	2	0	2
	PREDICT_CoV-106	Angolan Free-Tailed Bat	Kibondo District	4	0	4
	PREDICT_CoV-117	Egyptian Fruit Bat	Kyerwa District	3	3	0
	Bat coronavirus HKU9	Angolan Free-Tailed Bat, Egyptian Fruit Bat	Kibondo District, Kyerwa District	16	12	4
	Chaerephon bat coronavirus/ Kenya/KY22/2006	Angolan Free-Tailed Bat, Egyptian Fruit Bat, Little Free-Tailed Bat	Kibondo District, Kyerwa District, Kigoma Rural District	112	39	73
	Chaerephon bat coronavirus/ Kenya/KY41/2006	Angolan Free-Tailed Bat	Kibondo District	1	0	1
	Eidolon bat coronavirus	Egyptian Fruit Bat, Straw-Coloured Fruit Bat	Kyerwa District, Morogoro	130	73	57
	PREDICT_CoV-64	Pygmy Mouse	Kibondo District	1	1	0
Paramyxovirus	PREDICT_PMV-15	Angolan Free-Tailed Bat	Kibondo District, Kigoma Rural District	21	10	11
	PREDICT_PMV-141	Egyptian Fruit Bat	Kyerwa District	1	0	1
	PREDICT_PMV-178	Egyptian Fruit Bat	Kyerwa District	2	2	0
	PREDICT_PMV-143	African Grass Rat	Kyerwa District	1	1	0
	PREDICT_PMV-144	African Giant Shrew	Kyerwa District	5	4	0
	PREDICT_PMV-146	Montane White-Toothed Shrew	Kyerwa District	1	0	1
	PREDICT_PMV-150	Natal Multimammate Mouse	Kibondo District, Kigoma Rural District	2	1	1
	Rodent paramyxovirus MpR12	Natal Multimammate Mouse	Kyerwa District	1	1	0
	Canine distemper virus	Domestic Dog	Kibondo District	6	6	0
Influenza virus	Influenza A	Human	Kibondo District, Clinic (Kyerwa District), Clinic (Kigoma Rural District)	6	5	1
	Influenza B	Human	Clinic (Kyerwa District)	1	1	0
Total				**319**	**159**	**160**

FINDINGS IN PEOPLE

Several known viruses that cause respiratory illnesses were detected in people in both health centers and the community: Influenza A virus (n = 6), Influenza B virus (n = 1) and Betacoronavirus 1 (OC43) (n = 3). Influenza was more commonly detected in adult women in the rainy season. No viral infections were identified in children. In the Kibondo community, all Influenza A infections detected were identified on two consecutive days in April 2018, consistent with an active respiratory infection moving through the community during the rainy season. One adult woman enrolled at the Kigoma District clinic who tested positive for malaria also tested positive for Influenza A. Influenza A was detected in oral swabs in three individuals and feces of four individuals, with one person having both specimens positive; Influenza B was detected in an oral swab, and Betacoronavirus 1 (OC43) was detected in oral and nasal swabs.

DETAILED VIRAL FINDINGS IN PEOPLE

	Influenza A (n=6)	Influenza B (n=1)	Betacoronavirus 1 (OC43) (n=3)	Negative (n=871)	Overall (n=881)
Season					
Dry	1 (16.7%)	0 (0%)	3 (100%)	613 (70.4%)	617 (70.0%)
Rainy	5 (83.3%)	1 (100%)	0 (0%)	258 (29.6%)	264 (30.0%)
Gender					
Female	4 (66.7%)	1 (100%)	1 (33.3%)	463 (53.2%)	469 (53.2%)
Male	2 (33.3%)	0 (0%)	2 (66.7%)	408 (46.8%)	412 (46.8%)
Age					
Adult (≥18)	6 (100%)	1 (100%)	3 (100%)	743 (85.3%)	753 (85.5%)
Child (<18)	0 (0%)	0 (0%)	0 (0%)	128 (14.7%)	128 (14.5%)
Site					
Kibondo	4 (66.7%)	0 (0%)	1 (33.3%)	289 (33.2%)	294 (33.4%)
Kyerwa	1 (16.7%)	1 (100%)	0 (0%)	192 (22.0%)	194 (22.0%)
Kigoma Rural	1 (16.7%)	0 (0%)	2 (66.7%)	390 (44.8%)	393 (44.6%)

FINDINGS IN LIVESTOCK & DOMESTIC ANIMALS

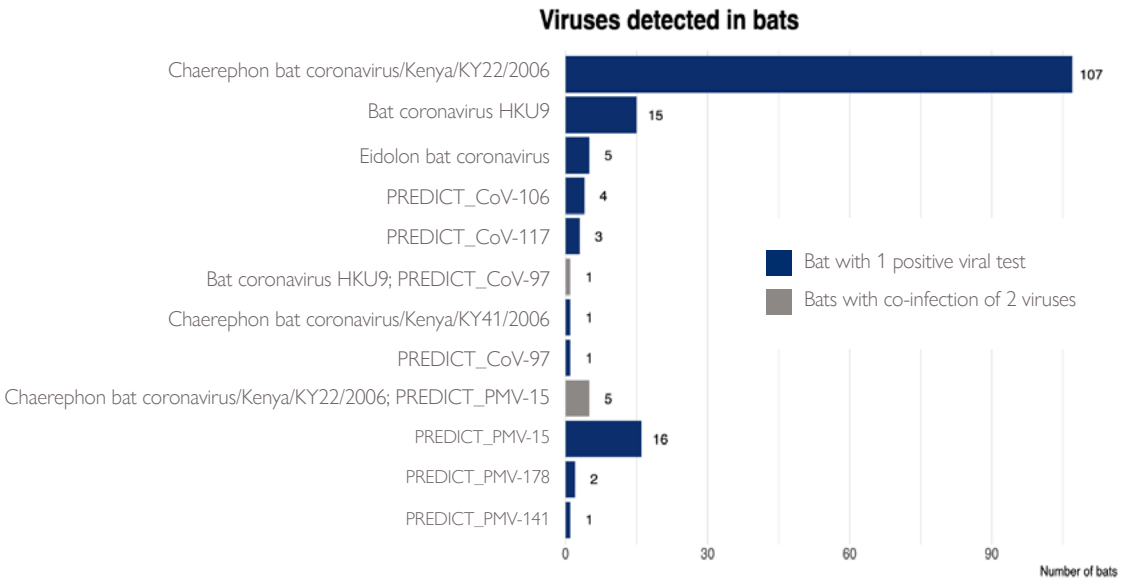
Out of the 372 livestock and domestic animals tested, we detected six virus sequences for Canine morbillivirus in domestic dogs (*Canis lupus familiaris*) at sampling sites in Kibondo. Canine distemper is a viral disease that affects many species of wild and domestic animals, and in dogs can cause symptoms ranging from mild to severe respiratory, gastrointestinal and neurological disease and death. This virus does not pose a threat to people but is relevant to wildlife conservation.

FINDINGS IN WILDLIFE

The PREDICT-Tanzania team sampled and tested 911 bats, 872 rodents and 193 non-human primates at concurrent surveillance sites. In rodents, we detected the coronavirus, PREDICT_CoV-64 in one Pygmy mouse (*Mus minotoides*) and five unique paramyxoviruses in 10 rodents including multiple shrews (*Crocidura* sp., n = 6), African grass rats (*Arvicanthis niloticus*, n = 1), and the Natal multimammate mouse (*Mastomys natalensis*, n = 3). Shrews were more likely to be positive for any virus among the rodents tested.

PREDICT_CoV-64 is a coronavirus belonging to the betacoronavirus genus, found previously in rodents in Tanzania as part of the PREDICT project. The genus Betacoronavirus includes viruses that are of significance to public health such as SARS and MERS, however this virus is not considered to be closely related to either of these viruses. At this time there is no evidence to suggest this virus poses a threat to human health. There is no evidence at this time to suggest that any of the paramyxoviruses identified in rodents and shrews as part of the PREDICT project in Tanzania pose a threat to human health. No viruses were detected in any of the non-human primate samples tested.

By far, the highest diversity of viruses identified and proportion of positive animals occurred in bats. Of 911 bats sampled and tested in the Lake Zone area, 161 bats were found to have positive viral findings. We detected seven different coronaviruses in 136 bats and three paramyxoviruses in 19 bats. One bat exhibited co-infection with two coronaviruses and five bats exhibited co-infection with both a coronavirus and paramyxovirus.



Chaerephon bat coronavirus/Kenya/KY22/2006 was the most common virus detected in bats sampled in the Lake Zone and we confirmed sequences of this virus in samples from 112 bats. This is a strain of the known alphacoronavirus Chaerephon bat coronavirus/Kenya/KY22/2006 (Genbank Accession no. HQ728486) that has previously been found in bats. There is no evidence at this time to suggest this virus poses a threat to human health. This virus was found in a several bat species including insectivorous Angolan free-tailed bats (*Mops condylurus*, n = 94) and Little free-tailed bats (*Chaerephon pumilus*, n = 17) as well one Egyptian fruit bat (*Rousettus aegyptiacus*). This virus was detected in 111 bats sampled during both the rainy and dry seasons in the Kibondo and Kigoma Rural Districts. The detection of this virus in a single Egyptian fruit bat sampled in abandoned mine shaft in the Kyerwa District is notable as the species and sampling environment are divergent from the rural and peri-domestic sites in the Kibondo and Kigoma Rural Districts. Rectal swabs were most likely to yield a positive viral finding for this virus, with 90 bats positive only on rectal swab, 17 bats positive on oral swab, and five bats with positive oral and rectal swabs.

In addition to Chaerephon bat coronavirus/Kenya/KY22/2006, PREDICT/Tanzania identified two additional alphacoronaviruses, four betacoronaviruses, and three paramyxoviruses. There is no evidence at this time to suggest any of these viruses pose a threat to human health, however given the recent emergence of novel betacoronavirus SARS-CoV-2, additional investigation into the ecology, evolution and global distribution of betacoronaviruses in wildlife is warranted. Further analysis of the betacoronaviruses PREDICT_CoV-106 and PREDICT_CoV-117 identified in Tanzania is ongoing at partner laboratories at UC Davis and Columbia University.

EPIDEMIOLOGICAL & BEHAVIORAL RISK

In addition to biological specimen collection, our PREDICT teams worked with local communities to learn about and better understand social and behavioral factors that might be associated with risks of zoonotic disease transmission, focusing on the "how" and "why" of risk. Using data-driven ethnographic and epidemiological methods, our team also worked to identify potential strategies that might be effective in preventing or mitigating zoonotic viral spillover and spread. Our team conducted qualitative (field observations, ethnographic interviews and focus group discussions) and quantitative (structured survey) behavioral risk investigations at all One Health surveillance sites.

HEALTH CENTER SURVEILLANCE

Of the 587 syndromic individuals enrolled and tested from the clinics in Kigoma Rural District (n=393) and Kyerwa District (n=194), 565 had fevers (≥38 °C) on admission, with an average fever of 38.6°C of three days duration. The most common presenting symptoms at enrollment included 1) fever; 2) headache; 3) malaise; 4) cough; and 5) joint or abdominal pain.

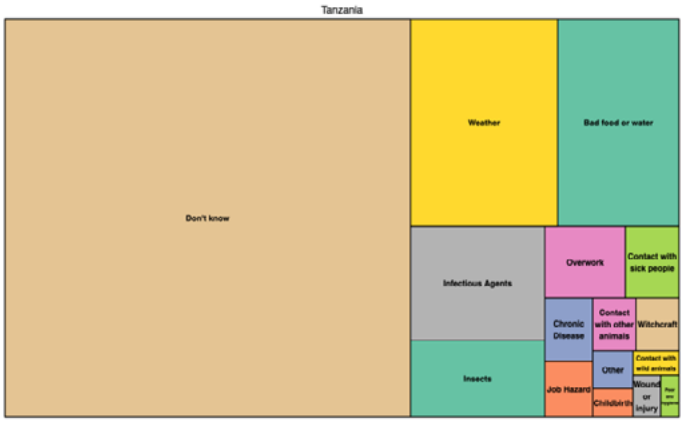
528 syndromic enrolled and tested humans were also tested for malaria using a malaria rapid diagnostic test; 38.1% of those tested for malaria were positive. All these humans were included for testing using our cPCR viral testing protocols.

ENROLLED & TESTED INDIVIDUALS BY AGE & GENDER

SITE ENROLLED	Kibondo District Community (n=294)	Clinic (Kyerwa District) (n=194)	Clinic (Kigoma Rural District) (n=393)	Total (n=881)
GENDER				
FEMALE	61 (20.7%)	112 (57.7%)	296 (75.3%)	469 (53.2%)
MALE	233 (79.3%)	82 (42.3%)	97 (24.7%)	412 (46.8%)
AGE GROUP				
ADULT	294 (100%)	147 (75.8%)	312 (79.4%)	753 (85.5%)
CHILD (<18)	0 (0%)	47 (24.2%)	81 (20.6%)	128 (14.5%)
AGE				
MEDIAN [MIN, MAX]	39 [18,76]	24 [2,82]	30 [2,88]	32 [2,88]

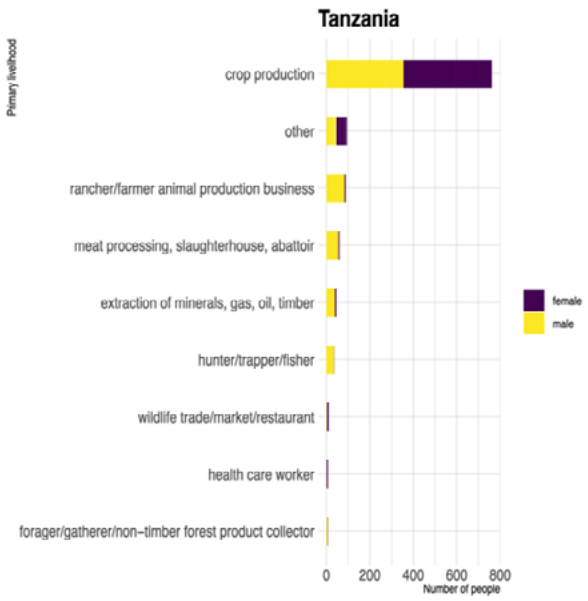
SELF-REPORTED CAUSE OF ILLNESS

For those >12 years old reporting an illness in the past year, a variety of responses were received. Across all education levels (none, primary, or secondary and above), the top five beliefs regarding cause of illness were 1) don't know; 2) weather; 3) bad food or water; 4) infectious agents; and 5) insects.



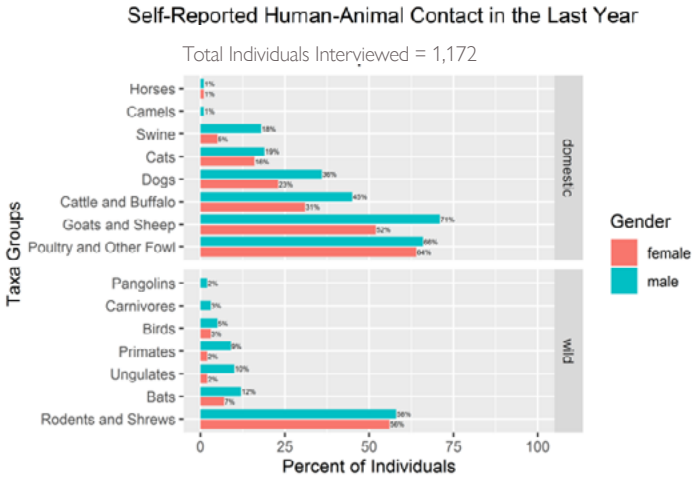
LIVELIHOODS OF SURVEYED INDIVIDUALS

Across all sites, the primary livelihood of both women and men surveyed was farming and crop production. Men were significantly more likely to be engaged in livestock production, meat processing businesses, and forestry or extraction activities. Women on the other hand, were more likely to be engaged in the wildlife trade, in trade, marketing, or restaurant businesses, or to be employed as a health care worker. Additional livelihoods reported by respondents included: homemaker, sales, construction, migrant laborer, and protected area worker. Several individuals reported being students or unemployed.



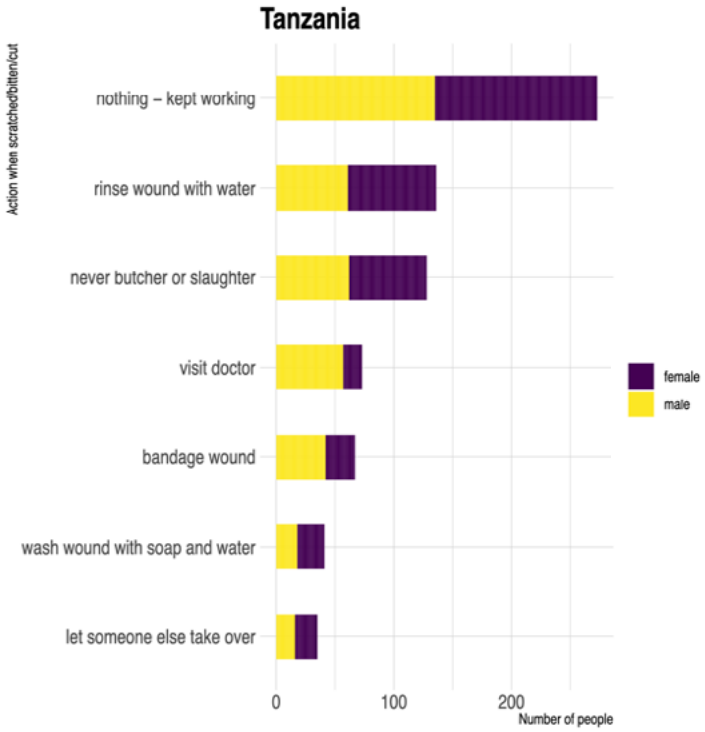
SELF-REPORTED HUMAN-ANIMAL CONTACT

Respondents were asked about the type of contact they had experienced with animals within the last 12 months. Across all sites, rodents were the most common type of wildlife encountered by both men and women. Both genders commonly had contact with poultry livestock, with men more likely to have contact with all classes of animals: ruminants, bats, wild ungulates (antelope, buffalo, etc.,) and non-human primates. Respondents self-reported their behaviors following an animal scratching or biting them, or after experiencing a cut or injury when butchering or slaughtering an animal; the majority of respondents (both men and women) answered that they took no preventive action.



HUMAN-ANIMAL CONTACT AT HIGH-RISK INTERFACES

During ethnographic interviews and focus groups, many respondents spoke about the increasing scarcity of wild meat and attributed this to increased human population density. Other respondents also shared insights and stories about wildlife raiding their crops. Destruction of crops by baboons and other non-human primates, rodents, and both wild and domestic ungulates is such a severe problem that some farmers spend anywhere from several weeks to seven months



living in temporary shelters in their fields to scare animals away. This behavior comes with its own set of health risks, as farms lack shelter and are exposed and are far away from sources of clean drinking water and healthcare services.

FOOD SAFETY, HUNTING & WILD MEAT CONSUMPTION

Across sites, interviewees described a range of conditions under which people eat the meat of animals known to have died of disease. While many communities have at least limited access to the services of livestock extension officers and community health workers who inspect meat after slaughter and prior to sale, respondents report that many animals are eaten without inspection, or possibly even following condemnation. Another pervasive theme is the claim that refugee populations drive hunting and bushmeat consumption, particularly of non-human primates.

COMMUNITY ENGAGEMENT & RISK COMMUNICATION

PREDICT was committed to community engagement and worked with local villages and partners to raise awareness of zoonotic disease threats and strengthen capacity for prevention, surveillance, and detection. Several of the bat species sampled by our team are known hosts for deadly or potentially dangerous zoonotic diseases; namely Egyptian fruit bats, which are reservoirs for Marburg virus, and Mops species bats, which have been documented as wildlife hosts for a newly detected ebolavirus (Bombali virus) in Guinea, Sierra Leone, and neighboring Kenya. We thus identified the need to provide risk reduction strategies targeting bats. Our team developed a communications plan and a behavior change resource to raise awareness among community members about ways to reduce disease risks associated with human-to-bat contact, while highlighting the need for bat conservation given their roles in critical ecosystem services.

A moderated picture book format, delivered by a trusted community leader, was selected as the best tool to put into the hands of our local team and in-country stakeholders. This new resource, *Living Safely with Bats* was piloted in Sierra Leone and by our team in Tanzania to garner input on ways to improve both the content and the process of delivery.

This resource can be downloaded at
p2.predict.global/living-safely-with-bats-book

In August of 2019, outreach and risk reduction campaigns were conducted with all communities and subnational health professionals. At these events, our team shared project findings, the *Living Safely with Bats* resource, and additional educational materials designed to raise awareness of zoonotic transmission risks from other animals. Broader findings and recommendations from the project were also shared with regional and national stakeholders, including the One Health Coordination Desk, which was established under the Prime Minister's office to strengthen multi-sectoral coordination and health security.

CAPACITY STRENGTHENING

From 2009-2020, PREDICT provided training to over 260 individuals across both animal and human health sectors and reached district-level professionals (veterinary officers, clinicians, game officers, etc.) on the front lines of the national disease surveillance system.

PREDICT trainings directly strengthened workforce capabilities to successfully and safely conduct core job functions and provided opportunities for students, interns, health professionals, and staff to strengthen skills in zoonotic disease surveillance and detection through hands-on learning in real world field-based settings.

PREDICT's labs, based at SUA and IHI, increased capacity for viral detection of both known and newly emerging zoonotic disease threats, and together have tested samples from over 5,200 animals and people. Both labs serve as key training centers for students and professionals, including government staff from the national lab system and standby to support the national lab system as referral nodes and technical assistance centers.

Read more about how our team supports women and science and contributes to COVID-19 response efforts **here**.

PRACTICAL IMPLICATIONS

- Our team collected samples from several rodent and bat species known as hosts for deadly or potentially dangerous zoonotic diseases in an area bordering an active Ebola virus outbreak.
- Bats and other wildlife are very common in villages and dwellings in this area, and we identified multiple high-risk pathways for virus transmission from wildlife to people, along with insights into peak season for virus spillover from bats, critical information for targeting cost-effective disease surveillance and timing of intervention strategies.
- Despite these risks and nationally organized Ebola virus sensitization and outreach campaigns, awareness of zoonotic disease transmission risks remains low and surveillance for emerging virus threats in these at-risk populations is virtually non-existent.
- We recommend continued investments in surveillance of these populations, especially wildlife using the One Health approach, along with focused investments in capacity strengthening for the subnational workforce and nascent One Health Platform to empower prevention, surveillance and detection in vulnerable transboundary areas.
- Finally, at request of our community stakeholders, those living day to day in these high-risk animal human interfaces, we recommend investments in interventions targeting risk reduction coupled with evaluations of education, social marketing, and behavior change communications for general health and disease prevention; interventions that might be taken to scale across the region via local schools and community organizations.

For more information
view the interactive report at
p2.predict.global

SPECIAL FEATURE

Peak Season for Viral Spillover

In Tanzania, we worked together with scientists from UC Davis and Ghana to assess the seasonality of coronavirus shedding by the straw-colored fruit bat (*Eidolon helvum*). Our teams passively collected ~100 fecal samples on a monthly basis during an entire year at two urban colonies: one in Accra, Ghana and one in Morogoro, Tanzania. Our data provides evidence that there is an association between coronavirus shedding in urban *E. helvum* roosts and the reproductive cycle of these bats, as coronaviruses are shed at a rate four times higher when pups are weaned compared to the rest of the year; an important finding for timely and effective disease control and prevention strategies.

Learn more at http://bit.ly/2O2creo

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