Grant Number: 2R01TW005869-05 REVISED

Principal Investigator(s):
PETER DASZAK, PHD

Project Title: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

PROGRAM ASSISTANT
WILDLIFE TRUST
460 WEST 34TH STREET
NEW YORK, NY 10001

Award e-mailed to: (b) (6)

Budget Period: 07/01/2008 – 06/30/2009
Project Period: 08/01/2002 – 06/30/2013

Dear Business Official:

The National Institutes of Health hereby revises this award (see "Award Calculation" in Section I and "Terms and Conditions" in Section III) to WILDLIFE TRUST in support of the above referenced project. This award is pursuant to the authority of 42 USC 241 42 CFR 52 and is subject to the requirements of this statute and regulation and of other referenced, incorporated or attached terms and conditions.

Acceptance of this award including the "Terms and Conditions" is acknowledged by the grantee when funds are drawn down or otherwise obtained from the grant payment system.

Each publication, press release or other document that cites results from NIH grant-supported research must include an acknowledgment of NIH grant support and disclaimer such as "The project described was supported by Award Number R01TW005869 from the Fogarty International Center. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Fogarty International Center or the National Institutes of Health."

Award recipients are required to comply with the NIH Public Access Policy. This includes submission to PubMed Central (PMC), upon acceptance for publication, an electronic version of a final peer-reviewed, manuscript resulting from research supported in whole or in part, with direct costs from National Institutes of Health. The author's final peer-reviewed manuscript is defined as the final version accepted for journal publication, and includes all modifications from the publishing peer review process. For additional information, please visit http://publicaccess.nih.gov/.

Award recipients must promote objectivity in research by establishing standards to ensure that the design, conduct and reporting of research funded under NIH-funded awards are not biased by a conflicting financial interest of an Investigator. Investigator is defined as the Principal Investigator and any other person who is responsible for the design, conduct, or reporting of NIH-funded research or proposed research, including the Investigator's spouse and dependent children. Awardees must have a written administrative process to identify and manage financial conflict of interest and must inform Investigators of the conflict of interest policy and of the Investigators' responsibilities. Prior to expenditure of these awarded funds, the Awardee must report to the NIH Awarding Component the existence of a conflicting interest and within 60 days of any new conflicting interests identified after the initial report. Awardees must comply with these and all other aspects of 42 CFR Part 50, Subpart F. These requirements also apply to subgrantees, contractors, or collaborators engaged by the Awardee under this award. The NIH website http://grants.nih.gov/grants/policy/coi/index.htm provides additional information.

If you have any questions about this award, please contact the individual(s) referenced in Section IV.

Sincerely yours,

BRUCE R BUTRUM
Grants Management Officer
FOGARTY INTERNATIONAL CENTER

Additional information follows

SECTION I – AWARD DATA – 2R01TW005869-05 REVISED

Award Calculation (U.S. Dollars)

Salaries and Wages	$78,887
Fringe Benefits	$17,118
Personnel Costs (Subtotal)	$96,005
Equipment	$35,500
Supplies	$37,000
Travel Costs	$10,500
Other Costs	$18,820
Consortium/Contractual Cost	$249,114
Federal Direct Costs	$446,939
Federal F&A Costs	$55,417
Approved Budget	$502,356
Federal Share	$502,356
TOTAL FEDERAL AWARD AMOUNT	$502,356
AMOUNT OF THIS ACTION (FEDERAL SHARE)	$0

SUMMARY TOTAL FEDERAL AWARD AMOUNT YEAR (5)	
GRANT NUMBER	**TOTAL FEDERAL AWARD AMOUNT**
2R01TW005869-05	$502,356
3R01TW005869-05S2	$45,000
3R01TW005869-05S1	$150,000
TOTAL	**$697,356**

SUMMARY TOTALS FOR ALL YEARS		
YR	**THIS AWARD**	**CUMULATIVE TOTALS**
5	$502,356	$697,356
6	$499,975	$499,975
7	$499,998	$499,998
8	$499,449	$499,449
9	$499,772	$499,772

Recommended future year total cost support, subject to the availability of funds and satisfactory progress of the project

Fiscal Information:

CFDA Number:	93.989
EIN:	1311726494A1
Document Number:	RTW005869B
Fiscal Year:	2008

IC	*CAN*	*2008*	*2009*	*2010*	*2011*	*2012*
TW	8476360	$256,356	$253,975	$253,998	$253,449	$253,772
TW	8476369	$246,000	$246,000	$246,000	$246,000	$246,000

Recommended future year total cost support, subject to the availability of funds and satisfactory progress of the project

NIH Administrative Data:
PCC: EID / **OC**: 414B / **Processed**: (b) (6) 06/09/2009

SECTION II – PAYMENT/HOTLINE INFORMATION – 2R01TW005869-05 REVISED

For payment and HHS Office of Inspector General Hotline information, see the NIH Home Page at http://grants.nih.gov/grants/policy/awardconditions.htm

SECTION III – TERMS AND CONDITIONS – 2R01TW005869-05 REVISED

This award is based on the application submitted to, and as approved by, NIH on the above-titled project and is subject to the terms and conditions incorporated either directly or by reference in the following:

a. The grant program legislation and program regulation cited in this Notice of Award.
b. Conditions on activities and expenditure of funds in other statutory requirements, such as those included in appropriations acts.
c. 45 CFR Part 74 or 45 CFR Part 92 as applicable.
d. The NIH Grants Policy Statement, including addenda in effect as of the beginning date of the budget period.
e. This award notice, INCLUDING THE TERMS AND CONDITIONS CITED BELOW.

(See NIH Home Page at 'http://grants.nih.gov/grants/policy/awardconditions.htm' for certain references cited above.)

An unobligated balance may be carried over into the next budget period without Grants Management Officer prior approval.

This grant is subject to Streamlined Noncompeting Award Procedures (SNAP).

In accordance with P.L. 110-161, compliance with the NIH Public Access Policy is now mandatory. For more information, see NOT-OD-08-033 and the Public Access website: http://publicaccess.nih.gov/.

This award is funded by the following list of institutes. Any papers published under the auspices of this award must cite the funding support of all institutes.

Fogarty International Center (FIC)

Treatment of Program Income:
Additional Costs

SECTION IV – TW Special Terms and Conditions – 2R01TW005869-05 REVISED

RELEASE OF RESTRICTION
The purpose of this revision is to release the restriction on the Notice of Award dated 9/13/2008 pertaining to Foreign Clearance for Bangladesh which received State approval on 6/2/2009.

CURRENT AND FUTURE YEAR LEVELS
In accordance with the October 27, 1995, NIH Guide announcement and NIH implementation, future-year recommended levels are shown as total costs (the sum of direct plus facilities and administrative costs).

HUMAN SUBJECTS RESTRICTION
NOTICE: UNDER GOVERNING REGULATIONS, FEDERAL FUNDS ADMINISTERED BY THE DEPARTMENT OF HEALTH AND HUMAN SERVICES SHALL NOT BE EXPENDED FOR RESEARCH INVOLVING HUMAN SUBJECTS, AND INDIVIDUALS SHALL NOT BE ENROLLED IN SUCH RESEARCH, WITHOUT PRIOR APPROVAL BY THE OFFICE FOR HUMAN RESEARCH PROTECTION (OHRP) OF AN ASSURANCE TO COMPLY WITH THE REQUIREMENTS OF 45 CFR 46 TO PROTECT HUMAN RESEARCH SUBJECTS. THIS RESTRICTION APPLIES TO ALL COLLABORATING SITES WITHOUT OHRP-APPROVED ASSURANCES, WHETHER DOMESTIC OR FOREIGN, AND COMPLIANCE MUST BE ENSURED BY THE AWARDEE.

GRANTEES MUST NOTIFY THE FIC AWARDING OFFICE IN WRITING WITHIN 30 DAYS AFTER THE FWA OR SPA HAS BEEN APPROVED AND PROVIDE A COPY OF THE IRB APPROVAL OF THE PROTOCOL. THESE DOCUMENTS MAY BE EMAILED OR FAXED TO THE GRANTS SPECIALIST.

The grantee institution may conduct only activities that are clearly severable and independent from activities that involve human subjects until OHRP has approved an assurance and FIC has received and accepted the grantee institution's certification of IRB approval. No funds may be drawn down from the payment system and no obligations may be made against Federal funds for research involving human subjects for any period not covered by both an OHRP-approved Federal-wide Assurance or Single Project Assurance and an IRB approval consistent with 45 CFR Part 46.

Failure to comply with the above requirements can result in suspension and/or termination of this award, withholding of support, audit disallowances, and/or other appropriate action.

ANIMAL SUBJECTS RESTRICTION
NOTICE: UNDER GOVERNING POLICY, FEDERAL FUNDS ADMINISTERED BY THE PUBLIC HEALTH SERVICE (PHS) SHALL NOT BE EXPENDED FOR RESEARCH INVOLVING LIVE VERTEBRATE ANIMALS WITHOUT PRIOR APPROVAL BY THE OFFICE OF LABORATORY ANIMAL WELFARE (OLAW) OF AN ASSURANCE TO COMPLY WITH THE PHS POLICY ON HUMANE CARE AND USE OF LABORATORY ANIMALS. THIS RESTRICTION APPLIES TO ALL PERFORMANCE SITES (e.g., COLLABORATING INSTITUTIONS, SUBCONTRACTORS, SUBGRANTEES) WITHOUT OPRR-APPROVED ASSURANCES, WHETHER DOMESTIC OR FOREIGN.

GRANTEES MUST NOTIFY THE FIC AWARDING OFFICE IN WRITING WITHIN 30 DAYS AFTER THE ASSURANCE HAS BEEN APPROVED AND PROVIDE A COPY OF THE APPROVAL. THIS INFORMATION MAY BE EMAILED OR FAXED TO THE SPECIALIST LISTED BELOW.

CONSORTIUM/CONTRACTUAL COSTS
This award includes funds for consortium activities. Consortiums are to be established and administered in accordance with the NIH Grants Policy Statement.

FOREIGN TRAVEL
U.S. Flag carriers must be used for departure from or entry into the U.S. and for any other portion of the trip where available.

PUBLICATIONS
All publications resulting from the research or research training supported by this award must acknowledge FIC and any co-funders (if applicable). This publication requirement applies not only to the primary grantee, but also to any subcontractors and /or trainees involved with the project.

REQUIRED EDUCATION IN THE PROTECTION OF HUMAN RESEARCH PARTICIPANTS
Investigators must ensure that the description of the education completed in the protection of human subjects for each individual, identified as "key personnel", in the proposed research has been documented and provided to the FIC awarding office. Key personnel include all individuals responsible for the design and conduct of the study. The Notice for this policy can be found at: http://grants.nih.gov/grants/guide/notice-files/NOT-OD-00-039.html.

GENDER AND MINORITY INCLUSION
If this grant proposes the use of human subjects, future non-competing applications require that you indicate the number, ethnicity, and gender of human subjects that are part of this study. If this information is not included in future non-competing grant applications, the funding for the application may be delayed.

ADDRESS FOR FUTURE NONCOMPETING PROGRESS REPORTS
FIC encourages the submission of noncompeting progress reports through the eRA Commons, found at https://commons.era.nih.gov/commons/index.jsp. Each grantee organization and principal investigator must be registered in order to use Commons. It is expected that use of Commons will soon be mandatory in order to receive grant funding from NIH, so registration should be completed as soon as possible. If using Commons, please submit your progress report no later than 45 prior to the anticipated start date.

If not using Commons, please submit your hard-copy noncompeting progress report, no later than 2 months prior to the anticipated start date, to the following address:

Division of Extramural Activities Support, OER
National Institutes of Health
6705 Rockledge Drive, Room 2207, MSC 7987
Bethesda, MD 20892-7987 (for regular or US Postal Service Express mail)
Bethesda, MD 20817 (for other courier/express mail delivery only)
Phone Number: (301) 594-6584

This is the new centralized mailing address for all NIH Institutes/Centers. Do NOT submit the non-competing progress report directly to Fogarty International Center.

For up-to-date information, you may access the NIH Home Page at http://www.nih.gov/ and the FIC Home Page at http://www.fic.nih.gov/.

STAFF CONTACTS

The Grants Management Specialist is responsible for the negotiation, award and administration of this project and for interpretation of Grants Administration policies and provisions. The Program Official is responsible for the scientific, programmatic and technical aspects of this project. These individuals work together in overall project administration. Prior approval requests (signed by an Authorized Organizational Representative) should be submitted in writing to the Grants Management Specialist. Requests may be made via e-mail.

Grants Management Specialist: Angela Smith
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-594-1211

Program Official: Joshua Rosenthal
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-402-0779

SPREADSHEET SUMMARY
GRANT NUMBER: 2R01TW005869-05 REVISED

INSTITUTION: WILDLIFE TRUST

Budget	*Year 5*	*Year 6*	*Year 7*	*Year 8*	*Year 9*
Salaries and Wages	$78,887	$78,887	$78,887	$78,887	$78,887
Fringe Benefits	$17,118	$17,118	$17,118	$17,118	$17,118
Personnel Costs (Subtotal)	$96,005	$96,005	$96,005	$96,005	$96,005
Equipment	$35,500	$27,500	$16,500		
Supplies	$37,000	$37,000	$37,000	$37,000	$37,000
Travel Costs	$10,500	$10,500	$10,500	$10,500	$10,500
Other Costs	$18,820	$50,437	$59,179	$71,828	$71,256
Consortium/Contractual Cost	$249,114	$227,914	$227,914	$227,914	$227,914
TOTAL FEDERAL DC	$446,939	$449,356	$447,098	$443,247	$442,675
TOTAL FEDERAL F&A	$55,417	$50,619	$52,900	$56,202	$57,097
TOTAL COST	$502,356	$499,975	$499,998	$499,449	$499,772

Facilities and Administrative Costs	*Year 5*	*Year 6*	*Year 7*	*Year 8*	*Year 9*
F&A Cost Rate 1	26.1%	26.1%	26.1%	26.1%	26.1%
F&A Cost Base 1	$212,325	$193,942	$202,683	$215,333	$218,761
F&A Costs 1	$55,417	$50,619	$52,900	$56,202	$57,097

Form Approved Through 11/30/2010

OMB No. 0925-0001

12143990

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Do not exceed character length restrictions indicated.

* PI: **DASZAK, PETER**

1 R01 TW008245-01

Dual:

IRG: BDA

Council: 01/2009

IPF:4415701

Received: 06/10/2008

1. TITLE OF PROJECT *(Do not exceed 81 characters, including spaces and punctuation.)*

The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

2. RESPONSE TO SPECIFIC REQUEST FOR APPLICATIONS OR PROGRAM ANNOUNCEMENT OR SOLICITATION ☐ NO ☒ YES
(If "Yes," state number and title)

Number: NSF 07-513 Title: NIH NSF Ecology of Infectious Diseases program

3. PROGRAM DIRECTOR/PRINCIPAL INVESTIGATOR | **New Investigator** ☒ No ☐ Yes

3a. NAME (Last, first, middle)	3b. DEGREE(S)	3h. eRA Commons User Name
Daszak, Peter	B.Sc. Ph.D.	(b) (6)

3c. POSITION TITLE	3d. MAILING ADDRESS *(Street, city, state, zip code)*
Executive Director	460 West 34th Street New York NY 10001
3e. DEPARTMENT, SERVICE, LABORATORY, OR EQUIVALENT Consortium for Conservation Medicine	
3f. MAJOR SUBDIVISION CCM	
3g. TELEPHONE AND FAX *(Area code, number and extension)* TEL: (b) (6) FAX: 212-3804465	E-MAIL ADDRESS: (b) (6)

4. HUMAN SUBJECTS RESEARCH	4a. Research Exempt	If "Yes," Exemption No.
☒ No ☐ Yes	☐ No ☐ Yes	

4b. Federal-Wide Assurance No.	4c. Clinical Trial	4d. NIH-defined Phase III Clinical Trial
	☐ No ☐ Yes	☐ No ☐ Yes

5. VERTEBRATE ANIMALS ☐ No ☒ Yes — 5a. Animal Welfare Assurance No. A4059-01

6. DATES OF PROPOSED PERIOD OF SUPPORT *(month, day, year—MM/DD/YY)*		7. COSTS REQUESTED FOR INITIAL BUDGET PERIOD		8. COSTS REQUESTED FOR PROPOSED PERIOD OF SUPPORT	
From	Through	7a. Direct Costs ($)	7b. Total Costs ($)	8a. Direct Costs ($)	8b. Total Costs ($)
7/1/08	6/30/13	$449,084	$499,634	$2,282,817	$2,498,828

9. APPLICANT ORGANIZATION	10. TYPE OF ORGANIZATION
Name: Wildlife Trust Address: 460 West 34th Street New York NY 10001	Public: → ☐ Federal ☐ State ☐ Local Private: → ☒ Private Nonprofit For-profit: → ☐ General ☐ Small Business ☐ Woman-owned ☐ Socially and Economically Disadvantaged
	11. ENTITY IDENTIFICATION NUMBER 311726494 DUNS NO. 077090066D Cong. District 08

12. ADMINISTRATIVE OFFICIAL TO BE NOTIFIED IF AWARD IS MADE	13. OFFICIAL SIGNING FOR APPLICANT ORGANIZATION
Name: Aleksei Chmura	Name: Aleksei Chmura
Title: Program Assistant	Title: Program Assistant
Address: 460 West 34th Street New York NY 10001	Address: 460 West 34th Street New York, NY 10001
Tel: (b) (6) FAX: 213-380-4465	Tel: (b) (6) FAX: 213-380-4465
E-Mail: (b) (6)	E-Mail: (b) (6)

14. APPLICANT ORGANIZATION CERTIFICATION AND ACCEPTANCE	SIGNATURE OF OFFICIAL NAMED IN 13. *(In ink. "Per" signature not acceptable.)*	DATE
I certify that the statements herein are true, complete and accurate to the best of my knowledge, and accept the obligation to comply with Public Health Services terms and conditions if a grant is awarded as a result of this application. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties.	Aleksei Chmura	6/9/2008

PROJECT SUMMARY (See instructions):

Nipah virus (NiV) is a lethal zoonotic paramyxovirus with fruit bat (Pteropus spp.) reservoir hosts. It emerged in 1999 in Malaysia via domestic pig amplifier hosts, causing an encephalitis outbreak with a 40% case fatality rate. Since this time, 7 recognized outbreaks of NiV have occurred in Bangladesh and India. The virus has achieved an advanced stage of emergence, with direct transmission from bats to people, capacity to infect the respiratory pathway, up to five cycles of human-to-human transmission, and increased (71%) case fatality. We propose that human population density and social behavior in Bangladesh, NiV viral biology, NiV ecology in fruit bats, and interactions between bats, livestock and humans create increased potential for NiV outbreaks and pandemic emergence. We will conduct 5 years of fieldwork in Bangladesh, collecting data on bat ecology, virology, demography and social behavior. We will use our results to parameterize a mathematical model of NiV dynamics within and among bats, livestock and humans. We will examine which factors cause sustained human-to-human outbreaks, and assess NiV's potential for pandemic emergence. We will test 4 hypotheses:

1) That NiV spillover risk from bats to humans is a factor of fruit bat population biology, especially their synchronous breeding patterns. We will examine how colony aggregation, birthing dynamics, and other interactions affect the potential for increased viral prevalence, and initiation of an outbreak.

2) That bat behavior in the human-dominated environment in Bangladesh has increased their contact with livestock and people, and led to a more advanced stage of NiV emergence. We will enhance our previously developed matrix model, and parameterize this with measurements of the migration rate between bat colonies based on satellite and radio telemetry. We will sequence NiV isolates, and examine strain diversity in bats in relation to spillover outbreaks.

3) That NiV transmission in Bangladesh is enhanced by human social behavior, high population density and specific viral traits, and that these factors promote human-to-human transmission. We will use outbreak data to examine whether specific human behaviors and NiV infection and which of the following promote person-to-person transmission: 1) Heterogeneity in respiratory shedding leading to some individuals acting as superspreaders; 2) Close physical contact between sick patients and relatives; 3) The propensity of Bangladesh NiV to infect the respiratory tract.

4) That NiV in Bangladesh presents a threat for regional and pandemic spread. We will use our model to estimate future spread of NiV under different conditions within Bangladesh and to other countries via international travel.

RELEVANCE (See instructions):

Nipah virus has emerged repeatedly in Bangladesh causing death in 70% of infected people undergoing chains of person-to-person transmission. Our work will examine why this virus is emerging, and help provide an early warning system for Nipah virus in Bangladesh. It will also give us a better understanding of the likelihood of this and other pathogens becoming pandemic.

PROJECT/PERFORMANCE SITE(S) (if additional space is needed, use Project/Performance Site Format Page)

Project/Performance Site Primary Location			
Organizational Name: Wildlife Trust Inc.			
DUNS: 077090066D			
Street 1: 460 West 34th Street	Street 2:		
City: New York	County:	State: NY	
Province:	Country: USA	Zip/Postal Code: 10001	
Project/Performance Site Congressional Districts: 08			

Additional Project/Performance Site Location			
Organizational Name: Princeton University			
DUNS: 002484665			
Street 1: 4 New South Building	Street 2:		
City: Princeton	County:	State: NJ	
Province:	Country: USA	Zip/Postal Code: 08544-0036	
Project/Performance Site Congressional Districts: 12			

SENIOR/KEY PERSONNEL. See instructions. *Use continuation pages as needed* to provide the required information in the format shown below. Start with Program Director(s)/Principal Investigator(s). List all other senior/key personnel in alphabetical order, last name first.

Name	eRA Commons User Name	Organization	Role on Project
Peter Daszak	(b) (6)	Wildlife Trust	Program Director
Stephen P. Luby	(b) (6)	ICDDR,B	Co-investigator
Paul Rota		CDC	Co-investigator
Andrew P. Dobson		Princeton University	Co-investgator
Auston Marm. Kilpatrick		Wildlife Trust	Co-investgator
Jonathan H. Epstein	(b) (6)	Wildlife Trust	Co-investgator
W. Ian Lipkin	(b) (6)	Columbia university	Consultant
Hume E. Field		Queensland DPI	Consultant
Jahangir Hossain		ICDDR,B	Co-investgator
Emily Gurley		ICDDR,B	Co-investigator

OTHER SIGNIFICANT CONTRIBUTORS

Name	Organization	Role on Project

Human Embryonic Stem Cells ☒ **No** ☐ **Yes**

If the proposed project involves human embryonic stem cells, list below the registration number of the specific cell line(s) from the following list: http://stemcells.nih.gov/research/registry/. *Use continuation pages as needed.*

If a specific line cannot be referenced at this time, include a statement that one from the Registry will be used.

Cell Line

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

Use only if additional space is needed to list additional project/performance sites.

Additional Project/Performance Site Location

Organizational Name: International Center for Diarrheal Disease Research, Bangladesh

DUNS: N/A

Street 1: 68 Shaheed Tajuddin Ahmed Sharani | Street 2: Mohakhali

City: Dhaka | County: | State:

Province: | Country: Bangladesh | Zip/Postal Code: Dhaka 1212

Project/Performance Site Congressional Districts: N/A

Additional Project/Performance Site Location

Organizational Name: Columbia University

DUNS:

Street 1: 630 West 168th Street | Street 2: Box 49

City: New York | County: | State: NY

Province: | Country: USA | Zip/Postal Code: 10032

Project/Performance Site Congressional Districts:

Additional Project/Performance Site Location

Organizational Name:

DUNS:

Street 1: | Street 2:

City: | County: | State:

Province: | Country: | Zip/Postal Code:

Project/Performance Site Congressional Districts:

Additional Project/Performance Site Location

Organizational Name:

DUNS:

Street 1: | Street 2:

City: | County: | State:

Province: | Country: | Zip/Postal Code:

Project/Performance Site Congressional Districts:

Additional Project/Performance Site Location

Organizational Name:

DUNS:

Street 1: | Street 2:

City: | County: | State:

Province: | Country: | Zip/Postal Code:

Project/Performance Site Congressional Districts:

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

DETAILED BUDGET FOR INITIAL BUDGET PERIOD
DIRECT COSTS ONLY

FROM 7/1/08 THROUGH 6/30/09

PERSONNEL (Applicant organization only)		Months Devoted to Project				DOLLAR AMOUNT REQUESTED (omit cents)		
NAME	ROLE ON PROJECT	Cal. Mnths	Acad. Mnths	Summer Mnths	INST.BASE SALARY	SALARY REQUESTED	FRINGE BENEFITS	TOTAL
Daszak, Peter	PD/PI							(b) (4), (b) (6)
Kilpatrick, A.M.	Co-investigator							
Epstein, J.H.	Co-investigator							
Field, H.E.	Consultant							
To be named	Postdoc							
To be named	Research asst.							
SUBTOTALS →						79,706	17,296	97,002

CONSULTANT COSTS	
EQUIPMENT *(Itemize)* Bat catching equipment, 5 dry shippers, Radiotelemetry, Satellite Collars and data transfer, Ultralow freezer	35,500
SUPPLIES *(Itemize by category)* Testing costs	37000
TRAVEL Foreign travel USA-Bangladesh	10,500
PATIENT CARE COSTS — INPATIENT	
PATIENT CARE COSTS — OUTPATIENT	
ALTERATIONS AND RENOVATIONS *(Itemize by category)*	
OTHER EXPENSES *(Itemize by category)* Participant support costs	18,820
CONSORTIUM/CONTRACTUAL COSTS — DIRECT COSTS	223,267
SUBTOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD *(Item 7a, Face Page)*	$ 449,084
CONSORTIUM/CONTRACTUAL COSTS — FACILITIES AND ADMINISTRATIVE COSTS	26,995
TOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD	$ 499,634

BUDGET FOR ENTIRE PROPOSED PROJECT PERIOD
DIRECT COSTS ONLY

BUDGET CATEGORY TOTALS	INITIAL BUDGET PERIOD (from Form Page 4)	ADDITIONAL YEARS OF SUPPORT REQUESTED			
		2nd	3rd	4th	5th
PERSONNEL: *Salary and fringe benefits. Applicant organization only.*	97,002	99,912	102,909	105,997	109,177
CONSULTANT COSTS					
EQUIPMENT	35,500	27,500	16,500	0	0
SUPPLIES	37,000	51,750	58,750	65,750	64,250
TRAVEL	10,500	12,400	12,400	12,400	12,400
PATIENT CARE COSTS — INPATIENT					
PATIENT CARE COSTS — OUTPATIENT					
ALTERATIONS AND RENOVATIONS					
OTHER EXPENSES	18,820	15,600	15,600	21,600	18,600
CONSORTIUM/ CONTRACTUAL COSTS — DIRECT	223,267				
SUBTOTAL DIRECT COSTS *(Sum = Item 8a, Face Page)*	449,084	457,831	458,075	458,937	458,890
CONSORTIUM/ CONTRACTUAL COSTS — F&A	26,995				
TOTAL DIRECT COSTS	499,634	499,975	499,998	499,449	499,772

TOTAL DIRECT COSTS FOR ENTIRE PROPOSED PROJECT PERIOD	$ 2,498,828

JUSTIFICATION. Follow the budget justification instructions exactly. Use continuation pages as needed.

Daszak, Peter (Wildlife Trust) Budget Justification

A. Key/Senior Personnel

The cost of salary support is based on the Wildlife Trust pay scale for similar existing positions. It is anticipated that salaries will increase at 3.9% on an annual basis corresponding to organization-wide increases.

Peter Daszak/Principal Investigator/Project Director: Dr. Daszak will spend (b) (4), (b) (6) of his time in management and supervision of this project. He will act as overall director of the whole program of work, managing all collaborators, overseeing field studies, testing arrangements, and ensuring smooth collaboration with PI Dobson who will lead the modeling component

A. Marm Kilpatrick/Senior Researcher: The Senior Researcher provides administrative as well as scientific oversight of the project. Dr. Kilpatrick's involvement will require (b) (4), (b) (6) of his time. The remainder of his salary is currently covered under other research projects. Dr Kilpatrick will develop and analyze parameterized models for enhanced Nipah virus outbreaks and the pandemic potential of Nipah virus.

Continued..../

Daszak, Peter (Wildlife Trust) Budget Justification (Continued)

B. Other Personnel

Post Doctoral Associate: the Post Doctoral Associate will be employed full-time for 5-years to work on this project. This position will be instrumental in developing and helping to supervise the grant. She or he will be responsible for coordinating this project with Dr. Daszak. In this role, as researcher, the Post Doctoral Associate will be expected to produce manuscripts for peer-review and liaising with Wildlife Trust to manage this grant will be part of duties. The specific research duties will be to conduct bat sampling and related fieldwork, including organizing field teams to conduct bat sampling, overseeing the collection, dissemination of samples, and the testing of these, and working with the modelers to parameterize their models, and adapt field and testing work to these models.

Research Assistant: The RA is expected to spend 25% of his or her time assisting with this project. Tasks will include literature research, database maintenance, data entry, drafting manuscripts, and assisting the Post Doctoral Associate.

C. Fringe Benefits

Fringe is calculated at the Wildlife Trust rate of 21.7%.

D.Permenant Equipment

An ultra-low freezer for sample storage at CCM and (5) dry shippers for sending samples at -70C from Bangladesh to the USA and Australia for testing. Bat catching equipment includes nets, poles, and personal protective equipment. This category also includes purchase of 7 satellite telemetry units ($,3000 ea.) plus annual data transfer from the ARGOS satellite service ($1,500/yr/collar) (CCM will provide funding for an additional 3 satellite collars) and 20 radio tracking collars and a receiver in years 1-3.

F. Participant Support Costs

Participant Support Costs are for travel and accommodation for fieldwork, annual NSF meetings, and annual collaborative meetings, and annual group meetings to be held in Bangladesh, the USA or in conjunction with another conference or relevance elsewhere. Annual Group meetings will include workshops for local collaborators on surveillance activities, recent outbreaks, and clinical management.
Annual meeting costs are for both collaborative PIs (Daszak and Dobson), the Co-PI (Luby), and 9 staff. Estimated costs are approximately $20,200 p.a., comprising travel for an equivalent of 7 people, assuming that the meeting will be held at a site where some of the staff are already based (7 x $1,600=11,200), accommodation (7 x $150 x 5 days=$5,250), subsistence (11 x $50 x 5 days =$2,750) and room rental ($1,000). Note that we have only requested part of these costs, and Wildlife Trust will fund the rest. Additional participant costs are requested in years 2 through 5 for attending trainings, workshops, and seminars to disseminate findings from the study.

G. Other Direct Costs

Materials and Supplies: This category also includes consumables for biological sample collection and storage and also office supplies, photocopy-fees, postage, computer software and licensing fees, and internet and telephone connections.

Other: testing costs - Year 1: we will be conducting molecular and serological testing of all bat sample (approx. 1600 samples) in the USA. This will cost 1600 x $8 ea (tot=$12,800) at Columbia Univ. A subset of the positive and negative samples from this will be sent to AAHL for viral culture and serum neutralization tests (to confirm ELISAs) which are done in a BSL 4 lab (approx 600 samples at a per test cost of $20 (tot = $12,000)). This category also includes reagents for PCR and ELISA and international shipping (approx

$12,200). Budget years 2-5 allow for 20% additional sample collection, testing, and shipping to allow for outbreak investigations that will require bat and domestic animal sampling.

I. Indirect Costs

Indirect Cost is calculated on all direct costs less collaborative travel at the rate of 21.9%.Year 1 of the grant includes an indirect cost on the first $25,000 of each of the four subawards at a the same rate (21.9%).

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

DETAILED BUDGET FOR INITIAL BUDGET PERIOD
DIRECT COSTS ONLY

FROM 7/1/08 THROUGH 6/30/09

PERSONNEL (Applicant organization only)		Months Devoted to Project				DOLLAR AMOUNT REQUESTED (omit cents)		
NAME	ROLE ON PROJECT	Cal. Mnths	Acad. Mnths	Summer Mnths	INST.BASE SALARY	SALARY REQUESTED	FRINGE BENEFITS	TOTAL
Stephen P. Luby	PD/PI							(b) (4), (b) (6)
Jahangir Hossain	Co-Investigator							
Emily Gurley	Co-Investigator							
Paul Rota	Consultant							
To be named	Lab. Specialist							
To be named	Lab. Officer							
To be named	Epi. Cooridinator							
	SUBTOTALS →					63,021	13,675	76,696

CONSULTANT COSTS

EQUIPMENT *(Itemize)*
Elisa reader ($5000), -70C Freezer ($11000), Liquid Nitrogen tank ($5200) 21,200

SUPPLIES *(Itemize by category)*
Laboratory and sample collection supplies (see budget justification) 93,604

TRAVEL
Foreign (within Bangladesh) travel 13,500

PATIENT CARE COSTS — INPATIENT

OUTPATIENT

ALTERATIONS AND RENOVATIONS *(Itemize by category)*

OTHER EXPENSES *(Itemize by category)*

CONSORTIUM/CONTRACTUAL COSTS	DIRECT COSTS	
SUBTOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD *(Item 7a, Face Page)*		$ 205,000
CONSORTIUM/CONTRACTUAL COSTS	FACILITIES AND ADMINISTRATIVE COSTS	16,400
TOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD		$ 221400

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

DETAILED BUDGET FOR INITIAL BUDGET PERIOD
DIRECT COSTS ONLY

FROM 7/1/08 THROUGH 6/30/13

PERSONNEL *(Applicant organization only)*		Months Devoted to Project				DOLLAR AMOUNT REQUESTED *(omit cents)*		
NAME	ROLE ON PROJECT	Cal. Mnths	Acad. Mnths	Summer Mnths	INST.BASE SALARY	SALARY REQUESTED	FRINGE BENEFITS	TOTAL
	PD/PI							
To be named	Research Physician							
To be named	Veterinary Officer							
To be named	Quantitative Researcher							
To be named	Laboratory Res. Officer							
To be named	Field Res. Officer							
To be named	Field Res. Asst.							
	SUBTOTALS →							

(b) (4), (b) (6)

CONSULTANT COSTS		
EQUIPMENT *(Itemize)*		
SUPPLIES *(Itemize by category)*		
TRAVEL		
PATIENT CARE COSTS	INPATIENT	
	OUTPATIENT	
ALTERATIONS AND RENOVATIONS *(Itemize by category)*		
OTHER EXPENSES *(Itemize by category)*		
CONSORTIUM/CONTRACTUAL COSTS	DIRECT COSTS	
SUBTOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD *(Item 7a, Face Page)*		$
CONSORTIUM/CONTRACTUAL COSTS	FACILITIES AND ADMINISTRATIVE COSTS	
TOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD		$

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

DETAILED BUDGET FOR INITIAL BUDGET PERIOD
DIRECT COSTS ONLY

FROM 7/1/08 THROUGH 6/30/13

PERSONNEL *(Applicant organization only)*		Months Devoted to Project				DOLLAR AMOUNT REQUESTED *(omit cents)*		
NAME	ROLE ON PROJECT	Cal. Mnths	Acad. Mnths	Summer Mnths	INST. BASE SALARY	SALARY REQUESTED	FRINGE BENEFITS	TOTAL
	PD/PI							
To be named	Hospital Physician							(b) (4), (b) (6)
To be named	Health Asst.							
	SUBTOTALS →							

CONSULTANT COSTS		
EQUIPMENT *(Itemize)*		
SUPPLIES *(Itemize by category)*		
TRAVEL		
PATIENT CARE COSTS	INPATIENT	
	OUTPATIENT	
ALTERATIONS AND RENOVATIONS *(Itemize by category)*		
OTHER EXPENSES *(Itemize by category)*		
CONSORTIUM/CONTRACTUAL COSTS	DIRECT COSTS	
SUBTOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD *(Item 7a, Face Page)*		$
CONSORTIUM/CONTRACTUAL COSTS	FACILITIES AND ADMINISTRATIVE COSTS	
TOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD		$

BUDGET FOR ENTIRE PROPOSED PROJECT PERIOD
DIRECT COSTS ONLY

BUDGET CATEGORY TOTALS		INITIAL BUDGET PERIOD (from Form Page 4)	ADDITIONAL YEARS OF SUPPORT REQUESTED 2nd	3rd	4th	5th
PERSONNEL: *Salary and fringe benefits. Applicant organization only.*		76,696	86,022	88,109	90,258	113,490
CONSULTANT COSTS						
EQUIPMENT		21,200	0	0	0	0
SUPPLIES		93,604	98,978	98,891	96,242	52,510
TRAVEL		13,500	20,000	20,000	18,500	39,000
PATIENT CARE COSTS	INPATIENT					
	OUTPATIENT					
ALTERATIONS AND RENOVATIONS						
OTHER EXPENSES						
CONSORTIUM/ CONTRACTUAL COSTS	DIRECT					
SUBTOTAL DIRECT COSTS *(Sum = Item 8e, Face Page)*		205,000	205,000	205,000	205,000	205,000
CONSORTIUM/ CONTRACTUAL COSTS	F&A	16,400	16,400	16,400	16,400	16400
TOTAL DIRECT COSTS		221,400	221,400	221,400	221,400	221,400

TOTAL DIRECT COSTS FOR ENTIRE PROPOSED PROJECT PERIOD $ 1,107,000

JUSTIFICATION. Follow the budget justification instructions exactly. Use continuation pages as needed.

Luby, Stephen P. (ICDDR,B) – Budget Justification

A. Key/Senior Personnel

The cost of salary support is based on ICDDR,B's pay scale for similar existing positions. It is anticipated that salaries will increase on a yearly basis based on organization-wide increases as well as increasing experience.

Steve Luby/Co-Principal Investigator: Dr. Luby will spend (b) (4), (b) (6) of his time in management and supervision of this project. However, his salary is not covered under this proposal because he is employed by CDC and therefore does not require salary support from research projects.

Emily Gurley/Co-Investigator/Program Coordinator: The Program Coordinator provides administrative as well as scientific oversight of the project. This person will be involved in every aspect of the study and this will require (b) (4), (b) (6) of time. Her salary is currently covered under other research projects.

Laboratory specialist: The laboratory specialist is an international scientist position that will be instrumental in developing and supervising the Nipah laboratory set-up and testing for the NIH grant. This will require approximately (b) (4), (b) (6) of his time for 5 years.

CONTD..../

Luby, Stephen P. (ICDDR,B) – Budget Justification Continued.....

Key Personnel continued...
Jahangir Hossian/Co-Investigator/Research physician: This will help to support the salary of one of the co-investigators of the study who will devote approximately (b) (4), of his time to the management and development of the epidemiology activities.

B. Other Personnel
Laboratory Officer: This position will be in charge of the Nipah laboratory testing done at ICDDR,B and oversight of all local lab activities. This will take approximately (b) (4), (b) (6) of their time in years 1-4.

Nipah epidemiology coordinator: This position will manage the day-to-day oversight of the epidemiological activities from Dhaka. This person will also travel with the mobile response team when needed. We have budgeted for one full-time coordinator for 5 years.

Veterinary officer: One research veterinarian will be responsible for overseeing the local bat collection activities and participating in outbreak investigations in testing domestic and wild animals. We have budgeted for one full-time vet officer.

Qualitative researcher: There will be one qualitative researcher for 5 years who will investigate Nipah confirmed cases to further define quantitative instruments and test prevention messages. We have covered (b) (4), (b) (6) of their salary in years 1 and 5 and (b) (4), (b) (6) in years 2-4 when the bulk of qualitative work will take place.

Laboratory research officers: Laboratory research officers will be required for assistance with processing and testing human and animal samples that come from the field. They are funded for all months of specimen collection.

Field research officer: We will cover 21 person months of time in year 5. This position will oversee data collection done by the field research assistants during the large survey conducted that year. We have also included 8 person-months of time in years 1-4 for outbreak data collection.

Field research assistants: The FRAs will administer questionnaires and assist with contract tracing during outbreak situations. They will also carry out other field-based surveys. We anticipate that a total of 4 FRA person-months will be needed per years 1 to 4. During year 5, we will require 68 person-months of time to complete the large survey.

Hospital physician stipend: We will provide a small stipend to physicians working in surveillance hospitals for data and specimen collection. They will receive approximately $45 per month, each.

Health assistant: One health assistant will be needed to transport collected specimens, data forms, and liquid nitrogen to and from the field.

C. Equipment over $5000
ELISA reader: One ELISA reader will be required for performing human and animal ELISA tests at ICDDR,B. This will cover the cost of the machine and it's shipping costs.

Freezer: One –70C freezer will be needed to store the samples that will be collected from the surveillance sites. It will be purchased in year 1.

Additional equipment

PC with printers: This will provide 3 PCs with printers for the administrative tasks associated with the project and the scientific work done by the coordinator, qualitative researcher, and the research physician.

Laptop: Two laptops will be purchased for the mobile investigation team.

Liquid nitrogen tanks: Samples will be stored in the field and transported to Dhaka in liquid nitrogen. We will need to purchase four small tanks (10L) for transporting liquid nitrogen from Dhaka to the specimen collection sites.

D. Travel

Domestic (within Bangladesh) travel

Local travel and site visits: Local travel is estimated to cost $500 per vehicle per week of travel in the field (includes driver and fuel). We have budgeted for 20-25 weeks of field transport in this budget and will use transport support from other activities as well. $22,000 has been budgeted for year 5 when the large survey team will require additional time in the field.

Per diem for local travel: Local per diem rates vary around the country but we have budgeted an average of $10 per overnight stay for food and lodging. We anticipate that we will spend $3500-5000 per year in per diem costs in years 1-4. The costs for year 5 are $17,000 considering the large survey that will be conducted.

E. *Trainee/participant* support costs: None.

F. Other direct costs

1. Materials and supplies:

Lab and sample collection supplies

Specimen collection supplies: We have budgeted $1.50 per specimen collection. This includes syringes, needles, vacutainers, etc, for human and animal sample collection (4000 over 5 years). The costs for these supplies are all covered in years 1-3.

Lumbar puncture kits: We have budgeted for collecting 700 lumbar punctures ($2 each) in 5 years, with all kits purchased in years 1 to 3.

Cryovials: These will cost approximately $0.36 each and we estimate using 10,000 cryovials in 5 years. We will purchase all within the first 3 years.

Cryovial boxes: These will be used to safely store and ship the cryovials. Based on the number of cryovials purchased we estimate that we will need 130 boxes based on using 10,000 cryovials. They will all be purchased in year 1.

Masks (N-95): We anticipate using approximately 4,500 masks during outbreaks and specimen collection. The masks cost approximately $1.50 each. All masks will be purchased in the first 3 years.

Pippettes: The lab will need one each Finnepippette (0-200 mcl), Finnepippette (0-40 mcl), and Multi channel pipette for specimen handling. Three Finnepippette (0-200 mcl) will be needed in the field- one for each surveillance site.

Cryogenic gloves: 4 cryogenic gloves will be required for using liquid nitrogen for specimen handling and storage.

RT-PCR reagents: These will be required for performing PCR testing at ICDDR,B on saliva and urine specimens collected from bats. We will test 600 urine swabs collected from tarps in years 1 to 5. We will test

400 urine and 400 saliva specimens from individual bats collected in years 1 to 4. Total or 1400 in years 1 to 4 and 600 in year 5. We have budgeted for $35 per sample.

ELISA bat reagents: We will perform 400 bat ELISAs per year in years 1 to 4 and have budgeted $15 per sample for this testing.

ELISA human reagents: We will perform 400 human ELISAs per year in years 1 to 5 and have budgeted $10 per sample for this testing.

Liquid nitrogen: We estimate that we will use approximately 35 L of liquid nitrogen per week of surveillance in the field. We have budgeted for 40 weeks in the field for years 1-4 and 25 weeks in year 5.

Office supplies: $1000 has been budgeted for office supplies for each year of the project.

Cold boxes: Three cold boxes will be purchased in year 1 to assist in specimen transport.

File cabinet: Three file cabinets will be purchased in year 1 to store data collected from this project.

2. Publishing and photocopying:
$1000 will cover photocopying of reports and questionnaires as well as other non-specific printing costs each year.

8. Communication, services and others
International shipping: Human samples will be shipped to CDC for quality assurance of local ELISA testing, virus isolation and sequencing. Bat samples will be shipped to AAHL for additional testing. Based on previous experience each shipment will cost approximately $1500 and we will make 3-4 shipments per year.

Mobile phone bill: Because of the logistical challenges of managing various surveillance and other epidemiological activities, communication among team members will be paramount. We have budgeted 18-36 months of service charges ($30) for each year.

Communications: $500-1000 per year will cover fax, postage, telephone and courrier costs between local staff and international collaborators.

Internet connections: Each connection with service costs $35 per month and we will cover 12 months of service for 2 persons each year, except year 5 when we cover 1 person.

Rent and utilities: We have budgeted $7000-12,000 per year to help cover costs of office and laboratory rents and utilities, including electricity and gas.

Training, workshop, seminar: This will cover costs for periodic dissemination of findings from the study as well as workshops for local collaborators on surveillance activities, recent outbreaks, and clinical management. We have budgeted $1000-4000 each year.

Data entry: We budgeted a bulk amount of about $2000 for data entry in years 1 to 4 for entering data collected from outbreak investigations. $10060 is budgeted for year 5 when the large survey will be conducted.

Routine lab testing: Each patient enrolled in our surveillance study will receive local lab testing of CSF. For routine investigation we will cover the costs of: CSF gram staining, CSF cytology, and CSF protein and glucose. These tests will help to clinically define Nipah virus infection in Bangladesh and help to identify

bacterial cause of encephalitis as well as inform the local treatment of the patient. It is estimated that testing per patient will cost $7.

X-rays: In order to better define the clinical presentation of Nipah virus infection any patients found during surveillance presenting with respiratory findings will undergo a chest radiograph. We anticipate that this will be about 20 patients per year and the estimated cost per radiograph is $2.

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

DETAILED BUDGET FOR INITIAL BUDGET PERIOD
DIRECT COSTS ONLY

FROM 7/1/08 THROUGH 6/30/09

PERSONNEL (Applicant organization only)		Months Devoted to Project				DOLLAR AMOUNT REQUESTED (omit cents)		
NAME	ROLE ON PROJECT	Cal. Mnths	Acad. Mnths	Summer Mnths	INST.BASE SALARY	SALARY REQUESTED	FRINGE BENEFITS	TOTAL
Andrew P. Dobson	PD/PI							(b) (4), (b) (6)
SUBTOTALS →								(b) (4), (b) (6)

CONSULTANT COSTS	
EQUIPMENT *(Itemize)*	
SUPPLIES *(Itemize by category)* misc. computer items, software upgrades, postage, courier service etc.	2,092
TRAVEL Domestic - $750; Foreign (USA-Bangladesh) - $5400	6,150
PATIENT CARE COSTS — INPATIENT	
PATIENT CARE COSTS — OUTPATIENT	
ALTERATIONS AND RENOVATIONS *(Itemize by category)*	
OTHER EXPENSES *(Itemize by category)*	
CONSORTIUM/CONTRACTUAL COSTS	DIRECT COSTS
SUBTOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD *(Item 7a, Face Page)*	$ 18,267
CONSORTIUM/CONTRACTUAL COSTS — FACILITIES AND ADMINISTRATIVE COSTS	10,595
TOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD	$ 28,862

BUDGET FOR ENTIRE PROPOSED PROJECT PERIOD
DIRECT COSTS ONLY

BUDGET CATEGORY TOTALS	INITIAL BUDGET PERIOD (from Form Page 4)	ADDITIONAL YEARS OF SUPPORT REQUESTED 2nd	3rd	4th	5th
PERSONNEL: *Salary and fringe benefits. Applicant organization only.*					(b) (4), (b) (6)
CONSULTANT COSTS					
EQUIPMENT					
SUPPLIES	2,092	2,176	2,263	2,353	2,447
TRAVEL	6,150	6,396	6,652	6,918	7,194
PATIENT CARE COSTS — INPATIENT					
PATIENT CARE COSTS — OUTPATIENT					
ALTERATIONS AND RENOVATIONS					
OTHER EXPENSES					
CONSORTIUM/ CONTRACTUAL COSTS — DIRECT					
SUBTOTAL DIRECT COSTS *(Sum = Item 8a, Face Page)*	18,267	19,005	19,813	20,640	21,465
CONSORTIUM/ CONTRACTUAL COSTS — F&A	10,595	11,023	11,492	11,971	12,450
TOTAL DIRECT COSTS	28,862	30,028	31,305	32,611	33,915

TOTAL DIRECT COSTS FOR ENTIRE PROPOSED PROJECT PERIOD **$ 156,721**

JUSTIFICATION. Follow the budget justification instructions exactly. Use continuation pages as needed.

Andy Dobson will develop models for the dynamics of Nipah virus in bats and humans; these will be used to examine the conditions that lead to the long-term persistence of Nipah in fruit bats and then to determine the conditions that lead to spillover into human populations. A second suite of models will be developed to examine the dynamics of Nipah virus in human populations immediately following emergence. In both cases the model structure will be extended to consider ecological, epidemiological and economic considerations; the latter can be used to develop cost benefit analyses for different ways of controlling or minimizing the scale of human outbreaks. An inflation factor of 4% is applied in Years 02-05.

SALARIES:

Andrew Dobson (PI)

(b) (4), (b) (6) summer salary (b) (4), (b) (6) is requested in each year. Salary is calculated at (b) (4), (b) (6) academic year salary as permitted by Princeton University.

Fringe Benefits are calculated at rates determined by Princeton University.

DOMESTIC TRAVEL:

One trip per year is budgeted in all years of the grant for the PI to attend the annual EID meeting in Washington, DC. Costs include air fare or train fare from Princeton/Newark, accommodations for 2-3 nights and miscellaneous costs for local transportation and per diem. Annual costs are estimated at $750. Contd../

Andrew P. Dobson, Princeton University Subcontract, Budget Justification continued.

FOREIGN TRAVEL:
Bangladesh: Funds are budgeted for one trip to Bangladesh each year of the grant. Cost calculations include air fare ($2,800), Accommodations for 10 nights at $200 per night ($2,000); local transportation, meals and miscellaneous travel costs at $60 per day ($600).
MATERIALS AND SUPPLIES include miscellaneous computer items, software upgrades, postage, courier service, etc. and are estimated at $2,100 per year in all years of the grant
INDIRECT COSTS are calculated at 58% modified total direct costs (excluding tuition, equipment over $5,000 and subcontract amounts over $25,000), per agreement between Princeton University and DHHS dated June 26, 2007.

F. Vertebrate animals

1. Detailed description of animal use.

All work with vertebrate animals will be conducted in Bangladesh.

Fruit bat capture. Capture and bleeding techniques have been approved by IACUC #G929-07. Fruit bats will be captured using a mist net described in section D.1. The net system is manned by two people during the entire capture period, and bats are removed from the net as soon as they become entangled to minimize stress and prevent injury. In our experience, a maximum of 15-20 bats can be safely held and processed by a team of three people per trapping period using gas anesthesia. Duration of trapping will depend on the capture rate. Bats are placed into a pillowcase and hung from a branch or post until samples are collected. Bats are held for a maximum of six hours.

Chemical restraint.

Based on revised sample size calculations that have increased the per site sample size to 100 bats, we will use isoflurane and a portable vaporizer (manufacturer) to restrain bats). Isoflurane has been shown to be safe and effective short-term chemical restraint for Pteropodid bats in the field (Jonsson 2004). Isoflurane has allowed us to successfully sample 100 bats in about 5-7 days. A portable isoflurane vaporizer will be used on this project (Harvard Apparatus, MA, USA). Bats will be under anesthesia for 10-12 minutes, and recovery is determined by presence of palpebral and withdrawal reflexes, as well as biting reflex. Bats are kept in a quiet, cool place while waiting to be processed and while recovering from anesthesia. Bats are given mango juice orally by syringe prior to release. Bats are released at their site of capture and are allowed to climb into a tree where they can either rest or fly.

Sample Collection. Bats will be anesthetized prior to sampling.

Bats: Two sets of three swabs will be taken from *Pteropus giganteus*: throat, urogenital tract, and rectal. 3.0 ml of blood will be collected from the radial artery or vein using a 23 gauge needle and 3cc syringe.

Animal Identification

Bats will be banded on the first phalanx of digit I, using stainless steel thumb bands (size #4 Gey Band & Tag Co, PA, USA) stamped with a unique serial number (Kunz, pers. com). A veterinary microchip (AVID Identification Systems, LA) carrying a unique ID number will be implanted subcutaneously between the scapulae according to manufacturer's instruction. These ID numbers can be retrieved using a microchip reader (AVID). This allows for two means of animal identification: the thumb bands can be viewed from a distance, allowing for crude censusing of marked bats using binoculars; and the microchip insures animal ID for collecting accurate recapture data in the event that the thumb band is lost.

Satellite Telemetry: Satellite transmitters placed on 6 fruit bats will allow us to measure the long-range movements of these flying foxes and the rate of migration between colonies and deduce whether these colonies are acting as a meta-population for NiV to exist endemically within. We will place 7 satellite collars (20 gram battery powered Platform Transmitting Terminals (PTT)– Microwave Telemetry, MD, USA) and 20 radio collars onto adult male and female *P. giganteus* at two different colonies using techniques developed on our (b) (4) PTTs will be attached to a 1.4mm leather collar using a contact adhesive reinforced with nylon thread stitched at the brace points of the PTT and sealed with epoxy resin. Collars will be placed around the neck and secured using two brass rivets. Collars are designed to hold the PTT in place between the shoulders of the fruit bat allowing sufficient girth to prevent strangulation but to prevent the collar from slipping over the bat's head; even if the bat grows (Collars can transmit for 1-2 years depending on the frequency of signal transmission). We will use a duty cycle of 10 hour transmission every 5 days. This will provide long-lat locations for the bats both during roosting and feeding activities over time. Transmitters are equipped with "mortality sensors" that transmit a VHS signal in the event that there is no motion on the collar for a prolonged period of time. We will attempt to recover transmitters using a VHS receiver to determine reasons for loss of collars. In addition, we will print contact information and a message in Bengali to return collars to ICDDR,B if found. We used this approach in Malaysia, and it led to the return of a lost collar in 2004. All collared fruit bats will be mature healthy male or female adults for which the PTT will be less than 3-5% of the total body weight. Females should be able to accommodate the additional weight of the transmitter as their pups can weigh up to 30% of

their body weight while still clinging to them (Hall and Richards 2000).

2. Justify use of animals, choice of species, numbers to be used.
Species and number used in study:
Fruit bats (*Pteropus giganteus*): 6,000
Pteropodid bats are the putative reservoir for henipaviruses The sample size (100 bats) was chosen to be able to detect both the presence of antibodies to Nipah virus in a colony of up to 10,000 bats at an assumed seroprevalence of 10% with a 95% confidence interval and a difference in seroprevalence of 30% between two time points or populations (Health 1982; Dohoo 2003).

3. Provide information on veterinary care. Animals will receive emergency veterinary care if necessary. There is no specific veterinary care that is appropriate for this project, nor are clinical veterinary facilities included as a performance site, as animals will be released within hours of capture.

4. Procedures for ensuring animal comfort, lack of distress, pain, or injury.
Bats: Bats will not be held longer than 6 hours. In our experience, bats tolerate this period well and there have been no clinical adverse effects seen in any of the bats captured and sampled in Malaysia and Bangladesh. Mist nets will be attended during capture periods, and bats will be extracted from the net as soon as they become entangled. This will minimize stress and prevent injury from entanglement. Bats will be placed in pillowcases and hung from tree branches while awaiting processing and during recovery. The pillowcases are sufficiently porous as to allow for ventilation. The enclosed environment seems to calm the bats, as they do not struggle once inside, but they hang quietly. Bats are protected from extreme heat or cold while under anesthesia, and lubrication is used on their eyes to protect them from injury. Bats are monitored by a veterinarian during all stages of capture, processing, and release. Bats are kept in a cool place while in the pillowcases. Prior to release, bats will be syringe-fed fruit juice to accommodate any hypoglycemia from capture. We have placed collars on captive Australian flying foxes and observed them for two months. These (b) (4) In Malaysia we have had a flying fox carrying a transmitter for seven months. Tidemann and Nelson report Grey-headed flying foxes carrying transmitters for up to a year (Tidemann and Nelson 2004).

5. Euthanasia: To date, there has been no mortality of fruit bats in CCM's or collaborator's work related to Nipah virus. More than 1,000 bats representing seven species of *Pteropus* have been captured for projects in Malaysia, India, and Australia. In the event of injury to an animal that results in pain and suffering, and reasonable veterinary care is unavailable, the animal will be euthanized by Dr Epstein or a trained veterinary officer using ketamine injected intramuscularly 37.5mg/kg (Heard 1996) and sodium pentobarbital injected intravenously at a dose of 1.0ml per 5kg injected intravenously. This protocol is in accordance with the AVMA euthanasia report (2001).

G. Select Agent Research
1. Identify the Select Agent(s) to be used in the proposed research.

Nipah virus is an overlap select agent regulated by both HHS and USDA. W3 will not be working with Nipah virus in these proposed activities; however, serum neutralization testing and viral culture of my samples will be performed under BSL 4 conditions at the Australian Animal Health Laboratory. We have also described field safety protocols for Biohazard below.

2. Provide the registration status of all entities* where Select Agent(s) will be used.

- **If the performance site(s) is a foreign institution, provide the name(s) of the country or countries where Select Agent research will be performed.**

The Australian Animal Health Laboratory (AAHL), located in Geelong Australia, is the largest and one of the most sophisticated biosecurity laboratories in the world and has an international reputation in the area of emerging BSL-4 pathogens. AAHL has been subcontracted for an NIH (NIAID) award to work on select agents

(PI: Broder, Christopher, C.) and as such, they are currently approved and have been site-visited by NIAID/CDC staff and have supplied the necessary documentation as described in 42 CFR Part 73.

3. Provide a description of all facilities where the Select Agent(s) will be used.

All work to be conducting using select agents will be performed within the BSL-4 laboratories at the Australian Animal Health Laboratory, Geelong, Australia under the direction of Dr Deborah Middleton. The laboratories are fully certified and have US Public Health Service approved animal welfare assurance (**assurance number A 5399-01**). The Australian Animal Health Laboratory (AAHL) is the largest and one of the most sophisticated laboratories in the world and has an international reputation in the area of emerging BSL-4 pathogens. AAHL is the only laboratory globally that regularly conducts large and small animal experiments with BSL-4 pathogens. In addition to approximately 2800 square meters of BSL-3 lab space, the facilities include not only flexible film isolators and one BSL4 laboratory (approximately 40 square meters) but also two animal rooms (approximately 140 square meters) in which animals infected with BSL-4 agents can be handled safely. AAHL has developed extensive protocols and training procedures to ensure that personnel working with zoonotic BSL-4 agents such as Hendra and Nipah viruses can do so in safety. The laboratory employs approximately 30 engineering staff specifically to ensure save and continuous operation of the secure facilities which far exceed the physical-plant infrastructure of a typical state-of-the-art biological research facility.

BIOHAZARD

Nipah virus is known to cause outbreaks with high case fatality rates and there are no vaccines available for this agent, although ribavirin has been shown to be somewhat successful in treating clinical cases (36% reduction in mortality) (Chong HT et al. 2001 Treatment of Acute Nipah virus Encephalitis with Ribavirin Ann. Neurol 49: 810-3). Nipah virus is classified as a BSL-4 agent. The work proposed in this application will involve two aspects: field work and laboratory work. Field work involves the highest risk of being infected by NiV, while handling bats, their blood samples or their excreta. Our field teams are run by a qualified veterinarian (Epstein, Co-investigator) with a great deal of wildlife experience and we take great care in the field to limit the risk of accidental exposure. We have been working specifically with *Pteropus* bats that carry NiV in Malaysia for the past 5 years under a previous R01 without incident. We have strict procedures for handling bats and working with samples from them as they are secured in the field and transported to the lab. In the field in Bangladesh, We will also adhere to the biohazard safety procedures at the ICDDR,B (Dr Luby's institution). While in the field we utilize full personal protective equipment when handling bats. This includes coveralls, a face shield, nitrile gloves, and a P100 respirator. All bat handlers wear nitrile gloves under leather welding gauntlets and safety glasses or a face shield when handling bats and nitrile gloves and a respirator when drawing blood from anesthetized bats. All field clothing and equipment is disinfected using Virkon disinfectant. All biological waste from field surveys is disposed of in the appropriate container (sharps box or an autoclave bag) and will be autoclaved at the ICDDR,B. All field staff have been vaccinated for rabies – another clinically significant virus that some bats carry – and all have their titer regularly checked, and carry booster injections with them in the field. All field teams have continual access to a supply of ribavirin, should any accidental exposure to bat fluids occur.

Field safety protocol

Our procedures to deal with bites, needle-sticks etc. are as follows: The wound is washed thoroughly with soap and water to clean away dirt and debris, then vigorously scrubbed with a sterile gauze bandage and benzalkonium chloride for 5 minutes. If bleeding, pressure is applied with a sterile bandage for until bleeding has stopped. If the wound continues to bleed, medical attention at the nearest hospital is sought. The bat from which the bite or exposure originated is identified, and the samples collected from it labeled on the data sheet that these were involved in an exposure. If possible, the bat is euthanized under anesthesia and it's brain is submitted for RFFT (rabies) testing at ICDDR,B. Blood samples are taken and submitted for rapid testing using ELISA for anti-NiV IgG and IgM. Swabs are also taken and submitted for rapid PCR testing for NiV. Our procedures require that the person potentially exposed reports to a major hospital within 24 hours to have wound examined and receive a rabies booster (single vaccine dose given intramuscularly as per CDC protocols). We also request a liver profile to make sure that baseline liver values are within normal limits. We then expect to begin a prophylactic (preventative) ribavirin course according to the published protocol for Nipah virus infection (Chong et al. 2001). All field technicians will be required to wear the same personal protective

equipment, and undergo the same training as I have, and adhere to the same protocols in the case of exposure.

The serological testing work is very low risk. We have been collaborating with Consultant Dr Ian Lipkin at Columbia University for over 2 years, and our staff have been trained in, and follow biohazard safety protocols. Co-investigator Epstein has registered with the federal registry for research on select agents. No viral culture will be attempted at Columbia. The serum will be heat inactivated prior to shipping (i.e. will be non-infectious on arrival in the USA). We will be extracting RNA and working only with RNA for PCR (i.e. a non-infectious procedure).

Dohoo I, W. Martin and H. Stryhn (eds) (2003). *Veterinary Epidemiologic Research*. AVC Inc, Charlottetown, Prince Edward Island, Canada.

Hall L, and Richards G (2000). *Flying Foxes: Fruit and Blossom Bats of Australia*, 1st edition. Krieger Publishing Company.

Health ABoA (1982). *Livestock Disease Surveys: A Field Mamual for Veterinarians*. Commonwealth of Australia, Canberra.

Heard DB, C. Owens, J. (1996). J. Ketamine and ketamine:xylazine ED(50) for short-term immobilization of the island flying fox (Pteropus hypomelanus). . *1996* **27**:44-48.

Jonsson NN, Johnston, S.D., Field, H., De Jong, C, Smith, C. (2004). Field anaesthesia of three Australian species of flying fox. *The Veterinary Record* **154**:664.

McLaughlin AB, Epstein JH, Prakash V, Smith CS, Daszak P, Field HE, et al. (Submitted April, 2005). Plasma biochemistry and hematological values for wild-caught flying foxes (Pteropus giganteus) in India. *Journal of Zoo and Wildlife Medicine*.

Tidemann CR, and Nelson JE (2004). Long-distance movements of the grey-headed flying fox (Pteropus poliocephalus). *Journal of Zoology* **263**:141-146.

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

CHECKLIST

TYPE OF APPLICATION *(Check all that apply.)*

☒ NEW application. *(This application is being submitted to the PHS for the first time.)*

☐ RESUBMISSION of application number: _____
(This application replaces a prior unfunded version of a new, renewal, or revision application.)

☐ RENEWAL of grant number: _____
(This application is to extend a funded grant beyond its current project period.)

☐ REVISION to grant number: _____
(This application is for additional funds to supplement a currently funded grant.)

☐ CHANGE of program director/principal investigator.

Name of former program director/principal investigator: _____

☐ CHANGE of Grantee Institution. Name of former institution: _____

☐ FOREIGN application ☒ Domestic Grant with foreign involvement List Country(ies) Involved: Bangladesh

INVENTIONS AND PATENTS *(Renewal appl. only)* ☒ No ☐ Yes

If "Yes," ☐ Previously reported ☐ Not previously reported

1. PROGRAM INCOME ***(See instructions.)***
All applications must indicate whether program income is anticipated during the period(s) for which grant support is request. If program income is anticipated, use the format below to reflect the amount and source(s).

Budget Period	Anticipated Amount	Source(s)
Full budget period	$0.00	

2. ASSURANCES/CERTIFICATIONS ***(See instructions.)***
In signing the application Face Page, the authorized organizational representative agrees to comply with the policies, assurances and/or certifications listed in the application instructions when applicable. Descriptions of individual assurances/certifications are provided in Part III and listed in Part I, 4.1 under Item 14. If unable to certify compliance, where applicable, provide an explanation and place it after this page.

3. FACILITIES AND ADMINSTRATIVE COSTS (F&A)/ INDIRECT COSTS. See specific instructions.

☒ DHHS Agreement dated: 1/7/06 ☐ *No Facilities And Administrative Costs Requested.*

☐ DHHS Agreement being negotiated with _____ Regional Office.

☐ No DHHS Agreement, but rate established with _____ Date _____

CALCULATION* *(The entire grant application, including the Checklist, will be reproduced and provided to peer reviewers as confidential information.)*

a. Initial budget period:	Amount of base $	228,114	x Rate applied	22.16	% = F&A costs	$	50,550
b. 02 year	Amount of base $	190,181	x Rate applied	22.16	% = F&A costs	$	42,144
c. 03 year	Amount of base $	189,183	x Rate applied	22.16	% = F&A costs	$	41,923
d. 04 year	Amount of base $	182,816	x Rate applied	22.16	% = F&A costs	$	40,512
e. 05 year	Amount of base $	184,486	x Rate applied	22.16	% = F&A costs	$	40,882
					TOTAL F&A Costs	$	216,011

*Check appropriate box(es):

☐ Salary and wages base ☒ Modified total direct cost base ☐ Other base *(Explain)*

☐ Off-site, other special rate, or more than one rate involved *(Explain)*

Explanation *(Attach separate sheet, if necessary.)*:

4. DISCLOSURE PERMISSION STATEMENT: If this application does not result in an award, is the Government permitted to disclose the title of your proposed project, and the name, address, telephone number and e-mail address of the official signing for the applicant organization, to organizations that may be interested in contacting you for further information (e.g., possible collaborations, investment)? ☐ Yes ☒ No

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE (if not in response to a program announcement/solicitation enter NSF 07-1-40)

NSF 07-513 12/12/07

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

0813157

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

EF - ECOLOGY OF INFECTIOUS DISEASES

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
12/12/2007	4	08040000 EF	7242	077090066D	12/12/2007 5:11pm

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

311726494

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

Wildlife Trust, Inc.

AWARDEE ORGANIZATION CODE (IF KNOWN)

6250004409

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

Wildlife Trust, Inc.
460 West 34th Street
New York, NY. 100012320

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

PERFORMING ORGANIZATION CODE (IF KNOWN)

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 2,498,829	60 months	07/01/08	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
☒ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date Planned
PHS Animal Welfare Assurance Number A4059-01
☒ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number FWA00001468
Exemption Subsection _____ or IRB App. Date Pending
☒ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
BG
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT
Consortium for Conservation Medicine

PI/PD FAX NUMBER
212-380-4465

PI/PD POSTAL ADDRESS
460 West 34th Street
17th floor
New York, NY 10001
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME Peter Daszak	PhD	1993	(b) (6)	(b) (6)
CO-PI/PD Stephen P Luby	MD	1986	(b) (6)	(b) (6)
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME Aleksei A Chmura	Electronic Signature	Dec 12 2007 4:20PM

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
(b) (6)	(b) (6)	212-380-4475

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/If not in response to a program announcement/solicitation enter NSF 07-140

NSF 07-513 12/12/07

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

0813111

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

EF - ECOLOGY OF INFECTIOUS DISEASES

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
12/12/2007	4	08040000 EF	7242	002484665	12/12/2007 5:12pm

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

210634501

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

Princeton University

AWARDEE ORGANIZATION CODE (IF KNOWN)

0026278000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

Off. of Research & Proj. Admin.
4 New South Building
Princeton, NJ 08544-0036

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

PERFORMING ORGANIZATION CODE (IF KNOWN)

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS ☐ IF THIS IS A PRELIMINARY PROPOSAL
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 156,721	60 months	07/01/08	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date _____
PHS Animal Welfare Assurance Number _____
☐ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number _____
Exemption Subsection _____ or IRB App. Date _____
☒ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
BG
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT
Ecology and Evolutionary Biology

PI/PD POSTAL ADDRESS

Princeton, NJ 085441003
United States

PI/PD FAX NUMBER
609-258-1334

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME Andrew P Dobson	PhD	1981	(b) (6)	(b) (6)
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

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(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

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(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

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(2) building (and any related equipment) is covered by adequate flood insurance.

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(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME Sally J Waltman	Electronic Signature	Dec 12 2007 3:55PM

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
(b) (6)	(b) (6)	609-258-1159

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

Directorate for Biological Sciences
Emerging Frontiers
Ecology of Infectious Diseases

Proposal Classification Form
PI: / Proposal Number: 0813157

CATEGORY I: INVESTIGATOR STATUS (Select ONE)

- ☐ Beginning Investigator - No previous Federal support as PI or Co-PI, excluding fellowships, dissertations, planning grants, etc.
- ☐ Prior Federal support only
- ☐ Current Federal support only
- ☑ Current & prior Federal support

CATEGORY II: FIELDS OF SCIENCE OTHER THAN BIOLOGY INVOLVED IN THIS RESEARCH (Select 1 to 3)

☐ Astronomy	☐ Engineering	☐ Psychology
☐ Chemistry	☑ Mathematics	☑ Social Sciences
☐ Computer Science	☐ Physics	☐ None of the Above
☐ Earth Science		

CATEGORY III: SUBSTANTIVE AREA (No selection required)

CATEGORY IV: INFRASTRUCTURE (No selection required)

CATEGORY V: HABITAT (No selection required)

CATEGORY VI: GEOGRAPHIC AREA OF THE RESEARCH (No selection required)

CATEGORY VII: CLASSIFICATION OF ORGANISMS (Select 1 to 4)

☑ VIRUSES	☐ Mitosporic Fungi	☐ Musci (Mosses)
☐ Bacterial	☐ Oomycota	☐ VASCULAR PLANTS
☐ Plant	☐ Yeasts	☐ FERNS & FERN ALLIES
☐ Animal	☐ Zygomycota	☐ GYMNOSPERMS
☐ PROKARYOTES	☐ LICHENS	☐ Coniferales (Conifers)
☐ Archaebacteria	☐ SLIME MOLDS	☐ Cycadales (Cycads)
☐ Cyanobacteria	☐ ALGAE	☐ Ginkgoales (Ginkgo)
☐ Eubacteria	☐ Bacillariophyta (Diatoms)	☐ Gnetales (Gnetophytes)
☐ PROTISTA (PROTOZOA)	☐ Charophyta	☐ ANGIOSPERMS
☐ Amoebae	☐ Chlorophyta	☐ Monocots
☐ Apicomplexa	☐ Chrysophyta	☐ Arecacaae (Palmae)
☐ Ciliophora	☐ Dinoflagellata	☐ Cyperaceae
☐ Flagellates	☐ Euglenoids	☐ Liliaceae
☐ Foraminifera	☐ Phaeophyta	☐ Orchidaceae
☐ Microspora	☐ Rhodophyta	☐ Poaceae (Graminae)
☐ Radiolaria	☐ PLANTS	☐ Dicots
☐ FUNGI	☐ NON-VASCULAR PLANTS	☐ Apiaceae (Umbelliferae)
☐ Ascomycota	☐ BRYOPHYTA	☐ Asteraceae (Compositae)
☐ Basidiomycota	☐ Anthocerotae (Hornworts)	☐ Brassicaceae (Cruciferae)
☐ Chytridiomycota	☐ Hepaticae (Liverworts)	☐ Fabaceae (Leguminosae)

- ☐ Lamiaceae (Labiatae)
- ☐ Rosaceae
- ☐ Solanaceae

☐ ANIMALS

- ☐ INVERTEBRATES
  - ☐ MESOZOA/PLACOZOA
  - ☐ PORIFERA (Sponges)
  - ☐ CNIDARIA
    - ☐ Hydrozoa (Hydra, etc.)
    - ☐ Scyphozoa (Jellyfish)
    - ☐ Anthozoa (Corals, Sea Anemones)
  - ☐ CTENOPHORA (Comb Jellies)
  - ☐ PLATYHELMINTHES (Flatworms)
    - ☐ Turbellaria (Planarians)
    - ☐ Trematoda (Flukes)
    - ☐ Cestoda (Tapeworms)
    - ☐ Monogenea (Flukes)
  - ☐ GNATHOSTOMULIDA
  - ☐ NEMERTINEA (Rynchocoela) (Ribbon Worms)
  - ☐ ENTOPROCTA (Bryozoa) (Plant-like Animals)
  - ☐ ASCHELMINTHES
    - ☐ Gastrotricha
    - ☐ Kinorhyncha
    - ☐ Loricifera
    - ☐ Nematoda (Roundworms)
    - ☐ Nematomorpha (Horsehair Worms)
    - ☐ Rotifera (Rotatoria)
  - ☐ ACANTHOCEPHALA (Spiny-headed Worms)
  - ☐ PRIAPULOIDEA
  - ☐ BRYOZOA (Ectoprocta) (Plant-like Animals)
  - ☐ PHORONIDEA (Lophophorates)
  - ☐ BRACHIOPODA (Lamp Shells)
  - ☐ MOLLUSCA
    - ☐ Monoplacophora
    - ☐ Aplacophora (Solenogasters)
    - ☐ Polyplacophora (Chitons)
    - ☐ Scaphopoda (Tooth Shells)
    - ☐ Gastropoda (Snails, Slugs, Limpets)
    - ☐ Pelecypoda (Bivalvia) (Clams, Mussels, Oysters, Scallops)
    - ☐ Cephalopoda (Squid, Octopus, Nautilus)
  - ☐ ANNELIDA (Segmented Worms)
    - ☐ Polychaeta (Parapodial Worms)
    - ☐ Oligochaeta (Earthworms)
    - ☐ Hirudinida (Leeches)
  - ☐ POGONOPHORA (Beard Worms)
  - ☐ SIPUNCULOIDEA (Peanut Worms)
  - ☐ ECHIUROIDEA (Spoon Worms)
  - ☐ ARTHROPODA
    - ☐ Cheliceriformes
      - ☐ Merostomata (Horseshoe Crabs)
      - ☐ Pycnogonida (Sea Spiders)
      - ☐ Scorpionida (Scorpions)
      - ☐ Araneae (True Spiders)
      - ☐ Pseudoscorpionida (Pseudoscorpions)
      - ☐ Acarina (Free-living Mites)
      - ☐ Parasitiformes (Parasitic Ticks & Mites)
    - ☐ Crustacea
      - ☐ Branchiopoda (Fairy Shrimp, Water Flea)
      - ☐ Ostracoda (Sea Lice)
      - ☐ Copepoda
      - ☐ Cirripedia (Barnacles)
      - ☐ Amphipoda (Skeleton Shrimp, Whale Lice, Freshwater Shrimp)
      - ☐ Isopoda (Wood Lice, Pillbugs)
      - ☐ Decapoda (Lobster, Crayfish, Crabs, Shrimp)
    - ☐ Hexapoda (Insecta) (Insects)
      - ☐ Apterygota (Springtails, Silverfish, etc.)
      - ☐ Odonata (Dragonflies, Damselflies)
      - ☐ Ephemeroptera (Mayflies)
      - ☐ Orthoptera (Grasshoppers, Crickets)
      - ☐ Dictyoptera (Cockroaches, Mantids, Phasmids)
      - ☐ Isoptera (Termites)
      - ☐ Plecoptera (Stoneflies)
      - ☐ Phthiraptera (Mallophaga & Anoplura) (Lice)
      - ☐ Hemiptera (including Heteroptera) (True Bugs)
      - ☐ Homoptera (Cicadas, Scale Insects, Leafhoppers)
      - ☐ Thysanoptera (Thrips)
      - ☐ Neuroptera (Lacewings, Dobsonflies, Snakeflies)
      - ☐ Trichoptera (Caddisflies)
      - ☐ Lepidoptera (Moths, Butterflies)
      - ☐ Diptera (Flies, Mosquitoes)
      - ☐ Siphonaptera (Fleas)
      - ☐ Coleoptera (Beetles)
      - ☐ Hymenoptera (Ants, Bees, Wasps, Sawflies)
    - ☐ Chilopoda (Centipedes)
    - ☐ Diplopoda (Millipedes)
    - ☐ Pauropoda
    - ☐ Symphyta (Symphyla)
  - ☐ PENTASTOMIDA (Linguatulida) (Tongue Worms)
  - ☐ TARDIGRADA (Tardigrades, Water Bears)
  - ☐ ONYCHOPHORA (Peripatus)
  - ☐ CHAETOGNATHA (Arrow Worms)
  - ☐ ECHINODERMATA
    - ☐ Crinoidea (Sea Lilies, Feather Stars)
    - ☐ Asteroidea (Starfish, Sea Stars)
    - ☐ Ophiuroidea (Brittle Stars, Serpent Stars)
    - ☐ Echinoidea (Sea Urchins, Sand Dollars)
    - ☐ Holothuroidea (Sea Cucumbers)
  - ☐ HEMICHORDATA (Acorn Worms, Pterobranchs)
  - ☐ UROCHORDATA (Tunicata) (Tunicates, Sea Squirts, Salps, Ascideans)
  - ☐ CEPHALOCHORDATA (Amphioxus/Lancelet)
- ☐ VERTEBRATES
  - ☐ AGNATHA (Hagfish, Lamprey)
  - ☐ FISHES
    - ☐ Chondrichthyes (Cartilaginous Fishes) (Sharks, Rays, Ratfish)
    - ☐ Osteichthyes (Bony Fishes)
      - ☐ Sarcopterygia (Lobe-finned Fishes) (Coelacanth, Lungfish)
      - ☐ Actinopterygia (Ray-finned Fishes)
  - ☐ AMPHIBIA
    - ☐ Anura (Frogs, Toads)
    - ☐ Urodela (Salamanders, Newts)
    - ☐ Gymnophiona (Apoda) (Caecilians)
  - ☐ REPTILIA
    - ☐ Chelonia (Turtles, Tortoises)
    - ☐ Serpentes (Snakes)
    - ☐ Sauria (Lizards)
    - ☐ Crocodylia (Crocodilians)
    - ☐ Rhyncocephalia (Tuatara)
  - ☐ AVES (Birds)
    - ☐ Paleognathae (Ratites)
    - ☐ Sphenisciformes (Penguins)
    - ☐ Procellariiformes (Albatrosses, Petrels, Fulmars)
    - ☐ Pelecaniformes (Pelicans, Gannets, Boobies, Tropicbirds)
    - ☐ Ciconiiformes (Herons, Bitterns, Egrets, Storks, Ibis, Flamingo)
    - ☐ Anseriformes (Ducks, Geese, Screamers)
    - ☐ Falconiformes (Vultures, Hawks, Eagles, Condors, Kites, Falcons)
    - ☐ Galliformes (Megapodes, Turkeys, Quail, Pheasants, Peafowl, etc.)
    - ☐ Gruiformes (Cranes, Rails, Gallinules, Coots, Bustards, Crakes)
    - ☐ Charadriiformes (Terns, Gulls, Stilts, Avocets, Plovers, Puffins, etc.)
    - ☐ Columbiformes (Pigeons, Doves)
    - ☐ Psittaciformes (Parrots, Lories, Cockatoos, Kakapo, Conures, etc.)
    - ☐ *Cuculiformes* (Cuckoos, Turacos, Anis, Coucal, Roadrunner, etc.)
    - ☐ Strigiformes (Owls)
    - ☐ Apodiformes (Hummingbirds, Swifts, Thornbills)
    - ☐ Coraciformes (Kingfishers, Todies, Bee-Eaters, Rollers, Hornbills, etc.)
    - ☐ Piciformes (Woodpeckers, Toucans, Jacamars, Barbets, Honeyguides)
    - ☐ Passeriformes (Passerines)
  - ☐ MAMMALIA

☐ Monotremata (Platypus, Echidna)	☐ Humans	☐ Perissodactyla (Odd-toed Ungulates) (Horses, Rhinos, Tapirs, etc.)
☐ Marsupalia (Marsupials)	☐ Rodentia	
☐ Eutheria (Placentals)	☐ Laboratory Rodents (Rat, Mouse, Guinea Pig, Hamster)	☐ Artiodactyla (Even-toed Ungulates) (Cattle, Sheep, Deer, Pigs, etc.)
☐ Insectivora (Hedgehogs, Moles, Shrews, Tenrec, etc.)	☐ Non-Laboratory Rodents	☐ Sirenia (Manatees, Dugongs)
☑ Chiroptera (Bats)	☐ Lagomorphs (Rabbits, Hares, Pikas)	☐ Proboscidea (Elephants)
☐ Edentata (Anteaters, Sloths, Armadillos)	☐ Tubulidenata (Aardvarks)	☐ Marine Mammals (Seals, Walrus, Whales, Otters, Dolphins, Porpoises)
☐ Primates	☐ Carnivora (Bears, Canids, Felids, Mustelids, Viverrids, Hyena, Procyonids)	☐ TRANSGENIC ORGANISMS
☐ Monkeys	☐ Ungulates	☐ FOSSIL OR EXTINCT ORGANISMS
☐ Apes (Gibbons, Orang-utan, Gorilla, Chimpanzee)		☐ NO ORGANISMS

CATEGORY VIII: MODEL ORGANISM (Select ONE)		
☑ NO MODEL ORGANISM	MODEL ORGANISM (Input up to 9 characters)	

Directorate for Biological Sciences
Emerging Frontiers
Ecology of Infectious Diseases

Proposal Classification Form
PI: / Proposal Number: 0813111

CATEGORY I: INVESTIGATOR STATUS (Select ONE)

- ☐ Beginning Investigator - No previous Federal support as PI or Co-PI, excluding fellowships, dissertations, planning grants, etc.
- ☐ Prior Federal support only
- ☐ Current Federal support only
- ☑ Current & prior Federal support

CATEGORY II: FIELDS OF SCIENCE OTHER THAN BIOLOGY INVOLVED IN THIS RESEARCH (Select 1 to 3)

☐ Astronomy	☐ Engineering	☐ Psychology
☐ Chemistry	☑ Mathematics	☑ Social Sciences
☐ Computer Science	☐ Physics	☐ None of the Above
☐ Earth Science		

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      - ☐ Diptera (Flies, Mosquitoes)
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      - ☐ Coleoptera (Beetles)
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    - ☐ Diplopoda (Millipedes)
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      - ☐ Actinopterygia (Ray-finned Fishes)
  - ☐ AMPHIBIA
    - ☐ Anura (Frogs, Toads)
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    - ☐ Gymnophiona (Apoda) (Caecilians)
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    - ☐ Chelonia (Turtles, Tortoises)
    - ☐ Serpentes (Snakes)
    - ☐ Sauria (Lizards)
    - ☐ Crocodylia (Crocodilians)
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  - ☐ AVES (Birds)
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    - ☐ Sphenisciformes (Penguins)
    - ☐ Procellariiformes (Albatrosses, Petrels, Fulmars)
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    - ☐ Ciconiiformes (Herons, Bitterns, Egrets, Storks, Ibis, Flamingo)
    - ☐ Anseriformes (Ducks, Geese, Screamers)
    - ☐ Falconiformes (Vultures, Hawks, Eagles, Condors, Kites, Falcons)
    - ☐ Galliformes (Megapodes, Turkeys, Quail, Pheasants, Peafowl, etc.)
    - ☐ Gruiformes (Cranes, Rails, Gallinules, Coots, Bustards, Crakes)
    - ☐ Charadriiformes (Terns, Gulls, Stilts, Avocets, Plovers, Puffins, etc.)
    - ☐ Columbiformes (Pigeons, Doves)
    - ☐ Psittaciformes (Parrots, Lories, Cockatoos, Kakapo, Conures, etc.)
    - ☐ Cuculiformes (Cuckoos, Turacos, Anis, Coucal, Roadrunner, etc.)
    - ☐ Strigiformes (Owls)
    - ☐ Apodiformes (Hummingbirds, Swifts, Thornbills)
    - ☐ Coraciformes (Kingfishers, Todies, Bee-Eaters, Rollers, Hornbills, etc.)
    - ☐ Piciformes (Woodpeckers, Toucans, Jacamars, Barbets, Honeyguides)
    - ☐ Passeriformes (Passerines)
  - ☐ MAMMALIA

☐ Monotremata (Platypus, Echidna)	☐ Humans	☐ Perissodactyla (Odd-toed Ungulates) (Horses, Rhinos, Tapirs, etc.)
☐ Marsupalia (Marsupials)	☐ Rodentia	☑ Artiodactyla (Even-toed Ungulates) (Cattle, Sheep, Deer, Pigs, etc.)
☐ Eutheria (Placentals)	☐ Laboratory Rodents (Rat, Mouse, Guinea Pig, Hamster)	☐ Sirenia (Manatees, Dugongs)
☐ Insectivora (Hedgehogs, Moles, Shrews, Tenrec, etc.)	☐ Non-Laboratory Rodents	☐ Proboscidea (Elephants)
☐ Chiroptera (Bats)	☐ Lagomorphs (Rabbits, Hares, Pikas)	☐ Marine Mammals (Seals, Walrus, Whales, Otters, Dolphins, Porpoises)
☐ Edentata (Anteaters, Sloths, Armadillos)	☐ Tubulidenata (Aardvarks)	☐ TRANSGENIC ORGANISMS
☐ Primates	☐ Carnivora (Bears, Canids, Felids, Mustelids, Viverrids, Hyena, Procyonids)	☐ FOSSIL OR EXTINCT ORGANISMS
☐ Monkeys	☐ Ungulates	☐ NO ORGANISMS
☐ Apes (Gibbons, Orang-utan, Gorilla, Chimpanzee)		

CATEGORY VIII: MODEL ORGANISM (Select ONE)		
☑ NO MODEL ORGANISM	MODEL ORGANISM (Input up to 9 characters)	

Project Summary.

Nipah virus (NiV) is highly lethal zoonotic paramyxovirus with fruit bat (*Pteropus* spp.) reservoir hosts. The virus emerged in Malaysia in 1999 via domestic pig amplifier hosts causing an encephalitis outbreak with a 40% case fatality rate; it is currently listed as a category C select agent by NIAID and CDC. Nipah virus has also emerged repeatedly in Bangladesh and India, with 7 recognized outbreaks since 2001. Here, the virus has achieved an advanced stage of emergence, with direct transmission from bats to people, capacity to infect the respiratory pathway, up to five cycles of human-to-human transmission, and increased (71%) case fatality rate.

Our central hypothesis is that dense human populations and close social behavior in Bangladesh combined with the ecology of NiV in fruit bats and interactions between bats and humans create an increased potential for extended NiV outbreaks and pandemic emergence. We will mathematically model NiV dynamics within and among bats, domestic animals, and humans; parameterize our model with field data on bat ecology, virology, and human demography/social behavior; and **use our model to examine factors that foster sustained human-to-human outbreaks, and pandemic emergence.** We will test 4 hypotheses:

1) **NiV spillover risk from bats to humans is tied to the population biology of bats, especially to synchronous breeding patterns.** In Bangladesh NiV activity varies from year to year and seasonally. We will conduct longitudinal surveys of bat colonies in Bangladesh using PCR on pooled colony urine samples, and serological testing of all age classes of bats to parameterize an age-structured mathematical model of bat-bat NiV dynamics. We will test whether colony aggregation, birthing dynamics, or interactions between them maximize the potential for increased viral prevalence to initiate an outbreak.
2) **Bat behavior in the human-dominated environment in Bangladesh has increased bat-human and bat-livestock contact rates, and led to a more advanced stage of NiV emergence.** We propose that the long association between bats and human agriculture in Bangladesh has led to loss of largescale migratory patterns in Bangladesh bats, and altered NiV dynamics to favor repeated emergence. We will enhance our previously developed matrix model, and parameterize this with measurements of the migration rate between bat colonies based on satellite and radio telemetry. We will sequence NiV isolates, and examine strain diversity in bats in relation to spillover outbreaks.
3) **NiV transmission is enhanced in Bangladesh by a combination of human social behavior, high population density, and viral traits which promote human-to-human transmission.** We will examine data from NiV outbreaks to test the association between specific human behaviors and NiV infection. We will assess risk factors for susceptibility to human-transmitted NiV infection within households and characterize food-borne exposure risk. We will intensify collection of NiV isolates and characterize strains involved in person-to-person transmission. We will collect samples from outbreak cases, families, controls, and surrounding livestock to clarify transmission pathways. We will parameterize our model and examine 3 factors that may promote person-to-person transmission: 1: heterogeneity in respiratory shedding resulting in some individuals acting as superspreaders; 2: close physical contact that sick patients have with relatives; and 3: the ability of Bangladesh NiV to infect the respiratory tract. We will use our model to determine social conditions that would cause R_0 to rise above 1.
4) **NiV in Bangladesh presents a threat for regional and pandemic spread.** We will model the current and future spread of NiV from village to village, village to cities, and from Bangladesh to other countries via travel.

The **intellectual merit** of this research is the development of a predictive model for the repeated emergence of a lethal zoonotic virus from wildlife and an examination of its pandemic potential. Results will provide a better understanding of the complexity of zoonotic emergence that involves chains of transmission including wildlife, domestic animals, and human-to-human transmission. Our research will provide unique insight into the advanced stages of zoonotic progression to pandemic spread.

The **broader impacts** include insight into the factors that drive disease emergence and pandemic spread – a threat to health in developing and developed countries. Findings will be disseminated to our contacts within agencies dealing with public health (CDC, WHO), trade (OIE, FAO), development (UNDP, USAID), and conservation (DIVERSITAS, IUCN), and through congressional briefings which Wildlife Trust organizes. This project provides opportunities for training under-represented groups in the USA at co-PI's institutions, which recruit women and minorities into science, and for mutual collaboration with Bangladeshi scientists, students, and leaders.

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Budget (Plus up to 3 pages of budget justification)	24	
Current and Pending Support	11	
Facilities, Equipment and Other Resources	4	
Special Information/Supplementary Documentation	0	
Appendix (List below.) **(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**		
Appendix Items:		

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

TABLE OF CONTENTS

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02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

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PI/PD Name: Peter Daszak

(b) (6)

Gender:

Ethnicity: (Choose one response)

Race:
(Select one or more)

Disability Status:
(Select one or more)

Citizenship: (Choose one)

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☐

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

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Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

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PI/PD Name: Stephen P Luby

Gender: ☐ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☐ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☐ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

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PI/PD Name: Andrew P Dobson

(b) (6)

Gender:

Ethnicity: (Choose one response)

Race:
(Select one or more)

Disability Status:
(Select one or more)

Citizenship: (Choose one)

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List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

(b) (6)

[redacted]

REVIEWERS NOT TO INCLUDE:

(b) (6) **- has indicated repeatedly that emerging diseases including Nipah vius are not important and should not be a funding priority**

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

PROJECT DESCRIPTION

1. INTRODUCTION

The majority of emerging infectious disease (EIDs) affecting humans are zoonotic[1,2]. Zoonoses with wildlife reservoirs in particular are a major threat to public health[3-5], and have caused some of the most significant pandemic EIDs in recent times (e.g. HIV/AIDS, SARS). Smaller scale outbreaks of wildlife-origin zoonoses also threaten global health due to high case fatality rates, lack of effective therapies or vaccines (e.g. Ebola virus, Nipah virus) and potential for future pandemic emergence (e.g. H5N1 HP avian influenza). Zoonotic emergence has been described as a three-[6] or five-stage[7] process from spill-over, through short cycles of human-to-human spread, sustained outbreaks, pandemic emergence, and ultimately (in some cases, e.g. measles) endemicity in humans. The importance of understanding this process is highlighted by the repeated spillover of H5N1 avian influenza, its potential to cause high mortality in a true pandemic[8], and recent evidence for short chains of human-to-human transmission[9]. In this proposal, we investigate Nipah virus (NiV) **a lethal zoonotic pathogen that has shown significant pandemic potential, with repeated spill-over from bats to people, high case fatality rates (overall 71%) and up to five generations of human-to-human transmission.**

Nipah virus in Malaysia and Singapore

Human Nipah virus (NiV) infection was first recognized in a large outbreak of 283 reported cases of encephalitis in peninsular Malaysia and Singapore during 1998-9[10, 11] which had a 39% case fatality ratio [10, 12]. Contact with sick pigs was the primary risk factor for infection [13], and the initial spillover was traced to a large piggery, in which NiV-infected pigs developed fever and a barking cough[14]. The human outbreak of Nipah infection ceased when pigs in the region were culled [15]. In Malaysia, NiV was recovered from the pharynx, respiratory secretions, and urine of infected patients[16], but there was only one case of likely person-to-person transmission - a nurse who cared for hospitalized NiV infected patients and had serologic evidence of Nipah infection and MRI findings characteristic of Nipah virus infection[17].

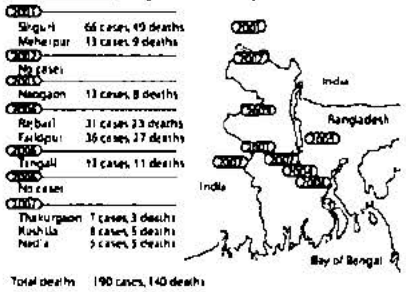
Substantial data implicate fruit bats (*Pteropus* spp.) as the natural reservoir of NiV. In initial studies after the Malaysia outbreak 25% (n=64) of *Pteropus vampyrus* and *P. hypomelanus* sampled had neutralizing antibodies to NiV [18]. Nipah virus was subsequently isolated from *Pteropus* urine and partially eaten fruit in Malaysia [19], and our own surveys show widespread evidence of infection across the region[20]. Fruit bats appear to be the reservoirs across Southeast Asia: In Cambodia[21], in Thailand[22], and from our own work, in India and Bangldadesh[18] (Preliminary data).

Nipah virus in Bangladesh

Seven outbreaks of NiV have been recognized in Bangladesh between 2001 – 2007, all occurring between January and May [23-28] (**Figure 1**). These involved 122 human cases, with a primary presentation of fever and central nervous system pathology, of which 87 died (a case fatality rate of 71%). Two other outbreaks were identified immediately over the border in India[29]. In Bangladesh[23], and Pteropid bats (*P. giganteus*) as the only wild animal with serologic evidence of infection [23, 24].

Three lines of evidence suggest that in Bangladesh, Nipah virus appears to have moved several steps closer to widespread emergence:

Figure 1: Map of the reported outbreaks of Nipah virus in Bangladesh 2001-2007. The total number of cases is 122, of which 87 (71%) died. Note that some years involve multiple spillover events.



1) There appears to be direct NiV transmission between bats and people. Although there are some epidemiological data that suggest potential livestock involvement in Bangladesh NiV spillover[28, 30], either NiV antibody nor the virus has been detected in intermediate hosts in Bangladesh and large herds of livestock are rare, so it appears that domestic animals are not a key amplifier host for NiV in Bangladesh. We will test the hypothesis that bat-to-human spillover in Bangladesh is direct, and model how livestock

involvement would affect spillover. **2) NiV has repeatedly spilled over from bats to humans in separate events, and with different viral strains.** Each Nipah outbreak and additional 17 other NiV spillover events (b) (4) were geographically distant from each other with no contact among cases. Phylogenetic data from viral isolates suggest that each outbreak was produced by a distinct viral spill-over event (see preliminary data below). In this proposed work, we will expand our sequence database for NiV to understand the evolution of the virus in various hosts, and examine whether the virus evolves during generations of person-to-person transmission. We will use these data to parameterize our mathematical model of spillover, chains of transmission within people, and enhanced outbreak or pandemic emergence under different human population densities. **3) There is clear evidence of multiple-generation chains of person-to-person transmission of Nipah virus in Bangladesh**. In the Meherpur outbreak in Bangladesh, epidemiological evidence suggests the index patient infected five other persons in the household[23]. Similar patterns were seen in the Naogaon[23] and Faridpur outbreaks, and in the latter, 5 generations of person-to-person transmission were reported[31]. Taken together the Bangladesh investigations have identified 9 individuals who transmitted NiV to 62 other people. This contrasts sharply with NiV in Malaysia or sinagpore, where intensive epidemiological investigations found no chains of human-to-human transmission. We will analyze contact tracing data from past and future NiV outbreak data to determine R_0 for NiV in Bangladesh outbreaks. **We will model NiV's capacity to cause enhanced outbreaks and its pandemic potential under different social structure, demographic variables (e.g. growing population density, aging population), caring practices, and travel and trade scenarios.**

II. HYPOTHESES AND RATIONALE

Our overall hypothesis is that dense human populations and close social behavior in Bangladesh combined with the ecology of NiV in fruit bats and interactions between bats and humans create an increased potential for extended NiV outbreaks and pandemic emergence. We will **mathematically model NiV dynamics within bats, and among bats, domestic animals and humans,** parameterize our model with field data on bat ecology, NiV virology, demography and human social behavior, and outbreak investigations, and **use the model to examine scenarios that may give rise to sustained human-to-human outbreaks, and pandemic emergence.** We will test four hypotheses:

1) NiV spillover risk from bats to humans is tied to the population biology of bats, especially to synchronous breeding patterns. In Bangladesh, years of multiple NiV spillover events are followed by years with no known activity. However, viral prevalence in bats remains low overall. We will conduct longitudinal surveys of bat colonies in Bangladesh using PCR on urine samples, and serological testing of all age classes of bats to parameterize a mathematical model of bat to bat NiV transmission dynamics. We will simulate colony aggregation and birthing dynamics to examine NiV maintenance, seasonal shedding dynamics, and activities of bats over the season that determine spillover risk (breeding, gestation, feeding, migrating) to help forecast and predict the timing and intensity of NiV outbreaks in humans.

2) Bat behavior in the human-dominated environment in Bangladesh has increased bat-human and bat-livestock contact rates, and led to a more advanced stage of NiV emergence. We propose that the long association between bats and human agriculture in a densely-populated and spatially homogenous landscape in Bangladesh has led to loss of large-scale migratory patterns in Bangladesh bats (*P. giganteus*) and altered NiV dynamics to favor repeated emergence. We will develop a matrix model for spill-over, amplification and human-tohuman transmission, and parameterize this with measurements of the migration rate between bat colonies based on satellite and radio telemetry. A critical barrier to improved understanding of NiV transmission to and from livestock is that only the single Malaysian livestock outbreak has been thoroughly investigated. Investigating more outbreaks, rigorously evaluating the potential contribution of domestic animals and direct bat-human contact, and systematically evaluating domestic animals for infection could provide important information to mitigate a deliberate introduction of Nipah into U.S. livestock.

3) NiV transmission is enhanced in Bangladesh by a combination of human social behavior, high population density, and viral traits which promote human-to-human transmission. We will examine outbreak data to test the association between specific human social behaviors and NiV infection. We will collect samples from outbreak cases, their families, case-controls and surrounding livestock to determine transmission pathways. We will evaluate the risk of food-borne transmission using surveys to measure bat-human contact via fruit consumption and food hygiene practices. We will assess risk factors for susceptibility to human-transmitted NiV infection by comparing the exposure of persons in a household of an NiV transmitter who develop NiV infection with persons in the same household who remain uninfected. We will collect additional NiV isolates and examine NiV strain diversity and evolutionary adaptation to human-to-human transmission. Finally, we will model three elements that we hypothesize contribute to person to person transmission: First, heterogeneity in respiratory shedding within people resulting in some individuals acting as superspreaders; second, the type of close physical contact that sick patients have with relatives; and third, the ability of Bangladesh NiV strains to infect respiratory cells. We will use our model to determine the social conditions and changes in viral shedding that would cause R_0 to rise above 1 and result in NiV emerging beyond the local scale.

4) NiV in Bangladesh presents a threat for regional and pandemic spread. We will model the impact of travel on the current and future spread of NiV from village to village, village to cities, and from Bangladesh to other countries.

C. PRELIMINARY DATA

Our preliminary data was developed under a previous NSF/NIH Ecology of Infectious Diseases award (R01-TW05869 – PI Daszak), and during outbreak investigation, surveillance and research by a joint ICDDR,B (Dhaka, Bangladesh) and Centers for Disease Control and Prevention (CDC - Atlanta) collaboration. These 3 groups have collaborated for the past 2 years in Bangladesh (see "Team", below).

Modeling Nipah virus and Hendra virus dynamics

Modeling Nipah virus emergence in Malaysia: Our NSF/NIH EID (#R01-TW05869) group built an age-structured mathematical model to describe NiV dynamics within the 30,000-head index pig farm in Malaysia[32, 33]. This model (**Figure 2, below**) was parameterized with herd management data from before and during the outbreak[34-36].

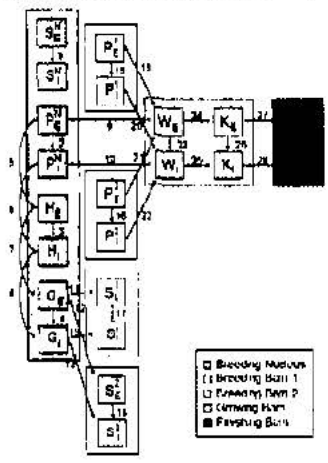


Figure 2 (left): Schematic representation of age- and disease-state transitions in our matrix SEIR model for Nipah virus dynamics within the index pig farm in Ipoh, Malaysia. Sows (S); Gilts (H, G); Piglets (P), 0-10 weeks old; Growers (W, K), 10-20 weeks of age; Finishers (F), 20-26 weeks.

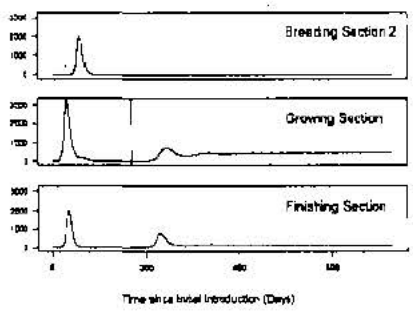


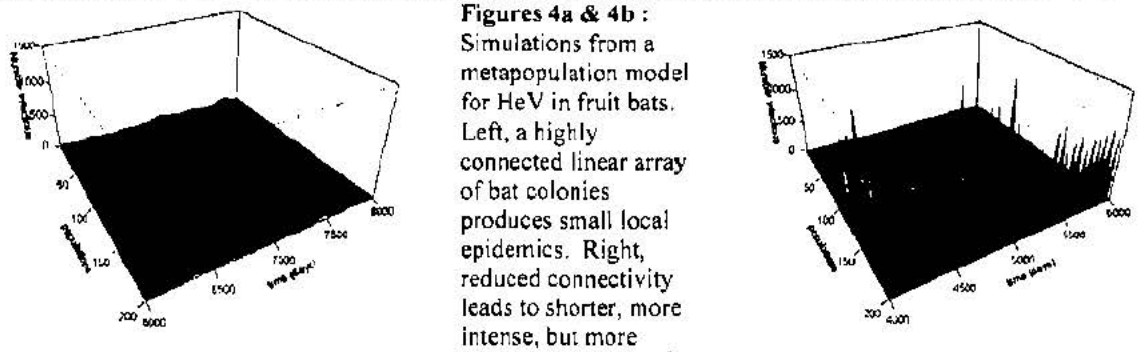
Figure 3 (right): Modeled timecourse of infection on the index farm. The number of infected pigs in each section over time. The virus is first introduced into the pig population at time t = 0. Re-introduction of the virus (blue line), coupled with the presence of waning maternal antibodies dampens R_0 and leads to endemicity of NiV and ultimately a large outbreak as pigs are sold to farms across Malaysia. The simulated pig dynamics closely matches outbreak epidemiology (Right: human cases vs time, Malaysia: note the long period between initial spillover and the outbreak peak)

In Malaysia, humans were dead-end hosts for NiV, and therefore the NiV dynamics in pigs were assumed to correlate directly with NiV dynamics in people, such that our model of pig dynamics

represented the dynamics of NiV in human cases. Under the population parameters of the index farm, and assuming a single spillover of NiV from bats to pigs, we were not able to simulate the long-term endemic nature of the NiV cases observed. However, re-examination of published data on sequence variation in Malaysian isolates suggested that multiple spillovers may have occurred[37]. We incorporated a second NiV spillover into the model and found that the virus circulated endemically. The change in dynamics between initial and subsequent introductions of the virus on the index farm results from the presence of acquired immunity in the sow population and maternal antibodies in the young pig population. We assumed that NiV maternal antibodies are likely to be lost at approximately 14 weeks of age (based on a related bat-borne paramyxovirus that infects pigs – Menangle virus[38]). Pigs born with maternal antibodies would therefore become susceptible to the virus roughly four weeks after entering the growing section, where they would remain for another six weeks. These dynamics produce a steady inflow of susceptible individuals sufficient to maintain the virus over a period of two years or more, explaining the epidemiology of the 1997-9 outbreak in Malaysia.

Modeling HeV dynamics within Australian fruit bats

Hendra virus (HeV), a close relative of NiV, is carried by *Pteropus* fruit bats in Australia. Hendra virus outbreaks are temporally sporadic. We used standard SEIR models parameterized around fixed bat populations, and found that HeV was unable to persist within the typical fruit bat colony sizes found in regions in Australia where HeV has emerged. We used metapopulation models to account for the large-scale migratory behavior of one species of Australian HeV reservoir – the little red flying fox[39]. Our models (**Figure 4**) predict that decreased migratory behavior and increased population fragmentation leads to a decline in herd immunity, and thus to more intense outbreaks after local reintroduction of virus[40].



Figures 4a & 4b : Simulations from a metapopulation model for HeV in fruit bats. Left, a highly connected linear array of bat colonies produces small local epidemics. Right, reduced connectivity leads to shorter, more intense, but more sporadic epidemics[40].

We hypothesize that this explains the sporadic nature of HeV emergence – i.e. aggregation of flying fox populations into urban centers results in pulses of infected individuals, increased bat density, and sporadic spill-over to livestock and people. **This work demonstrates that modeling dynamics of henipaviruses within fruit bat reservoir hosts can help explain the dynamics of spill-over to humans, and thus patterns of emergence.**

Modeling NiV dynamics within Bangladeshi fruit bats

As part of an NIH-K08 training award for one of our team (Co-PI, Epstein), now in its second of four years, we have developed a preliminary SEIR model of NiV dynamics in *Pteropus giganteus* in Bangladesh, and begun to collect data to parameterize this. He will examine NiV persistence in a closed bat population and how birth and death rate, and population size affect the steady-state viral prevalence and the thresholds for enhanced transmission within a bat population.

Field and experimental studies of Nipah virus dynamics within bats

Nipah and Hendra virus in Malaysian and Australian Fruit bats. Our work in Malaysia demonstrates wide distribution of NiV fruit bat populations[30]. We also conducted a longitudinal survey of a stable (island) colony of *P. hypomelanus*, sampling 50 bats every 3 months for 36 months and testing for NiV

antibodies and virus. Our results (**Figures 5 & 6**) demonstrated temporal variation in seroprevalence, seropositive post-weaning juveniles (1-2 years old) and periodic increases in overall seroprevalence (Aug 03 – Aug 04), suggesting that NiV was actively circulating during the period of study [41].

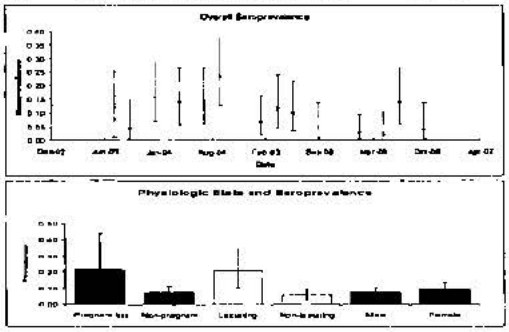


Figure 5 (left): Temporal variation in Nipah virus seroprevalence in *Pteropus hypomelanus* flying foxes across a three-year period on Tioman Island, Malaysia (2003-2006). Our work shows that virus circulates within this population, and that there may be seasonal transmission patterns.

Figure 6 (below): Comparison of Nipah virus seroprevalence in female bats in various states of physiologic stress. Pregnant or lactating bats were more likely to have antibodies to Nipah virus than other females and males, suggesting that there may be heterology in exposure rates within a population.

Pregnant and lactating bats had a significantly higher seroprevalence when compared to non-pregnant, non-lactating bats and male bats and we hypothesize that physiological stress during the breeding cycle may increase viral transmission [42, 43]. These bats are seasonal breeders, and give birth in pulses annually (April – July) which may affect the overall susceptibility of the population by introducing susceptibles, which may drive viral outbreaks[44]. This hypothesis is supported by our work on HeV dynamics in the Australian little red flying fox[39].

<u>These insights into the ecology of HeV and NiV suggest 1) that the seasonal, communal breeding cycle that fruit bats undergo leads to seasonal fluctuations in viral transmission, and likely spill-over;</u> and 2) that there are **<u>causal links between anthropogenic environmental change and henipavirus emergence.</u>**

Studies on NiV in *Pteropus giganteus* in Bangladesh and India. CCM and ICDDR,B have identified over 10 permanent roosting sites for *P. giganteus* both inside and outside the region where Nipah outbreaks have occurred in Bangladesh.

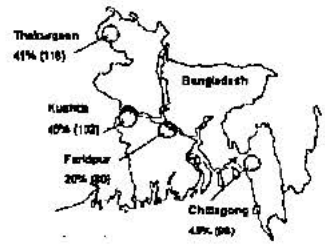


Figure 7. Seroprevalence (# tested) of NiV in *Pteropus giganteus* in Bangladesh. Chittagong is not associated with any human cases, but Thakurgaon (2007), Kushtia (2007), and Faridpur (2004) are.

We have recorded colony sizes and tested bats for NiV antibodies at four permanent colonies (**Figure 7**), and have begun a longitudinal survey of a single colony Faridpur in which we will take repeated samples of 100 bats every three months for 36 months to monitor changes in viral shedding and seroprevalence. These preliminary data suggest that Nipah virus infection is geographically widespread in *P. giganteus* within Bangladesh.

Social conditions and human behaviors that contribute to NiV spillover in Bangladesh

Identifying NiV spillovers by enhanced surveillance

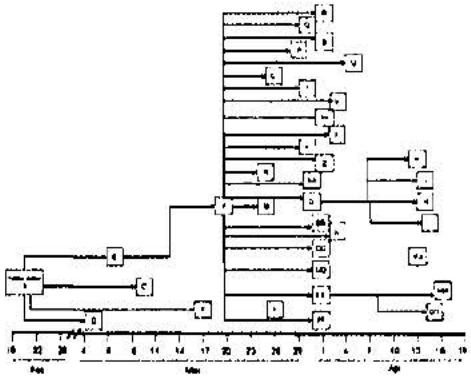
In 2006, we established a collaboration for active NiV surveillance, outbreak investigation and control. In this protocol, IEDCR is notified of unusual outbreaks of fever and neurological illness from personnel at government hospitals. This collaboration has been very successful and has identified 701 encephalitis cases, including 17 clusters. Among the 17 cluster investigations, 13 were clusters of 2 cases that appear to be unrelated to each other, while on investigation three were larger clusters that appeared to represent outbreaks of encephalitis. **<u>One of these 4 outbreaks was confirmed as a Nipah outbreak involving 7 persons in Thakurgaon District in January-February 2007.</u>** We have set up two hospitals at which serum and, if available, cerebrospinal fluid are collected from all patients who meet the encephalitis case definition during the time of year when most NiV outbreaks have been recognized,. Between January 15 and March 31, 2007, 58 serum samples were collected, 3 of which had IgM antibodies against NiV. <u>Repeated testing at CDC were 100% concordant with local results.</u>

Investigating transmission pathways. Over the last six years our collaborative ICDDR,B, IEDCR, CDC study team investigated seven Nipah outbreaks in Meherpur, Naogaon, Goalando, Faridpur, Tangail,

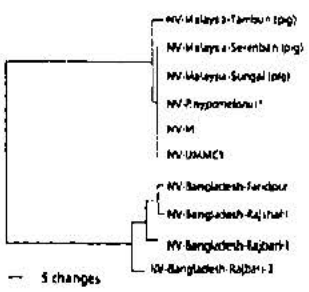
Thakurgaon, and Kushtia in Bangladesh. Our outbreak investigations have identified **four potential routes of transmission from bats to people: First,** direct contact with Nipah infected bat secretions. During the Goalando outbreak boys who climbed trees where bats foraged for food were more likely to develop Nipah than controls (OR 15.2, 95% CI 2.3, undefined)[31]; **Second,** drinking date palm sap. Sap is collected by tapping palm trees, and leaving pots to collect sap overnight, when bats are foraging, and for which there is evidence of contamination of the sap by bats. In the Tangail case control study, the only exposure that was significantly associated with illness was drinking raw date palm sap (64% among cases versus, 18% among controls OR 7.9, P=0.01)[45]. Our previous experiments in the BSL-4 laboratory in AAHL demonstrate that NiV can survive for up to 4 days in fruit juice and fruit bat urine at room temperature [46, 47]. **Third,** ingestion of bat-contaminated fruit. Partially eaten fruit from trees and on the ground is commonly eaten by people, and in our recent CCM-led surveys, we found that people at two NiV outbreak sites predominantly eat fruit from their own back yards. We found 100% overlap between fruit people consume and fruit known to be eaten by *P. giganteus* (26 fruit species). The majority (>75%) of respondents in Faridpur (n=36) and Kushtia (n=39) stated that they eat fruits previously bitten by animals. **The fourth** potential route of transmission is via other animals which may eat dropped fruit or other food contaminated with Nipah virus secretions from bats[48], and transmit NiV to people [25, 49]. The ICDDR,B anthropology team learned that special attention is given to animals during illness, and they are commonly hugged and stroked. Religious beliefs proscribe consuming animals which have died due to a disease or illness, and families will kill ill animals before they die so that they can consume the meat.

Characterizing the conditions that promote repeated person to person transmission of NiV in Bangladesh

In the Faridpur outbreak investigation, our team used network analysis to link cases to each other and found significant evidence of person-to-person transmission (**Figure 8**)[31]. We also found that in the Meherpur outbreak, among persons living with people infected with NiV, having contact with secretions from a Nipah patient was associated with illness (OR 5.73, 95% CI 1.00, 32.7)[23]. In the Faridpur outbreak physical contact with an NiV infected patient who later died (OR 13.4, 95% CI 2.0, 89) was the strongest risk factor for developing NiV infection [31]. In the Thakurgaon outbreak illness was significantly associated with being in the same room with a Nipah case when he had fever and altered mental status (86% versus 9.5%, OR 57, confidence interval 4.4-744, p<0.001) or was coughing (86% versus 0%, OR undefined, p=0.04)[50]. In a review of the 122 cases Nipah cases identified in Bangladesh, 62 (51%) developed their illness ≥ 5 days after close contact with another Nipah case[51]. During the Faridpur outbreak investigation, we collected 465 environmental swabs. Eleven were positive for Nipah virus using RT-PCR, and all were collected from the surrounding wall and bed frame where a confirmed Nipah patient had been hospitalized five weeks before the environmental samples were collected [31]. This supports our anthropological interviews, which show intensive contact between healthy family members and sick patients infected with NiV.



Investigating the molecular characteristics of NiV in Bangladesh



The CDC Molecular Virology Team sequenced strains from outbreaks in Bangladesh and compared these to strains isolated from Malaysia [52]. The overall nucleotide homology between the Bangladesh NiV genome and the Malaysia genome was 91.8% suggesting they are different strains [52]. The sequences of the nucleoprotein open reading frames of the 4 NiV isolates from Bangladesh shared 99.1% nucleotide homology, in contrast to the sequences obtained from all of the human cases in Malaysia which were nearly identical to each other [15, 53, 54] (See **Figure 9**, left: phylogram,). These

data suggest an ongoing, geographically scattered spillover of NiV from bats to humans in Bangladesh.

Preliminary studies of pandemic spread

We have previously examined the near-global spread of H5N1 avian influenza by considering the trade in poultry and pet birds and the movement of migratory birds [55] and found that 44 of 52 country introductions were consistent with trade or migratory bird movement (Figure X), suggesting that this approach offers significant promise for predicting the movement of pathogens linked to trade. We have also modeled the spread of West Nile virus to Galapagos, Hawaii, and Barbados[56-58]. Other workers have published similar analyses predicting the spread of SARS[59], disease vectors[60], and the future spread of H5N1 should it be viably transmitted among humans[61].

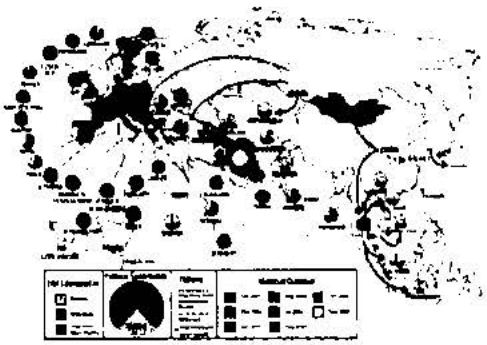


Figure 10: Spread of H5N1 avian influenza in Asia, Europe, and Africa based on analyses of viral phylogeny, poultry trade, bird migration and wild bird trade[62]

RESEARCH PLAN

Our Team. In this proposal, we bring together the PI and key members of a team ("HERG" – the "Henipavirus Ecology Research Group", www.henipavirus.org) funded through a previous NSF/NIH Ecology of Infectious Diseases award (R01-TW05869) to work on Nipah virus in Malaysia, the PI and team responsible for NiV epidemiology, outbreak investigation and research at the ICDDR,B in Dhaka, Bangladesh, a key paramyxovirus researcher at the Centers for Disease Control and Prevention in Atlanta, and a leading virologist at Columbia University. Our team includes authors of >30 papers on NiV and HeV, and a multidisciplinary team that has been collaborating on NiV in Bangladesh for the past 2 years.

D. Research Design and Methods

Differential equation and matrix models for NiV spill over, outbreak, and pandemic emergence

Our overall hypothesis is that measurable and predicable factors in the ecology of NiV within fruit bat reservoir hosts, and between these, domestic animals and humans explain the increased potential for extended outbreaks and pandemic emergence of NiV in Bangladesh. We aim to mathematically model NiV dynamics within bats, and among bats, domestic animals and humans. We will parameterize our model with field data on bat ecology, NiV virology, demography and human social behavior, and outbreak investigations, and **use the model to examine scenarios that may give rise to sustained human-to-human outbreaks, and pandemic emergence.**

Our first step is to produce a model to describe the complexity of NiV spill-over in Bangladesh. The risk of a Nipah outbreak needs to consider both the probability of different transmission events occurring and the cost of those events (in terms of public health and loss of livelihood) if they lead to subsequent episodes of transmission. As Nipah is endemic in fruit bats that transmission is occurring constantly at a level that maintains the virus at endemic levels (Ro=1); there is essentially no cost to humans, nor bats, due to this background transmission. Transmission from bats to humans or livestock is a much rarer event, but has a higher cost as it often leads to the death of the first exposed patient, while also increasing the probability of human-to-human transmission now occurring; the more humans are infected, the higher the cost. If control of Nipah virus is to minimize cost, then it should initially focus on preventing bat-to-human transmission. We know this occurs when date palm fruits are harvested, although there are other risk activities. Once the virus establishes in humans then control should focus on minimizing rate of spread, this can best be done by isolating infected patients and in particular minimizing contact with individuals who themselves have high contact rates.

We can capture the essential features of these dynamics in sets of coupled differential equations for susceptible, S, infected, I, and recovered, R, human hosts.

$dS/dt = b(S+R) - dS - S(\beta_{HB} I_B + \beta_{HH} I_H)$; $dI/dt = S(\beta_{HB} I_B + \beta_{HH} I_H) - (d+\sigma+\alpha)I$; and $dR/dt = \sigma I - dR$; here b and d are host birth and death rates, β_{HB} is the rate of transmission from bats to humans, β_{HH} is the rate of transmission within the human population, α is the rate at which infected hosts die, and $1/\sigma$ is the length of time for which they are infectious, I_B and I_H are the number of infected bats and humans at any one time. A similar set of equations could easily be written for bats with the β_{BH} set to zero as there is no transmission from humans to bats.

The condition for an epidemic outbreak (Ro>1) can then be determined by expressing the initial transient dynamics of the system as a next generation matrix[63, 64]. As there is no transmission from humans to bats, then we need only focus on Ro in each host species. In the case of bats, Ro is likely close to unity as the pathogen is endemic and stable in this species. In contrast there exists significant potential for Ro to be greater than 1 for Nipah in human populations. To examine the consequences of this and to estimate rates of transmission within the human population, we need to develop an age-structured model for the human population. We can simplify this by dividing the human population into seven-year age cohorts (which mature at a rate 1/7), this allows us to differentiate between children who are too young to climb trees (<7), those that do (7= to 14), and then older age classes who may travel or mix with other sectors of society at different rates. If we assume a maximum of seven age classes, then everyone older than 42 will be in the oldest age class. The dynamics of Nipah virus in this population may be described by the following set of equations:

$$dS_0/dt = b\sum_{j=0}^{6}(S_j + R_j) - (d_0 + m)S_0 - S_0\left(\sum_{k=1}^{6}\beta_{Ak} I_k\right); \quad dS_i/dt = mS_{i-1} - (d_i + m)S_i - S_i\left(\beta_{HB} I_B + \sum_{k=1}^{6}\beta_{Ak} I_k\right)$$

$$dI_i/dt = S_i\left(\beta_{HB} I_B + \sum_{k=1}^{6}\beta_{Ak} I_k\right) - (d_i + \sigma + \alpha_i)I_i; \text{ and } dR_i/dt = \sigma I_i + mI_{i-1} - d_i R_i$$

These equations could readily be solved numerically for parameters values that could easily be estimated from the Nipah virus human outbreaks in Bangladesh for which data are available. They could also be readily extended to include special classes of 'super-spreaders' such as the date-palm drink salesmen who move from village to village dispensing infected date palm juice. We can also examine whether small boys aged 7-14, are the primary cases, or whether older people who drink the date-palm juice. Similarly sick people in the oldest or the youngest age classes may receive disproportionate attention, and thus have higher rates of transmission. These effects may readily be explored within this model framework.

(iii) NiV spillover risk from bats to humans and the role it plays in the population biology of bats, especially in synchronous breeding patterns

There is strong seasonality to NiV outbreaks in Bangladesh, and pteropid bats have strongly seasonal breeding[65] and migration patterns[66], but there is little known about temporal dynamics of NiV shedding in bat populations. We hypothesize that NiV shedding in *P. giganteus* peaks in bats between January and May, during pregnancy, and corresponding to the outbreak season. We will establish longitudinal surveillance to regularly test bats from within the outbreak zone (the 'Nipah belt' – see Figure X) to evaluate the proportion of bats that have been infected with NiV and are shedding NiV.

Bat urine collection. We will conduct longitudinal surveillance for 60 months on a large (>2,000), permanent *P. giganteus* colony in Faridpur District, Bangladesh in the region where NiV outbreaks have repeatedly occurred. We have selected a colony that local residents report as being present year-round and that has been present for ≥10 years. Every month we will collect 400 urine sample swabs from underneath the roost following Chua's method[67]. Swabs will be immediately placed into viral transport media (2 per cryovials)[67] and an aliquot of viral transport media from each tube will be added to Trizol LS (tri-reagent) in a separate cryovial for PCR analysis, then placed into a dry shipper and stored at -70C at ICDDR,B.

Fruit bat capture, Sample Collection and Transport (see also Vertebrate animals biohazard

section). Fruit bats will be caught when returning from feeding (between ~ 1 and 5 am) using large (30' x 30') mist nets made locally in Dhaka, suspended by rope between two bamboo poles mounted in trees. The net will be positioned across an open area either adjacent to a colony or in an established flyway near a colony, as in our previous work[68]. A maximum of 25 bats will be caught per trapping period, to enable safe processing. For human and animal safety, we will anesthetize bats using Isoflurane gas[69]. We will sample 100 bats every three months (1600 bats over four years), recording weight, approximate age, sex, physical condition, and pregnancy or lactation status; and collecting a blood sample (2-3 ml depending on body weight), two sets of urine samples and two sets of throat swabs: One for PCR, and one for virus isolation. A cold chain involving liquid nitrogen dry shippers will be used to ensure sample quality. Serum samples will be tested using an IgG and IgM ELISA at ICDDR,B and Columbia University (See letter of support), and a subset by serum neutralization test at the Australian Animal Health Lab (AAHL), CSIRO, as in our previous work[33, 70, 71]. All bats will be thumb-banded, microchipped and released.

RT-PCR, Viral Culture, Serology. For the urine samples collected from tarps underneath the bat roosts we will pool samples from 10 swabs[72]. For all urine and saliva samples we will use Taqman™ Real time (RT-PCR) as described by Guillaume [73], using our standard primers and fluorescent probes for NiV[74-76]. For all PCR-positive urine and saliva samples we will send corresponding samples to the AAHL for culture in the BSL-4 lab. Although not a major objective of the study, the project provides an opportunity to recover additional strains of NiV from bats. We will use a blocking ELISA [77] with a MAb, validated with pig serum, specific to Nipah virus which shows no cross-reaction to Hendra virus[77]. We will use a newly-available IgM ELISA (b) (4) to identify recently infected bats. We will confirm at least 10% of ELISA-positive and ELISA-negative samples by SNT.

Analysis. The primary assessment of NiV shedding will be via urine swabs from underneath bat roosts tested by PCR in pools of 10[72] (400 swabs per month = 40 pooled samples per month). The proportion of PCR positive aggregated samples will be calculated. We hypothesize that NiV shedding is most frequent from December – May (the peak outbreak timing). Assuming that 2% of pooled urine specimens will have detectable NiV RNA at that time (as we have found previously) and that this will be lower (0.5%) at other times, then 1,978 samples (33 urine pools per month) would provide 80% power to detect this difference with 95% confidence. Thus, the planned 40 pools per month should be sufficient to test this hypothesis. For the individual bat samples, the primary outcome of interest will be the proportion of seropositive bats. We hypothesize that seroprevalence will vary significantly over time and that acute NiV infections detected by IgM antibodies will be more common between December and May compared to June through November. This is supported by preliminary data (above). A total of 1600 bats will give sufficient power to assess differences by year and by time of year. We will be able to gather important information on the characteristics of individual bats that shed NiV (age, sex, pregnancy, lactation status).

Expected challenges and solutions. 1) International fieldwork can be challenging. However, our collaboration with ICDDR,B brings decades of experience conducting long term scientific studies in Bangladesh, and unparalleled logistics support. The CCM has a large network of international projects and collaborators (www.conservationmedicine.org [78]) and staff are used to working in countries with similar demographics, logistics and culture; **2)** Viral prevalence in bats is low (~1%) – this issue is addressed in Hypothesis 3, below (NiV strain characterization); **3)** The IgM antibody for NiV infection is new, and there is a risk it may be insensitive or non specific, and so undercut the assessment of new infections. This is unlikely, (b) (6) We will also address this by assessing the change in cross sectional prevalence of Nipah IgG antibodies from longitudinal surveillance to separately model disease incidence, calculating exposure separately for each age-class (e.g. juveniles vs. adults), [79]. This will provide a minimum estimate of incidence.

H2) Bat behavior in the human-dominated environment in Bangladesh has increased bat-human contact rates typical of more advanced stages of NiV emergence

We propose that the long association between bats and human agriculture in densely-populated Bangladesh has led to loss of large-scale migratory patterns in Bangladesh bats (*P. giganteus*) and altered

NiV dynamics to favor repeated emergence. We will parameterize our matrix model for spill-over, amplification and human-to-human transmission with measurements of the migration rate between bat colonies based on satellite and radio telemetry. We will use 30 radio transmitters and 10 satellite transmitters (Microwave telemetry, USA) to record local and long-range movements of *P. giganteus*. This work will provide critical data on connectivity among bat populations (e.g. inter-colony movement), foraging behavior, roosting behavior, and migration. This data will be used to inform our bat models. Our group has extensive experience using telemetry with bats[20, 80]. The combination of radio and satellite telemetry will provide both large and fine-scale resolution of location data, i.e. how far the bats will fly to forage (satellite), and in which type of tree they feed (radio).

We hypothesize that land-use change occurred earlier in Bangladesh (c. 4,000 b.p.) than Malaysia, forcing bats to develop a dependence on planted fruit crops, and a higher bat-human contact rate. Further, hunting bats with shotguns, which is common in some parts of Southeast Asia, is uncommon in Bangladesh, which may also permit a more sedentary behavior, decreased colony connectivity, which our previous work on Hendra virus suggests would result in larger outbreaks[39, 40] (Figure X). Our telemetry data will provide an inter-colony migration term for our mathematical model. We also predict that the pulse of juveniles born each year introduces susceptibles into a bat population, which may (over time) create the necessary proportion of susceptible individuals to allow an rapid expansion of NiV transmission in batsoutbreak. We will set up a long-term study in a bat population with lower NiV seroprevalence (e.g. Faridpur, 14%) and monitor viral shedding via urine collection, as well as immigration / emigration using radio and satellite telemetry. We predict that we will detect a significant increase in either viral shedding or seroprevalence following an outbreak within the colony.

To date, the seven outbreaks in Bangladesh have occurred within the central and western parts of the country, but there have been no reported cases of Nipah virus in the East, despite the presence of surveillance and reporting. We will compare the size and seroprevalence of bat colonies and contact rate between bats and humans in locations both within and outside of the region where Nipah virus outbreaks have occurred as part of our anthropological studies on fruit and date palm juice consumption.

(H3) NiV transmission is enhanced in Bangladesh by a combination of human social behavior, high population density, and viral traits which promote human-to-human transmission.

Bangladesh has the densest human population of any country globally, with 1000 persons per square kilometer (2706/mile^2), 75% of whom live in rural areas[81]. This, in itself is a high risk for viral spillover, but is likely exacerbated by human behavior that brings people into direct contact with bats, fomites, or contaminated fruit or food (e.g. hunting bats, collecting date palm sap, eating contaminated fruit). We will examine these behaviors by analysis of outbreak data, and heightened examination of spillover events.

Spillover Identification and Human Sample Collection. We will aggressively identify spillover events, with a five level activity to identify human Nipah cases performed by physicians trained at ICDDR,B on annual courses. We describe this below, where we address potential difficulties. We will collect CSF and respiratory samples from suspected Nipah patients in collaboration with our enhanced surveillance physicians. If a suspect Nipah patient with evidence of acute brain pathology dies, and if the family consents, then a transethmoidal or retro orbital needle biopsy will be performed [82, 83]. Samples will be kept in a cold chain. CSF aliquots and brain tissue from confirmed (IgM positive) human cases or from a case cluster will be forwarded to the Centers for Disease Control and Prevention (CDC) for virus isolation and culture. The likelihood of isolating virus from CSF or central nervous system tissue during the course of the acute CNS disease is relatively high [15]. If high quality CSF can be obtained from CNS cases and NiV confirmed by IgM capture assays, the likelihood of viral isolation or direct amplification of viral sequence by using RT-PCR will also be high.

Finally, when outbreaks are suspected or confirmed, our bat team will be rapidly deployed to collect samples from the closest bat roosts to the outbreak cases (see sample collection – above). This will assist in understanding the relation between local bat NiV infections and spillover, and provide an additional opportunity to collect relevant viral isolates for subsequent phylogenetic and other virological studies, including comparison with the longitudinal survey isolates, which will act as a 'control' for outbreak

strains, to identify characteristics of these that may differ from other strains circulating in bats.

Initial Exposure Assessment. The outbreak investigation team will locate the closest roosts to the community and investigate specific human activities likely important for transmission of Nipah virus from bats to persons: e.g. palm sap harvesting, tree climbing, fruit collection and purchase, fruit consumption, animal husbandry and others. We will use standard anthropological methods to explore this context including in-depth open ended interviews with key informants and respondents such as probable Nipah cases or their proxies to examine biologically plausible potential exposures.

Assessing human risks for infection. Over the course of seven prior outbreak investigations we have developed a questionnaire that collects standardized information on relevant exposures from prior outbreaks. Trained, experienced interviewers will administer the questionnaire to suspect or confirmed cases of Nipah infection, or their proxies. Controls will be recruited from the village of the cases using standard techniques[27, 84]. After informed consent (and child assent for ages 7 – 17 years) the study team will administer the exposure questionnaire to the control and collect a blood sample that will be evaluated for Nipah antibodies. The blood test will allow an evaluation of sub-clinical NiV illness in the community, and also improve the power of the analysis by minimizing the misclassification of sub-clinical cases as controls. Prior recognized outbreaks in Bangladesh have involved a median of 12 cases. Assuming the median values of the 7 prior NiV outbreaks that were investigated with a case control study (prevalence of the exposure of interest among cases 74% and among controls 41%, matched odds ratio of 7.0.) then with 13 cases and 52 controls, we would have 80% power to detect such exposures with 95% confidence. Confounding will be evaluated using conditional logistic regression for matched analysis.

Investigating human-to-human transmission: Our previous outbreak investigations and the investigation in Siliguri, India suggest that person to person transmission of NiV has occurred in several prior outbreaks. We hypothesize that three elements contribute to person to person transmission: first, some persons are unusually efficient respiratory transmitters of Nipah infection; second, persons who have direct physical contact with respiratory secretions of efficient Nipah spreaders are at risk of infection; and third, some strains of Nipah virus are more likely to cause pulmonary disease in humans.

Characterizing NiV transmitters. Each case will be evaluated for characteristics that may contribute to their becoming Nipah spreaders based on a standardized history (e.g. of preceding pulmonary disease etc.). Chest radiographs will be used for suspect Nipah cases with respiratory symptoms who report dyspnea or who have abnormal breath sounds on physical exam and daily collection of respiratory secretions for assessment of presence of Nipah virus RNA by PCR. A person will be classified as a probable NiV transmitter if they meet the Nipah case definition, and if at least one other person who had contact with them when they were clinically ill develops NiV infection 5 - 15 days after that contact. Persons will be classified as confirmed NiV transmitters if virus isolated from both the transmitter and the susceptible case have an identical genetic sequence (see NiV strain characteristics below).

The characteristics of NiV transmitters will be compared to NiV patients who do not transmit the virus to other persons using relative risks and 95% confidence limits. From 2001 through 2007 we identified 122 human NiV cases or a mean of 17 per year; 9 (7%) transmitted NiV to other persons. These 9 identified NiV spreaders in Bangladesh transmitted NiV to a mean of 7 persons. We expect that with the enhanced surveillance of this project we will identify 128 Nipah cases during over 5 years. In addition, we have begun collecting more detailed information on respiratory symptoms and risk factors beginning with the 18 cases identified in 2007. Thus, we project that we will have 146 cases and 12 NiV transmitters to assess risk factors for becoming a transmitter. This provides sufficient power to identify marked differences between transmitters and non-transmitters.

Domestic animal testing. Preliminary studies in Bangladesh have not identified any domestic animals with serologic evidence of NiV infection [23], but domestic animal sampling has not been conducted systematically in all of the prior NiV outbreak investigations. Serum samples will be collected from all domestic mammals, both ill and well, from the households of all consenting cases and among other domestic mammals the cases had contact with. In addition, any ill domestic animals from the immediate area (e.g. the same village that human NiV cases were identified in) will have a blood, urine and saliva sample collected.

NiV strain characteristics. Strains from human Nipah cases will be characterized in Dr Paul Rota's lab. at the Centers for Disease Control that has provided virology diagnostics for the Nipah virus outbreaks that have occurred in Bangladesh in the past [23,45,85-88]. The CDC will provide training and diagnostic reagents to identify Nipah patients with acute central nervous system disease. Virus isolation will be conducted in Vero E6 cells in the BSL4 lab by the Special Pathogens Branch at CDC. RNA will be extracted from clinical samples or infected cell cultures and RT-PCR performed using standard reaction conditions [52,89] and primers targeting regions of the N and M genes[52,89]. Complete genomic sequences will be obtained from representative samples [52,89,90] and phylogenetic analyses conducte[89,90].

Nipah strains isolated from humans and bats will be shared between collaborating laboratories and the isolates characterized to compare the genetic relationship among strains. The relatedness of unique strains associated with human to human transmission will be compared to the relatedness of other strains isolated from humans. During outbreaks in 2004, four isolates of NiV from human cases were obtained. With added measures for sample collection and increased surveillance for cases over 5 years, we conservatively expect to be able to collect 12 additional isolates available from humans in Bangladesh, of whom half are likely to be associated with human to human transmission. (Because human to human transmission outbreaks last longer, there is more opportunity to identify them and collect samples.) If the rate of NiV isolation from *P. giganteus* in Bangladesh is similar to the c.1% rate noted among other *Pteropid* species [21,22], then among the 1600 bats individually sampled we expect identify 3 strains and among the 28,000 pooled urine samples an additional 56 strains.

Modeling human to human NiV transmission. We will examine four major components of the person to person transmission of NiV: (1) estimating the basic reproductive number, R_0 of NiV in humans; (2) measuring the contribution of super-spreaders in person to person outbreaks; (3) evaluating evidence for attenuation of the virus as hosts are sequentially infected; (4) estimating R_0 for NiV under different pattens of social behavior using data from the epidemiological surveys.

NiV outbreaks that have epidemiologically confirmed person to person to person transmission of virus can be used to estimate the R_0 for NiV in humans and to examine the factors that either enhance or restrict the magnitude of outbreaks. We will initially use the removal method developed by Ferrari et al [91] to estimate R_0. This method is based on the statistics that underlie the Mark-Recapture methods widely used in population biology [92]; it has the singular advantage that it simply requires the time series of numbers of individuals infected on sequential dates during the course of the outbreak and does not require any information on the size of the population. We have previously applied the technique to data from Ebola outbreaks in Zaire, and for foot and mouth disease in the UK and found that it gives accurate and repeatable results. Where data are available on the size of the village, or numbers of potential susceptible individuals, we will also employ the standard methods described in [93].

Our prior outbreak investigations suggest that the size of each outbreak of NiV is highly sensitive to the presence of 'super-spreaders', individuals who infect a disproportionate number of new cases. We shall use the methods developed by Lloyd-Smith et al [94] to quantify the impact of heterogeneities in transmission due to the influence of individuals whose age, sex, or social activity brings them into close contact with large numbers of susceptible individuals when they are infectious. This will allow us to identify characteristics of hosts against whom control efforts would be most efficiently focused.

Third, we will examine evidence of changes in the presentation of human NiV infection during its first few serial passages in humans following its initial transmission from bats to humans. We will quantify incubation period, case fatality rate, and recovery time for individuals infected by bats and those infected as second, third, fourth and later generations of infection; we will subdivide each infected host into different categories, classified by similar age and sex classes. We will then statistically test for sequential changes in incubation and mortality that imply that the repeated exposure to humans leads to changes in virulence of the virus. Taken together, these activities will describe the dynamics of person to person transmission of NiV in Bangladesh.

Finally, we will use our parameterized matrix model to determine the impact of changes in behavior on R_0 for NiV. Specifically, we will examine the impact of increased density due to population growth in Bangladesh, altered eating patterns, and different social structure in cities vs. villages. We will determine

the conditions necessary for R0 to rise above one which will lead to persistence and spread.

Community Level Risk Factors. We will analyze the risk factors for community-level infection by NiV. Beginning in the fourth year of the project, we will select 3 sets of communities: 1) All those where human NiV spillover cases have been identified; 2) 40 communities from within the Nipah affected region where Nipah cases have not been identified; and 3) 40 communities from outside the region where Nipah cases have been identified. The control communities within the Nipah affected regions will be selected by overlaying a grid on the Nipah affected region, generating random coordinates, and identifying the closest human settlement to the coordinates that was not a site of a Nipah spillover. Epidemiological interviews will be conducted at these control and spillover communities as described earlier. The primary analysis will be a comparison of characteristics of case villages, i.e. villages where human NiV spillover has been identified, to control villages, i.e. villages within the region where NiV outbreaks have been repeatedly identified, but NiV spillover has not been identified. This will be an unmatched case control analysis where different characteristics will be compared using odds ratios and confidence intervals. Confounding will be controlled through modeling with multiple logistical regression. Secondary analysis will compare the characteristics of spillover villages to the control villages that are located outside of the zone where NiV outbreaks have been repeatedly identified. **This analysis will provide insight on why, with *P. giganteus* bats ranging across Bangladesh, spillovers are so geographically restricted**.

Potential difficulties. 1) Too few NiV spill over events will be identified to assess NiV transmission. We do not expect this to happen. We have identified 24 spillovers including 7 outbreaks in the last seven years. This suggests that NiV outbreaks occur repeatedly in this area. Moreover, the increasingly aggressive surveillance activities that we have piloted have been able to both successfully identify clusters of encephalitis, as well as more sporadic cases. In addition, the surveillance for clusters of encephalitis cases which we have successfully piloted demonstrates that we can reliably identify clusters both in big NiV spillover years and years where no NiV was detected. The aggressive approach to identify and collect samples from these clusters that this proposal allows means that we have a high probability of identifying diseases that cause clusters of fatal encephalitis that have a high probability of being newly recognized pathogens. Thus, even when we do not find NiV, the project will be productive. **2)** Domestic animals which have transmitted NiV to humans may have died by the time human cases are recognized and the investigation team reaches the village where NiV spillover occurred. However, the mortality rate of NiV in domestic animals is well below 100% (e.g. it was <5% among adult pigs in Malaysia despite often significant respiratory infections [14]). Thus, we expect to identify evidence of domestic animal infection, especially if it is repeatedly involved in human NiV infection. 3) Too few NiV isolates may be collected to confirm the chain of person to person transmission, and to compare strains associated with person to person transmission with those that are not. In prior outbreaks IEDCR was notified after the majority of the cases had died. Strategies to identify sufficient strains include several levels of enhanced surveillance for NiV cases. With improved surveillance we expect earlier identification of outbreaks, and so increased opportunity to collect relevant specimens. **4)** Affected communities may define exposure to secretions differently, and so exposure assessments may not be strictly comparable across outbreaks and limit pooling data. To mitigate this risk, the anthropology team will review all of the exposure assessments from prior outbreaks, and strive to be exhaustive in characterizing personal exposure in the initial outbreaks. Even if more refined questions are developed in subsequent outbreaks, the initial questions will also be retained in subsequent outbreaks to permit comparison. **5)** Too few instances of person to person NiV transmission will be recognized to identify risk factors and permit modeling. To mitigate this risk we are proposing markedly enhanced surveillance focusing on those areas and times where human NiV cases have been recognized in the past. We are enrolling all identified NiV cases and their household members to investigate risk factors for both becoming a NiV transmitter and for susceptibility to transmission. This pooling of study populations over several transmission events markedly increases power. The sample size calculations are based on conservative assumption from passive surveillance. Taken together we expect to have sufficient power.

H4) NiV in Bangladesh presents a threat for regional and pandemic spread

We will adapt recently developed modeling techniques[59, 95] to predict the spread of NiV from village to village, village to cities, and from Bangladesh to other countries via shared borders and air travel. We will use data from the village surveys (see above) to estimate travel within Bangladesh and to neighboring countries, recently obtained data from the International Air Travel Association (IATA) on international airport-to-airport travel [96-98] to quantify international air travel. The spread of NiV from Bangladesh to other countries via air travel can be estimated by adapting an expression derived for SARS[59]:

$$\text{Probability of spread to destination } d \propto N_C^{*} L\left(\frac{1}{H_C}\sum_{d=1}^{D} T_{C,d}\right)$$

where N^* is the number of individuals with recent latent NiV infections in city C, L is the latent period (9±3 days for NiV[99]) from exposure to onset of illness (after which individuals are assumed to be too sick to travel), and the term in parentheses is the connectedness of area C to all other areas d, d=1 to D. The full expression estimates the probability each traveler, $T_{X,d}$, that leaves city C to destination d each day, will be infected with NiV. The sum is divided by H_C, the population size of city C, to account for the fraction of the human population that travels [59, 95]. We will also use the survey data, which include questions on local and international travel, to determine if individuals that travel from villages where NiV outbreaks have occurred are more or less likely to travel internationally than others that travel to and live in the cities. A similar expression can be used to determine the spread of NiV between villages and between villages and the city. Thus, we can use the survey data and connectance models to predict where the cases should occur in Bangladesh after a local outbreak, which countries are most likely to acquire NiV infection via infected patients traveling and how this might change under changing travel patterns. Finally, modeling of human-to-human transmission under different patterns of social behavior will determine the R_0 of NiV in cities and other villages. Combined with the connectance models, this will determine the likelihood of regional and pandemic spread.

We note that pandemic spread is not simply a product of travel and transmission dynamics. It is also related to the visibility of symptoms, the capacity of medical staff and public health officials to identify and treat a patient, block travel and spread, and thereby reduce R_0. Thus, it is the substantial latent period that poses substantial risks for spreading NiV beyond the outbreak village, and the infectiousness of an individual before and after becoming symptomatic that determine the likelihood of spread. These will be a key outcome of the epidemiological investigations described previously.

VI. LOGISTICS AND TIMETABLE

This research will take place over five years and involves collaboration among four institutions: Wildlife Trust (Daszak); International Center for Diarrheal Disease Research, Bangladesh (Luby), Princeton University (Dobson); Centers for Disease Control and Prevention (Rota). Testing will be done on a contract basis for bats at AAHL, Australia and Columbia University (Lipkin). PI Daszak will coordinate research activities through monthly conference calls (as already conducted for all CCM collaborative projects), annual meetings rotated among the lead institutions, and other collaborative meetings during each year scheduled around conferences and field study travel. Timetable for proposed research:

Yr	Field studies	Analyses and Models	Other
1	Begin longitudinal bat surveys, telemetry and human surveillance.	Sensitivity and elasticity analyses, sample testing.	Staff hire/training, permits and IACUC, 1st ann.. meeting in Bangladesh
2	2 [nd] training mtg for Nat'l Survey; Continued bat and human surveys. Deploy 2[nd] year satellite collars.	GIS mapping of bat movement, parameterize models, sample testing.	2 [nd] ann. meeting in USA at major public health or ecology conference.
3	3 [rd] annual training session for National Survey; bat sampling and telemetry; outbreak resp.	Epi analyses from active surveillance and outbreak investigations, continue all other work.	Third annual group meeting in Bangladesh
4	4 [th] ann. training session for National Survey; end 36 month bat	Begin model testing (simulations), all other work continues	Fourth annual meeting at International scientific

	study, continue other surveys.		conference
5	Launch village-level evaluations, finish off all field surveys.	Fully-parameterized models, predictive modeling of enhanced outbreaks and pandemic spread.	Fifth, final annual meeting,

VII. BROADER IMPACTS AND TRAINING

This project will provide insight into the factors that drive disease emergence and pandemic spread – a major threat to global health. The findings will be disseminated through the PI and Co-PI's contacts in agencies dealing with public health (CDC, WHO), and through congressional briefings which Wildlife Trust organizes. The project will provides opportunities for training under-represented groups within the USA through graduate student mentoring, training postdoctoral and technical support staff, and undergraduate research programs at the PI's home institutions that aim to recruit women, minorities and "first generation college" students into scientific activities. It will also enable **mutual collaboration among students from the four US institutions, and Bangladeshi scientists, students and leaders associated with the ICCDR, Bangladesh.** A key part of the broader impact of this study will be the piloting of intervention strategies to combat Nipah virus spillover and spread to 1) interrupt bat contact with date palm juice (e.g. netting over collection pots), and 2) attempt to implement barrier nursing practices by persons who care for Nipah patients to reduce secondary Nipah virus transmission through educational outreach. Over the five years of this project, we will train over 15 undergraduates in independent research project, 20 Masters in Public Health students from Johns Hopkins (a CCM partner), 4 veterinary students; 3 graduate Ph.D students and 2 postdoctoral assistants.

VIII. RESULTS FROM PRIOR NSF-FUNDED RESEARCH

Peter Daszak (PI), Jon Epstein and Andy Dobson NSF/NIH EID R01-TW05869
Anthropogenic change and the emergence of novel zoonotic paramyxoviruses 07/01/02-06/30/07
This work produced 39 papers published, in press or in review on the ecology of viral diseases, including a paper in *Science* on the origin of SARS[100], a paper (b) (4) a paper in *PNAS* on pandemic spread[62] and a paper in review at (b) (4) (b) (4). It has involved training 7 Ph.D. students and 11 undergraduate researchers.

A Marm Kilpatrick (PI) and Peter Daszak EF- EF-0622391 $2,269,000
Predicting spatial variation in West Nile virus transmission 10/15/06-9/30/11
The first 14 months of work has produced 11 papers published or in press and 1 in review, including articles in *Nature*, *PNAS*, *EID*, *VBZD*, and two in *AJTMH*. We have demonstrated continental scale declines in N. American birds[101], examined pandemic spread[55], and analyzed WNV ecology in birds, mammals and vector[57, 101-108].

IX. Vertebrate Animals and Biohazard

Given space restrictions we can only be brief. Justification of the bat sample sizes is given in the research design. For animal welfare considerations, all animal work will be conducted by a veterinarian (Dr Epstein or Dr Shahneaz), using appropriate restraint (for livestock) and anesthesia (for bats). Detailed protocols are on file with Wildlife Trust's and Tufts Vet School's IACUC committees. All techniques have been approved for other recent projects on Nipah virus in bats and are CCM standard operating procedures. Nipah virus is a BSL-4 agent. CCM and ICDDR,B has strict procedures for handling animals and working with or transporting samples from them. All personnel utilize full personal protective equipment when handling animals (coveralls, safety glasses or a face shield, and nitrile gloves under leather welding gauntlets for bats, and a P100 respirator). All field clothing and equipment is disinfected using Virkon or other anti-viral disinfectant. All biological waste from field surveys is disposed of in the appropriate container (sharps box or an autoclave bag) and autoclaved at ICDDR,B. All staff are trained in biosafety technique. All staff are vaccinated for Rabies and have recently-tested, high titers. The team also has a supply of Ribavirin, which is used only in the event that 1) a possible exposure to Nipah virus has occurred; and 2) a fever occurs within 7 days following exposure, to minimize side-effects.

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Professional Preparation

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Appointments

Executive Director, Consortium for Conservation Medicine	2001 – current
Faculty Research Scientist, University of Georgia	1999 – 2001
Guest Researcher, Centers for Disease Control and Prevention (CDC)	1999
Faculty Research Scientist, Kingston University, UK	1993 – 1998
Research Assistant, University of East London	1989 – 1992

Publications (out of 104 peer-reviewed papers and chapters); * = corresponding author

Five most closely related to proposed project

Daszak, P., Cunningham, A.A. & Hyatt, A.D. (2000). Emerging infectious diseases of wildlife - threats to biodiversity and human health. **Science** 287: 443-449

Li, W., Shi, Z., Yu, M., Ren, W., Smith, C., Epstein, J.H., Wang, H., Crameri, G., Hu, Z., Zhang, H., Zhang J., McEachern, J., Field, H., Daszak, P., Eaton, B.T., Zhang, S. & Wang, L.-F. (2005). Bats are natural reservoirs of SARS-like coronaviruses. **Science** 310: 676-679.

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Five other relevant publications

Ekbom, A., Daszak, P., Kraaz, W. & Wakefield, A.J. (1996). Crohn's disease after *in utero* measles virus exposure. **Lancet** 348: 515-517.

Berger, L., Speare, R., Daszak, P., *et al.* (1998). Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. **PNAS** 95: 9031-9036.

Kilpatrick, A.M., Kramer, L.D., Jones, M.J., Marra, P.P. & Daszak P. (2006). West Nile virus epidemics in North America are driven by shifts in mosquito feeding behavior. **PLoS Biol.** 4: 606-610

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[redacted]

Cui, J., Han, N., Streicker, D., Li, G., Tang, X., Shi, Z., Hu, Z., Zhao, G., Fontanet, A., Yi, G., Wang, L., Jones, G, .Field, H.E., Daszak, P.* (Co-corresp, Author) & Zhang, S.* (Co-corresp. Author) (2007). Evolutionary relationships between bat coronaviruses and their hosts. **Emerg. Infect. Dis.** 13: 1526-1532

Synergistic Activities

Awards, citations, honors

Co-founder, and honorary Co-Director, Joint Institute for Wildlife & Zoonoses, Shanghai (2007); NIH Director's Pioneer Award Finalist (2007); Invited panelist, climate change and disease debate in Australian Parliament's Great Hall (2007); Zayed Prize (2nd) to authors of Millennium Ecosystem Assessment (2006); Paper cited as "Editor's Choice" *Science* 311: 1675 (2006); News article on EID 'hotspots' project in *Science* 307: 1190 (2005); ISI "fast-breaking paper" citation (2002); CSIRO Silver Medal for research on emerging amphibian disease (2000); Meritorious service award, CDC (1999); Honored with the naming of a species of centipede (*Cryptops daszaki*, Lewis 2001)

Panel membership

CDC: ad hoc member, ZCD1 SGI, 09PAR07-231 (2007);DIVERSITAS (UNESCO/ICSU): Executive Comm. member, Treasurer (2007-); DIVERSITAS: Chair, program on Biodiversity and Health (2006-); OIE (World Organization for Animal Health) ad hoc committee on amphibian diseases (2006-); NIAID: ZRG1 IRAP-Q Ad hoc member (2005-6); Intl. Ecohealth Assoc: Charter Board, Treasurer, Chair of Development Comm., Co-Chair of Membership Comm. (2005-); Australian Biosecurity CRC – International Advisory Standing Comm. (2004); NIAID: Steering Comm., workshop on zoonotic viral emergence (2005); NRC: Panel member "National Needs for Research in Veterinary Science" (2004-5); NRC: reviewer, NEON report (2004); NCEAS working group: Infectious diseases in mammalian mating and social systems (2004); Millennium Ecosystem Assessment: Lead Author, human health (2002-5); NIH: ZRG1 IDM-G 90 Topics in Virology, *Ad hoc* member (2003-4);

Editorial Boards & Reviewing

Review Editor, *Endangered Species Research* (2006-); International Reviewers Panel, *Medical Science Monitor* (2006-); Editorial Board, *Conservation Biology* (2004-); Co-editor, Executive Editorial Board member, *Ecohealth* Springer (2003-); Regular *ad hoc* reviewer for *Nature*, *Science*, *PNAS*, *PLoS Biology*, *Emerg. Infect. Dis.*, *Trends in Ecology and Evolution* and others. Regular reviewer of grants for *NIH*, *NSF* and others.

Collaborators & Other Affiliations

AA Aguirre (Wildlife Trust); DJ Bradley (UK); CC Brown (UGA); DS Burke (Pitt); S Campbell (Suffolk County DOH); James P Collins (ASU), AA Cunningham (UK); P Daniels (CSIRO); AP Dobson (Princeton); AP Dupuis (NYSDOH); P Epstein (Harvard); H Field (Queensland); RC Fleischer (Smithsonian); AR Gould (CSIRO); R Hanselmann (Tufts); WB Karesh (WCS); LD Kramer (NYSDOH); TG Ksiazek (CDC); S Luby (CDC); PP Marra (Smithsonian); JP Rodríguez (Venezuela); SN Stuart (CI); ND Wolfe (Hopkins).

Graduate and Postdoctoral Advisors:

Ph.D Advisor: SJ Ball, University of East London, UK

Postdoc Advisors: RM Pittilo, Kingston University, UK; D Porter, Georgia

Thesis Advisor and Postgraduate-Scholar Sponsor:

Postdocs - BH Sherman (Columbia), Bryan Porter (UGA), Kate Jones (Columbia), Kate Smith (UGA), Matt Bonds (Columbia); *Graduate Students – Ph.D*: R Day (Kingston, UK), T Sasikaran (Kingston, UK), D Bruce (UCL, UK), OB Mohammed (Kingston, UK), C Leander (UGA), J Riach (UGA), A Gomez (Columbia), K Olival (Columbia), J Epstein (Imperial, UK), L Schloegel (Kingston, UK), V Vazquez (UGA)

Stephen Luby
Programme on Infectious Diseases & Vaccine Sciences,
ICDDR,B, Mohakhali, Dhaka 1212, Bangladesh
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Professional Preparation

Creighton University , USA Philosophy	BA (honors)	1981
Univ. of Texas, Southwestern, USA Medicine	MD	1986
Univ. or Rochester, USA Internal Medicine	Board Certified	1989
Centers for Disease Control and Prevention, USA, Epidemiology		1992

Appointments

Head, Programme on Infectious Diseases ICDDRB, Bangladesh	2004 - current
Medical Epidemiologist, Centers for Disease Control, USA	1998 - 2004
Assistant Professor, Aga Khan University	1993 - 1998
Preventive Medicine Resident, Centers for Disease Control, USA	1991 – 1993
Epidemic Intelligence Service Officer, CDC, USA	1990 – 1992
Attending Physician, Genesee Hospital, USA	1989 - 1990

Publications

Five most closely related to proposed project

Daszak, P, Plowright R, Epstein JH, Pulliam J, Abdul Rahman S, Field HE, Smith CS, Olival KJ, Luby S, Halpin K, Hyatt AD. & the Henipavirus Ecology Research Group (HERG). The emergence of Nipah and Hendra virus: pathogen dynamics across a wildlife-livestock-human continuum. In: Collinge S, Ray S, editors. Disease Ecology: Community structure and pathogen dynamics. Oxford University Press, 2006; pp. 186-201.

Epstein JH, Field HE, Luby S, Pulliam JRC, Daszak P. Nipah virus: Impact, origins and causes of emergence. **Current Infectious Disease Reports**. 2006;8:59-65.

Luby SP, Rahman M, Hossain MJ, Blum LS, Husain NM, Gurley E, Khan R, Ahmed B, Rahmin S, Nahar N, Kenah E, Comer JA, Ksiazek TG. Foodborne transmission of Nipah virus, Bangladesh. **Emerging Infectious Diseases**. 2006;12:1888-1894.

Gurley E, Montgomery J, Hossain MJ, Bell M, Zad OK, Islam MR, Molla MAR, Carroll D, Ksiazek T, Rota PA, Lowe L, Comer JA, Rollin P, Czub M, Grolla A, Feldmann H, Luby SP, Woodward JL, Breiman RF. Person-to-person transmission of Nipah virus within a Bangladeshi Community. **Emerging Infectious Diseases**. 2007 13: 1031-1037

Altaf A, Luby S, Ahmed AJ, Zaidi NA, Khan AJ, Mirza S, McCormick J, Fisher-Hoch S. Outbreak of Crimean-Congo haemorrhagic fever in Quetta, Pakistan: Contact tracing and risk assessment. **Tropical Medicine and International Health**. 1998, (11):878-82.

Five other relevant publications

Redd S, Kazembe P, Luby S, Nwanyanwu O, Hightower A, Ziba C, Wirima J, Chitsulo L, Franco C, Olivar M. Clinical algorithm for the treatment of Plasmodium falciparum malaria in children. **Lancet**. 1996 347:223-227.

Luby S, Qamruddin C, Shah A, Omair A, Pasha O, Khan AJ, Hoodbhoy F, McCormick J, Fisher-Hoch S. The relationship between therapeutic injections and high prevalence of hepatitis C infection in Hafizabad, Pakistan. **Epidemiology and Infection**. 1997, 119:349-356.

Crump JA, Luby SP, Mintz ED. The Global Burden of Typhoid Fever. **Bulletin of the World Health Organization**. 2004 May; 82(5):346-353.

Luby SP, Agboatwalla M, Feikin DR, Painter J, Billhimer W, Altaf A, Hoekstra RM. Effect of handwashing on child health: a randomised controlled trial. **Lancet**. July 15, 2005; 366:225-33.

Khan AJ, Luby SP, Fikree FF, Karim A, Obaid S, Dellawala S, Mirza S, Malik T, Fisher-Hoch S, McCormick JB. Injections and Hepatitis B and C transmission in Peri-Urban Karachi, Pakistan. **Bulletin of the World Health Organization**. 2000; 78(8):956-963.

Synergistic Activities

- Associate Editor, Emerging Infections Section, Journal of Health Population and Nutrition
- Adjunct Faculty: Emory University (USA), Aga Khan University (Pakistan)
- Outstanding Teaching Award, Aga Khan University, 1996
- Editor, Health and Science Bulletin (Bangladesh)
- PhD Epidemiology, Thesis review committee, Swiss Tropical Institute, 2003 and Deakin University (Australia), 2004
- Reviewer (last 3 years only) for *American Journal of Infection Control, Bulletin of the World Health Organization, Emerging Infectious Diseases, Health Policy and Planning, Epidemiology and Infection, International Journal of Epidemiology, International Journal of Health Care Quality, JAMA, Journal of Infectious Diseases, Journal of Water and Health, Lancet Infectious Diseases, Transactions of the Royal Society of Tropical Medicine and Hygiene, Social Science and Medicine, Tropical Medicine and International Health, British Medical Journal*

Thesis Advisor and Postgraduate-Scholar Sponsor:

Masters Theses Supervision I Jehan (McGill), R NoorAli (McGill), A Quddus (Aga Khan), S Hozhabri (Aga Khan), AA Siddiqui (Aga Khan), A Bari (Aga Khan), MI Raza (Aga Khan), H Raza (Aga Khan), P Laorakpong (Emory), G Tanaka (Emory), NI Alamgir (BRAC)

Collaborators and Co-authors in the past 48 months

AK Azad (Institute for Epidemiology and Disease Control Research (IEDCR), Bangladesh); Nima Asgari (WHO, China); Alice Croisier (WHO, Switzerland); Tasnim Azim (ICDDR,B); Shakila Banu (ICDDR,B, Bangladesh); William Bellini (CDC, USA); Lauren Blum (ICDDR,B); Michael Bell (CDC, USA); Eric Bertherat (WHO, Switzerland); Robert F. Breiman (CDC, USA); Abdullah Brooks (ICDDR,B); Darin Carroll (CDC, USA); James A. Comer (CDC, USA); Markus Czub (University of Manitoba); Peter Daszak (CCM, USA); Jonathan Epstein (CCM, USA); Heinz Feldmann (University of Manitoba); Pierre Formenty (WHO, Switzerland); Alicia Fry (CDC, USA); Emily Gurley (ICDDR,B); Jena Hamadani (ICDDR,B, Bangladesh); Brian Harcourt (CDC, USA); Jahangir Hossain (ICDDR,B, Bangladesh); Mollah Abid Hossain (Dhaka Medical College, Bangladesh); Rafiqul Islam (Suhrawardy Medical College Hospital, Bangladesh); John Jernigan (CDC, USA); Salah Uddin Khan (ICDDR,B); Rasheda Khan (ICDDR,B); Rasheda Khanam (ICDDR,B); Thomas Ksiazek (CDC, USA); Alec Mercer (ICDDR,B); Joel Montgomery (NAMRU, Lima, Peru); Susan Montgomery (CDC, USA); MR Mollah (IEDCR); Riyadh Muhammad (CDC, USA); Nazmun Nahar (ICDDR,B); Khairun Nessa (ICDDR,B); Lyle Petersen (CDC, USA); Mahmudur Rahman (IEDCR, Bangladesh); Motiur Rahman (ICDDR,B); Pierre Rollin (CDC, USA); Paul Rota (CDC, USA), James J. Sejvar (CDC, USA); Arjun Srinivassan (CDC, USA); Rebeca Sultana (ICDDR,B); CT Tan (Malaysia); AKMR Uddin (Dhaka Medical College, Bangladesh); Rashid-uz-Zaman (ICDDR,B).

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Professional Preparation

Brandeis University	Biology	BA	1996
Tufts University Sch. Vet. Med.	Vet Med	D.V.M, Intl. Cert, MPH	2002
Kingston University, London		PhD (Candidate)	2007-

Appointments

Senior Research Scientist, Consortium for Conservation Medicine, NY	2003 - present
Adjunct Asst. Clinical Professor, Tufts Univ. Sch. Med., Boston, MA	2007 – present
Clinical Assoc. Professor, Tufts Cummings Sch. Vet. Med., Grafton, MA	
Adjunct Faculty, Mailman School of Public Health, Columbia Univ, NY	2006 - present
Adjunct Faculty, CERC, Columbia Univ, NY	2003 - present
Veterinary Internship, Ocean State Vet. Specialists, RI	2002-2003
Public Health Externship, Div. Viral and Rickettsial Dis., CDC, Atlanta	2002

Publications

Five most closely related to proposed project

McCall, B.J., Epstein, J.H. & Annette, N., (2000) Potential human exposure to Australian bat Lyssavirus, Queensland, 1996-1999. **Emerging Infectious Diseases**; 6: 259-264

Li W, Shi Z, Yu M, Ren W, Smith C, Epstein JH, Wang H, Crameri G, Hu Z, Zhang H, Zhang J, McEachern J, Field H, Daszak P, Eaton BT, Zhang S & Wang L-F (2005) Bats are natural reservoirs of SARS-like coronaviruses. **Science**; 310: 676-679.

Epstein, J.H., Field, H.E., Luby, S., Pulliam, J., and Daszak, P. (2006). Nipah Virus: Impact, Origins, and Causes of Emergence. **Current Infectious Disease Reports**; 8: 59-65.

Epstein, J.H., Rahman, S.A., Zambriski, J.A., Halpin, K., Meehan, G., Jamaluddin, A.A., Hassan, S.S., Field, H.E., Hyatt, A.D., Daszak, P. & HERG. (2006). Feral cats (*Felis catus*) as possible vectors for Nipah virus. **Emerging Infectious Diseases**. 12: 1178-1179.

(b) (4)

Five other relevant publications

Epstein, J.H., McKee, J., Shaw, P., Hicks, V., Micalizzi, G., Daszak, P., Kilpatrick, A.M. & Kaufman, G. (2006). The Australian white ibis (*Threskiornis molucca*) as a reservoir of zoonotic and livestock pathogens. **EcoHealth**. 3: 290-298.

Breed A., Field, H., Epstein, J., Plowright, R.K., and Daszak, P. (2006). Emerging henipaviruses and flying foxes – conservation and management perspectives. **Biological Conservation**. 131 211-220.

Halpin, K., Hyatt, A.D., Plowright, R.K., Epstein, J.H., Daszak, P., Field, H.E., Wang, L., Daniels, P., and the Henipavirus Ecology Research Group (2007). Emerging viruses – coming in on a wrinkled wing and a prayer. **J. Clinical Infectious Diseases**. 44; 711-717.

Daszak, P., Epstein, J.H., Kilpatrick, A.M., Aguirre, A.A., Karesh, W.B. & Cunningham, A.A. (2007). Collaborative research approaches to the role of wildlife in zoonotic disease

emergence. In: *Wildlife and Emerging Zoonotic Diseases: The Biology, Circumstances, and Consequences of Cross-Species Transmission.* Eds. Childs, J.E., J.S. MacKenzie and J.A. Richt. **Current Topics in Microbiology and Immunology.** Pp. 463 – 475.

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Synergistic Activities

- IUCN Veterinary Specialist Group (2003 – present); IUCN Chiroptera Species Specialist Group (2007 – present)
- Invited speaker, WHO, Emerging Zoonotic Diseases Working Group meeting (2004); Panel member, Swiss Re Executive Roundtable on Emerging Diseases (2004); Invited speaker, Royal Swedish Academy of Forestry and Agriculture (2004); Invited speaker, Swedish University of Agricultural Sciences: Disease Emergence (2004)
- Member: Delta Omega Honor Society, Tufts University School of Medicine Alpha Rho Chapter Graduate Programs in Public Health (1st alumni inductee; 1st keynote speaker). (2006); Delta Omega Public Health Honors Society (2006); Am. Vet. Med. Assoc.; Am. Assoc Zoo Vet.; Wildlife Disease Association; NY Acad Sci; Advisory comm, Suffolk Co. Board of Public Hlth; Intl Assoc. Ecology & Hlth;
- Reviewer: *Science, Emerging Infectious Diseases, New England Journal of Medicine, Journal of Infectious Diseases, Conservation Biology, Biological Conservation, Ecohealth,* and several book chapters.
- Outstanding Alumnus Award, Tufts Cummings School of Veterinary Medicine (2007); Certificate in International Veterinary Medicine (1st recipient). Tufts University School of Veterinary Medicine (2002); Sylvia Mainzer Public Health Award. For outstanding achievement in the field of public health. Tufts University School of Veterinary Medicine (2002).

Collaborators & Other Affiliations

AA Aguirre (Wildlife Trust); B. Chomel (UC Davis); K.B. Chua (Malaysia); T. Coulson (Imperial College, UK); AA Cunningham (UK); P Daniels (CSIRO); P. Daszak (CCM); AP Dobson (Princeton); P Epstein (Harvard); H Field (Queensland); J. Hossain (Bangladesh); Abd. Aziz Jamaluddin (Malaysia); K. Jones (UK); WB Karesh (WCS); TG Ksiazek (CDC); W.I.Lipkin, (Columbia Univ); S Luby (CDC, Bangladesh); F.X. Meslin (WHO); J Patz (Johns Hopkins); K. Pelican (Smithsonian Institution); T. Phillips (NIH); A. Walsh, (U. Florida); ND Wolfe (UCLA).

Graduate Advisors:

Ph.D Advisor: T. Coulson, Imperial College, London; AA. Cunningham, Institute of Zoology, London; P. Daszak (CCM, New York)

Graduate student advisor:

DVM/MPH: S. Wilson (Tufts Sch. Vet Med., MA); M. Hillyard (Tufts, MA), J. McRobbie (Tufts); *DVM:* J. Zambriski (Tufts, MA); A. McLaughlan (Tufts); *PhD:* K. Olival (Columbia Univ., NY); *MD:* M. McCarthy (Harvard Univ., MA). *Undergraduate Students*: A. Chmura (Columbia Univ.), J. Westrum (Columbia)

Emily Gurley
Programme on Infectious Diseases & Vaccine Sciences,
ICDDR,B, Mohakhali, Dhaka 1212, Bangladesh
E-mail: egurley@icddrb.org

Professional Preparation

Oglethorpe University, History	BA	1996
Emory University, International Health	MPH	2001

Appointments

Coordinator, Programme on Infectious Diseases ICDDRB, Bangladesh	2003 - current
Qualitative Researcher, Centers for Disease Control, USA	2002 - 2003
Research Assistant, Southeast AIDS Training and Education Center	2000 - 2002
NGO Development Volunteer, US Peace Corps, Romania	1997 – 1999

Publications

Five most closely related to proposed project

Gurley ES, Montgomery JM, Hossain MJ, Islam MR, Molla MAR, Shamsuzzaman SM, Akram K, Zaman K, Asgari N, Comer JA, Azad AK, Rollin PE, Ksiazek TG, Breiman RF. Lack of nosocomial transmission of Nipah virus in a Bangladeshi hospital. **Infection Control and Hospital Epidemiology**. 2007;28(6):740-42.

Gurley ES, Montgomery J, Hossain MJ, Bell M, Azad AK, Islam MR, Molla MAR, Carroll D, Ksiazek T, Rota PA, Lowe L, Comer JA, Rollin P, Czub M, Grolla A, Feldmann H, Luby SP, Woodward JL, Breiman RF. Person-to-person transmission of Nipah virus within a Bangladeshi Community. **Emerging Infectious Diseases**. 2007 13: 1031-1037

Luby SP, Rahman M, Hossain MJ, Blum LS, Husain NM, Gurley E, Khan R, Ahmed B, Rahmin S, Nahar N, Kenah E, Comer JA, Ksiazek TG. Foodborne transmission of Nipah virus, Bangladesh. **Emerging Infectious Diseases**. 2006;12:1888-1894.

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Harcourt BH, Lowe L, Tamin A, Liu X, Bankamp B, Bowden N, Rollin PE,Comer JA, Ksiazek TG, Hossain MJ, Gurley ES, Breiman RF, BelliniWJ, and Rota PA. Genetic characterization of Nipah Virus, Bangladesh, 2004. **Emerging Infectious Diseases**. 2005 Oct;11(10):1594-1597.

Five other relevant publications

(b) (4)

Sejvar J, Hossain J, Saha SK, Gurley ES, Banu S, Jamadani JD, Faiz MA, Siddiqui FM, Mohammad QD, Mollah AH, Uddin R, Alam R, Rahman R, Tan CT, Bellini W, Rota P, Breiman RF, Luby SP. Long-Term Neurologic and Functional Outcome in Nipah Virus Infection. **Annals of Neurology**. 2007 Sep;62(3):235-42.

Mercer A, Khanam R, Gurley ES, Azim T. Sexual risk behaviour of married men and women in Bangladesh who have lived apart due to the husband's work-migration. **Sexually Transmitted Diseases**. 2007May;34(5):265-73.

(b) (4)

Synergistic Activities

- Editor, ICDDR,B's *Health and Science Bulletin*
- Reviewer for *Indian Journal of Medical Research*

Collaborators and Co-authors in the past 48 months

AK Azad (Institute for Epidemiology and Disease Control Research (IEDCR), Bangladesh); Nima Asgari (WHO, China); Alice Croisier (WHO, Switzerland); Tasnim Azim (ICDDR,B); Shakila Banu (ICDDR,B, Bangladesh); William Bellini (CDC, USA); Lauren Blum (ICDDR,B); Michael Bell (CDC, USA); Eric Bertherat (WHO, Switzerland); Robert F. Breiman (CDC, USA); Abdullah Brooks (ICDDR,B); Darin Carroll (CDC, USA); James A. Comer (CDC, USA); Markus Czub (University of Manitoba); Peter Daszak (CCM, USA); Jonathan Epstein (CCM, USA); MA Faiz (Dhaka Medical College, Bangladesh); Heinz Feldmann (University of Manitoba); Pierre Formenty (WHO, Switzerland); Alicia Fry (CDC, USA) Jena Hamadani (ICDDR,B, Bangladesh); Brian Harcourt (CDC, USA); Jahangir Hossain (ICDDR,B, Bangladesh); Mollah Abid Hossain (Dhaka Medical College, Bangladesh); Rafiqul Islam (Suhrawardy Medical College Hospital, Bangladesh); John Jernigan (CDC, USA); Salah Uddin Khan (ICDDR,B); Rasheda Khan (ICDDR,B); Rasheda Khanam (ICDDR,B); Thomas Ksiazek (CDC, USA); Stephen P. Luby (CDC, USA); Alec Mercer (ICDDR,B); Joel Montgomery (NAMRU, Lima, Peru); Susan Montgomery (CDC, USA); MR Mollah (IEDCR); Riyadh Muhammad (CDC, USA); Nazmun Nahar (ICDDR,B); Khairun Nessa (ICDDR,B); Lyle Petersen (CDC, USA); Mahmudur Rahman (IEDCR, Bangladesh); Motiur Rahman (ICDDR,B); Pierre Rollin (CDC, USA); Paul Rota (CDC, USA), James J. Sejvar (CDC, USA); Arjun Srinivassan (CDC, USA); Rebeca Sultana (ICDDR,B); CT Tan (Malaysia); AKMR Uddin (Dhaka Medical College, Bangladesh); Rashid-uz-Zaman (ICDDR,B).

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Professional Preparation

Dhaka Medical College Hospital, Dhaka	MBBS	1991
London School of Hygiene & Tropical Medicine, MSc, Communicable Disease Epidemiology.		1998

Appointments

Assistant Scientist, ICDDR,B	2004-current
Medical Officer, Clinical Sciences Division, ICDDR,B	1999-2003
Research Medical Officer, ICDDR,B	1998-1999
Research Medical Officer, ICDDR,B	1994-1997
Postgraduate training, Dhaka Medical College Hospital	1992-1993
Medical Residency (Internship training), Dhaka Medical College Hospital	1991-1992

Publications

Five most closely related to proposed project

(b) (4)

Sejvar JJ, **Hossain J**, Saha SK, Gurley ES, Banu S, Hamadani JD, Faiz MA, Siddiqui FM, Mohammad QD, Mollah AH, Uddin R, Alam R, Rahman R, Tan CT, Bellini W, Rota P, Breiman RF, Luby SP. Long-term neurological and functional outcome in Nipah virus infection. Ann Neurol. 2007 Aug 15

Gurley ES. MJ, **Hossain MJ**, Bell M, Azad AK, Islam MR, Molla MAR, Carroll D, Ksiazek TG, Rota PA, Lowe L, Comer JA, Rollin P, Czub M, Grolla A, Feldmann H, Luby SP, Woodward JL, Breiman RF. Person-to-person transmission of Nipah virus within a Bangladeshi Community. Emerging Infectious Diseases. 2007 Jul;13(7). 1031-37

Gurley ES, Montgomery JM, **Hossain MJ**, Islam MR, Molla MA, Shamsuzzaman SM, Akram K, Zaman K, Asgari N, Comer JA, Azad AK, Rollin PE, Ksiazek TG, Breiman RF. Risk of nosocomial transmission of nipah virus in a Bangladesh hospital. Infect Control Hosp Epidemiol. 2007 Jun;28(6):740-2. Epub 2007 May 11.

Five other relevant publications

(b) (4)

Luby SP, Rahman M, **Hossain MJ**, Blum LS, Husain NM, Gurley E, Khan R, Ahmed B, Rahmin S, Nahar N, Kenah E, Comer JA, Ksiazek TG. Evidence for Foodborne

Transmission of Nipah Virus, Bangladesh. *Emerging Infectious Diseases*. 2006 December; 12 (12): 1888-94.

Ivan V. Kuzmin, Michael Niezgoda, Darin S. Carroll, Natalie Keeler, **Mohammed Jahangir Hossain**, Robert F. Breiman, Thomas G. Ksiazek and Charles E. Rupprecht. Lyssavirus Surveillance in Bats, Bangladesh. Emerg Infect Dis. 2006 March; 12(3):

Harcourt BH, Lowe L, Tamin A, Liu X, Bankamp B, Bowden N, Rollin PE, Comer JA, Ksiazek TG, **Hossain MJ**, Gurley ES, Breiman RF, Bellini WJ, Rota PA. Genetic characterization of Nipah virus, Bangladesh, 2004. Emerg Infect Dis. 2005 Oct;11(10):1594-7.

Hsu VP, **Hossain MJ**, Parashar UD, Ali MM, Ksiazek TG, Kuzmin I, Niezgoda M, Rupprecht C, Bresee J, Breiman RF. Nipah virus encephalitis reemergence, Bangladesh. Emerg Infect Dis. 2004 Dec;10(12):2082-7.

Synergistic Activities

Society Membership and leadership

Advisor from September 2007: AusReady (The Asia Pacific Emerging Infectious Diseases Facility. An Australian Government, AUSAID Initiative.

Editorial activities

Editor and Reviewer: Shasthya Sanglap, ICDDR,B

Honors and awards

Awarded EU fund for MSc in Communicable Disease Epidemiology for the session of 1997-98 at London School of Hygiene and Tropical Medicine

Collaborators & Other Affiliations

Collaborators & Co-authors

Azad AK (IEDCR, Bangladesh); A. Croisier (WHO, Switzerland); Banu Shakila (ICDDR,B, Bangladesh); Bell Michael (CDC, USA); Breiman RF (CDC, USA); Carroll Darin (CDC, USA); Comer Andy (CDC, USA); Eric Bertherat (WHO, Switzerland); Faiz MA (Dhaka Medical College, Bangladesh); Gurley Emily (ICDDR,B, Bangladesh); Hamadani JD (ICDDR,B, Bangladesh); Islam R (IEDCR, Bangladesh); James J. Sejvar (CDC, USA); Joel Montgomery (CDC, USA); Jonathan Epstein (CCM, USA); Ksiazek Thomas (CDC, USA); Luby SP (CDC, USA); Mollah MR (IEDCR); Mollah Abid Hossain (Dhaka Medical College, Bangladesh); Pierre Rollin (CDC, USA); P. Formenty (WHO, Switzerland); Rahman M (IEDCR, Bangladesh); Rota Paul (CDC, USA), Susan Montgomery (CDC, USA), Tan CT (Malaysia); Uddin AKMR (Dhaka Medical College, Bangladesh).

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a. Professional Preparation

Univ. California, Los Angeles	Mechanical Eng. & Philos.	BS & BA	1995
Massachusetts Institute of Technology	Mechanical Eng.	MS	1997
Univ. Wisconsin, Madison	Zoology	PhD	1998-2003

b. Appointments

Research Associate, Smithsonian Institution	2004-
Adjunct Research Scientist, Columbia University	2003-
Senior Research Scientist, Consortium for Conservation Medicine	2004-
Research Fellow, Consortium for Conservation Medicine	2003

c. Publications

Five Publications related to the application

Kilpatrick, A. M., A. Chmura, A., D. Gibbons, W., R. C. Fleischer, P. P. Marra, and P. Daszak. 2006. Predicting the global spread of H5N1 avian influenza. **PNAS** 103:19368–19373.

Kilpatrick, A. M., P. Daszak, S. J. Goodman, H. Rogg, L. D. Kramer, V. Cedeno, and A. A. Cunningham. 2006. Predicting pathogen introduction: West Nile virus spread to Galapagos. **Conservation Biology** 20:1224-1231.

Kilpatrick, A. M., L. D. Kramer, M. J. Jones, P. P. Marra, and P. Daszak. 2006. West Nile virus epidemics in North America are driven by shifts in mosquito feeding behavior. **PLoS Biology** 4:606-610.

Kilpatrick, A.M., L.D. Kramer, M.J. Jones, P.P. Marra, P. Daszak, D.M. Fonseca. 2007. Genetic influences on mosquito feeding behavior and the emergence of zoonotic pathogens **Am J Tropical Medicine & Hygiene** 77(4) 667-671

LaDeau, S.L., A.M. Kilpatrick, P.P. Marra. 2007. West Nile virus emergence and large-scale declines of North American bird populations. **Nature** (447) 710-713

Five other significant publications

Kilpatrick, A.M., Ives. A.R. 2003. Species interactions can explain Taylor's power law for ecological time series. **Nature** 422: 65-68

Kilpatrick, A. M., P. Daszak, M. J. Jones, P. P. Marra, and L. D. Kramer. 2006. Host heterogeneity dominates West Nile virus transmission. **Proc. Roy. Soc. B 273** 2327 - 2333.

Kilpatrick, A.M., L.D. Kramer, S. Campbell, E.O. Alleyne, A.P. Dobson, P. Daszak. 2005. West Nile Virus Risk Assessment and the Bridge Vector Paradigm. **Emerging Infectious Diseases** 11(3) 425-9

Wolfe, N.D., P. Daszak, A.M. Kilpatrick, and D.S. Burke. 2005. Bushmeat Hunting, Deforestation and Predicting Zoonotic Emergence **Emerging Infectious Diseases** 11(12): 1822-7

Kilpatrick, A.M., Y. Gluzberg, J. Burgett, and P. Daszak. 2004. A quantitative risk assessment of the pathways by which West Nile virus could reach Hawaii. **Ecohealth** 1(2) 205-209

d. Synergistic Activities

Testified before Congress: Committee on Government Reform, congressional hearing "Current Challenges in Combating the West Nile virus" October 2004.

Worked with USDA and Government Accountability Office to revise H5N1 avian influenza surveillance/management plans

Worked on Hawaii USGS task force and with government of Ecuador to prevent introduction of West Nile virus to Hawaii and Galapagos

Grant reviewer for *NSF*, *NIH* and 28 journals, incl. Nature, PLoS Biology, J.Animal Ecology, EID, Proc. Roy. Soc. B, Theor. Pop. Biol., Am. J. Trop. Med. Hyg.

Review committee, Society for Conservation Biology Annual Meeting, NY 2004

Invited expert, Galapagos West Nile Virus Workshop, Galapagos National Park HQ, Puerto Ayora (2004)

Invited expert, policy meeting on preventing brucellosis transmission from bison to cattle in Yellowstone (2004)

e. Collaborators & Other Affiliations

i. Collaborators and Co-Editors: Aguirre, AA, Wildlife Trust, Alleyne, EO, Rockland County Department of Health, Atkinson, CT, Pacific Island Ecosystems Research Center, USGS-BRD, Brand, C, National Wildlife Health Center, USGS, Burgett, J, USFWS, Pacific Islands Office, Caffrey, CL, National Audubon Society, Campbell, S, Suffolk County Department of Health, Dhondt, A, Cornell U., Dupuis, AP, New York State Department of Health, Fajardo-Ramos L, I. Venezolano de Inv. Cient., Gluzberg, Fleischer, R, Smithsonian, Y, Columbia U., Gibbons, D. RSPB, Gross, K, NC State U., Hanselmann, R, Tufts U., Hudson, PJ, Penn State U., Ives, AR, U. of Wisconsin, Madison, Lampo, M, I. Venezolano de Inv. Cient., LaPointe, D, Pacific Island Ecosystems Research Center, USGS-BRD, Lease, JK Pacific Island Ecosystems Research Center, USGS-BRD, McLean, RG, National Wildlife Research Center, Mitchell, WA, Indiana State U., Novak, R, U. of Illinois at Urbana-Champaign, Porter, WP, U. of Wisconsin, Madison, Rodríguez A, Universidad de los Andes, Venezuela, Rodríguez, JP, Instituto Venezolano de Investigaciones Científicas, Venezuela, Smith, G, Penn State U., Woodworth, BL, Pacific Island Ecosystems Research Center, USGS-BRD

ii. Graduate and Postdoctoral Advisors:

PhD. Advisor: Warren P. Porter, University of Wisconsin, Madison

iii. Thesis Advisor and Postgraduate-Scholar Sponsor

Graduate Students Mentored: Andres Gomez (PhD), Columbia University; Cathy Tuglus, (M.S.) Columbia University, Ryan Peters (M.S.) George Mason University; Violeta Jimenez (B.S.) Columbia University

W. Ian Lipkin
Columbia University Mailman Sch. Public Health, New York
E-mail: (b) (6)

Professional Preparation

Sarah Lawrence College, Bronxville	Liberal Arts	B.A.	1974
Rush Medical Colleage, Chicago IL	Medicine	M.D.	1978

Appointments

Professor of Epidemiology, Neurology & Pathology; Director, Ctr for Infection and Immunity, Mailman School of Public Health, Columbia Univ, NY	2007-
PI & Sci Dir., Northeast Biodefense Ctr., NY (region II NIAID ctr of excellence)	2003-
Director, Jerome L. and Dawn Greene Infectious Disease Lab; Endowed Prof. of Neurology & Pathology, Columbia Univ Mailman Sch. Publ. Hlth	2002 – 2007
Louise Turner Arnold Professor of Neuroscience, UC Irvine	2000 – 2002
Adjunct Professor, Scripps, La Jolla CA	1996 – 2002
Sabbatical Professor, Inst Virology, Wurzburg, Germany	1996 – 1997
Asst Prof.-Assoc. Prof.-Full Professor (1996-02), UC Irvine	1990 – 2002
Postdoc fellow, Scripps Research Inst., La Jolla CA	1984 – 1990
Resident in Neurology, UCSF	1981 – 1984
Intern in Medicine, Presbyterian Hospl., U. Pittsburgh	1978 – 1979
Clinical Clerk, Inst. Neurol., London UK	1977 – 1978

Publications

Five most closely related to proposed project

Jia, X. Y., T. Briese, I. Jordan, A. Rambaut, H. C. Chi, J. S. Mackenzie, R. A. Hall, J. Scherret, and W. I. Lipkin. 1999. Genetic analysis of West Nile New York 1999 encephalitis virus. **Lancet** 354:1971-1972.

Cox-Foster, D. L., S. Conlan, E. C. Holmes, G. Palacios, J. D. Evans, N. A. Moran, P. L. Quan, T. Briese, M. Hornig, D. M. Geiser, V. Martinson, D. vanEngelsdorp, A. L. Kalkstein, A. Drysdale, J. Hui, J. H. Zhai, L. W. Cui, S. K. Hutchison, J. F. Simons, M. Egholm, J. S. Pettis, and W. I. Lipkin. 2007b. A metagenomic survey of microbes in honey bee colony collapse disorder. **Science** 318:283-287.

Palacios, G., T. Briese, V. Kapoor, O. Jabado, Z. Q. Liu, M. Venter, J. H. Zhai, N. Renwick, A. Grolla, T. W. Geisbert, C. Drosten, J. Towner, J. Y. Ju, J. Paweska, S. T. Nichol, R. Swanepoel, H. Feldmann, P. B. Jahrling, and W. I. Lipkin. 2006. MassTag polymerase chain reaction for differential diagnosis of viral hemorrhagic fevers. **Emerging Infectious Diseases** 12:692-695.

Palacios, G., P. L. Quan, O. J. Jabado, S. Conlan, D. L. Hirschberg, Y. Liu, J. Zhai, N. Renwick, J. Hui, H. Hegyi, A. Grolla, J. E. Strong, J. S. Towner, T. W. Geisbert, P. B. Jahrling, C. Buechen-Osmond, H. Ellerbrok, M. P. Sanchez-Seco, Y. Lussier, P. Formenty, S. T. Nichol, H. Feldmann, T. Briese, and W. I. Lipkin. 2007. Panmicrobial oligonucleotide array for diagnosis of infectious diseases. **Emerging Infectious Diseases** 13:73-81.

Quan, P. L., G. Palacios, O. J. Jabado, S. Conlan, D. L. Hirschberg, F. Pozo, P. J. M. Jack, D. Cisterna, N. Renwick, J. Hui, A. Drysdale, R. Amos-Ritchie, E. Baumeister, V. Savy, K. M. Lager, J. A. Richt, D. B. Boyle, A. Garcia-Sastre, I. Casas, P. Perez-Brena, T. Briese, and W. I. Lipkin. 2007. Detection of respiratory viruses and subtype identification of influenza a viruses by GreeneChipResp oligonucleotide microarray. **Journal of Clinical Microbiology** 45:2359-2364.

Five other relevant publications

Lipkin, W. I., G. H. Travis, K. M. Carbone, and M. C. Wilson. 1990. Isolation and Characterization of Borna Disease Agent Cdna Clones. **Proceedings of the National Academy of Sciences of the United States of America** 87:4184-4188.

Briese, T., J. C. Delatorre, A. Lewis, H. Ludwig, and W. I. Lipkin. 1992. Borna Disease Virus, a Negative-Strand Rna Virus, Transcribes in the Nucleus of Infected-Cells. **Proceedings of the National Academy of Sciences of the United States of America** 89:11486-11489.

Briese, T., A. Schneemann, A. J. Lewis, Y. S. Park, S. Kim, H. Ludwig, and W. I. Lipkin. 1994. Genomic Organization of Borna-Disease Virus. **Proceedings of the National Academy of Sciences of the United States of America** 91:4362-4366.

Briese, T., W. G. Glass, and W. I. Lipkin. 2000. Detection of West Nile virus sequences in cerebrospinal fluid. **Lancet** 355:1614-1615.

Gu, J., Z. G. Xie, Z. C. Gao, J. H. Liu, C. Korteweg, J. X. Ye, L. T. Lau, J. Lu, Z. F. Gao, B. Zhang, M. A. McNutt, M. Lu, V. M. Anderson, E. C. Gong, A. C. H. Yu, and W. I. Lipkin. 2007. H5N1 infection of the respiratory tract and beyond: a molecular pathology study. **Lancet** 370:1137-1145.

Synergistic Activities

Honors

National MS Soc Postdoc Fellow, 1984; Silver Medal for Claret (Amateur) Sonoma County Fair, 1985; NINDS Clinical Investigator Development Award, 1987; National Alliance for Research in Schizophrenia and Depression Young Investigator, 1991; Pew Scholar Biomedical Sciences, 1991; State-of-the-Art Lecturer, American Soc Virology, 1997; Lecturer, XXIst Collegium Internationale Neuropsychopharmacologicum, 1997; Lecturer, 50th Anniversary NIAID/NIH, 1998; Visiting Professor, Japanese Health Sci Fdn, 1999; Visiting Bruenn Professor, Columbia Univ 2000; Millenium Commencement Speaker, Sarah Lawrence College, 2000; American Soc for Microbiol/Waksman Fdn Lecturer, 2001; Ellison Medical Fdn Senior Scholar in Global Infectious Diseases, 2002; Distinguished Lecturer, Institute of Genomics and Bioinformatics, UC Irvine, 2003; Special Advisor for Ministry of Science & Technology, People's Republic of China, 2003; Advisory Board, Guangzhou Ctr Biomedicine and Health, 2003; Dalldorf Res Physician NYS Dept of Health, 2003; Advisory Board, Institut Pasteur de Shanghai; Fellow, NY Academy of Sciences, 2003; CDC Distinguished Lecturer, 2005; Honorary Director, Beijing Infectious Disease Ctr, 2005; Visiting Professor Beijing University; Fellow, American Soc for Microbiol, 2006; Alumnae Citation for Achievement and Service, Sarah Lawrence College, 2006.

Panel Membership

Amer Bd of Internal Medicine, 1981; Amer Bd of Psychiatry and Neurology, 1986; National MS Soc Advisory Com on Fellowships, 1991-94; PI, UCI-Markey Program in Human Neurobiology, 1994-99; Founding Chair, Scientific Advisory Bd, Cure Autism Now Fdn, 1998-2000; Advisory Bd, 1st Intl Conf on Emerging Zoonoses, 1996; Organizer, Keystone Symp on Infections of the Nervous System, 1998; NCI/NIAID Blue Ribbon Panel on New Approaches to Identifying Infectious Etiologies of Chronic Disease, 1999; Bio-Centric Operations, US Joint Warfighting Center (bioterrorism), 1999; Organizer, NIAID Blue Ribbon Panel on Neurovirology, 2000; Organizer, Banbury Conf on Microbiology, Immunology and Toxicology of Autism and Other Neurodevelopmental Disorders, 2000; Organizer, Infectious Etiologies of Neuropsychiatric Disorders, World Congress Biol Psychiatry, Berlin, 2001; Organizer, FASEB Conf Microbial Pathogenesis, 2002; NCI Blue Ribbon Panel, Microbial Infection and Human Cancer, 2002; Scientific Advis Bd, 454 Life Sciences Corp, 2003; WHO SARS Lab Network, 2003; External Reviewer, Bd of Scientific Counselors, NIMH, 2003; Founding Chair, Emerging Infectious Diseases Discussion Group, NY Acad of Sciences, 2003; WHO Lab Network, 2004.

Paul Rota
Division of Viral Diseases,
Centers for Disease Control and Prevention
E-mail: (b) (6)

Professional Preparation

Rutgers College, USA	Microbiology	BA	1980
Michigan State University, USA	Microbiology	PhD	1985

Appointments

Lead Scientist, Molecular Virology Team, Measles, Mumps, Rubella, and Herpes Viruses Laboratory Branch, Centers for Disease Control, USA 1991 – current
Research Microbiologist, Influenza Branch, Centers for Disease Control, USA 1988-1991
Research Associate, Influenza Branch, Centers for Disease Control, USA 1986-1988

Publications

Five most closely related to proposed project

Harcourt, B. H., L. Lowe, A.Tamin, X. Liu, B. Bankamp, N. Bowden, P. E.Rollin, J. A. Comer, T. G. Ksiazek, M. J. Hossain, E. S. Gurley, R. F. Breiman, W. J. Bellini, P. A. Rota, (2005). Genetic characterization of Nipah viruses isolated during two outbreaks in Bangladesh in 2004. **Emerging Infectious Diseases,** 11, 1594-7.

Chadha, M. S., J. A. Comer, L.Lowe, P. A. Rota, P. E. Rollin, W. J. Bellini, T. G. Ksiazek, A. C.Mishra. (2006). Nipah Virus Identified as the Agent Responsible for an Outbreak of Encephalitis in Siliguri, India. **Emerging Infectious Diseases**. 12:235-240.

Halpin, K., B. Bankamp, B. H. Harcourt, W. J. Bellini, and P. A. Rota. 2004. Nipah virus conforms to the rule of six in a minigenome replication assay. **J Gen Virol** 85:701-707.

Tamin, A.T., Harcourt, B.H., Ksiazek, T.G., Rollin, P.E., Bellini, W.J. and Rota, P.A. (2002) Functional properties of the fusion and attachment glycoproteins of nipah virus. **Virology** 296:190-200

Harcourt, B.H, Tamin, A., Halpin, K., Ksiazek, T. G., Rollin, P.E., Bellini, W.J. and Rota, P. A. (2001) Molecular characterization of the polymerase gene and genomic termini of Nipah virus. **Virology** 287:192-201.

Five other relevant publications

Rota, P. A., M. S. Oberste, S. S. Monroe, W. A. Nix, R. Campagnoli, J. P. Icenogle, S. Penaranda, B. Bankamp, K. Maher, M. H. Chen, S. Tong, A. Tamin, L. Lowe, M. Frace, J. L. DeRisi, Q. Chen, D. Wang, D. D. Erdman, T. C. Peret, C. Burns, T. G. Ksiazek, P. E. Rollin, A. Sanchez, S. Liffick, B. Holloway, J. Limor, K. McCaustland, M. Olsen-Rasmussen, R. Fouchier, S. Gunther, A. D. Osterhaus, C. Drosten, M. A. Pallansch, L. J. Anderson, and W. J. Bellini. 2003. Characterization of a novel coronavirus associated with severe acute respiratory syndrome. **Science** 300:1394-1399.

Chua,K.B.,Bellini, W.J., Rota, P.A., Harcourt, B.H., Tamin, A., Lam, S.K., Ksiazek, T.G., Rollin, P.E., Zaki, S.R., Goldsmith, C.S., Shieh, W.J., Roehrig, J.T., Gubler , D., Eaton, B., Gould, A.R., Olson, J., Field, H., Daniels, P., Ling, A.E., Peters, C.J., Anderson, L.J. and Mahy, B.J.W. (2000). Nipah Virus: A newly emerging deadly paramyxovirus with a host range that includes man. **Science**. 288:1432-1435.

Bellini, W. J., J. S. Rota, L. E. Lowe, R. S. Katz, P. R. Dyken, S. R. Zaki, W. J. Shieh, and P. A. Rota. (2005). Subacute sclerosing panencephalitis: more cases of this fatal disease are

prevented by measles immunization than was previously recognized. **J Infect Dis** 192:1686-93.

Rota, P. A., S. L. Liffick, J. S. Rota, R. S. Katz, S. Redd, M. Papania, and W. J. Bellini. 2002. Molecular epidemiology of measles viruses in the United States, 1997-2001. **Emerg Infect Dis** 8:902-908.

Rota, P. A., J. S. Rota, S. B. Redd, M. J. Papania, and W. J. Bellini. 2004. Genetic analysis of measles viruses isolated in the united states between 1989 and 2001: absence of an endemic genotype since 1994. **J Infect Dis** 189 Suppl 1:S160-164.

Synergistic Activities

- Adjunct Professor, Immunology and Molecular Pathogenesis, Emory University, Atlanta, GA
- Adjunct Associate Professor, Biology Department, Georgia State University, Atlanta, GA

Collaborators and Co-authors in the past 48 months

AK Azad (Institute for Epidemiology and Disease Control Research (IEDCR), Bangladesh); Nima Asgari (WHO, China); Alice Croisier (WHO, Switzerland); Tasnim Azim (ICDDR,B); Shakila Banu (ICDDR,B, Bangladesh); William Bellini (CDC, USA); Lauren Blum (ICDDR,B); Michael Bell (CDC, USA); Eric Bertherat (WHO, Switzerland); Robert F. Breiman (CDC, USA); Abdullah Brooks (ICDDR,B); Darin Carroll (CDC, USA); James A. Comer (CDC, USA); Markus Czub (University of Manitoba); Peter Daszak (CCM, USA); Jonathan Epstein (CCM, USA); Heinz Feldmann (University of Manitoba); Pierre Formenty (WHO, Switzerland); Alicia Fry (CDC, USA); Emily Gurley (ICDDR,B); Jena Hamadani (ICDDR,B, Bangladesh); Brian Harcourt (CDC, USA); Jahangir Hossain (ICDDR,B, Bangladesh); Mollah Abid Hossain (Dhaka Medical College, Bangladesh); Rafiqul Islam (Suhrawardy Medical College Hospital, Bangladesh); John Jernigan (CDC, USA); Salah Uddin Khan (ICDDR,B); Rasheda Khan (ICDDR,B); Rasheda Khanam (ICDDR,B); Thomas Ksiazek (CDC, USA); Stephen P. Luby (ICDDR,B); Alec Mercer (ICDDR,B); Joel Montgomery (NAMRU, Lima, Peru); Susan Montgomery (CDC, USA); MR Mollah (IEDCR); Riyadh Muhammad (CDC, USA); Nazmun Nahar (ICDDR,B); Khairun Nessa (ICDDR,B); Lyle Petersen (CDC, USA); Mahmudur Rahman (IEDCR, Bangladesh); Motiur Rahman (ICDDR,B); Pierre Rollin (CDC, USA); James J. Sejvar (CDC, USA); Arjun Srinivassan (CDC, USA); Rebeca Sultana (ICDDR,B); CT Tan (Malaysia); AKMR Uddin (Dhaka Medical College, Bangladesh); Rashid-uz-Zaman (ICDDR,B).

Biographical Sketch **Andrew P. Dobson**

A. Institution Address

Department of Ecology and Evolutionary Biology
Princeton University, Princeton, NJ 08544-1003

Education

1973-1976	Department of Pure and Applied Biology, Imperial College, London University, B.Sc. (Hons.) Zoology and Applied Entomology
1976-1978	Zoology Department, King's College, London University. Research Assistant to R. M. Anderson and P. J. Whitfield.
1978-1981	Edward Grey Institute, Department of Zoology, Oxford University, D.Phil.: "Mortality Rates of British Birds."

Fields of Interest and Specialization

Population dynamics of infectious diseases in natural populations. Conservation biology. Population dynamics, life history strategies of birds and mammals (particularly primates and elephants).

B. Appointments

2001	Professor
1996-	Associate Professor
1995-	Director of Undergraduate Seniors
1990-1993	Director of Graduate Studies
1990-	Assistant Professor, Ecology and Evolutionary Biology, Princeton University
1986-1990	Biology Department, University of Rochester, Assistant Professor
1983-1986	Biology Department, Princeton University, U.S.A. N.A.T.O. Post-Doctoral Fellow. "The coevolution of parasitic helminths and their hosts."
1981-1983	Department of Pure and Applied Biology, Imperial College, London University. N.E.R.C. Post-Doctoral Research Fellow. "The dynamics of parasites in wild animal populations."

C. Publications most closely related to the project:

1. Lafferty, K. D., Dobson, A. P. & Kuris, A. M. 2006 Parasites dominate food web links. *PNAS* **103**, 11211-11216.
2. Hampson,K. etal, Dobson, A.P. 2007. Synchronous cycles of dog rabies across sub-Saharan Africa and the impact of control levels. PNAS 104, 7717-7722.
3. Dobson, A. 2004. Population dynamics of pathogens with multiple host species. *The American Naturalist* **164**: S64-S78.
4. Dobson, A. P., Cattadori, I., Holt, R. D., Ostfeld, R. S., Keesing, F., Krichbaum, K., Rohr, J. R., Perkins, S. E. & Hudson, P. J. 2006a Sacred Cows and Sympathetic Squirrels: The Importance of Biological Diversity to Human Health. *PLOS Medicine* **3**, e231.
5. McCallum, H. and A.P. Dobson. 2002. Disease, habitat fragmentation and conservation. *Proceedings of the Royal Society of London B* **269**: 2041-2049.

Five other significant publications (from a total of 215):

1. Dobson, A. P., Lodge, D. M., Alder, J., Cumming, G., Keymer, J. E., Mooney, H. A., Rusak, J. A., Sala, O. E., Wall, D. H., Winfree, R., Wolters, V. & Xenopoulos, M. A. 2006 Habitat loss, trophic collapse and the decline of ecosystem services. *Ecology* **87**, 1915-1924.
2. Hudson, P.J., Dobson, A.P. and D.Newborn. 1998. Prevention of population cycles by parasite removal. *Science* **282**: 2256-2258.
3. Borer, E. Hosseini, P., Seabloom, E. & Dobson, A.P. 2007. Pathogen-induced reversal of native dominance in a grassland community. PNAS, 104, 5473-5478.

4. Grenfell, B.T. and A.P. Dobson, Eds. 1995. *Ecology of Infectious Diseases in Natural Populations.* Cambridge University Press, Cambridge.
5. Hudson, P.J., Rizzoli, A., Grenfell, B., Hesterbeek, H. and A.P. Dobson, Eds. *The Ecology of Wildlife Diseases.* Oxford University Press, 2001. (See review in *Ecology*, Wilson, M., Dec. 2002.)

D. Synergistic Activities

I have been directly involved in a variety of synergistic activities, both in relation to this research and in relation to other work and teaching. In partial recognition of this I was elected as one of the first cohort of Aldo Leopold Leadership Fellows by the Ecological Society of America.

All of my epidemiological and conservation work involves different aspects of outreach: I have helped train veterinary workers in Tanzania and written computer software for Kenya Wildlife Service. I've given talks about parasite ecology at a diversity of locations from local schools to the Vatican. I worked with Bailey Silleck on an IMAX film adaptation of my book *Conservation and Biodiversity,* which premiered in 2001. We have started working on scripts for two further films. I am writing an undergraduate textbook on *The Ecology and Evolution of Infectious Disease* (with Leslie Real); I'm also writing a more accessible 'trade-book' on how ecologists have developed an understanding of infectious diseases in natural systems and a guide book to the Ecology of the Serengeti to celebrate the 150th Anniversary of the Frankfurt Zoological Society.

E. Other Collaborators:

i. Collaborators and Co-Editors

P. Daszak, Wildlife Trust, Cons. Conservation Medicine
David Duffy, University of Hawaii, Oahu
F. Gulland, Marine Mammal Rehabilitation Center
A. Hyatt, CSIRO, Australian Animal Health Lab
Mercedes Pascual, Ann Arbor, Michigan
L. Lowenstein, U. of California, Davis
M. Meagher, National Biological Service
M. D. Samuels, USGS National Wildlife Health
M.E. Torchin, U. of California, Santa Barbara
Leslie Real, Emory University
A. Dhondt, Cornell U.
B. T. Grenfell, Penn State University
P. J. Hudson, Penn State U.
Kevin Lafferty, UCSB, California
Armand Kuris, UCSB, California
H. McCallum, U. of Queensland
C. Packer, U. of Minnesota, Twin Cities
Sarah Cleaveland, Edinburgh University
D. Wilcove, Princeton University
Tony Sinclair, UBC, Vancouver.

ii. Graduate Advisor: Christopher Perrin, Oxford University
Post-doctoral Sponsor: Robert May, Princeton University and Roy Anderson, Imperial College.

iii. Post-doctoral Fellows:

Sonia Altizer (Univ. of Minnesota)
Johannes Foufopoulos (U. Wisconsin, Madison)
Parviez Hosseini (Cornell University)
Margarita Lampo (Caracas Univ.)
Cassandra Nuñez (Princeton Univ.)
Walter Jetz (Univ. California, San Diego)
Giulio de Leo (Polytechnico Milano)
Nicholas Georgiadis (Syracuse Univ.)
Margaret Kinnaird (Univ. of Florida)
Karin Lindström (Uppsala Univ.)
Tim O'Brien (Univ. of Florida)

Graduate Students:

Jorge Ahumada (Princeton U.)
Katie Hampson (Princeton U.)
Martha Hurley (Princeton U.)
Paula Kahumbu (Princeton U.)
Juliet Pulliam (Princeton U.)
Rachael Winfree (Princeton U.)
Charles Foley (Princeton U.)
Ricardo Holdo (Princeton U.)
Anna Jolles (Princeton U.)
Kelly Lee (Princeton U.)
Jon-Paul Rodriguez (Princeton)
Leslie Reperant (Princeton U.)

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION	FOR NSF USE ONLY		
Wildlife Trust, Inc.	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		
Peter Daszak			

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Peter Daszak - Exec. Dir./Sr. Researcher				(b) (4), (b) (6)	$
2. Auston M Kilpatrick - Sr. Researcher					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (1) POST DOCTORAL SCHOLARS					
2. (1) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (0) GRADUATE STUDENTS				(b) (4), (b) (6)	
4. (0) UNDERGRADUATE STUDENTS					
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (0) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				97,002	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Bat Catching Equipment $ 10,000					
Dry Shipper (5) 0					
Radio Telemetry, Satellite Collars, & Data Transfer 25,500					
Ultralow Freezer 0					
TOTAL EQUIPMENT				35,500	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				10,500	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 10,648					
3. SUBSISTENCE 4,952					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				15,600	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				253,482	
6. OTHER				37,000	
TOTAL OTHER DIRECT COSTS				290,482	
H. TOTAL DIRECT COSTS (A THROUGH G)				449,084	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Base (Rate: 22.0000, Base: 180002) (Cont. on Comments Page)					
TOTAL INDIRECT COSTS (F&A)				50,550	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				499,634	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 499,634	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME	FOR NSF USE ONLY		
Peter Daszak	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Aleksei Chmura			

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET COMMENTS - Year 1

** I- Indirect Costs
Indirect on first $25,000 for each subaward (Rate: 21.9000, Base 50000)

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION	FOR NSF USE ONLY		
Wildlife Trust, Inc.	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		
Peter Daszak			

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Peter Daszak - Exec. Dir./Sr. Researcher**				(b) (4), (b) (6)	$
2. **Auston M Kilpatrick - Sr. Researcher**					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL SCHOLARS					
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (**0**) GRADUATE STUDENTS				(b) (4), (b) (6)	
4. (**0**) UNDERGRADUATE STUDENTS					
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (**0**) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**99,912**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Bat Catching Equipment $ **0**					
Dry Shipper (5) **6,000**					
Radio Telemetry, Satellite Collars, & Data Transfer **9,000**					
Ultralow Freezer **12,500**					
TOTAL EQUIPMENT				**27,500**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**12,400**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **10,648**					
3. SUBSISTENCE **4,952**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**15,600**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**5,750**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**250,669**	
6. OTHER				**46,000**	
TOTAL OTHER DIRECT COSTS				**302,419**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**457,831**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: 0.0000, Base: 0) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**42,144**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**499,975**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **499,975**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME	FOR NSF USE ONLY		
Peter Daszak	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Aleksei Chmura			

2 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET COMMENTS - Year 2

** I- Indirect Costs
Base (Rate: 22.0000, Base 191562)

SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION	FOR NSF USE ONLY		
Wildlife Trust, Inc.	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		
Peter Daszak			

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Peter Daszak - Exec. Dir./Sr. Researcher				(b) (4), (b) (6)	$
2. Auston M Kilpatrick - Sr. Researcher					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (1) POST DOCTORAL SCHOLARS					
2. (1) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (0) GRADUATE STUDENTS				(b) (4), (b) (6)	
4. (0) UNDERGRADUATE STUDENTS					
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (0) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				102,909	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Bat Catching Equipment $ 0					
Dry Shipper (5) 9,000					
Radio Telemetry, Satellite Collars, & Data Transfer 7,500					
Ultralow Freezer 0					
TOTAL EQUIPMENT				16,500	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				12,400	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 10,648					
3. SUBSISTENCE 4,952					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				15,600	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				11,250	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				251,916	
6. OTHER				47,500	
TOTAL OTHER DIRECT COSTS				310,666	
H. TOTAL DIRECT COSTS (A THROUGH G)				458,075	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: 0.0000, Base: 0) (Cont. on Comments Page)					
TOTAL INDIRECT COSTS (F&A)				41,923	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				499,998	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 499,998	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME	FOR NSF USE ONLY		
Peter Daszak	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Aleksei Chmura			

3 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET COMMENTS - Year 3

** I- Indirect Costs
Base (Rate: 22.0000, Base 190559)

SUMMARY PROPOSAL BUDGET

YEAR 4

ORGANIZATION	FOR NSF USE ONLY		
Wildlife Trust, Inc.	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Peter Daszak**	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Peter Daszak - Exec. Dir./Sr. Researcher**				(b) (4), (b) (6)	$
2. **Auston M Kilpatrick - Sr. Researcher**					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL SCHOLARS					
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (**0**) GRADUATE STUDENTS				(b) (4), (b) (6)	
4. (**0**) UNDERGRADUATE STUDENTS					
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (**0**) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**105,997**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Bat Catching Equipment $ **0**					
Dry Shipper (5) **0**					
Radio Telemetry, Satellite Collars, & Data Transfer **0**					
Ultralow Freezer **0**					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**12,400**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **14,744**					
3. SUBSISTENCE **6,856**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**21,600**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**10,750**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**253,190**	
6. OTHER				**55,000**	
TOTAL OTHER DIRECT COSTS				**318,940**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**458,937**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: 0.0000, Base: 0) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**40,512**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**499,449**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **499,449**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME	FOR NSF USE ONLY		
Peter Daszak	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Aleksei Chmura			

4 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET COMMENTS - Year 4

** I- Indirect Costs
Base (Rate: 22.0000, Base 184147)

SUMMARY PROPOSAL BUDGET

YEAR 5

ORGANIZATION	FOR NSF USE ONLY		
Wildlife Trust, Inc.	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		
Peter Daszak			

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Peter Daszak - Exec. Dir./Sr. Researcher				(b) (4), (b) (6)	$
2. Auston M Kilpatrick - Sr. Researcher					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (2) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (1) POST DOCTORAL SCHOLARS					
2. (1) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (0) GRADUATE STUDENTS				(b) (4), (b) (6)	
4. (0) UNDERGRADUATE STUDENTS					
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (0) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				109,177	

D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)		
Bat Catching Equipment	$ 0	
Dry Shipper (5)	0	
Radio Telemetry, Satellite Collars, & Data Transfer	0	
Ultralow Freezer	0	
TOTAL EQUIPMENT		0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)		0
2. FOREIGN		12,400

F. PARTICIPANT SUPPORT COSTS			
1. STIPENDS	$ 0		
2. TRAVEL	12,696		
3. SUBSISTENCE	5,904		
4. OTHER	0		
TOTAL NUMBER OF PARTICIPANTS (0)	TOTAL PARTICIPANT COSTS		18,600
G. OTHER DIRECT COSTS			
1. MATERIALS AND SUPPLIES			0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION			9,250
3. CONSULTANT SERVICES			0
4. COMPUTER SERVICES			0
5. SUBAWARDS			254,463
6. OTHER			55,000
TOTAL OTHER DIRECT COSTS			318,713
H. TOTAL DIRECT COSTS (A THROUGH G)			458,890
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: 0.0000, Base: 0) (Cont. on Comments Page)			
TOTAL INDIRECT COSTS (F&A)			40,882
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)			499,772
K. RESIDUAL FUNDS			0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)			$ 499,772 $

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME	FOR NSF USE ONLY		
Peter Daszak	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Aleksei Chmura			

5 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET COMMENTS - Year 5

** 1- Indirect Costs
Base (Rate: 22.0000, Base 185827)

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION	FOR NSF USE ONLY		
Wildlife Trust, Inc.	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		
Peter Daszak			

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Peter Daszak - Exec. Dir./Sr. Researcher**				(b) (4), (b) (6)	$
2. **Auston M Kilpatrick - Sr. Researcher**					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**5**) POST DOCTORAL SCHOLARS					
2. (**5**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (**0**) GRADUATE STUDENTS				(b) (4), (b) (6)	
4. (**0**) UNDERGRADUATE STUDENTS					
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (**0**) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**514,997**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ **79,500**					
TOTAL EQUIPMENT				**79,500**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**60,100**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **59,384**					
3. SUBSISTENCE **27,616**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**87,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**27,750**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**9,250**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**1,263,720**	
6. OTHER				**240,500**	
TOTAL OTHER DIRECT COSTS				**1,541,220**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**2,282,817**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**216,011**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**2,498,828**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **2,498,828**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME	FOR NSF USE ONLY		
Peter Daszak	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Aleksei Chmura			

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0813157

Daszak, Peter (Wildlife Trust) Budget Justification

A. Key/Senior Personnel

The cost of salary support is based on the Wildlife Trust pay scale for similar existing positions. It is anticipated that salaries will increase at (b) (4), (b) (6) on an annual basis corresponding to organization-wide increases.

Peter Daszak/Principal Investigator/Project Director: Dr. Daszak will spend (b) (4), (b) (6) of his time in management and supervision of this project. He will act as overall director of the whole program of work, managing all collaborators, overseeing field studies, testing arrangements, and ensuring smooth collaboration with PI Dobson who will lead the modeling component

A. Marm Kilpatrick/Senior Researcher: The Senior Researcher provides administrative as well as scientific oversight of the project. Dr. Kilpatrick's involvement will require (b) (4), (b) (6) of his time. The remainder of his salary is currently covered under other research projects. Dr Kilpatrick will develop and analyze parameterized models for enhanced Nipah virus outbreaks and the pandemic potential of Nipah virus.

B. Other Personnel

Post Doctoral Associate: the Post Doctoral Associate will be employed full-time for 5-years to work on this project. This position will be instrumental in developing and helping to supervise the grant. She or he will be responsible for coordinating this project with Dr. Daszak. In this role, as researcher, the Post Doctoral Associate will be expected to produce manuscripts for peer-review and liaising with Wildlife Trust to manage this grant will be part of duties. The specific research duties will be to conduct bat sampling and related fieldwork, including organizing field teams to conduct bat sampling, overseeing the collection, dissemination of samples, and the testing of these, and working with the modelers to parameterize their models, and adapt field and testing work to these models.

Research Assistant: The RA is expected to spend 25% of his or her time assisting with this project. Tasks will include literature research, database maintenance, data entry, drafting manuscripts, and assisting the Post Doctoral Associate.

C. Fringe Benefits

Fringe is calculated at the Wildlife Trust rate of 21.7%.

D.Permenant Equipment

An ultra-low freezer for sample storage at CCM and (5) dry shippers for sending samples at -70C from Bangladesh to the USA and Australia for testing. Bat catching equipment includes nets, poles, and personal protective equipment. This category also includes purchase of 7 satellite telemetry units ($3000 ea.) plus annual data transfer from the ARGOS satellite service ($1,500/yr/collar) (CCM will provide funding for an additional 3 satellite collars) and 20 radio tracking collars and a receiver in years 1-3.

F. Participant Support Costs

Participant Support Costs are for travel and accommodation for fieldwork, annual NSF meetings, and annual collaborative meetings, and annual group meetings to be held in Bangladesh, the USA or in conjunction with another conference or relevance elsewhere. Annual Group meetings will include workshops for local collaborators on surveillance activities, recent outbreaks, and clinical management.

Annual meeting costs are for both collaborative PIs (Daszak and Dobson), the Co-PI (Luby), and 9 staff. Estimated costs are approximately $20,200 p.a., comprising travel for an equivalent of 7 people, assuming that the meeting will be held at a site where some of the staff are already based (7 x $1,600=11,200), accommodation (7 x $150 x 5 days=$5,250), subsistence (11 x $50 x 5 days =$2,750) and room rental ($1,000). Note that we have only requested part of these costs, and Wildlife Trust will fund the rest. Additional participant costs are requested in years 2 through 5 for attending trainings, workshops, and seminars to disseminate findings from the study.

G. Other Direct Costs

Materials and Supplies: This category also includes consumables for biological sample collection and storage and also office supplies, photocopy-fees, postage, computer software and licensing fees, and internet and telephone connections.

Other: testing costs - Year 1: we will be conducting molecular and serological testing of all bat sample (approx. 1600 samples) in the USA. This will cost 1600 x $8 ea (tot=$12,800) at Columbia Univ. A subset of the positive and negative samples from this will be sent to AAHL for viral culture and serum neutralization tests (to confirm ELISAs) which are done in a BSL 4 lab (approx 600 samples at a per test cost of $20 (tot = $12,000)). This category also includes reagents for PCR and ELISA and international shipping (approx $12,200). Budget years 2-5 allow for 20% additional sample collection, testing, and shipping to allow for outbreak investigations that will require bat and domestic animal sampling.

I. Indirect Costs

Indirect Cost is calculated on all direct costs less collaborative travel at the rate of 21.9%.Year 1 of the grant includes an indirect cost on the first $25,000 of each of the four subawards at a the same rate (21.9%).

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION	FOR NSF USE ONLY		
International Centre for Diarrhoeal Disease Research, Bangladesh	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1.	0.00	0.00	0.00	$	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (11) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	76,696	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				76,696	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				76,696	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
ELISA Reader $ 5,000					
Freezer (-70?C) 11,000					
Liquid N2 tank (10L) 5,200					
TOTAL EQUIPMENT				21,200	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				13,500	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				93,604	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				93,604	
H. TOTAL DIRECT COSTS (A THROUGH G)				205,000	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
FirstIndirectCostItem (Rate: 8.0000, Base: 205000)					
TOTAL INDIRECT COSTS (F&A)				16,400	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				221,400	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 221,400	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Aleksei Chmura**	Date Checked	Date Of Rate Sheet	Initials - ORG

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0813157

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION	FOR NSF USE ONLY		
International Centre for Diarrhoeal Disease Research, Bangladesh	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1.	0.00	0.00	0.00	$	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (11) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	86,022	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				86,022	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				86,022	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
ELISA Reader $ 0					
Freezer (-70?C) 0					
Liquid N2 tank (10L) 0					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				20,000	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				98,978	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				98,978	
H. TOTAL DIRECT COSTS (A THROUGH G)				205,000	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
FirstIndirectCostItem (Rate: 8.0000, Base: 205000)					
TOTAL INDIRECT COSTS (F&A)				16,400	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				221,400	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 221,400	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Aleksei Chmura**	Date Checked	Date Of Rate Sheet	Initials - ORG

2 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET YEAR 3

ORGANIZATION	FOR NSF USE ONLY		
International Centre for Diarrhoeal Disease Research, Bangladesh	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1.	0.00	0.00	0.00	$	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**11**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**88,109**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**88,109**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**88,109**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
ELISA Reader $ **0**					
Freezer (-70?C) **0**					
Liquid N2 tank (10L) **0**					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**20,000**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**96,891**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**96,891**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**205,000**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
FirstIndirectCostItem (Rate: 8.0000, Base: 205000)					
TOTAL INDIRECT COSTS (F&A)				**16,400**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**221,400**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **221,400**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Aleksei Chmura**	Date Checked	Date Of Rate Sheet	Initials - ORG

3 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 4

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **International Centre for Diarrhoeal Disease Research, Bangladesh**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1.	0.00	0.00	0.00	$	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (11) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	90,258	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				90,258	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				90,258	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
ELISA Reader $ 0					
Freezer (-70?C) 0					
Liquid N2 tank (10L) 0					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				18,500	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				96,242	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				96,242	
H. TOTAL DIRECT COSTS (A THROUGH G)				205,000	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
FirstIndirectCostItem (Rate: 8.0000, Base: 205000)					
TOTAL INDIRECT COSTS (F&A)				16,400	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				221,400	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 221,400	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME

ORG. REP. NAME*: **Aleksei Chmura**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

4 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 5

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **International Centre for Diarrhoeal Disease Research, Bangladesh**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1.	0.00	0.00	0.00	$	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (11) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	113,490	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				113,490	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				113,490	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
ELISA Reader $ 0					
Freezer (-70?C) 0					
Liquid N2 tank (10L) 0					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				39,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				52,510	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				52,510	
H. TOTAL DIRECT COSTS (A THROUGH G)				205,000	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
FirstIndirectCostItem (Rate: 8.0000, Base: 205000)					
TOTAL INDIRECT COSTS (F&A)				16,400	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				221,400	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 221,400	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME

ORG. REP. NAME*
Aleksei Chmura

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initial's - ORG

5 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0813157

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **International Centre for Diarrhoeal Disease Research, Bangladesh**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR:

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1.	0.00	0.00	0.00	$	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (0) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (55) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	454,575	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				454,575	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				454,575	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ 21,200					
TOTAL EQUIPMENT				21,200	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				39,000	
2. FOREIGN				72,000	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				438,225	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				438,225	
H. TOTAL DIRECT COSTS (A THROUGH G)				1,025,000	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				82,000	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				1,107,000	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 1,107,000	$

M. COST SHARING PROPOSED LEVEL $ 0 | AGREED LEVEL IF DIFFERENT $

PI/PD NAME

ORG. REP. NAME*: **Aleksei Chmura**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

0813157

Luby, Stephen P. (ICDDR,B) – Budget Justification

A. Key/Senior Personnel

The cost of salary support is based on ICDDR,B's pay scale for similar existing positions. It is anticipated that salaries will increase on a yearly basis based on organization-wide increases as well as increasing experience.

Steve Luby/Co-Principal Investigator: Dr. Luby will spend (b) (4), (b) (6) of his time in management and supervision of this project. However, his salary is not covered under this proposal because he is employed by CDC and therefore does not require salary support from research projects.

Emily Gurley/Co-Investigator/Program Coordinator: The Program Coordinator provides administrative as well as scientific oversight of the project. This person will be involved in every aspect of the study and this will require (b) (4), (b) (6) of time. Her salary is currently covered under other research projects.

Laboratory specialist: The laboratory specialist is an international scientist position that will be instrumental in developing and supervising the Nipah laboratory set-up and testing for the NIH grant. This will require approximately (b) (4), (b) (6) of his time for 5 years.

Jahangir Hossian/Co-Investigator/Research physician: This will help to support the salary of one of the co-investigators of the study who will devote approximately (b) (4), (b) (6) of his time to the management and development of the epidemiology activities.

B. Other Personnel

Laboratory Officer: This position will be in charge of the Nipah laboratory testing done at ICDDR,B and oversight of all local lab activities. This will take approximately (b) (4), (b) (6) of their time in years 1-4.

Nipah epidemiology coordinator: This position will manage the day-to-day oversight of the epidemiological activities from Dhaka. This person will also travel with the mobile response team when needed. We have budgeted for one full-time coordinator for 5 years.

Veterinary officer: One research veterinarian will be responsible for overseeing the local bat collection activities and participating in outbreak investigations in testing domestic and wild animals. We have budgeted for one full-time vet officer.

Qualitative researcher: There will be one qualitative researcher for 5 years who will investigate Nipah confirmed cases to further define quantitative instruments and test prevention messages. We have covered (b) (4), (b) (6) of their salary in years 1 and 5 and (b) (4), (b) (6) in years 2-4 when the bulk of qualitative work will take place.

Laboratory research officers: Laboratory research officers will be required for assistance with processing and testing human and animal samples that come from the field. They are funded for all months of specimen collection.

Field research officer: We will cover 21 person months of time in year 5. This position will oversee data collection done by the field research assistants during the large survey conducted that year. We have also included 8 person-months of time in years 1-4 for outbreak data collection.

Field research assistants: The FRAs will administer questionnaires and assist with contract tracing during outbreak situations. They will also carry out other field-based surveys. We anticipate that a total of 4 FRA person-months will be needed per years 1 to 4. During year 5, we will require 68 person-months of time to complete the large survey.

Hospital physician stipend: We will provide a small stipend to physicians working in surveillance hospitals for data and specimen collection. They will receive approximately (b) (4), per month, each. (b) (6)

Health assistant: One health assistant will be needed to transport collected specimens, data forms, and liquid nitrogen to and from the field.

C. Equipment over $5000

ELISA reader: One ELISA reader will be required for performing human and animal ELISA tests at ICDDR,B. This will cover the cost of the machine and it's shipping costs.

Freezer: One –70C freezer will be needed to store the samples that will be collected from the surveillance sites. It will be purchased in year 1.

Additional equipment

PC with printers: This will provide 3 PCs with printers for the administrative tasks associated with the project and the scientific work done by the coordinator, qualitative researcher, and the research physician.

Laptop: Two laptops will be purchased for the mobile investigation team.

Liquid nitrogen tanks: Samples will be stored in the field and transported to Dhaka in liquid nitrogen. We will need to purchase four small tanks (10L) for transporting liquid nitrogen from Dhaka to the specimen collection sites.

D. Travel

Domestic (within Bangladesh) travel

Local travel and site visits: Local travel is estimated to cost $500 per vehicle per week of travel in the field (includes driver and fuel). We have budgeted for 20-25 weeks of field transport in this budget and will use transport support from other activities as well. $22,000 has been budgeted for year 5 when the large survey team will require additional time in the field.

Per diem for local travel: Local per diem rates vary around the country but we have budgeted an average of $10 per overnight stay for food and lodging. We anticipate that we will spend $3500-

5000 per year in per diem costs in years 1-4. The costs for year 5 are $17,000 considering the large survey that will be conducted.

E. Trainee/participant support costs: None.

F. Other direct costs

1. Materials and supplies:

Lab and sample collection supplies
Specimen collection supplies: We have budgeted $1.50 per specimen collection. This includes syringes, needles, vacutainers, etc, for human and animal sample collection (4000 over 5 years). The costs for these supplies are all covered in years 1-3.

Lumbar puncture kits: We have budgeted for collecting 700 lumbar punctures ($2 each) in 5 years, with all kits purchased in years 1 to 3.

Cryovials: These will cost approximately $0.36 each and we estimate using 10,000 cryovials in 5 years. We will purchase all within the first 3 years.

Cryovial boxes: These will be used to safely store and ship the cryovials. Based on the number of cryovials purchased we estimate that we will need 130 boxes based on using 10,000 cryovials. They will all be purchased in year 1.

Masks (N-95): We anticipate using approximately 4,500 masks during outbreaks and specimen collection. The masks cost approximately $1.50 each. All masks will be purchased in the first 3 years.

Pippettes: The lab will need one each Finnepippette (0-200 mcl), Finnepippette (0-40 mcl), and Multi channel pipette for specimen handling. Three Finnepippette (0-200 mcl) will be needed in the field- one for each surveillance site.

Cryogenic gloves: 4 cryogenic gloves will be required for using liquid nitrogen for specimen handling and storage.

RT-PCR reagents: These will be required for performing PCR testing at ICDDR,B on saliva and urine specimens collected from bats. We will test 600 urine swabs collected from tarps in years 1 to 5. We will test 400 urine and 400 saliva specimens from individual bats collected in years 1 to 4. Total or 1400 in years 1 to 4 and 600 in year 5. We have budgeted for $35 per sample.

ELISA bat reagents: We will perform 400 bat ELISAs per year in years 1 to 4 and have budgeted $15 per sample for this testing.

ELISA human reagents: We will perform 400 human ELISAs per year in years 1 to 5 and have budgeted $10 per sample for this testing.

Liquid nitrogen: We estimate that we will use approximately 35 L of liquid nitrogen per week of surveillance in the field. We have budgeted for 40 weeks in the field for years 1-4 and 25 weeks in year 5.

Office supplies: $1000 has been budgeted for office supplies for each year of the project.

Cold boxes: Three cold boxes will be purchased in year 1 to assist in specimen transport.

File cabinet: Three file cabinets will be purchased in year 1 to store data collected from this project.

2. Publishing and photocopying:
$1000 will cover photocopying of reports and questionnaires as well as other non-specific printing costs each year.

8. Communication, services and others
International shipping: Human samples will be shipped to CDC for quality assurance of local ELISA testing, virus isolation and sequencing. Bat samples will be shipped to AAHL for additional testing. Based on previous experience each shipment will cost approximately $1500 and we will make 3-4 shipments per year.

Mobile phone bill: Because of the logistical challenges of managing various surveillance and other epidemiological activities, communication among team members will be paramount. We have budgeted 18-36 months of service charges ($30) for each year.

Communications: $500-1000 per year will cover fax, postage, telephone and courrier costs between local staff and international collaborators.

Internet connections: Each connection with service costs $35 per month and we will cover 12 months of service for 2 persons each year, except year 5 when we cover 1 person.

Rent and utilities: We have budgeted $7000-12,000 per year to help cover costs of office and laboratory rents and utilities, including electricity and gas.

Training, workshop, seminar: This will cover costs for periodic dissemination of findings from the study as well as workshops for local collaborators on surveillance activities, recent outbreaks, and clinical management. We have budgeted $1000-4000 each year.

Data entry: We budgeted a bulk amount of about $2000 for data entry in years 1 to 4 for entering data collected from outbreak investigations. $10060 is budgeted for year 5 when the large survey will be conducted.

Routine lab testing: Each patient enrolled in our surveillance study will receive local lab testing of CSF. For routine investigation we will cover the costs of: CSF gram staining, CSF cytology,

and CSF protein and glucose. These tests will help to clinically define Nipah virus infection in Bangladesh and help to identify bacterial cause of encephalitis as well as inform the local treatment of the patient. It is estimated that testing per patient will cost $7.

X-rays: In order to better define the clinical presentation of Nipah virus infection any patients found during surveillance presenting with respiratory findings will undergo a chest radiograph. We anticipate that this will be about 20 patients per year and the estimated cost per radiograph is $2.

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION **Princeton University**				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Andrew P Dobson**				AWARD NO.		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)	
1. **Andrew P Dobson - Professor**				(b) (4), (b) (6)	$	
2.						
3.						
4.						
5.						
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)						
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)						
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (**0**) POST DOCTORAL SCHOLARS						
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)						
3. (**0**) GRADUATE STUDENTS				(b) (4), (b) (6)		
4. (**0**) UNDERGRADUATE STUDENTS						
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						
6. (**0**) OTHER						
TOTAL SALARIES AND WAGES (A + B)						
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)						
TOTAL EQUIPMENT				**0**		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**750**		
2. FOREIGN				**5,400**		
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS $ **0**						
2. TRAVEL **0**						
3. SUBSISTENCE **0**						
4. OTHER **0**						
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**		
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES				**2,092**		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**		
3. CONSULTANT SERVICES				**0**		
4. COMPUTER SERVICES				**0**		
5. SUBAWARDS				**0**		
6. OTHER				**0**		
TOTAL OTHER DIRECT COSTS				**2,092**		
H. TOTAL DIRECT COSTS (A THROUGH G)				**18,267**		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 58.0000, Base: 18267)**						
TOTAL INDIRECT COSTS (F&A)				**10,595**		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**28,862**		
K. RESIDUAL FUNDS				**0**		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **28,862**	$	
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $					

PI/PD NAME **Andrew P Dobson**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Sally Waltman**	Date Checked	Date Of Rate Sheet	Initials - ORG

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION **Princeton University**				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed	 Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Andrew P Dobson**				AWARD NO.		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)	
1. **Andrew P Dobson - Professor**				(b) (4), (b) (6)	$	
2.						
3.						
4.						
5.						
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)						
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)						
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (**0**) POST DOCTORAL SCHOLARS						
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)						
3. (**0**) GRADUATE STUDENTS				(b) (4), (b) (6)		
4. (**0**) UNDERGRADUATE STUDENTS						
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						
6. (**0**) OTHER						
TOTAL SALARIES AND WAGES (A + B)						
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)						
TOTAL EQUIPMENT				**0**		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**780**		
2. FOREIGN				**5,616**		
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS $ **0**						
2. TRAVEL **0**						
3. SUBSISTENCE **0**						
4. OTHER **0**						
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**		
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES				**2,176**		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**		
3. CONSULTANT SERVICES				**0**		
4. COMPUTER SERVICES				**0**		
5. SUBAWARDS				**0**		
6. OTHER				**0**		
TOTAL OTHER DIRECT COSTS				**2,176**		
H. TOTAL DIRECT COSTS (A THROUGH G)				**19,005**		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 58.0000, Base: 19005)**						
TOTAL INDIRECT COSTS (F&A)				**11,023**		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**30,028**		
K. RESIDUAL FUNDS				**0**		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **30,028**	$	
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $					

PI/PD NAME **Andrew P Dobson**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Sally Waltman**	Date Checked	Date Of Rate Sheet	Initials - ORG

2 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION	FOR NSF USE ONLY		
Princeton University	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		
Andrew P Dobson			

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Andrew P Dobson - Professor**				(b) (4), (b) (6)	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS					
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (**0**) GRADUATE STUDENTS				(b) (4), (b) (6)	
4. (**0**) UNDERGRADUATE STUDENTS					
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (**0**) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**811**	
2. FOREIGN				**5,841**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**2,253**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**2,253**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**19,813**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 58.0000, Base: 19813)**					
TOTAL INDIRECT COSTS (F&A)				**11,492**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**31,305**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **31,305**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME	FOR NSF USE ONLY		
Andrew P Dobson	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Sally Waltman			

3 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 4

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Princeton University**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Andrew P Dobson**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Andrew P Dobson - Professor**				(b) (4), (b) (6)	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS					
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (0) GRADUATE STUDENTS				(b) (4), (b) (6)	
4. (0) UNDERGRADUATE STUDENTS					
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (0) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				844	
2. FOREIGN				6,074	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				2,353	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				2,353	
H. TOTAL DIRECT COSTS (A THROUGH G)				20,640	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 58.0000, Base: 20640)**					
TOTAL INDIRECT COSTS (F&A)				11,971	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				32,611	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 32,611	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Andrew P Dobson**

ORG. REP. NAME*: **Sally Waltman**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

4 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 5

ORGANIZATION	FOR NSF USE ONLY		
Princeton University	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Andrew P Dobson**	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Andrew P Dobson - Professor**				(b) (4), (b) (6)	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS					
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (**0**) GRADUATE STUDENTS				(b) (4), (b) (6)	
4. (**0**) UNDERGRADUATE STUDENTS					
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (**0**) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**877**	
2. FOREIGN				**6,317**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**2,447**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**2,447**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**21,465**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 58.0000, Base: 21465)**					
TOTAL INDIRECT COSTS (F&A)				**12,450**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**33,915**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **33,915**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME	FOR NSF USE ONLY		
Andrew P Dobson	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Sally Waltman**	Date Checked	Date Of Rate Sheet	Initials - ORG

5 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION	FOR NSF USE ONLY		
Princeton University	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		
Andrew P Dobson			

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Andrew P Dobson - Professor				(b) (4), (b) (6)	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS					
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (0) GRADUATE STUDENTS				(b) (4), (b) (6)	
4. (0) UNDERGRADUATE STUDENTS					
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (0) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				4,062	
2. FOREIGN				29,248	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				11,331	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				11,331	
H. TOTAL DIRECT COSTS (A THROUGH G)				99,190	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				57,531	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				156,721	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 156,721	$
M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $					

PI/PD NAME	FOR NSF USE ONLY		
Andrew P Dobson	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Sally Waltman			

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification

Andrew Dobson

Andy Dobson will develop models for the dynamics of Nipah virus in bats and humans; these will be used to examine the conditions that lead to the long-term persistence of Nipah in fruit bats and then to determine the conditions that lead to spillover into human populations. A second suite of models will be developed to examine the dynamics of Nipah virus in human populations immediately following emergence. In both cases the model structure will be extended to consider ecological, epidemiological and economic considerations; the latter can be used to develop cost-benefit analyses for different ways of controlling or minimizing the scale of human outbreaks.

An inflation factor of 4% is applied in Years 02-05.

SALARIES:
Andrew Dobson (PI)
(b) (4), (b) (6) summer salary (b) (4), (b) (6) is requested in each year. Salary is calculated at 0.5/9ths academic year salary as permitted by Princeton University.

Fringe Benefits are calculated at rates determined by Princeton University.

DOMESTIC TRAVEL:
One trip per year is budgeted in all years of the grant for the PI to attend the annual EID meeting in Washington, DC. Costs include air fare or train fare from Princeton/Newark, accommodations for 2-3 nights and miscellaneous costs for local transportation and per diem. Annual costs are estimated at $750.

FOREIGN TRAVEL:
Bangladesh: Funds are budgeted for one trip to Bangladesh each year of the grant. Cost calculations include air fare ($2,800), Accommodations for 10 nights at $200 per night ($2,000); local transportation, meals and miscellaneous travel costs at $60 per day ($600).

MATERIALS AND SUPPLIES include miscellaneous computer items, software upgrades, postage, courier service, etc. and are estimated at $2,100 per year in all years of the grant

INDIRECT COSTS are calculated at 58% modified total direct costs (excluding tuition, equipment over $5,000 and subcontract amounts over $25,000), per agreement between Princeton University and DHHS dated June 26, 2007.

Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Daszak, Peter	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
West Nile and Pox Viruses: Ecology, Pathogenesis and Immunity

Source of Support: NIAID (L. Kramer NY State DoH; subcontr on $15,000,000 award)
Total Award Amount: $592,290 Total Award Period Covered: Oct. 1, 2002 – Sept. 30, 2009
Location of Project: Consortium for Conservation Med., Wildlife Trust (Daszak PI)
Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Biodiversity and Ecosystem Services Training Network (BESTNet)

Source of Support: NSF Research Coordination Network
Total Award Amount: $500,000 Total Award Period Covered: Feb 1 2007 - Jan 31, 2010
Location of Project: Arizona State University (Charles Perrings PI)
Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Predicting spatial variation in West Nile virus transmission

Source of Support: NSF/NIH Ecology of Infectious Diseases
Total Award Amount: $2,263,188 Total Award Period Covered: Sep 1 2006 - Aug 31 2011
Location of Project: Consortium for Conserv. Med., Wildlife Trust (Kilpatrick PI)
Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
NSF RCN: EcoHealthNet

Source of Support: NSF Research Coordination Networks
Total Award Amount: $499,712 Total Award Period Covered: Jan 1 2008 - Dec 31 2012
Location of Project: Consortium for Conservation Medicine, Wildlife Trust
Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Risk of viral emergence from bats

Source of Support: NIAID Non-Biodefense Emerging Infectious Diseases
Total Award Amount: $$3,051,586 Total Award Period Covered: Jul 1 2008 - Jun 30 2013
Location of Project: Wildlife Trust, Consortium for Conservation Medicine
Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Daszak, Peter

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Current proposal: Collaborative Research: Ecology, Emergence and pandemic potential of Nipah virus in Bangladesh

Source of Support: NSF/NIH Ecology of Infectious Diseases

Total Award Amount: $2,498,829 Total Award Period Covered: 07/01/2008-06/30/2013

Location of Project: CCM, Wildlife Trust, Princeton & Bangladesh

Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Collaborative Research: Predicting emerging disease hotspots in wildlife and humans at a global scale

Source of Support: NSF/NIH Ecology of Infectious Diseases

Total Award Amount: $2,496,611 Total Award Period Covered: 07/01/2008-06/30/2013

Location of Project: CCM, Wildlife Trust, Princeton

Person-Months Per Year Committed to the Project. Cal (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (7/95) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Luby, Stephen P.	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Burden of pneumococcal and Hib disease in children in Bangladesh

Source of Support: WHO Pneumococcal ADIP/Hib Initiative

Total Award Amount: $2,045,227 Total Award Period Covered: Jun. 1, 2006 – Dec. 31, 2008

Location of Project: ICDDR,B (Luby PI)

Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Oseltamivir efficacy in reducing influenza transmission

Source of Support: Centers for Disease Control

Total Award Amount: $1,495,758 Total Award Period Covered: Sep 1 2007 - Mar 31, 2009

Location of Project: ICDDR,B (Brooks PI)

Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Care seeking for meningo-encephalitis

Source of Support: World Health Organization/Centers for Disease Control

Total Award Amount: $103,437 Total Award Period Covered: July 1 2007 - Dec 31 2009

Location of Project: ICDDR,B (Luby PI)

Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

NSF RCN: EcoHealthNet

Source of Support: NSF Research Coordination Networks

Total Award Amount: $499,712 Total Award Period Covered: Jan 1 2008 - Dec 31 2012

Location of Project: Consortium for Conservation Medicine, Wildlife Trust

Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Epidemiology of Influenza in Bangladesh

Source of Support: Centers for Disease Control and Prevention

Total Award Amount: $299,535 Total Award Period Covered: Sep 1 2007 - Mar 31, 2009

Location of Project: ICDDR,B (Brooks PI)

Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Luby, Stephen P.

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Current proposal: Collaborative Research: Ecology, Emergence and pandemic potential of Nipah virus in Bangladesh

Source of Support: NSF/NIH Ecology of Infectious Diseases

Total Award Amount: $2,498,829 Total Award Period Covered: 07/01/2008-06/30/2013

Location of Project: CCM, Wildlife Trust, Princeton & Bangladesh

Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Epstein, Jonathan H.

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Understanding the Ecology of Nipah Virus in Bangladesh

Source of Support: NIAID (K08 Mentored Clinical Training Award)

Total Award Amount: $523,800 Total Award Period Covered: Jul 1, 2007 – Jun 30, 2011

Location of Project: Consortium for Conservation Medicine, Wildlife Trust

Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
NSF RCN: EcoHealth.Net

Source of Support: NSF Research Coordination Networks

Total Award Amount: $499,712 Total Award Period Covered: Jan 1 2008 - Dec 31 2012

Location of Project: Wildlife Trust, CCM (Daszak, PI)

Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Current proposal: Collaborative Research: Ecology, Emergence and pandemic potential of Nipah virus in Bangladesh

Source of Support: NSF/NIH Ecology of Infectious Diseases

Total Award Amount: $2,498,829 Total Award Period Covered: 07/01/2008-06/30/2013

Location of Project: CCM, Wildlife Trust, Princeton & Bangladesh

Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Gurley, Emily	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Surveillance for respiratory nosocomial infections in Bangladesh

Source of Support: CDC
Total Award Amount: $59,000 Total Award Period Covered: March 2007-September 2008
Location of Project: ICDDR,B (Gurley/PI)
Person-Months Per Year Committed to the Project. Cal (b) (4), (b) (6) Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Outbreak investigation and disease dectection in Bangladesh

Source of Support: CDC
Total Award Amount: $379,000 Total Award Period Covered: October 2007-September 2008
Location of Project: ICDDR,B (Steve Luby PI)
Person-Months Per Year Committed to the Project. Ca (b) (4), (b) (6) Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Measuring health effects of indoor air pollution interventions

Source of Support: World Bank
Total Award Amount: $2,263,188 Total Award Period Covered: September 2007-April 2008
Location of Project: ICDDR,B (Steve Luby PI)
Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Current proposal: Collaborative Research: Ecology, Emergence and pandemic potential of Nipah virus in Bangladesh
Source of Support: NSF/NIH Ecology of Infectious Diseases
Total Award Amount: $2,498,829 Total Award Period Covered: 07/01/2008-06/30/2013
Location of Project: CCM, Wildlife Trust, Princeton & Bangladesh
Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Hossain, Jahangir	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Long-term neurologic and functional outcome in patients with Nipah virus infection
Source of Support: CDC, USA
Total Award Amount: $25,000 Total Award Period Covered: May 2005-Sept 2008
Location of Project: ICDDR,B (Jahangir Hossain/Local PI)
Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: 0 Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Long-term neurologic and functional outcome in patients with Japanese Encephalitis
Source of Support: CDC, USA
Total Award Amount: $15,000 Total Award Period Covered: May 2006 - Sept, 2008
Location of Project: ICDDR,B (Jahangir Hossain /Local PI)
Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Outbreak investigation and disease detection in Bangladesh
Source of Support: CDC
Total Award Amount: $379,000 Total Award Period Covered: October 2007 - Sept 2008
Location of Project: ICDDR,B (Steve Luby PI)
Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Current proposal: Collaborative Research: Ecology, Emergence and pandemic potential of Nipah virus in Bangladesh
Source of Support: NSF/NIH Ecology of Infectious Diseases
Total Award Amount: $2,498,829 Total Award Period Covered: 07/01/2008-06/30/2013
Location of Project: CCM, Wildlife Trust, Princeton & Bangladesh
Person-Months Per Year Committed to the Project. Cal: (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Kilpatrick	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Predicting spatial variation in West Nile virus transmission

Source of Support: National Science Foundation

Total Award Amount: $2,263,188 Total Award Period Covered: 10/16/06-9/30/11

Location of Project: Consortium for Conservation Medicine, Wildlife Trust

Person-Months Per Year Committed to the Project. 4.0 Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

West Nile and pox viruses: Ecology, pathogenesis, immunity

Source of Support: NIH/NIAID

Total Award Amount: $684,000 Total Award Period Covered: 10/01/02 - 09/30/09

Location of Project: Consortium for Conservation Medicine, Wildlife Trust

Person-Months Per Year Committed to the Project. 4.0 Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Relating behavior and life functions to populations level effects in marine mammals

Source of Support: Oil Exploration & Production Sound and Marine Life

Total Award Amount: $614,541 Total Award Period Covered: 2/1/2008-1/31/2010

Location of Project: UCSC

Person-Months Per Year Committed to the Project. 1.0 Cal: Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

CURRENT PROPOSAL:Collaborative research: Predicting emerging disease hotspots in wildlife and humans at a global scale

Source of Support: NIH/NSF – Ecology of Infectious Diseases

Total Award Amount: $2,496,611 Total Award Period Covered: 07/01/2008 - 06/30/2013

Location of Project: Consortium for Conservation Medicine, Wildlife Trust

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.0

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Collaborative Research: Ecology, Emergence and pandemic potential of Nipah virus in Bangladesh

Source of Support: NIH/NSF – Ecology of Infectious Diseases

Total Award Amount: $2,496,611 Total Award Period Covered: 07/01/2008 - 06/30/2013

Location of Project: CCM, Wildlife Trust, Princeton & Bangladesh

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.0

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

W. Ian Lipkin – Current and Pending Support

Current

U54 AI1057158 Lipkin (PI) 09/04/03 to 02/29/08
Northeast Biodefense Center $25,000,000
Establish a Regional Center of Excellence for Biodefense and Emerging Infectious Disease Research.

U01 NS047537 Lipkin (PI) 09/30/03 to 05/31/08
Gene:Environment Interactions in an Autism Birth Cohort
Establish a 100,000 child prospective birth cohort in Norway, collect clinical data and samples, map the natural trajectory of neurodevelopmental disorders, and establish a foundation for determining the role of gene-environment interactions in pathogenesis of neurodevelopmental disorders.

UC1 AI062705 Lipkin (PI) 09/30/04 to 08/31/08
MassTag PCR Detection of Respiratory Pathogens
Establish a multiplex PCR platform for differential diagnosis of acute respiratory disease.

HL083850 Lipkin (PI) 05/08/06 to 04/30/10
Pathogen Discovery in Chronic Lung Disease by Mass Tag PCR and Microarrays
Employ high throughput molecular diagnostic tools to survey for pathogen discovery in idiopathic pulmonary fibrosis, pulmonary arterial hypertension and bronchiolitis obliterans syndrome.

1U01AI070411 Lipkin (PI) 09/01/06 to 08/31/11
Viral Arrays for Biodefense
Establish and validate a viral sequence database and its complementary oligonucleotide array technology for detection and differentiation of influenza viruses and hemorrhagic fever viruses.

1 R24 EY017404 Hageman (PI, Univ of Iowa) 08/01/06-07/31/11
Subcontract to Columbia (Lipkin) from the Univeristy of Alabama
Development of Complement Modulating Therapeutics for AMD
The sub-contract will survey clinical samples (eyes and blood) for evidence of infection using two novel molecular diagnostic platforms, Mass Tag PCR and GreeneChips.

HHSN266200400036C Lefkowitz (PI, Univ Alabama) 06/30/06 to 06/28/09
Subcontract to Columbia (Lipkin) from the Viral Bioinformatics Resource Center
ICTVdB: A Virus Database for Biodefense and Emerging Infectious Disease Research
Curate and improve the user interface of the electronic database of the International Committee for Taxonomy of Viruses.

Pending

Not yet assigned Daszak (PI, CCM Wildlife Trust) 07/01/08 – 06/30/13
Risk of viral emergence from bats

NIAID Non-Biodefense Emerging Infectious Diseases $3,051,586
To conduct viral discovery on bat specimens from emerging disease hotspots globally

Not yet assigned Daszak (PI, CCM Wildlife Trust) 07/01/08-06/30/13
Current proposal: Collaborative Research: Ecology, Emergence and pandemic potential of Nipah virus in Bangladesh
NSF/NIH Ecology of Infectious Diseases $2,498,829

Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Rota, Paul	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Current proposal: Collaborative Research: Ecology, Emergence and pandemic potential of Nipah virus in Bangladesh

Source of Support: NSF/NIH Ecology of Infectious Diseases

Total Award Amount: $2,498,829 Total Award Period Covered: 07/01/2008-06/30/2013

Location of Project: CCM, Wildlife Trust, Princeton & Bangladesh

Person-Months Per Year Committed to the Project. Cal (b) (4), (b) (6) Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (7/95) USE ADDITIONAL SHEETS AS NECESSARY

CURRENT SUPPORT

Support:	Current
Project /Proposal Title:	Viral Transmission Dynamics in the Serengeti
Source of Support:	University of Minnesota (subcontract to Princeton; NSF primary)
Total Award Amount:	$511,626
Total Award Period Covered:	06/01/02 – 05/31/08
Location of Project:	Princeton University
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

Support:	Current
Project /Proposal Title:	Anthropogenic Effects on Host-trematode Dynamics
Source of Support:	Univ. of California, Santa Barbara (subcontract; NSF primary)
Total Award Amount:	$71,635
Total Award Period Covered:	06/01/02 – 05/31/08
Location of Project:	Princeton University
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

Support:	Current
Project /Proposal Title:	Collaborative Research: The Interplay of Extrinsic and Intrinsic Factors in Epidemiological Dynamics: Cholera as a case study
Source of Support:	National Science Foundation
Total Award Amount:	$93,064
Total Award Period Covered:	09/15/04 – 08/31/08
Location of Project:	Princeton University
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

Support:	Current
Project /Proposal Title:	Cholera Across Scales: Oceanic Links to Climate and Local Estuarine Conditions
Source of Support:	Univ. of Michigan (subcontract to Princeton; NOAA primary)
Total Award Amount:	$29,331
Total Award Period Covered:	09/30/04 – 09/29/08
Location of Project:	Princeton University
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

Support:	Current
Project /Proposal Title:	Collaborative Research: Predicting the Effects of Environmental Change and Host Diversity on the Dynamics of Insect-Vectored Generalist Pathogens
Source of Support:	National Science Foundation
Total Award Amount:	$463,119
Total Award Period Covered:	09/01/05 – 08/31/10
Location of Project:	Princeton University
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

Support:	Current
Project /Proposal Title:	Community Dynamics of an Emergent Pathogen: Intrinsic Versus Extrinsic Mechanisms
Source of Support:	Cornell University (subcontract to Princeton; NSF primary)
Total Award Amount:	$110,771
Total Award Period Covered:	10/01/06 – 09/30/11
Location of Project:	Princeton University
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

PENDING SUPPORT

Support:	Pending
Project/Proposal Title:	Collaborative Research: The Ecology and Epidemiology of Ungulate Diseases in Northern Tanzania
Source of Support:	National Science Foundation
Total Award Amount:	$1,267,230
Total Award Period Covered:	09/01/08 – 08/31/13
Location of Project:	Princeton University, University of Edinburgh, University of Florida, Lincoln Park Zoo, and Tanzania
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

Support:	Pending
Project /Proposal Title:	Dissertation Research: Transmission and spread of the highly pathogenic avian influenza H5N1 virus in mammals (Leslie Reperant, graduate student)
Source of Support:	National Science Foundation
Total Award Amount:	$10,680
Total Award Period Covered:	05/01/08 – 10/31/09
Location of Project:	Princeton University and Erasmus Medical Center, The Netherlands
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

Support:	Pending
Project /Proposal Title:	THIS PROPOSAL: Collaborative Research: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh
Source of Support:	National Science Foundation
Total Award Amount:	$156,339
Total Award Period Covered:	07/01/08 – 06/30/13
Location of Project:	Princeton University and Bangladesh
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

Support:	Pending
Project /Proposal Title:	Collaborative Research: Predicting emerging disease hotspots in wildlife and humans at a global scale
Source of Support:	National Science Foundation
Total Award Amount:	$145,770
Total Award Period Covered:	07/01/08 – 06/30/13
Location of Project:	Princeton University
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

Support:	Pending
Project /Proposal Title:	Collaborative Research: Cholera and climate II: disentangling the interactions of pathogen, environment and host immunity
Source of Support:	National Science Foundation
Total Award Amount:	$134,594
Total Award Period Covered:	09/01/08 – 08/31/12
Location of Project:	Princeton University
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

Support:	Pending
Project /Proposal Title:	Collaborative Research: How Ecological Networks Influence Infectious Diseases: New Theory and Empirical Study of Parasitism Using Pacific Coast Estuaries as Model Ecosystems
Source of Support:	National Science Foundation
Total Award Amount:	$499,911
Total Award Period Covered:	07/01/08 – 06/30/13
Location of Project:	Princeton University
Person-Months Per Year Committed to the Project:	Cal: (b) (4), (b) (6) Acad: (b) (4), (b) (6) Sumr: (b) (4), (b) (6)

i Facilities, equipment and other resources

Wildlife Trust, Consortium for Conservation Medicine, New York (PI Daszak)
Dr Daszak is the Executive Director of the Consortium for Conservation Medicine based at Wildlife Trust, New York. The CCM is a collaborative partnership among Johns Hopkins Bloomberg School of Public Health, Tufts University School of Veterinary Medicine, Pittsburgh University Graduate School of Public Health, the USGS National Wildlife Health Center, the University of Wisconsin's Nelson Institute for Environmental Research and Wildlife Trust, a conservation biology research NGO. The aim of the CCM is to investigate the relationship between anthropogenic environmental factors, and the emergence and impact of infectious diseases of wildlife and humans, and to rapidly disseminate research results into education, policy and practical conservation work. All administrative, executive and office activities of the CCM are supported by the Wildlife Trust endowment and core funding from other foundations.

The CCM itself has (b) (4) square feet of office space with 15 PCs networked via Columbia University, 9 jet printers and 5 laser printers, all other standard office facilities and office staff funded by core foundation funding supports all administrative activities. It also has conference rooms to host meetings, support staff dedicated to running CCM programs and a small (b) (4)sq. ft.) wet lab for basic specimen handling. The CCM has access, via its partnership with Tufts, Johns Hopkins, Pittsburgh, Wisconsin and the USGS National Wildlife Health Center, to a range of lab facilities. This includes facilities for a range of biological and microbial investigations and some of the country's leading faculty in disease ecology, epidemiology and microbiology.

Dr Daszak is a member of Columbia University's Earth Institute, and an adjunct faculty at Columbia University and has full access to laboratory facilities at Columbia University's Lamont Doherty Earth Observatory and the Center for Environmental Research and Conservation. These include histology and light microscopy (Zeiss, Leica and other photomicroscopes), electron microscopy, freezers, refrigerated and freezer rooms, pathogen culture facilities and state of the art molecular facilities, as well as the world-class computer analysis equipment that CIESIN is most widely known for. PI Dr Daszak and Dr Epstein are adjuncts at Columbia University's Mailman School of Public Health, and work closely with Dr W. Ian Lipkin there, who has excellent molecular virology facilities (including BSL-3 animal facility) and is a consultant on this application.

International Center for Diarrheal Disease Research, Bangladesh (ICDDR,B)

ICDDR,B is currently constructing a (b) (4)sq ft specimen handling laboratory to BSL-3 specifications, and an adjoining (b) (4)sq ft laboratory for real time PCR diagnosis. The facility is scheduled to be completed by December 31, 2007. The specimen handling laboratory will be used for avian influenza surveillance and outbreak specimen handling, including the specimens from this application. This will be the second BSL-3 facility at ICDDR,B. (The other is used for tuberculosis). The PCR laboratory will be used for viral respiratory diagnosis including the diagnosis of influenza viruses and Nipah virus from respiratory secretions. A (b) (4)square foot laboratory with an exhaust hood located at IEDCR will be used for the Nipah serological testing.

The district hospitals in Bangladesh see patients who present directly to the hospital as well as patients who are referred in because of the seriousness of their illness. Each district hospital admits patients 24 hours per day. They are supported by a trained medical and nursing staff. They have the capacity to collect diagnostic blood samples, and cerebrospinal fluid via lumbar puncture. All animals will be trapped and released so no animal facilities will be required. The PI's office is

in Bangladesh at ICDDR,B is 2 - 6 hours away by car from the communities and hospitals where prior outbreaks have been identified. The epidemiology team's offices are in the same building. The PI's office is a 3 minute walk away from the laboratory, and a 10 minute walk from the offices at laboratory at IEDCR.

The laboratory under construction is also being equipped through funding from another project. Major equipment for the laboratory include a Biohazard Class 111 hood, a table top centrifuge machine with closed bucket, a 37 oC incubator, an Elisa washer, Elisa reader with PC Control, a -86 oC and a -20 oC freezer, a CO2 incubator, an inverted microscope, a PCR machine, a Bio Doc-It-System, a compound microscope, and a 5 kilovolt voltage stabilizer and uninterrupted power supply for the PCR machine and the hood. Each of the scientific collaborators has a personal computer on a secure network with a high speed internet connection

Centers for Disease Control and Prevention (CDC – consultant Rota)

The Measles, Mumps, Rubella and Herpesvirus Laboratory at CDC moved into the new Emerging Infectious Diseases Building in October, 2005. This state-of-the-art facility has BSL-2 and BSL-3 laboratory space. The coinvestigators from CDC will have access to approximately (b) (4)sq. ft. of laboratory and office space. The Measles, Mumps, Rubella,and Herpesvirus Laboratory has all of the equipment necessary to perform the molecular biologic studies proposed. Major equipment includes: 2 ABI 3100 Sequencers, ABI 9700 for real-time RT-PCR, multiple thermocyclers, agarose and SDS-PAGE electrophoresis equipment, Nano-Drop spectrophotometer, scanner and hybridization chamber for microarrays, MaConnell Mini-prep station, high speed centrifugeand ultrcentrifuge. The laboratory has numerous procedure rooms containing C02 incubators and Class-2 BSCs as well as a procedure room dedicated to radioisotope work. Liquid N2 storage is available for cell lines.

Nipah virus is a biosafety level 4 (BSL-4) virus according to the NIH-CDC Guidelines for biosafety in Microbiological and Biomedical Laboratories (BMBL) which requires that the virus be grown and handled only in a facility with appropriate staff and facilities to operate at this biosafety level. There are currently only 3 facilities that are fully operational at this level in the U.S. In addition, Nipah virus is also a dual (USPHS/USDA) select agent and requires special security measures in addition to BSL-4 facilities. The CDC Special Pathogens Branch operates BSL-4 facilities with approximately (b) (4) net square feet of usable BSL-4 laboratory space. The staff of this group has several senior scientists with between 15 and 20 years of experience operating laboratories at BSL4. The lab is equipped with the necessary safety containment infrastructure (positive pressure suits, autoclaves, HVAC systems, gamma source for inactivation of diagnostic specimens and prepared antigens, contaminated waste disposal systems, laboratory animal housing units) and equipment to isolate, grow, store, and characterize, and produce diagnostic reagents to support the basic, applied and epidemiological investigation of a wide variety of high hazard pathogens. The recent record of the Special Pathogens Branch use of this facility includes a principal role in the discovery and initial characterization of Nipah virus, elucidation of further information on its geographic distribution and further outbreak investigations in India and Bangladesh.

The lab is equipped with the necessary safety containment infrastructure (positive pressure suits, autoclaves, HVAC systems, gamma source for inactivation of diagnostic specimens and prepared antigens, contaminated waste disposal systems, laboratory animal housing units) and equipment to isolate, grow, store, and characterize, and produce diagnostic reagents to support the basic, applied and epidemiological investigation of a wide variety of high hazard pathogens.

The Australian Animal Health Laboratory (AAHL – see letter of support)

This laboratory will conduct viral isolation and serum-neutralization tests on bat samples (animal samples are outside the scope of the CDC – a primarily human health institution). This work will be contracted on a cost-per-sample basis (see letter of support, appendix). Non-BSL4 laboratories are inside the secure area of AAHL which has approximately (b) (4) square feet of BSL-3 lab space. There are 2 labs of approximately (b) (4) square feet each, equipped with 2 CO_2 incubators for tissue culture, inverted, bright field microscopes, several high speed and ultracentrifuges, three biological safety cabinets, 2 PCR machines, an ELISA plate reader, luminometer, gel electrophoresis and western blot equipment and -20°C and -80°C storage facilities. A number of shared resources are also available including liquid handling robotics, fluorescence microscopes and image analysis software. Each laboratory is linked via LAN to a main frame and computers in offices outside the secure area.

The AAHL BSL-4 laboratory facility is approximately (b) (4) square feet and is equipped with the necessary air supply systems, a CO2 incubator and large roller machine encased in an incubator, a low speed bench and high speed ultracentrifuge, -80°C freezer, inverted microscope, dunk tank, class 1 And class II biohazard cabinets and computer linkage to the LAN. The laboratory has all the necessary ancillary facilities such as BSL-4 suits and Microchem Plus shower capacity required for BSL-4 facilities. Individuals working at BSL-4 wear head phones which permit instant communication with others outside the laboratory. An extensive training and safety program is in place to ensure operator safety. An engineering staff of about 30 ensure continuous and safe operation of the secure (BSL3 and BSL4) facilities at AAHL.

AAHL's large animal facility has 28 large animal rooms, two of which (b) (4) and (b) (4) square feet) have the capacity to operate at BSL-4. The animal rooms contain specially designed cages which have wire crushing mechanisms capable of pushing the animal to one side of the cage to permit easy and safe anaesthetization. Animal experiments done at BSL-4 are thoroughly planned by all scientific staff involved in the experiment with input form animal technicians, engineering, and microbiological security staff involved in the operation of the BSL-4 labs. Animals held at BSL-4 are under constant video surveillance and temperature is continuously monitored via radio telemetry.

Pentium computers are present in both non-BSL-4 laboratories and the BSL-4 laboratory in the secure area and linked to the AAHL server by a LAN. PIs have offices within and outside the secure area of AAHL and has access to full time library, records and IT personnel in addition to state of the art copying and printing facilities. Common support facilities in the secure area of AAHL include cold rooms, dark rooms, fluorescent microscopes, ELISA facilities and image analysis facilities.

Columbia University's Center for Infection and Immunity (Consultant Ian Lipkin)

PI Daszak and key personnel Epstein will collaborate on initial testing of bat samples by ELISA and PCR at Ian Lipkin's laboratory at Columbia University
The Center for Infection and Immunity occupies approximately (b) (4) square feet on two floors in the Mailman School of Public Health of Columbia University. The center proper contains isolated areas for work with cultured mammalian cells, radioactivity, recombinant DNA and Biohazard Level (BL)-2 and BL-3 infectious agents, as well as a separate laboratory for molecular epidemiology using real time PCR. To minimize potential for spurious results, access to the latter

laboratory is restricted; the room is positive pressure and equipped with overhead UV lamps; individual glove boxes are used for nucleic acid extraction and addition of reagents for PCR analyses.
The Center for Infection and Immunity is registered for 'Possession, Use, and Transfer of Select Biological Agents and Toxins'.

Computer equipment in the Center for Infection and Immunity includes personal computers and printers, and software for word processing, graphics, statistics, nucleic acid and protein sequence analysis. Computers are linked to larger systems on the Columbia campus that allow reference searches, computer mail and access to national and international protein and nucleic acid databases. The Center for Infection and Immunity includes approximately (b) (4) square feet of office and computer
space.

The Center for Infection and Immunity contains an ultracentrifuge and high speed preparative centrifuge, phosphorimager, on-line thermal cycler (ABI 7700), HPLC, flow cytometer for bead based immunologic and molecular assays (Luminex), automated sequencer (ABI 310), Agilent LC/MS 1D system, microfuges, MultiDrop plate dispenser station, CO2 incubators for noninfected and infected cell lines, autoclave, scintillation counter, liquid nitrogen, dry ice, and darkroom with film developer incubators for bacterial plates, shaking incubator for plasmid preparation, freezers and refrigerators, thermal cyclers, cryostat, motorized sliding cryomicrotome suitable for cutting thick sections (Microm HM440E), brightfield and fluorescent microscope, inverted fluorescent microscope, water purification system, gel boxes and power supplies for nucleic acid and protein electrophoresis, gel dryer, water baths, pH meter, balances, tissue homogenizers, vacuum pumps, speedvac, vacuum oven, spectrophotometer, gel documentation system, UV transilluminator and gel documentation system, glassware, plasticware and pipetting aids. In close proximity are a confocal microscope, luminometer, FACS, amino acid analyzer, and DNA and protein sequencers.

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory:

Clinical:

Animal:

Computer: **Dobson's office and computer lab are equipped with several PCs and Macintosh computers and an HP laser-jet printer.**

Office: **Dobson's office is in recently renovated space in the Department of Ecology and Evolutionary Biology and is adjacent to office space available for Dobson's students, postdocs and visitors.**

Other: **The Princeton University Library is one of the largest biology libraries in the U.S. It has a comprehensive and complete selection of books and journals. Members of Princeton University also have access to libraries at Rutgers, The State University of New Jersey and the University of Pennsylvania, as well as many others.**

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

The PI has access to secretarial support for the project.

THE JEROME L. AND DAWN GREENE
INFECTIOUS DISEASE LABORATORY

MAILMAN SCHOOL OF PUBLIC HEALTH
Columbia University

W. Ian Lipkin, MD
Jerome L. and Dawn Greene
Professor of Epidemiology and Director
Professor of Neurology and Pathology
College of Physicians & Surgeons

December 1st, 2007

Peter Daszak
Consortium for Conservation Medicine
Wildlife Trust
460 West 34th St
New York, NY 10001

Dear Peter,

This letter is to confirm my strongest possible support for your grant application "Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh". Nipah virus is an important pathogen with a high case fatality rate for which there is no approved therapy or vaccine. Recent evidence indicating multi-generation person-to-person transmission highlights its public health significance. This is a natural extension of the work we are already pursuing with you on pathogen discovery in bats. You and your colleagues will enjoy access to BSL-3 containment, thermal cyclers, Luminex, DNA sequencers, electrophoresis and gel documentation systems, plate readers, and bioinformatics programs. Our faculty will provide expertise needed for development and implementation of serological and molecular assays.

Best wishes,

W. Ian Lipkin, M.D.

722 West 168th Street, 18th Floor, New York, NY 10032
TEL 212 342 9003 • FAX 212 342 9044 • EMAIL wil2001@columbia.edu • www.greenelab.columbia.edu

CSIRO Livestock Industries
Australian Animal Health Laboratory
5 Portarlington Rd, East Geelong VIC 3220
Telephone: +61 3 5227 5000 Facsimile: +61 3 5227 5555
www.csiro.au

Dr P Daszak
Executive Director
Consortium for Conservation Medicine
460 West 34th Street, 17th Floor
New York
NY 10001
USA

Dear Dr Daszak,

Re: Testing of samples for Nipah virus and virus isolation

This letter is to confirm that we would be willing and able to provide research support to your investigations on the epidemiology of the important emerging viral disease caused by Nipah virus in Bangladesh.

Specifically, we will:

1. Conduct serum neutralisation tests (SNT) to identify NiV antibody within serum samples from animal species as outlined in your formal proposal.
2. Conduct virus isolation tests on samples generated through your research investigations as outlined in your formal proposal.

We will conduct the above activities as laid out in the agreed budget. The charge for both serum neutralisation tests and virus isolation tests will be US$20 for each test and each sample.

The CSIRO Australian Animal Health Laboratory is suitably equipped and accredited to conduct the above testing under Biosafety Level 4 containment conditions. All staff to be associated with this work have been trained to work at BSL4 and undergone competency assessment. Our testing laboratories handle large volumes of animal samples and testing is carried out under AS ISO/IEC17025 accreditation. Our management system complies with the requirements of AS/NZS ISO9002:1994 (Certificate number 7868).

We look forward to ongoing collaboration with CCM; our scientific collaboration has been extremely rewarding in the past and we have every expectation that the current proposal will lead to equally significant outcomes, particularly with respect to mitigation of the risk of Nipah virus emergence.

Yours sincerely,

Dr Deborah Middleton, BVSc, MVSc, PhD
Theme Leader: Transforming Animal Biosecurity
CSIRO Australian Animal Health Laboratory
PB24 Geelong 3220
Australia

(b) (6) (b) (6) (ph) ++61 3 5227 5555 (fax)

Department of Health and Human Services
Public Health Service

CDC

Measles, Mumps, Rubella and
Herpes Viruses Laboratory
Branch
MS-C-22
Centers for Disease
Control and Prevention
1600 Clifton Rd.
Atlanta, GA, USA 30333
Tel: 404-639-4181
Fax: 404-639-4187

December 12, 2007

Peter Daszak
Consortium for Conservation Medicine
Wildlife Trust
460 West 34th St
New York, NY 10001

Dear Peter,

It would be a pleasure to collaborate with you on your proposal ""Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh". Our lab at CDC is willing be an active participant in the development of molecular tests to detect Nipah virus infection and in the genetic characterization of new isolates of Nipah virus.

This project has the potential to greatly expand our knowledge about how NIV spills over from its wildlife reservoir into humans and the process of person to person transmission so that effective strategies for prevention of human disease can be developed.

Sincerely,

Paul A. Rota, Ph.D.
Supervisory Microbiologist, CDC

Grant Number: 3R01TW005869-05S1

Principal Investigator(s):
PETER DASZAK, PHD

Project Title: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

PROGRAM ASSISTANT
WILDLIFE TRUST
460 WEST 34TH STREET
NEW YORK, NY 10001

Award e-mailed to: (b) (6)

Budget Period: 09/26/2008 – 06/30/2009
Project Period: 08/01/2002 – 06/30/2013

Dear Business Official:

The National Institutes of Health hereby awards a grant in the amount of $150,000 (see "Award Calculation" in Section I and "Terms and Conditions" in Section III) to WILDLIFE TRUST in support of the above referenced project. This award is pursuant to the authority of 42 USC 241 42 CFR 52 and is subject to the requirements of this statute and regulation and of other referenced, incorporated or attached terms and conditions.

Acceptance of this award including the "Terms and Conditions" is acknowledged by the grantee when funds are drawn down or otherwise obtained from the grant payment system.

Each publication, press release or other document that cites results from NIH grant-supported research must include an acknowledgment of NIH grant support and disclaimer such as "The project described was supported by Award Number R01TW005869 from the Fogarty International Center. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Fogarty International Center or the National Institutes of Health."

Award recipients are required to comply with the NIH Public Access Policy. This includes submission to PubMed Central (PMC), upon acceptance for publication, an electronic version of a final peer-reviewed, manuscript resulting from research supported in whole or in part, with direct costs from National Institutes of Health. The author's final peer-reviewed manuscript is defined as the final version accepted for journal publication, and includes all modifications from the publishing peer review process. For additional information, please visit http://publicaccess.nih.gov/.

Award recipients must promote objectivity in research by establishing standards to ensure that the design, conduct and reporting of research funded under NIH-funded awards are not biased by a conflicting financial interest of an Investigator. Investigator is defined as the Principal Investigator and any other person who is responsible for the design, conduct, or reporting of NIH-funded research or proposed research, including the Investigator's spouse and dependent children. Awardees must have a written administrative process to identify and manage financial conflict of interest and must inform Investigators of the conflict of interest policy and of the Investigators' responsibilities. Prior to expenditure of these awarded funds, the Awardee must report to the NIH Awarding Component the existence of a conflicting interest and within 60 days of any new conflicting interests identified after the initial report. Awardees must comply with these and all other aspects of 42 CFR Part 50, Subpart F. These requirements also apply to subgrantees, contractors, or collaborators engaged by the Awardee under this award. The NIH website http://grants.nih.gov/grants/policy/coi/index.htm provides additional information.

If you have any questions about this award, please contact the individual(s) referenced in Section IV.

Sincerely yours,

BRUCE R BUTRUM
Grants Management Officer
FOGARTY INTERNATIONAL CENTER

Additional information follows

SECTION I – AWARD DATA – 3R01TW005869-05S1

Award Calculation (U.S. Dollars)

Federal Direct Costs	$122,850
Federal F&A Costs	$27,150
Approved Budget	$150,000
Federal Share	$150,000
TOTAL FEDERAL AWARD AMOUNT	$150,000

AMOUNT OF THIS ACTION (FEDERAL SHARE) $150,000

SUMMARY TOTAL FEDERAL AWARD AMOUNT YEAR (5)	
GRANT NUMBER	**TOTAL FEDERAL AWARD AMOUNT**
3R01TW005869-05S1	$150,000
2R01TW005869-05	$502,356
3R01TW005869-05S2	$45,000
TOTAL	**$697,356**

SUMMARY TOTALS FOR ALL YEARS		
YR	**THIS AWARD**	**CUMULATIVE TOTALS**
5	$150,000	$697,356

Fiscal Information:

CFDA Number:	93.989
EIN:	1311726494A1
Document Number:	RTW005869B
Fiscal Year:	2008

IC	*CAN*	*2008*
OD	8478849	$150,000

NIH Administrative Data:
PCC: EID / **OC**: 414C / **Processed**: (b) (6) 09/24/2008

SECTION II – PAYMENT/HOTLINE INFORMATION – 3R01TW005869-05S1

For payment and HHS Office of Inspector General Hotline information, see the NIH Home Page at http://grants.nih.gov/grants/policy/awardconditions.htm

SECTION III – TERMS AND CONDITIONS – 3R01TW005869-05S1

This award is based on the application submitted to, and as approved by, NIH on the above-titled project and is subject to the terms and conditions incorporated either directly or by reference in the following:

a. The grant program legislation and program regulation cited in this Notice of Award.
b. Conditions on activities and expenditure of funds in other statutory requirements, such as those included in appropriations acts.
c. 45 CFR Part 74 or 45 CFR Part 92 as applicable.
d. The NIH Grants Policy Statement, including addenda in effect as of the beginning date of the budget period.
e. This award notice, INCLUDING THE TERMS AND CONDITIONS CITED BELOW.

(See NIH Home Page at 'http://grants.nih.gov/grants/policy/awardconditions.htm' for certain references cited above.)

An unobligated balance may be carried over into the next budget period without Grants Management Officer prior approval.

This grant is excluded from Streamlined Noncompeting Award Procedures (SNAP).
In accordance with P.L. 110-161, compliance with the NIH Public Access Policy is now mandatory. For more information, see NOT-OD-08-033 and the Public Access website: http://publicaccess.nih.gov/.

This award is funded by the following list of institutes. Any papers published under the auspices of this award must cite the funding support of all institutes.

Office Of The Director, National Institutes Of Health (OD)

Treatment of Program Income:
Additional Costs

SECTION IV – TW Special Terms and Conditions – 3R01TW005869-05S1

SUPPLEMENT FUNDING
This supplement provides $160,000 to support the Avian Flu/Predictive model for the Global spread of H5N1. Funds are provided by the Office of Public Health Emergency Preparedness, and restricted for this purpose only unless approval to rebudget is obtained from FIC.

CURRENT AND FUTURE YEAR LEVELS
In accordance with the October 27, 1995, NIH Guide announcement and NIH implementation, future-year recommended levels are shown as total costs (the sum of direct plus facilities and administrative costs).

CONSORTIUM/CONTRACTUAL COSTS
This award includes funds for consortium activities. Consortiums are to be established and administered in accordance with the NIH Grants Policy Statement.

FOREIGN TRAVEL
U.S. Flag carriers must be used for departure from or entry into the U.S. and for any other portion of the trip where available.

PUBLICATIONS
All publications resulting from the research or research training supported by this award must acknowledge FIC and any co-funders (if applicable). This publication requirement applies not only to the primary grantee, but also to any subcontractors and /or trainees involved with the project.

For up-to-date information, you may access the NIH Home Page at http://www.nih.gov/ and the FIC Home Page at http://www.fic.nih.gov/.

STAFF CONTACTS

The Grants Management Specialist is responsible for the negotiation, award and administration of this project and for interpretation of Grants Administration policies and provisions. The Program Official is responsible for the scientific, programmatic and technical aspects of this project. These individuals work together in overall project administration. Prior approval requests (signed by an Authorized Organizational Representative) should be submitted in writing to the Grants Management Specialist. Requests may be made via e-mail.

Grants Management Specialist: Angela Smith
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-594-1211

Program Official: Joshua Rosenthal
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-402-0779

SPREADSHEET SUMMARY
GRANT NUMBER: 3R01TW005869-05S1

INSTITUTION: WILDLIFE TRUST

Budget	*Year 5*
Salaries and Wages	$44,950
Fringe Benefits	$11,950

Personnel Costs (Subtotal)	$56,900
Travel Costs	$4,950
Consortium/Contractual Cost	$61,000
TOTAL FEDERAL DC	$122,850
TOTAL FEDERAL F&A	$27,150
TOTAL COST	$150,000

Facilities and Administrative Costs	***Year 5***
F&A Cost Rate 1	22.1%
F&A Cost Base 1	$122,850
F&A Costs 1	$27,150
F&A Cost Rate 2	0%
F&A Cost Base 2	$0
F&A Costs 2	$0

TW 005869
~~$160,000~~
160,000 per JR 9/22/08

A predictive model for of the global spread of H5N1

PI: Peter Daszak, Consortium for Conservation Medicine, Wildlife Trust, New York: Daszak@conservationmedicine.org

Co-PI (subcontract): A. Marm. Kilpatrick, University of California, Santa Cruz: Kilpatrick@conservationmedicine.org

Introduction

Highly pathogenic H5N1 avian influenza emerged in Hong Kong in 1996-7(*1*) and by mid-June 2008 had subsequently caused outbreaks in poultry or wild birds in 58 countries as well as 383 human cases, including 241 deaths (2). Hundreds of millions of chickens, ducks, turkeys, and geese have died or have been culled to prevent the spread of the virus. This culling, and export bans on affected countries has led to an economic impact of more than $10 billion (3). Despite efforts to eradicate H5N1 it has continued to cause outbreaks in Asia, Europe, and Africa. The major pathways of virus movement include migratory birds, the transport of poultry and poultry products, and the trade in wild birds. **However, their role in individual H5N1 introduction events, viral persistence, and in future spread is not well understood and has been debated extensively (4-10). In addition, while the the pathway of introduction for past events and introduction into the USA has been examined previously (11), no predictive framework for where and when the virus will spread to next has been developed.**

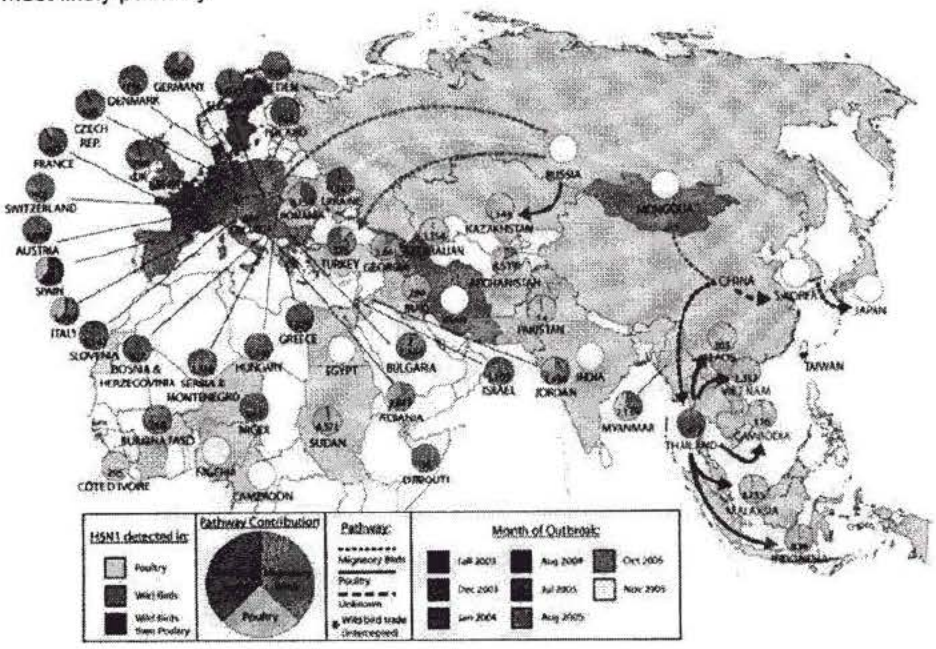
Determining the country where H5N1 will spread to next and how it will be introduced could enable proactive control measures to be implemented. These include vaccination of poultry to prevent establishment, bringing backyard poultry indoors to prevent spillover from infected wild birds, and quarantine measures for trade of poultry, poultry products, and pet birds.

Preliminary data

In a previous study (11), we acquired and integrated data to analyze the previous spread of highly pathogenic H5N1 avian influenza and to estimate the most likely pathway for it's continued global spread. We obtained published data on phylogenetic relationships of H5N1 virus isolates, detailed data on migratory bird movements, and data from the FAO on international trade in poultry and wild birds. We analyzed these data to determine the most likely mode of spread for each of 52 individual H5N1 introduction events from 1997 to 2006 (**Fig 1**). We showed that 9 of 21 of H5N1 introductions to countries in Asia were most likely through trade in poultry, and 3 of 21 were most likely through migrating birds. In contrast, spread to most (20/23) countries in Europe was most likely via migratory birds. Spread in Africa was likely partly by poultry (2/8 introductions) and partly by migrating birds (3/8). We used data for the Americas estimate the relative risk of H5N1 being introduced into the New World via poultry trade, the wild bird trade and wild bird migration. Our analyses suggested that H5N1 is two to three orders of magnitude more likely to be introduced into the Western Hemisphere through infected poultry and into the mainland USA by subsequent movement of migrating birds from neighbouring countries, than from eastern Siberia via migratory birds. These results highlighted the synergism between trade and wild animal movement in the emergence and pandemic spread of pathogens, and demonstrated the value of predictive models for disease control.

Fig. 1 Spread of H5N1 in Asia, Europe, and Africa. Pie charts show the total number of infectious bird-days (# infected birds * days shedding virus) and fraction from each pathway for birds moving between previous H5N1 outbreak countries and the focal country. Arrows give the month of the outbreak and hypothesized direction of spread for 2003-2005 introductions. Empty

white pie charts denote spreading events where insufficient data were available to deduce the most likely pathway.



Research Plan

We propose a plan of work that moves our prior modelling framework from a pathway analysis to a predictive model that predicts both where the virus is most likely to spread next, and also where it is not likely to spread. We will then test the validity of the model by 'back-predicting' prior spread, analyze the role of other possible pathways, and test a key hypothesis about the role of migratory shorebirds in viral spread. Finally, we will examine the role of wildlife markets as hotspots for influenza emergence. We will focus on four important issues that arise from our earlier work and which will ultimately lead to a long term field and data modelling research program on H5N1:

1) Developing a forward-predictive model for the global spread of H5N1 in bird

Our prior analysis (11) was limited to examining the most likely pathway for introductions that had occurred, but did not examine the predictive value of the model to determine where the virus would spread to, and countries that were less at risk for introduction. To test the model, we will use data on trade and bird migration between each outbreak country and every possible destination country. We will re-create the pattern of spread of H5N1 using these data, and assess how accurate our model is. If, as we expect, we find strong predictive power, we will then identify countries that are predicted to have a high risk of H5N1, as well as subsequent patterns of spread if the virus is established in each country.

As part of this work, we will bring our analyses up-to-date with the latest information on H5N1 outbreaks, incorporating re-introduction events, and the persistence of outbreaks in a country.

2) Determining the role of shorebirds in H5N1 spread

Our previous research helped to solve one of the key questions in the spread of H5N1 avian influenza: are migratory birds involved in the spread of the virus? Most scientists

now accept that wild birds do play an important role, and now an important follow up question is: which birds are moving the virus over substantial differences? The two largest and most important groups are anseriformes (ducks, geese, and swans), and shorebirds (including gulls). Whether both groups are involved and to what extent has critical implications for the areas that are at risk for the introduction of H5N1. For example, large numbers of shorebirds regularly migrate between areas where H5N1 has been circulating in the past few years and is currently circulating, and South Africa, Australia, and the lower 48 states of the USA. In contrast, very few anseriformes make movements between H5N1 outbreak areas and any of these three regions. Thus, it is crucial to determine if shorebirds are playing a role in the spread of H5N1. We will also ask a related question: To what extent do ducks and shorebirds transmit viruses between them during migration or on the breeding and wintering grounds? To do this, we will combine four lines of data: 1) analysis of past spreading events that were most consistent with wild bird movement and determine whether they are more consistent with the movement of anseriformes or shorebirds, 2) examine the large set of recently published reports on H5N1 surveillance to determine if shorebirds are frequently found infected with H5N1; 3) examine previous studies on influenza infection where the viral isolates were sequenced or genetically characterized to determine the extent of spillover of viruses from anseriformes to shorebirds; and 4) use data from our field studies, described below, to examine the behavioural and virological overlap between anseriformes and shorebirds.

3 The persistence of H5N1 virus in wild birds

We will address a critical question: can H5N1 persist in wild birds without continual introduction from domestic poultry? We to address this question, we will examine the persistence and spread of H5N1 over the past 6 years, and the genetic relationships between viral isolates and ask: is the pattern more consistent with the virus overwintering in Siberian breeding grounds, emerging from southern wintering grounds, and being spread by wild birds during migration, or do wild bird infections appear most consistent with spill over from poultry.

4 Wildlife markets

Building on our past work under a previous NIH award (R01-TW05869, Fogarty Intl. Center) identifying the likely wildlife origin of SARS (12), The Consortium for Conservation Medicine (CCM) has entered into a partnership with East China Normal University in Shanghai to form the CCM-ECNU Joint Institute for Wildlife Zoonoses. As part of this collaboration, we have been given access to test wildlife and domestic animal samples in a series of wildlife markets ('wetmarkets') in Guangdong Province, P.R. China. We are actively collecting data from these markets and are able to test for avian influenza and other zoonotic pathogens. We will combine our data with other reports to assess how important wildlife markets are as a source of spillover of zoonotic pathogens, including influenza.

5 Field data collection in Shanghai, China, to test local transmission among species

One of the aims of our work will be to build preliminary data for a future larger, R01 grant application. Towards this, we will work with our Chinese colleagues at ECNU who have a large program to assess the presence of avian influenza by serology and PCR at the important Dongtan wetland site on Chongming Island, near Shanghai. Our long term goal is to use this site to study the ecology of H5N1 and low-pathogenicity avian influenza viruses in the field. We will collate and translate data from ECNU work on Chongming and assess the diversity of migrating and overwintering shorebirds and waterfowl, and the proximity of domestic duck flocks, backyard poultry and poultry farms. We already have access to avian influenza serological data from a large study

at Chongming, and will collaborate with our ECNU to analyze these data, and collect samples for isolation and PCR.

Logistics/Work plan

Our PI collaboration: This application involves PI of an FIC-funded EID award for Nipah virus ecology in South Asia (Daszak, R01-TW05869), and the PI of an NSF-funded EID award for West Nile virus ecology in the US (Kilpatrick, EF-0622391). Both have collaborated extensively over the last 5 years, and both are co-investigators on each other's EID award. Thus, in the course of normal business, they meet regularly, conduct regular conference calls, and collaborate closely on zoonotic emerging diseases. In this application, they will jointly supervise 2 postdoc researchers to conduct data-gathering and collation, analyses and modelling to understand aspects of H5N1 emergence and spread in birds. Travel funds will support postdoc travel to visit the other PI's lab and to exchange information, ideas and analyses.

Access to data: The CCM specializes in analyzing patterns of disease emergence and spread and acts as a repository for data on anthropogenic and environmental drivers of EIDs. We work collaboratively and imaginatively to acquire and collate large datasets on these drivers, as proposed in the current application. For example, our group has published analyses of how demographic and environmental factors can predict the likely sources of new zoonoses (13), and how global trade in wildlife may act as a conduit for pathogens and invasive species (14). We have demonstrated proof of concept of our proposed work in a recent paper in *PNAS* (11), and are confident we can acquire the necessary data required for this proposed work.

Budget (annual)

	CCM	UCSC
Co-PI salary	0	0
Benefits	0	0
Postdoc (12 months)	50, 000	45, 000
Benefits	13,550	11,250
Consumables	4, 450	775
Travel	7,000	2500
Subtotal	**75,000**	**59,525**
26% indirect on subaward	19,500	15,475
Total ~~Direct~~	**150,000**	
Grand total	**183,170**	

sub

36000 × 26% = 9360 to A/sub

51640
9360
61,000 to A
+10K

Budget Justification: Because this is a special grant request, we are requesting no salary or benefits for the PI or co-PI, and will make up salary from other sources. We request full salary a postdoc to be based at the CCM (Wildlife Trust) in New York, jointly supervised by Daszak and Kilpatrick, to work on the analyses of the wildlife trade, wildlife markets and to assess the field sites in China. We request full salary for a postdoc to be based at UCSC, jointly supervised by Kilpatrick and Daszak, to undertake the re-analyses of the prior and global spread of H5N1 avian influenza. We request 21.7% benefits for the postdoc based at CCM and 25% benefits for the postdoc based at UCSC. We request a small consumables budget for computer supplies, data sources etc., and a small travel budget to enable the postdocs to meet

Other Support / FSR

regularly. Travel will be supplemented by other grants that the PIs have secured. We request the federally-approved F&A rates of 26% on the UCSC subaward, and 22.1% F&A on total direct costs (the federally-approved rate for Wildlife Trust).

References

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11. Kilpatrick, A. M., Chmura, A. A., Gibbons, D. W., Fleischer, R. C., Marra, P. P., & Daszak, P. (2006) *Proceedings of the National Academy of Sciences of the United States of America* **103,** 19368-19373.
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14. (b) (4)

F&A
Other Support

Grant Number: 5R01TW005869-06 REVISED

Principal Investigator(s):
PETER DASZAK, PHD

Project Title: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

PROGRAM ASSISTANT
WILDLIFE TRUST
460 WEST 34TH STREET
NEW YORK, NY 10001

Award e-mailed to: (b) (6)

Budget Period: 07/01/2009 – 06/30/2010
Project Period: 08/01/2002 – 06/30/2013

Dear Business Official:

The National Institutes of Health hereby revises this award (see "Award Calculation" in Section I and "Terms and Conditions" in Section III) to WILDLIFE TRUST in support of the above referenced project. This award is pursuant to the authority of 42 USC 241 42 CFR 52 and is subject to the requirements of this statute and regulation and of other referenced, incorporated or attached terms and conditions.

Acceptance of this award including the "Terms and Conditions" is acknowledged by the grantee when funds are drawn down or otherwise obtained from the grant payment system.

Each publication, press release or other document that cites results from NIH grant-supported research must include an acknowledgment of NIH grant support and disclaimer such as "The project described was supported by Award Number R01TW005869 from the Fogarty International Center. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Fogarty International Center or the National Institutes of Health."

Award recipients are required to comply with the NIH Public Access Policy. This includes submission to PubMed Central (PMC), upon acceptance for publication, an electronic version of a final peer-reviewed, manuscript resulting from research supported in whole or in part, with direct costs from National Institutes of Health. The author's final peer-reviewed manuscript is defined as the final version accepted for journal publication, and includes all modifications from the publishing peer review process. For additional information, please visit http://publicaccess.nih.gov/.

Award recipients must promote objectivity in research by establishing standards to ensure that the design, conduct and reporting of research funded under NIH-funded awards are not biased by a conflicting financial interest of an Investigator. Investigator is defined as the Principal Investigator and any other person who is responsible for the design, conduct, or reporting of NIH-funded research or proposed research, including the Investigator's spouse and dependent children. Awardees must have a written administrative process to identify and manage financial conflict of interest and must inform Investigators of the conflict of interest policy and of the Investigators' responsibilities. Prior to expenditure of these awarded funds, the Awardee must report to the NIH Awarding Component the existence of a conflicting interest and within 60 days of any new conflicting interests identified after the initial report. Awardees must comply with these and all other aspects of 42 CFR Part 50, Subpart F. These requirements also apply to subgrantees, contractors, or collaborators engaged by the Awardee under this award. The NIH website http://grants.nih.gov/grants/policy/coi/index.htm provides additional information.

If you have any questions about this award, please contact the individual(s) referenced in Section IV.

Sincerely yours,

BRUCE R BUTRUM
Grants Management Officer
FOGARTY INTERNATIONAL CENTER

Additional information follows

SECTION I – AWARD DATA – 5R01TW005869-06 REVISED

Award Calculation (U.S. Dollars)

Federal Direct Costs	$449,356
Federal F&A Costs	$50,619
Approved Budget	$499,975
Federal Share	$499,975
TOTAL FEDERAL AWARD AMOUNT	$499,975
AMOUNT OF THIS ACTION (FEDERAL SHARE)	$0

SUMMARY TOTAL FEDERAL AWARD AMOUNT YEAR (6)	
GRANT NUMBER	**TOTAL FEDERAL AWARD AMOUNT**
5R01TW005869-06	$499,975
3R01TW005869-06S1	$204,688
3R01TW005869-06S2	$51,225
3R01TW005869-06S3	$199,698
TOTAL	**$955,586**

SUMMARY TOTALS FOR ALL YEARS		
YR	**THIS AWARD**	**CUMULATIVE TOTALS**
6	$499,975	$955,586
7	$499,998	$499,998
8	$499,449	$499,449
9	$499,772	$499,772

Recommended future year total cost support, subject to the availability of funds and satisfactory progress of the project

Fiscal Information:

CFDA Number:	93.989
EIN:	1311726494A1
Document Number:	RTW005869B
Fiscal Year:	2009

IC	*CAN*	*2009*	*2010*	*2011*	*2012*
TW	8476360	$249,975	$253,998	$253,449	$253,772
TW	8476369	$250,000	$246,000	$246,000	$246,000

Recommended future year total cost support, subject to the availability of funds and satisfactory progress of the project

NIH Administrative Data:
PCC: EID / **OC**: 414E / **Processed**: [redacted] (b) (6) 09/18/2009

SECTION II – PAYMENT/HOTLINE INFORMATION – 5R01TW005869-06 REVISED

For payment and HHS Office of Inspector General Hotline information, see the NIH Home Page at http://grants.nih.gov/grants/policy/awardconditions.htm

SECTION III – TERMS AND CONDITIONS – 5R01TW005869-06 REVISED

This award is based on the application submitted to, and as approved by, NIH on the above-titled project and is subject to the terms and conditions incorporated either directly or by reference in the following:

a. The grant program legislation and program regulation cited in this Notice of Award.
b. Conditions on activities and expenditure of funds in other statutory requirements, such as those included in appropriations acts.
c. 45 CFR Part 74 or 45 CFR Part 92 as applicable.
d. The NIH Grants Policy Statement, including addenda in effect as of the beginning date of the budget period.

e. This award notice, INCLUDING THE TERMS AND CONDITIONS CITED BELOW.

(See NIH Home Page at 'http://grants.nih.gov/grants/policy/awardconditions.htm' for certain references cited above.)

An unobligated balance may be carried over into the next budget period without Grants Management Officer prior approval.

This grant is subject to Streamlined Noncompeting Award Procedures (SNAP).

In accordance with P.L. 110-161, compliance with the NIH Public Access Policy is now mandatory. For more information, see NOT-OD-08-033 and the Public Access website: http://publicaccess.nih.gov/.

This award is funded by the following list of institutes. Any papers published under the auspices of this award must cite the funding support of all institutes.

Fogarty International Center (FIC)

Treatment of Program Income:
Additional Costs

SECTION IV – TW Special Terms and Conditions – 5R01TW005869-06 REVISED

REVISION
This award is revised for internal accounting purposes only.

FUNDING LEVEL
This non-competing award is issued in accord with the FIC FY09 Funding Strategy: http://www.fic.nih.gov/funding/fy_strategy/2009funding.htm and is consistent with the NIH Guide Notice NOT-OD-09-002 http://grants.nih.gov/grants/guide/notice-files/NOT-OD-09-002.html.

CURRENT AND FUTURE YEAR LEVELS
In accordance with the October 27, 1995, NIH Guide announcement and NIH implementation, future-year recommended levels are shown as total costs (the sum of direct plus facilities and administrative costs).

CONSORTIUM/CONTRACTUAL COSTS
This award includes funds for consortium activities. Consortiums are to be established and administered in accordance with the NIH Grants Policy Statement.

FOREIGN TRAVEL
U.S. Flag carriers must be used for departure from or entry into the U.S. and for any other portion of the trip where available.

PUBLICATIONS
All publications resulting from the research or research training supported by this award must acknowledge FIC and any co-funders (if applicable). This publication requirement applies not only to the primary grantee, but also to any subcontractors and /or trainees involved with the project.

HUMAN SUBJECTS IRB APPROVAL
The Fogarty International Center has received documentation of the applicant organization's valid IRB approval for this project. The applicant organization is responsible for ensuring that any consortium/subcontract organization, involved in human subject research activities with this grant, have an appropriate IRB approval.

REQUIRED EDUCATION IN THE PROTECTION OF HUMAN RESEARCH PARTICIPANTS
Investigators must ensure that the description of the education completed in the protection of human subjects for each individual, identified as "key personnel", in the proposed research has been documented and provided to the FIC awarding office. Key personnel include all individuals responsible for the design and conduct of the study. The Notice for this policy can be found at: http://grants.nih.gov/grants/guide/notice-files/NOT-OD-00-039.html.

GENDER AND MINORITY INCLUSION

If this grant proposes the use of human subjects, future non-competing applications require that you indicate the number, ethnicity, and gender of human subjects that are part of this study. If this information is not included in future non-competing grant applications, the funding for the application may be delayed.

ADDRESS FOR FUTURE NONCOMPETING PROGRESS REPORTS
FIC encourages the submission of noncompeting progress reports through the eRA Commons, found at https://commons.era.nih.gov/commons/index.jsp. Each grantee organization and principal investigator must be registered in order to use Commons. It is expected that use of Commons will soon be mandatory in order to receive grant funding from NIH, so registration should be completed as soon as possible. If using Commons, please submit your progress report no later than 45 prior to the anticipated start date.

If not using Commons, please submit your hard-copy noncompeting progress report, no later than 2 months prior to the anticipated start date, to the following address:

Division of Extramural Activities Support, OER
National Institutes of Health
6705 Rockledge Drive, Room 2207, MSC 7987
Bethesda, MD 20892-7987 (for regular or US Postal Service Express mail)
Bethesda, MD 20817 (for other courier/express mail delivery only)
Phone Number: (301) 594-6584

This is the new centralized mailing address for all NIH Institutes/Centers. Do NOT submit the non-competing progress report directly to Fogarty International Center.

For up-to-date information, you may access the NIH Home Page at http://www.nih.gov/ and the FIC Home Page at http://www.fic.nih.gov/.

STAFF CONTACTS

The Grants Management Specialist is responsible for the negotiation, award and administration of this project and for interpretation of Grants Administration policies and provisions. The Program Official is responsible for the scientific, programmatic and technical aspects of this project. These individuals work together in overall project administration. Prior approval requests (signed by an Authorized Organizational Representative) should be submitted in writing to the Grants Management Specialist. Requests may be made via e-mail.

Grants Management Specialist: Angela Smith
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-594-1211

Program Official: Joshua Rosenthal
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-402-0779

SPREADSHEET SUMMARY
GRANT NUMBER: 5R01TW005869-06 REVISED

INSTITUTION: WILDLIFE TRUST

Facilities and Administrative Costs	***Year 6***	***Year 7***	***Year 8***	***Year 9***
F&A Cost Rate 1	26.1%	26.1%	26.1%	26.1%
F&A Cost Base 1	$193,942	$202,683	$215,333	$218,761
F&A Costs 1	$50,619	$52,900	$56,202	$57,097

OMB No. 0925-0001

Grant Number 5R01TW5869-6	**Total Project Period** From: 08/01/2002 To: 06/30/2013
EIN: **Review Group:** 1311726494A1 ZRG1 BDA-K (50) R	**Requested Budget Period:** From: 07/01/2009 To: 06/30/2010
Title of Project: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh	**Due Date:** 05/16/2009 **Submitted Date:** 08/06/2009

Program Director/Principal Investigator: PETER DASZAK 460 West 34th Street New York , NY 10001 **Phone Number:** (b) (6) **Fax Number:** **Email Address:** (b) (6)	**Applicant Organization:** WILDLIFE TRUST WILDLIFE TRUST 460 West 34th Street New York , NY 10001 **Department:** **Major Subdivision:**
Administrative Official: Aleksei Avery Chmura WILDLIFE TRUST 61 ROUTE 9W PALISADES , NY 109648000 **Phone Number:** (b) (6) **Fax Number:** **Email Address:** (b) (6)	**Signing Official:** Aleksei Avery Chmura WILDLIFE TRUST 61 ROUTE 9W PALISADES , NY 109648000 **Phone Number:** (b) (6) **Fax Number:** **Email Address:** (b) (6)
Human Subjects: ☐ No ☒ Yes **Research Exempt:** ☒ No ☐ Yes **Exemption No:** **FWA Number:** **Phase III Clinical Trial:** ☒ No ☐ Yes	**Vertebrate Animals:** ☐ No ☒ Yes **Animal Assurance Number:** A3415-01 **Inventions and Patents:** ☒ No ☐ Yes ☐ Previously Reported ☒ Not Previously Reported
Program Income: ☒ No ☐ Yes	

Budget Period	**Anticipated Amount**	**Source**
F&A Changes:		

Primary Project/Performance Site Location

Organizational Name: WILDLIFE TRUST		
DUNS: 077090066		
Street 1: WILDLIFE TRUST	Street 2: 460 West 34th Street	
City: New York	County:	State: NY
Province:	Country: UNITED STATES	Zip/Postal Code: 10001
Congressional Districts: 08		

Program Director/Principal Investigator:	**Grant Number**
PETER DASZAK	5R01TW5869-6
Applicant Organization:	**Period Covered by this Report:**
WILDLIFE TRUST	07/01/2008 - 06/30/2009

Title of Project:

The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

SNAP Questions:

Has there been a change in the other support of Senior/Key Personnel since the last reporting period?

☒ **No** ☐ **Yes**

Justification:

Will there be, in the next budget period, a significant change in the level of effort for the PD/PI or other Senior/Key Personnel designated on the Notice of Award from what was approved for this project?

☒ **No** ☐ **Yes**

Justification:

Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

☒ **No** ☐ **Yes**

Justification:

Changes in Select Agent Research? ☒ **No** ☐ **Yes**

Changes in Multiple PD/PI Leadership plan? ☒ **No** ☐ **Yes**

Human Subject Education Requirement:

Has the Involvement of Human Subjects changed since previous submission? ☒ **No** ☐ **Yes**

Has the Involvement of Animal Subjects changed since previous submission? ☒ **No** ☐ **Yes**

Publications:

Citation ID:	**Citation Source:**	**Citation Text:**
42148	NIHMS	Rhys Fogarty, , Kim Halpin, Alex D. Hyatt, Peter Daszak, Bruce A. Mungall; Henipavirus susceptibility to environmental variables; Virus research;

Research Accomplishments: File is not uploaded
Other Document File: File is not uploaded
Other Support File: File is not uploaded

Senior/Key Personnel Report						
Program Director/Principal Investigator: PETER DASZAK			**Grant Number** 5R01TW5869-6			
Name:	**Degree(s) Name:**	**SSN:**	**Role on Project:**	**Months Devoted to Project**		
				Cal	**Acad**	**Sum**
PETER DASZAK	PHD, BS	(b) (6)	PD/PI	(b) (4), (b) (6)		

Progress report text July 2008 - 2009

NIH R01 Nipah virus Bangladesh (5R01TW005869-06)

Personnel and Training

We have trained five Bangladeshi individuals, 3 veterinarians and 2 field technicians, as part of the Nipah virus surveillance team. We have developed two teams of professionals to conduct field surveillance of bat populations. One team is covering the eastern part of Bangladesh and is located in Chittagong at Chittagong Veterinary and Animal Sciences University (CVASU). The team developed in Chittagong is headed by Dr. Shahneaz Ali Khan, a veterinarian and lecturer at the university. Dr. Khan was trained in all phases of field work including bat capture techniques, animal handling, anesthesia, sampling methods, sample storage, logistical planning, and safety. Dr. Ali Khan worked under the direct supervision of veterinarians from Wildlife Trust from 2006 - 2008. He was then hired as a lecturer by CVASU and continues to collaborate with Wildlife Trust on our Nipah virus work. CVASU is poised to be a strong partner in this collaboration with Wildlife and ICDDR,B, and we intend to continueto train students and graduates from CVASU in wildlife epidemiology.

The other Nipah virus bat surveillance team is headed by Dr. Ariful Islam, who graduated from CVASU in 2007 and is currently completing a Master's degree there. Dr. Islam heads the team operating in the Western part of the country, which includes our longitudinal surveillance site in Faridpur district. He has undergone the identical training regimen as Dr. Ali Khan and is successfully managing the Western team and acts as our liaison with the ICDDR.B Nipah virus surveillance team. The final veterinarian hired is Dr. Ausraful 'Rajib" Islam based at ICDDR, B in Dhaka. He is the newest member of the team is has started the training program. He will serve as research scientist and logistics coordinator for the two field teams and assist with outbreak responses. We expect him to fully trained over the next two months.

We have two fully-trained field technicians, Mohammad Pitu Biswas and Mohammad Sheikh Gofur. Each has extensive animal handling experience, as they were former hunters and trappers. They have been trained and are competent in all aspects of animal handling and safety and have a good understanding of sample handling and storage. They have worked with us on bat surveillance for since 2006 and have become invaluable members of the team.

Equipment

We have made significant progress in terms of sample storage capacity, laboratory facilities and logistical capability over the past year. Two -80°C storage freezers have been installed at the ICDDR,B's new BSL3 lab in Dhaka. This will significantly improve our sample storage capability. In addition the lab will soon be equipped with a Mass Tag PCR system and a lab technician trained by a member of Ian Lipkin's laboratory at the Center for Infection and Immunity at Columbia University. This will enable us to screen samples in country for more rapid results, and identify those samples most likely to produce discovery of new pathogens. We also have purchased two new nitrogen storage dewars that enhance our capacity and flexibility for field activities. They can serve as both dry shipper and/or liquid nitrogen storage with increased sample storage capacity and increased time between recharging. This will place less time constraints on field expeditions and allow our field teams to collect samples simultaneously.

Spatial serological survey of *P. giganteus*

Figure 1 shows the prevalence of anti-Nipah virus antibodies based on an IgG ELISA [1] at six of eight locations in our spatial survey, begun in 2006 under 1R01-TW05869 and supported, in part, from K08AI067549-01A (Epstein PI). Kushtia and Thakurgaon samples were also tested by SNT at the Australian Animal Health Laboratory (results not shown). Four sites sampled bat colonies located within 30km of human outbreaks [Thakurgaon, Kushtia, Tangail and Faridpur], and four locations are in districts that have not had any reported human cases of Nipah virus encephalitis [Khulna, Comilla, Sylhet, and Chittagong].

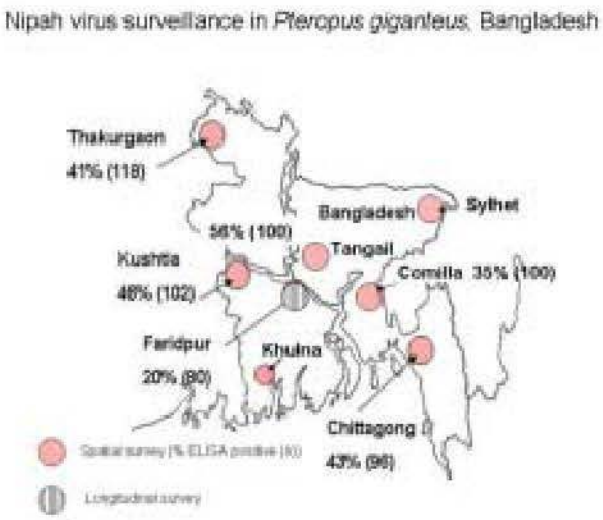


Fig.1. Map of Bangladesh showing seroprevalence of NiV antibodies in *P. giganteus.* Prevalences are based on an IgG ELSIA. Faridpur is also the site of a longitudinal study. Data presented for Faridpur is based on the initial sample in 2006, and serial data from quarterly sampling over 36 months will be available in year 2 of this grant.

12-month serological study in juvenile bats in four locations to detect outbreaks

We conducted preliminary analysis of serological data from our spatial study in *P. giganteus* to determine whether there was a difference in seroprevalence between juvenile and adult bats; and if so, whether we would be able to detect an outbreak of Nipah virus by monitoring the serological profile of the juveniles in a colony over 12 months.

Analysis of serological profiles from bats sampled in five different locations

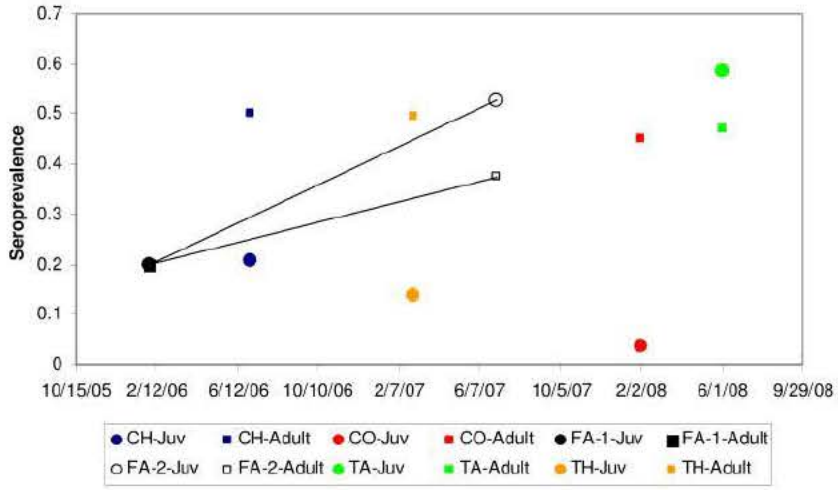


Figure 2. Seroprevalence by ELISA at five sites over two years for adult and juvenile bats. Abbreviations are: Chittagong (CH), Comilla (CO), Faridpur (FA), Tangail (TA), Thakurgaon (TH).

We limited our analysis to only samples tested by ELISA to avoid skewing the results due to the discrepancies between SNT and ELISA (data not shown). We used a generalized linear model with a logit link (equivalent to a binary logistic regression) asking whether the following factors make it more likely for each bat to be seropositive:

- Age (juveniles, adults – I took out the 6 neonates, but see below)
- Sex
- Site
- Julian Date (date with year removed, 1 = January 1st)
- Age*Jdate interaction (to let the effect of date vary with age)

In this model, all variables were significant except Sex, which was removed from the model (the fitted model is below as Table 1). The analysis produced the following fitted model of the probability of being seropositive vs. Jdate for Faridpur (FA), with the ages split out (Figure 3):

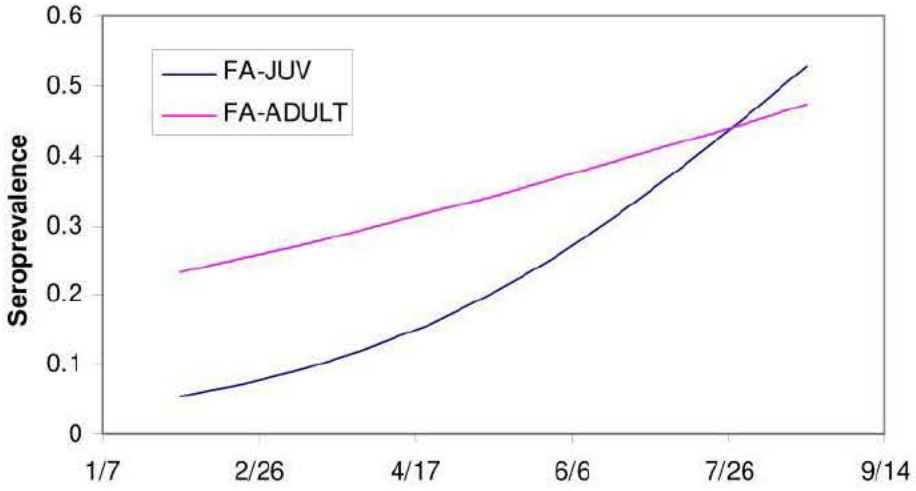


Figure 3. Fitted seroprevalence vs. Julian Date for adult and juvenile bats at Faridpur.

We note that the strong increase with Jdate is strongly influenced by the two visits to Faridpur where the early visit (Jan-Feb, 2006) had very low seroprevalence in Juveniles and Adults and by the later visit (July, 2007) both adults and juveniles had much higher seroprevalences, with the juveniles increasing and ending up with a higher seroprevalence than adults by July, as indicated by the crossing lines on the graph above:

Juveniles 3/15 or 20% (Feb) to 20/38 or 53% (July)

Adults 13/65 or 20% (Feb) to 18/48 or 38% (July)

The data from the other sites was slightly different in that the Chittagong visit in July 2006 had a similarly high prevalence as the Faridpur July 2007 visit in Adults (36/72 50%) but lower in Juveniles (5/24 21%). The visit to Thakurgaon in Feb-Mar 2007 also had a high prevalence in adults (44/89 or 49%), but a very low prevalence in juveniles (4/29 14%). At one other site in Feb 2008, Comilla, there was low prevalence in juveniles (1/27 4%) and similar prevalence to other sites in adults (33/73 45%). Finally, juveniles at yet another site, Tangail, in June, 2008, had very high seropositivity (24/41 59%) which was slightly but not significantly higher than adults (25/53 47%) at this site during this visit. In addition, at Tangail, 5/6 pre-weaned pups were ELISA positive, and 4/5 of the mom's of these pups were ELISA +. Overall, this data indicates a lack of recent activity at Comilla, and suggests an outbreak occurred in the last 1-3 years at Tangail (there was a human outbreak in 2005 [2], and it would be logical to assume that bats were shedding prior to the first human case).

118 samples were collected from Kushtia in August, 2007 and were tested by SNT only, where both Juveniles and adults had ~50% seroprevalence. Thus, although this analysis is heavily influenced by the two samples from Faridpur, what it suggests is that there was likely a Nipah epidemic in Faridpur between Feb 06 and July 07, and epidemics at other sites occurred before the juveniles were born.

The goal of our analyses was to estimate the expected seroprevalences at various times of the year in juveniles and adults in order to determine goals for sample sizes necessary to detect outbreaks. What

these data suggest is that adult prevalence is likely to be as low as 20-25% in between epidemics with a required sample size for a coefficient of variation (Standard deviation/mean) of 0.1 of ~15 animals (Figure 4), but only 10 animals are needed when prevalence is closer to 50%. For the juveniles, except after an epidemic, prevalences seem to be in the 10-20% range, needing a sample size of ~18 animals for the same precision.

Given these relatively high seroprevalences, we asked the question – should we be sampling more sites repeatedly, but with fewer animals per sample? Given the very small gains in precision past 20 animals (Figure 4) for all but very low prevalences, we determined it would be significantly more informative to sample between 15 and 20 adults and 15 and 20 juveniles from each of 2 sites rather than 40 - 50 of each from one site, especially because, if it were done 2-3 times per year, it could help to identify and localize separate outbreaks.

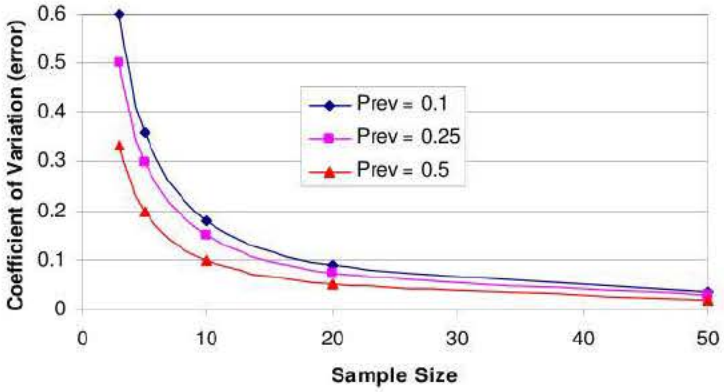


Figure 4. Coefficient of variation (standard deviation/mean) vs. sample size for three seroprevalence estimates based on the statistical relationship between variance and the mean for a binomial variable.

Table 1. GLM results. "Reference" levels for relative risk ratios were CH (site), juveniles (age).

Predictor	Coef	StDev	Z	P	Ratio	Lower	Upper
Constant	-3.4555	0.6761	-5.11	<0.001			
Site							
CO	0.9664	0.479	2.02	0.044	2.63	1.03	6.72
FA	0.1596	0.3171	0.5	0.615	1.17	0.63	2.18
TA	0.8582	0.3188	2.69	0.007	2.36	1.26	4.41
TH	1.0922	0.4329	2.52	0.012	2.98	1.28	6.96
Date	0.01481	0.003209	4.62	<0.001	1.01	1.01	1.02
Age							
Adults	1.9347	0.4971	3.89	<0.001	6.92	2.61	18.34
Age*Date							
Adults	-0.00937	0.002996	-3.13	0.002	0.99	0.98	1
Term	Chi-Square	DF	P				
Site	14.868	4	0.005				

Thus, we determined from our preliminary data that we would be able to detect outbreaks by selectively testing juveniles through their first year of life, and could reduce our per-site sample size from 100 bats to 15-20 bats and still detect sero-conversion. We have developed a protocol for a monthly sampling of juvenile and adult bats at two locations: one colony near a human outbreak site (Ramnagar, Rajbari district), and the other in an area with no reported Nipah virus encephalitis cases (Chakuria,Chittagong district); and semi-annual sampling at another two locations (Tangail and one TBD) where we will sample 30 – 40 juveniles and 30-40 adults to broaden our monitoring.

We will begin our modified sampling protocol I late July, 2009. Over the next 12 months we will collect samples from 850 bats across four sites. Samples will include blood, saliva, urine, and roost urine. Each bat will be marked with an electronic microchip with a unique ID number.

It is currently unknown how long maternal antibodies to Nipah virus last in juvenile bats, but a recent study of [redacted] (b) (4) *P. giganteus* generally give birth in late April early May, and pups will cling to their dams for about the first 3 months of life. We predict that by September/October, pups born to dams with Nipah virus antibodies will become seronegative, and we will be able to observe a general decline in juvenile seroprevalence over the first several months of the study. After that point, spikes in juvenile seroprevalence (and overall seroprevalence) will suggest that Nipah virus has circulated through the colony.

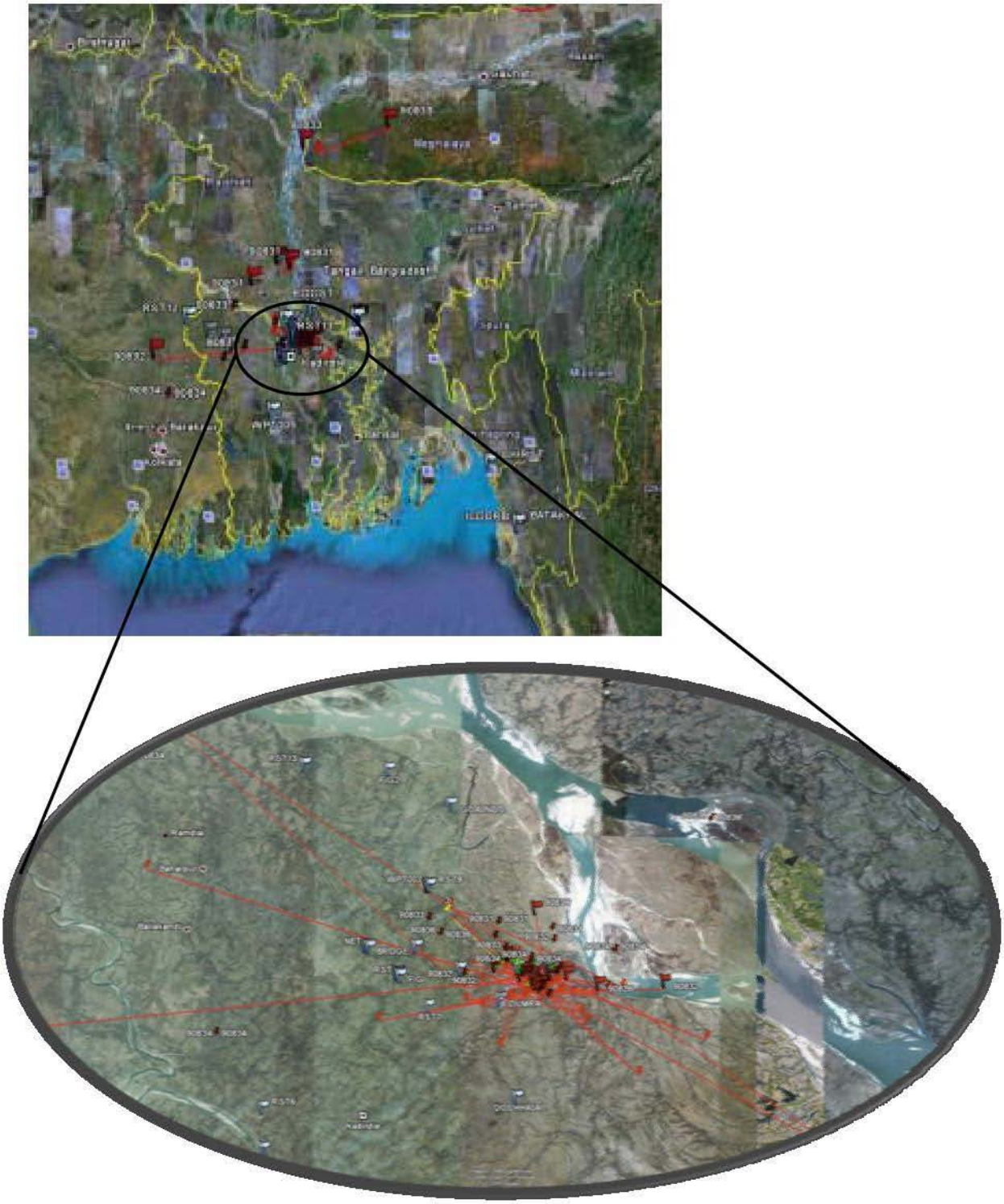
Longitudinal study

In 2007, we began a longitudinal study of a single bat population in Faridpur, less than 30km from the location of a human outbreak in 2004. We have been collecting saliva, urine, and serum from 100 bats every 3 months, and implanting ID microchips into each bat, allowing us to identify individuals, measure recapture rates, and estimate the population size. We sampled 400 *P. giganteus* from July, 2008 – july 2009, as part of our long-term longitudinal study in Faridpur (begun under NIAID K08AI067549-01A2, Epstein PI, and now partly supported under this grant). A total of 1200 sera will have been collected from our longitudinal study will be batch tested using an IgG ELISA at the Center for Infection and Immunity in June, 2010, which will mark the end of the first 3-year phase of our longitudinal study. We will be testing all 1200 sera from this site at one time with the same set of reagents to minimize test-to-test error. We will use the resulting serology data to determine whether there are seasonal changes in seroprevalence, particularly in juvenile bats, that may indicate that an outbreak has occurred. We will also test pooled urine from individual bats and pooled urine collected from underneath the colony for Nipah virus nucleic acid in order to determine whether there is seasonal shedding of Nipah virus, as has been suggested in other pteropid species [3].

Satellite Telemetry: *Pteropus giganteus*

This study is the first of its kind in Bangladesh and the first to place collars on both male and female bats. In February, 2009 we deployed six PTTs affixed to collars. We selected 3 male and 3 female adult bats – the first time this group has collared female bats. The bats were captured in Shubarampur, a roost site near our longitudinal study site in Faridpur. Results from the first month of data are shown in **Figure 5**. In general, all six bats remained near the roost site where they were first captured. Bat 90831, a female bat, flew 50 miles north to Sirajganj in May to a location 15 miles from Tangail, the site of a 2005 human outbreak. We have observed that the bats have stayed close to the Brahmaputra river, a centrally located geological landmark running north south. Flying foxes are known to roost near freshwater sources, and (b) (4) Flying foxes are also believed to use rivers and other geological features to navigate during migratory flights [4]. Bat 90832, also a female bat, appears to have flown 100 miles west into West Bengal, India, indicating an international migratory route, similar to what our group found from our telemetry studies of *P. vampyrus* in Malaysia [5]. The long-range movement of *P. giganteus* has significant epidemiological implications for Nipah virus distribution. It appears likely that bat populations in India are connected to those in Bangladesh, which increases the range through which Nipah virus may be maintained under a metapopulation structure. This dynamic will be explored in our disease modeling under Specific Aim XX.

Figure 5. Map of Bangladesh showing satellite telemetry data from six *Pteropus giganteus*.



Nipah virus encephalitis outbreaks, humans

There were no reported cases of Nipah virus encephalitis from July 2008 – July 2009. ICDDR,B has active surveillance for encephalitis in place in 12 hospitals throughout Bangladesh. We have been working on expanding diagnostic capacity at ICDDR,B for Nipah virus. The ICDDR,B will be opening a new BSL 3 diagnostic laboratory in July 2009. The lab will have PCR and Serology capabilities, and in the next year they will have the ability to run a Nipah virus IgG ELISA (reagents donated by the Australian Animal Health Laboratory) and MassTag PCR (equipment and reagents from the Center for Infection and Immunity, W.I.Lipkin)

Literature Cited

1. Epstein, J.H., et al., *Henipavirus infection in fruit bats (Pteropus giganteus), India.* Emerging Infectious Diseases, 2008. **14**(8): p. 1309-1311.
2. Luby S., et al., *Foodborne Transmission of Nipah Virus, Bangladesh.* Emerging Infectious Diseases, 2006. **12**(12).
3. Wacharapluesadee S, et al., *A Longitudinal Study of the Prevalence of Nipah virus in Pteropus lylei Bats in Thailand: Evidence for Seasonal Preference in Disease Transmission.* Vector Borne Zoonotic Dis, 2009. **[Epub ahead of print]**.
4. Hall, L., Richards, G., *Flying Foxes: Fruit and Blossom Bats of Australia.* 1st ed. 2000: Krieger Publishing Company. 135.
5. (b) (4)

(b) (4)

THIS AWARD IS ISSUED UNDER THE AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009 AND IS SUBJECT TO SPECIAL HHS TERMS AND CONDITIONS AS REFERENCED IN SECTION III

Grant Number: 3R01TW005869-06S1 REVISED

Principal Investigator(s):
PETER DASZAK, PHD

Project Title: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

PROGRAM ASSISTANT
WILDLIFE TRUST
460 WEST 34TH STREET
NEW YORK, NY 10001

Award e-mailed to: (b) (6)

Budget Period: 09/01/2009 – 08/31/2011
Project Period: 09/01/2009 – 08/31/2011

Dear Business Official:

The National Institutes of Health hereby revises this award (see "Award Calculation" in Section I and "Terms and Conditions" in Section III) to WILDLIFE TRUST in support of the above referenced project. This award is pursuant to the authority of 42 USC 241 42 CFR 52 and is subject to the requirements of this statute and regulation and of other referenced, incorporated or attached terms and conditions.

Acceptance of this award including the "Terms and Conditions" is acknowledged by the grantee when funds are drawn down or otherwise obtained from the grant payment system.

Each publication, press release or other document that cites results from NIH grant-supported research must include an acknowledgment of NIH grant support and disclaimer such as "The project described was supported by Award Number R01TW005869 from the Fogarty International Center. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Fogarty International Center or the National Institutes of Health."

Award recipients are required to comply with the NIH Public Access Policy. This includes submission to PubMed Central (PMC), upon acceptance for publication, an electronic version of a final peer-reviewed, manuscript resulting from research supported in whole or in part, with direct costs from National Institutes of Health. The author's final peer-reviewed manuscript is defined as the final version accepted for journal publication, and includes all modifications from the publishing peer review process. For additional information, please visit http://publicaccess.nih.gov/.

Award recipients must promote objectivity in research by establishing standards to ensure that the design, conduct and reporting of research funded under NIH-funded awards are not biased by a conflicting financial interest of an Investigator. Investigator is defined as the Principal Investigator and any other person who is responsible for the design, conduct, or reporting of NIH-funded research or proposed research, including the Investigator's spouse and dependent children. Awardees must have a written administrative process to identify and manage financial conflict of interest and must inform Investigators of the conflict of interest policy and of the Investigators' responsibilities. Prior to expenditure of these awarded funds, the Awardee must report to the NIH Awarding Component the existence of a conflicting interest and within 60 days of any new conflicting interests identified after the initial report. Awardees must comply with these and all other aspects of 42 CFR Part 50, Subpart F. These requirements also apply to subgrantees, contractors, or collaborators engaged by the Awardee under this award. The NIH website http://grants.nih.gov/grants/policy/coi/index.htm provides additional information.

If you have any questions about this award, please contact the individual(s) referenced in Section IV.

Sincerely yours,

BRUCE R BUTRUM
Grants Management Officer
FOGARTY INTERNATIONAL CENTER

Additional information follows

SECTION I – AWARD DATA – 3R01TW005869-06S1 REVISED

Award Calculation (U.S. Dollars)

Federal Direct Costs	$159,788
Federal F&A Costs	$44,900
Approved Budget	$204,688
Federal Share	$204,688
TOTAL FEDERAL AWARD AMOUNT	$204,688

AMOUNT OF THIS ACTION (FEDERAL SHARE) $0

Fiscal Information:

CFDA Number:	93.701
EIN:	1311726494A1
Document Number:	RTW005869Z
Fiscal Year:	2009

IC	*CAN*	*2009*
TW	8485038	$204,688

Recommended future year total cost support, subject to the availability of funds and satisfactory progress of the project

NIH Administrative Data:
PCC: FSP / **OC**: 414C / **Processed**: (b) (6) 12/03/2009

SECTION II – PAYMENT/HOTLINE INFORMATION – 3R01TW005869-06S1 REVISED

For payment and HHS Office of Inspector General Hotline information, see the NIH Home Page at http://grants.nih.gov/grants/policy/awardconditions.htm

SECTION III – TERMS AND CONDITIONS – 3R01TW005869-06S1 REVISED

This award is based on the application submitted to, and as approved by, NIH on the above-titled project and is subject to the terms and conditions incorporated either directly or by reference in the following:

a. The grant program legislation and program regulation cited in this Notice of Award.
b. Conditions on activities and expenditure of funds in other statutory requirements, such as those included in appropriations acts.
c. 45 CFR Part 74 or 45 CFR Part 92 as applicable.
d. The NIH Grants Policy Statement, including addenda in effect as of the beginning date of the budget period.
e. This award notice, INCLUDING THE TERMS AND CONDITIONS CITED BELOW.

(See NIH Home Page at 'http://grants.nih.gov/grants/policy/awardconditions.htm' for certain references cited above.)

ARRA TERM OF AWARD: This award provides additional funding for 5R01TW005869-06. This additional funding is provided under the American Recovery and Reinvestment Act of 2009 (ARRA) and is subject to the HHS-Approved Standard Terms and Conditions for ARRA. Approved text for NIH awards can be found at: http://grants.nih.gov/grants/policy/NIH_HHS_ARRA_Award_Terms.pdf. Recipients should pay particular attention to the special quarterly reporting requirements required by Section 1512 of the Recovery Act as specified in Term #2. Unless the parent grant is also awarded with ARRA funds, these special quarterly reporting requirements apply only to this additional funding. Recipients should not include any information about the parent grant when responding to the quarterly reporting requirements. When both the parent grant and these additional funds are awarded with ARRA funding, the quarterly reporting requirement applies to the entire ARRA funding and can be reported as a single quarterly report.

Grantees are reminded to include specific information on the ARRA additional funding as part of the annual progress report(s) of the parent grant.

Separate financial reporting (SF 272 and Financial Status Reports) will be required to be submitted covering this additional funding. These will be in addition to any required financial reports for the parent grant.

Separate closeout documents (Final Progress Report, Final Financial Status Report, and Final Invention Statement) will also be required to closeout the Recovery Act funding at the time the ARRA funding ends. These closeout reports for the ARRA funding are required even when the parent grant continues.

Note, if the parent grant is also awarded with ARRA funds, separate financial and other closeout documents described above are **not** required. Any reporting on the additional funds provided in this award will be required as part of normal reporting of the parent grant

Unless the parent grant is also awarded with ARRA funds, the ARRA funds provided under this award are not available for rebudgeting or carryover into the parent grant. Any ARRA funding remaining at the end of the funding period for this award must be reported as an unobligated balance.

Carry over of an unobligated balance into the next budget period requires Grants Management Officer prior approval.

In accordance with P.L. 110-161, compliance with the NIH Public Access Policy is now mandatory. For more information, see NOT-OD-08-033 and the Public Access website: http://publicaccess.nih.gov/.

This award represents the final year of the competitive segment for this grant. Therefore, see the NIH Grants Policy Statement (12/1/2003 version) for closeout requirements at: http://grants.nih.gov/grants/policy/nihgps_2003/NIHGPS_Part8.htm#_Toc54600151.

A final Financial Status Report (FSR) (SF 269) must be submitted through the eRA Commons (Commons) within 90 days of the expiration date; see NIH Guide Notice NOT-OD-07-078 for additional information on this electronic submission requirement. The final FSR must indicate the exact balance of unobligated funds and may not reflect any unliquidated obligations. There must be no discrepancies between the final FSR and the Payment Management System's (PMS) Federal Cash Transaction Report (SF-272).

Furthermore, unless an application for competitive renewal is submitted, additional grant closeout documents consisting of a Final Invention Statement and Certification form (HHS 568), (not applicable to training, construction, conference or cancer education grants) and a final progress report must also be submitted within 90 days of the expiration date.

NIH also strongly encourages electronic submission of the final progress report and the final invention statement through the Closeout feature in the Commons. If the final progress report and final invention statement are not submitted electronically, copies of the HHS 568 form may be downloaded at: http://grants.nih.gov/grants/forms.htm.

Submissions of the final progress report and HHS 568 may be e-mailed as PDF attachments to the NIH Central Closeout Center at: deascentralized@od.nih.gov

Paper submissions of the final progress report and the HHS 568 may be faxed to the NIH Central Closeout Center at 301-480-2304 or mailed to the NIH Central Closeout Center at the following address:

NIH/OD/OER/DEAS
Central Closeout Center
6705 Rockledge Drive, Room 2207
Bethesda, MD 20892-7987 (for regular or U.S. Postal Service Express mail)
Bethesda, MD 20817 (for other courier/express mail delivery only)

The final progress report should include, at a minimum, a summary of progress toward the achievement of the originally stated aims, a list of significant results (positive and/or negative), a list

of publications and the grant number. If human subjects were included in the research, the final progress report should also address the following:

- Report on the inclusion of gender and minority study subjects (using the gender and minority Inclusion Enrollment Form as provided in the PHS 2590 and available at http://grants.nih.gov/grants/forms.htm).
- Where appropriate, indicate whether children were involved in the study or how the study was relevant for conditions affecting children (see "Public Policy Requirements and Objectives-Requirements for Inclusiveness in Research Design-Inclusion of Children as Subjects in Clinical Research" in the PHS 398 at URL http://grants.nih.gov/grants/policy/nihgps_2003/NIHGPS_Part5.htm#_Toc54600090)
- Describe any data, research materials (such as cell lines, DNA probes, animal models), protocols, software, or other information resulting from the research that is available to be shared with other investigators and how it may be accessed.

Note, if this is the final year of a competitive segment due to the transfer of the grant to another institution, then not all the requirements stated above are applicable. Specifically a Final Progress Report is not required. However, a final FSR is required and should be submitted electronically as noted above. In addition, if not already submitted, the Final Invention Statement is required and should be sent directly the assigned Grants Management Specialist.

Treatment of Program Income:
Additional Costs

SECTION IV – TW Special Terms and Conditions – 3R01TW005869-06S1 REVISED

SECTION IV - ADDITIONAL TERMS AND CONDITIONS
END DATE
This award is revised to adjust the end date for the supplement.

FOREIGN TRAVEL
U.S. Flag carriers must be used for departure from or entry into the U.S. and for any other portion of the trip where available.

PUBLICATIONS
All publications resulting from the research supported by this award must acknowledge such support with the following or a comparable footnote:

> This project was supported by NIH Research Grant #
> funded by the Fogarty International Center.

Award recipients are strongly encouraged to submit to PubMed Central (PMC), upon acceptance for publication, an electronic version of peer-reviewed, original research publications, resulting from research supported in whole or in part, with direct costs from NIH. The author?s final manuscript is defined as the final version accepted for journal publication, and includes all modifications from the publishing peer review process. For additional information, please visit http://www.nih.gov/about/publicaccess/.

GENDER AND MINORITY INCLUSION
If this grant proposes the use of human subjects, future non-competing applications require that you indicate the number, ethnicity, and gender of human subjects that are part of this study. If this information is not included in future non-competing grant applications, the funding for the application may be delayed.

STAFF CONTACTS
The Program Official is responsible for the scientific, programmatic and technical aspects of this project. The Grants Management Specialist is responsible for the negotiation, award and administration of this project and for interpretation of Grants Administration policies and provisions. These individuals work together in overall project administration. For up-to-date information, you may access the NIH Home Page at http://www.nih.gov/ and the FIC Home Page at http://www.fic.nih.gov/.

STAFF CONTACTS

The Grants Management Specialist is responsible for the negotiation, award and administration of this project and for interpretation of Grants Administration policies and provisions. The Program Official is responsible for the scientific, programmatic and technical aspects of this project. These individuals work together in overall project administration. Prior approval requests (signed by an Authorized Organizational Representative) should be submitted in writing to the Grants Management Specialist. Requests may be made via e-mail.

Grants Management Specialist: Angela Smith
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-594-1211

Program Official: Joshua Rosenthal
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-402-0779

SPREADSHEET SUMMARY
GRANT NUMBER: 3R01TW005869-06S1 REVISED

INSTITUTION: WILDLIFE TRUST

Cover Letter
Notice NOT-OD-056

Request for Recovery Act Administrative Supplement for US Global Health Postdoctoral Scientist Support

Principal Investigator: Peter Daszak

Grant 2R01TW005869-05: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

Supplement amount requested: $204,688 (2 year award)

Contact details for PI:

Dr. Peter Daszak
President
Wildlife Trust

Email: (b) (6)
Ph: (b) (6)

Institutional Official

Mr. Aleksei Chmura
Senior Program Coordinator
Wildlife Trust
Email: (b) (6)
Ph: (b) (6)

Form Approved Through 11/30/2010 OMB No. 0925-0001

Department of Health and Human Services
Public Health Services

Grant Application

Do not exceed character length restrictions indicated.

LEAVE BLANK—FOR PHS USE ONLY.

Type	Activity	Number
Review Group		Formerly
Council/Board (Month, Year)		Date Received

1. TITLE OF PROJECT *(Do not exceed 81 characters, including spaces and punctuation.)*
The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

2. RESPONSE TO SPECIFIC REQUEST FOR APPLICATIONS OR PROGRAM ANNOUNCEMENT OR SOLICITATION ☐ NO ☒ YES
(If "Yes," state number and title)
Number: 2R01TW005869-05 Title: Fogarty Supplement for U.S. Global Health Postdoctoral Scientists Support

3. PROGRAM DIRECTOR/PRINCIPAL INVESTIGATOR — **New Investigator** ☒ **No** ☐ **Yes**

3a. NAME (Last, first, middle)	3b. DEGREE(S)	3h. eRA Commons User Name
Daszak, Peter	PhD	daszak

3c. POSITION TITLE
President

3d. MAILING ADDRESS *(Street, city, state, zip code)*
460 West 34th Street, 17th Floor
New York, NY 10001

3e. DEPARTMENT, SERVICE, LABORATORY, OR EQUIVALENT
Wildlife Trust

3f. MAJOR SUBDIVISION
Conservation Medicine

3g. TELEPHONE AND FAX *(Area code, number and extension)*
TEL: (b) (6) FAX: 212-380-4465

E-MAIL ADDRESS:
(b) (6)

4. HUMAN SUBJECTS RESEARCH	4a. Research Exempt	If "Yes," Exemption No.
☒ No ☐ Yes	☒ No ☐ Yes	

4b. Federal-Wide Assurance No.	4c. Clinical Trial	4d. NIH-defined Phase III Clinical Trial
FWA00001468	☒ No ☐ Yes	☒ No ☐ Yes

5. VERTEBRATE ANIMALS ☐ No ☒ Yes — 5a. Animal Welfare Assurance No. A4059-01

6. DATES OF PROPOSED PERIOD OF SUPPORT *(month, day, year—MM/DD/YY)*		7. COSTS REQUESTED FOR INITIAL BUDGET PERIOD		8. COSTS REQUESTED FOR PROPOSED PERIOD OF SUPPORT	
From	Through	7a. Direct Costs ($)	7b. Total Costs ($)	8a. Direct Costs ($)	8b. Total Costs ($)
09/01/2009	08/31/2011	$79,795	$102,217	$159,788	$204,688

9. APPLICANT ORGANIZATION
Name Wildlife Trust
Address 460 West 34th Street, 17th Floor
New York, NY 10001

10. TYPE OF ORGANIZATION
Public: → ☐ Federal ☐ State ☐ Local
Private: → ☒ Private Nonprofit
For-profit: → ☐ General ☐ Small Business
☐ Woman-owned ☐ Socially and Economically Disadvantaged

11. ENTITY IDENTIFICATION NUMBER
31-1726494
DUNS NO. 077090066D Cong. District 8

12. ADMINISTRATIVE OFFICIAL TO BE NOTIFIED IF AWARD IS MADE
Name Aleksei Chmura
Title Authorized Organizational Representative
Address 460 West 34th Street, 17th Floor
New York, NY 10001
Tel: (b) (6) FAX: 212-380-4465
E-Mail: (b) (6)

13. OFFICIAL SIGNING FOR APPLICANT ORGANIZATION
Name Aleksei Chmura
Title Authorized Organizational Representative
Address 460 West 34th Street, 17th Floor
New York, NY 10001
Tel: (b) (6) FAX: 212-380-4465
E-Mail: (b) (6)

14. APPLICANT ORGANIZATION CERTIFICATION AND ACCEPTANCE: I certify that the statements herein are true, complete and accurate to the best of my knowledge, and accept the obligation to comply with Public Health Services terms and conditions if a grant is awarded as a result of this application. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties.

SIGNATURE OF OFFICIAL NAMED IN 13. *(In ink. "Per" signature not acceptable.)*
Aleksei Chmura

DATE
06/01/2009

PROJECT SUMMARY (See instructions):

The following Fogarty ARRA Supplement for U.S. Global Health Postdoctoral Scientist Support is to provide two years of salary, travel expenses, and laboratory and field supplies for Dr. Kevin J. Olival – a minorities worker who graduated with distinction from a Ph.D program working on bat genetics and disease ecology (see Biosketch). Kevin has unique skills in field collection of samples from bats, population genetic modeling, phylogenetics and molecular biology. His first postdoc position with the AMNH has been canceled due to Recession-related budget cuts, and therefore he fits perfectly the aims of the ARRA stimulus funding – to hire new staff and to bring in new skills that will accelerate scientific discovery. Dr. Olival, who is from an under-represented minorities background, will also bring valuable ethnic and cultural diversity to our team. Raised in a multi-racial household in Hawaii, Dr. Olival is part- Asian, legally Native American (Cherokee), and part Portuguese. The specific aims of this postdoctoral mentored research plan are complementary to our parent grant, "The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh" (2R01TW005869-05), and are threefold: Aim 1) Use genetic methods to quantify the dispersal and population connectivity of Pteropus giganteus, an important wildlife reservoir for Nipah virus (NiV) in Bangladesh; Aim 2) Use the additional staff member to accelerate and expand the field acquisition of non-Pteropus bat and NiV samples from Bangladesh; Aim 3) Use molecular and ecological tools to analyze the potential of fruit as a pathway for NiV spillover from bats to humans.

This proposal fits within three of the 5 main goals outlined in the FIC strategic plan. Specifically, it will: 1) close the "know-do" gap by using applied research (as proposed here) to implement effective, low-cost measures to reduce the risk of NiV spillover from bats to humans via infected fruit (Goal 2 of the Strategic Plan); 2) train a US postdoctoral scientist for a career in global health through international research collaborations (Goal 3 of the Strategic Plan); 3) build capacity to decrease the risk of NiV emergence in Bangladesh – a resource poor country (Goal 4 of the Strategic Plan).

RELEVANCE (See instructions):

PROJECT/PERFORMANCE SITE(S) (if additional space is needed, use Project/Performance Site Format Page)

Project/Performance Site Primary Location			
Organizational Name: Wildlife Trust			
DUNS: 077090066D			
Street 1: 460 West 34th Street		Street 2: 17 Floor	
City: New York	County: Manhattan		State: NY
Province:	Country: USA		Zip/Postal Code: 10001
Project/Performance Site Congressional Districts: 08			

Additional Project/Performance Site Location			
Organizational Name: International Center for Diarrheal Diseases Research, Bangladesh			
DUNS:			
Street 1: Center for Health and Population Research		Street 2: GPO 128	
City: Dhaka	County:		State:
Province:	Country: Bangladesh		Zip/Postal Code: 1212
Project/Performance Site Congressional Districts: N/A			

SENIOR/KEY PERSONNEL. See instructions. *Use continuation pages as needed* to provide the required information in the format shown below. Start with Program Director(s)/Principal Investigator(s). List all other senior/key personnel in alphabetical order, last name first.

Name	eRA Commons User Name	Organization	Role on Project
Peter Daszak	daszak	Wildlife Trust	PI

OTHER SIGNIFICANT CONTRIBUTORS

Name	Organization	Role on Project

Human Embryonic Stem Cells ☒ **No** ☐ **Yes**

If the proposed project involves human embryonic stem cells, list below the registration number of the specific cell line(s) from the following list: http://stemcells.nih.gov/research/registry/. *Use continuation pages as needed.*

If a specific line cannot be referenced at this time, include a statement that one from the Registry will be used.

Cell Line

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

DETAILED BUDGET FOR INITIAL BUDGET PERIOD
DIRECT COSTS ONLY

FROM 09/01/2009 THROUGH 08/31/2010

PERSONNEL (Applicant organization only)		Months Devoted to Project				DOLLAR AMOUNT REQUESTED (omit cents)		
NAME	ROLE ON PROJECT	Cal. Mnths	Acad. Mnths	Summer Mnths	INST.BASE SALARY	SALARY REQUESTED	FRINGE BENEFITS	TOTAL
Peter Daszak	PD/PI							(b) (4), (b) (6)
Kevin Olival	PostDoc							
SUBTOTALS →								(b) (4), (b) (6)

CONSULTANT COSTS	
EQUIPMENT *(Itemize)*	
SUPPLIES *(Itemize by category)* Lab & Field Supplies - Reagents, Shipping, Storage, & Lab Analysis (Sequencing)	6,300
TRAVEL Airfare & Transporation to Bangladesh	4,800
PATIENT CARE COSTS — INPATIENT	
PATIENT CARE COSTS — OUTPATIENT	
ALTERATIONS AND RENOVATIONS *(Itemize by category)*	
OTHER EXPENSES *(Itemize by category)*	

CONSORTIUM/CONTRACTUAL COSTS	DIRECT COSTS	
SUBTOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD *(Item 7a, Face Page)*		$ 79,795
CONSORTIUM/CONTRACTUAL COSTS	FACILITIES AND ADMINISTRATIVE COSTS	22,422
TOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD		$ 102,217

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

DETAILED BUDGET FOR INITIAL BUDGET PERIOD
DIRECT COSTS ONLY

FROM 09/01/2009 THROUGH 08/31/2010

PERSONNEL (Applicant organization only)		Months Devoted to Project				DOLLAR AMOUNT REQUESTED (omit cents)		
NAME	ROLE ON PROJECT	Cal. Mnths	Acad. Mnths	Summer Mnths	INST.BASE SALARY	SALARY REQUESTED	FRINGE BENEFITS	TOTAL
Peter Daszak	PD/PI							(b) (4), (b) (6)
Kevin Olival	PostDoc							
SUBTOTALS →								(b) (4), (b) (6)

CONSULTANT COSTS	
EQUIPMENT *(Itemize)*	
SUPPLIES *(Itemize by category)* Lab & Field Supplies - Reagents, Shipping, Storage, & Lab Analysis (Sequencing)	3,750
TRAVEL Airfare & Transporation to Bangladesh	4,800
PATIENT CARE COSTS — INPATIENT	
PATIENT CARE COSTS — OUTPATIENT	
ALTERATIONS AND RENOVATIONS *(Itemize by category)*	
OTHER EXPENSES *(Itemize by category)*	
CONSORTIUM/CONTRACTUAL COSTS — DIRECT COSTS	
SUBTOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD *(Item 7a, Face Page)*	$ 79,993
CONSORTIUM/CONTRACTUAL COSTS — FACILITIES AND ADMINISTRATIVE COSTS	22,478
TOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD	$ 102,471

BUDGET FOR ENTIRE PROPOSED PROJECT PERIOD
DIRECT COSTS ONLY

BUDGET CATEGORY TOTALS	INITIAL BUDGET PERIOD (from Form Page 4)	ADDITIONAL YEARS OF SUPPORT REQUESTED 2nd	3rd	4th	5th
PERSONNEL: *Salary and fringe benefits. Applicant organization only.*		(b) (4), (b) (6)			
CONSULTANT COSTS					
EQUIPMENT					
SUPPLIES	6,300	3,750			
TRAVEL	4,800	4,800			
PATIENT CARE COSTS — INPATIENT					
PATIENT CARE COSTS — OUTPATIENT					
ALTERATIONS AND RENOVATIONS					
OTHER EXPENSES					
CONSORTIUM/ CONTRACTUAL COSTS — DIRECT					
SUBTOTAL DIRECT COSTS *(Sum = Item 8a, Face Page)*	79,795	79,993			
CONSORTIUM/ CONTRACTUAL COSTS — F&A	22,422	22,478			
TOTAL DIRECT COSTS	102,217	102,471			

TOTAL DIRECT COSTS FOR ENTIRE PROPOSED PROJECT PERIOD $ 204,688

JUSTIFICATION. Follow the budget justification instructions exactly. Use continuation pages as needed.

Personnel

This ARRA supplemental award is for two years of salary, travel expenses, and laboratory and field supplies for a U.S. Global Health Postdoctoral Scientist, Dr. Kevin J. Olival. Budget includes a (b) (4), (b) (6) (b) (4), (b) (6)

Travel

$4,800 is requested in each of two years for travel to Bangladesh to collect bat and fruit samples and conduct ELISA assays for NiV at ICDDR,B. This includes three 6-week sampling trips in Year 1, and two 9-week sampling trips in Year 2. We have calculated the international costs for each trip based on an economy airfare from NYC to Dhaka at ($1,000) and $150 per week lodging and food, and $50 per week internal travel costs.

(continued)

Budget Justification (ctd.)

Lab and Field Supplies

Year 1 budget ($6,300) includes microsatellite genotyping and mtDNA sequencing reagents, as well as reagents for RT-PCR of NiV samples at Columbia University. Additional materials will also be supplied by supporting laboratories, AMNH and CU (see letters of support). In Year 2, laboratory and field supplies are estimated at $3,750, as costs will be lower with fewer field and lab expenses.

Indirect costs

Indirect costs on total direct costs are requested at our Federally-audited rate of 28.1%.

CDA TOC Substitute Page Candidate (Last, first, middle):

Use this Table of Contents for Research Career Development Awards. Include candidate's name on each page.

RESEARCH CAREER DEVELOPMENT AWARD TABLE OF CONTENTS (Substitute Page)

Page Numbers

Note: Font and margin requirements must conform to limits provided in the Specific Instructions.

*Include these items only when applicable.

CITIZENSHIP

☒ U.S. citizen or non-citizen national

☐ Permanent resident of U.S. (If a permanent resident of the U.S., a notarized statement must be provided by the time of award.)

☐ Non-citizen with temporary visa (Applicable for only the K99 program)

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and other significant contributors in the order listed on Form Page 2.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME	POSITION TITLE
Kevin James Olival	Post-doctoral Researcher
eRA COMMONS USER NAME (credential, e.g., agency login)	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Colorado State University	B.S.	1997	Bio-agricultural Sciences
Columbia University	M.A.	2003	Conservation Biology
Columbia University	Ph.D.	2008	Evolutionary Biology
American Museum of Natural History	Postdoc	2009	Host-pathogen evolution

A. Positions and Honors

Positions and Employment

1999-2002 Research Associate, Kewalo Marine Lab, University of Hawaii, HI
2002- Research Collaborator, Consortium for Conservation Medicine, NY
2003 Lecturer in Disease Ecology, Columbia University Continuing Education, NY
2003-2008 Doctoral Student, Columbia University, NY
2006-2008 Instructor, Columbia University Secondary School Summer Program, NY
2008- Post-doctoral Researcher, Sackler Institute for Comparative Genomics, American Museum of Natural History, NY

Other Experience and Professional Memberships

1998-2000 Member, American Association for the Advancement of Science
2001-2006 Member, Society for Conservation Biology
2002-2007 Emerging disease guest researcher, Veterinary Research Institute, Malaysia
2002-2008 Emerging disease guest researcher, Wildlife Conservation Society, Cambodia and Malaysia
2003-2005 Member, American Society of Mammalogists
2003- Member, Henipavirus Ecology Research Group
2004 Abstract Review Committees, Society for Conservation Biology Annual Meeting, New York,
2005 Wildlife field research collaborator, Institute for Ecology and Biological Resources, Vietnam
2005 Wildlife genetics/disease research collaborator, Pasteur Institute, Cambodia
2005- Member, Bat Conservation International
2005- Member, New York Academy of Sciences
2008- Grant Referee, Research Fellowship Program Wildlife Conservation Society
2008- Grant Referee, Fauna and Flora International, Rufford Innovation Awards
2005 Judge, New York Science and Engineering Fair, NYAS
2006-2007 Research Mentor, Conservation Genetics Program, AMNH, New York
2007 Symposium Organizer, Bat Hunting and Bushmeat Symposium, Phuket, Thailand
2007 Steering and Poster Selection Committees, Small Matters: Microbes and Their Role in Conservation, AMNH Spring Symposium, New York, April 2007.
2009 Organizational Committee, Bat Migration and Disease Symposium, Berlin, Germany
2009 Abstract Review Committee, “Exploring the Dynamic Relationship Between Health and the Environment”, AMNH Spring Symposium, New York

Honors

1993-1997 Colorado State, Distinguished Scholar Award
1993-1997 Colorado State, Academic Grant

1993-1995	Charles N. Shepardson Memorial Scholarship
1993-1995	Delano F. Scott Scholarship in Agriculture
2002-2008	Columbia University Faculty Fellow
2003	Honorable mention, NSF Graduate Research Fellowship
2003	Article on research - front page of The Wall Street Journal, 19 June.
2004-2007	Environmental Protection Agency, STAR Fellowship Award
2005	Research highlighted in The Economist, 17 November.
2008	Graduated with Distinction, PhD, Columbia University

B. Peer-Reviewed publications (in chronological order)

1. Hadfield, MG, BS Holland, and **KJ Olival**. (2004) Contributions of *ex situ* propagation and molecular genetics to conservation of Hawaiian tree snails. In: Experimental approaches to conservation biology, M.S. Gordon and S.M. Bartol, Editors. University of California Press: Berkeley. pp. 16-34.

2. **Olival, KJ** and P Daszak. (2005) The ecology of emerging neurotropic viruses. Journal of NeuroVirology 11: 440-445.

3. Pulliam, JRC, H Field, **KJ Olival**, and H.E.R.G. (2005) An alternative explanation of Nipah virus strain variation. Emerging Infectious Diseases 11(12): 1978-1979.

4. **Olival, KJ** and H Higuchi. (2006) Monitoring the long-distance movement of wildlife in Asia using satellite telemetry. In: Conservation Biology in Asia, J McNeely, et al., editors. Society for Conservation Biology Asia Section and Resources Himalaya Foundation: Kathmandu, Nepal. pp. 319-339.

5. Daszak, P, R Plowright, JH Epstein, JH Pulliam, SA Rahman, HE Field, CS Smith, **KJ Olival**, S Luby, K Halpin, AD Hyatt, and H.E.R.G. (2006) The emergence of Nipah and Hendra virus: pathogen dynamics across a wildlife-livestock-human continuum. In: Disease Ecology: Community structure and pathogen dynamics, S. Collinge and C. Ray, Editors. Oxford University Press: Oxford. pp. 188-203.

6. **Olival, KJ**, EO Stiner, and SL Perkins. (2007) Detection of *Hepatocystis sp.* in Southeast Asian Flying Foxes (Pteropodidae) using Microscopic and Molecular Methods. Journal of Parasitology 93(6): 1538-1540.

7. Murdock, C, **KJ Olival**, and SL Perkins. Feeding preference of snow-melt mosquitoes (Culicidae: *Culiseta* and *Ochelerotatus*) show a link between cervid amplifying hosts for Jamestown Canyon Virus (Bunyaviridae: *Orthobunyavirus*) and humans. *In Review* Journal of Vector-Borne and Zoonotic Disease

8. Epstein, JH, **KJ Olival**, JRC Pulliam, CS Smith, J Westrum, T Hughes, A Dobson, A Zubaid, SA Rahman, MM Basir, H Field, and P Daszak. Management of *Pteropus vampyrus,* a hunted migratory species with a multinational home-range. *In Review* Journal of Applied Ecology

9. Turmelle, A and **KJ Olival**. Impacts of host colony size and population structure on viral diversity in bats (Order Chiroptera). *In Review* EcoHealth

10. Smith, CS, JH Epstein, HE Field, R Plowright, A Breed, **KJ Olival**, and P Daszak. Tracking fruit bats with satellite telemetry. *Submitted to* Journal of Mammalogy

11. **Olival, KJ**. Correlates and evolutionary consequences of population genetic structure in bats. Invited book chapter in: Evolutionary History of Bats: Fossils, Molecules, and Morphology, G.F. Gunnell and N. Simmons, Editors. *Submitted*

C. Research Support

ONGOING RESEARCH SUPPORT

Perkins and Simmons (PIs) June 2008 – June 2009
American Museum of Natural History
Molecular evolution of non-human malaria parasites and bat hosts
Role: Postdoc

COMPLETED RESEARCH SUPPORT (during last 3 years)

Olival (PI)
US Environmental Protection Agency 2004-2007
STAR Fellowship Award FP-91638101-0
Support for dissertation research for 3 years. “Population genetic study of flying-foxes to elucidate relationship between anthropogenic ecological change and infectious disease emergence”

Olival (PI) 2005-2007
Bat Conservation International
Student Research Grants
Support for dissertation research including: fieldwork capturing fruit bats and collecting tissue samples in Southeast Asia, and consumables for molecular genetic research

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and other significant contributors in the order listed on Form Page 2.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME	POSITION TITLE
Peter Daszak	Executive Director, Consortium for Conservation Medicine, Wildlife Trust
eRA COMMONS USER NAME daszak	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Bangor University (UK)	BSc. (hons)	1986	Zoology
University of East London (UK)	Ph.D	1994	Infectious Diseases

A. Positions and Honors

Positions and Employment

1989-2 Research Assistant, University of East London
1993-8 Senior Faculty Research Scientist, Kingston University
1998 Guest Researcher, Centers for Disease Control and Prevention (CDC)
1999-2001 Faculty Research Scientist, University of Georgia
2001- Adjunct Faculty, Tufts Univ. Sch. Veterinary Med.; Univ. Georgia; Columbia Univ.
2001- Executive Director, Consortium for Conservation Medicine
2007- Honorary Co-Director, Joint Institute for Wildlife & Zoonoses, ECNU, Shanghai, China
2009- President, Wildlife Trust, New York.

Other Experience and Professional Membership

Keynote speaker Merieux Foundation Conference on Emerging paramyxoviruses, France (2000); UN Millenium Ecosystem Assessment: Lead Author, human infectious diseases (2006); NIH: ad hoc member, ZRG1 IDM-G 90 study section: Virology, Biodefense & Emerg. Diseases (2003-5); Editorial Board, Conservation Biology (Blackwell); Founding Co-Editor *EcoHealth* (Springer) (2004-); NAS – Committee Member, Future Needs in Veterinary Research (2004-5); DIVERSITAS (UNESCO-ICSU): Member of Scientific Committee (2004-; Treasurer 2007-); NIAID: Steering Committee, workshop on virus-host shifts & emergence of new pathogens (2005); Australian Biosecurity Cooperative Research Center: International Standing Advisory Committee (2005-); NIH: ad hoc member, ZRG1 IRAP-Q study section (infectious diseases, epidemiology) (2005-7); International EcoHealth Association: Founding board of directors, Treasurer (2006-); CDC: ad hoc member, ZCD1 SGI, 09PAR07-231, R36 Research Dissertation Awards (2007-); European CDC: Keynote speaker, future infectious disease threats (2008-); Asian Disaster Preparedness Center (ADPC), Bangkok: Member of reference group (2008-); NAS – IOM: Committee Member, Global capacity for EID surveillance (2008-9); Scientific Advisory Board, NIAID Center of Excellence, avian influenza (CRISAR), UCLA (2008-); NIAID: Steering Committee, workshop on viruses from bats (2009).

Honors

Meritorious service award, Centers for Disease Control and Prevention (CDC) (1999); CSIRO silver medal for collaborative research (2000); Honored by the naming of a new species of centipede, *Cryptops daszaki* (J Nat Hist 2002; 36: 76-106) (2002); *Science* paper cited by ISI as a "fast-breaking paper" (2002); CBS 60 Minutes documentary on Nipah virus research (aired twice); 6th Annual Lecturer, Medicine & Humanities, Texas A&M (2003); *PLOS Biology* paper cited as "editor's choice", *Science* 311: 1675 (2006); Zayed International Prize for the

Environment (2nd) –for MEA (2006); Finalist, Director's Pioneer Award (2007); Discovery Channel documentary on Nipah virus research, Bangladesh (2008); Presidential Lecturer, University of Montana (2008)

B. Peer-reviewed publications (selected from over 120); * = Corresponding author

1. Ekbom A, **Daszak P**, Kraaz W & Wakefield AJ. Crohn's disease after *in utero* measles virus exposure. *Lancet* 1996; 348: 515-517.
2. Berger L, Speare R, **Daszak P**, et al. Chytridiomycosis causes amphibian population declines in the rain forests of Australia and Central America. *PNAS* 1998; 95: 9031-9036.
3. **Daszak P**, Berger L, Cunningham AA, Hyatt AD, Green DE & Speare R Emerging infectious diseases & amphibian population declines. *Emerging Infectious Diseases* 1999; 5: 735-748.
4. **Daszak P**, Cunningham AA & Hyatt AD Emerging infectious diseases of wildlife - threats to biodiversity and human health. *Science* 2000; 287: 443-449
5. **Daszak P**, Cunningham AA & Hyatt AD Anthropogenic environmental change and the emergence of infectious diseases in wildlife. *Acta Tropica* 2001; 78:103-116.
6. Mazzoni R, Cunningham AA, **Daszak P** et al. Emerging pathogen in frogs (*Rana catesbeiana*) farmed for international trade. *Emerging Infectious Diseases* 2003; 9: 995-998
7. Goldsmith CS, Whistler T, Rollin PE, Ksiazek TG, Rota PA, Bellini WJ, **Daszak P**, Wong KT, Shieh W-J & Zaki SR Elucidation of Nipah virus morphogenesis and replication using ultrastructural and molecular approaches. *Virus Research* 2003; 92: 89-98
8. Field HE, Mackenzie J & **Daszak P** Novel viral encephalitides associated with bats (Chiroptera) – host management strategies. *Archives of Virology* 2004; S18: 113-121.
9. Anderson PK, Cunningham AA, Patel NG, Morales FJ, Epstein PR & **Daszak P**. Emerging infectious diseases of plants. *Trends in Ecology and Evolution* 2004; 19: 535-544.
10. Li W, Shi Z, Yu M, Ren W, Smith C, Epstein JH, Wang H, Crameri G, Hu Z, Zhang H, Zhang J, McEachern J, Field H, **Daszak P**, Eaton BT, Zhang S & Wang L-F Bats are natural reservoirs of SARS-like coronaviruses. *Science* 2005; 310: 676-679.
11. Olival KJ & **Daszak P** The ecology of emerging neurotropic viruses *J. Neurovirology* 2005; 11: 441-446
12. Kilpatrick AM, Kramer LD, Campbell S, Alleyne EO, Dobson AP & **Daszak P** West Nile virus risk and the bridge vector paradigm. *Emerging Infectious Diseases* 2005; 11: 425-429.
13. Wolfe ND, **Daszak P**, Kilpatrick AM & Burke DS. Bushmeat hunting, deforestation and prediction of zoonotic disease emergence. *Emerging Infectious Diseases* 2005; 11: 1822-1827.
14. Pulliam J, Field H, Olival KJ & the Henipavirus Ecology Research Group (**Daszak P.**). An alternative explanation of Nipah virus strain variation. *Emerging Infectious Diseases* 2005; 11: 1978-1979
15. Epstein JH, Rahman SA, Halpin K, Meehan G, Jamaluddin AA, Hassan SS, Field HE, Hyatt AD, **Daszak P** Feral cats (*Felis catus*) and risk for Nipah virus. *Emerging Infectious Diseases* 2006;12: 1178-1179.
16. Kilpatrick AM, **Daszak P**, Jones MJ, Marra PP & Kramer LD Host heterogeneity dominates West Nile virus transmission. *Proceedings of the Royal Society: Biological Sciences* 2006; 273: 2327-2333.
17. Epstein JH, Field HE, Luby S, Pulliam JRC & **Daszak P.** Nipah Virus: Impact, Origins and Causes of Emergence. *Current Infectious Disease Reports* 2006; 8: 59-65
18. **Daszak P** *et al*. The emergence of Nipah and Hendra virus: pathogen dynamics across a wildlife-livestock-human continuum. In: Collinge S & Ray S, Eds. *Disease Ecology* OUP 2006; 186-201
19. Kilpatrick AM, Kramer LD, Jones MJ, Marra PP & **Daszak P** West Nile virus epidemics in North America are driven by shifts in mosquito feeding behavior. *PLoS Biology* 2006; 4: 606-610.
20. Mendelson JR, Lips KR, Gagliardo RW, Rabb GB, Collins JP, Diffendorfer JE, **Daszak P** *et al.* Policy Forum: Confronting amphibian declines and extinctions. *Science* 2006; 313: 48.
21. Wang L-F, Shi Z, Zhang S, Field H, **Daszak P** & Eaton BT. A review of bats and SARS: virus origin and genetic diversity. *Emerging Infectious Diseases* 2006; 12: 1834-1840.
22. Kilpatrick AM, Chmura AA, Gibbons DW, Fleischer RC, Marra PP & **Daszak P**. Predicting the global spread of H5N1 avian influenza. *PNAS* 2006;103: 19368-19373.
23. Rodríguez JP, Taber AB, **Daszak P**. et al. Policy Forum: The globalization of conservation: A view from the South. *Science*; 317: 755-756.

24. Field HE, Mackenzie J & **Daszak P** Henipaviruses: Emerging paramyxoviruses associated with fruit bats. *Current Topics Microbiol. Immunol.* 2007; 315: 133-159.
25. Cui J, Han N, Streicker D, Li G, Tang X, Shi Z, Hu Z, Zhao G, Fontanet A, Yi G, Wang L, Jones G, .Field HE, **Daszak P* (Corresponding Author)** & Zhang, S. Evolutionary relationships between bat coronaviruses and their hosts. *Emerging Infectious Diseases* 2007;13: 1526-1533
26. Kilpatrick AM, Kramer LD, Jones MJ, Marra PP, **Daszak P**, Fonseca DM. Genetic influences on mosquito feeding behavior & the emergence of zoonotic pathogens. *Am. J. Trop. Med. Hyg.* 2007;77:667-71
27. Gomez A, Kilpatrick AM, Kramer LD, Dupuis AP, Jones MJ, Goetz S, Marra PP, **Daszak P**, Aguirre AA Land use and West Nile virus seroprevalence in wild mammals. *Emerging Infectious Diseases* 2008;14:962-965
28. Jones KE, Patel NG, Levy MA, Storeygard A, Balk D, Gittleman JL, and **Daszak P* (Corresponding Author)**. Global trends in emerging infectious diseases. *Nature* 2008;451:990-993
29. Wyatt KB, Campos PF, Gilbert MTP, Kolokotronis SO, Hynes WH, Ball SJ, DeSalle R, **Daszak P**, MacPhee RDE, Greenwood AD. Historical mammal extinction on Christmas Island (Indian Ocean) correlates with introduced infectious disease. *PLoS One* 2008; 3: e3602.
30. Smith KF, Behrens M, Schloegel LM, Marano N, Burgiel S & **Daszak P* (Corresponding Author)**. Reducng the risks of the wildlife trade. *Science* 2009;324:594-595.
31. Pulliam JR, Epstein JH, Dushoff J, Rahman SA, Meehan G, Bunning M, HERG, Jamaluddin AA, Hyatt AD, Field HE, Dobson AP & **Daszak P* (Corresponding Author)**. Agricultural intensification, epidemic enhancement and the emergence of new lethal zoonoses from wildlife. *Nature* in review.

C. Research Support

ONGOING RESEARCH SUPPORT

2 R01TW005869 Daszak (PI) 09/01/08 – 08/31/13
NIH Ecology of Infectious Diseases (Fogarty International Center)
The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh
To conduct mathematical modeling and fieldwork to understand the dynamics of Nipah virus in Bangladesh
Role: PI $2,501,550

1 R01AI079231 Daszak (PI) 09/18/08 – 08/31/13
NIAID Non-Biodefense Emerging Infectious Diseases
Risk of viral emergence from bats.
This project is to model hotspots for viral diversity and emergence in bats, to identify new viruses from bats, and to examine the pathogenicity and infectiousness for these novel pathogens.
Role: PI $2,687,394

N01 AI-25490 Kramer (PI) 10/01/02 - 10/01/09
NIH/NIAID
West Nile & pox viruses: ecology, pathogenesis & immunity
This subcontract provides partial salary for a postdoc to conduct field studies, mathematical modeling and analysis of the ecology of West Nile virus in the USA.
Role: PI on a subcontract $875,770 subcontract

NSF EF-062239 Kilpatrick (PI) 09/01/06 - 08/30/11
National Science Foundation/National Institutes of Health: Ecology of Infectious Diseases program
Predicting spatial variation in West Nile virus transmission
This project is to assess the interaction between vector populations, reservoir host populations and West Nile virus across an urban-to-rural human density gradient in the northeastern USA.
Role: Co-PI $2,263,168

NSF 860196696 Charles Perrings (PI) 02/01/07 – 01/31/10
NSF Research Coordination Network (RCN)
Biodiversity and Ecosystem Services Training Network (BESTNet)
To provide interdisciplinary research and training among ecologists and health scientists.
Role: Co-PI

3R01TW005869-05S1 Daszak (PI) 09/01/08 – 08/31/09
NIH EID (Fogarty Interntional Center)
Supplemental funding: Predicting the risk of global H5N1 spread
This project will involve mathematical modeling and fieldwork in China to understand risk of H5N1 spread.
Role: PI $150,000

3R01TW005869-05S2 Daszak (PI) 09/01/08 – 08/31/09
NIH EID (Fogarty International Center)
Supplemental funding: Avian Influenza Data Sharing
To organize an international workshop on data sharing for avian influenza research
Role: PI $45,000

NSF – BCS 0826779 Daszak (PI)
NSF Human and Social Dynamics 10/01/08 – 03/31/12
AOC - HSD – Collaborative Research: Human-related factors affecting emerging infectious diseases
This work involves modeling, analyzing and predicting emerging diseases distributions and their correlation with socio-economic and environmental drivers.
Role: PI on lead proposal $700,000

NIH/NIGMS - DPI0D000370 (Wolfe, PI) 07/01/06 – 07/31/09
NIH Director's Pioneer Award
Zoonotic Emergence Network (ZEN) Malaysia
This study will survey wildlife hunters and restaurant workers - individuals at high risk to exposure of wild animal pathogens through the bushmeat trade, for exposure to zoonotic and novel pathogens.
Role: PI on subcontract $600,000 subcontract

Google.org Daszak (PI) 07/01/08 – 06/30/10
Viral Discovery in Bangladesh
This work involves collection of wildlife samples and laboratory analysis for viral discovery and characterization
Role: PI on subcontract $400,000 subcontract

Rockefeller Foundation Daszak (PI) 09/01/08 – 08/31/09
Viral Discovery in Bangladesh and India
Collection of wildlife trade/domestic animal samples for viral discovery and characterization
Role: PI $349,910

PENDING

U54 Naumova (PI) Pending
NIH MIDAS
Causality of Seasonality: Human, Animal & Environmental Drivers of Infections
The major goal of this research is to analyze large datasets and model seasonality in infectious diseases
Role: CoPI - PI on a subcontract $631,605 subcontract

NSF/NIH EID Perrings (PI) Pending
NSF/NIH Ecology of Infectious Diseases
Predicting the Disease-Risks of International Commerce and Trade (PreDICT). To examine patterns of disease spread through trade, to develop predictive mathematical models on disease spread and economic impact.
Role: PI on a collaborative grant (ASU lead grant). $672,177 subcontract

NIAID Daszak (PI) Pending
ARRA Administrative Supplement NOT OD-09-056
Risk of viral emergence from bats
To hire a postdoctoral scientist who will estimate viral diversity in bats, accelerate discovery of new pathogens and analyze their co-evolutionary relationships with hosts
Role: PI $234,274

NIH Fogarty International Center — Pending
ARRA Challenge Grant 15-TW-101. Models to predict health effects of climate change.
To
Role: PI — $999,999

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and other significant contributors in the order listed on Form Page 2.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME	POSITION TITLE
Stephen P. Luby, MD	Head, Programme on Infectious Diseases and Vaccine Sciences
eRA COMMONS USER NAME SPLUBY	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Creighton University, Omaha, NE	B.A.	1981	Philosophy
University of Texas, Southwestern Medical School, Dallas, TX	M.D.	1986	Medicine
University of Rochester—Strong Memorial Hospital, Rochester, NY	Residency	1986-1989	Internal Medicine
Centers for Disease Control and Prevention, Atlanta, GA	Fellowship	1990-1992	Epidemiology
Centers for Disease Control and Prevention, Atlanta, GA	Fellowship	1991-1993	Preventive Medicine

A. Positions and Honors

Positions

- 1981-1982: Computer programmer, Pulmonary laboratory, Hartford Hospital, Hartford, CT
- 1986-1989: Internal medicine resident, Strong Memorial Hospital, Rochester, NY
- 1989-1990: Attending physician, Emergency Division, The Genesee Hospital, Rochester, NY
- 1990-1992: Epidemic Intelligence Service Officer, South Carolina Department of Health, Columbia, SC
- 1992-1993: Preventive medicine resident, Malaria Branch, Centers for Disease Control and Prevention
- 1993-1998: Assistant professor, epidemiology, Aga Khan University, Karachi, Pakistan
- 1998-2004: Medical epidemiologist, Foodborne and Diarrheal Diseases Branch, Centers for Disease Control and Prevention, Atlanta, GA
- 2004 –present: Head, Programme on Infectious Disease and Vaccine Sciences, ICDDRB, Centre for Health and Population Research, Dhaka, Bangladesh

Honors

- Outstanding Teaching Award, Aga Khan University, Karachi, Pakistan (1996)
- HIV/AIDS Prevention Shield, Sindh, Pakistan, Government of Sindh, (2001).
- Senior author on Alexander D. Langmuir Prize winning manuscript for most outstanding manuscript submitted by an Epidemic Intelligence Service Officer, Center for Disease Control, (2001).
- Senior author on Manuscript awarded the Nakano Citation for an outstanding scientific paper published in 2003, National Centers for Infectious Diseases, Centers for Disease Control (2004).
- First author on Nakano Award Manuscript, National Centers for Infectious Diseases, Centers for Disease Control, 2005
- Favourite paper in infectious diseases, 2005. Lancet Infectious Diseases, December 2005
- First author on Nakano Award Manuscript, National Centers for Infectious Diseases, Centers for Disease Control, 2006
- Shepard Award, (Centers for Disease Control and Prevention, Best Paper in the Prevention and Control Category 2006, First author)
- Senior author on Nakano Award Manuscript, Collaborative Centers for Infectious Diseases, Centers for Disease Control, 2007

B. **Peer-reviewed publications (selected from 126)**

1. **Luby S**, Jones J, Horan J. A large salmonellosis outbreak associated with a frequently penalized restaurant. *Epidemiology and Infection*, 1993; 110:31-39.
2. **Luby S**, Jones J, Dowda H, et. al. A large outbreak of gastroenteritis caused by diarrheal toxin producing *Bacillus cereus*. *Journal of Infectious Diseases*. June 1993, 167:1452-1455.
3. **Luby S**, Jones J. An outbreak of Salmonella enteritidis from locally produced Grade A eggs, South Carolina. Southern Medical Journal. December 1993, 86(12):1350-1353.
4. **Luby S**, Jones J, Horan J. Using CD4 counts to evaluate the stages and epidemiology of HIV infection in South Carolina public clinic patients. American Journal of Public Health. March 1994, 84(3):377-381.
5. **Luby S**, Kazembe P, Redd S, Ziba C, Nwanyanwu O, Hightower A, Franco C, Chitsulo L, Wirima J, Olivar M. Clinical signs for the diagnosis of anemia in African children, Bulletin of the World Health Organization. 1995 73:477-482.
6. Redd S, Kazembe P, **Luby S**, Nwanyanwu O, Hightower A, Ziba C, Franco C, Olivar M. Clinical algorithm for the treatment of *Plasmodium falciparum* malaria in children. *Lancet*. 1996 347:223-227.
7. **Luby S**, Qamruddin C, Shah A, Omair A, Pasha O, Khan AJ, Hoodbhoy F, McCormick J, Fisher-Hoch S. The relationship between therapeutic injections and high prevalence of hepatitis C infection in Hafizabad, Pakistan. *Epidemiology and Infection*. 1997, 119:349-356.
8. Siddiqui R, **Luby S**. Discitis following surgery for prolapsed intervertebral discs at a hospital in Pakistan. *Infection Control and Hospital Epidemiology*. 1998, 19(7):526-529.
9. Paul R, Patel A, Mirza S, Fisher-Hoch S, **Luby S**. Expansion of epidemic dengue viral infections to Pakistan. *International Journal of Infectious Diseases* 1998, 2(4):197-201.
10. Altaf A, **Luby S**, Ahmed AJ, Zaidi NA, Khan AJ, Mirza S, McCormick J, Fisher-Hoch S. Outbreak of Crimean-Congo haemorrhagic fever in Quetta, Pakistan: Contact tracing and risk assessment. *Tropical Medicine and International Health*. 1998, (11):878-82.
11. Pasha O, **Luby S**, Khan AJ, Shah A, McCormick J, Fisher-Hoch S. Household members of hepatitis C virus infected people in Hafizabad, Pakistan: Infection by injections from health care providers. Epidemiology and Infection. 1999 Dec; 123(2): 515-518
12. Khan AJ, **Luby SP**, Fikree FF, Karim A, Obaid S, Dellawala S, Mirza S, Malik T, Fisher-Hoch S, McCormick JB. Injections and Hepatitis B and C transmission in Peri-Urban Karachi, Pakistan. *Bulletin of the World Health Organization*. 2000; 78(8):956-963.
13. **Luby S**, Agboatwalla M, Raza A, Sobel J, Mintz ED, Baier K, Hoekstra RM, Rahbar MH, Hassan R, Qureshi SM, Gangarosa EJ. Microbiologic effectiveness of hand washing with soap in an urban squatter settlement, Karachi, Pakistan. Epidemiology and Infection. 2001 Oct;127(2):237-44.
14. Brooks JT, Rowe SY, Shillam P, Heltzel DM, Kamm K, Hannah EL, Hunter SB, Puhr ND, Slutsker L, Hoekstra, RM, **Luby SP**. *Salmonella* Typhimurium infections transmitted by chlorine-pretreated clover sprout seeds. *American Journal of Epidemiology*. 2001 154(11):1020-8.
15. Dunne EF, Angoran-Biene YH, Kamelan-Tano Y, Sibailly T, Monga B, Kouadio L, Roels TH, Wiktor SZ, Lackritz EM, Mintz ED, **Luby S**. Is Drinking Water in Abidjan, Côte d'Ivoire, Safe for Infant Formula? *Journal of the Acquired Immune Deficiency Syndromes*. 2001 Dec; 28(4):393-8.
16. Quddus A, **Luby S**, Rahbar, Pervaiz Y. Neonatal tetanus: mortality rate and risk factors in Loralai District, Pakistan. Int J Epidemiol. 2002 Jun;31(3):648-653.
17. Olsen SJ, Blastula SC, Magnano AR, Landrigan C, Holland BH, Tauxe RV, Mintz ED, **Luby S**. Outbreaks of typhoid fever in the United States, 1960-1999. *Epidemiol Infect*. 2003;130:13-21.
18. Mujeeb SA, Malik MA, Altaf A, Shah SA, **Luby S**. Infection control practices in clinical laboratories in Pakistan. Infection Control and Hospital Epidemiology. February 2003; 24(2):141-2.
19. Mujeeb SA, Malik MA, Altaf A, Hutin Y, **Luby S**. Recycling of injection equipment in Pakistan. Infection Control and Hospital Epidemiology. 2003 Feb; 24(2):145-6.
20. Usman HR, Akhtar S, Rahbar MH, Hamid S, Moatter T, **Luby SP**. Injections in health care settings: a risk factor for acute hepatitis B virus infection, Karachi, Pakistan. Epidemiology and Infection. 2003 Apr;130(2):293-300.
21. Hutin Y, **Luby S,** Paquet C. A large cholera outbreak in Kano City, Nigeria: The importance of hand washing with soap and the danger of street vended water. *J Water Health*. March 2003; 1:45-52.

22. **Luby SP**, Agboatwalla M, Painter J, Altaf A, Billhimer W, Hoekstra RM. Effect of Intensive Handwashing Promotion on Childhood Diarrhea in High-Risk Communities in Pakistan: A Randomized Controlled Trial. *JAMA*. 2004 June 2, 291(21): 2547-2554.
23. Parviz S, Chotani R, McCormick J, Fisher-Hoch S, **Luby S**. Rabies deaths in Karachi, Pakistan: fruits of ineffective post-exposure treatment. *Int J Infect Dis.* 2004 Nov;8(6):346-352.
24. **Luby S**, Hoodbhoy F, Jan A, Shah A, Hutin Y. Long term improvement in unsafe injection practices following community intervention. International Journal of Infectious Diseases. 2005 Jan;9(1):52-59.
25. Crump JA, Otieno PO, Slutsker L, Keswick BH, Rosen DH, Hoekstra RM, Vulule JM, **Luby SP**. Household based treatment of drinking water with flocculant-disinfectant for preventing diarrhoea in areas with turbid source water in rural western Kenya: cluster randomised controlled trial. BMJ, 2005 Sep 3; 331:478-483.
26. **Luby SP**, Agboatwalla M, Feikin DR, Painter J, Billhimer W, Altaf A, Hoekstra RM. Effect of handwashing on child health: a randomised controlled trial. Lancet. July 15, 2005; 366:225-33.
27. Epstein JH, Field HE, **Luby S**, Pulliam JRC, Daszak P. Nipah virus: Impact, origins and causes of emergence. Current Infectious Disease Reports, 2006; 8:52-58.
28. Daszak, P, Plowright R, Epstein JH, Pulliam J, Abdul Rahman S, Field HE, Smith CS, Olival KJ, **Luby S**, Halpin K, Hyatt AD, & (HERG). The emergence of Nipah and Hendra virus: pathogen dynamics across a wildlife-livestock-human continuum. In: Collinge S, Ray S, editors. Disease Ecology: Community structure and pathogen dynamics. Oxford Univeristy Press; 2005,247-63.
29. **Luby SP**, Rahman M, Hossain MJ, Blum LS, Husain NM, Gurley E, Khan R, Ahmed B, Rahmin S, Nahar N, Kenah E, Comer JA, Ksiazek TG. Foodborne Transmission of Nipah Virus, Bangladesh. *Emerging Infectious Diseases*. 2006 Dec 12(12):1888-1894.
30. Ram PK, Naheed A, Brooks WA, Hossain MA, Mintz ED, Breiman RF, **Luby SP**. Risk factors for typhoid fever in a densely populated slum in Dhaka, Bangladesh. Epidemiology and Infection. 2007 135:458-65.
31. Bowen A, Huilai M, Ou J, Billhimer W, Long T, Mintz E, Hoekstra RM, **Luby S**. A Cluster-Randomized Controlled Trial Evaluating the Effect of a Handwashing Promotion Program in Chinese Primary Schools, American Journal of Tropical Medicine and Hygiene. June 2007 76(6):1166-1173.
32. Gurley E, Montgomery J, Hossain MJ, Bell M, Zad OK, Islam MR, Molla MAR, Carroll D, Ksiazek T, Rota PA, Lowe L, Comer JA, Rollin P, Czub M, Grolla A, Feldmann H, **Luby SP**, Woodward JL, Breiman RF. Person-to-person transmission of Nipah virus within a Bangladeshi Community. Emerging Infectious Diseases. 2007July 13(7):1031-1037.
33. Sejvar JJ, Hossain MJ, Saha SK, Faiz MA, Gurley E, Banu S, Bellini W, Rota P, Breiman RF, **Luby SP**. Long-term neurologic and functional outcome in patients with Nipah virus infection. Annals of Neurology, In Press.

C. RESEARCH SUPPORT

ONGOING RESEARCH SUPPORT

Nipah Virus Transmission in Bangladesh 9/1/05 – 6/1/08
NIH/ International Centres for Tropical Disease Research
Objective : Identify outbreaks and investigates routes of transmission to infected persons with Nipah virus infection in Bangladesh in 2006/7.
Role: PI

Meningo-encephalitis surveillance in Bangladesh
World Health Organization 08/01/2007 – 12/31/2008
Objective : To estimate the incidence of vaccine preventable causes of meningo-encephalitis in Bangladesh
Role: Co-investigator

Surveillance for hospitalization and death due to pneumonia, meningitis and sepsis in Dhaka, Bangladesh
National Vaccine Program Office 10/01/05 – 10/01/07
Objective : To pilot and evaluate a hospital based model of assessing disease burden of vaccine preventable diseases.
Role: PI

Burden of pneumococcal and Hib disease in children in Bangladesh
Pneumococcal ADIP/Hib Initiative 04/01/04 – 12/31/2007
Objective : To determine burden of Hib and pneumococcus include pneumococcal serotype specific burden in children under age 5 years in Bangladesh
Role: PI

Health impact of large scale hygiene promotion program
UNICEF 05/01/2007 – 12/31/2009
Objective : To measure the change in behavior and health outcome of community based hygiene promotion targeting 15 million persons.
Role: PI

Improving hand hygiene in a low income urban community in Dhaka
Procter and Gamble 9/1/2007 – 12/31/2008
Objective: Evaluate the acceptability and microbiological effectiveness of a waterless hand cleanser in a highly contaminated setting
Role: PI

Bangladesh HIB assessment 9/1/2007 – 7/31/2010
Objective: Assess the impact of the introduction of hemophilus influenzae type B vaccination on the incidence of Hib meningitis in urban Dhaka, Bangladesh
Role: Co-PI

COMPLETED RESEARCH SUPPORT

Long-term neurologic and functional outcome in patients with Nipah virus encephalitis
Centers for Disease Control and Prevention 06/2005-12/2006
Objective: To assess the long term neurologic function and sequelae of Nipah survivors
Role: Co-Investigator

Assessing and improving drinking water quality following flooding
UNICEF 07/01/2005 – 12/31/2005
Objective: Evaluate if methods for water quality assessments and interventions to improve water quality were effective.
Role: PI

Health outcome evaluation of in-home flocculation and chlorination to improve drinking water quality in the setting of highly turbid source water.
Procter & Gamble Company June 2002 – February 2005
Objective: To evaluate the efficacy of a combined flocculant disinfectant versus treatment with chlorine bleach of highly turbid drinking water in rural Western Kenya.
Role: Co-Principle Investigator

Efficacy of Flocculent Technology as an Arsenic Mitigation Strategy
Procter & Gamble Company July 2002 – June 2005
Objective: To evaluate the efficacy of a flocculent disinfectant in reducing arsenic and improving microbiological safety in families using tube well water contaminated with high levels of arsenic in Matlab, Bangladesh
Role: Principle Investigator

DO NOT SUBMIT UNLESS REQUESTED
Renewal Applications Only
SENIOR/KEY PERSONNEL REPORT

All Senior/Key Personnel for the Current Budget Period

Name	Degree(s)	SSN (last 4 digits)	Role on Project (e.g. PI, Res. Assoc.)	Months Devoted to Project		
				Cal	Acad	Summer
Peter Daszak	PhD	(b) (6)	PI			(b) (4), (b) (6)
Stephen P. Luby	PhD		co-PI			
Andrew P. Dobson	PhD		co-PI			
Auston M. Kilpatrick	PhD		Sr. Researcher			

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

CHECKLIST

TYPE OF APPLICATION *(Check all that apply.)*

☒ NEW application. *(This application is being submitted to the PHS for the first time.)*

☐ RESUBMISSION of application number: _____
(This application replaces a prior unfunded version of a new, renewal, or revision application.)

☐ RENEWAL of grant number: _____
(This application is to extend a funded grant beyond its current project period.)

☐ REVISION to grant number: _____
(This application is for additional funds to supplement a currently funded grant.)

☐ CHANGE of program director/principal investigator.

Name of former program director/principal investigator: _____

☐ CHANGE of Grantee Institution. Name of former institution: _____

☐ FOREIGN application ☒ Domestic Grant with foreign involvement List Country(ies) Involved: Bangladesh

INVENTIONS AND PATENTS *(Renewal appl. only)* ☒ No ☐ Yes

If "Yes," ☐ Previously reported ☐ Not previously reported

1. PROGRAM INCOME ***(See instructions.)***

All applications must indicate whether program income is anticipated during the period(s) for which grant support is request. If program income is anticipated, use the format below to reflect the amount and source(s).

Budget Period	Anticipated Amount	Source(s)

2. ASSURANCES/CERTIFICATIONS ***(See instructions.)***

In signing the application Face Page, the authorized organizational representative agrees to comply with the policies, assurances and/or certifications listed in the application instructions when applicable. Descriptions of individual assurances/certifications are provided in Part III and listed in Part I, 4.1 under Item 14. If unable to certify compliance, where applicable, provide an explanation and place it after this page.

3. FACILITIES AND ADMINSTRATIVE COSTS (F&A)/ INDIRECT COSTS. See specific instructions.

☒ DHHS Agreement dated: 7/01/2007 ☐ No Facilities And Administrative Costs Requested.

☐ DHHS Agreement being negotiated with _____ Regional Office.

☐ No DHHS Agreement, but rate established with _____ Date _____

CALCULATION* *(The entire grant application, including the Checklist, will be reproduced and provided to peer reviewers as confidential information.)*

a. Initial budget period:	Amount of base $	79,795	x Rate applied	28.10	% = F&A costs	$	22,422
b. 02 year	Amount of base $	79,993	x Rate applied	28.10	% = F&A costs	$	22,478
c. 03 year	Amount of base $		x Rate applied		% = F&A costs	$	
d. 04 year	Amount of base $		x Rate applied		% = F&A costs	$	
e. 05 year	Amount of base $		x Rate applied		% = F&A costs	$	
					TOTAL F&A Costs	$	44,900

*Check appropriate box(es):

☐ Salary and wages base ☒ Modified total direct cost base ☐ Other base *(Explain)*

☐ Off-site, other special rate, or more than one rate involved *(Explain)*

Explanation *(Attach separate sheet, if necessary.):*

4. DISCLOSURE PERMISSION STATEMENT: If this application does not result in an award, is the Government permitted to disclose the title of your proposed project, and the name, address, telephone number and e-mail address of the official signing for the applicant organization, to organizations that may be interested in contacting you for further information (e.g., possible collaborations, investment)? ☒ Yes ☐ No

Timeline, Kevin J. Olival

Work will begin in September 2009 and continue for two years. Significant time will be spent in Bangladesh each year conducting field work and NiV ELISA assays in collaboration with local scientists at ICDDR,B. PCR-based NiV assays on bat samples and fruit swabs will take place at Columbia University (CU), and genotyping of *P. giganteus* will be done at the American Museum of Natural History (AMNH) in New York. Incorporating genetic data into epidemiological models, developing cost-effective, intervention strategies to reduce NiV exposure from fruit, and peer-reviewed manuscript preparation will occur in the second year of the project.

Year 1 (2009-10)

	Sept – Nov	Dec – Feb	March – May	June – Aug
Sample collection in Bangladesh	→	→	→	→
NiV assays (ELISA), Bangladesh	→	→	→	→
NiV assays (RT-PCR), CU, NY		→	→	
P. giganteus genotyping, AMNH, NY	→	→		
P. giganteus genetic analysis			→	→

Year 2 (2010-11)

	Sept – Nov	Dec – Feb	March – May	June – Aug
Sample collection in Bangladesh	→	→	→	
NiV assays (ELISA), Bangladesh	→	→	→	
NiV assays (RT-PCR), CU, NY		→	→	
Epidemiological modeling	→	→		
Develop fruit intervention strategies		→	→	→
Manuscript preparation	→	→	→	→

Career development plan, Kevin J. Olival

Education and Research Training Background

Dr. Kevin J. Olival graduated with distinction from Columbia University in 2008 with a Ph.D in Ecology and Evolutionary Biology. His dissertation research focused on the population genetics and phylogeography of large fruit bats in Southeast Asia, with implications for Nipah virus dynamics and emergence. He conducted month-long expeditions to Southeast Asia his second and third year, and then spent nearly a year working in four countries of Southeast Asia capturing bats and collecting samples, and collaborating closely with local scientists and NGOs. During his studies at Columbia University, Kevin received an Environmental Policy Certificate with a focus on international, environmental and emerging disease policy. This stand-alone degree required extensive coursework including: Domestic and International Environmental Politics, Economics of Sustainable Development, Infectious Disease Epidemiology, International Environmental Law, and an internship in Malaysia with the Wildlife Trust to learn techniques in wildlife veterinary medicine. **Dr. Olival, is from an under-represented minorities background, and is the first member of his family to graduate college. He will bring valuable ethnic and cultural diversity to our team. Raised in a multi-racial household in Hawaii, Dr. Olival is part- Asian, legally Native American (Cherokee), and part Portuguese.**

Kevin has completed one year as a post-doc at the American Museum of Natural History, working closely with Drs. Nancy Simmons and Susan Perkins investigating the evolution of bats and their associated parasites and pathogens. Unfortunately, he is being laid off at the end of summer 2009 due to Recession-related budget cuts (see letter, Nancy Simmons). His work at the AMNH included discovering several new blood-borne parasites in bats; molecular systematics of non-human *Plasmodium* parasites; meta-analysis of bat species to determine the underlying factors that affect genetic structure; and phylogeny of *Pteropus* spp. using museum specimens and ancient DNA techniques. Kevin has unique skills in both the field and laboratory that include ecological techniques to capture and survey for bats, experience with satellite telemetry of wildlife, molecular biology, population genetic analysis, phylogenetics, and molecular evolution.

U.S. and Foreign Mentorship

Mentorship will be provided jointly by Dr. Peter Daszak, President of Wildlife Trust (WT); and Dr. Stephen Luby, Head of Infectious Disease & Vaccine Sciences at the International Center for Diarrheal Disease Research, Bangladesh (ICDDR,B). Several important career skills will be developed during this post-doctoral training. These include: **1)** Research methods for designing and conducting epidemiological investigations in developing countries; **2)** Training of local scientists and field assistants during fieldwork and sample collection; **3)** Mathematical modeling of infectious diseases through training by scientists and research collaborators at WT. Specific focus will be on using the program R and using epidemiological matrix models; **4)** Learning how to plan research effectively for a collaborative international project; **5)** Serologic and molecular techniques for testing samples (by ELISA and RT-PCR); **6)** Lastly, valuable skills in applying research to successful implementation of policy will be developed. Results from the proposed research plan will be used to implement effective, low-cost measures to reduce the risk of NiV spillover from bats to humans via infected fruit in Bangladesh. This aspect of the project will aim to close the "know-do" research implementation gap listed as one of the goals of the Fogarty International Center Strategic Plan.

Kevin's mentored research will be guided by regular communication with both mentors through in-person meetings and regular phone conferences. It is expected that Kevin will spend substantial time (research visits of 6-12 weeks, 3-times per year) with his International Mentor, Dr. Steve Luby, at ICDDR,B in Bangladesh. During these times he will work specifically under ICDDR,B's auspices, directed by Dr. Luby and his team. At these times he will meet with Dr. Luby at least weekly, and will conduct 2-weekly conference calls with Drs. Daszak and Luby together to review progress and iron out problems. At all other times he will be based at the Global Headquarters of Wildlife Trust in New York, reporting directly to Dr. Daszak and conducting at least weekly meetings to monitor the progress of his research. Wildlife Trust maintains an open and interactive work environment and there will be many opportunities for Kevin to engage in dialogue and collaboration with other head scientists at WT. These include mathematical modelers, statisticians, epidemiologists, veterinarians, wildlife biologists and others.

At Wildlife Trust, Kevin's mentoring will include training in all of the skills essential to becoming a successful scientist. Kevin will take part in group lab meetings, staff meetings, attend seminars, present research at

conference, and be mentored by both Drs. Daszak and Luby in the art of drafting successful multi-author international collaborative papers, grant applications, and in reviewing papers for journals, reviewing grants, and other activities that are essential to a successful career as a scientist. He will be given adjunct status at Columbia University, which is granted automatically to all Wildlife Trust doctoral staff as part of WT's membership in the CERC consortium. This will enable Kevin to conduct normal faculty duties such as attending departmental seminars, teaching, mentoring students and attending faculty meetings. Finally, Kevin will be encouraged to attend National and International meetings to report his research, including the American Society for Tropical Medicine and Hygiene, and will attend meetings of the Consortium for Conservation Medicine, which is headquartered at Wildlife Trust and includes two schools of public health as members (Hopkins and Pittsburgh).

Career Development

Kevin aspires to build an international career in infectious disease epidemiology in developing countries in Southeast Asia. **He hopes to gain the training required to become a global health scientist, working internationally to help reduce the infectious disease burden in developing countries.** Kevin's prior research training was focused on the phylogeography of the wildlife reservoirs of Nipah virus, with only some exposure to infectious disease epidemiology. While he became skilled in capture of fruit bats and the taking of biological samples from them, he would like to vastly improve his understanding of infectious disease epidemiology (particularly in developing countries). Working through a partnership with WT and ICDDR,B will ensure that those skills are developed through the highest level of international collaboration and on-the-ground training. For example, while Kevin has the skills to conduct the testing for NiV on fruit discarded by bats in Bangladesh, his understanding of how to identify the correct sample size is basic. The epidemiologists at ICDDR,B and at WT will give him an excellent grounding in this part of his research, using the study design for his own research as a basis.

Finally, Kevin has a passion for turning rigorous science into effective control measures, and aims to keep this as a central goal of his career development. The proposed research on Nipah virus ecology in Bangladesh includes efforts to design control measures for NiV spillover, and will give Kevin a thorough background in this critical work.

Training in responsible conduct of research

This training will be conducted in four parts. First, Kevin will attend Columbia University's course on responsible conduct of research which is open to all adjunct faculty. He will also take online courses with NIH to be trained in IRB research and Columbia's IACUC training. Wildlife Trust maintains its own IACUC, albeit that we do not have an Animal Assurance number due to not having laboratory animals on the premises. Kevin will be expected to sit in as an observer at Wildlife Trust IACUC meetings. Secondly, on his first fieldtrip to Bangladesh, Kevin will be escorted in the field by veterinary staff from Wildlife Trust and ICDDR,B to be re-trained in animal capture, restraint and sample collection techniques. All training handling live animals will follow IACUC-approved protocols for their ethical and humane treatment. Additional training will be given in proper biosafety techniques in both field and laboratory settings to work with animals potentially infected with Nipah virus. Thirdly, Kevin will be mentored by Drs. Daszak and Luby in the ethics of writing and publication of peer-reviewed papers, in grantsmanship, and in the art of giving high quality scientific presentations. Finally, Kevin will be trained at WT and ICDDR,B in best practice for working in developing countries.

Additional Training Experience

Through collaboration with Dr. Ian Lipkin at Columbia University (see letter of support), Kevin will learn additional techniques in viral molecular biology (including ELISA assays and RT-PCR) to complement his own set of laboratory skills. Kevin will attend the following meetings, presenting papers on his work at each one:

- Annual Meetings, American Society of Tropical Medicine and Hygiene;
- Ecology and Evolution of Infectious Diseases (to be held in Cornell, NY, June 1-5, 2010);
- EcoHealth Biennial meeting 2010;
- Consortium for Conservation Medicine annual retreats;
- International Congress of Emerging Infectious Diseases (Atlanta, 2010)
- First Bangladesh-India congress on One Health and Conservation Medicine (Fall, 2009).

Specific Research Aims

Nipah virus (NiV) is a lethal zoonotic paramyxovirus with a wildlife (bat) reservoir host [1, 2]. It was first reported in Malaysia, where it spilled over from bats to pigs, causing severe respiratory infection, and subsequently to people causing a severe, lethal encephalitis with a mortality rate of around 40% [3]. NiV has caused eight human outbreaks in Bangladesh since 2001, infecting 206 known cases with a striking overall mortality rate of 71.3% [4-7]. This, the lack of effective therapies or vaccines, and the discovery of chains of human-to-human infection in Bangladesh [7, 8], mark NiV as a significant threat to health in this country.

In the parent grant, we propose a series of studies to analyze the risk of spillover of NiV. These include field studies of viral and antibody prevalence and migration in reservoir hosts (*Pteropus* fruit bats), anthropological studies of human behavior, outbreak investigation and enhanced human surveillance for encephalitis in hospitals across Bangladesh. In this ARRA supplementary application, we seek funding for an outstanding, minorities postdoctoral fellow, Dr Kevin Olival, **who achieved a distinction for his Ph.D**, but is being laid off from his current postdoc at AMNH due to recession-related budget cuts. **Dr. Olival, is from an under-represented minorities background, and is the first member of his family to graduate college. He will bring valuable ethnic and cultural diversity to our team.** Raised in a multi-racial household in Hawaii, Dr. Olival is part- Asian, legally Native American (Cherokee), and part Portuguese. **Dr Olival's goal is to get the training required to become a global health scientist, working internationally to help reduce the infectious disease burden in developing countries.** If successful, this U.S. Global Health Postdoctoral Scientist funding will help us conduct additional work that will **1)** substantially accelerate the rate of scientific discovery in our project; **2)** use novel techniques not available in our current grant; **3)** bring in the possibility of new approaches to intervention in this serious disease. Below, we propose 3 aims which will enhance our research. We have included the Background & Significance, and the Research Design, Methods & Data Analysis for each of these separately, following the specific aim

Specific Aim 1: Use genetic methods to quantify the dispersal and population connectivity of *P. giganteus*, the key wildlife reservoir for Nipah virus (NiV) in Bangladesh. The wildlife reservoirs of NiV are bats, which migrate across large distances and roost communally. We have shown that fragmentation of fruit bat populations has led to increased risk of spillover of Hendra virus in Australia [9]. Here we propose a population genetic analysis of *Pteropus giganteus* across Bangladesh to analyze the connectedness of that population and assess the risk of spikes in viral transmission due to dynamics of herd immunity.

Specific Aim 2: Accelerate the field acquisition of bat and NiV samples from Bangladesh and expand to include non-*Pteropus* hosts. While previous studies have shown non-Pteropus spp. bats, including both fruit bats and insectivorous bats, may carry Nipah or Nipah-like viruses [10, 11], no one has studied their potential role in zoonotic transmission in Bangladesh. We will collect 800 samples of serum, oral and urogenital swabs from the 30+ species of bats present in Bangladesh. This will accelerate our sample collection, but also help us analyze what the NiV dynamics are in these species, and how this alters the risk of spillover

Specific Aim 3: Use molecular tools and field observation to analyze the potential of fruit as a pathway for NiV spillover from bats to humans. Previous studies have shown that feeding on fruit potentially contaminated by bats is a risk factor for NiV infection. We will collect fruit which shows evidence of animal bites from below feeding trees and within markets in Bangladesh. We will test these fruit for bat DNA to assess which bat species feed on these fruit, and we will test salivary contamination on them for NiV. We will then target the feeding trees with infrared cameras to confirm which species are feeding on these trees. We will use our data to design intervention strategies in the hope to cut the chain of spillover for this lethal virus.

1.1 Specific Aim 1: Use genetic methods to quantify the dispersal and population connectivity of *P. giganteus*, the key wildlife reservoir for Nipah virus (NiV) in Bangladesh.

1.2 Background and Significance: The structure or connectivity of wildlife populations has strong implications for zoonotic disease dynamics and spillover to people [12, 13]. Our group has used mathematical

models to analyze Hendra virus (a close relative of NiV) dynamics in *Pteropus* bats, and found that greater fragmentation of bat populations leads to more intense virus outbreaks due to cycles of declines in herd immunity [9, 14]. Thus, a key to better understanding NiV dynamics in their reservoir host is to first quantify the movement of individuals and the degree of connectivity between populations [15]. This can be done in two ways: 1) Directly via mark-recapture or telemetry studies, or; 2) Estimating migration indirectly from population genetic data. Genetic estimates of dispersal confer several advantages over direct methods in elusive, nocturnal bats [16] including, larger sample sizes, lower costs, shorter time frame for studies, and the ability to estimate both historical *and* contemporary rates of migration.

Population genetic structure has only been measured for a few species of *Pteropus*, and based on studies of Australian species, it's often assumed that these large bats are panmictic - genetically undifferentiated and highly connected - across their range [17, 18]. However, Dr. Kevin Olival's own Ph.D research provides molecular evidence from sympatric *Pteropus* in Southeast Asia, to show extreme differences in the amount of population connectivity between these two important NiV reservoir species (**Figure 1**) [19].

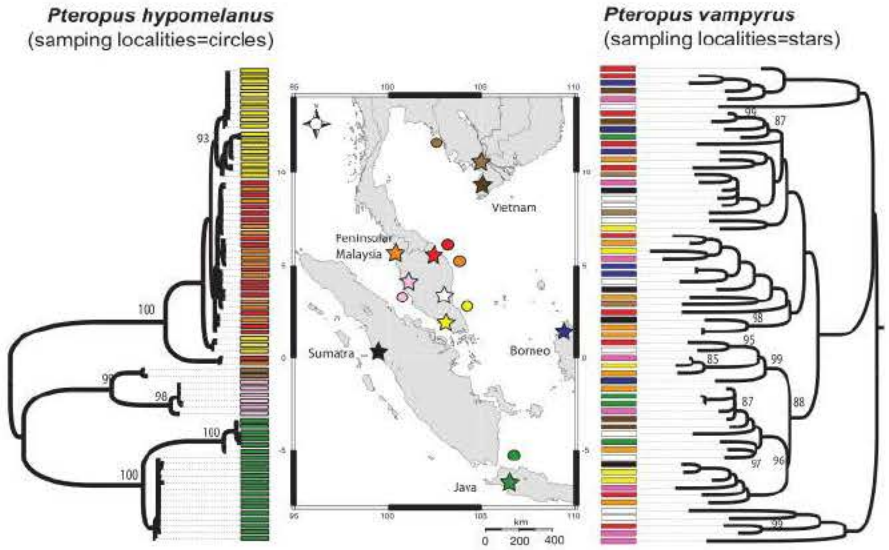


Figure 1. Contrasting patterns of population genetic structure in two *Pteropus* species in Southeast Asia. *P. vampyrus* (right) has low levels of population genetic structure as evident from the admixture of mtDNA haplotypes from geographically distant localities – a pattern consistent with high levels of dispersal across the region. Conversely, *P. hypomelanus* (left) is highly structured by geography, with virtually no gene flow or dispersal evident between populations except two islands <100km apart in NE Peninsular Malaysia (red and orange). Sequence data from mtDNA control region for ~50 individuals per species [19].

Large fruit bats of the genus *Pteropus* are thought to be the most important reservoirs for emerging Henipaviruses across their range [4, 20-27]. In Bangladesh, NiV seroprevalence in *P. giganteus* populations ranges from 20-56% (**Figure 2**), suggesting that this species is critical for the endemic circulation of NiV and for the seven human outbreaks (total 122 cases, 87 deaths; Case Fatality rate 71.3%) that have occurred since 2001. Despite its importance to understanding NiV dynamics, the level of population connectivity in *P. giganteus* in Bangladesh is currently unknown. Our parent grant highlights this gap in knowledge and aims at elucidating viral dynamics through longitudinal sampling of *P. giganteus* colonies and satellite and radio telemetry. Preliminary data from satellite telemetry of 6 collared bats has shown only very local movements of <50km over the past few months. Here we propose to add population genetic data from this key reservoir host to better parameterize our models of NiV dynamics in wildlife reservoirs.

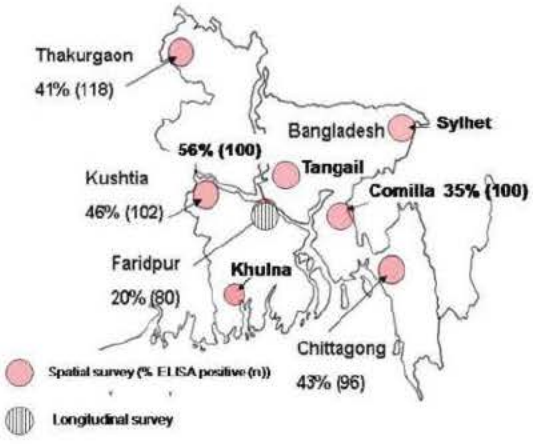


Figure 2. Sampling localities and NiV seroprevalence (# tested) for *P. giganteus* in Bangladesh as of November 2008. Human NiV outbreaks have occurred at Thakurgaon (2007), Kushtia (2007), Tangail (2005) and Faridpur (2004).

In our parent grant, we hypothesized that bat behavior in the human-dominated environment in Bangladesh has increased bat-human contact rates, and led to a more advanced stage of NiV emergence. Using population genetic data from mitochondrial and nuclear DNA markers we will test the null hypothesis that colonies of *P. giganteus* in Bangladesh are genetically panmictic – connected by random mating and extensive co-mingling. Alternatively, *P. giganteus* populations may form discrete genetic units across the landscape suggesting more limited dispersal, as

would be expected if bat populations have become more localized due to fruit farming and land-use change in Bangladesh over the past hundreds to thousands of years. **If this ARRA supplement application is successful, and we are able to hire Dr. Olival, it will dramatically accelerate our research, by providing a new tool to use in our analysis of dispersal.**

1.3 Research Design, Methods, and Data Analysis: We will use novel, population genetic techniques to estimate levels of population genetic structure, dispersal patterns, and heterogeneity in contact rates between *P. giganteus* colonies in Bangladesh. These data will be used to parameterize our model that describes NiV transmission within *Pteropus* populations to create more realistic predictions of viral dynamics between reservoir populations.

We will use wing biopsies [28], blood, and oral swab samples already collected during preliminary survey work from 8 *P. giganteus* colonies in Bangladesh (for samples sizes, see Figure 1). At least 50 individuals from each of 8 populations will be genotyped in this study. This will allow for statistically significant results when assessing genetic diversity within and between populations [29]. All samples are currently stored in the Lipkin laboratory at Columbia University, and will be transferred to the American Museum of Natural History for bat DNA work (**see letters of support**).

Whole genomic DNA will be isolated from samples using Qiagen DNeasy tissue kits. The rapidly evolving mtDNA control region will be amplified using genus-specific primers [19] and used to quantify population structure and historical patterns gene flow. Fourteen *Pteropus*-specific nuclear microsatellite primers [30] will also be used to quantify fine-scale movement patterns and contemporary gene flow. All loci will be amplified using Polymerase Chain Reaction (PCR) and sequenced or genotyped using an ABI 3730xl automated capillary sequencer.

Maximum likelihood and Bayesian methods will be used to quantify the directionality and amount (number of migrants) of gene flow between bat colonies, and to identify first generation migrants in populations via assignment tests—the molecular analog of mark-recapture studies [31-33]. Coalescent-based methods will be used to differentiate between ongoing gene flow and incomplete lineage sorting [34, 35]. To visualize connectivity between populations haplotype networks will also be constructed from mtDNA data [36]. We will test for sex-biased dispersal patterns in *P. giganteus* by comparing levels of population genetic structure from bi-parentally inherited microsatellite DNA vs. maternally-inherited mitochondrial DNA [37].

Historical and contemporary migration estimates from genetic data will be combined with data acquired from ongoing satellite and radio telemetry studies, to fully characterize the connectivity between known *P. giganteus* roosts in Bangladesh. We will then parameterize our matrix model that describes NiV transmission within bat populations (see parent grant) using these estimates. This will be a critical development, because it is normally extremely difficult to estimate the dispersal or migration of hosts in a modeling exercise.

2.1 Specific Aim 2: Accelerate the field acquisition of bat and NiV samples from Bangladesh and expand to include non-*Pteropus* hosts

2.2 Background and Significance: Following the initial 1997-98 outbreak of NiV in Malaysia, a large number of domestic and wildlife reservoirs were screened for NiV including 237 wild caught bats from 14 species. While *Pteropus* spp. were found to have the highest seroprevelance (*P. hypomelanus* 31%, *P. vampyrus* 17%), other smaller-bodied fruit bats, *Cynopterus brachyotis* and *Eonycteris spelaea*, and one microchiroptera, *Scotophilus kuhlii,* also had neutralizing antibodies to NiV [23]. In China, antibodies to NiV were found in 9 of 23 bat species screened, including 3 species of *Myotis* (Microchiroptera) and *Rousettus leschenaultia* (Megachiroptera) [11]. **The role that these non-*Pteropus* species play in the endemic circulation and cross-species transmission of NiV has been virtually uninvestigated in Bangladesh or elsewhere.**

Our parent grant aims to examine viral dynamics within *P. giganteus* in Bangladesh, however the presence of alternative, susceptible hosts in a community can substantially alter disease dynamics and transmission patterns [38]. In a simple case where all fruit bat species are equally competent NiV reservoirs, the presence of multiple reservoir hosts will increase the overall prevalence of NiV in the system and broadly increase the risk of spillover. Modeling wildlife disease within multi-host communities has shown that the rate and severity of epidemics depends on the number of species involved and the contact rates, or connectivity, between them [39]. For example, highly connected, multi-host communities produced the largest and most rapid epidemics in models of canine distemper virus [39].

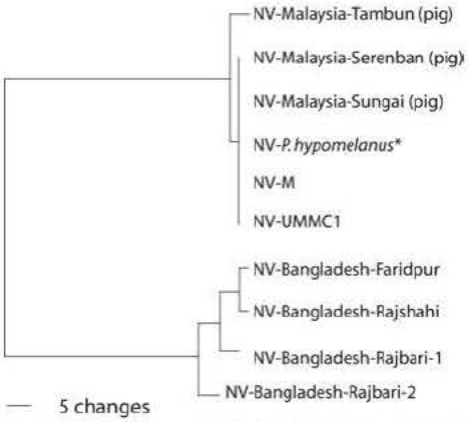


Figure 3. NiV strains in Bangladesh had more sequence variation (99% homologous) than those obtained from Malaysia which were nearly identical to each other [40]. . This suggests multiple spillover events in Bangladesh and strain diversity in wildlife reservoirs.

Higher levels of sequence diversity of NiV in Bangladesh compared to Malaysia (**Figure 3**) points to repeated spillovers into the human population, but also to a background diversity of viral strains in wildlife reservoirs [40]. This viral diversity may be maintained by population genetic structure of the primary host species [41] (i.e. *P. giganteus* per Aim 1), or by the involvement of multiple host species, each harboring slightly different strains of the virus. There are at least 30 species of bats known from Bangladesh [42], including 8 species that have previously tested seropositive for NiV in other countries [11, 23].

2.3 Research Design, Methods, and Data Analysis. Sampling: We plan to collect samples from a diverse range of bat species over two years to test for evidence of NiV infection in non-*Pteropus* hosts. We will sample 50 non-*Pteropus* bats at each of 4 localities (Rajbari, Kushtia, Faridpur, and Tangail) with known *P. giganteus* roosts and previous human outbreaks of NiV (**Figure** 1). Sampling will occur for 2 weeks every 6 months for two years (total 800 bats). Small fruit bats will be captured during foraging or when returning to the roost (between ~ 1 and 5 am) using mist nets (**see attached IACUC letter**). To maximize the habitats sampled, nets will be suspended between bamboo poles mounted in the tree canopy and on poles at ground level. Echolocating microbats will be captured using harp traps per established protocols [43]. A maximum of 25 bats will be caught per trapping period to enable safe processing and we will anesthetize fruit bats using Isoflurane gas [44]. We will field identify species and collect weight, forearm length, approximate age, sex, physical condition, and pregnancy or lactation status. Wing biopsies will be collected as genetic vouchers and to build the DNA "barcoding" database (see Aim 3). Blood samples will be collected from brachial veins (larger fruit bats) or patagial venous puncture (small bats) [43], and two sets of urine samples and throat swabs will be collected per bat. As per our standard protocols in Bangladesh, a cold chain involving liquid nitrogen dry shippers will be used to ensure sample quality. All bats will be marked, photographed, and released after sampling.

Serology, RT-PCR, and Viral Culture: Serum samples will be tested using an IgG and IgM ELISA at ICDDR,B. We will confirm at least 10% of ELISA-positive and ELISA-negative samples by SNT (under an arrangement with AAHL, in our parent grant). All urine and saliva samples will be tested at Columbia University using reverse-transcription PCR (RT-PCR) [45], using our standard primers [46-48]. For all PCR-positive urine and saliva samples we will send corresponding samples to the AAHL for culture in their BSL-4 lab, as set up in our parent grant.

Analysis: During this study we are likely to recover additional strains of NiV by sampling a diverse range of bat species. Phylogenetic relationships among these and previously published sequences will be examined using neighbor-joining, maximum likelihood, and Bayesian analyses. Dr. Kevin Olival will work with the mathematical modelers on the parent grant (Drs. Andy Dobson and Parviez Hosseini) to examine whether, using simulations of a parameterized SEIR model for bat-to-bat transmission, the large viral strain diversity can be supported without the presence of alternative hosts. This will allow us to deduce whether significant transmission occurs outside of the *P. giganteus* host.

3.1 Specific Aim 3: Use molecular tools and field observation to analyze the potential of fruit as a pathway for NiV spillover from bats to humans.

3.2 Background and Significance: NiV spillover in Bangladesh has occurred directly from bats to humans on multiple occasions through several different transmission routes. Evidence from recent outbreaks in Bangladesh point to raw date palm sap consumption as the only exposure significantly associated with illness (odds ratio 7.9, p=0.01) [6]. In earlier outbreaks, climbing trees was a significant risk factor and anecdotal evidence pointed to consumption of bat-contaminated fruit by young boys as a likely route for NiV emergence [49]. In preliminary interviews with farmers and villagers, the majority (>75%) of respondents in Faridpur (n=36) and Kushtia (n=39) stated that they eat fruits previously bitten by animals. Our surveys also indentified 26 fruit species eaten by both *P. giganteus* and humans. Additionally, a number of fruit resources, e.g. seasonal figs,

are used by multiple fruit bat species [50] and may be a source for interspecific spillover of NiV among natural reservoirs. Experimental trials conducted by our group under a previous R01 have demonstrated that NiV can survive for up to two days on the surface of mango flesh [51], thus consumption of bat-contaminated fruit may be an pathway for NiV spillover to humans. Quantifying the potential risk of spillover from infected fruit will allow us to predict future emergence events and develop cost-effective intervention strategies to prevent foodborne transmission of NiV.

3.3 Research Design, Methods, and Data Analysis: It is currently unknown which bat (or other) species are damaging fruit consumed by humans and the likelihood of ingesting live NiV from this route. To close this knowledge gap, we will combine molecular techniques and infrared camera technology to quantify NiV spillover risk from fruit. We will use PCR-based techniques to identify fruit bat species (via DNA "barcoding") from residual DNA left on partially eaten fruit, and to detect Nipah virus RNA from damage fruit collected beneath trees and from vendors at two sites (Kushtia and Faridpur) previously associated with Nipah virus outbreaks. During fieldwork we will also use IR camera technology (**Figure 4a**, **left**), per our previous palm sap studies [52], to observe foraging behavior in selected fruit trees and confirm species IDs from molecular "barcoding". Figure 4a shows a date palm tree, scraped to remove bark (green arrow), with a tap and pot for collection of date palm sap (yellow arrows). The tree is being visited by a *Pteropus giganteus* (blue arrow), and a non-pteropid fruit bat (red circle).

We will collect damaged fruit (**Figure 4b, below**) at dawn from households where the residents had informed us that bats had been seen or heard feeding within the past few days. Swabs will be taken from the bitten surface of these fruits, placed in Trizol solution, and stored at -70C. Powerful forensic techniques have been developed to extract DNA from a residual amount of cells [53], and these will be used to obtain bat DNA from the fruit surface. In previous work, we commonly amplified bat DNA using housekeeping genes from oral swabs taken from *P. giganteus*, so expect that chewed fruit will also contain sufficient host DNA. A common "barcoding" gene, mtDNA cytochrome oxidase I, will be sequenced with conserved mammal primers and used to identify bat (or other mammal) species by comparing sequences against Genbank and from DNA obtained during our own sampling of bats in Bangladesh (see Aim 2). Swabs will be screened for NiV using established PCR techniques [45].

In 2007 we collected 69 swabs from 21 pieces of fruit in the Faridpur village, and 42 swabs from 24 pieces of fruit in the Kushtia village. These samples are currently stored at Columbia University at -70C and have not yet been analyzed. They will be used initially to obtain preliminary data and optimize laboratory methods for this project. Results from this study including NiV presence/absence on fruit, feeding preferences of different bat species identified by host DNA and IR cameras, and NiV seroprevelance data from non-*Pteropus* species (Aim 2) will be used to develop a relative risk index of NiV spillover from bats to people via infected fruit.

Intervention: Educational outreach is likely to be the most effective strategies in the short term to preventing a more severe outbreak of this NiV. Through our ongoing partnership with ICDDR,B, we will use data collected here **to develop appropriate and cost-effective intervention strategies to reduce the risk of NiV spillover from infected fruit**. These efforts will complement ongoing work to reduce palm sap transmission [54] and may include: assessing frequency of sale of fruit species found to be most often fed on by bat species with high NiV seroprevelance; encouraging early harvesting of selected high-risk fruit species in areas with active bat foraging; and better dissemination of information via posters and brochures regarding the risk of contracting NiV from fruit.

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Applicant: Kevin J. Olival
Mentor: Dr. Peter Daszak

Reference for Kevin J. Olival, Applicant

Dear Committee,

I am writing as a prospective domestic mentor for Dr. Kevin Olival, who we are applying for supplementary ARRA funding as a Global Health Postdoctoral Scientist under my Fogarty International Center-funded Ecology of Infectious Diseases Grant "The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh" (2R01TW005869-05).

I have known Kevin for 6 years as a member of his committee for his Ph.D on *Pteropus* phylogeny and I believe he is the perfect candidate for this fellowship. Firstly, he is an outstanding young researcher who was awarded a 'Distinction' for his Ph.D. He has vision, scientific rigor, and is a critical thinker and extremely hard worker. Out of the 15 or so students I've supervised, he is easily in the top two. Secondly, he is an excellent international collaborator. He is a self-starter who sets goals, plans his strategy, makes contacts with key collaborators early and pushes hard for completion. He is culturally sensitive. Indeed he himself is from an under-represented minorities background, and is the first member of his family to graduate college. Raised in a multi-racial household in Hawaii, Kevin is part-Asian, legally Native American (Cherokee), and part Portuguese. Thirdly, his longterm career goals are to get the training required to become a global health scientist, working internationally to help reduce the infectious disease burden in developing countries. Finally, he fits the ARRA goals extremely well because he is being laid off from his current postdoc at the American Museum of Natural History because they failed to raise enough funding due to the recession.

As well as these outstanding characters, Kevin has an excellent skill set to bring to our group. He has great field skills, and has worked extensively in Southeast Asia, trapping and sampling bats, and working on ecological studies. He also has great lab skills, through his Ph.D on molecular phylogeny and his postdoc at the AMNH. Finally, he is a very efficient writer. These talents mark him out as a potential future leader in the field: He has great instincts for research and an excellent 'can-do' attitude. He is eager to take on challenges and deliver to deadlines without fail. He is honest and sincere, and it is a pleasure to work with him.

Kevin would very much like to learn epidemiological skills, and conduct further research on Nipah virus, to build on his Ph.D work at our Malaysian sites. I am very keen to support his career in researchand will be able to make our resources available to him extensively as part of our Nipah virus team. If we receive funding, I will being Kevin into our structured field and lab mentoring system, conduct weekly meetings with him, engage in 2-weekly conference calls with him and our collaborators in Bangladesh, and involve him in lab meetings, staff meetings, and other activities. It will also give me

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great pleasure to help train him in the arts of paper writing, collaborative research and grantsmanship to help him achieve the high goals of which he is capable.

For these reasons, I unreservedly recommend him to the committee, and look forward to working with him as a Fogarty Global Health Postdoctoral Scientist.

Yours sincerely,

Dr Peter Daszak
President

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icddr,b
KNOWLEDGE FOR
GLOBAL LIFESAVING SOLUTIONS

25th May 2009

Dr. Peter Daszak
Wildlife Trust
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Re: International Mentor Letter of Support – Application for ARRA Global Health Postdoc support.

Dear Peter:

I am writing in strong support of Kevin Olival's application to become a Global Health Postdoc under an ARRA supplementary application related to our Fogarty International Center-funded R01 "The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh (2 R01-TW005869) which is in its first year.

I have already met Kevin while he worked on his Ph.D under you as part of the original Fogarty-funded Nipah virus R01. He was studying the phylogeny and migration of the wildlife reservoirs for Nipah virus in Malaysia – *Pteropus vampyrus* fruit bats. I was impressed by his intelligence and dedication to conducting the international fieldwork needed for his project. I remember that this work became very important in solving the reason why Nipah virus emerged in Malaysia – by understanding the part that bats played in the process.

I am extremely pleased to offer my services as an international mentor to Kevin and consider this a logical and useful extension of the significant collaboration that we at ICDDR,B have with your group at Wildlife Trust. I am offering full support of our group to Kevin, and will make space available for him here at ICDDR,B when he visits, and integrated him into our group. He will have access to office and lab space, the vehicle pool, freezer space and all other logistics that he requires to do his proposed work.

I have read through Kevin's proposal, and his proposed work will complement the work we are doing on Nipah virus very well. It will bring in new techniques to study wildlife reservoir spillover risk, increase our capacity to collect samples, and accelerate the new scientific discoveries we will make on the parent grant. I believe it also fulfils the goals of the ARRA stimulus funding extremely well.

Crucially, it will also fulfill parts of the Fogarty strategic plan by **1)** helping build capacity to decrease the risk of NiV emergence in Bangladesh – a resource poor country; **2)** helping close the "know-do" gap by using applied research (as proposed here) to implement effective, low-cost measures to reduce the risk of NiV spillover from bats to humans via infected fruit; **3)** training a US postdoctoral scientist for a career in global health through international research collaborations.

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Fax : 880-2-8823116,8812530,9885657,8811686,8812529,8826050,8811568
Phone : 880-2-8860523-32, Web: http://www.icddrb.org

I wish you well with this proposal, and look forward to mentoring Kevin, and continuing our collaborations on Nipah virus in Bangladesh.

Sincerely,

Stephen P. Luby, MD
Head, Programme on Infectious Diseases and Vaccine Sciences
and Agency Head, Centers for Disease Control and Prevention,
US Embassy, Dhaka, Bangladesh

THE CENTER FOR
INFECTION AND IMMUNITY

MAILMAN SCHOOL OF PUBLIC HEALTH
Columbia University

W. Ian Lipkin, MD
John Snow Professor of Epidemiology and Director
Professor of Neurology and Pathology
College of Physicians & Surgeons

25th May 2009

Letter of Support – Application for ARRA Global Health postdoctoral fellowship support.

Dear Peter,

I am writing in strong support of your application for supplementary ARRA funding related to your Fogarty-funded R01 "The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh (2 R01-TW005869) which is in its first year.

The aims of your application are to analyze the ecology of Nipah virus in Bangladesh, and understand the risk of its future emergence, of human-to-human NiV transmission and its potential to spread out of the region. Work toward these aims will be greatly enhanced by more efficient collection of samples, novel approaches to studying reservoir behavior, and analyzing more closely the pathways of spillover. Your supplementary funding request is aligned with these aims and has the additional benefit of providing fellowship support for an underrepresented minorities investigator.

I wish you success with this proposal, and look forward to continuing our work together.

Best wishes,

W. Ian Lipkin

722 West 168th Street, 18th Floor, New York, NY 10032
TEL 212 342 9033 • **FAX** 212 342 9044 • **EMAIL** wil2001@columbia.edu • www.cii.columbia.edu

AMERICAN MUSEUM OF NATURAL HISTORY

George Amato
Sackler Institute for Comparative Genomics
American Museum of Natural History
Central Park West at 79th Street
New York, NY 10024
212 769-5736

May 26, 2009

Dr. Peter Daszak
President, Wildlife Trust
460 West 34th Street, 17th Floor
New York, NY 10001

Dear Peter:

I would like to confirm my enthusiastic support of Dr. Kevin J. Olival as a postdoctoral researcher candidate under supplementary ARRA funding to your NIH-funded Ecology of Infectious Diseases Grant "The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh" (2R01TW005869-05).

I've had the pleasure of working with Dr. Olival for the past five years, most directly this past year since he began a post-doc in our laboratory at the AMNH. Dr. Olival is among the small group of researchers I've met who clearly understands the link between ecology/biodiversity conservation and human health, and as such, he has been instrumental in developing these concepts in our own curriculum at the AMNH. Dr. Olival has been on the steering committee for two conferences we've recently held on disease and conservation, and a couple of weeks ago he presented his research to the Center for Biodiversity and Conservation's advisory board meeting. His presentation was polished and made the complex issues of his novel research—that uses population genetic data from wildlife hosts to better understand zoonotic disease dynamics—accessible to the general audience. In fact, I often highlight Dr. Olival's research in my own board and funding meetings as an example of the type of applied molecular work we would like to encourage and promote at the Sackler Institute for Comparative Genomics (SICG) at AMNH.

I strongly believe, as you do, that emerging disease research provides the right foundation for integrating disciplines in the natural sciences including population genetics, phylogenetics, and biodiversity conservation. I offer my full support of this proposal and will be happy to keep the resources at the SICG available for Dr. Olival to accomplish his proposed genetic research on Bangladesh's fruit bats over the next couple of years.

You could not have found a more promising candidate for this position, and trust that Dr. Olival's expertise will bring new insights to the ecology and transmission dynamics of

Nipah virus in Bangladesh. I strongly endorse this work and look forward to a continued and fruitful collaboration between Wildlife Trust and the AMNH.

Sincerely,

George D. Amato

George Amato
Director, Sackler Institute for Comparative Genomics
And Conservation Genetics

AMERICAN MUSEUM ō NATURAL HISTORY

27 May 2009

Dr. Peter Daszak
President, Wildlife Trust
460 West 34th Street, 17th Floor
New York, NY 10001

Dear Peter:

I am writing in strong support of Dr. Kevin J. Olival as a Postdoctoral Researcher candidate under supplementary ARRA funding to your NIH-funded Ecology of Infectious Diseases Grant "The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh" (2R01TW005869-05).

Dr. Olival is an exceptional young scientist who is uniquely proficient in lab, field, and analytical methods. I have had the pleasure of working with Dr. Olival on many projects over the past 4 years during his time as both a PhD student and as a Postdoctoral Researcher at the American Museum of Natural History (AMNH), and have been impressed by his work in all circumstances. This past month, the AMNH was forced to make major budget cuts due to the current recession. Unfortunately for me (and for Dr. Olival), his position was eliminated for the next fiscal year as part of these cuts, and he will be without a job as of the summer of 2009. I think it would be a loss to the scientific community for Dr. Olival to have to abandon his important work; furthermore, his research skills are clearly complementary to those of the Wildlife Trust, especially those outlined in your NIH-funded project on Nipah virus emergence and ecology.

The AMNH is a long-standing leader in the study of evolution and the development of phylogenetic theory and methods. Continuing with this tradition, Dr. Olival has focused on the phylogeny and population genetic structure of bats, and especially the co-evolution of bats and their parasites/viruses. His work is of great interest to researchers in many fields and has led to many exciting discoveries. With my colleague, Susan Perkins, Dr. Olival has been at the forefront of research on non-human *Plasmodium* genetics, and has discovered and characterized several new malaria parasites from bats. Most recently, he has developed a novel meta-analysis to examine the ecological and evolutionary correlates of viral diversity in bats; using similar methods he is currently writing a chapter "Correlates and evolutionary consequences of population genetic structure in bats" for a book on bat evolution that I am editing with a colleague. This volume will be published by Cambridge University Press.

In my opinion you could not find a better postdoctoral candidate, and this would be a perfect use of our stimulus funding – to hire a key research leader who, due to the recession, has unfortunately lost his job.

Sincerely,

Dr. Nancy B. Simmons
Chair, Division of Vertebrate Zoology
Curator-in-charge, Department of Mammalogy

THIS AWARD IS ISSUED UNDER THE AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009 AND IS SUBJECT TO SPECIAL HHS TERMS AND CONDITIONS AS REFERENCED IN SECTION III

Grant Number: 3R01TW005869-06S2 REVISED

Principal Investigator(s):
PETER DASZAK, PHD

Project Title: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

PROGRAM ASSISTANT
WILDLIFE TRUST
460 WEST 34TH STREET
NEW YORK, NY 10001

Award e-mailed to: (b) (6)

Budget Period: 09/01/2009 – 08/31/2011
Project Period: 09/01/2009 – 08/31/2011

Dear Business Official:

The National Institutes of Health hereby revises this award (see "Award Calculation" in Section I and "Terms and Conditions" in Section III) to ECOHEALTH ALLIANCE, INC. in support of the above referenced project. This award is pursuant to the authority of 42 USC 241 42 CFR 52 and is subject to the requirements of this statute and regulation and of other referenced, incorporated or attached terms and conditions.

Acceptance of this award including the "Terms and Conditions" is acknowledged by the grantee when funds are drawn down or otherwise obtained from the grant payment system.

Each publication, press release or other document that cites results from NIH grant-supported research must include an acknowledgment of NIH grant support and disclaimer such as "The project described was supported by Award Number R01TW005869 from the Fogarty International Center. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Fogarty International Center or the National Institutes of Health."

Award recipients are required to comply with the NIH Public Access Policy. This includes submission to PubMed Central (PMC), upon acceptance for publication, an electronic version of a final peer-reviewed, manuscript resulting from research supported in whole or in part, with direct costs from National Institutes of Health. The author's final peer-reviewed manuscript is defined as the final version accepted for journal publication, and includes all modifications from the publishing peer review process. For additional information, please visit http://publicaccess.nih.gov/.

Award recipients must promote objectivity in research by establishing standards to ensure that the design, conduct and reporting of research funded under NIH-funded awards are not biased by a conflicting financial interest of an Investigator. Investigator is defined as the Principal Investigator and any other person who is responsible for the design, conduct, or reporting of NIH-funded research or proposed research, including the Investigator's spouse and dependent children. Awardees must have a written administrative process to identify and manage financial conflict of interest and must inform Investigators of the conflict of interest policy and of the Investigators' responsibilities. Prior to expenditure of these awarded funds, the Awardee must report to the NIH Awarding Component the existence of a conflicting interest and within 60 days of any new conflicting interests identified after the initial report. Awardees must comply with these and all other aspects of 42 CFR Part 50, Subpart F. These requirements also apply to subgrantees, contractors, or collaborators engaged by the Awardee under this award. The NIH website http://grants.nih.gov/grants/policy/coi/index.htm provides additional information.

If you have any questions about this award, please contact the individual(s) referenced in Section IV.

Sincerely yours,

BRUCE R BUTRUM
Grants Management Officer
FOGARTY INTERNATIONAL CENTER

Additional information follows

SECTION I – AWARD DATA – 3R01TW005869-06S2 REVISED

Award Calculation (U.S. Dollars)

Federal Direct Costs	$39,988
Federal F&A Costs	$11,237
Approved Budget	$51,225
Federal Share	$51,225
TOTAL FEDERAL AWARD AMOUNT	$51,225

AMOUNT OF THIS ACTION (FEDERAL SHARE) $0

SUMMARY TOTAL FEDERAL AWARD AMOUNT YEAR (6)	
GRANT NUMBER	**TOTAL FEDERAL AWARD AMOUNT**
3R01TW005869-06S2	$51,225
3R01TW005869-06S1	$204,688
TOTAL	**$255,913**

SUMMARY TOTALS FOR ALL YEARS		
YR	**THIS AWARD**	**CUMULATIVE TOTALS**
6	$51,225	$255,913
7	$0	$0
8	$0	$0
9	$0	$0

Recommended future year total cost support, subject to the availability of funds and satisfactory progress of the project

Fiscal Information:

CFDA Number:	93.701
EIN:	1311726494A1
Document Number:	RTW005869Z
Fiscal Year:	2009

IC	*CAN*	*2009*
TW	8485038	$51,225

Recommended future year total cost support, subject to the availability of funds and satisfactory progress of the project

NIH Administrative Data:
PCC: FSIC / **OC**: 414C / **Processed**: (b) (6) 05/03/2011

SECTION II – PAYMENT/HOTLINE INFORMATION – 3R01TW005869-06S2 REVISED

For payment and HHS Office of Inspector General Hotline information, see the NIH Home Page at http://grants.nih.gov/grants/policy/awardconditions.htm

SECTION III – TERMS AND CONDITIONS – 3R01TW005869-06S2 REVISED

This award is based on the application submitted to, and as approved by, NIH on the above-titled project and is subject to the terms and conditions incorporated either directly or by reference in the following:

a. The grant program legislation and program regulation cited in this Notice of Award.
b. Conditions on activities and expenditure of funds in other statutory requirements, such as those included in appropriations acts.
c. 45 CFR Part 74 or 45 CFR Part 92 as applicable.
d. The NIH Grants Policy Statement, including addenda in effect as of the beginning date of the budget period.
e. This award notice, INCLUDING THE TERMS AND CONDITIONS CITED BELOW.

(See NIH Home Page at 'http://grants.nih.gov/grants/policy/awardconditions.htm' for certain references cited above.)

ARRA TERM OF AWARD: This award provides additional funding for R01TW005869-06. This additional funding is provided under the American Recovery and Reinvestment Act of 2009 (ARRA) and is subject to the HHS-Approved Standard Terms and Conditions for ARRA. Approved text for NIH awards can be found at: http://grants.nih.gov/grants/policy/NIH_HHS_ARRA_Award_Terms.pdf. Recipients should pay particular attention to the special quarterly reporting requirements required by Section 1512 of the Recovery Act as specified in Term #2. Unless the parent grant is also awarded with ARRA funds, these special quarterly reporting requirements apply only to this additional funding. Recipients should not include any information about the parent grant when responding to the quarterly reporting requirements. When both the parent grant and these additional funds are awarded with ARRA funding, the quarterly reporting requirement applies to the entire ARRA funding and can be reported as a single quarterly report.

Grantees are reminded to include specific information on the ARRA additional funding as part of the annual progress report(s) of the parent grant.

Separate financial reporting (SF 272 and Financial Status Reports) will be required to be submitted covering this additional funding. These will be in addition to any required financial reports for the parent grant. Regarding the Financial Status Report, when multiple competitive revisions/administrative supplements are awarded to the same parent grant, only one ARRA-specific report is required at the time the project period of the last ARRA revision/supplement ends.

Separate closeout documents (Final Progress Report, Final Financial Status Report, and Final Invention Statement) will also be required to closeout the Recovery Act funding at the time the ARRA funding ends. These closeout reports for the ARRA funding are required even when the parent grant continues. When multiple competitive revisions/administrative supplements are awarded to the same parent grant, only one ARRA-specific Final financial report is required at the time the project period of the last ARRA revision/supplement ends. Separate Final Progress Reports and Final Invention Statements are still required.

Note, if the parent grant is also awarded with ARRA funds, separate financial and other closeout documents described above are **not** required. Any reporting on the additional funds provided in this award will be required as part of normal reporting of the parent grant

Unless the parent grant is also awarded with ARRA funds, the ARRA funds provided under this award are not available for rebudgeting or carryover into the parent grant. Any ARRA funding remaining at the end of the funding period for this award must be reported as an unobligated balance.

Carry over of an unobligated balance into the next budget period requires Grants Management Officer prior approval.

In accordance with P.L. 110-161, compliance with the NIH Public Access Policy is now mandatory. For more information, see NOT-OD-08-033 and the Public Access website: http://publicaccess.nih.gov/.

This award represents the final year of the competitive segment for this grant. Therefore, see the NIH Grants Policy Statement Section 8.4 Closeout for closeout requirements at: http://grants.nih.gov/grants/policy/#gps .

A final Federal Financial Report (FFR) (SF 425) must be submitted through the eRA Commons (Commons) within 90 days of the expiration date; see the NIH Grants Policy Statement Section 8.4.1.4 Financial Reports, http://grants.nih.gov/grants/policy/#gps, for additional information on this submission requirement. The final FFR must indicate the exact balance of unobligated funds and may not reflect any unliquidated obligations. There must be no discrepancies between the final FFR expenditure data and the Payment Management System's (PMS) cash transaction data.

A Final Invention Statement and Certification form (HHS 568), (not applicable to training, construction, conference or cancer education grants) must be submitted through the eRA Commons (Commons) within 90 days of the expiration date.

Furthermore, unless an application for competitive renewal is submitted, a final progress report must also be submitted within 90 days of the expiration date. Institute/Centers may accept the progress report contained in competitive renewal (type 2) in lieu of a separate final progress report. Contact the awarding IC for IC-specific policy regarding acceptance of a progress report contained in a competitive renewal application in lieu of a separate final progress report.

NIH strongly encourages electronic submission of the final progress report and the final invention statement through the Closeout feature in the Commons. If the final progress report and final invention statement are not submitted through the Commons, a copy can be emailed or sent to the contacts listed below. Copies of the HHS 568 form may be downloaded at: http://grants.nih.gov/grants/forms.htm.

Submissions of the final progress report and HHS 568 may be e-mailed as PDF attachments to the NIH Central Closeout Center at: DeasCentralized@od.nih.gov.

Paper submissions of the final progress report and the HHS 568 may be faxed to the NIH Central Closeout Center at 301-480-2304 or mailed to the NIH Central Closeout Center at the following address:

NIH/OD/OER/DEAS
Central Closeout Center
6705 Rockledge Drive, Room 2207
Bethesda, MD 20892-7987 (for regular or U.S. Postal Service Express mail)
Bethesda, MD 20817 (for other courier/express mail delivery only)

The final progress report should include, at a minimum, a summary of progress toward the achievement of the originally stated aims, a list of significant results (positive and/or negative), a list of publications and the grant number. If human subjects were included in the research, the final progress report should also address the following:

Report on the inclusion of gender and minority study subjects (using the gender and minority Inclusion Enrollment Form as provided in the PHS 2590 and available at http://grants.nih.gov/grants/forms.htm).

Where appropriate, indicate whether children were involved in the study or how the study was relevant for conditions affecting children (see NIH Grants Policy Statement Section 4.1.15.7 Inclusion of Children as Subjects in Clinical Research at URL http://grants.nih.gov/grants/policy/#gps).

Describe any data, research materials (such as cell lines, DNA probes, animal models), protocols, software, or other information resulting from the research that is available to be shared with other investigators and how it may be accessed.

Note, if this is the final year of a competitive segment due to the transfer of the grant to another institution, then not all the requirements stated above are applicable. Specifically a Final Progress Report is not required. However, a final FFR is required and should be submitted electronically as noted above. In addition, if not already submitted, the Final Invention Statement is required and should be sent directly the assigned Grants Management Specialist.

Treatment of Program Income:
Additional Costs

SECTION IV – TW Special Terms and Conditions – 3R01TW005869-06S2 REVISED

REVISION
This award is revised to change the budget period end date to reflect the two-year budget period of this supplement.

FIC ARRA Supplement Term
This supplement is awarded based on the Information and Communication Technology (ICT) Administrative Supplement request received and evaluated by FIC staff. If there is a scope change from the original request, grantees must obtain FIC approval.

Grantees are reminded to include specific information on the ARRA additional funding as part of the annual progress report(s) of the parent grant.

ARRA QUARTERLY REPORTING REQUIREMENTS
See the NIH Guide Notice NOT-OD-09-129 regarding ARRA quarterly reporting requirements: http://grants.nih.gov/grants/guide/notice-files/NOT-OD-09-129.html

FOREIGN TRAVEL
U.S. Flag carriers must be used for departure from or entry into the U.S. and for any other portion of the trip where available.

PUBLICATIONS
All publications resulting from the research or research training supported by this award must acknowledge FIC and any co-funders (if applicable). This publication requirement applies not only to the primary grantee, but also to any subcontractors and /or trainees involved with the project.

For up-to-date information, you may access the NIH Home Page at http://www.nih.gov/ and the FIC Home Page at http://www.fic.nih.gov/.

STAFF CONTACTS

The Grants Management Specialist is responsible for the negotiation, award and administration of this project and for interpretation of Grants Administration policies and provisions. The Program Official is responsible for the scientific, programmatic and technical aspects of this project. These individuals work together in overall project administration. Prior approval requests (signed by an Authorized Organizational Representative) should be submitted in writing to the Grants Management Specialist. Requests may be made via e-mail.

Grants Management Specialist: Angela Smith
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-594-1211

Program Official: Joshua Rosenthal
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-402-0779

SPREADSHEET SUMMARY
GRANT NUMBER: 3R01TW005869-06S2 REVISED

INSTITUTION: ECOHEALTH ALLIANCE, INC.

Facilities and Administrative Costs	***Year 6***	***Year 7***	***Year 8***	***Year 9***
F&A Cost Rate 1	28.1%			
F&A Cost Base 1	$39,988			
F&A Costs 1	$11,237			

Cover Letter
Notice NOT-OD-056

Request for Recovery Act Administrative Supplement for Support of Information and Communication Technology Initiatives in Research and Research Training Programs

Principal Investigator: Peter Daszak

Grant 2R01TW005869-05: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

Supplement amount requested: $62,464 (2 year award)

Contact details for PI:

Dr. Peter Daszak
President
Wildlife Trust

Email: (b) (6)
Ph: (b) (6)

Institutional Official

Mr. Aleksei Chmura
Senior Program Coordinator
Wildlife Trust
Email: (b) (6)
Ph: (b) (6)

Form Approved Through 11/30/2010 OMB No. 0925-0001

Department of Health and Human Services
Public Health Services

Grant Application

Do not exceed character length restrictions indicated.

LEAVE BLANK—FOR PHS USE ONLY.

Type	Activity	Number
Review Group		Formerly
Council/Board (Month, Year)		Date Received

1. TITLE OF PROJECT *(Do not exceed 81 characters, including spaces and punctuation.)*
The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

2. RESPONSE TO SPECIFIC REQUEST FOR APPLICATIONS OR PROGRAM ANNOUNCEMENT OR SOLICITATION ☐ NO ☒ YES
(If "Yes," state number and title)
Number: 2R01TW005869-05 Title: Fogarty ARRA Supplement for Support of ICT Initiatives

3. PROGRAM DIRECTOR/PRINCIPAL INVESTIGATOR — **New Investigator** ☐ No ☐ Yes

3a. NAME (Last, first, middle)	3b. DEGREE(S)	3h. eRA Commons User Name
Daszak, Peter	PhD	(b) (6)

3c. POSITION TITLE
President

3d. MAILING ADDRESS *(Street, city, state, zip code)*
460 West 34th Street, 17th Floor
New York, NY 10001

3e. DEPARTMENT, SERVICE, LABORATORY, OR EQUIVALENT
Wildlife Trust

3f. MAJOR SUBDIVISION
Conservation Medicine

3g. TELEPHONE AND FAX *(Area code, number and extension)*
TEL: (b) (6) FAX: 212-380-4465

E-MAIL ADDRESS:
(b) (6)

4. HUMAN SUBJECTS RESEARCH	4a. Research Exempt	If "Yes," Exemption No.
☒ No ☐ Yes	☒ No ☐ Yes	

4b. Federal-Wide Assurance No.	4c. Clinical Trial	4d. NIH-defined Phase III Clinical Trial
FWA00001468	☒ No ☐ Yes	☒ No ☐ Yes

5. VERTEBRATE ANIMALS ☐ No ☒ Yes — 5a. Animal Welfare Assurance No. A4059-01

6. DATES OF PROPOSED PERIOD OF SUPPORT *(month, day, year—MM/DD/YY)*		7. COSTS REQUESTED FOR INITIAL BUDGET PERIOD		8. COSTS REQUESTED FOR PROPOSED PERIOD OF SUPPORT	
From	Through	7a. Direct Costs ($)	7b. Total Costs ($)	8a. Direct Costs ($)	8b. Total Costs ($)
09/01/2009	08/31/2011	$19,999	$31,239	$39,990	$62,464

9. APPLICANT ORGANIZATION
Name: Wildlife Trust
Address: 460 West 34th Street, 17th Floor
New York, NY 10001

10. TYPE OF ORGANIZATION
Public: → ☐ Federal ☐ State ☐ Local
Private: → ☒ Private Nonprofit
For-profit: → ☐ General ☐ Small Business
☐ Woman-owned ☐ Socially and Economically Disadvantaged

11. ENTITY IDENTIFICATION NUMBER
31-1726494
DUNS NO. 077090066D Cong. District 8

12. ADMINISTRATIVE OFFICIAL TO BE NOTIFIED IF AWARD IS MADE
Name: Aleksei Chmura
Title: Program Coordinator
Address: 460 West 34th Street, 17th Floor
New York, NY 10001
Tel: (b) (6) FAX: 212-380-4465
E-Mail: (b) (6)

13. OFFICIAL SIGNING FOR APPLICANT ORGANIZATION
Name: Aleksei Chmura
Title: Program Coordinator
Address: 460 West 34th Street, 17th Floor
New York, NY 10001
Tel: (b) (6) FAX: 212-380-4465
E-Mail: (b) (6)

14. APPLICANT ORGANIZATION CERTIFICATION AND ACCEPTANCE: I certify that the statements herein are true, complete and accurate to the best of my knowledge, and accept the obligation to comply with Public Health Services terms and conditions if a grant is awarded as a result of this application. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties.

SIGNATURE OF OFFICIAL NAMED IN 13. *(In ink. "Per" signature not acceptable.)*
Aleksei Chmura

DATE: 06/01/2009

PROJECT SUMMARY (See instructions):

This supplementary ARRA ICT proposal requests fundint to significantly accelerate the scientific discovery in our parent R01 grant, awarded last year. In the parent grant, we analyze the risk of spillover of Nipah virus (NiV), a lethal zoonotic disease with a wildlife reservoir host, which has caused repeated outbreaks in Bangladesh and an overall mortality rate of 71.3%. Specific aims include landscape-scale analyses of factors that drive emergence, and of wildlife reservoir (bat). Given the complexities of these spatial and temporal analyses, we seek ARRA ICT funding to enable greater access to GIS technology and training. The activities under this grant are coordinated by the PI, Dr Peter Daszak, at Wildlife Trust, New York. They involve extensive collaboration with the ICDDR,B in Bangladesh; the CDC in Atlanta; and 3 US universities. Coordination is hampered by the limitations of telephone connections in Bangladesh, which are notoriously poor, often leading to dropped calls or poor sound quality. In contrast, the T1 lines at ICDDR,B, which relies heavily on internet communication, are much more reliable. We aim to acquire a central video-conferencing solution, and internet upgrade at Wildlife Trust to improve our collaborative capacity.

These aims address the goals of ARRA by fostering 1) The acquisition of new technology; 2) Acceleration of scientific discovery through more effective collaboration; 3) Contracting for additional skills (training) from a US-based provider; 4) Contracting with a US-based internet supplier; and 5) Providing technical training for US- based staff which will help them in job retention. They also address goal 4 the FIC Strategic Plan: To foster a sustainable research environment in low- and middle-income countries. Specifically, providing video conference linkage between ICDDR,B in Bangladesh, Wildlife Trust and the 3 other key collaborating institutions in our parent proposal addresses the specific language in goal 4: "Key strategic priorities include establishing linkages or hubs for sharing resources and knowledge across sites and encouraging the adoption of information technology to advance research progress".

RELEVANCE (See instructions):

PROJECT/PERFORMANCE SITE(S) (if additional space is needed, use Project/Performance Site Format Page)

Project/Performance Site Primary Location			
Organizational Name: Wildlife Trust			
DUNS: 077090066D			
Street 1: 460 West 34th Street		Street 2: 17 Floor	
City: New York	County: Manhattan		State: NY
Province:	Country: USA		Zip/Postal Code: 10001
Project/Performance Site Congressional Districts:			

Additional Project/Performance Site Location			
Organizational Name:			
DUNS:			
Street 1:		Street 2:	
City:	County:		State:
Province:	Country:		Zip/Postal Code:
Project/Performance Site Congressional Districts:			

SENIOR/KEY PERSONNEL. See instructions. *Use continuation pages as needed* to provide the required information in the format shown below. Start with Program Director(s)/Principal Investigator(s). List all other senior/key personnel in alphabetical order, last name first.

Name	eRA Commons User Name	Organization	Role on Project
Peter Daszak	(b) (6)	Wildlife Trust	PI

OTHER SIGNIFICANT CONTRIBUTORS

Name	Organization	Role on Project

Human Embryonic Stem Cells ☒ No ☐ Yes

If the proposed project involves human embryonic stem cells, list below the registration number of the specific cell line(s) from the following list: http://stemcells.nih.gov/research/registry/. *Use continuation pages as needed.*

If a specific line cannot be referenced at this time, include a statement that one from the Registry will be used.

Cell Line

Use only if additional space is needed to list additional project/performance sites.

Additional Project/Performance Site Location			
Organizational Name: Wildlife Trust			
DUNS: 07-709-0066			
Street 1: 460 W. 34th Street		Street 2: 17th Floor	
City: New York	County:		State: NY
Province:	Country: United States of America		Zip/Postal Code: 10001
Project/Performance Site Congressional Districts:			

Additional Project/Performance Site Location			
Organizational Name: ICDDR,B			
DUNS: 731524711			
Street 1: 68 Shahid Tajuddin Ahmed Sarani		Street 2: Mohakhali (GPO Box 128, Dhaka 1000)	
City: Dhaka 1212	County:		State:
Province:	Country: Bangladesh		Zip/Postal Code:
Project/Performance Site Congressional Districts:			

Additional Project/Performance Site Location			
Organizational Name: Princeton University			
DUNS: 002484665			
Street 1: Office of Research and Proj. Admin.		Street 2: 4 New South Building	
City: Princeton	County:		State: NJ
Province:	Country: USA		Zip/Postal Code: 08544
Project/Performance Site Congressional Districts:			

Additional Project/Performance Site Location			
Organizational Name: University of California at Santa Cruz			
DUNS: 125084723			
Street 1: A332 Earth & Marine Sciences		Street 2:	
City: Santa Cruz	County:		State: CA
Province:	Country: USA		Zip/Postal Code: 95064
Project/Performance Site Congressional Districts:			

Additional Project/Performance Site Location			
Organizational Name:			
DUNS:			
Street 1:		Street 2:	
City:	County:		State:
Province:	Country:		Zip/Postal Code:
Project/Performance Site Congressional Districts:			

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

DETAILED BUDGET FOR INITIAL BUDGET PERIOD
DIRECT COSTS ONLY

FROM 09/01/2009 THROUGH 08/31/2010

PERSONNEL (Applicant organization only)		Months Devoted to Project				DOLLAR AMOUNT REQUESTED (omit cents)		
NAME	ROLE ON PROJECT	Cal. Mnths	Acad. Mnths	Summer Mnths	INST.BASE SALARY	SALARY REQUESTED	FRINGE BENEFITS	TOTAL
Peter Daszak	PD/PI							(b) (4), (b) (6)
Parviez Hosseini	Co-Investigator							
SUBTOTALS →								(b) (4), (b) (6)

CONSULTANT COSTS	
EQUIPMENT *(Itemize)* Tandberg Edge 95 server + service - 1 x 12,800; Tandberg MXP 150 - 2 x 1,900; ISP Upgrade - 12 x 199.99	18,999
SUPPLIES *(Itemize by category)*	
TRAVEL	
PATIENT CARE COSTS — INPATIENT	
PATIENT CARE COSTS — OUTPATIENT	
ALTERATIONS AND RENOVATIONS *(Itemize by category)*	
OTHER EXPENSES *(Itemize by category)* Training for Mr. Chmura	1,000
CONSORTIUM/CONTRACTUAL COSTS — DIRECT COSTS	
SUBTOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD *(Item 7a, Face Page)*	$ 19,999
CONSORTIUM/CONTRACTUAL COSTS — FACILITIES AND ADMINISTRATIVE COSTS	11,239
TOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD	$ 31,239

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

DETAILED BUDGET FOR INITIAL BUDGET PERIOD
DIRECT COSTS ONLY

FROM 09/01/2010 THROUGH 08/31/2011

PERSONNEL (Applicant organization only)		Months Devoted to Project				DOLLAR AMOUNT REQUESTED (omit cents)		
NAME	ROLE ON PROJECT	Cal. Mnths	Acad. Mnths	Summer Mnths	INST.BASE SALARY	SALARY REQUESTED	FRINGE BENEFITS	TOTAL
Peter Daszak	PD/PI							(b) (4), (b) (6)
Parviez Hosseini	Co-Investigator							
SUBTOTALS →								(b) (4), (b) (6)

CONSULTANT COSTS		
EQUIPMENT *(Itemize)* ArcGIS server hardware 1 x 8,100; ESRI ArcGIS server & license 1 x 6,500; ISP Ugprage 12 x 199.99 & Tandberg service 1 x 990		17,989
SUPPLIES *(Itemize by category)*		
TRAVEL		
PATIENT CARE COSTS	INPATIENT	
	OUTPATIENT	
ALTERATIONS AND RENOVATIONS *(Itemize by category)*		
OTHER EXPENSES *(Itemize by category)* Training for Drs. Hosseini & Olival - 2 x 1,000		2,000
CONSORTIUM/CONTRACTUAL COSTS	DIRECT COSTS	
SUBTOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD *(Item 7a, Face Page)*		$ 19,989
CONSORTIUM/CONTRACTUAL COSTS	FACILITIES AND ADMINISTRATIVE COSTS	11,234
TOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD		$ 31,224

BUDGET FOR ENTIRE PROPOSED PROJECT PERIOD
DIRECT COSTS ONLY

BUDGET CATEGORY TOTALS	INITIAL BUDGET PERIOD (from Form Page 4)	ADDITIONAL YEARS OF SUPPORT REQUESTED 2nd	3rd	4th	5th
PERSONNEL: *Salary and fringe benefits. Applicant organization only.*		(b) (4), (b) (6)			
CONSULTANT COSTS					
EQUIPMENT	18,999	17,989			
SUPPLIES					
TRAVEL					
PATIENT CARE COSTS — INPATIENT					
PATIENT CARE COSTS — OUTPATIENT					
ALTERATIONS AND RENOVATIONS					
OTHER EXPENSES	1,000	2,000			
CONSORTIUM/ CONTRACTUAL COSTS — DIRECT					
SUBTOTAL DIRECT COSTS *(Sum = Item 8a, Face Page)*	19,999	19,989			
CONSORTIUM/ CONTRACTUAL COSTS — F&A	11,239	11,234			
TOTAL DIRECT COSTS	31,239	31,224			

TOTAL DIRECT COSTS FOR ENTIRE PROPOSED PROJECT PERIOD $ 62,464

JUSTIFICATION. Follow the budget justification instructions exactly. Use continuation pages as needed.

Personnel

Peter Daszak Ph.D, Principal Investigator and President, Wildlife Trust, New York (No Salary Requested). Daszak is an emerging disease ecologist specializing in analyzing the process of zoonotic disease emergence. He will be responsible for overall coordination of the project (including work conducted under subcontracts at CIESIN, UCSC and NYSDoH). Parviez Hosseini, Ph.D. Senior Research Fellow, Wildlife Trust, New York (b) (4), (b) (6) Hosseini is an emerging disease ecologist specializing in mathematical and statistical modeling of vector-borne diseases, with a background and experience in deploying Information Technology in research settings.

Kevin Olival, Ph.D. is a currently a post-doc at the American Museum of Natural History, and is the subject of an ARRA Global Health Postdoctoral Scientist to be a post-doc at Wildlife Trust, NY in September 2009 (b) (4), (b) (6) Aleksei Chmura is a graduate student at Kingston University under Daszak, pursuing a Ph.D. in Biological Sciences, researching the ecology of emerging diseases in Asia (b) (4), (b) (6)). Hosseini and Chmura will largely be responsible for coordination of acquisition and installation of videoconference and GIS systems, with oversight from Daszak. Chmura, Hosseini, and Olival, will be the trainees for the GIS coursework. (cont'd)

Budget Justification (ctd.)

Technological Equipment and Services
In year 1, we are planning on purchasing a Tandberg (New York, NY) Edge 95 server for video conferencing, and two Tandberg MXP 150s, an initial year of videoconference service from Tandberg that includes on-site support and assistance with installation, and a second year of service from Tandberg that provides basic service and off-site support, because we feel the initial assistance with installation issues is well-worth the cost. One Tandberg MXP 150 (MSRP $1900) will be maintained at ICDDR,B; this unit is below the 10% threshold for a foreign entity under ARRA, and the clear purpose of this unit is to enable greater communication between Wildlife Trust, a U.S.-based N.G.O., the other US-based institutions involved in this project, and ICDDR,B. Additionally we will upgrade our Internet access to at least 3 Mbps from our current Internet service provider.

In year 2, we are planning on purchasing a Dell system with Microsoft Windows to serve as the GIS server. For the GIS server, we will obtain licenses for ESRI (Redlands, CA) ArcGIS server and ArcView.

Training
Three US-based research staff will be trained (Chmura, Olival, Hosseini). Training for the 3 research staff will be with ESRI, provider of the ArcGIS software, who conveniently have a training center in New York, NY, within in five miles of Wildlife Trust's offices.

Travel
N/A, training is within regular commuting distance for Wildlife Trust.

Indirect costs
Indirect costs on total direct costs are requested at our audited rate of 28.1%.

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and other significant contributors in the order listed on Form Page 2.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME	POSITION TITLE
Parviez Hosseini	Senior Research Fellow Wildlife Trust
eRA COMMONS USER NAME	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Brown University, RI	Sc. B.	1994	Applied Math – Biology
University of California, Santa Barbara, CA	Ph.D.	2002	Biological Sciences

A. Positions and Honors

Positions and Employment

2009 – Senior Research Fellow, Wildlife Trust
2005 – 2008 Associate Research Scholar, Princeton University
2004 – 2005 Post-doctoral Associate, jointly Princeton University and Cornell University, Lab of Ornithology.
2002 – 2004 Post-doctoral Associate, Cornell University, Lab of Ornithology

Professional Memberships and other relevant experience

1999 – Member: Ecological Society of America
2007 SEEDS diversity mentor
2008 – Member: British Ecological Society
2008 SEEDS travel award reviewer
2009 Guest Lecturer, Ecole des hautes études en santé publique, Paris, France.

Honors and Awards

2007 – Science, Editor's Choice, Ecology/Evolution, Perennial Infection, 6 April 2007, 316:19
2007 – Faculty of 1000 Biology: Evaluation for Borer et al PNAS 2007 Mar 27 104 (13):5473-8

B. Peer-reviewed publications (in chronological order)

*** indicates corresponding author**

1. Seabloom, E. W., P. R. Hosseini, A. G. Power, and E. T. Borer, 2009, Diversity and composition of viral communities: coinfection of barley and cereal yellow dwarf viruses in California grasslands. *American Naturalist.*173:E79-E98.
2. A. J. Brandt, E. W. Seabloom, **P. R. Hosseini**, 2009, Phylogeny and provenance affect plant–soil feedbacks in invaded California grasslands. *Ecology*: 90:1063-1072.
3. Ballantyne, F., D. Menge, A. Ostling, and **P. R. Hosseini**, 2008, Nutrient recycling affects autotroph and ecosystem stoichiometry, *American Naturalist*. 171:511-523.
4. Borer, E., **P. R. Hosseini**, E. Seabloom, and A. P. Dobson, 2007, Pathogen-induced reversal of native dominance in a grassland community *Proceedings of the National Academy of Sciences (U.S.A.)*.

5. **Hosseini, P. R.**, A. A. Dhondt, and A. P. Dobson, 2006, Spatial Spread of an Emerging Infectious Disease: Conjunctivitis in House Finches – Seasonal Rates and Geographic Barriers, *Ecology*. 87: 3037–3046.
6. **Hosseini, P. R.**, 2006, Pattern Formation and Individual-Based Models: The Importance of Understanding Individual-Based Movement. *Ecological Modeling* 194: 357-371.
7. Altizer, S., A. Dobson, **P. Hosseini,** P. Hudson, M. Pascual, and P. Rohani, 2006, Seasonality and the dynamics of infectious diseases. *Ecology Letters* 9:467-484.
8. Dhondt, A. A., S. Altizer, E. G. Cooch, A. K. Davis, A. Dobson, M. J. L. Driscoll, B. K. Hartup, D. M. Hawley, W. M. Hochachka, **P. R. Hosseini**, C. S. Jennelle, G. V. Kollias, D. H. Ley, E. C. H. Swarthout, K. V. Sydenstricker, 2005, Dynamics of a novel pathogen in an avian host: Mycoplasmal conjunctivitis in house finches. *Acta Tropica* 94(1):77-93
9. **Hosseini, P. R.,** A. Dobson and A. A. Dhondt, 2004, Seasonality and wildlife disease: How seasonal birth, aggregation and variation in immunity affect the dynamics of Mycoplasma gallisepticum in House Finches. *Proceedings of the Royal Society of London: Biological Sciences.* 271:2569-2577.
10. Kollias, G. V., K. V. Sydenstricker, H. W. Kollias, D. H. Ley, **P. R. Hosseini,** V. Connolly, and A. A. Dhondt, 2004, Experimental infection of individually caged House Finches with Mycoplasma gallisepticum. *J. Wildlife Diseases.* 40: 79-86.
11. **Hosseini, P. R.** 2003. How localized consumption stabilizes predator-prey systems with finite frequency of mixing. *American Naturalist* 161:567-585.
12. Campbell, S. P., A. Clark, L. Crampton, A. D. Guerry, L. T. Hatch, P. R. Hosseini, J. J. Lawler, R. J. O'Connor. 2002. An assessment of monitoring efforts in endangered species recovery plans. *Ecological Applications.* 12:674-681.
13. Ellner, S. P., E. McCauley, B. E. Kendall, C. J. Briggs, P. Hosseini, S. Wood, A. Janssen, M. W. Sabelis, P. Turchin, R. M. Nisbet, and W. W. Murdoch. 2001. Spatial dynamics and population persistence in a multispecies metapopulation: are spatial models necessary? *Nature*, 412(6846): 538-543.
14. McCauley, E., B. Kendall, A. Janssen, W. Murdoch, P. Hosseini, C. Briggs, S. Ellner, R. Nisbet, P. Turchin, and S. Wood. 2000. Inferring colonization processes from population dynamics in spatially-structured predator-prey systems. *Ecology*, 81(12): 3350-3361.
15. Nisbet, R. M., E. B. Muller, A. J. Brooks, and P. Hosseini. 1997. Models relating individual and population response to contaminants. *Environmental Modeling and Assessment,* 2:7-12.

C. Research Support

NONE

DO NOT SUBMIT UNLESS REQUESTED
Renewal Applications Only
SENIOR/KEY PERSONNEL REPORT

All Senior/Key Personnel for the Current Budget Period

Name	Degree(s)	SSN (last 4 digits) (b) (6)	Role on Project (e.g. PI, Res. Assoc.)	Months Devoted to Project Cal	Acad	Summer (b) (4), (b) (6)
Peter Daszak	PhD		PI			
Stephen P. Luby	PhD		co-PI			
Andrew P. Dobson	PhD		co-PI			
Auston M. Kilpatrick	PhD		Sr. Researcher			

Program Director/Principal Investigator (Last, First, Middle): Daszak, Peter

CHECKLIST

TYPE OF APPLICATION *(Check all that apply.)*

☒ NEW application. *(This application is being submitted to the PHS for the first time.)*

☐ RESUBMISSION of application number: _____
(This application replaces a prior unfunded version of a new, renewal, or revision application.)

☐ RENEWAL of grant number: _____
(This application is to extend a funded grant beyond its current project period.)

☐ REVISION to grant number: _____
(This application is for additional funds to supplement a currently funded grant.)

☐ CHANGE of program director/principal investigator.

Name of former program director/principal investigator: _____

☐ CHANGE of Grantee Institution. Name of former institution: _____

☐ FOREIGN application ☒ Domestic Grant with foreign involvement List Country(ies) Involved: Bangladesh

INVENTIONS AND PATENTS *(Renewal appl. only)* ☒ No ☐ Yes

If "Yes," ☐ Previously reported ☐ Not previously reported

1. PROGRAM INCOME ***(See instructions.)***

All applications must indicate whether program income is anticipated during the period(s) for which grant support is request. If program income is anticipated, use the format below to reflect the amount and source(s).

Budget Period	Anticipated Amount	Source(s)

2. ASSURANCES/CERTIFICATIONS ***(See instructions.)***

In signing the application Face Page, the authorized organizational representative agrees to comply with the policies, assurances and/or certifications listed in the application instructions when applicable. Descriptions of individual assurances/certifications are provided in Part III and listed in Part I, 4.1 under Item 14. If unable to certify compliance, where applicable, provide an explanation and place it after this page.

3. FACILITIES AND ADMINSTRATIVE COSTS (F&A)/ INDIRECT COSTS. See specific instructions.

☒ DHHS Agreement dated: 7/01/2007 ☐ No Facilities And Administrative Costs Requested.

☐ DHHS Agreement being negotiated with _____ Regional Office.

☐ No DHHS Agreement, but rate established with _____ Date _____

CALCULATION* *(The entire grant application, including the Checklist, will be reproduced and provided to peer reviewers as confidential information.)*

a. Initial budget period:	Amount of base $	19,999	x Rate applied	28.10	% = F&A costs	$	11,239
b. 02 year	Amount of base $	19,989	x Rate applied	28.10	% = F&A costs	$	11,234
c. 03 year	Amount of base $		x Rate applied		% = F&A costs	$	
d. 04 year	Amount of base $		x Rate applied		% = F&A costs	$	
e. 05 year	Amount of base $		x Rate applied		% = F&A costs	$	
					TOTAL F&A Costs	$	22,474.25

*Check appropriate box(es):

☐ Salary and wages base ☒ Modified total direct cost base ☐ Other base *(Explain)*

☐ Off-site, other special rate, or more than one rate involved *(Explain)*

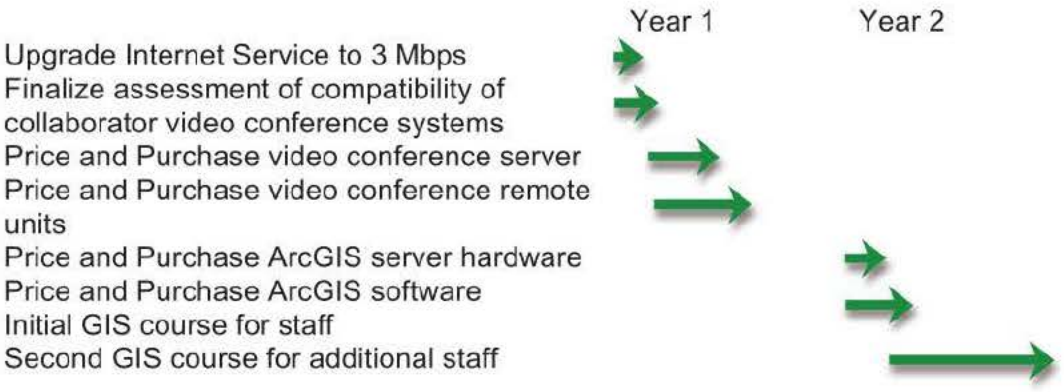
Explanation *(Attach separate sheet, if necessary.):*

4. DISCLOSURE PERMISSION STATEMENT: If this application does not result in an award, is the Government permitted to disclose the title of your proposed project, and the name, address, telephone number and e-mail address of the official signing for the applicant organization, to organizations that may be interested in contacting you for further information (e.g., possible collaborations, investment)? ☒ Yes ☐ No

Timeline

Upon funding, we will re-assess the available Internet options to maximize savings, and then initiate the upgrade in Internet service capacity. We will spend the first month of funding finalizing our initial assessment of compatibility of videoconference systems, particularly relative to our collaborators. We will also assess if any new technological innovations or price changes may affect our purchase decision. We will then purchase remote units for our field site bases with internet access, and one unit for ICDDR,B.
In the second year of funding, we will focus on enhancing our GIS capabilities, obtaining the GIS server and software. Once the initial setup is complete, our staff will begin appropriate coursework as soon as possible.

We have chosen to install video conferencing first, as this will enable the enhancement of planning stages, as well as coordination later, while upgrading our GIS capabilities is key for data analysis, the data analysis phase of the original grant is expected to more intense in year 2.



B-1. Description of Activities

Nipah virus (NiV) is a lethal zoonotic paramyxovirus with a wildlife (bat) reservoir host [1, 2]. It was first reported in Malaysia, where it spilled over from bats to pigs, causing severe respiratory infection, and subsequently to people. In people, NiV causes encephalitis, coma and death, and has a high mortality rate (around 40% in Malaysia) [3]. NiV has caused seven human outbreaks in Bangladesh since 2001, infecting 122 known cases, and causing 87 deaths [4-7]. The overall mortality rate in Bangladesh (71.3%) is striking. This, the lack of effective therapies or vaccines, and the discovery of chains of human-to-human infection in Bangladesh [7, 9], mark NiV as a significant threat to health in this country.

In the parent grant, we propose a series of studies to analyze the risk of spillover of NiV. These include field studies of viral and antibody prevalence and migration in reservoir hosts (*Pteropus* fruitbats), anthropological studies of human behavior, outbreak investigation, enhanced human surveillance for encephalitis in hospitals across Bangladesh. These studies also include landscape-scale analyses of factors that drive emergence, and alter wildlife reservoir spillover potential. For this activity, we seek ARRA ICT funding to enable greater access to GIS technology and training for our staff.

The activities under this grant are coordinated by the PI, Dr Peter Daszak, based at Wildlife Trust – a science-based NGO in New York. They involve extensive collaboration with the International Center for Diarrheal Disease Research, Bangladesh (ICDDR,B) – Dr Steve Luby; the Centers for Disease Control and Prevention, Atlanta (CDC) – Dr Paul Rota; Columbia University, New York – Dr Ian Lipkin; Princeton University – Dr Andy Dobson; and Univ. California Santa Cruz – Dr A. Marm. Kilpatrick. Currently, coordination of the whole group occurs via email and telephone conference calls. However, the phone lines in Bangladesh are poor, and the T1 internet line at ICDDR,B is much more reliable. In this ARRA supplementary application, we therefore also seek a central video-conferencing solution, and an internet upgrade at Wildlife Trust to support this.

1) GIS Technology and Training

In the parent grant, we aim to analyze the migration of bat reservoirs for NiV by following their movements using satellite and radio telemetry. We also aim to conduct spatial analysis of the dynamics of NiV spillover as it relates to bat movement, seasonality, fruit tree phenology and demography. To date, we have deployed six satellite collars on bats in Bangladesh and have been receiving location data since February, 2009. We plan to deploy up to 30 collars over the next 4 years, which will result in a relatively large spatial data set that will require coordinated analysis with our colleagues in Bangladesh who will be working on predictive modeling and risk map construction. Given the complexities of the spatial and temporal analyses we aim to conduct, we are looking to build our infrastructure to allow greater cooperative access to spatial information by acquiring a GIS server that will allow central shared access to GIS tools and databases. Such a server will have more memory and hard drive space than possible in laptops, but will allow remote desktop access either within the office, or from around the world. It will also allow the use and purchase of advanced GIS software on a cost effective basis. In order most effectively utilize such a server, we will also seek outside training in GIS software for three key US-based team-members (Drs Hosseini, Olival and Chmura).

We are currently planning on obtaining two additional ArcView licenses, as well a ArcGIS server license, the leading GIS software from ESRI corporation. This will enable us to build our GIS capabilities, and by implementing ArcGIS in a server environment, it will allow shared access to more advanced data analysis techniques. It will allow for central collation of multi-field site data in a central location, and will enable more complex, yet coordinate data analysis.

2) Communication Technology

Given the logistics of international collaboration, we are looking to acquire a central video conferencing solution for Wildlife Trust, such that we can increase communications with other collaborators as well as select central field locations. While many of our university counterparts already have access to video conferencing technology, we are currently limited to telephone communications, or to single end-user web solutions

designed without research in mind. This often limits the effectiveness of communicating of results and findings, as we cannot effectively talk, view a presentation (i.e., a graph of results so far), and see one another as with video conferencing. In addition, telephone lines in Bangladesh are notoriously difficult, often dropping calls or having poor sound quality. In contrast, the T1 lines at ICDDR,B, which relies heavily on internet communication, is much more reliable. We therefore often have to spend valuable research time and money on travel, in order to effectively coordinate our efforts. While such travel cannot be eliminated, it can be reduced to more essential levels. We can also expand communications to occasions that would not warrant travel, and achieve more research coordination through video conferencing between larger group meetings. This strategy should reduce the costs of our research, and substantially increase the quality and efficiency of our collaboration.

We have obtained price and availability for a system from Tandberg corporation, that would incorporate a mix of a larger central video conferencing service housed at Wildlife Trust, and several smaller portable devices that could transported to field locations. We are also planning to use mobile video conference systems from the same company that can operate independent of a T1 or other dedicated Internet connection. Tandberg has experience deploying solutions in many difficult environments, including remote construction sites. Our current plans are to maintain one unit at ICDDR,B. Note that the unit cost will be $1900, which is below the 10% threshold for a foreign entity under ARRA, and the clear purpose of this unit is to enable greater communication between Wildlife Trust, a U.S.-based N.G.O., the other US-based institutions involved in this project, and ICDDR,B. This system is based on the H.323 standard, and thus should be compatible with almost all other systems, including those at our collaborators' academic institutions. Additionally, such a video conferencing system would facilitate mentoring of many of the junior research staff at ICDDR,B involved with this project by senior research staff at ours and partner institutions. This will increase the contact between younger researchers and senior scientists who are reperesent a broad diversity of disciplines, and will increase the likelihood of interdisciplinary research, discussion, and the generation of insights in the key area of emerging infectious disease, which necessitates medical, veterinary, mathematical, evolutionary, and ecological knowledge.

B-2. Justification

This ICT intervention will enhance our ability for inter- and intra-group communication and provide an increased ability to analyze the GPS location data we are collecting. Together both of these interventions will allow quicker processing of data into deliverables. The video conferencing communications solution will enhance the quality of our research by allowing senior research staff to better coordinate efforts among field locales, increase mentoring of junior research staff, and provide an additional communication safety net. Increasing our GIS analysis capabilities from standard laptops, to a central GIS server will increase analytic capability, allow for larger datasets and analyses, and provide a central data storage and consolidation solution. Both of these interventions advance goals proposed in the original research design, but will speed the process, and deepen the nature of the research.

B-3. Potential Barriers to Implementation

For the video conferencing technology, we will need to assess and validate that any system we purchase will be compatible with our key collaborators, including our international partner ICDDR,B. However, since all rely on a high speed internet connection, and all of our collaborators (including ICDDR,B) have this, it should be straightforward.

One key barrier to implementation of both the GIS technology and the Communication technology at the moment is our own internet access. Our current setup is limited to 768 kbps; thus our grant also seeks funds to increase this level to at least 3 Mbps. We have checked with our current Internet service provider, and those in our area, and currently 3 Mbps is the greatest speed available to us at our location. However, several providers are upgrading service in the area, and higher speeds may actually be available at lower cost once these upgrades, which are outside our control, are in place. The switch to 3 Mbps service would readily

obtainable, would meet the current and future needs of our project, and consists simply of initiating a request for higher service levels, and paying the increased cost.

B-4. Sustainable Deliverable Outcomes

By setting up and obtaining a GIS server, we will have expanded our research capabilities. While software and licenses will have to be update regularly, and the hardware periodically, the training obtained by our staff in using GIS software will build longer-term capacity that will accelerate scientific discovery in the longterm. Additionally, once initiated, we will likely to be able to sustain these capabilities through later research grants and other funding.

By acquiring advanced video conferencing services with this grant, we would be able to sustain increased levels of communications with our international and US-based research partners beyond the two-year period of our grant request. Such systems would provide a long-term capacity for enhanced research coordination at Wildlife Trust, where the majority of our scientific programs are related to global investigation of emerging zoonoses. One of our other long-term global research programs is the discovery of zoonotic viruses. The porposed video communications system will not only facilitate coordinated meetings with co-investigators in Brazil, China, Mexico, and Malaysia, but will allow us to communicate in real-time with field teams who are implementing standardized sampling protocols and who will significantly benefit from increased communication. Further, field scientists will be able to directly communicate with laboratory scientists, who will be able to provide critical feedback about sample collection and handling – **ultimately increasing the efficiency of fieldwork, reducing costs both in time and money, and accelerating scientific discovery**.

Internet-based video conferencing will allow greater interaction between Wildlife Trust scientists and a wide array of institutions for the purpose of providing outgoing communications and seminars on disease emergence, as well as for researchers at Wildlife Trust to have access to seminars at remote locations such as our collaborators in Brazil, Mexico, Uganda, Indonesia, India and China. This will increase productivity with respect to grant and manuscript writing with US-based partner institutions, such as Columbia University, Princeton University, and the New York State Department of Health, as well as international partners such as the Indian Institute for Ecology, the East China Normal University in Shanghai, and IPE in Brazil. **The aim of this grant writing will be to generate international funding for our own (US-based) group from our collaborator's countries – a direct benefit to the US economy, in the spirit of ARRA.**

B-5. How Activities address ARRA

This activity addresses the ARRA goals by fostering **1)** The acquisition of new technology to increase productivity; **2)** Acceleration of scientific discovery by fostering more efficient and effective collaboration; **3)** Contracting for additional skills (training) from a US-based software provider; **4)** Contracting with a US-based internet supplier to increase our bandwidth; and **5)** Providing technical training for US- based staff (both at Wildlife Trust HQ and in the field) which will help them in job retention.

Given the goals and budget of our ICT supplement request, our proposal is largely focused on procuring additional needed equipment. In addition, to make the most effective use of this equipment (GIS server and software), we will be contracting for additional needed skills (training) from the US-based software provider (ESRI) for educational opportunities for key staff members. This will also provide these staff members with educational opportunities that will aid them in job retention, at Wildlife Trust and beyond, by having a wider array of skills for which they can be employed. Additionally we have focused on two of the key types of activities that were highlighted in the supplement notice, video conferencing for the group and GIS software, hardware and training. Thus we have focused key goals of the ARRA, by building infrastructure capacity and educational opportunities, by procuring the necessary equipment and training.

Addressing the Fogarty International Center's Strategic Plan

Our proposal addresses goal 4 the FIC Strategic Plan: To foster a sustainable research environment in low- and middle-income countries. It does this by providing video conference linkage between ICDDR,B in

Bangladesh with Wildlife Trust and the 3 other key collaborating institutions in our parent proposal. This addresses the specific language in goal 4: "Key strategic priorities include establishing linkages or hubs for sharing resources and knowledge across sites and **encouraging the adoption of information technology to advance research progress**".

References cited

1. Chua, K.B., et al., *Nipah virus: a recently emergent deadly paramyxovirus.* Science, 2000. **288**(5470): p. 1432-5.
2. Chua, K., et al., *Isolation of Nipah virus from Malaysian Island flying foxes.* Microbes Infect, 2002. **4**(2): p. 145-51.
3. Chua, K.B., et al., *Fatal encephalitis due to Nipah virus among pig-farmers in Malaysia.* Lancet, 1999. **354**(9186): p. 1257-1259.
4. Hsu, V.P., et al., *Nipah virus encephalitis reemergence, Bangladesh.* Emerging Infectious Diseases, 2004. **10**(12): p. 2082-2087.
5. ICDDRB, *Nipah encephalitis outbreak over wide area of western Bangladesh.* Health and Science Bulletin, 2004. **2**(1): p. 7-11.
6. Luby, S.P., et al., *Foodborne transmission of Nipah virus, Bangladesh.* Emerging Infectious Diseases, 2006. **12**(12): p. 1888-1894.
7. Gurley, E.S., et al., *Person-to-person transmission of Nipah virus in a Bangladeshi community.* Emerging Infectious Diseases, 2007. **13**(7): p. 1031-1037.
8. Yob, J.M., et al., *Nipah virus infection in bats (Order Chiroptera) in Peninsular Malaysia.* Emerging Infectious Diseases, 2001. **7**(3): p. 439-441.
9. Gurley, E.S., et al., *Risk of nosocomial transmission of Nipah virus in a Bangladesh hospital.* Infection Control and Hospital Epidemiology, 2007. 28(6): p. 740-742.

icddr,b
KNOWLEDGE FOR
GLOBAL LIFESAVING SOLUTIONS

29th May 2009

Dr Peter Daszak,
Wildlife Trust,
New York

Dear Peter

It gives me great pleasure to write a letter of support for your ARRA Administrative Supplemental grant for Support of Information and Communication Technology Initiatives (Notice NOT-OD-056). This application is a supplement to the Fogarty International Center-funded Ecology of Infectious Diseases award 2R01TW005869 which I am a co-PI on with you and our collaborators at Princeton, Santa Cruz, Columbia, and the CDC.

This is a perfectly-timed application. We are in the first year of our 5-year award, and are ramping up our collaboration both on this Nipah virus project, and a supplementary award for H5N1 avian influenza. While our groups work well together as collaborators, we are completely dependent on phone conference calls for team meetings. With phone lines to Bangladesh far less reliable than our T1 internet line, your request for Video-conferencing support is timely and exciting. Likewise, much of our research is based on interpretation of landscape-scale data as it relates to Nipah virus epidemiology and wildlife reservoir movement. ARRA funding for GIS software and training, and for satellite telemetry will be extremely valuable.

I would like to respectfully urge the panel to support this application. If funded, it would be a substantial boost to our collaborative research, and will fulfill the ARRA goals by a) modernizing research infrastructure, b) provide additional career-building educational opportunities for staff, and c) accelerating scientific discovery.

Sincerely,

Stephen P. Luby

Stephen P. Luby, MD
Head, Programme on Infectious Diseases and Vaccine Sciences
and Agency Head, Centers for Disease Control and Prevention,
US Embassy, Dhaka, Bangladesh

International Centre for Diarrhoeal Diseases Research, Bangladesh
68 Shaheed Tajuddin Ahmed Sharani, Mohakhali, Dhaka 1212, Bangladesh
Mail : ICDDR,B, GPO Box 128, Dhaka 1000, Bangladesh
Fax : 880-2-8823116,8812530,9885657,8811686,8812529,8826050,8811568
Phone : 880-2-8860523-32, Web: http://www.icddrb.org

Grant Number: 5R01TW005869-07

Principal Investigator(s):
PETER DASZAK, PHD

Project Title: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

PROGRAM ASSISTANT
WILDLIFE TRUST
460 WEST 34TH STREET
NEW YORK, NY 10001

Award e-mailed to: (b) (6)

Budget Period: 07/01/2010 – 06/30/2011
Project Period: 08/01/2002 – 06/30/2013

Dear Business Official:

The National Institutes of Health hereby awards a grant in the amount of $499,998 (see "Award Calculation" in Section I and "Terms and Conditions" in Section III) to WILDLIFE TRUST in support of the above referenced project. This award is pursuant to the authority of 42 USC 241 42 CFR 52 and is subject to the requirements of this statute and regulation and of other referenced, incorporated or attached terms and conditions.

Acceptance of this award including the "Terms and Conditions" is acknowledged by the grantee when funds are drawn down or otherwise obtained from the grant payment system.

Each publication, press release or other document that cites results from NIH grant-supported research must include an acknowledgment of NIH grant support and disclaimer such as "The project described was supported by Award Number R01TW005869 from the Fogarty International Center. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Fogarty International Center or the National Institutes of Health."

Award recipients are required to comply with the NIH Public Access Policy. This includes submission to PubMed Central (PMC), upon acceptance for publication, an electronic version of a final peer-reviewed, manuscript resulting from research supported in whole or in part, with direct costs from National Institutes of Health. The author's final peer-reviewed manuscript is defined as the final version accepted for journal publication, and includes all modifications from the publishing peer review process. For additional information, please visit http://publicaccess.nih.gov/.

Award recipients must promote objectivity in research by establishing standards to ensure that the design, conduct and reporting of research funded under NIH-funded awards are not biased by a conflicting financial interest of an Investigator. Investigator is defined as the Principal Investigator and any other person who is responsible for the design, conduct, or reporting of NIH-funded research or proposed research, including the Investigator's spouse and dependent children. Awardees must have a written administrative process to identify and manage financial conflict of interest and must inform Investigators of the conflict of interest policy and of the Investigators' responsibilities. Prior to expenditure of these awarded funds, the Awardee must report to the NIH Awarding Component the existence of a conflicting interest and within 60 days of any new conflicting interests identified after the initial report. Awardees must comply with these and all other aspects of 42 CFR Part 50, Subpart F. These requirements also apply to subgrantees, contractors, or collaborators engaged by the Awardee under this award. The NIH website http://grants.nih.gov/grants/policy/coi/index.htm provides additional information.

If you have any questions about this award, please contact the individual(s) referenced in Section IV.

Sincerely yours,

BRUCE R BUTRUM
Grants Management Officer
FOGARTY INTERNATIONAL CENTER

Additional information follows

SECTION I – AWARD DATA – 5R01TW005869-07

Award Calculation (U.S. Dollars)

Federal Direct Costs	$447,098
Federal F&A Costs	$52,900
Approved Budget	$499,998
Federal Share	$499,998
TOTAL FEDERAL AWARD AMOUNT	$499,998

AMOUNT OF THIS ACTION (FEDERAL SHARE) $499,998

SUMMARY TOTALS FOR ALL YEARS		
YR	**THIS AWARD**	**CUMULATIVE TOTALS**
7	$499,998	$499,998
8	$499,449	$499,449
9	$499,772	$499,772

Recommended future year total cost support, subject to the availability of funds and satisfactory progress of the project

Fiscal Information:

CFDA Number:	93.989
EIN:	1311726494A1
Document Number:	RTW005869B
Fiscal Year:	2010

IC	*CAN*	*2010*	*2011*	*2012*
TW	8476360	$253,998	$253,449	$253,772
TW	8476369	$246,000	$246,000	$246,000

Recommended future year total cost support, subject to the availability of funds and satisfactory progress of the project

NIH Administrative Data:
PCC: EID / **OC**: 414E / **Processed**: (b) (6) 08/04/2010

SECTION II – PAYMENT/HOTLINE INFORMATION – 5R01TW005869-07

For payment and HHS Office of Inspector General Hotline information, see the NIH Home Page at http://grants.nih.gov/grants/policy/awardconditions.htm

SECTION III – TERMS AND CONDITIONS – 5R01TW005869-07

This award is based on the application submitted to, and as approved by, NIH on the above-titled project and is subject to the terms and conditions incorporated either directly or by reference in the following:

a. The grant program legislation and program regulation cited in this Notice of Award.
b. Conditions on activities and expenditure of funds in other statutory requirements, such as those included in appropriations acts.
c. 45 CFR Part 74 or 45 CFR Part 92 as applicable.
d. The NIH Grants Policy Statement, including addenda in effect as of the beginning date of the budget period.
e. This award notice, INCLUDING THE TERMS AND CONDITIONS CITED BELOW.

(See NIH Home Page at 'http://grants.nih.gov/grants/policy/awardconditions.htm' for certain references cited above.)

An unobligated balance may be carried over into the next budget period without Grants Management Officer prior approval.

This grant is subject to Streamlined Noncompeting Award Procedures (SNAP).

In accordance with P.L. 110-161, compliance with the NIH Public Access Policy is now mandatory. For more information, see NOT-OD-08-033 and the Public Access website: http://publicaccess.nih.gov/.

This award is funded by the following list of institutes. Any papers published under the auspices of this award must cite the funding support of all institutes.

Fogarty International Center (FIC)

Treatment of Program Income:
Additional Costs

SECTION IV – TW Special Terms and Conditions – 5R01TW005869-07

FUNDING LEVEL
This non-competing award is issued in accord with the FIC FY10 Funding Strategy: http://www.fic.nih.gov/funding/fy_strategy/2010funding.htm and is consistent with the NIH Fiscal Policy Notice NOT-OD-10-039: http://grants.nih.gov/grants/guide/notice-files/NOT-OD-10-039.html.

PUBLICATIONS
All publications resulting from the research or research training supported by this award must acknowledge FIC and any co-funders (if applicable). This publication requirement applies not only to the primary grantee, but also to any subcontractors and /or trainees involved with the project.

CURRENT AND FUTURE YEAR LEVELS
In accordance with the October 27, 1995, NIH Guide announcement and NIH implementation, future-year recommended levels are shown as total costs (the sum of direct plus facilities and administrative costs).

CONSORTIUM/CONTRACTUAL COSTS
This award includes funds for consortium activities. Consortia are to be established and administered in accordance with the NIH Grants Policy Statement: http://odoerdb2.od.nih.gov/gmac/nihgps_2003/nihgps_2003.pdf

CATEGORICAL
Consortia and training-related expenses appear in the "other costs" category, trainee travel expenses appear in the "trainee travel" category, faculty travel expenses appear in the "travel" category, and personnel costs appear in the "salaries & wages" category.

FOREIGN TRAVEL
U.S. Flag carriers must be used for departure from or entry into the U.S. and for any other portion of the trip where available.

ANIMAL SUBJECTS RESTRICTION
Funds included in this award for research involving live vertebrate animals are restricted and may not be used for any other purpose without the written prior approval of the NIH awarding component. Under governing PHS Policy no funds may be drawn down from the payment system and no obligations made against federal funds for research involving live vertebrate animals prior to approval by the Office of Laboratory Animal Welfare (OLAW) of an Animal Welfare Assurance in accordance with the PHS Policy on Humane Care and Use of Laboratory Animals. This restriction applies to the applicant organization and all performance sites (e.g., collaborating institutions, sub-contractors sub-grantees) lacking OLAW- approved Assurances, whether domestic, foreign or interinstitutional. If the applicant organization does not have an Animal Welfare Assurance and the animal work will be conducted at an institution with an Assurance, the grantee must obtain an Inter-institutional Assurance from OLAW. Failure to submit the Animal Welfare Assurance to OLAW within the required timeframe or to otherwise comply with the above requirements can result in suspension and/or termination of this award, withholding of support, audit disallowances, and/or other appropriate action.

GRANTEES MUST NOTIFY THE FIC AWARDING OFFICE IN WRITING WITHIN 30 DAYS AFTER THE ASSURANCE HAS BEEN APPROVED AND PROVIDE A COPY OF THE APPROVAL. THIS INFORMATION MAY BE EMAILED OR FAXED TO THE SPECIALIST LISTED AT THE END OF THE NOTICE OF AWARD.

PROGRESS REPORT
Progress report request: The FIC would appreciate receiving emailed electronic copies of your progress reports to (b) (6) although we will still need the paper copy you usually send. The electronic copy will help with our record-keeping, speed up processing of noncompeting continuations and help when pulling together ?success stories? (e.g. for Congress, the NIH Director, etc.) from your work as a grantee.

FINANCIAL STATUS REPORTS (Standard Form 269)
In accordance with the NIH Grants Policy Statement, non-SNAP grantees must submit an annual Financial Status Report (FSR) within 90 days of the end date of each budget period. The FSR must be submitted in English, in terms of U.S. dollars and use the current rate in existence at the time it is prepared. The Financial Status Report must be submitted via the eRA Commons: https://commons.era.nih.gov/commons/. Questions regarding the FSR should be directed to:

Contact: Shannon Hershman
Government Accounting Branch
Office of Financial Management
National Institutes of Health
2115 East Jefferson St., MSC 8500
Room 4B432
Bethesda, MD 20892-8500
http://ofm.od.nih.gov/fsr.asp

-OR-

Rockville, MD 20852 (Use for FedEx, UPS and other courier services only)
Telephone: (b) (6)
Fax: 301-402-4934
http://ofm.od.nih.gov/fsr.asp

ADDRESS FOR FUTURE NONCOMPETING PROGRESS REPORTS
Please submit your hard-copy noncompeting progress report, no later than 2 months prior to the anticipated start date, to the followirg address:

Division of Extramural Activities Support, OER
National Institutes of Health
6705 Rockledge Drive, Room 2207, MSC 7987
Bethesda, MD 20892-7987 (for regular or US Postal Service Express mail)
Bethesda, MD 20817 (for other courier/express mail delivery only)
Phone Number: (301) 594-6584

This is the new centralized mailing address for all NIH Institutes/Centers. Do NOT submit the non-competing progress report directly to Fogarty International Center.

For up-to-date information, you may access the NIH Home Page at http://www.nih.gov/ and the FIC Home Page at http://www.fic.nih.gov/.

STAFF CONTACTS

The Grants Management Specialist is responsible for the negotiation, award and administration of this project and for interpretation of Grants Administration policies and provisions. The Program Official is responsible for the scientific, programmatic and technical aspects of this project. These individuals work together in overall project administration. Prior approval requests (signed by an Authorized Organizational Representative) should be submitted in writing to the Grants Management Specialist. Requests may be made via e-mail.

Grants Management Specialist: Angela Smith
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-594-1211

Program Official: Joshua Rosenthal
Email: (b) (6) **Phone**: (b) (6) **Fax**: 301-402-0779

SPREADSHEET SUMMARY
GRANT NUMBER: 5R01TW005869-07

INSTITUTION: WILDLIFE TRUST

Facilities and Administrative Costs	*Year 7*	*Year 8*	*Year 9*
F&A Cost Rate 1	26.1%	26.1%	26.1%
F&A Cost Base 1	$202,683	$215,333	$218,761
F&A Costs 1	$52,900	$56,202	$57,097

OMB No. 0925-0001

Grant Number 5R01TW5869-7	**Total Project Period** From: 08/01/2002 To: 06/30/2013
EIN: **Review Group:** 1311726494A1 ZRG1 BDA-K (50) R	**Requested Budget Period:** From: 07/01/2010 To: 06/30/2011
Title of Project: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh	**Due Date:** 05/16/2010 **Submitted Date:** 06/07/2010

Program Director/Principal Investigator: PETER DASZAK 460 West 34th Street New York , NY 10001 **Phone Number:** (b) (6) **Fax Number:** **Email Address:** (b) (6)	**Applicant Organization:** WILDLIFE TRUST WILDLIFE TRUST 460 West 34th Street New York , NY 10001 **Department:** **Major Subdivision:**
Administrative Official: Aleksei Avery Chmura 460 W 34th St., 17th Floor New York , NY 10001 **Phone Number:** (b) (6) **Fax Number:** 1.212.380.4465 **Email Address:** (b) (6)	**Signing Official:** Aleksei Avery Chmura 460 W 34th St., 17th Floor New York , NY 10001 **Phone Number:** (b) (6) **Fax Number:** 1.212.380.4465 **Email Address:** (b) (6)
Human Subjects: ☒ No ☐ Yes **Research Exempt:** ☒ No ☐ Yes **Exemption No:** **FWA Number:** **Phase III Clinical Trial:** ☒ No ☐ Yes	**Vertebrate Animals:** ☐ No ☒ Yes **Animal Assurance Number:** A3415-01 **Inventions and Patents:** ☒ No ☐ Yes ☐ Previously Reported ☒ Not Previously Reported
Program Income: ☒ No ☐ Yes	

Budget Period	**Anticipated Amount**	**Source**
F&A Changes:		

Primary Project/Performance Site Location

Organizational Name: WILDLIFE TRUST		
DUNS: 077090066		
Street 1: WILDLIFE TRUST	Street 2: 460 West 34th Street	
City: New York	County:	State: NY
Province:	Country: UNITED STATES	Zip/Postal Code: 10001
Congressional Districts: 08		

Program Director/Principal Investigator:	Grant Number
PETER DASZAK	5R01TW5869-7
Applicant Organization:	**Period Covered by this Report:**
WILDLIFE TRUST	07/01/2009 - 06/30/2010

Title of Project:

The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

SNAP Questions:

Has there been a change in the other support of Senior/Key Personnel since the last reporting period?

☒ No ☐ Yes

Justification:

Will there be, in the next budget period, a significant change in the level of effort for the PD/PI or other Senior/Key Personnel designated on the Notice of Award from what was approved for this project?

☒ No ☐ Yes

Justification:

Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

☒ No ☐ Yes

Justification:

Changes in Select Agent Research? ☒ No ☐ Yes

Changes in Multiple PD/PI Leadership plan? ☒ No ☐ Yes

Change in human embryonic stem cell (hESC) line(s) used? ☒ No ☐ Yes

Justification:

Human Subject Education Requirement:

Has the Involvement of Human Subjects changed since previous submission? ☒ No ☐ Yes

Has the Involvement of Animal Subjects changed since previous submission? ☒ No ☐ Yes

Publications:

Valid NIHMSID:	Citation ID:	Citation Source:	Citation Text:
		PD/PI Entered	(b) (4)
		PD/PI Entered	

PD/PI Entered	(b) (4)
PD/PI Entered	

All Personnel Report						
Program Director/Principal Investigator: PETER DASZAK			**Grant Number** 5R01TW5869-7			
Name:	**Commons ID:**	**Degree(s) Name:**	**SSN:**			
PETER DASZAK	(b) (6)	PHD, BS	(b) (6)	**Months Devoted to Project**		
Role on Project:	**Supplement Support:**		**DoB:** (MM/YY)	**Cal**	**Acad**	**Sum**
PD/PI			(b) (6)	(b) (4), (b) (6)		

Progress report highlights July 2009 - 2010

Grant Number: 5R01TW005869-07

Project Title: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

PI: Dr. Peter Daszak

Institution: Wildlife Trust

- **Enhanced surveillance in 12 Bangladesh hospitals for outbreaks of Nipah virus (NiV) encephalitis in humans:** We have identified the large outbreak in Faridpur on January 2010. There were eight Nipah cases. From July 2008 – July 2009 there were no Nipah cases identified, but subsequent laboratory evaluation identified a case and recovered an isolate at CDC.

- **Expanded diagnostic capacity at ICDDR,B for Nipah virus:** The ICDDR,B will be opening a new BSL 3 diagnostic laboratory in July 2009, which will have PCR and Serology capabilities, and in the next year they will have the ability to run a Nipah virus IgG ELISA and MassTag PCR.

- **Spatial serological survey of *P. giganteus* at 8 locations in Bangladesh:** Laboratory testing of these samples is in progress and results are expected in late 2010.

- **12-month serological study to detect outbreaks in bat colonies:** In April, 2010 we began a 12-month serological survey of juvenile bats in April in four districts designed to detect outbreaks in bat colonies based on changes in Nipah seroprevalence

- **Longitudinal study:** We have sampled 400 *P. giganteus* from July, 2009 – july 2010 in Faridpur. 1,600 sera have been collected and will be batch tested using an IgG ELISA at the Center for Infection and Immunity in July, 2010.

- **Satellite Telemetry: *Pteropus giganteus*:** We now have a full year's worth of data on bat movement in Bangladesh showing that bats typically remained near the roost site where they were first captured.

- **Remote sensing habitat study:** Preliminary analysis show differences in habitat and food availability near roosting sites may relate to migratory patterns, which has significant epidemiological implications for Nipah virus distribution

- **Discovery of a novel GB virus from Bangladesh bats**: Sequence analyses of sera from 16 free-ranging *Pteropus giganteus* bats from a single colony in Bangladesh indicated the presence of a previously undescribed GBV-like flavivirus. This is a potentially significant finding because of the potential that this may be a zoonotic virus.

- **Personnel and Training:** We have now trained six Bangladeshi veterinarians and four field technicians, to expand our Nipah virus surveillance team. We have developed two independent teams of professionals to conduct field surveillance of bat populations and to implement our 12-month juvenile bat surveillance study, which began in April 2010

- **4 Papers submitted, in press, or published from this grant during the last 12 months:** including (b) (4)

Progress report text July 2009 - 2010

Grant Number: 5R01TW005869-07

Project Title: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

PI: Dr. Peter Daszak

Institution: Wildlife Trust

Enhanced surveillance for outbreaks of Nipah virus (NiV) encephalitis in humans

One of our key goals is the early identification of NiV outbreaks in people so that we can 1) conduct sampling of bats at outbreak sites, 2) obtain isolates of NiV from people and bats, and 3) conduct epidemiological investigations to determine the causes of NiV outbreaks. ICDDR,B is continuing active surveillance for encephalitis in 12 hospitals throughout Bangladesh. In collaboration with the Government of Bangladesh, ICDDR,B has conducted human Nipah encephalitis surveillance in ten hospitals in the region where human Nipah outbreaks have been repeatedly identified. Six hospitals are active surveillance sites where the study physicians maintain a registry of patients who meet a case definition of meningoencephalitis syndrome and evaluate whether individual patients are part of a geographic and temporal cluster of meningoencephalitis cases. We investigate all clusters. In addition, from January to March each year we collect blood and cerebrospinal fluid samples from all patients who meet a meningoencephalitis case definition or admitted to the three large hospitals in this region that have historically seen the most human Nipah infections. This allows us to identify sporadic infections and increases the probability of collecting Nipah virus isolates. We test all serum for anti Nipah IgM. Virus isolation is conducted at CDC.

From July 2009 to April 2010, we have enrolled a total of 919 cases with meningoencephalitis syndrome. Of them, 107 (11.6 %) died.

During this period, surveillance physicians reported 11 clusters. Seven from Rajshahi Medical College Hospital, one from Rangpur Medical College Hospital and three from Faridpur Medical College Hospital. One cluster of Faridpur was Nipah encephalitis cluster.

We have identified the large out outbreak in Faridpur on January 2010. There were eight Nipah cases. Three were anti Nipah IgM positive, two negative and the rest three were not reported to hospital. Case fatality was 88% (7/8).There were two episodes of transmission. The initial Nipah cases were more likely to consume raw date palm sap prior to illness than controls (75% vs.7%, OR undefined, p=0.005). Subsequent cases were more likely to have contact with a symptomatic case patient than controls (100 % vs.14%, OR undefined, p =0.005).

Besides these three cases of outbreak, we have found nine more anti Nipah IgM positive sporadic cases from Faridpur surveillance hospital. Among sporadic cases, again case fatality was 88% (8/9). No other case has been detected from other surveillance sites.

Among sporadic cases, two were date palm sap collector by profession. One was a physician of Faridpur medical college hospital who took care of two other isolated cases admitted in hospital within last two weeks of his illness onset. We found that the physician didn't use personal protective equipments during care giving. The physician and one of the two cases died.

From July 2008 – July 2009 there were no Nipah cases identified, but subsequent laboratory evaluation identified a case and recovered an isolate at CDC.

We have expanded diagnostic capacity at ICDDR,B for Nipah virus. The ICDDR,B will be opening a new BSL 3 diagnostic laboratory in July 2009. The lab will have PCR and Serology capabilities, and in the next year they will have the ability to run a Nipah virus IgG ELISA (reagents donated by the Australian Animal Health Laboratory) and MassTag PCR (equipment and reagents from the Center for Infection and Immunity, W.I.Lipkin)

Spatial serological survey of *P. giganteus*

The aim of this work is to examine whether NiV is present in bat colonies throughout Bangladesh, or only in the regions where human outbreaks have occurred. The aim is to test the hypothesis that human behavioral factors are the key for NiV emergence, not bat viral dynamics. *Figure 1* shows the prevalence of anti-Nipah virus antibodies based on an IgG ELISA [1] at six of eight locations in our spatial survey, begun in 2006 under 1R01-TW05869 and supported, in part, from K08AI067549-01A (Epstein PI). Kushtia and Thakurgaon samples were also tested by SNT at the Australian Animal Health Laboratory (Thakurgaon results in Homaira et a. 2010). Four sites sampled bat colonies located within 30km of human outbreaks (Thakurgaon, Kushtia, Tangail and Faridpur - Faridpur has had multiple clusters of human cases between 2001-2010), and four locations are in districts that have not had any reported human cases of Nipah virus encephalitis (Khulna, Comilla, Sylhet, and Chittagong). Laboratory testing of these samples is in progress and results are expected in late 2010.

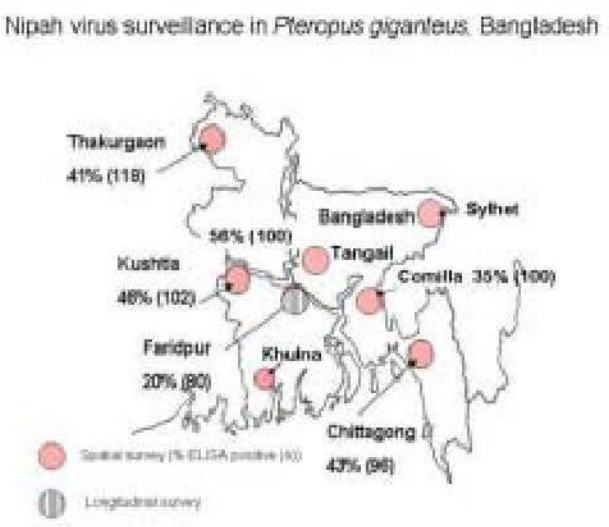


Fig.1. Map of Bangladesh showing seroprevalence of NiV antibodies in *P. giganteus.* Prevalence data are based on an IgG ELSIA. Faridpur is also the site of a longitudinal study. Data presented for Faridpur is based on the initial sample in 2006, and serial data from quarterly sampling over 36 months will be available in year 3 of this grant.

12-month serological study to detect outbreaks in bat colonies

In April, 2010 we began a 12-month serological survey of juvenile bats in April in four districts designed to detect outbreaks in bat colonies based on changes in Nipah seroprevalence. We had determined from our preliminary data that we would be able to detect outbreaks by selectively testing juveniles through their first year of life, and could reduce our per-site sample size from 100 bats to 15-20 bats and still detect sero-conversion. The four sites are broken down into two sets: the first two sites will be surveyed monthly, collecting blood from 20 juvenile bats (born this year) and 20 adults at each site. The

second set will be surveyed every 6 months and will provide additional scope both geographically and temporally so that we can monitor seroprevalence in two other locations. The monthly sites are in Rajbari District, a site which has had human Nipah virus outbreaks; and Chittagong, a site which has not but at which we know bats carry Nipah virus. The two bi-annual sites are Tangail (human outbreak in 2005) and Dinajpur (non-outbreak site).

It is currently unknown how long maternal antibodies to Nipah virus last in juvenile bats, but a recent study of (b) (4), . *P. giganteus* generally give birth in late April early May, and pups will cling to their dams for about the first 3 months of life. We predict that by September/October, pups born to dams with Nipah virus antibodies will become seronegative, and we will be able to observe a general decline in juvenile seroprevalence over the first several months of the study. After that point, spikes in juvenile seroprevalence (and overall seroprevalence) will suggest that Nipah virus has circulated through the colony.

Longitudinal study

The aim of the longitudinal study is to get further information on the seasonality of NiV dynamics within a single bat population. In 2007, we began a longitudinal study of a single bat population in Faridpur, less than 30km from the location of a human outbreak in 2004. We have been collecting saliva, urine, and serum from 100 bats every 3 months, and implanting ID microchips into each bat, allowing us to identify individuals, measure recapture rates, and estimate the population size. We have continued this study and have sampled 400 *P. giganteus* from July, 2009 – july 2010, as part of our long-term longitudinal study in Faridpur (begun under NIAID K08AI067549-01A2, Epstein PI, and now partly supported under this grant). A total of 1600 sera have been collected from our longitudinal study will be batch tested using an IgG ELISA at the Center for Infection and Immunity in July, 2010. We will be testing all 1600 sera from this site at one time with the same set of reagents to minimize test-to-test error. We will use the resulting serology data to determine whether there are seasonal changes in seroprevalence, particularly in juvenile bats, that may indicate that an outbreak has occurred. We will also test pooled urine from individual bats and pooled urine collected from underneath the colony for Nipah virus nucleic acid in order to determine whether there is seasonal shedding of Nipah virus, as has been suggested in other pteropid species [2].

Satellite Telemetry: *Pteropus giganteus*

We are using Satellite telemetry to test the hypothesis that bats in Bangladesh are more sedentary than Malaysia, where Nipah virus was originally discovered. We hypothesize that this sedentary behavior represents a different bat-human contact pattern than Malaysia and increases the frequency of spillover events. This study is the first of its kind in Bangladesh and the first to place collars on both male and female bats. In February, 2009 we deployed six PTTs affixed to collars. We selected 3 male and 3 female adult bats – the first time this group has collared female bats. The bats were captured in Shubarampur, a roost site near our longitudinal study site in Faridpur. We now have a full year's worth of data on bat movement in Bangladesh. Results from the first year of data are shown in **Figure 5A and 5B**. All six bats typically remained near the roost site where they were first captured. This is a marked contrast from what we observed with *Pteropus*

vampyrus in Malaysia (**Fig 5C)** [3]. Bat 90831, a female bat, flew 50 miles north to Sirajganj in May to a location 15 miles from Tangail, the site of a 2005 human outbreak. We have observed that the bats have stayed close to the Brahmaputra river, a centrally located geological landmark running north south. The mean maximum roosting (daytime) and feeding (nigh time) displacement respectively was 2.19 (+/- 1.37) km and 5.04 (+/- 3.72) km. Flying foxes are known to roost near freshwater sources, and these bats have been (b) (4) Flying foxes are also believed to use rivers and other geological features to navigate during migratory flights [4]. Bat 90832, also a female bat, appears to have flown 100 miles west into West Bengal, India, indicating an international migratory route, similar to what our group found

Figure 5. Map of Bangladesh showing satellite telemetry data from six *Pteropus giganteus*.

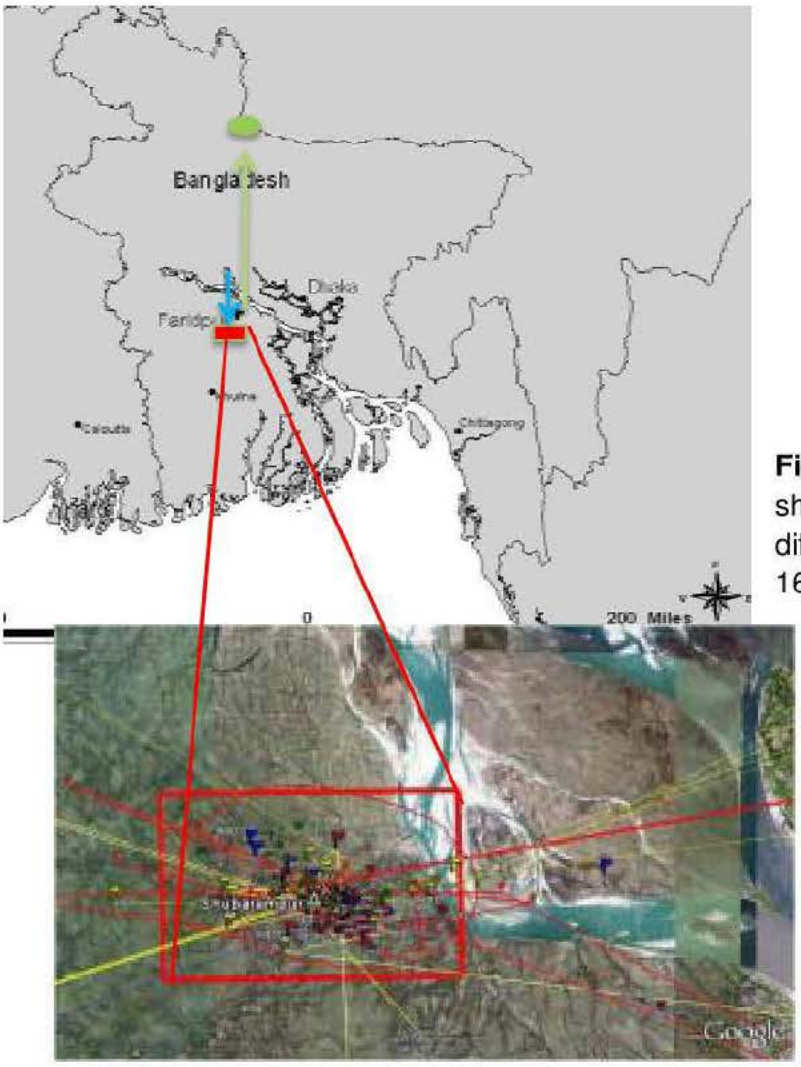


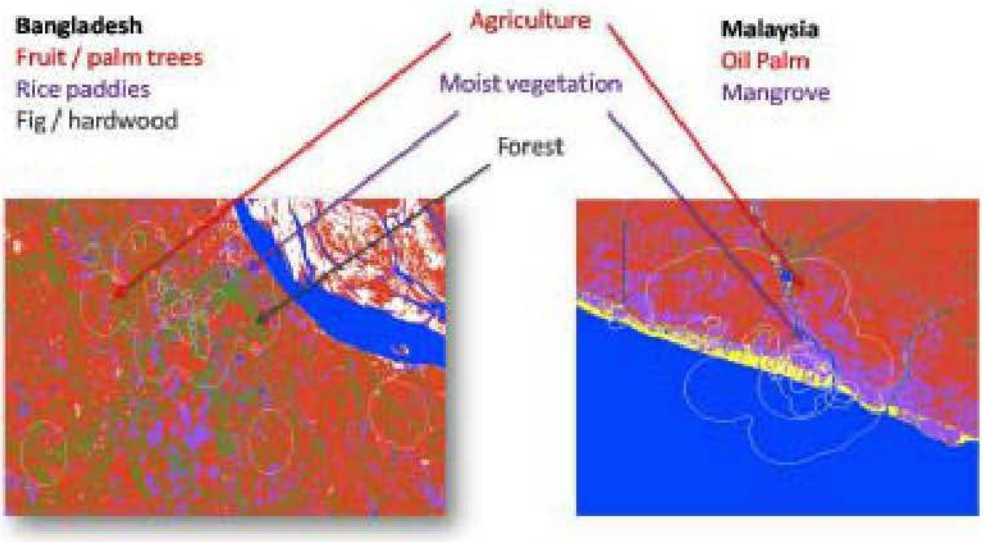
Figure 5A-C. 5A. Map of Bangladesh showing long range movement of two different female bats, one that traveled 160 km up to the India border and one that traveled 80km along the Brahmaputra river. **5B.** Inset showing telemetry data points from six bats over a 5-month period (Feb-July 2009). Bats typically stayed within 7 km of the roost tree, a marked difference from the hundreds of kilometers bats travelled in Malaysia (**5C**) in a 2004-7 study[3].

Remote sensing habitat study.

We are using remote sensing to study the differences in bat habitat surrounding the roost sites where we deployed satellite collars. Landsat imagery was obtained from the USGS Global Visualization Viewer (GLOVIS). GIS was used to create buffers that represent the most frequency recorded location points collected from Platform Telemetry Terminals (PTTs) attached to collars on tagged *Pteropus* fruit bats in Bangladesh and Malaysia. These buffers were overlaid on satellite imagery to analyze the land cover within the buffered bat habitat areas (**Figure 6**). Preliminary analysis shows that the bat habitats in Malaysia, are predominately forested areas (66.9% and 92.7%, respectively). The primary roost in Malaysia is also located in thick

vegetation, although in this case it is mostly mangroves (23.3%) as well as oil palm crops (30.4%, classified as agriculture). The foci of the Bangladeshi primary roost is located in a small forested area (27.0%), although the surrounding area is dominated by agricultural crops and rice paddies (59.7% and 11.3%, respectively) with small stands of forest interspersed in the landscape. The differences in habitat and food availability near roosting sites may indicate how large displacement is likely to be from a roost site during feeding activities, and may relate to migration patterns. The long-range movement of *P. giganteus* has significant epidemiological implications for Nipah virus distribution. If there is less long-range movement and thus relatively less connectivity among bat colonies in Bangladesh when compared to Malaysia where there appears to be frequent long-range movement and theoretically more connectivity among geographically disparate colonies, then there may be less frequent introductions of Nipah virus from infected bats. Less frequent introductions could allow for more time for the proportion of immune (seropositive) bats to decrease. A colony that has a low anti-Nipah seroprevalence and conversely a large susceptible proportion of the population, would theoretically be at risk for a larger outbreak (more potential infected individuals) should there be an introduction of Nipah virus. A greater proportion (and number) of infected individuals could then increase the risk of spillover to people via date palm juice contamination or other mechanisms. This dynamic will be explored in our disease modeling under Specific Aim 5 with our telemetry studies of *P. vampyrus* in Malaysia [5].

Figure 6. Remote sensing data to compare habitat and pteropid bat movement data between Malaysia and Bangladesh. Preliminary analysis indicates that there is more food available in the immediate vicinity of the studied bat roost in Bangladesh compared to Malaysia. Food availability is one of the drivers of bat migration and may be one reason that we observed more long-range movement by bats in Malaysia.



Discovery of a novel GB virus from bats Bangladesh

There has been a great deal of interest in the zoonotic potential of novel viruses from bats, following our earlier identification of SARS-like coronaviruses in bats in China in our original Nipah virus grant from the Fogarty International Center. As part of our surveillance for the current project, and in collaboration with a NIAID grant, we screened sera from 16 *Pteropus giganteus* bats from Faridpur, Bangladesh using high-throughput pyrosequencing. Sequence analyses indicated the presence of a previously undescribed virus that has approximately 50% identity at the amino acid level to GB virus A and C (GBV-A and -C). Viral nucleic acid was present in 5 of 98 sera (5%) from a single colony of free-ranging bats. Infection was not associated with evidence of hepatitis or hepatic dysfunction. Phylogenetic analysis indicates that this first GBV-like flavivirus reported in bats constitutes a distinct species within the *Flaviviridae* family and is ancestral to the GBV-A and -C virus clades. Several zoonotic flaviviruses, including Japanese

encephalitis virus, West Nile virus, and Kyasanur forest virus have been identified in bats; however, to date, GB viruses have not [6]. GB viruses A and C (GBV-A and -C) represent two recently identified species that are currently unassigned members of the family *Flaviviridae* [7]. GBV-A viruses have been described in New World primates and are not known to infect humans [8-10], while GBV-C (also known as Hepatitis G virus (HGV)) have frequently been isolated from humans in many regions of the World, including India and Bangladesh [10-14], and from wild chimpanzees (*Pan troglodytes*) in Africa [15, 16]. This is a potentially significant finding because of the potential that this may be a zoonotic virus. Future work will include attempting to identify GBV-bat nucleic acid from hepatitis patient samples in Bangladesh.

Personnel and Training

We have now trained six Bangladeshi veterinarians and four field technicians, to expand our Nipah virus surveillance team. We have developed two independent teams of professionals to conduct field surveillance of bat populations and to implement our 12-month juvenile bat surveillance study, which began in April 2010 to coincide with the birthing season of *Pteropus giganteus*. The primary Nipah virus bat surveillance team is headed by Dr. Ariful Islam, who graduated from CVASU in 2007 and completed a Master's degree in 2010. Dr. Islam heads the team operating in the Western part of the country, which includes our longitudinal surveillance site in Faridpur district as well as sites in Tangail and Dinajpur districts. He is successfully managing the Western team and acts as our liaison with the ICDDR.B. Dr. Stephen Luby has increased the size of his veterinary corps in his Programme on Infectious Disease and Vaccine Sciences at ICDDR,B to eight veterinarians, each of whom has trained or worked with our Nipah virus research team. Most recently, we trained Drs. Ausraful Islam, Dr. Sukanto (a visiting fellow), and Dr. Najmul Haider in bat capture and sampling techniques, working with a different species of frugivorous bat, *Rousettus leischnaulti*.

A second team is covering the eastern part of Bangladesh and is located in Chittagong at Chittagong Veterinary and Animal Sciences University (CVASU). The team is headed by Dr. Shahneaz Ali Khan, a veterinarian and lecturer at the university. Dr. Khan was trained under this program in all phases of field work including bat capture techniques, animal handling, anesthesia, sampling methods, sample storage, logistical planning, and safety. Dr. Ali Khan has worked under our Nipah virus surveillance program since 2006. He was hired as a lecturer by CVASU in 2008 and continues to collaborate with Wildlife Trust on our Nipah virus work, leading the new bat surveillance team and training graduate veterinarians in field epidemiology. CVASU is a strong partner in this collaboration with Wildlife and ICDDR,B, and we continue to train students and graduates from CVASU in wildlife epidemiology. On April 7 and 8, 2010, Drs. Jonathan Epstein and Kevin Olival each gave oral presentations about the work done under this project in a One Health conference in Dhaka which was organized by CVASU and ICDDR,B and co-sponsored by Wildlife Trust. The conference was attended by students and faculty, as well as international scientists and government officials.

We have two fully-trained field technicians, Mohammad Pitu Biswas and Mohammad Sheikh Gofur. Each has extensive animal handling experience, as they were former hunters and trappers. They have been trained and are competent in all aspects of animal handling and safety and have a good understanding of sample handling and storage. They have worked with us on bat surveillance for since 2006 and have become invaluable members of the team. We have now added two new technicians: Mr. Bellal and Mr. Abdul Hai who are training with both teams.

Papers submitted, in press or published from this grant during the last 12 months

1. (b) (4)
2.
3.
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Abstracts at the following meetings:

Bats and Emerging Viral Diseases Workshop, NIAID, Bethesda, MD (Sep 2009)

WHO/FAO/OIE Australia meeting (Nov 2009)

Berlin Bat meeting (Feb 2010)

One Health meeting, Dhaka, Bangladesh (April 2010)

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Principal Investigator(s):
PETER DASZAK, PHD

Project Title: The Ecology, Emergence and Pandemic Potential of Nipah virus in Bangladesh

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Award e-mailed to: (b) (6)

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Project Period: 08/01/2002 – 06/30/2013

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