

**WINDWARD
ISLANDS
RESEARCH
& EDUCATION
FOUNDATION**

2016 Annual Report



Cover Photo: On February 1, 2016 the World Health Organization declared a Public Health Emergency of International Concern in response to clusters of microcephaly and Guillain-Barre syndrome in the Americas, which were associated with the ongoing Zika virus outbreak in the region. The picture depicts Dr. Bill Nelson of Tetracore demonstrating the real time PCR equipment which can simultaneously diagnose Zika, Chikungunya and Dengue infection.



Mission Statement

WINDREF seeks to advance health and sustainable environmental development through multi-disciplinary research and education programs. WINDREF strives for program excellence by promoting collaborative relationships between internationally recognized scholars and regional scientists, and by adhering to the highest ethical and academic standards in the design and conduct of research.

Goals

- To provide a scientific resource centre capable of coordinating international collaborative research of the highest calibre in the areas of medicine, medical and veterinary public health, environmental health, anthropology, sociology, ecology, marine and terrestrial biology, and ethics.
- To provide a first rate academic opportunity to scientists from the Caribbean and around the world through unique research opportunities that enhances the knowledge and welfare of local and international communities.
- To conduct applied scientific research for the benefit of community and health development at the local, national and international levels.
- To share relevant scientific information with local and international communities in the pursuit of evidence-based policies.

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Director's Report on WINDREF Activities in 2016

2016 proved to be an extremely productive year for WINDREF. It was a year in which we recorded our largest ever funding intake and included our first direct NIH grant, an expansion to the physical facilities of the research Institute in Grenada and a further expansion of our research and education programs. We also mourned the loss of our first UK president Lord Walton who was a terrific inspiration to us. It seems only fitting to start this report with our obituary to his extraordinary contributions to science and medicine.

John Walton, Lord Walton of Detchant, sadly passed away on Thursday, 21 April, 2016 after a brilliant career during which he made enormous contributions to many fields in medicine. He graduated with a first class honors MBBS from Newcastle upon Tyne, then part of the University of Durham, England in 1945. He spent two years in the British army, becoming second-in command of a hospital ship, which covered the final evacuation of Palestine in 1948. He spent a year at the Massachusetts General Hospital in Boston with Raymond D Adams from 1953 to 1954. He was appointed Professor of Neurology in Newcastle and Dean of Medicine (1971-1981). From 1983-1989 he was head of Green College, Oxford. He obtained his MD in 1952, FRCP in 1960, DSc in 1973, and founding fellow of the Academy of Medical Sciences in 1998. He served as president for many organizations including the British Medical Association (1980-1982), the General Medical Council (1982-1989), the Royal Society of Medicine (1984-1986), the Association of British Neurologists (1986-1987) and the World Federation of

Neurologists (1989-1997). He was knighted in 1978 and became a cross bench life peer in the House of Lords in 1989. He had honorary degrees from seven British Universities and from universities in France, Italy and Thailand and was an honorary member of 21 national neurological associations.

Lord Walton served as the first president of WINDREF (UK) from 1999 to 2004. He made many visits to Grenada and gave the WINDREF lecture entitled "A doctor in the house" in 2005. For his contributions he also was awarded the Mike Fisher Memorial award in 2006. He loved his local football team Newcastle United and he thoroughly enjoyed playing golf with a tremendously competitive spirit, a quality he brought to everything he put his hand to. His clear thinking, brilliant mind and incisive but fair decisions were much appreciated and will be greatly missed by everyone.

Following the outbreak of Chikungunya virus (CHIKV) in 2014 the Zika virus (ZIKV) arrived in Grenada at the end of April 2016. As with the CHIKV outbreak WINDREF was rapidly able to respond to the Ministry of Health's request to provide a diagnostic service to complement that provided by the Caribbean public health agency (CARPHA). Once again the service was provided through our close collaboration with the U.S. Navy diagnostic laboratory (NIDDL) in Bethesda, Maryland and Tetracore. This annual report details our work conducted in collaboration with many partners on the Zika outbreak, which has lasted much longer than the previous CHIKV outbreak in 2014. The global impact of these arboviruses, together with that of Dengue, all of which are transmitted by the *Aedes aegypti* mosquito has formed the focus of much of our work

during 2016. All of the other research projects remained ongoing during the year.



WINDREF research scientists and Dr. Bill Nelson from Tetracore in the laboratory with the real-time PCR machine, which was used for the diagnosis of Zika, Dengue and Chikungunya viruses during the recent Zika virus outbreak in Grenada.

A major expansion of the physical facilities of the WINDREF Research Institute took place between mid-May and mid-August 2016. Two new offices were created at the front of the building and an expansion of the conference room was completed. This has provided much-needed office space for the new biostatistician, Dr. Paul Fields, who has been a senior research fellow with WINDREF for almost 15 years.

The 16th annual WINDREF and 8th annual K.B. Taylor Memorial lecture was delivered by Professor Ian McConnell on 9th November 2016 entitled "One Health: lessons from the past and future opportunities". Approximately 300 faculty and students attended the lecture, which was received very positively, and a number stayed on to talk to the speaker at the reception afterwards. Prof McConnell is Emeritus Professor of Veterinary Science in

department of Veterinary Medicine at the University of Cambridge, UK. He is a Founding Fellow of the Academy of Medical Sciences. His work resulted in his election to Fellowships of the Royal Society of Medicine and Royal College of Pathologists, Edinburgh

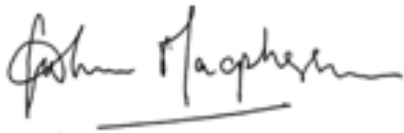


Ian McConnell and Cal Macpherson share some thoughts on one health prior to the lecture.

and he is a Professorial Fellow in Vet Science of Darwin College Cambridge.

After obtaining his veterinary degree from the University of Glasgow, Professor McConnell carried out his PhD in immunology at Cambridge. He has held various academic positions in the Royal Postgraduate Medical School in London, the Medical Research Council's Laboratory in Cambridge and was Professor of Veterinary Pathology at the University of Edinburgh from 1984-1994. He returned to Cambridge in 1994 as Professor of Veterinary Science and Director of Research in the veterinary school. Prof McConnell has 170 peer-reviewed publications, which focus on studies on the immune system in health and disease. His particular focus is on infectious diseases of man and animals including zoonoses and their impact at a global level on public health. On behalf of the members of the Grenada, United Kingdom, and United States Boards of

Trustees and Directors, I would like to thank our collaborators and donors for making 2015 a very successful year for WINDREF. We thank all of our donors for supporting the work of WINDREF over the past year, and look forward to another successful year in 2017.



Calum N.L. Macpherson
Director, WINDREF

WINDREF Organization

Board of Directors

- Baroness Howells of St. David's, OBE (President)
- Calum N. L. Macpherson, PhD, DIC, FRSPH (Vice President & Director)
- Trevor P. Noel, MPH, FRSPH (Deputy Director)
- Margaret Lambert, MA, (Secretary Treasurer)
- Mary Jeanne Kreek, MD, PharmD (Hon), PhD (Hon)
- Karen Lawson, PhD
- Allen Pensick, PhD
- Ellen Ratner, MEd
- Joseph Feldman, MD
- Lord Soulsby of Swaffham Prior, MRCVS, DVSM, MA, CBIol, FIBiol, DSc (Hon), (Past President)

Board of Trustees (United Kingdom)

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- Sir Kenneth Calman, KCB, FRCSE
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- QPM, DL, FRSA,
- Lord Trees of The Ross, DVM, PhD
- Sir Kenneth Stuart, MD, DSc
- Richard Summerfield, MB, BChir
- Neil Poulter, MD
- Patrick Orr
- Margaret Lambert, MA (Ex Officio)
- Calum Macpherson, PhD, DIC, FRSPH (Ex Officio)

Scientific Advisory Board

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- John R. David, MD
- John J. Ferguson, MBChB, FRCGP
- Malcolm A. Ferguson-Smith, MBChB, FRCP, FRCPath
- Edmond Fischer, DSc
- Sir Malcolm Macnaughton, MD, LL.D., FRCPG, FRAC
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- Oscar Jordan, GCM, MB, ChB, FRCPE, DCH
- Mary Jeanne Kreek, MD, PharmD (Hon), PhD (Hon)
- Ian McConnell, BVMS, FRSE, F. Med. Sci.
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- Neil Poulter, MD, PhD
- Sir Kenneth Stuart, MD, DSc (Hon)
- Melinda S. Sothern, PhD, CEP
- Richard Scribner, MD, MPH
- M. S. Swaminathan, DSc
- John B. Zabriskie, MD
- James Hospedales, MB, BS, MSc

Administration — Grenada

Dr. Randall Waechter continued as Grants Administrator, Mr. Kareem Coomansingh continued as IRB Administrator and was also promoted to Assistant Grants Coordinator, Ms. Isha English continued as Assistant Administrator, and Ms. Naomi Alexander

continued as Secretary in 2016. Ms. Yvette Baptiste joined WINDREF as secretary in 2016. Ms. Celia Clyne Edwards provides legal support.

Administration — United States

WINDREF (USA) was established as a 501(c)3 non-profit organization to facilitate coordination of the USA activities and to administer charitable donations from the United States. Its goal is to enhance the development of WINDREF's research and educational programs. The offices are located in Great River, New York. Ms. Tyeast Shaw provides administrative and logistical support, and Mr. Michael Cahill provides legal support.

Administration — United Kingdom

WINDREF (UK) was set-up as a charitable trust in Winchester, England in 1999 to promote collaboration between WINDREF scientists and academic centers of research in the United Kingdom and the European community. A Board of Trustees was appointed in 1999 to oversee the activities of WINDREF (UK).

Senior Research Fellows

- Hugh W. Ferguson, BVM&S, PhD, Dipl. ACVP, MRCVS, FRCP
- Paul Fields, PhD
- Paul Garner, MBBS, PhD
- Mary Glenn, PhD
- Duane Gubler, ScD
- Ruth Milner, MSc
- Stephen Morse, PhD
- Leslie Ramsammy, PhD, DSc (Hon)
- Douglas Slater, MD, MPH
- Stanley Weiss, MD
- Melinda Southern, PhD
- Richard Scribner, MD, PhD

Research Fellows

- John Adamski, MD, MSc, MPH
- Muge Akpinar-Elci, MD, MPH
- Zuri Amuleru-Marshall, PhD
- Glennis Andall, PhD
- Charles Avgeris, MD, MSc
- Satesh Bidaisee, DVM, MSPH, MSB, FRSPH, EdD
- Beverly Bonaparte, BSN, PhD
- Grant Burgess, PhD
- Dirk Burkhardt, MD, MSc, PhD
- Reccia Charles, PhD
- Sonia Chehil, MD, FRCPC
- Cheryl Cox Macpherson, PhD
- Andrea Easter-Pilcher, PhD
- Francis Fakoya, MBBS, PhD
- Martin Forde, ScD
- Orazio Giliberti, MD
- Natalie Hendon, PharmD
- Richard Kabuusu, DVM, MPH
- Victoria Kimotho, MPH
- Svetlana Kotelnikova, PhD
- Desiree LaBeaud, MD, MSc
- Barbara Landon, PsyD
- Matthias Lorenz, PhD
- Marios Loukas, MD, PhD
- Theresa McCann, MPH, PhD
- Barrymore McBarnette, MD, MPH, MBA
- Craig McCarty, PhD
- Clare Morrall, PhD
- Trevor Noël, MPH
- Shamdeo Persaud, MD, MPH
- Roger Radix, MD, MPH, MIB, FRSPH
- Christine Richards, PhD, MPH
- Bonnie Rusk, MSc
- Samina Rutrecht, PhD
- Hugh Sealy, PhD., P.Eng.
- Karen Schioler, PhD
- Shanti Singh, MD, MPH
- Kamilah Thomas-Purcell, PhD, MPH
- Randall Waechter, BBA, PhD

Research Scientists

Sadiq Al-Tamini, Jonathan Ashcroft, Sumita

Asthana, Yitzhack Asulin, Bishara Baddour, The study protocol was reviewed and approved by the St. George's University Institutional Review Board (IRB) (Project number: 09014) and the Ministry of Health (Grenada) Research Oversight Committee (ROC) and the Ministry of Education (Grenada) ROC. On the advice of our WINDREF statistician thirty eight of the fifty six primary schools in Grenada were selected for inclusion in this study and if a grade/standard was selected all members of that grade/standard were given the opportunity to participate regardless of their class size to adhere to ethical soundness.

Jean-Pierre Barakat, Matthew Beeson, Keith Bensen, Matthew Boles, Karen Brennan, William Brown, Matt Browne, Ella Cameron, Nicholas Caputo, Jessica Clayton, Mmakgomo Coangae, Rae Connolly, Abraham El-Sedfy, Karla Farmer, Daniel Firer, Kristy Fisher, Scott Forman, Brandon Francis, Vamsi Guntur, François Hallé, Anthony Junck, Megan Kaminskyj, Sebastian Kreitzschitz, Erik Lacy, Ede Langevine, Richard Lehman, Jason Lowther, Setshidi Makwinja, Paul Mancuso, Baher Maximos, Shanice McKain, John McCormack, David Melamed, Kirk Minkus, Jerry Mitchell, Jessica Morlok, Kevin Neill, Bayela Nfila, Yolanda Ng, Michael Nillas, Steve Nimrod, Andre Panagos, Rakesh Patel, Barry Politi, Sandeep Pulim, Sean Ramsammy, Justin Rebo, Alan Rhoades, Laura Robinson, Karin Schioler, Corey Schwartz, Sarah Scott, Christopher Skaff, Nadia Solomon, David Steinberg, Derrick Tlhoiwe, Sarah Treter, Nghia Truong, James Tsai, Dan Twyan, Frank Van Natta, Ru-Amir Walker, Juliette Williams, David Winokur, Colleen Wunderlich, Elliot Yung.

Current Research Projects

Elimination of the Neglected Tropical Diseases in the Western Hemisphere with Particular Reference to the Soil Transmitted Helminths

This study focuses on the Incidence of Neglected Tropical Diseases with a specific emphasis on the Soil Transmitted Helminths (STH) with the aim to tackle the three main helminthes; *A.lumbricoides*, *T.trichiura* and *N.americanus/A.duodenale*. The study has been part of a national elimination program for Grenada, Carriacou and Petite Martinique.

The informed consent forms and attitudes, behavior, and practices (ABP) questionnaires were distributed to the 38 schools and disseminated by the school principals to the parents/guardians. These informed consent forms and ABP questionnaires had already been pilot tested in several schools that were not included in the surveillance part of the study. Informed written consent was obtained from all parents or legal guardians of minors. All participants were free to withdraw from the study at any time during the consultation with no further obligation.

Before a questionnaire was administered or any stool sample was obtained, an informed consent to participate was obtained. A parental or guardian signature at the bottom of the form indicated authorization for a child's participation in the study. One signed consent form was required per participant, such that when multiple children from one house participated in the study, they each had their own consent form. After informed consent was obtained, the participant was officially enrolled in the study and was assigned a participant number. This number was present on all the questionnaires and stool samples that were subsequently

collected for that participant. The incidence of STH was ascertained and the possible correlation of these results with the ABP questionnaire was investigated. The positive subjects were treated using albendazole.

Data Collection

A paper copy questionnaire to ascertain the ABP of school students that had been pilot tested on parents and guardians of primary school students from Grade 4 at the South St. George Government School was used for this study. This paper copy questionnaire was to ascertain the socioeconomic status of participants and their potential for current, past and future exposure/infection. The paper copy questionnaire was administered to the parents or guardians when they signed the informed consent. The questionnaire consisted of twelve questions that were applicable to STH. In addition, a piloted electronic questionnaire was created for the primary school students and it was administered via Turning point and the use of an Automatic Response System (ARS) ("clickers") prior to and after a 10-minute PowerPoint presentation that was designed to sensitize the students to STH and their control. The use of the electronic questionnaire pre and post intervention was to test the difference in short term knowledge recall. The post-intervention electronic questionnaire was administered within a year of the initial intervention to test long term knowledge recall. All three questionnaires were pilot tested with people who did not otherwise participate in the survey.

Educational Component - Intervention to inform knowledge

After assessing the ABP and establishing the

baseline prevalence we established the knowledge level of the children and subjected them to an intervention to inform knowledge that was assessed using ARS. In addition, the students were sensitized via laminated educational posters that were placed in each



Figure 1: One of the STH Control/Elimination program posters placed in all 56 primary schools in Grenada

of the 56 primary schools throughout Grenada (Figure 1).

In each of the primary schools the posters were erected and a poster ambassador was appointed to safeguard the poster. One year later all 56 posters were intact and still on display in their schools. The ARS (seen in Figure 2) allowed for comparative analysis before and after the intervention at the individual, school and country level. This ARS technology has never been used for STH and definitely not in the Caribbean region. This tested the effectiveness of the intervention and was novel. This lent itself to both public health and parasitology in that it sought to intervene at a country level...this had not been done in Grenada before. This intervention medium will provide advantages for middle and low-income countries where

resources are at a minimum.



Figure 2: Automatic Response Systems (ARS); Primary school students with the turning point

The assessment of the 56 primary school areas to characterize STH was facilitated through the novel use of ARS (Figure 2) as well as field observation. The ARS provided individual and school level data characterizing factors believed to be associated with STH in Small Island Developing States (SIDS) such as Grenada.

The protocol involved in using the ARS was as follows:

- Schools were randomly selected
- Classes were randomly selected
- Sample number in Parishes was proportional to population distribution
- Class register was obtained (Names and Gender noted)
- Assignment of Turning point clicker number to individual students to ensure no swapping of clickers (see Figure 2 above)
- Only students present on the day were surveyed
- Classes were Grade 4 and/or Grade 5 (to allow for attrition levels)

The five step process used to assess the

students' short and long-term knowledge: Eight questions were administered via turning point technology.

An educational STH intervention presentation was given to the students.

The same eight questions were administered again.

The students were assessed for their short term recall knowledge.

The same eight questions were administered seven months later without the intervention presentation and the students' long term recall knowledge was assessed.

An example of the ability of using the ARS (Figure 2) to achieve immediate comparative results pre and post the intervention for a question administered during the pilot testing of the study (Table 1).

Comparative Results	Responses			
	Pre Presentation		Post Presentation	
	Percent	Count	Percent	Count
15. Where do people get worms from?				
A. Dogs	15.22%	7	6.67%	3
B. Cats	2.17%	1	2.22%	1
C. Cows	2.17%	1	2.22%	1
D. Chickens	30.43%	14	6.67%	3
E. Other People who have it	50.00%	23	82.22%	37
	100%	46	100%	45

Table 1: Turning Point technology comparative results for questions asked at a primary

Results

The attitudes behavior and practice of schoolchildren as relayed by the parents or guardians is displayed in Table 2.

Questions	Response:Proportion (95% Confidence Interval)
Does your child regularly wash his or her hands before eating?	Yes: 66% (63 – 69%) Unsure: 24% (21 – 27%) No: 10% (8 – 12%)
Where does your family get its water supply?	Inside Pipe: 85% (82 – 88%) Standpipe: 14% (11 – 16%) River: 1% (0.6 – 2.3%)
What kind of toilet facility does your household have?	Indoor Toilet: 57% (54 – 61%) Outdoor Latrine: 43% (39 – 46%)
Does your child play around an outdoor latrine area?	Always: 3% (1.3 – 3.5%) Sometimes: 26% (23 – 30%) Never: 71% (68 – 75%)
Does your child wear shoes outdoors?	Always: 40% (37 – 44%) Sometimes: 58% (55 – 62%) Never: 2% (0.8 – 2.6%)
Does the person who prepares food for your family wash vegetables before cooking and fruits before cooking?	Always: 90% (88 – 92%) Sometimes 10% (8 – 12%) Never: 0.1% (0.0 – 0.7%)
Has your child ever had deworming medication?	Yes: 82% (79 – 84%) No: 18% (16 – 21%)

Table 2: Attitude, Behavior and Practice (ABP) of primary school children as relayed by parents/guardians

Parish	Number of students sampled	Positives	Estimated Prevalence %	Not-Greater-Than Confidence Intervals
Petite Martinique	6	0	0	<39 %
Carriacou	8	0	0	<31 %
St. Andrew's	191	3	1.6	< 4 %
St. David's	26	0	0	<11 %
St. George's	170	0	0	< 2 %
St. John's	43	1	2.3	<11 %
St. Mark's	31	1	3.2	<14 %
St. Patrick's	51	2	3.9	<12 %
Total	526	7	1.3	< 2.5 %

Table 3: Estimated STH Prevalence in Primary school children by Parish

The initial stool samples were analysed and the results can be seen in Table 3.

The knowledge intervention was assessed using ARS and the results can be seen in Figure 3, 4 and 5. The initial number of Primary school participants in the ARS STH intervention in March 2013 was 903 students from 38 schools. Of the 903 students from the initial ARS survey, 767 were followed up and 136 participants were lost to follow up. This represented an 85% inclusion on follow up of participants from 7 months previously and a 15% loss to follow up for the ARS STH intervention.

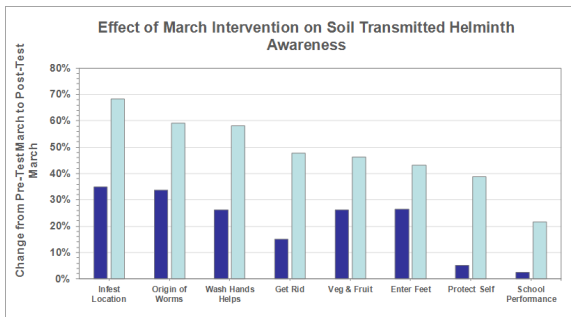


Figure 3: Short – Term Change in STH Awareness March 2014

In Figure 3 there was a positive short-term effect from the educational intervention in STH knowledge for all questions across all 903 students ($p < .001$).

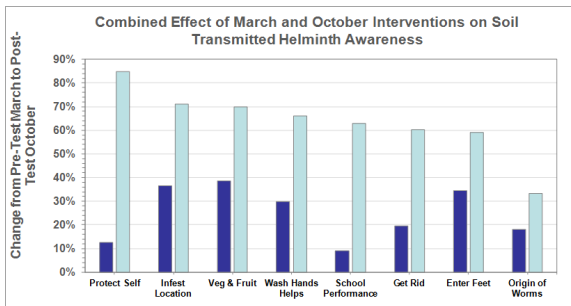


Figure 4: Long – Term Change in STH Awareness March 2014 pre intervention - October 2014

In Figure 4 there was a positive long-term effect from the educational intervention in STH knowledge for all questions across all 767 students ($p < .001$)

In Figure 5 the passage of time with no

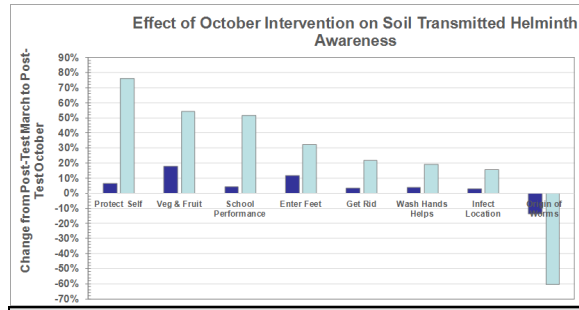


Figure 5: Time Effect on STH Awareness without Reinforcement March 2014 post inter-

reinforcing intervention showed a decrease in knowledge for only one of the eight questions (Origin of Worms) across all 767 students ($p = 0.011$).

There was no significant statistical difference across schools. In summation, there was no evidence of a location effect; i.e., it did not matter where we administered the treatment. The average improvement as a percent of possible improvement was 52%. This is a significant statistical difference across questions. In summation, the students did better in respect of their factual knowledge after the PowerPoint presentation treatment.

The final stool samples were analysed after the interventions and the results can be seen in Table 3.

Discussion

Parish	Number of students sampled	Positives	Estimated Prevalence %	Not-Greater-Than Confidence Intervals (95%)
Petite Martinique	6	0	0	< 39 %
Carriacou	8	0	0	< 31 %
St. Andrew's	189	0	0	< 2 %
St. David's	23	0	0	< 12 %
St. George's	157	0	0	< 2 %
St. John's	43	0	0	< 7 %
St. Mark's	30	0	0	< 10 %
St. Patrick's	48	0	0	< 6 %
Total	504	0	0	< 0.6 %

Table 3: Estimated STH Prevalence in primary school children by parish post interventions of

1) Attitude Behavior and Practice

The questionnaires administered by paper to evaluate the individual level data characterizing STH related outcomes and predictors at both the individual and school level were from 811 participants (parents or guardians). It is hoped that this tool can be generally applied to other tropical countries as a precursor in an effort to more effectively control disease transmission on a wider scale. The practical recommendations such as In-house sanitation facilities can be made. The wearing of shoes outdoors would be another more practical recommendation that should be enforced to prevent hookworm infection. The fact that the majority of parents or guardians (82 % of those surveyed) are familiar with antihelminthics is a positive from the perspective of compliance when their children are afflicted with STH and need to be treated. There is no requirement for social marketing because the drugs both generic and brand name are known by the community which is different to the challenge

that exists with new drugs on the market. Once these responses are taken into account it will enable limited resources to be used more efficiently to combat the problem of infection with STH in SIDS. The evidence is there to assist the policy makers with instituting evidence based policies. It is hoped that through this medium there will be an increase in the appreciation of the public health importance of STH in Grenada.

2) Knowledge (Turning Point technology)

The response by students via ARS was not different across schools. There was a change of factual knowledge by giving the students an educational experience via ARS. There are arguments for giving education in conjunction with chemotherapy on a case by case basis. We can make a conjecture as it relates to eliminating it. It is *prima facia* valid. The overarching argument is that it will help: it is cheap to administer, it is easy to administer and the cost is minimal. At a fundamental level ARS communicated key information: some STH larvae can enter through the skin of the feet and washing hands with soap and water after playing outside reduces the chance of getting STH. It is not possible to state whether it was the chemotherapy or the education or the combination that led to the elimination of the STH from Grenada. However, both were done and here is the result. It is a positive move because other diseases can be eliminated. In general, persons that had no or limited knowledge are now empowered with knowledge to affect their behavior and make a difference.

3) Sample prevalence (Stool)

Comparing the proportion of positive cases after the intervention (0.0%) with the

proportion of positive cases before the intervention (1.3%) using an exact Chi-square test, the results shows that the proportions are statistically different (p -value $< .001$). This provides strong evidence in support of a reduction in the prevalence of STH within the school children involved in the study. The results also show that if the entire population of Grenadian school children had received the intervention, the proportion of positive cases would not be greater than 0.8% (98% confidence). Using this information we can analyze the three hypotheses; in testing hypothesis 1 we can say that yes, STH were present in primary school children in the parishes of Grenada. In testing hypothesis 2, the prevalence of STH was low enough for it to be feasible to eliminate them within a twelve month period in a small Caribbean island nation such as Grenada. The estimated prevalence among school attending children in Grenada was 1.3%. We can say with 95% confidence that the true prevalence is no greater than 2.5% before treatment and education (intervention). In testing hypothesis 3, the combination of regular education and targeted treatment reduced the estimated prevalence to zero. We can say that the true prevalence is not greater than 0.6% for children receiving the educational and treatment intervention.

In conclusion, this study has provided evidence that a combination program of education and targeted treatment can be effective in small island developing states for control and/or possible elimination of STH.

The results of this study have been presented as three separate presentations (one oral and two poster presentations) at the Caribbean Public Health Agency (CARPHA) 60th Diamond

Jubilee Conference in June 2015. The hospital laboratory at the General hospital has communicated that they have seen no cases of the four soil transmitted helminths that have been worked on in this program over the last year. These results have been written up as part of a PhD dissertation. This bodes well for the Grenada national elimination program that continues.

Submitted by Trevor Paul Noël

Zika Surveillance in the Southern Caribbean and Reference Lab Support

Clinical and Serological Observations from a Case Series Study during the Asian-Lineage Zika Virus Outbreak in Grenada during 2016

Research Summary

In an effort to document an outbreak of the Zika virus in a small island nation, the WINDREF Zika Research Team studied the spatial and temporal distribution of cases, demographic characteristics of patients, and clinical manifestations of the Zika virus during an outbreak in Grenada in 2016. This study was of particular interest since Grenada had never had a previous Zika virus outbreak and the population was immunologically naïve.

Data were collected at medical facilities throughout the country on 514 patients during the outbreak. The index case occurred in St. Andrew Parish on April 26, peak transmission occurred during the week of June 26, and the last case was recorded during the week of October 30. St. George Parish, the parish with the highest population density, had the highest attack rate of 32.0 per 10,000 of people in the population.

Of the 514 patients enrolled in this study, 208 patients (40%) were judged to be positive for Zika virus infection. These included 131 males of whom 45% tested positive, and 380 females of whom 45% tested positive for the virus. Among the female patients, 117 were pregnant and 45 of those cases (38%) were deemed to be infected with the virus.

The distinctive symptoms most commonly presented during the outbreak were rash, fever, headache, chills, lymphadenopathy, nausea or vomiting, and diarrhea. Since the symptoms observed during the Zika outbreak are similar to the symptoms of the potentially co-circulating Dengue and Chikungunya viruses, accurate diagnosis of Zika can be challenging for clinicians and requires both knowledge of distinctively predictive symptoms and laboratory confirmation.

Background on the Zika Virus

Seventeen percent of all disease cases worldwide, or more than one billion occurrences annually, are from vector-borne diseases, resulting in over one million deaths. The vectors responsible for transmitting these diseases include mosquitoes, ticks, flies, and even certain aquatic snails. With increasing trade, international travel, and average global temperatures, vector-borne outbreaks could increase in severity and frequency. Thus it is becoming increasingly important that these diseases be documented and studied in order to mitigate the morbidity and mortality resulting from their infections. Although much research has focused on studying these diseases, there is limited information regarding their occurrence in small island nations such as Grenada.

Two mosquito species, *Aedes aegypti* and *Aedes albopictus*, are efficient transmission vectors for the yellow fever, Dengue, Chikungunya, and Zika viruses. Arthropod-borne flaviviruses can co-circulate and are known to cause co-infections. The vectors thrive primarily in tropical and sub-tropical areas, but have been spreading into temperate climates as well. Currently, 174 countries and territories – including Grenada – host stable populations.

In Grenada, *Aedes aegypti* was responsible for the transmission of Dengue fever during late 2001 and early 2002, and Chikungunya fever in 2014. Although originally from Central Africa where the ancestral *Aedes aegypti formosus* bred in riverbeds, tree holes and rock pools, *Aedes aegypti* today breeds in clean domestic and peridomestic water sources and exhibits both domestic and sylvatic life cycles.

Research Method

An outbreak of Zika virus fever occurred in Grenada from late April to mid-November in 2016. In collaboration with the Grenadian Ministry of Health, the Zika Research Team at the Windward Islands Research and Education Foundation (WINDREF) provided patient survey forms to healthcare facilities throughout the country for clinicians to record and report patient demographic and symptomatic information. The forms were designed to collect information on 20 symptoms that were possibly indicative of Zika virus infection.

Physicians provided the WINDREF Zika Research Team with whole blood and urine samples collected in health care facilities from across the tri-island state of Grenada.

St. George's General Hospital laboratory spun the blood samples to separate the sera, aliquoted each sample into two sub-samples, and sent one to the Caribbean Public Health Agency (CARPHA) in Trinidad for testing and the other to WINDREF. The WINDREF samples were further aliquoted into two sub-samples. Half of the sub-samples were sent to the Naval Infectious Diseases Diagnostic Laboratory (NIDDL) at the Naval Medical Research Center in Maryland, USA, for testing. The other half were stored at WINDREF for archival purposes. The serum samples were tested with rRT-PCR and IgM ELISA for Zika, Dengue and Chikungunya viruses, and the urine samples were tested with rRT-PCR. In addition, samples were tested with IgM and IgG ELSIA for other arboviruses such as the viruses for yellow fever, encephalitis and West Nile.

Patient enrollment in this study was optional and all participants were given counseling prior to enrollment about the aims of the study and the potential risks for participation. Ethical approval of this study was given by the St. George's University (SGU) Institutional Review Board (IRB).

Research Results

Spatial and Temporal Distribution of Cases

The outbreak began in the last week of April in St. Andrew Parish when a 28-year-old female, who reported to have traveled to St. Vincent within the prior two-weeks, tested positive for the Zika virus. Her reported symptoms included rash, fever, headache, joint pain, body pain, lymphadenopathy, nausea or vomiting, and diarrhea. This case is considered the index case for the country. It is possible, although unknown, that this

patient introduced Zika virus to Grenada when she returned from her trip, since St. Vincent reported its first case in late February.

The spatial and temporal distributions of cases by parish during the outbreak are summarized in Table 1. The parishes are listed in ascending order of the date of the first case in each parish. The date of the week of the first observed case is shown as well as the week of peak occurrence and the week of the last recorded case for each parish in Grenada. The total number of Zika virus positive cases is listed by parish and the indicated attack rate per 10,000 people in the population of each parish. Population data are from the 2011 Grenadian Census.

With a population of 25,722 people, St. Andrew Parish had an indicated attack rate of 14.0 cases of Zika virus infection per 10,000 people in the population. The 36 positive cases in St. Andrew represented 17% of the total Zika virus positive cases identified in this study.

The next parish to report its first case was St. Mark Parish, in the northwest of the country, during the week of May 9. St. Mark has a population of 4,086 and with 12 positive cases it had an indicated attack rate 29.4 positive cases per 10,000 in the population.

St. George Parish, in the southwest, with a population of 36,823, was the next to report its first case in late May. With 116 positive cases, St. George had an indicated attack rate of 32.0 per 10,000 people in the population.

After St. George Parish, three parishes reported their first case within two weeks of each other, with St. Patrick in the week of

June 5, followed by St. David, and St. John. Carriacou, located northeast off the coast of St. Patrick, is accessible only by ferry or plane, and was the last parish to have a diagnosed case of Zika virus. It reported its first case during the week of July 3.

Of the 514 enrolled patients, 208 cases (40%) tested positive for the Zika virus. When a sample tested positive for the Zika virus via rRT-PCR, the patient was considered a confirmed case of infection, while if the sample tested positive for anti-Zika IgM, the patient was considered a presumptive case of infection. Two cases of rRT-PCR for Chikungunya virus were confirmed, one of which tested positive for anti-Zika IgM.

The country-wide attack rate during the outbreak was 20.1 per 10,000 people, and peak transmission occurred in the week of June 26 with 26 cases. The reported date of symptom onset was used as the week of indicated infection. When the symptom onset date was not available, the date of sample collection was used as a conservative infection date.

Figure 1 displays in a map of Grenada the spatial distributions of cases. The color-coding is based on the attack rate by parish

Parish	First Case	Maximum Cases	Last Case	Zika Virus Positive Cases	Population	Attack Rate per 10,000
St. Andrew	April 24	July 17	Sept 11	36	25,722	14.0
St. Mark	May 8	June 26	Oct 2	12	4,086	29.4
St. George	May 22	June 26	Oct 30	118	36,823	32.0
St. Patrick	June 5	July 31	Oct 16	15	10,980	13.7
St. David	June 12	July 17	Aug 28	12	12,561	9.6
St. John	June 26	July 10	Aug 28	6	7,802	7.7
Carriacou	July 3	July 3	Sept 4	9	5,354	16.8
Grenada	April 24	June 26	Oct 30	208	103,328	20.1

Table 1. Summary of Spatial and Temporal Distributions of Cases by Parish during the 2016 Zika Outbreak in Grenada

(positive cases per 10,000 people). The data are displayed in the format: Week of first case, week of the last case, total number of cases, and number of cases of Guillain-Barre syndrome. The number of Guillain-Barre syndrome cases in each parish was strongly positively correlated with the number of Zika virus infection cases ($r = 0.94$, $p < 0.001$).

Figure 2 presents graphically the temporal distribution of cases during the outbreak by week. There were 208 confirmed (dark blue) and presumptive cases (light blue) positive for Zika virus infection. Eight cases (green) identified by the Grenadian Ministry of Health as Guillain-Barre syndrome cases are also shown.

Demographic Characteristics of Patients

The age distribution of the sample ranged from one day old to 90 years old, with a median age of 30 years. Of 73 patients under the age of 20, 28 (38%) tested positive for the Zika virus, while of the 433 patients 20 years of age and older, 178 (41%) tested positive for the Zika virus. Eight patients did not specify their ages. There was no evidence the rate of infection was different between the age groups (test of proportions, $p > 0.05$).

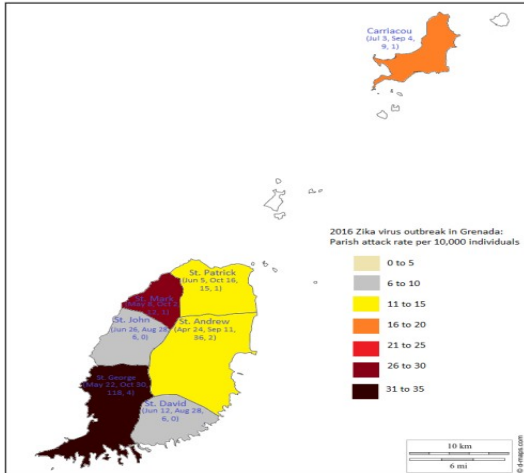


Figure 1. Spatial Distribution of Cases by Parish during the 2016 Zika Outbreak in Grenada

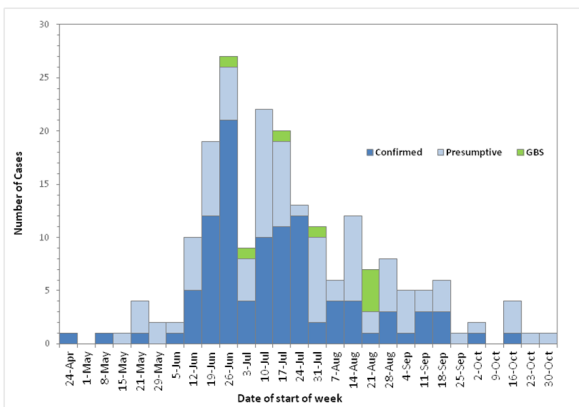


Figure 2: Temporal Distribution of Cases by Week during the 2016 Zika Outbreak in Grenada

Of the 131 males in the study, 59 (45%) tested positive for the Zika virus. Of the 380 females in the study, 148 (39%) tested positive for the Zika virus. Three patients did not specify their genders. There was no evidence the rate of infection was not different between genders (test of proportions, $p > 0.05$).

Of the 380 female patients in the study, 117 (31%) were pregnant while 260 female patients were not pregnant. The pregnancy

status was unknown for three female patients. Since 45 of the pregnant patients (38%) and 99 of the non-pregnant patients (38%) tested positive for the Zika virus, there no evidence the rate of infection was related to pregnancy status (test of proportions, $p > 0.05$).

Clinical Manifestations of the Zika Virus

Of the 514 patients enrolled in this study, 424 (82%) were symptomatic with 192 (45%) testing positive and 232 testing negative for the Zika virus. Table 2 lists the most common symptoms among the Zika virus positive cases in descending order of frequency. The odds ratios (OR) for a patient with that symptom testing positive versus negative are shown in the right-most column. The symptoms with an OR > 1.0 are highlighted in yellow as these indicated a meaningful distinction between positive and negative cases.

Most Common Symptoms among Cases Testing Positive for Zika Virus	Zika Virus Positive Cases (n = 192)	Zika Virus Negative Cases (n = 232)	Odds Ratio (95% Confidence Interval)
Rash	155 (81%)	127 (55%)	3.6 (2.3 to 5.6)
Fever	113 (59%)	108 (46%)	1.7 (1.1 to 2.5)
Joint pain	97 (51%)	113 (48%)	1.1 (0.8 to 1.6)
Headache	73 (38%)	118 (29%)	1.5 (1.0 to 2.3)
Body pain	68 (36%)	72 (31%)	1.2 (0.8 to 1.9)
Eye pain	66 (36%)	72 (31%)	1.4 (0.9 to 2.1)
Chills	47 (25%)	37 (16%)	1.7 (1.1 to 2.8)
Lymphadenopathy	39 (20%)	19 (8%)	2.9 (1.6 to 5.2)
Nausea or Vomiting	38 (20%)	19 (8%)	2.8 (1.6 to 5.0)
Diarrhea	26 (14%)	13 (6%)	2.7 (1.3 to 5.4)

Table 2. Top Ten Most Common Symptoms Reported among Symptomatic Cases

Guillain-Barre syndrome, which presents with severe and sometimes life-threatening transient paralysis, has been noted to occur during Zika virus outbreaks around the world. There were nine cases – four males and five females – of Guillain-Barre syndrome that occurred during the 2016 Zika virus outbreak in Grenada. The affected patients ranged in

age from 21 to 67 years old, with a median of 41 years old.

There was one patient from St. Mark Parish confirmed by the Grenadian Ministry of Health to have Guillain-Barre syndrome who was not enrolled in this study. For the eight patients who were enrolled in this study, the earliest case of Guillain-Barre syndrome occurred during the week of June 26 – the week of peak Zika virus transmission – while the last four cases occurred during the week of August 21.

Of the eight Guillain-Barre syndrome cases enrolled in this study, four tested positive by IgM serology for Zika virus, two had non-specific anti-flavivirus IgM, and two patients showed no evidence of Zika infection. Six cases of Guillain-Barre syndrome were tested by IgG ELISA and all six tested positive for the Zika virus, while five also tested positive for the Dengue virus and four also tested positive for the Chikungunya virus.

Discussion of Findings

Spatial and Temporal Distribution of Cases

The Zika virus vector, *Aedes aegypti*, is known to be an endophagic urban dweller that clusters around population centers. In the Dengue virus (2001-2002) and Chikungunya virus (2014) outbreaks in Grenada, cases tended to cluster in population centers as they did during the Zika virus outbreak, since all three are flaviviruses carried by the same mosquito species.

Most of the cases of Zika virus infection (70%) came from the densely populated parishes of St. George with 53% of the positive cases and 36% of Grenada's population followed by St.

Andrew with 17% of the positive cases and 25% of Grenada's population. The parishes of St. Mark and St. George had the highest indicated attack rates. We conjecture that this could be because these parishes had early cases of the disease and thus there was ample time for the virus to circulate within their immunologically naïve populations.

Demographic Characteristics of Patients

Testing positive for Zika virus infection was not found to be related to age group, gender or pregnancy. However, of the 117 pregnant women, 67 (57%) were asymptomatic, while of all other cases only 23 of 397 (6%) were asymptomatic. Thus, there was strong evidence that pregnancy status was related to a woman being symptomatic or asymptomatic (test of proportions, $p < 0.001$). It is reasonable to suggest that foreknowledge of the effects of Zika virus on a maturing fetus and fearing the potential negative health effects on their unborn fetuses motivated pregnant women to seek screening tests even though they did not display symptoms, while the rest of the patients enrolled in the study sought testing due to being symptomatic.

Of the pregnant women who reported the trimester of their pregnancy, 11 of 17 (65%) were in either their first or second trimester. The first and second trimesters are thought to bear the highest risk of congenital Zika virus syndrome in patients with symptomatic Zika virus infection. As is well known, this syndrome can have a range of negative health consequences in a newborn, and thus these cases are of particular concern. Although an incidence rate of microcephaly has been estimated as 1% to 3% in newborns whose mothers tested positive for Zika virus

infection during their first or second trimesters, the effects of Zika virus infection are less well known in children of asymptomatic mothers and identified early through testing. The potential for congenital and later effects in children of asymptomatic Zika virus positive mothers is being studied further in Grenada by the WINDREF Zika Research Team.

Clinical Manifestations of the Zika Virus

Consistent with the symptoms reported in Zika virus outbreaks in other countries, the most commonly observed symptoms in cases that tested positive for Zika virus in Grenada were similar to the symptoms of other potentially co-circulating flaviviruses: Chikungunya virus and Dengue virus. The similarity of these symptoms means that an accurate diagnosis of Zika virus infection can be challenging and requires both knowledge of the symptoms that are the most predictive for testing positive for the Zika virus and laboratory testing of blood and urine samples.

Based on the results in this study, the symptoms that can be considered predictive of a patient testing positive for Zika virus are rash, fever, headache, chills, lymphadenopathy, nausea or vomiting, and diarrhea. Notably, although conjunctivitis has been observed to be a differential diagnostic symptom for Zika infection in studies in other countries, there was no evidence that it was a predictive symptom during the outbreak in Grenada. The presence or absence of the predictive symptoms documented in this study can guide clinicians diagnose future Zika virus infections.

Since the patients enrolled in this study were patients who had voluntarily gone to a medical facility seeking treatment, 92% of the positive cases in this study were symptomatic compared to the typically observed symptomatic proportion of only 20% to 25% of Zika-infected cases. Correspondingly, 76% of the negative cases in this study were symptomatic, indicating the reasonable tendency for people to seek testing when they have symptoms during a known Zika outbreak.

Consequently, the patients enrolled in this study consisted largely of symptomatic individuals (82%), but the symptomatic rate in the general population was likely to have been lower. If the symptomatic rate of infected individuals in Grenada was closer to the typical rate and if the rate of infection was the same among people who did not seek medical care for Zika infection during the outbreak, we estimate that a total of about 18,400 people were infected during the outbreak resulting in an attack rate in the general population of 17.8% (17.7% to 18.0%).

For eight of the nine cases of Guillain-Barre syndrome that occurred during the Zika virus outbreak the date of onset was known and occurred during a nine-week period and coincided both spatially and temporally with high rates Zika virus infection. Since the global annual incidence of Guillain-Barre syndrome is estimated at 1.0 to 2.0 per 100,000 individuals, if nine cases of Guillain-Barre syndrome occurred every nine weeks year round, the number of cases in Grenada would have been 35 times the worldwide average annual incidence rate. Such a dramatic incidence rate, combined with the fact that six of the eight cases of Guillain-

Barre syndrome in our study displayed evidence of recent Zika or other flavivirus infection, adds to the growing body of evidence that higher incidence rates of Guillain-Barre syndrome coincide with higher incidence rates of Zika virus infection and thereby suggests a possible link between Zika infection and Guillain-Barre syndrome.

Conclusion

Increasing global trade, travel, and climate change could be contributing to increasing both the abundance and range of flaviviruses vectors. If these trends continue, the impact of diseases that have been restricted to tropical regions may spread to other parts of the world in the coming years.

Currently there are few studies that examine the occurrence and spread of Zika virus in a small island setting. The spatial and temporal distribution of cases, demographic characteristics of patients, and the clinical manifestations of Zika virus recorded in this study could greatly aid planning for and managing future outbreaks of Zika virus and other flaviviruses in the Caribbean as well as other similar geographic regions.

Zika in Pregnant Women Study

The autochthonous presence of the Zika virus in the Americas was first detected in Chile in March 2014. The first confirmed case of local vector-borne transmission of Zika virus in Grenada was reported on May 5, 2016. An outbreak of the virus occurred in Brazil in May 2015, resulting in immense global concern over the suspected link between the Zika virus and microcephaly. The growing number of microcephalic cases and of other neurological disorders at this time resembled

trends from the 2013 Zika outbreak in French Polynesia. As a result, The World Health Organization declared the growing number of cases a Public Health Emergency of International Concern on February 1, 2016. Since research efforts have since confirmed a correlation between Zika and microcephaly, the WHO Emergency Committee recommended addressing the long-term nature of the disease and focusing research efforts on the consequences of this unique virus.

Figure 1. Members of the ZIKA Response team from WINDREF, St. George's University, United States



Navy, Department of Defence and Tetracore in WINDREF laboratory discussing ZIKA PCR results.

At the request of the Government of Grenada (Ministry of Health), WINDREF was asked to define a specific program to facilitate the zika testing of all pregnant mothers that wanted to avail of the free testing service on offer.



Figure 2. George Mitchell, Chief Medical Officer, Ministry of Health, Grenada with Trevor Noël, Deputy Director, WINDREF and public health volunteers following the feed back of ZIKA results to pregnant mothers.

To date, we have sampled and tested 350 pregnant women. These results have been fed back to all the patients via the Ministry of Health personnel in the hospital, clinics and medical stations in Grenada, Carriacou and Petite Martinique.



Figure 3. Community Health Nurses (MOH), Vector control personnel (MOH), WINDREF personnel and volunteers following discussion of feedback of results and vector control mechanisms.

The personnel from St. George's University Psychological Services Center have been working with the Ministry of Health community nurses to provide psychological capacity building to enhance the feedback of results to the pregnant mothers during

antenatal clinics and post partum if necessary.

This Zika pregnancy cohort support program will span the course of the epidemic. It was started in November 2016 and will continue into 2017. The results continue to be analyzed and a final report will be submitted to the stakeholders when the sampling, testing and analyses are completed.

Submitted by the ZIKA response team (The ZIKA response team consists of Ministry of Health personnel, WINDREF, SGU, US Navy, US Department of Defence and Tetracore)

Neurodevelopment and Vector-borne Diseases: Building Research Capacity in the Tropics

Up to 200 million children – mostly in developing nations – are at risk of failing to reach full neurodevelopmental potential. This waste of human capital impacts the ability of the next generation in these nations to solve the challenges that lock individuals, communities, and societies in poverty. The goal is to eliminate extreme inequality and maximize neurodevelopment in all children regardless of where they are born. Numerous factors can impact early neurodevelopment and cognitive function: preterm birth, genetic predispositions and epigenetic changes as a result of pre-, peri- and post-natal trauma and environmental factors, access to appropriate health care and socioeconomic factors, and physical and psychological stress. Among these causes, infection of the nervous system by viral and parasitic diseases is among the most avoidable. Infectious and parasitic vector-borne diseases (VBD), such as malaria, arboviruses (such as chikungunya

[CHIKV], zika [ZIKV], and dengue [DENV]) and other neglected tropical diseases are a particular burden for developing nations, where they directly impact health in the short-term and also via long-term sequelae, including impacts on the developing nervous system.

Arbovirus infections cause a broad spectrum of disease, ranging from asymptomatic infection to life-threatening syndromes such as encephalitis and haemorrhagic fever. In many endemic areas, they are frequently misdiagnosed as malaria. Given widely prevalent misclassification bias, information regarding the range and distribution of arbovirus-related disease in at-risk populations is lacking. Children are often at greater risk for arboviral exposure than adults, but previous surveys have rarely focused on this vulnerable population, yielding only imprecise estimates of disease burden among the pediatric (and general) population. Studies to evaluate long-term disease sequelae have been rare; therefore, the full impact of arboviral disease is unknown. Both mild and severe arboviral disease, including DENV, CHIKV, and possibly ZIKV are known to cause long-term neurologic and ocular sequelae in children. Better recognition of the sequelae of arboviral disease in childhood (as planned in this study) should unmask a substantial burden of disease in sub-Saharan Africa currently not captured by the WHO. Encephalopathy is the most common neurologic manifestation among newborns infected with CHIKV, with approximately 50% of neonates showing abnormal MRI in the form of supra-tentorial long-lasting cerebral edema with transient hemorrhages. Recent evidence indicates that perinatal mother to child CHIKV infection is associated with poor

neurocognitive outcomes as a result of microcephaly or white matter restriction. Specifically, 50% of infected newborns showed delayed coordination and language at two years of age. Severe CHIKV neonatal encephalopathy is associated with an even poorer outcome: in follow-up among 12 children with encephalopathy, five developed microcephaly and four developed cerebral palsy.

Thus, there is evidence for a link between CHIKV (and possibly other VBD) and cognitive functioning in infants. However, these results have not yet been replicated in other sites, and have not been compared to internationally standardized developmental norms. Further, longitudinal follow-up of children who were infected with CHIKV prenatally or perinatally has not been conducted. Preliminary data suggests that 50% of infected newborns in la Réunion demonstrated impairment in coordination and language at two years of age, but it is not known if those impairments will have an impact later in life when the infants begin formal schooling. A longitudinal research program is needed to follow children who have experienced neurocognitive delay related to CHIKV infection. Finally, from a public health perspective, it is important to confirm and further specify the potential link between infectious VBD, neurodevelopment, and cognitive functioning among children, and to decipher which biological mechanisms underlie this relationship so that pregnant women living in endemic regions can take preventive measures. To address these issues, it is essential to build VBD research capacity in low-middle-income (developing) countries in the tropics where these diseases are endemic, and the burden of impaired neurodevelopment is felt most. The recent

emergence of ZIKV in northern Brazil and its association with microcephaly, highlights the urgent need for a regional centre of VBD-neurodevelopment that can monitor emerging threats, conduct research in the region, and support local governments and health officials in preparing for and responding to such outbreaks.

To gain more cross-sectional and longitudinal data on the link between VBD, neurodevelopment, and later cognitive functioning in developing regions, specific research capacity needs to be built up: (1) Financial (research grant) and in-kind support; (2) Existing expert support in the targeted subject area(s); (3) On-the-ground human resources for research leadership, project management and coordination, field work, lab work, data work, and administrative work; (4) Student trainees to build local capacity; (5) Equipment, information technology, and facilities support; (6) On-the-ground university and research institute administrative support; (7) Local and regional government, and relevant NGO, and professional/academic institutional support (i.e., a VBD-neurodevelopment network).

In early 2016 we proposed to establish a research program in the Caribbean that will examine the connection between VBD and neurodevelopment from pre-natal to early adolescence, using CHIKV as the initial VBD of interest. This region consists of over 700 islands surrounded by the Caribbean Sea and the Atlantic Ocean. There are 30 countries or individual territories in the region, plus the mainland countries of Belize, Suriname and Guyana, all of which are LMICs and member states of the Caribbean Community (CARICOM), a regional common market established in 1973. The Caribbean has a

population of over 41 million, consisting mostly of African, Indian, or Chinese descent. In the ten LMIC countries in the region (Belize, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St. Lucia, St. Vincent, and Suriname), population health remains a key challenge. While chronic diseases are rapidly increasing in importance, tropical infectious diseases still carry the greatest burden across these countries. Initially, the proposed research program will use cross-sectional studies to examine the connection between CHIKV and neurodevelopment among young infants, with the goal of establishing the capacity to examine other VBD (i.e., DENV, ZIKV), other parasitic/neglected tropical diseases, and chronic diseases (e.g., obesity, diabetes) via both cross-sectional and longitudinal studies in the future.

Researchers from St. George's University (SGU) will partner with researchers from Stanford University in California with arboviral expertise, researchers from the Université de La Réunion in Réunion, France with CHIKV and neurodevelopment expertise, and researchers from the inter-NDA Consortium at Oxford University with neurodevelopmental testing expertise to carry out the research plan. Faculty from these institutions have already been working together for almost two years in separate projects to: 1) examine VBD outbreaks, especially CHIKV, and 2) perform neurodevelopment testing in infants. Existing CHIKV research is based on a serosurvey of 493 Grenadians during the 2014 outbreak on the island, 89% of whom were confirmed infected with CHIKV using IgM and/or PCR tests, as well as a one-year follow up (Shope project). The neurodevelopment research is based on a \$270,000 Grand Challenges

Canada-funded grant (#0587-03) that examines the connection between corporal punishment and cognitive outcomes, as tested via the interNDA battery at two years of age. That 2-year study is currently in its final year of operation.

For the initial two-year grant period, the project team will test the following research question: Is there a link between perinatal mother-to-child CHIKV infection in utero and neurodevelopment among infants at two years of age in Grenada? Based on previous, yet very limited number of studies, we hypothesize impaired neurodevelopment in children born to mothers infected with CHIKV during pregnancy, compared to children who were not exposed during pregnancy. Gérardin and colleagues⁵ demonstrated that neurocognitive outcomes, measured via movement/posture, coordination, language, and sociability skills, was lower in children exposed to perinatal mother-to-child CHIKV infection than in children not exposed to perinatal mother-to-child infection. We hope to replicate and further clarify these results while addressing some of that study's key weaknesses: (1) lack of international neurocognitive comparison and standardization of neurocognitive measures, and (2) no reporting of neurodevelopmental measures (i.e., vision, hearing).

Aim 1: Build capacity for arboviral and neurodevelopmental research at St. George's University in Grenada: Through initial NIH grant funding and the implementation of Aims 2, 3 and 4, we will build local capacity to examine the connection between arboviruses and neurodevelopment, as described in sections 6 and 7 below.

Aim 2: Assess the burden of confounding factors to better understand the specific impact of CHIKV on neurodevelopment and inform public health priorities: By measuring a set of key variables, we will be able to determine the impact of prenatal and postnatal CHIKV on neurocognitive outcomes while accounting for other factors that can impact neurodevelopment, such as preterm birth, fetal alcohol spectrum disorders (FASD), maternal diet and gestational diabetes, infections, dietary intake, toxic exposure and violence during infancy. This will allow us to explain the burden of CHIKV and other factors, thereby informing public health priorities.

Aim 3: Determine the prevalence of mother to child transmission of CHIKV in Grenadian pregnant mothers: We have collated Grenada birth data for 9 months prior to the CHIKV outbreak, during the outbreak from August through December 2014, and 11 months following the outbreak. There were 2,840 births before and after the CHIKV outbreak and 710 births during the outbreak. To carry out the proposed study, we have worked with the Grenada Ministry of Health to generate lists of potential study participants. Mothers who gave birth during the identified time frame of the study (i.e., during the outbreak and 11 months after the outbreak) and whose infants are alive and with the mother at time of study enrolment will be eligible for participation. Men, children over the age of 30 months, and any woman who did not give birth during the specified dates of the study are not eligible for participation. Mothers will be given a survey detailing the onset and symptoms related to their CHIKV infection because they are very likely to recall the approximate timeframe of illness (i.e., first, second, third trimester or during

delivery) given the severity of CHIKV symptoms. Confounding factors will also be measured (see limitations section below). Once enrolled, mothers and their offspring will be tested for exposure to CHIKV by ELISA (InBios CHIKj IgG kit)⁶¹. All infants with positive IgG results will be further tested for recent (not in utero) exposure by IgM ELISA (InBios CHIKj IgM kit) which, if positive, supports transmission 6-12 months prior (CDC - personal communication). Non CHIKV-exposed infants and moms, CHIKV-exposed moms but not infants, CHIKV-exposed moms and infants, and time of exposure during pregnancy will be used to divide groups for comparison: 1) Children who are IgG and IgM positive will be considered as cases of perinatal mother-to-child infection or as postpartum infections according to the timing or absence of maternal infection; 2) Children who are IgG positive, but IgM negative, and whose mother recalls disease during pregnancy will be considered “in utero infections” if maternal infection occurred during the CHIKV outbreak period; 3) Children who are IgM and IgG negative and whose mother recalls disease during pregnancy will be considered “in utero exposed”; and 4) children who are IgG negative and whose mother is also IgG negative will be considered unexposed. It is also important to note that, given the intensity of the initial outbreak, there have been no reports of acute CHIKV infection from the Grenada Ministry of Health since the outbreak ended at the end of 2014. Thus, the likelihood is very low that infants who test positive for CHIKV who were born near the end of or shortly after the outbreak were infected by a vector rather than via vertical transmission. Based on previous studies carried out by the Windward Islands Research and Education Foundation (WINDREF) in Grenada, we estimate a 60%

follow-up rate among all eligible participants. Thus, we expect to recruit and test 426 moms and their infants who were born during the outbreak, 423 moms and their infants who were born after the outbreak and may have been exposed to the virus in utero, and 190 moms and their infants who were born at least nine months after the outbreak (and thus, very unlikely to be exposed to the virus in utero).

Aim 4: Measure the neurodevelopment of children at 2 years of age exposed at different trimesters in utero to CHIKV and compare with unexposed children: While controlling for perinatal complications and socioeconomic factors (see surveys attached in the appendices), we will administer the Intergrowth-21st Neurodevelopment Assessment (interNDA)⁶² - a holistic assessment of early child development - to examine potential differences in neurodevelopment between the two-year old infants exposed to CHIKV and those who were not exposed to CHIKV. The interNDA is designed to: (1) Measure multiple dimensions of early childhood development - vision, auditory processing, cognition, language, fine & gross motor skills, behaviour, attention, social-emotional reactivity, sleep, circadian rhythm and daytime physical activity, (2) Incorporate neurophysiological tests (electroencephalography & actigraphy) with psychological and clinical assessments, (3) Be free from cultural biases and therefore suitable for use in international settings, (4) Be easy and reliable to administer by non-specialists, and quick to administer with minimal infrastructure in under 45 minutes, (5) Be sensitive enough to detect differences in healthy populations of children, (6) Characterize outcomes across a spectrum in order to screen for neuro-disability in

population-based settings, (7) Measure entire visual and auditory pathways (rather than components of the visual or auditory apparatus), (8) Yield objective, rather than subjective, information about the child's performance. The interNDA is electronically based and has good reliability across international settings and validity against the Bayley Scales⁶². The English version of the Revised Brunet Lezine scale (see appendix), used by Gérardin and colleagues⁵ will also be administered to assess the internal validity of the interNDA to previously published data.

To examine the feasibility of establishing a VBD-neurodevelopment research program at SGU, we will implement a pilot project designed to test the above research questions. The successful implementation of this project and replication of results reported by Gérardin and colleagues will prove the feasibility of the approach. Specifically, markers of success will include: (1) the establishment of key personnel on the ground to carry out VBD-neurodevelopment research (i.e., research project manager, nurse for collecting biological samples, research technicians trained in collecting neurodevelopmental and neurocognitive data, a lab technician trained to analyze biological samples via ELISA), (2) laboratory supplies to run valid and reliability assessment of biological samples, (3) reporting of results back to the local community through policy reports and in academic channels through peer-reviewed publications, (4) inclusion of Master's level Caribbean students in the project, to start training the next generation of regional scientists in VBD neurodevelopment research. Following the procurement of additional funding, PhD-level training will be targeted to build research capacity among

Caribbean students. This training can be offered by the existing School of Graduate studies at SGU, in collaboration with international partners.

To strengthen research capacity in VBD and neurodevelopment, we will establish a Regional Center for Child Neurodevelopment at SGU that will address seven identified areas of needed support:

1) Financial (research grant) and in-kind support: External funding sources are needed to hire key research personnel, support student trainees, collect data and samples in the field, analyze samples, establish data sets, and report findings in print and meetings (i.e., travel). In-kind support can be provided by partner institutions (e.g., SGU) in the form of released faculty time for research, but external funding must be secured first. This grant proposal provides the groundwork for external funding, and will be supplemented by further grant applications by the research team. The PIs have already secured almost a dozen grants for their ongoing work, giving them the experience and know-how to secure further grants.

2) Existing expert support in the targeted subject area(s): The research team has extensive expertise in VBD, child neurodevelopment, preterm birth surveillance, FASD prevention, social determinants, and fieldwork in Grenada. Together, the PIs have secured 15 external grants as PIs or Co-PIs and published 47 papers.

3) On-the-ground human resources for research leadership, project management and coordination, field work, lab work, data work, and administrative work: Grenada and

the Eastern Caribbean (i.e., Barbados, Trinidad and Tobago) provide an ideal population from which to draw well-educated, young professionals graduating from SGU, the University of the West Indies (UWI), and the University of Trinidad and Tobago, among other institutions of higher education. Grenada provides a safe and welcoming environment for would-be researchers, and the SGU campus is home to 570 faculty and 4,000+ students from over 140 countries.

4) Student trainees to build local capacity: In close follow-up to human resource capacity, the education of future researchers and support staffs must be addressed. Schools of Graduate Studies and technical colleges are key partners in the research endeavour, where trainees can gain valuable hands-on experience and leading researchers can impart knowledge. SGU has a School of Graduate Studies (SGS) which was founded in 1994, and offers over 30 graduate degree programs, including PhD, MSc, MEd, MPH, MBA, and dual MD and DVM degrees coupled with MSc, MPH and MBA degrees. The SGS has matriculated over 1,000 MPH, 500 MBA, 70 MSc and 20 PhD students since its inception. Over 1,000 of the graduates were from low-middle income countries (LMICs) in the Caribbean or Africa. Twenty-one of the MSc and PhD graduates from Caribbean LMICs are now working in academic and government public health positions in those LMICs.

5) Equipment, information technology, and facilities support: The research enterprise requires extensive administrative support, dedicated lab space, an ethics board, a research grants office, biostatistics support, a modern information technology

infrastructure, and a procurement and logistical support office for securing equipment and supplies. SGU currently has all of these support services, and university administration has identified these services as key areas for future growth and support as the university expands upon its research portfolio. For example, the SGU Office of Research allocates \$60,000 USD per year to fund small research grant initiatives (SRGI). Over the past 9 years, this program has awarded \$128,171 to SGU faculty members for 31 internal research projects on VBD. A consulting senior faculty member (Dr. Paul Fields) has been providing on-the-ground biostatistics support for SGU researchers and students for over ten years.

6) On-the-ground university and research institute administrative support: Currently, very limited VBD and/or neurodevelopment research is conducted in developing countries. Studies that are carried out are often initiated by, or rely on, expertise in developed countries. Further, developing countries often play the role of “sample source”, collecting data or biological samples, and sending those samples to universities in developed countries for analysis. In this proposed project, all research will be carried out on site in Grenada and sample testing will occur in WINDREF/SGU labs. In order to build more research capacity in the Caribbean, it is first necessary to identify stable institutions with the infrastructure, administrative capacity, culture, and track record to support the complex research enterprise. SGU, established in 1976, and with current enrolment of over 7,000 students, provides all of these. WINDREF, an independent 501(c) 3 non-profit research institute established in 1994 and housed on the SGU campus, is also a critical partner in strengthening research

capacity in VBD and neurodevelopment. WINDREF administers approximately \$700,000 USD in annual external research funding for its research fellows, who are mostly SGU faculty members. WINDREF has dedicated research laboratory space and conference room facilities and, in collaboration with SGU, has extensive experience conducting large (250+ attendees) and small local, regional and international conferences, short-term workshops and certificate-level training programs. The proposed research program involves the collection of samples in Grenada, analysis of biological samples in Grenada in conjunction with expert training from Stanford, and data basing/results analysis in Grenada. Together, WINDREF and SGU have the facilities to support such an endeavour.

7) Local and regional government, relevant NGO, and professional/academic institutional support (i.e., VBD-neurodevelopment network): SGU and WINDREF have long-standing working relationships with the Grenada government and other governments, NGOs, and institutions in the region, including the Caribbean Public Health Agency (CARPHA), and the University of West Indies (UWI), as discussed in section 7.

SGU already possesses many of the resources needed to successfully carry out the proposed project. It has an Institutional Review Board, which is registered with the US Department of Health and Human Services, to provide ethical review and clearance. It also has a Research Oversight Committee - consisting of members of the University, the Government of Grenada and civil society - to review all research that involves government resources or institutions (i.e., hospitals, clinics, schools). It has experts in tropical

diseases and neurodevelopment. WINDREF, a non-profit research institute located on the SGU campus, has all the necessary administrative resources to support the proposed project. SGU provides undergraduate, graduate, medical, veterinary, nursing, and public health education for hundreds of Grenadian students annually. As such, human resource capacity exists on the ground for further research study implementation. To continue moving forward, funding is needed to train research assistants, lab technicians, field workers, and graduate students in VBD and neurodevelopment research. This includes sample and data collection, data management, data analysis, writing of results, and ethical conduct of research. Funding is needed to support active connections with world leading experts, so that they can be onsite in Grenada to train local faculty, research personnel, and students. Lab supplies are needed to collect and analyze biological samples. Funding is needed for local transportation and cellular service to collect data in the field. Caribbean students need to be involved in research projects in this area, receiving research training and experience that will build local human resources capacity.

Submitted by Randall Waechter and Angelle Desiree LaBeaud

Community Health Initiatives – Sport for Health

Over the past few decades a rise in non-communicable diseases globally and especially in developing nations has occurred. This may be due to socioeconomic disparities (1) and more so the increasing income inequality (2) as well as the westernization of diets combined with a decrease in physical activity. Based on WHO report, non-communicable diseases (NCD) are responsible for 63% of deaths globally, with nearly 80% of NCD deaths occurring in low and middle-income nations (3). The greatest risk factors for NCD are tobacco use, physical inactivity, alcohol abuse and unhealthy diet.

Physical activity is a critical component for decreasing overall mortality and incidence of NCD (3,4,5), furthermore exercise improves cognition in older adults (6,7,8,9). Subsequently, there are individual and community based exercise programs that exist around the world; both with beneficial effects. However, studies show community based programs to be effective in managing and improving the outcomes of non-communicable diseases, especially cardiovascular disease, hypertension and obesity (10,11). Community based programs also show an increase in participation and a decrease in health care costs (12). The use of community based approaches to health improvement is not new and serves as a multi-pronged approach to create change. A community approach engages and empowers members of the community to make lasting and effective changes (13). In order to address NCDs these factors are vital to ensuring long term successful health outcomes.

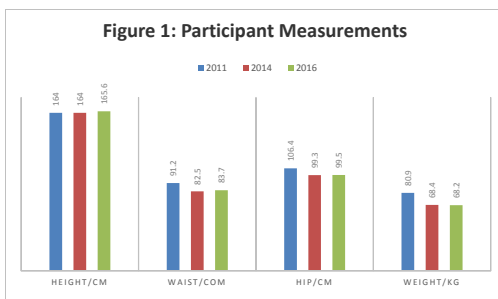
Objective: The Sports for Health program is designed by WINDREF in 2011 to reduce risk factors of chronic diseases including obesity among Grenadians. In 2016, participants of the community based exercise program continued to be assessed with basic health outcome measures.

Methodology: The study population in 2016 consisted of 264 Grenadian citizens enrolled in five different community exercise programs as part of the Royal Grenada Police Force, Point Saline and La Sage, Grenville, Gouyave and Tanteen community exercise program. Initial data collection for this prospective cohort study began during March of 2011 and continued data collection in 2014 was compared with 2016 data. The health indicators for the Sports for Health program was designed to monitor and analyze program participants' physical health indicators, such as Body Mass Index (BMI) and Waist to Hip ratio over time.

Results: During the baseline evaluation period in March 2011, complete data sets were obtained for 427 participants. During the evaluation period of March 2014, 337 complete data sets were collected from participants from 2011 and during 2016 evaluation, 264 complete data sets were obtained. The height, weight, BMI, Waist, hip, and waist: hip ratio is presented in Table 1 below.

	2011	2014	2016
Number of Participants	427	337	264
Height (cm)	164±9	164±7.6	165.6 ± 10.3
Weight (kg)	80.9±14.9	68.4±19	68.2 ± 16.9
BMI	30.3±7.1	25.4±6.8	25.2 ±6.1
Waist (cm)	91.2±12.6	82.5± 19	83.7 ± 12.5
Hip (cm)	106.4±11.8	99.3± 15.7	99.5 ± 10.7
Waist:Hip Ratio (WHR)	0.86±0.07	0.82 ± 0.08	0.82 ± 0.05
All data, except WHR, reported as mean ± standard deviation. P<.05 for comparisons of BMI and Waist:Hip ratio			

Using a Student's T-test ($\alpha=0.05$) demonstrated a significant difference for both measures between 2011 and 2014 while there was no demonstrated difference between 2014 and 2016. Overall changes in participant measures of waist, hip and weight measurements reported a decrease in all measurements in 2014 with maintenance in 2016. The change in BMI measurement between the group in 2011 and 2014 showed a decrease of 4.9, then maintenance in 2016. The waist to hip ratio reduction of 0.04 was observed between 2011 and 2014 and also maintained in 2016 (see Figure 1).



Conclusions: This study aimed to evaluate the efficacy of the Grenada Sports for Health program, a community based exercise program, in improving health outcomes. The data obtained showed that the program was effective especially from 2011 to 2014 with maintenance of physical measures in 2016 among those that participate. Continuing to utilize the program will provide the beneficial effect of community based exercise in reducing the non-communicable disease burden, especially obesity in Grenada.

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Public Health Students Association of St. George's University

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Submitted by Satish Bidaisee and Calum Macpherson

Community Health Initiatives – Touch Toes Test

Diabetes affects 347 million individuals throughout the world, or about 5% of the global population. Ten percent of prevalent diabetes cases are due to type 1 diabetes, which is treated with daily doses of insulin. The other 90% of diabetes cases in the world are type 2 diabetes, which is treated with medication and lifestyle changes. Type 2 diabetes used to be a disease associated with developed countries. However, in developing countries, where the main concern used to be infectious diseases, chronic disease mortality is increasing. Type 2 diabetes is a significant problem in developing countries; 80% of diabetic deaths occurred in “low- and middle-income nations”. This increasing phenomenon is occurring as populations become more sedentary, and eat foods that are calorie dense and nutrient poor, causing epidemic proportions of obesity.

Diabetes has systemic effects on the body. Diabetes affects your blood sugar and prolonged episodes of elevated blood glucose levels can cause widespread organ damage and serious complications. A common complication of diabetes is peripheral neuropathy (PN). PN is present in 10% of newly diagnosed type 2 diabetics. PN rates increase with duration of diabetes, with 50% of diabetics developing PN after 25 years. The percentages of diabetics that develop PN go as high as 66%, such as in Sudan. The median life expectancy of diabetic amputees is 22 months.

The objective of this study is to measure the quality of life of diabetic amputees, and to identify the factors that contribute to lower quality of life standards. The method used was

The Touch Toe Test which was implemented by WINDREF in 2013. This method identified a significant population of persons who have received amputation procedures as a result of complications associated with diabetes for its 2016 activities. The study is a qualitative inquiry using interviews to explore and understand the quality of life of these individuals. Semi-structured interviews reviewed amputees life experiences and social realities on how being an amputee impacts their life. Participants were included if they: 1) received above ankle amputations due to diabetes. 2) had the procedure done in Grenada. 3) had normal cognition - could hold conversations, answer questions, and make informed decisions. 4) were 18 years or older. Participants were excluded if they received their amputation procedure outside of Grenada, had compromised cognition, or were under 18. Phone interviews were conducted. The sample population was obtained by snowball sampling.

The results can be seen in the table below:

Question	Answers				
Diseases Affecting Them	Diabetes Only (3)	Diabetes and Hypertension (3)			
Lifestyle Changes	Diet (2)	Mobility Problems (4)			
Life Since the operation	Happy	Overall Happy	Depressed and Lonely (2)	Apathetic	Has come to accept it
Closeness with Friends	Very close to friends (3)	Close to friends (2)	Did not answer		
Closeness with Family	Very close to family (3)	Close to children	No relationship with family (2)		
How they feel others look at them	Stigmatized (2)	Not stigmatized (2)	Never cared how others felt about them	Did not answer	
Most time spent with	Family (3)	Alone (3)			
Faith	Very Spiritual (6)				
Change in Faith	No change (3)	More spiritual (3)			
Effect on Family	No effect or changes on the fa	Not applicable	Family was sad and has come to accept it	Caused a divorce	
Job Importance	Very important (6)				
Job Status	Unemployed (6)				
Biggest Challenges	Mobility (5)	Finances (3)	Stigma (2)	Living Conditions	Bruising from Prosthetic

ID Number	Age	Gender	Parish of Residence	Amputation	Diseases Affecting Them	Lifestyle Changes	Life Since the operation
1	47	M	St. George	BKA	Diabetes	Diet	Happy
5	54	M	St. Andrew	Double BKA	Diabetes	Mobility problems	Depressed, lonely
7	75	F	St. David	Double	Diabetes, Hypertension	Mobility problems	Overall happy
8	56	M	St. George	Double BKA	Diabetes	Mobility problems	Apathetic
10	54	F	St. Patrick	BKA	Diabetes, Hypertension	Diet	Come to accept to amputation
14	59	M	St. Thomas	BKA	Diabetes, Hypertension	Mobility problems	Depressed, lonely

Closeness with Friends	Closeness with Family	How they feel others look at them	Most time spent with	Faith
Very Close	Very Close	Doesn't care	Family	Very Spiritual
Close to friends	No relationship with family	NA	Alone	Very Spiritual
Very Close	Very close	Not stigmatized	Family (Husband)	Very Spiritual
Close to friends	No relationship with family	Stigmatized (says he doesn't care)	Alone	Very Spiritual
Very Close	Very Close	Not stigmatized	Family (Children)	Very Spiritual
Did not answer	Close to Children	Stigmatized (says he doesn't care)	Alone	Very Spiritual

Change in Faith	Family	Job Importance	Job Status	Biggest Challenges
No Change	They were sad at first, but they have come to accept it	Very Important	Unemployed	Bruising from prosthetic
More Spiritual	NA	Very Important	Unemployed	Limits to mobility, finances
No Change	No effect on the family, nothing has changed	Very Important	Unemployed	Limits to mobility
More Spiritual	NA	Very Important	Unemployed	Mobility, stigma from others, finances
No Change	No effect on the family, nothing has changed	Very Important	Unemployed	Limits to mobility
More Spiritual	Wife left him, brother has become estranged	Very Important	Unemployed	Mobility, stigma from others, finances, living conditions

Fourteen physical therapy patients were referred for the study. Six persons did not respond, one person refused to be interviewed, and one person was misclassified; they did not have diabetes. All of the participants that were interviewed had received below the knee amputations. The participants lived in St. George, St. Andrew, St. David, St. Patrick, and St. Thomas, with a median age of 55 (range of 47-75). Three of the 6 participants were affected with hypertension. Since the amputation, two participants were happy, one was indifferent, and 3 were sad, but have come to accept it. The main lifestyle changes by participants were a change in diet (2) and staying home all day due to limited mobility (4). All 6 were very close to their friends and 3 had grown apart from their family. Two of the participants felt stigmatized, 2 of the participants felt they were not stigmatized, 1 participant said they were indifferent, and 1 participant did not answer. Three participants spent most of their time with their family and the other 3 were alone.

The family life of 4 participants did not change after amputation. One participant was never married, and his family was either deceased or not in contact with him. One participant stated that having the amputation completely changed his life for the worse. Losing his foot caused him to lose his job, which strained his marriage, and ended in divorce. All of the participants stated that they were close with god, and that having a job was very important to them. Because of the amputation, they had all lost their jobs.

This was a baseline study to obtain quality of life data on diabetic amputees in Grenada. Their quality of life has decreased since the amputation. It was observed that having more

social relationships contributed to a higher quality of life. It was also found that financial instability, stigma, and loneliness contributed to lower quality of life. These factors need to be further investigated before any intervention can be put in place to increase the quality of life diabetic amputees in Grenada.

Submitted by Satesh Bidaisee

Community Health Initiatives – One Health, One Medicine

WINDREF in 2016 launched a One Health Initiative Grant where scientists were invited to submit proposals for funding based on research related to human, animal and environmental health. In total, 6 submissions received funding in the amount of 450,000 USD over a three-year period. WINDREF also celebrated the inaugural One Health Day on November 3rd, 2016 through a secondary school One Health project competition in Grenada, a fundraising event to support Stray Dog Control for Grenada and another One Health One Medicine (OHOM) Massive Open Access Online Course (MOOC).

Massive Open Online Courses (MOOCs) employ online learning technology to deliver high quality educational experiences to large groups of students (Koutropoulos and Zaharias, 2015). The shift to online environments is considered to provide greater access to educational opportunities, however, according to Head (2014), careful consideration is needed as reported retention rates does not favor a successful educational experience. Retention is a major challenge in MOOCs as high drop out rates among students have

resulted in completion rates that average below 4% with rates as low as 1% (Krause et. al., 2015). High drop out rates according to Khalil and Ebner (2014) are often attributed to feelings of isolation and lack of interactivity. Engaging students in MOOCs is the strategy to promote retention, however, this is difficult with large class sizes containing geographical, timezone, language, technology and educational diversity (Hew, 2015).

The 2016, two OHOM MOOCs was delivered on the online platform, SGUx. The two courses included the content modules of Ecosystem Health and Sustainable Approach held in June and November of 2016 respectively. The courses additionally included student engagement tools and applications such as interactive blog domain for discussion questions, interactive case study reviews, peer review student seminar presentations and live virtual office hours and presentation, communication through social media and comprehensive examination for course credit. The minimum amount of time that a student was expected to engage each one of the course was 16 hours, which included synchronous and asynchronous content.

Course related statistics for the 2016 OHOM MOOCs

	Ecosystem Health	Sustainable Approach
Course Platform	SGUx	SGUx
Course Content	4 modules	4 modules
Period of Time	June, 2016	November, 2016
Time commitment	16 hours	16 hours
Number of Students	624	672
Number of Countries	21	27
Cost	Free	Free
Credit	Yes	Yes
Live Sessions	Yes	Yes
Peer Review	Yes	Yes
Social Media Communication	Yes	Yes
% Retention	22.5%	23.4%

The 2016 OHOM courses had greater percentage retention than previous courses offered and five times above the average retention rate for MOOCs. The OHOM 2016 course was a deliberate effort to apply non-traditional methods of interactive learning used for online education. Interactive learning according to Wintrup et. al (2015) results in enabling students to feel engaged and commit to completing MOOCs. In comparing previous OHOM MOOCs with the 2016 offerings, differences in approach for interactive learning for 2016 included:

Live sessions including presentations as well as engaged discussion on a weekly basis connected to the relevant module in a given week.

Interactive blog submissions were students commented and critiqued each others' postings which added another learning dimension to the course experience.

Peer review evaluations prepared and submitted seminar presentations allowed students the opportunity to learn from each other's work as well as engage in the course assessment process.

Course communications were facilitated with chat tools on the SGUx platform which was linked to social media outlets and allowed for a rapid communication rate and following throughout the course.

Credit offer after successfully completing the course requirements and comprehensive proctored final exam was also accepted by the students as a quantifiable incentive for retaining their involvement in the course.

The increased interactions among students and with the course instructors produced the five times above the average for MOOCs. The interactive tools and applications implemented for 2016.

Interactive learning with the relevant online infrastructure provided live engagement of students through delivering course content, course discussions, peer review evaluations and social media communications was found to be effective in significantly increasing the retention rate of students in the OHOM MOOC offered by SGU.

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Submitted by Satish Bidaisee

Grenadian Women's Perspectives on Screening for Breast and Cervical Cancer: A Collaborative Approach to Prevention

In July 2015, the proposal entitled, 'Perspectives on the uptake of breast and cervical cancer screening in the English Speaking Windward Islands: A collaborative approach' was approved for funding through the Caribbean Public Health Agency (CARPHA) and the National Cancer Institute (NCI) in the United States. The proposal was one of six funded under the request for proposals. The study is funded for two years, 2016 -2017, in the amount of US\$50,000.00. This study has multiple data collection locations in the English- speaking Windward Islands including Grenada, St. Lucia, St. Vincent and the Grenadines and Dominica. The study aims are: 1) To identify cultural factors that influence participation in breast and cervical cancer screening among women living in the English speaking Windward Islands and 2) To determine the clinical and social services that are available that enhance or support the quality of life for breast and cervical cancer patients in each of the 4 English speaking Windward Islands from the perspective of the gatekeepers who provide care for patients.

Implementation of the project began in January 2016. To achieve the aims of the study focus group discussions were held for

women and in-depth interviews for health practitioners involved in providing services for breast and cervical cancer patients. Initially the researchers obtained IRB approval and appointed a country liaison in each of the participating countries. Using online forums, meetings were held and contractual agreements signed with liaisons. Training sessions were also conducted via this method. Furthermore, liaisons were required to complete the National Institutes of Health (NIH) training for researchers and submit their certificates. Additionally, transcriptionists were identified by the liaisons for each country and contractual agreements entered into using the same method as was used for the liaisons. To ensure that the research protocol was being adhered to, site visits were conducted in each island at the start of data collection.

As of December 2016, Phase one of the project has been completed. This comprised of 3 focus group discussions and 5-7 key informant interviews in each of the countries. Submission of all attendance records, demographic forms, audio files as well as transcripts for all focus groups and interviews completed as specified in the contract. Country liaisons and transcriptionists have also received payments based upon the agreed upon payment schedule. Currently, final reports are being completed for submission.

Progress to Date: The number of participants: 128. We have collected data in each of the 4 countries (Dominica, Grenada, St. Lucia, St. Vincent & the Grenadines). We completed 22 individual interviews with oncology professionals and conducted 9 focus groups that included 106 local women in each country.

Summary of findings to date: The data is currently being prepared for analysis.

Security and Maintenance of Confidentiality: All data from this study has no personal or identifying information attached to it. The PI requested a waiver of signed consent to protect participant confidentiality. All data is being kept electronically on a password-protected computer and a backup file is being kept in a password protected cloud storage program. Any identifying information used for recruitment is kept separate from the data and will be destroyed once the study findings are written up.

Next Steps: Phase 2 of the project will begin in January 2017. This will involve coding and analysis of data, completion of the final report and presentation of results to Ministries of Health in each of the participating Windward Islands, preparing articles for publication, and conference presentations. More importantly, the findings will be used to plan culturally appropriate programs, specific to each of the four participating Caribbean Islands, to encourage uptake of screening and promotion preventative health behaviors. Furthermore, recommendations will be provided to the Ministries of Health of each island for strengthening of the screening system, treatment and support services. The ultimate goal is to reduce morbidity and mortality from the breast and cervical cancers.

Submitted by Kamilah B. Thomas-Purcell, Christine Richards, & Marva Joseph

Reachwithin

Reachwithin's mission is to improve the health and well-being of Grenada's most vulnerable youth. In recent years, reachwithin has focused its programming on benefiting formerly maltreated children currently living in residential care facilities across Grenada. This is done through a multidimensional approach that aims to improve internal (i.e. coping skills) and external (i.e. quality of care) resources for children.

In 2016 reachwithin focused on 3 key areas: 1) Caregiver education and capacity building; 2) youth services; 3) support activities and special fundraising initiatives and 4) increasing capacity via a collaboration with SalusWorld and SGU's new Clinical-Community Psychology Master's program.

1) Caregiver Education

Reachwithin provides the following care homes with support: Queen Elizabeth Home, Belair Home, Dorothy Hopkins Home, PAM, Richmond Hill Home for Boys and the new Bacollete Centre.

2) Youth Services

The Yoga program continues to make headway by offering supplemental training opportunities to community caregivers, public service workers and care home staff via lectures at SGU and on-site educational classes run by Lorna Douglas. Mr. Jerry Bascombe has increased our delivery of Youth Yoga classes and has recently begun offering weekly sessions at the new Bacollette Centre. As the result of a generous donation from one of SGU's student groups, reachwithin will be able to purchase drums to

continue the popular drumming program at all the care homes, under the supervision of Mr. Bascombe. With support from future volunteers and SGU student groups, it is hoped that the organization will continue to expand in 2017, benefiting as many youths as possible.

3) Special Fundraising Activities

On November 26th, 2016, reachwithin held its second fundraising campaign, this time in partnership with RunDeSpice. Several young men from Grenada's care homes represented reachwithin by taking part, running alongside our program facilitator, Mr. Jerry Bascombe. William, a former care home resident, surprised himself by placing first in the marathon. His aptitude for endurance running apparent, he vowed to take part again next year by training even harder the second time around. We wish him success in 2017!

Life Skills Program

In 2016 reachwithin added to its programming via the introduction of a new Transitional Living support group. The program is designed in collaboration with Grenadian youth who are former care home residents and its aim is to provide emotional support and guidance to young people who are transitioning out of the care and towards responsible independent living. During the 2016 group sessions, reachwithin staff met with about 6 young men, during which time current challenges were identified and coping strategies explored.

Lorna Douglas introduced NEWLO's life skills program at the homes for teens currently in care. She met with the youth several times a month to impart independent living skills, ensuring that they are better prepared

for life on their own. Those interested in learning job skills were encouraged to apply to the NEWLO and those already enrolled were supported through graduation. One youth left ready to become a carpenter while the other has a new set of sewing skills.

Submitted by Meghan Tyrrell

Saving Brains: A Community-based Conscious Discipline Program to Reduce Corporal Punishment in the Caribbean

The Saving Brains Grenada initial pilot project came to an end in the Fall of 2016, and a final report has been submitted to the funding agency, Grand Challenges Canada. The purpose of the project was to disseminate a 'Conscious Discipline Meme' in which corporal punishment is seen as counterproductive, and more positive alternatives that focus on parent-child attachment and skillful child raising practices are vitally important. To accomplish this, we implemented a train-the-trainer model, teaching Conscious Discipline Paraprofessionals (CDPPs) who traveled to communities to meet weekly with parents and their children--to model Conscious Discipline, foster positive attachment, and impart new skills. These CDPPs were supported by a mobile resource unit that also traveled to the communities to provide further training and resources and provide high national visibility for the project. The impact and results from the program are encouraging:

- Over the course of the 2-year project, 105 Ministry of Social Development Roving Caregivers received Conscious Discipline training and were certified as Paraprofessionals. Each trainee spent an average of 12.5 days in workshops and travelled throughout Grenada visiting families with children from birth to age

three, providing stimulation and Conscious Discipline techniques.

- At the completion of the study, 66 of these Paraprofessionals were still in the field delivering the service to moms and their young infants. Each session was one hour in length.
- Paraprofessionals made over 2,000 home visits in 60 Grenadian communities during the 2-year project
- Over the course of the 2 year project, 843 caregivers and their infants received at least some in-home visits from the Paraprofessionals, and more than 400 received the minimum target number of visits (10).
- A Conscious Discipline Mobile Resource Unit, staffed by project manager Ms. Stephanie Holmes, was established and visited communities throughout Grenada over the course of the project to provide classes in Conscious Discipline and to support the Roving Caregivers.



The Saving Brains Grenada Mobile Resource Unit

- The Mobile Resource Unit supported Paraprofessionals when they went into the community, and acted as a “mobile billboard”, advertising the project to the Grenadian public.
- The Mobile resource Unit visited 50

Grenadian communities every two months during the 2-year project

- 340 of the 843 infants in the project were randomly-selected for outcomes assessment: 168 in the intervention and 172 in the waitlist control
- Significantly more Grenadians reported hearing about “Saving Brains Grenada?” after the study was completed (16.2%) than at the beginning of the study (13.4%), $\chi^2=3.79$, $p=.052$ ($n=999$)
- 40.4% of respondents reported in the affirmative to the question: “Have you seen this bus in Grenada?” ($n=1,126$)
- The mean rating for “overall experience at the bus” was 4.4 (0= extremely bad; 5=extremely good) ($n=80$)
- 100% of parents/caregivers who visited the Saving Brains bus said they would recommend bus visits for other parents/caregivers with small children!
- Parents in the intervention group showed more stable attitudes toward corporal punishment from pre-intervention to post-intervention than parents in the control group whose attitudes deteriorated over the 2 years of the study, suggesting that the training and modeled attitudes influenced parents’ views of corporal punishment.
- The majority (71.6%) of the intervention group parents who were tested ($n=131$) provided positive responses when asked about what they would do in different daily scenarios encountered with their toddler, suggesting that the parents took up the model attitudes
- We noted that the mean age for the intervention group (27.9 months) was higher than the mean age for the control group (26.4 months). Consequently, we included age as a covariate in modeling the cognitive responses of the toddlers.

Considering only the toddlers whose parents had received more than 10 Conscious Discipline training sessions, and accounting for the difference in ages between the intervention and control groups, we found that toddlers in the intervention group scored higher on the Intergrowth 21st Neurodevelopmental Assessment total cognitive score (Mean Score = 42.9) than toddlers in the control group (Mean Score = 39.1). The difference in scores was significantly different from zero ($t = 2.236, p = .027$). Using Cohen's d , we determined that the effect size was small-medium ($d = .435$; 95% CI: .049 to .821). Therefore, the results indicate evidence of higher total cognitive achievement by the intervention group.

train educators in CD techniques.



Saving Brains Grenada Project Manager, Ms. Stephanie Holmes, interacts with a Grenadian girl while teaching Conscious Discipline to parents and caregivers

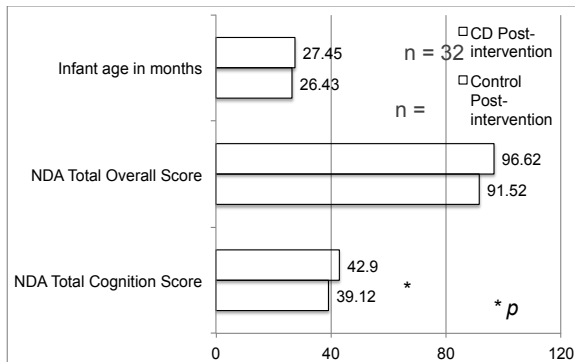


Figure 1: Neurodevelopment (NDA) scores for waitlist control vs. intervention group



Families visit the Saving Brains Grenada Mobile Resource Unit

The project team is now seeking further funding to scale the project up from late 2017 onward. This scale-up will include the expansion of the CD-based in-home visits to more communities in Grenada, expanding the CD training to daycare workers, opening a CD-based best-practice demonstration elementary school in Grenada, inviting interested individuals and government representatives from Grenada and throughout the Region to visit the CD best practice school, and encourage other schools in Grenada to

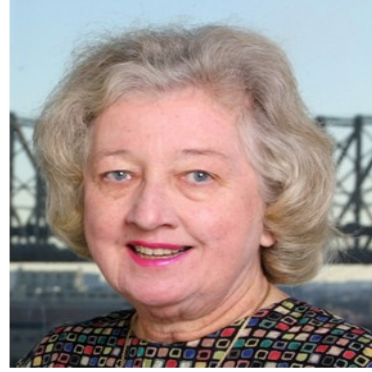
Submitted by Barbara Landon Landon and Randall Waechter

Genetic Correlates of the Addictive Diseases: Cocaine, Alcohol and Marijuana Addiction in Grenada, West Indies

In Grenada, blood samples are taken from normal volunteers, drug-free former cocaine users, drug-free former marijuana users, drug-free former alcohol users, or current drug and alcohol users. To assess their levels and types of addiction, a standard scale – developed by the Kreek Lab – is used for each patient, called the KMSK scale. The KMSK scale is a brief survey that is 90-100% effective in screening for alcohol, marijuana, cocaine and heroin addiction. This scale is used for all patients studied in the Kreek Lab. The patients are also asked about their family origin, as this information may play a role in further genetic studies done by the Kreek Lab.

To date, 55 case participants have completed the full KMSK questionnaires and blood draws in Grenada. Our control participant's selection is ongoing and we have completed 93 control samples. The samples and KMSK and family origin questionnaires that are administered are sent to Rockefeller University (New York) where they are analyzed.

In the past, our research nurses have included Nestar Edwards (Chief Nursing Officer for Grenada), Beverly Mends, Kathleen Collier, and Nurse Idis Mark-George. Recent talks have been held to include nurses from the St. George's University School of Nursing and the Ministry of Health (Grenada). These nurses have been entrusted with the process of receiving a signed informed consent form and drawing the blood and administering the Family Origin Questionnaire and the KMSK scale to the participants.



Dr. Mary Jeanne Kreek, Head of the Kreek Laboratory, Rockefeller University, New York.



From L to R: Dave Alexander - Drug Czar, Drug Control Office; Trevor Noël, Mary Jeanne Kreek - Rockefeller University; Elizabeth Japal - Assistant Drug Control Officer

The Kreek Lab collaborates with WINDREF in Grenada in an effort to gain a better understanding of the biology of addictive diseases, particularly the genetic basis of addiction. Grenada provides a unique study sample as heroin and other such opiates have yet to enter the country. In most countries, opiate and cocaine addiction is rampant and sometimes may go hand in hand. Thus, the Grenada study acts as a control for any heroin-cocaine addiction comorbidity observed in previous genetic studies of addicts.

Whole blood samples taken from subjects in Grenada are shipped to the Kreek Lab at Rockefeller University for DNA isolation. The DNA is further analyzed by lab members who look for any polymorphisms – variations in DNA – that may occur in specific regions of the DNA: mu and kappa opioid receptor genes being two of the many.

Projects of a similar nature are being run in several other areas of the world, including Stockholm, Lund, and Uppsala in Sweden, Oslo in Norway, Tel Aviv in Israel, Las Vegas in Nevada, Oakland in California and New York City in New York, USA.

Trevor Noel is the WINDREF representative on the Grenada Drug Intervention Network (GRENDIN). GRENDIN celebrated its thirteenth anniversary in December and we continue to work closely with Drug Avoidance Officers from the Ministry of Education. Both WINDREF and Rockefeller University have been collaborating with the Drug Avoidance office on this project for twelve years.

Submitted by Trevor Paul Noël

Caribbean University Interdisciplinary and Integrated Drug Demand Reduction Project

This project is designed as the first phase of one of several approaches for responding to the region's need for an inter-disciplinary and comprehensive approach to the drug problem.

In this proposal, the focus is on the community outreach activities by building capacity within Grenada and St. Vincent while drawing on the considerable academic expertise at SGU to evaluate the impact and effectiveness of the treatment programmes and interventions carried out in Grenada and

St. Vincent.

The project goals will be achieved through research geared toward assessing the needs for best treatment and aimed at reducing drug demand; evaluation of the economic cost for drug demand reduction; training workshops on drug demand reduction for community outreach personnel and evaluation of the effectiveness of the training. Additional goals include: developing treatment policies, standards, protocols; and, using best practices that foster prevention, timely identification, and management of the drug use problem by health providers.

The aim of the needs assessment phase of the project is to describe the nature of drug treatment and obstacles or barriers encountered in seeking care for substance use with the aim of recommending strategies to the Drug Rehabilitation Sector that inform policy which will aid in the development of programs and interventions to address the needs of the communities in Grenada, Saint Lucia and St. Vincent. This project has the support of a coalition of organizations, including the Drug Rehabilitation sectors of Grenada and Saint Lucia.

The project utilizes a qualitative design where focus group discussion sessions consisting of 6 - 8 participants are or will be conducted in each country. Focus groups will be conducted until data saturation is reached.

The subject population for this research consists of key community members / stakeholders, drug users and family members of drug users. There are three (3) groups of key stakeholders: persons who use substance and seek treatment; family members of persons who use substances; persons involved

in the treatment and care of those who use substances for the Grenada arm of the study and only one (persons who use substance and seek treatment) for the Saint Vincent and Saint Lucia arms.

The study is ongoing. To date Grenada focus group sessions have been completed. Sessions were held at the Mt. Gay facility where groups of persons who used substances, family members and health care providers were interviewed. The data are currently being transcribed for analysis in 2017.

The St. Vincent round of focus groups started in November 2016 and will continue into January 2017. Following completion of the sessions in St. Vincent the data will be added to the software for comparison with the Grenada data.

Saint Lucia is the third country from which data would be collected. The IRB process is still ongoing and it is hoped that this would be resolved to enable data collection in February/March 2017.

Submitted by Shelly Rodrigo

Caribbean Research Ethics Education Initiative

The Caribbean Research Ethics Education Initiative (CREEi) is drawing attention to, and building capacity for, research ethics across the Caribbean basin. CREEi's successes are apparent though its trainees and alumni who have become BSEC members and officers, obtained regionally influential positions, published in peer reviewed journals, and been awarded internationally prestigious opportunities.

CREEi's Advisory Board includes Derrick Aarons (CARPHA's ethicist, CREEi faculty member, and founding President of the Bioethics Society of the English-speaking Caribbean - BSEC). He has provided CREEi trainees and alumni opportunities in 2016 to serve on CARPHA's IRB and conduct and participate in CARPHA's training activities. Carla Saenz, PAHO's Bioethics Regional Advisor, has also facilitated and supported CREEi and its efforts to strengthen regional capacity for research ethics. In partnership with CARPHA, PAHO, BSEC, and others, CREEi alumni are already functioning as research ethicists, bioethics educators, and policy advocates who contribute to systems of regulatory review and oversight, and improve protections from harm for residents of Caribbean countries.

CREEi alumni accomplishments include, for example, Sharmella Roopchand-Martin who received a highly competitive fellowship in the Department of Bioethics at the National Institutes for Health (NIH) in the USA; Rosmond Adams who was employed by CARPHA in Trinidad; and Allana Roach who was employed by SGU in Grenada. These and other CREEi alumni have joined BSEC and serve as BSEC officers; presented webinars and at the International Association of Bioethics 2016 conference; applied for fellowships and academic employment; and received guidance on manuscripts prior to submitting to peer reviewed publications.

CREEi's hybrid online and onsite courses provide comprehensive graduate education in research ethics to cohorts of 8 to 10 English-speaking and Spanish-speaking trainees. After successfully completing 2 onsite and 4 online courses, trainees are awarded a Diploma. An

important and growing part of CREEi's curriculum is the Responsible Conduct of Research (RCR) which deals with peer reviewed papers and grants, adjudication of scientific misconduct, mock IRB exercises, interpersonal skills for conflict resolution, teaching RCR in the Caribbean context, and similar topics of regional and international relevance. CREEi's top performing alumni are offered a scholarship to complete an online MSc degree in Bioethics at Clarkson University in the USA.

A summary of 2016 outputs and 2017 plans from the Caribbean Research Ethics Education Initiative (CREEi) is bulleted below. CREEi is an NIH Fogarty funded grant and additional information is available in WINDREF's 2014 and 2015 Annual Reports and at <https://www.fic.nih.gov/Grants/Search/Pages/bioethics-TW009731.aspx>.

January – December 2016 Outputs

Peer reviewed publication: Philpott, Hall, Gefenas, Macpherson, Strasberg. Fogarty and Charge of Moral Imperialism: A Response to Hellmann et al. Archives of Medical Research. 47.1 (2016): 65-66.

CREEi Facebook: Established to develop Alumni Network, share information, and expand visibility

Promotion: Kamille Williams promoted from Assistant to Project Coordinator; Chermaine Antoine appointed Assistant

Hosted in Grenada:

Capstone for Cohort 1 and Proseminar for Cohort 2

Faculty development sessions on goals and challenges; and strategies for 2016-2017

Updated and distributed 'Call for Applications for Cohort 3' (application deadline Jan 9, 2017)

Initiated development of D43 grant proposal to complement CREEi by boosting capacity for regional institutions to grant PhDs and postdoctoral posts in global health and ethics

January - May 2017 Plans

Review, select, and notify applications of acceptance or other status for Cohort 3

Host onsite courses in Grenada

Proseminar Cohort 3: May 8-13 (involve Cohorts 1 and 2 when possible)

Capstone Cohort 2: May 4-11 (involve Cohort 1 when possible)

Enhance partnerships with BSEC, CARPHA, PAHO, and others to support self-sustaining research ethics networks

Submitted by Cheryl Macpherson

United Nations Framework Convention on Climate Change (UNFCCC) St. George's Regional Collaboration Centre (RCC)

The centre is a collaboration between the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, WINDREF, and the Department of Public Health and Preventive Medicine (DPHPM) at St. George's University (SGU). The centre was established in 2013 and since then it has promoted climate action in 16 independent Caribbean countries in the Caribbean region.

In 2016 RCC experienced a change in the team with Maria Laura Vinuela joining the Centre to head the team. Nigel Edwards continued in his role as technical officer and Randy Waechter as administrator of the fund through the year. Veronica Previti joined this year as an intern and Karleen Bowen as administrative assistant.



Veronica Previti, Maria Laura Vinuela, Karleen Bowen, Randall Waechter & Odran “Nigel” Edwards

The activities of the RCC St George’s in 2016 are summarized below.

1. Official unveiling of the new UNFCCC Regional Collaboration Centre St. George’s

April 2016 saw the official unveiling of the new UNFCCC Regional Collaboration Centre St. George’s sign at St. George’s University in Grenada. The unveiling coincided with the extension of the memorandum of understanding between the UNFCCC and partner organization Windward Islands Research and Education Foundation (WINDREF).



Satesh Bidaisee, Odran “Nigel” Edwards, Maria Laura Vinuela, Hugh Sealy, Martin Forde, Marios Loukas

2. Capacity Building and Outreach

RCC St George’s together with UNDP organized 6 capacity building workshops in June and September. The objective of the trainings were to provide the governments of St. Vincent, St. Lucia, Grenada, Suriname, Guyana and Belize the tools needed to develop their climate change policies and measures to achieve their targets for the power and transport sectors in their Nationally Determined Contributions (NDCs), leveraging from the lessons learnt from the Clean Development Mechanism (CDM) and Nationally appropriate Mitigation Actions (NAMA). The workshops were financed by the Japanese-Caribbean Climate Change Partnership (J-CCCP). The RCC provided the technical support and delivered all 2-days workshops.



Participants to the Mitigation Training Workshop held at St. George’s University in July 2016

RCC St. George’s together with RCC Bogotá organized a webinar on 1 June to discuss the financing opportunities for CDM projects in the Latin-America and Caribbean regions. The webinar introduced opportunities for receiving climate change funding through sale

of carbon credits and engagement with public and private investors.

RCC St. George's organized a workshop on Article 6 and the future of the CDM at the Latin American and Caribbean Carbon Forum (LACCF) in Panama September, which discussed how market and non-market based approaches will help countries meet their commitments under Article 6 of the Paris Agreement. During the Forum, the RCC St. Georges moderated several round table discussions with representatives of the governments of Belize, St. Lucia, Dominican Republic, Antigua and Barbuda, Cuba, Haiti, Suriname and Jamaica aiming to identify activities that can assist such countries in the implementation of their National Determined Contributions (NDCs). Such activities will be implemented by the partners of the Nairobi Framework Partnership.



Maria Laura Vinuela working with governmental representatives at the Latin American and Caribbean Carbon Forum in Panama

This year, RCC St George's released the first number of its newsletter. Such number was circulated on 02 December and focused on climate finance and presented climate finance

opportunities available in the region to assist with the implementation of mitigation projects and programmes which are essential to enhance SIDS' ability to achieve low-carbon economic growth.

3. Participation in Events

- (i) Vinuela, M.L. (2016) "Carbon Expo", May, Köln, Germany
- (ii) Vinuela, M.L. (2016) "Mitigation training in Grenada" June, St. George's, Grenada
- (iii) Edwards, N. (2016) "Mitigation training in St. Lucia" June, Castries, St. Lucia.
- (iv) Kumar, D. (2016) "Mitigation training in St. Vincent" June, Kingstown, St. Vincent and the Grenadines
- (v) Vinuela, M.L. (2016) "Mitigation training in Suriname" June, Paramaribo, Suriname
- (vi) Vinuela, M.L. (2016) "Regional Workshops for Latin-America and the Caribbean for national experts on the preparation of biennial update reports (BURs)", July, Castries, St. Lucia
- (vii) Vinuela, M.L. (2016) "NDC regional Dialogue for Latin America and the Caribbean", July, San Jose, Costa Rica
- (viii) Vinuela, M.L. (2016) "Caribbean non-State actor dialogue on Article 6 of the Paris Agreement", July, St. George's, Grenada
- (ix) Edwards, N. (2016) "Regional workshop on Energy Efficiency Standards and Regulation", July, St. George's, Grenada
- (x) Vinuela, M.L. (2016) "OLADE's Energy workshop", September, St. George's, Grenada
- (xi) Vinuela, M.L. (2016) "Mitigation training in Belize", September, Belize City, Belize
- (xii) Galvan, D. (2016) "Mitigation training in Guyana", September, Georgetown, Guyana
- (xiii) Vinuela, M.L. (2016) "Caribbean Renewable Energy Forum", October, Miami, US

(xiv) Vinuela, M.L. (2016) "Paving the Way for NDC Implementation" December, San Jose, Costa Rica



Maria Laura Vinuela in panel discussion at Caribbean Renewable Energy Forum



Maria Laura Vinuela interviewed by national television to present the outcome of the "Mitigation training in Grenada" held at St. George's University

4. Intended Nationally Determined Contributions

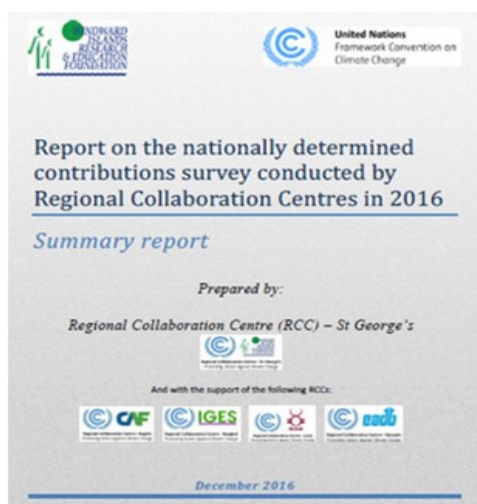
In June this year regional Caribbean non-state actors met in St. Georges University (SGU) to discuss Article 6 of the Paris Agreement. The objective of the event was to kick-start an active dialogue among regional experts on options for interpreting and operationalizing elements contained in Article 6 of the Paris agreement. At the meeting, the regional

experts concluded, among other things and with varying levels of agreement, that: (i) The economic instruments under the Paris Agreement could help countries achieve their national plans (so-called Nationally Determined Contributions (NDCs)) and/or allow countries to commit to greater ambition; (ii) Consideration of sustainable development benefits needs to be strengthened, especially in relation to poverty alleviation and adaptation co-benefits, perhaps by establishing a link with the United Nations Sustainable Development Goals; (iii) The economic instruments should enable transparency and ensure a robust monitoring, reporting and verification of results while being simple and user friendly; (iv) Quantified NDCs should be a prerequisite for transfers of emission reduction outcomes, but highlighted difficulties as NDCs might not be comparable; (v) Transferred emission reduction outcomes should be quantifiable in similar units, such as tonnes of CO₂-equivalent; and (vi) Great similarity could exist between the Sustainable Development Mechanism under the Paris Agreement and the market-based mechanisms under the Kyoto Protocol, which incentivize the private sector to develop emission reduction and development projects.



Participants to the "Caribbean non-State actor dialogue on Article 6 of the Paris Agreement" held at St. George's University

In 2016, the RCC St. George's published a report on the outcome of the survey conducted by Regional Collaboration Centers (RCCs) in West Africa, East Africa, Asia, Latin America and the Caribbean (LAC) on NDCs. This survey aimed to collect information from designated national authorities (DNAs) on the status of NDCs in countries in order to identify areas of NDC implementation requiring immediate financial, technical or capacity building support.



The information obtained through the survey was used to develop project ideas, which will be implemented by partners of the Nairobi Framework. A total of 10 projects were identified: 1. Sustainable Development in SIDS in the power sector; 2. Circular economy and waste management; 3. Regionally integrated market mechanisms; 4. NAMAs for NDC implementation; 5. Article 6 implementation; 6. Support to NDC implementation; 7. Legal framework for private sector engagement; 8. Crowdfunding for mitigation action; 9. Mitigation in transport sector; and 10. Legislation for the carbon market. It is expected that these projects will be implemented in several countries in the Caribbean region between 2017 and 2018.

5. Partnerships

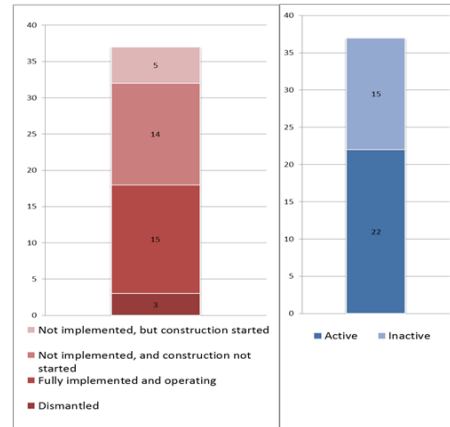
RCC St George's has forged several partnerships during 2016 working together in regional activities, including the following:

- The Caribbean MRV Hub: GHGMI, UNDP GPS: This partnership was forged to establish a regional measurement, reporting, and verification (MRV) collaboration centre for national greenhouse gas (GHG) inventory and related reporting by Caribbean countries. This Caribbean regional MRV collaboration centre, will operate from St. George's University and will enhance the transparency of reporting by Caribbean countries under the UNFCCC and the Paris Agreement by pooling regional expertise from participating countries and donor support to cooperatively establish the essential institutional arrangements for MRV.
- Mitigation training for the Caribbean, J-CCCP: The aim was to conduct six mitigation training workshops in St. Vincent, St. Lucia, Grenada, Suriname, Guyana and Belize.
- Top-down development of Standardized Baselines (SBLs), J-CCCP: This will facilitate the development of 6 SBLs in the energy, forestry and transport sectors of St. Vincent, St. Lucia, Grenada, Suriname, Guyana and Belize.
- NAMA on efficient lightening in the residential sector of Grenada, OLADE: This regards the development of a NAMA that will promote the implementation of energy efficiency measures in Grenada.
- Energy efficiency support to the government of Grenada, United States National Renewable Energy Laboratory (NREL): This partnership was forged to

support the government of Grenada to identify and implement energy efficiency capacity building events in the country.

- Energy Chamber, Trinidad and Tobago: The aim is to establish a regional carbon market in the Caribbean region.

RCC St George’s plans to expand the number of partnerships in the region, and to continue to formalize new and existing partnerships for the implementation of specific projects.



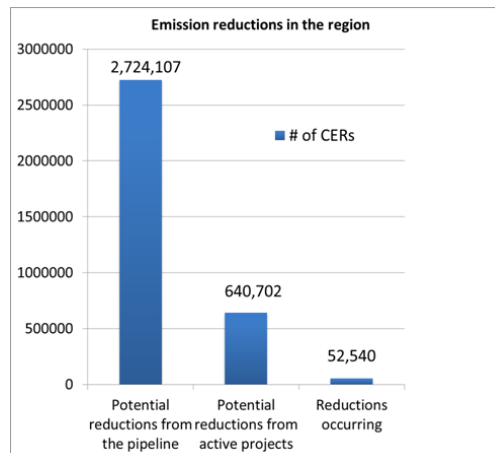
6. CDM Project Support

The centre provided direct technical support to several CDM project activities and programmes in the region at different stages of the CDM cycle (prior consideration, validation, registration, verification, and issuance). RCC has supported CDM projects facing difficulties to payback their CDM loan scheme and to obtain Letter of Approval to overcome these barriers.

RCC St George’s is also supporting the matchmaking between CDM projects and investors, an example of this was the opportunities identified for project developers in Cuba which hold issued emission reductions credits in the UNFCCC registry.

Finally, RCC St George’s pro-actively contacted all the CDM projects and PoAs in the Caribbean to understand the status of the projects and the support needed. Through in-depth discussions we were able to build good rapport with the project participants and gathered valuable insights. For instance, it was found that there is a significant amount of projects that are not actively engaged in the CDM, however, most of the project that were implemented thanks to the CDM are still operating and reducing emissions.

It was also found that the Caribbean region is not fully realizing its mitigation potential. From the 2 million emission reduction (ERs) that can be generated with CDM projects, only 24% are actively generating emissions reductions, out of which only 8% of such emissions reductions are claimed as UN Carbon Credits.



The RCC St. George’s will continue working to support the implementation and operation of mitigation projects that will allow the region to achieve its full mitigation potential.

7. Standardized Baseline Support (on-going, approval, top-down)

The standardized baselines (SBLs) allow a baseline to be calculated only once for an

entire class of projects or industry sector, as opposed to being calculated separately for each CDM project. SBL can potentially reduce transaction costs, enhance transparency, objectivity and predictability, and facilitate access to the CDM, particularly with regard to underrepresented project types and regions. SBL are intended to scale up the abatement of greenhouse gas (GHG) emissions, while ensuring environmental integrity. In some cases, such standardized baselines are of interest to countries and stakeholders for their use in nationally appropriate mitigation actions (NAMAs) and measurement, reporting and verification (MRV) activities.

In 2016, RCC St George's supported the development and submission of several SBLs in the region. These included the SBL for grid emission factor (GEF) of Antigua and Barbuda, Grenada, St Vincent and the Grenadines and Haiti. The GEF for Grenada has been approved by the CDM Executive Board.

RCC St George's also initiated the support to the seven new SBLs: Grid Emission Factor (GEF) for Saint Lucia; GEF for Guyana; GEF for Suriname; Transport sector in Saint Vincent and the Grenadines; Transport sector in Belize; Transport sector for Saint Lucia and Afforestation/Reforestation for Guyana. This work will continue next year and will integrate with the work that such countries are planning to implement their NDCs.

8. Internships

RCC St. George's hosted four interns during the year:

- Kelisha Caesar (SGU) supported the revision of the Standardized Baseline (SBL) for the power sector in Grenada.



- David Do (SGU) supported the development of the NDC survey report, in particular, he developed the charts and graphs that depicted the outcomes of the survey conducted by RCCs in all regions.
- Katherine O'Neill (SGU) prepared a report on the National Communications (NCs) submitted by CARICOM member countries.
- Veronica Previti (UNFCCC internship) supported the development of the newsletter and a campaign to collect information on the status of CDM projects in the RCC St. George's pipeline. She has also supported the RCC's routine operations.

9. Summary of the RCC dialogue on how Paris can boost climate action

The "Caribbean non-State actor dialogue on Article 6 of the Paris Agreement" organized by the regional collaboration centre (RCC) St George's took place in Grenada on 12 July 2016. The objective of the event was to kick-start an active dialogue among regional experts on options for interpreting and operationalizing elements contained in Article 6 of the Paris Agreement.

At the meeting, the regional experts concluded, among other things and with varying levels of agreement, that:

- The economic instruments under the Paris Agreement could help countries achieve their national plans (so-called Nationally Determined Contributions (NDCs)) and/or allow countries to commit to greater ambition;
- Consideration of sustainable development benefits needs to be strengthened, especially in relation to poverty alleviation and adaptation co-benefits, perhaps by establishing a link with the United Nations Sustainable Development Goals;
- The economic instruments should enable transparency and ensure a robust monitoring, reporting and verification of results while being simple and user friendly;
- Quantified NDCs should be a prerequisite for transfers of emission reduction outcomes, but highlighted difficulties as NDCs might not be comparable;
- Transferred emission reduction outcomes should be quantifiable in similar units, such as tonnes of CO₂-equivalent;
- Great similarity could exist between the Sustainable Development Mechanism under the Paris Agreement and the market-based mechanisms under the Kyoto Protocol, which incentivize the private sector to develop emission reduction and development projects. Specifically in the context of the Caribbean region, the experts highlighted the following:
 - The need for the Caribbean region to maintain the momentum started with the development of the NDCs, so that the countries do not fall behind with the new mechanisms, as happened with the CDM.
 - Set low-carbon development as a priority and not just a limited focus on mitigation.
 - The need for Caribbean States to cooperate in some sectors to address the issue of scale

and ensure better access to finance and technology, the possibility of a common regional NDC was also discussed.

- The need to further engage the non-State actors in arriving at regional positions and to have mechanisms to create awareness of the outcomes from the negotiations.
- To investigate how the energy sector (the largest contributor to mitigation) may be invited to participate at the negotiations and how they may be informed on the negotiations on cooperative approaches that are being discussed under article 6.

The dialogues formed the second stage of a project, started in 2015, funded by the governments of Germany and Norway, aimed at supporting developing countries in the use of economic instruments to achieve their NDCs. Similar dialogues will continue in 2017.

Submitted by Maria Laura Vinuela and Hugh Sealy

Conservation Leaders in the Caribbean (CLiC)

Dr. Andrea Easter-Pilcher is one of six international collaborators on a 2014 United States Fish and Wildlife Service (USFWS) grant (\$125,000) which supports a groundbreaking conservation leadership training and capacity-building program in the Caribbean and Latin America. The overarching vision for Conservation Leaders in the Caribbean (CLiC) is “healthy, functional marine and terrestrial Caribbean ecosystems enabling ecologically and economically sustainable development to meet both human and wildlife needs.” The mission is to facilitate the careers of young conservation professionals by teaching them the skills to launch, develop, and implement successful conservation campaigns, while connecting them with existing leaders in the

field. The primary goal of CLiC is to establish an enduring Caribbean leadership-training program that facilitates a “coalition of forces” conservation network of regional governmental agencies, non-governmental organizations, and universities dedicated to securing the future of wildlife resources across the wider Caribbean. CLiC candidates (fellows) must be Caribbean or Latin American residents and have completed their bachelor’s degree in a related field. Since the team’s initial grant award of \$125,000, they have received two additional grant extensions from the USFWS (\$30,000 in 2015 and \$68,000 in 2016). The team has also received a small grant of \$2,500 (2015) from the Helen Johnston Family Foundation in support of the CLiC fellows.

A main objective of the inaugural CLiC program was successfully completed in October 2016 when, with outstanding deliveries of their team projects before an audience of some 50 people who were present in-person and online, the 17 graduating CLiC fellows from 12 countries - the first cohort (2014-2016) - made for a fitting end to what is now being hailed as a unique conservation leadership program in the wider Caribbean. After an 18-month training and mentorship journey led by a voluntary Board of 6 Directors, fellows accounted for this investment in building their leadership capacity to a diverse mix inclusive of the principal donor USFWS, existing and potential partners, and their peers. The event in the form of a “brown bag” was hosted by the USFWS with the center of focus being the CLiC project presentations. These projects were broad in range, addressing conservation of hawksbill sea turtles and parrotfish; management of invasive lionfish populations; restoration of mangrove forests and reducing

the trafficking of wildlife species – with achievable biodiversity targets identified through the open standards process.

An important take-away was that these projects (being team-selected) have fostered a sense of ownership among the fellows, with great expectations far beyond the 18-month implementation period. Critical success factors include the 5-year planning cycle and the elements of sustainability built into each project (community involvement, linkage to home institutions, individual interests and partnerships), which are expected to promote continued implementation.

The CLiC strategy provides the fellows with valuable experience in international collaboration and networking. The fellows emerging from the CLiC program will be capable of initiating and managing new conservation initiatives within their home countries and across international boundaries.

As the first cohort comes to a successful end, the Board of Directors goes into planning mode for the next cohort, with a first training session for the new cohort of fellows to be held in May of 2017 on the St. George’s University (SGU) campus. The call for applicants will be early in 2017. The Board’s focus going forward will be on improving the current model and attaining sustainability. One of the fellows speaking (at the brown bag in Washington D.C.) of the impact of his team’s project on a local community, endorsed CLiC simply by stating - “Small initiatives do work”.

Project partners for CLiC include the USFWS, International Fund for Animal Welfare (IFAW), SGU and the Windward Islands Research and

Education Foundation (WINDREF). The CLIC leadership-training program is currently based at SGU. Dr. Easter-Pilcher sits on the Board of Directors.

Further Invited international activity by Dr. Easter-Pilcher in 2016:

- Represented the country of Grenada as an official member of the Party and delegate to the Convention on International Trade in Endangered Species of Flora and Fauna (CITES) CoP17 in Johannesburg, South Africa-2016.
- Invited as a rare species specialist and visiting scientist to the Sikhote-Alin Biosphere Reserve in the Russian Far East - Sept. and Oct. 2015
- Invited lecture at the Natural Resources Institute (Graduate School) at the University of Manitoba: Island Biogeography of the Caribbean

Submitted by Andrea Easter-Pilcher

The Occurrence of Microplastic in the Intestinal Tract of Commercially Exploited Fish from Grenada

This research was a short pilot study of the Caribbean regional node of the Global Partnership on Marine Litter (GPML Caribbean) which is co-hosted by the Gulf and Caribbean Fisheries Institute (GCFI) and the United Nations Environment Programme (UNEP) Regional Coordinating Unit for the Caribbean. Funding for this project came from UNEP via GCFI. The research comprised of Principle Investigator Dr. Clare Morrall, a professor of the Department of Biology, Ecology and Conservation at St. George's University ably assisted by Dr. Emily Vogler, of the University of California, Irvine; Mr. Denzel Adams, a recent graduate of the Marine,

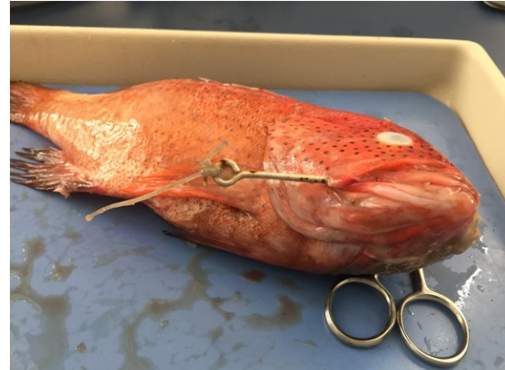
Wildlife and Conservation Biology programme at St. George's University; and Ms. Michelle Taylor, a current student in the Department of Biology, Ecology and Conservation.

The aim of the project was to investigate the occurrence of microplastics in commercially exploited fish in Grenada. Microplastics are defined by UNEP as particles that are less than 5mm in size, and can include fibres, microbeads and small pieces of plastic film.

Seven fish species were examined; a total of 34 samples (6 samples of each Red Hind, Red Snapper, Mutton Snapper and Barracuda, 5 samples of Blue Runner, 4 samples of Mahi Mahi and 1 sample of Yellowfin Tuna). Measurements of the fish were taken, including the fork length, overall weight and gut weight. Liver samples were taken, and stored for future analysis. Gut samples were digested in 10% potassium hydroxide (KOH) solution and placed in a water bath at 60°C for a number of days. Samples were passed through an 180µm sieve and rinsed with water to remove any residual KOH. Samples were carefully examined using a dissecting microscope. Potential plastic was removed and further examined under the compound microscope.



Our research revealed that 97.1% of the samples contained microplastics. In total, 272 pieces of microplastic fibre and 14 pieces of microplastic film were found in the samples. 94.1% of the samples contained microplastic fibres and 26.5% contained microplastic film pieces. Clear fibres were the most common colour found, followed closely by blue fibres. Yellow, red, orange, green and pink fibres were also found. The most fibres found in one sample were 25. Two of our Mutton Snapper samples also contained macroplastics: a 2cm long piece of white film was found in one Mutton Snapper and an entire fish was removed from the stomach of another complete with fishing hook, with the plastic fishing line still attached!



Hooked fish with fishing line found in the stomach of a larger fish

The findings of this project were presented at the 69th Gulf and Caribbean Fisheries Institute conference in Grand Cayman in November 2016 by Ms. Taylor. Our research was very well received and much discussion was generated. A manuscript titled: 'Micro-plastic in commercially exploited fish from Grenada, West Indies' is currently being finalized to be submitted to the Gulf and Caribbean Research journal in early 2017. This project is close to completion but further research in this area is planned.

Submitted by Ms. Michelle Taylor and Dr. Clare Morrall

Water Quality Assessment in Clark's Court Bay Marine Protected Area, Grenada, West Indies

The Woburn Clark's Court Bay Marine Protected Area (WCCB MPA), located in Woburn, St. George's is one of four established MPAs in Grenada. A recently concluded collaborative project between WINDREF and Environmental Testing Unit, SGU included Dr. Svetlana Kotelnikova (1,4,5), Ms. Makeda Matthew at the Department of Microbiology and Immunology and Environmental Testing Unit at St. George's University (SGU), Ms. Karla Farmer-Diaz (3,6,8), Dr. Randall Waechter at



Samples of microplastics found in fish

WINDREF, Mr. Jerry Enoe and Dr. Hugh Sealy in the Department of Public Health and Preventive Medicine at SGU (2), and Dr. Clare Morrall in the Department of Wildlife and Conservation Ecology in the School of Arts and Sciences at SGU (7). This project was supported by the Nature Conservancy with Funding from the World Bank, and implemented in close collaboration with Fisheries Division Ministry of Agriculture, Grenada, the Woburn Fishery Association, and the WCCB MPA Community Organization. SGU provided laboratory space and equipment, which is utilized by the Environmental Testing Unit at the University.



Figure 1. Nariman Konjkavfard, Karla Farmer, Javier Barranco, Makeda Matthew during SGU Research Day 2016 (8).



Figure 2. Albert Wei-Chin Li an MRSI candidate, SOM term 2.

One of the main objectives of this project was to create a baseline of water quality (WQ) pa-

rameters that can be utilized for the creation of a sustainable and economical water quality assessment not only for Grenada, but also for the wider region. The team examined the water quality and provided a plan for the continued monitoring of water quality in the WCCB MPA. There were multiple objectives reported elsewhere (1-7), however here we report mostly on the water quality assessment.

To achieve this objective we held planning and information sessions that engaged the various participants or stakeholder groups that included marine protected area related professionals, students and community members. These sessions highlighted the priorities of the hypothesized sources of pollution of the MPA and the significance of monitoring WQ. The stakeholder groups were also trained to test and assess the various aspects pertaining to WQ with protocols that were specifically created for the monitoring of WQ in the WCCB MPA (3).

The WQ testing and analysis protocols were derived from a compilation of previously established water quality methodologies employed by Hach technologies and the Environmental Testing Unit at St Georges University in Grenada. The protocols focused on the most effective parameters that were to be observed for a comprehensive but cost-effective assessment of WQ (1). These parameters were then used as a means to document the current water quality in the WCCB MPA and also allowed for the identification of possible sources of point and non-point pollution in the WCCB MPA.

We identified 5 sites (Figure 3) to observe and perform our analysis on and these sites were: Site 1 - designated as USRF which was located up-stream of the Rum Factory

Site 2 - DSRF - which was downstream of the Clark's Rum Factory and a suspected pollution source

Site 3 – Mangrove, at the mouth of the river runoff from the mangrove into Woburn bay.

Site 4 –Jetty which was at the Clarke's Court Bay Jetty

Site 5 – Benji Bay, a bay located further out into in the MPA.

Working as a team of two, Ms. Matthew and Ms. Farmer (Figures 1 and 2), and utilizing the prepaid assistance of the local fishermen association, performed the water sampling. During three 6-week sampling periods between the months of February 2015 to November 2015; weekly samples were collected from 5 different sites in triplicates and each replicate was analyzed 5 times. The sampling was performed in 6-week intervals to provide measurements that spanned both the dry season (December 1st-May 30) and the tropical rainy season (June 1st –November 30th). Rainfall data were also collected for the entire sampling period by Mr. Jerry Enoe to add to the analysis.

Statistical analysis of spatial, temporal and test-dependent variation, was performed along with t-test-based comparisons. To accomplish this, 20 physical and biochemical parameters were analyzed in the field and in the lab using new developed protocols and manually recorded into lab notebooks. The methods were described and cited in the project's reports (1, 3, 4). The results were recorded and the analysis was performed by Dr. Kotelnikova in collaboration with SGU Medical Student Research Initiative researcher Albert Wei-Chin (Figure 2) and Microbiology Research Selective participant Javier Barranco (Figure1).

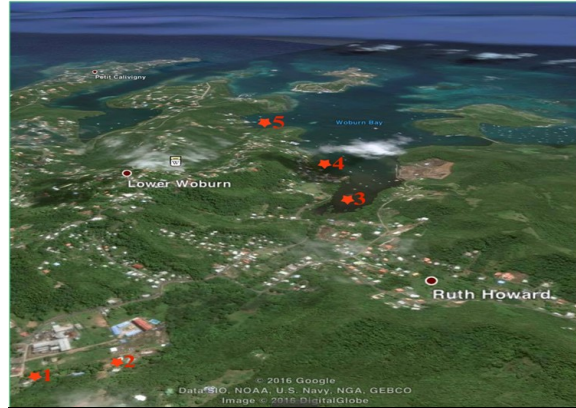


Figure 3: Sample sites for the water collection and analysis in the WCCB MPA, 1-Upstream (USRF), 2- Downstream Rum Factory site (DSRF), 3-Mangrove, 4- Clark Court Jetty (CC Jetty), 5-Benji Bay site

The WQ in WCCBMPA was evaluated by comparing the detected levels of pollutants to the limits of the USA Environmental Protection Agency (EPA) and previously observed levels in the control coastal seawaters of Grenada by the Environmental Testing Unit at SGU.

Using the pairwise correlation analysis of each parameter among different tested sites over three periods of six weeks, the team assessed the relationships among the levels of each parameter and therefore the source of pollution. The value of each parameter was evaluated using the inter-parameter correlation analysis using the EPA indicators of BOD5 (Figure 4) and Fecal Coliforms (Figure 6) as a reference. The least expensive and the most informative indicators were identified. The compliance was evaluated using major indicators for both river and marine sites.

The river watershed, following the discharge from The Clarke's Court Rum distillery and mangrove runoff, were identified as the major sources of organic pollution in the WCCB MPA in accordance with the gradient correlation

analysis of such parameters as Biochemical Oxygen Demand (BOD5) and most probable viable numbers of heterotrophic bacteria. The levels of BOD5 in non-polluted waters are normally expected to be 1 to 3 mg/L and in moderately polluted water, it is expected to be 3 to 6 mg/L. In Grenada it is illegal to discharge water with BOD5 levels above 50 mg/L. However, our data indicated increased concentrations of degradable organic matter downstream of the rum factory's discharge point. The DSRF site showed BOD5 values above the limits for legal discharge (Figure 4) on 10 of the 18 sampling occasions.

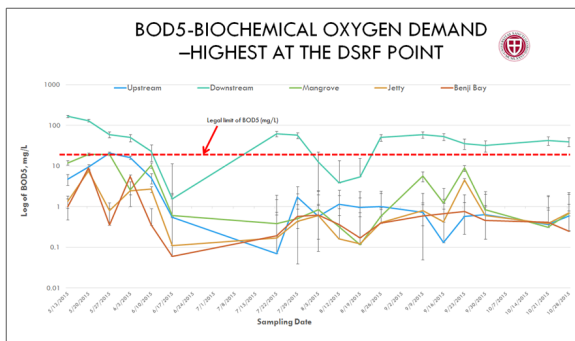


Figure 4: BOD5 average levels, spatial, temporal and method-dependent variation observed in five tested sites for the course of 18 weeks

The level of organic matter in the surface water, which results in the organotrophic count, is typically between 103 and 105 cells per ml. However, at the DSRF and Benji Bay sites, the observed values were higher than 107 (Figure 5). The maximum culturability of these bacteria is known to be below 10%, therefore the real numbers were at least 10 times higher.

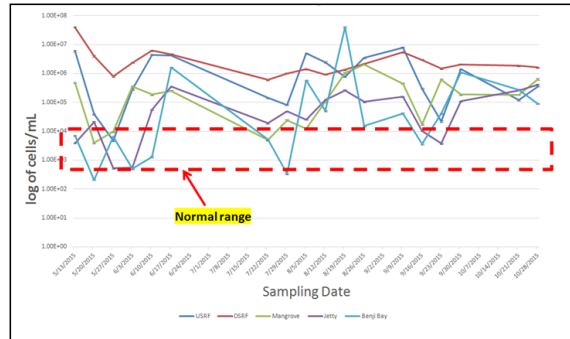


Figure 5: Organotrophic bacterial average levels, spatial, temporal and method-dependent variation observed in five tested sites for the course of 18 weeks.

Anthropogenic pollution with sewage and gray water runoff from yacht latrines, domestic and business septic tanks, cattle manure and finally organic discharge due to the deforestation of the mangrove, resulted in an increased numbers of the most probable numbers of Fecal Coliforms (FC). The levels of the fecal indicators were above the recommended EPA values of 123 cells/100ml for recreational waters (Figure 6). This was detected in 100% of sampling occasions in all tested sites, both in the waterway and marine waters, except for the Benji Bay site, which was polluted at a frequency ranging from 50 to 100%.

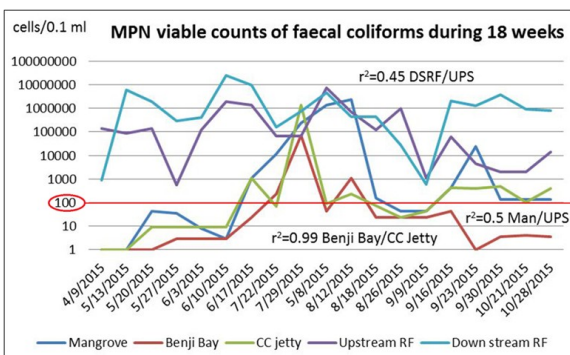


Figure 6: Fecal coliform MPN average levels, spatial, temporal and method-dependent variation observed in five tested sites for the course of 18 weeks.

This project allowed for the creation of a novel regional baseline for coastal water quality and resulted in the establishment of economical methodologies that can be implemented and reproduced. We identified the point and non-point sources of pollution in the WCCB MPA and eutrophication of the MPA was registered as sedimentation, increased turbidity, BOD5, ammonium, iron, copper and decreased pH, Dissolved Oxygen, and alkalinity in the coastal water (4,5).

Recommendations for the continued success of the WQIP were made available to the government (1-5,6) and they included suggestions such as:

- Providing information to the public on water quality throughout outreach programs, website and community meetings.
- Conducting environmental education programs that enable the community to better understand how their actions affect water quality and their impact on the WCCB MPA
- Develop programs of pollution reduction by regulating the industrial activities, as well as controlling diffuse sources, to prevent coastal water pollution.

The project was a success and we hope that it leads to more collaborative efforts between these parties in the future. The reports listed below are available from the authors and the Office of Research at WINDREF.

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Acknowledgements

- To St. George's University for accommodating the project and the Environmental Testing Unit at SGU for equipment
- St. George's University Department of Microbiology for timely replacement of a required multi-meter
- Woburn Fishermen Association for timely water transportation
- Grenada Taxi Association for transportation to the sampling sites
- The Nature Conservancy for Funding FY15-C-EC-GEF-WB-SusFin-WINDREF-WQIP, 2015

Submitted by Svetlana Kotelnikova, Makeda Matthew & Karla Farmer-Diaz

Genome Annotation Project

Research fellow students started their studies of annotation tools during term 3.1 of Pre-Medical Genetics while working on proteins which were assigned following a number of research hypotheses formulated by the instructor (Figure 1Figure 2). Students were assigned into groups of 4-5 individuals with a designated teaching assistant who had previously successfully completed the project. The hypothetical proteins were manually anno-

tated and statistics for its proposed function were documented using a customized wiki site (eg: Sgugenetics). The research was continued into the summer while using social media applications to aid in group communication and interaction with the instructors.

The results from the research were presented as three posters and as an oral presentation both locally and internationally (Figures 3, 5, 6). Biology candidate Katisha Daniel was awarded for the Best Undergraduate poster presentation during the SGU Research Day 2016 (Figure 4). The projects' data collection, analysis, and presentation took approximately ten months. They represented dynamic collaboration between multiple programs and schools while being guided by Svetlana Kotelnikova, PhD and Ravindra Naraine, MSc from the Department of Microbiology and Immunology at SOM.



Figure 1: Spring 2015 Annotating Team: Ramirez, J., Ramtahal, V., Bally, R., Williams, J., Boodram, R., Walcott, T., Frank, S., Tau, F., Charles, A., Jeffrey, Z., Alleyne, S., Ohammah, C., Aladesua, T., Smith, N., Anderson, A., Daniel, K., Im, D., Joseph, A., Nweye, Q., Yorke, G., Findley, L., Cheesman, A., Cooke, T. Naraine, R., Kotelnikova, S.



Figure 2: Fall 2015 Annotating team: Ashley Yearwood, Peo Rabasha, Shubani Singh, Watipa Makhumalo, Sajni Patel, Verneth Joseph, Alvin Charles, Anirudh Kotha, Terrisha Walcott, Ravindra Naraine.

Here we present details of two of the projects that lead to 130 reads in the Research Gate. CRISPRs are attracting active interest of the scientific community at the moment; therefore our study had an unexpectedly high impact.

Research Clustered Regularly-Interspaced Short Palindromic Repeats (CRISPRs) are short fragments of nucleotides known as spacer sequences that are sandwiched between similarly sized nucleotide repeats. These spacer sequences represent acquired nucleic fragments from Mobile Genetic Elements (MGE) including viruses that have previously infected the organism (Bhaya, Davison, & Barrangou, 2011). It has been found that Prokaryotes use the CRISPR system as a form of an “acquired immune system” to protect themselves from invasion from MGE (Bhaya, et al., 2011).

Prokaryotes can defend themselves from viral infection using several defence mechanisms including masking of receptor sites to prevent viral entry, blocking of viral DNA injection, restriction modification system to degrade viral DNA and abortive infection mechanisms to

prevent viral replication (Labrie, Samson, & Moineau, 2010). These mechanisms represent first line defences and do not result in a stored long-term “memory” of the infection. The CRISPR system on the other hand represent an acquired and long-term defence strategy against future infections. Specific CRISPR associated genes (Cas) which are usually located in close proximity to the repetitive array can detect specific viral nucleotides. After detection, it incorporates a short fragment of the viral genetic element into the CRISPR to form a member of the repeat array. The short fragment is now one of the spacer sequences. With each survival of a novel viral infection, and the detection by the CRISPR gene system, a new spacer is incorporated upstream of the previously added spacer. This creates a concise and chronological library of all previous infections. Upon reinfection by the same virus, other Cas genes in conjunction with the previously incorporated spacer sequence are used to target the invading virus. This is achieved when the spacer sequence anneals to its complementary viral DNA triggering another Cas gene to degrade the viral DNA (Bhaya, et al., 2011).

The types of Cas genes and its CRISPR repeats have been analysed by the Undergraduate students from St. George’s University as part of an annotating project during the Spring (Figure 1) and Fall (Figure 2) of 2015. The students participated in the annotation and identification of CRISPR Cas genes and repeats in the extremely acidophilic Archaea, *Ferroplasma acidarmanus* and *Picrophilus torridus*. Both of these organisms are evolutionarily related and have been found inhabiting extremely acidic environments where they can contribute to the bioleaching of heavy metals and radionucleotides (Dopson, Baker-Austin, Hind, Bowman, & Bond, 2004; Schleper et al.,

1995).

Three putative CRISPR Cas Operons were identified for both *Ferroplasma* and *Picrophilus*. However, the annotating team has so far gathered sufficient bioinformatic evidence to characterize two out of three CRISPR-Cas operons in *Ferroplasma* and one out of three CRISPR-Cas operon in *Picrophilus*. Approximately twenty-one viral spacers linked to the characterized genes in *Ferroplasma* were identified and analysed while ~86 were found to be associated with the analysed CRISPR operon in *Picrophilus*. At the end of the annotation, we were able to determine the types of Cas genes present in each operon and that the characterized CRISPRs belonged to CRISPR type I system which targets DNA MGE.

The sequence based similarity analysis of the 21 spacers in *Ferroplasma* hinted to previous infection by novel and yet unidentified viruses, with a few spacers showing low level similarity to plasmids found in *Staphylococcus aureus* and *Rhizobium etli* and also to viral sequences from the giant virus *Pandoravirus salinus*. Further analysis is being done to completely characterize the spacers in both organisms and provide further information on the organism-virus dynamics in these extreme environments. However, the Spring 2015 Annotating team has already presented some of their research “Characterization of CRISPR-Cas Operons and spacer elements in the acidophile, *Ferroplasma acidarmanus fer1*” during the Virus Evolution and Molecular Epidemiology (VEME) Conference/Workshop in Trinidad in August 2015 (Figure 3).

The CRISPR systems have recently become an important workhorse for molecular biology. It has allowed an easy method to modify an organism’s genome by either knocking out

genes or creating variant forms of a gene. It has also allowed an easier method to create microorganisms that are resistant to viral infections. It has potential future roles as an antimicrobial agent to target specific resistant microorganisms, gene therapy and treatment of viral infections (Rath, Amlinger, Rath, & Lundgren, 2015). Continued analysis of novel CRISPR-Cas genes may result in discovery of better and more efficient mechanisms for biotechnological use.

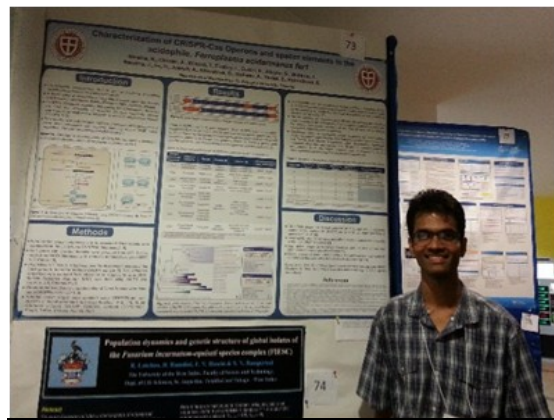


Figure 3: Ravindra Naraine presenting poster on [CRSIPRs in *Ferroplasma*](#) during VEME Conference, Trinidad, August 2015



Figure 4: Ravindra Naraine, Alvin Charles, Dr. Kotelnikova, Lisa Findley, Terrisha Walcott, Katisha Daniel and Dr. Pensick with Research Day AWARD for the Best Poster presentation 2016.

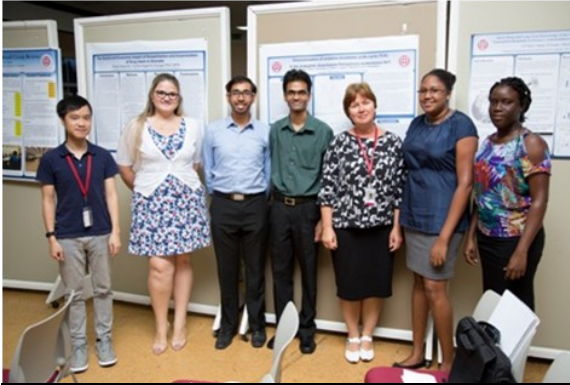


Figure 5: Nickolas Choong, Olena Khvostova, Vikram Nair, Ravindra Naraine, Svetlana Kotelnikova, Tishena Lloyd, Shahida Mark. S. [Characterization of oxidative tricarboxylic acids cycle \(TCA\) in the acidophilic *Euroarchaeum Ferroplasma acidarmanus fer1*](#). During SGU Research Day 2016 in February 2016.



Figure 6: Anirudh Kotha, Sajni Patel, Ashley Yearwood, Svetlana Kotelnikova, Ravindra Naraine. [CRISPR system in *Picrophilus torridus*](#), during SGU Research Day 2016.

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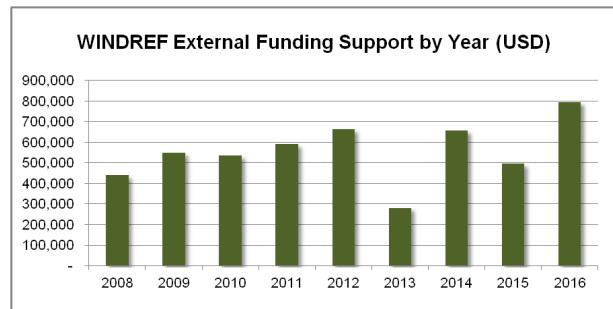
Submitted by Ravindra Naraine & Svetlana Kotelnikova

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2016 Grant Applications

Fourteen grant applications were submitted to external funding agencies in 2016. The total potential value of these grant applications was \$12,787,07 USD – a 59% increase over the total potential value of grant applications in 2015. To date, four of these applications were funded, seven were not funded, and decisions on the other three are outstanding. The grant applications are listed below (green: funded, red: not funded, black: waiting to hear back).

- **Randall Waechter, Desiree LaBeaud, Barbara Landon, & Trevor Noël: Neurodevelopment and Vector-borne Diseases: Building Research Capacity in the Tropics - funded by the National Institutes of Health (NIH) Fogarty Center**

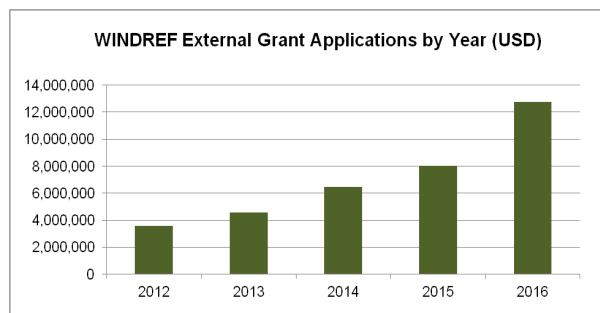
- Desiree LaBeaud & Calum Macpherson: The Spectrum of Zika Disease in Grenada – funded by Stanford University
- Clare Morrall: The Occurrence of Microplastic in the Intestinal Tract of Commercially Exploited Fish from Grenada - funded by the Gulf and Caribbean Fisheries Institute
- Shelly Rodrigo: Planning for a Sustainable and Robust RCRE in the Caribbean. US Department of Health and Human Services
- Hugh Sealy, Randall Waechter, & Ricardo Energy and Environment UK: Japan-Caribbean Climate Change Partnership. United Nations Development Program (UNDP).
- Sonia Cheetham-Brow: International Research Scholars Program - Howard Hughes Medical Institute. Bill & Melinda Gates Foundation.
- Desiree LaBeaud, Calum Macpherson, Charles King, Trevor Noël, Randall Waechter: Host and Viral Determinants of Chronic Chikungunya Disease. National Institute of Health.
- Calum Macpherson, Trevor Noël, & Todd Myers: Zika Surveillance in the Southern Caribbean - funded by the US Naval Infectious Diseases Diagnostic Laboratory
- Melinda Sothern, Roger Radix, Trevor Noël, Randall Waechter, Richard Scribner: The Grenada Intervention Study: Identifying Mechanisms in Support of Sustainable Diet and Physical Activity Behaviors in Black Adolescent Females. National Institutes of Health
- Calum Macpherson, Trevor Noël, Paul Fields, Satish Bidaisee, Randall Waechter, Sonia Cheetham-Brow, Kathryn Gibson, Diana Stone, Dan Fitzpatrick, Joana Raynor, & George Mitchell: The Prevention, Detection and Response to Emerging and Re-emerging Vector-Borne Diseases. USAID.
- Martin Forde: Detection of Zika Virus by Efficient Isothermal Nucleic Acid Amplification Technologies and Improved Antigenic Test. Canadian Institutes of Health Research & International Development Research Center
- Satish Bidaisee, Randall Waechter, Calum Macpherson: Investigation of the role of domestic and wild animals as reservoir and/or amplifying hosts in the transmission of Zika virus. Canadian Institutes of Health Research & International Development Research Center
- Calum Macpherson, Roman Ganta, Shirley Luckhart, Melinda Wilkerson, Diana Stone, Kathryn Gibson, Brian Butler, Cheryl Macpherson, Randall Waechter, Donald Simeon, B. Olowukure - Vector-Borne Disease Research Training in the Caribbean
- Andrew Sobering: Clinical Genetic Diagnosis: Outreach to an Underserved Caribbean Community. Australian Aid.

The final research grant count for 2015 is as follows: Seven applications with a total value of \$8,022,471 were submitted, of which one was successful. This represents a 14% success rate. Of the 46 grant applications submitted between January 2012 and December 2015, 20 were successful. This represents a 43% success rate over this four-year period. The value of grant applications and external funding received by year is outlined in the charts.

Despite strong global competition for external grants, we continue to achieve an impressive hit rate of successful grants to applications. More SGU faculty and WINDREF fellows are learning about the grant writing process and submitting grants to external funders.

WINDREF also took on the role of grant funder

in 2016, through the One Health Research Initiative (OHRI). Under this program, seven grantees were funded up to \$128,000 USD for up to three years.



Ongoing externally funded projects

There were eighteen ongoing funded projects in 2016 with a total multi-year value of \$3.02 million USD:

- Noël, T. (2009-2014). Neglected Tropical Diseases (NTDs) and Rheumatic Fever in Grenada: a project to prevent/eliminate helminthic and rheumatic fever infections among children (5-15 years of age). Bartholomew J. Lawson Foundation. \$41,903.
- Noël, T. (2010-) Genetic Correlates of the Addictive Diseases: Cocaine, Alcohol and Marijuana Addiction - Grenada, WI, Dr. Mary-Jeanne Kreek, Kreek Laboratory, Rockefeller University. \$40,000.
- Macpherson, C., Noël, T. & Bidaisee, S. (2011-). Sport for Health. House of Lords Fundraiser and Ratner Family Fund. \$55,000.
- Lawson, K. & Tyrrell, M. (2013-). Reach Within. Bartholomew J. Lawson Foundation. \$203,697.
- Sealy, H. (2013-). UNFCCC Clean Development Mechanism (CDM) Caribbean Regional Collaborating Centre (RCC) at St. George's University. UNFCCC Secretariat Clean Development Mechanisms Programme. \$95,179.
- Ratner, E. & Macpherson, C. (2013-). Outreach Activities in South Sudan. Multiple Donors. \$208,599.
- Rodrigo, S. (2013-2015). Drug Demand Reduction: A Caribbean University Interdisciplinary and Integrated Proposal. Executive Secretariat of the Inter-American Drug Abuse Control Commission (ES/CICAD). \$40,000.
- Morrall, C., Waechter, R., & Campbell, E. (2014-). In-country Project Coordinator for the Eastern Caribbean Marine Managed Areas Network (ECMMAN) Project. The Nature Conservancy. \$52,393.
- Cox Macpherson, C., Philpott, S. & Hall, R. (2014-2019). Caribbean Research Ethics Education Initiative (CREEi). Fogarty International Center – National Institutes of Health. \$1,100,000
- Easter-Pilcher, A., et al. (2014-). Conservation Leadership in the Caribbean (CLiC). U.S. Fish and Wildlife Service, Division of International Affairs, via the International Fund for Animal Welfare (IFAW). \$157,968.
- Sealy, H. (2015-). Intended Nationally Determined Contributions (INDC) Consultancy to the UNFCCC St. George's Regional Collaborating Centre. United Nations Framework Convention on Climate Change Secretariat. \$93,314.
- Richards, C., & Thomas-Purcell, K. (2015-). Perspectives on the Uptake of Breast, Cervical, and Prostate Cancer Screening in the English Speaking Windward Islands. Caribbean Public Health Agency (CARPHA). \$50,000.
- Clunes, M., Macpherson, C. C. (2016-). Palliative Care Association of Grenada. Iota Epsilon Alpha Organization. \$5,952.
- LaBeaud, D. & Macpherson, C. (2016). The Spectrum of Zika Disease in Grenada. Stanford University. \$34,992.

- Macpherson, C., Noël, T., & Myers, T. (2016). Zika Surveillance in the Southern Caribbean and Reference Lab Support. Naval Medical Research Center. \$80,000.
- Morrall, C. (2016-17). The Occurrence of Micro-plastic in the Intestinal Tract of Commercially Exploited Fish in from Grenada. Gulf & Caribbean Fisheries Institute. \$8,085.
- Waechter, R., LaBeaud, D., Landon, B., & Noël, T. (2016-18). Neurodevelopment and Vector-borne Diseases: Building Research Capacity in the Tropics. National Institutes of Health - Fogarty International Center. \$298,938.
- Macpherson, C. (2016-19). One Health Research Initiative. \$450,000.
- two Caribbean countries
- Assessment of the effectiveness of broad-spectrum treatment to children with protozoan and nemathelminthic parasitic infections on diarrhea and school attendance
- The effects of iron-deficiency anemia on cognition and behavior in infants
- Diurnal variation of urinary endothelin-I and blood pressure: related hypertension
- Alcohol consumption in Grenada
- The incidence and mortality of cancer in Grenada over the ten year period: 1990-1999
- The prevalence of abnormal haemoglobin traits in Grenadian secondary school adolescents
- Knowledge, attitudes, beliefs and practices of sickle cell anemia in Grenadian primary and secondary school children
- Decompression sickness among the indigenous fishing population in Grenada: Assessing the burden of disease
- WINDREF / SGU Hurricane Relief
- Spice Research Program
- Sulfate-reducing bacteria in oxidized freshwater of tropical mangroves
- Novel antibiotics from tropical marine environments: drug development in Grenada
- Study of the mutacin C-7A
- Gram-negative bacteria isolated from aquatic environments of Grenada (61.4°W, 12.0°N), West Indies
- Identification of bacteria producing antibiotics isolated from deep marine biofilms of Grenada
- SGU Environmental Testing Unit (ETU)
- Post-hurricane water surveillance in prob-

Past Research Projects

Non-communicable Diseases

- Angiotensin converting enzyme and angiotensinogen gene polymorphisms in the Grenadian population: relation to hypertension
- Development of a decision rule for screening Obstructive Sleep Apnea and its epidemiologic relevance to the people of Grenada
- Prevalence and associated risk factors of hypertension in a sample population of native Caribbean's in Grenada, West Indies
- Assessing the prevalence of diabetic complications by examining type I and type II adult diabetics for signs of retinopathy, neuropathy, nephropathy and dermatological changes associated with poor glucose control within the native Caribbean population of Grenada
- Hypertension management and control in

- lematic areas of Grenada
 - Evaluation of the relocation potential for villagers residing in Queen Elizabeth National Park, Uganda
 - Study of the calls of the spotted hyena at feeding
 - Survey on the attitude of villagers in Queen Elizabeth National Park, Uganda towards the threat of lions, leopards and hyenas
 - Epidemiology of human injuries resulting from wildlife in ten villages within Queen Elizabeth National Park, Uganda
 - Rural Ugandan village perspective on lion, leopard and hyena conservation
 - Epidemiology of human injuries by wildlife in six villages within Queen Elizabeth National Park, Uganda
 - Prevalence of *Campylobacter fetus* subspecies *venerealis* and other microorganisms in the reproductive tracts of cattle from the southern region of Santo Domingo, Dominican Republic
 - Antimicrobial properties of skin secretions from *Eleutherodactylus johnstonei* on bacteriological isolates
 - Examination and analysis of prostate cancer in Grenada
 - A Church-based intervention to improve hypertension prevention and control among women in Grenada
 - Occupational Health Problems among Nutmeg Factories Workers, SGU Small Research Grant Initiative
 - Sport for Health Programme
 - Grenada School Nutrition Study: Evidence to Inform Policy
 - Genetic Correlates of the Addictive Diseases: Cocaine, Alcohol and Marijuana Addiction - Grenada
 - Promoting Resilience Among Medical Students: A Comparison of Mindfulness, Yoga, and Exercise
- Infectious Diseases**
- Investigation of the prevalence of SIV in the mona monkey (*Cercopithecus mona*) in Grenada
 - Seroprevalence of HIV-I and HIV-II in pregnant women in Grenada, W.I. – their knowledge of AIDS and their exposure hazards to the virus
 - A cross sectional study of the current status of *Schistosoma mansoni* in St. Lucia by field surveys and supplementary data collection
 - Identification and characterization of hantaviruses among the mammal population of Grenada
 - HIV/AIDS health education and evaluation program in Grenada
 - The seroprevalence of *Toxoplasma gondii* in a population of pregnant women and cats in Grenada, West Indies
 - The efficiency of diagnosing women of *Toxoplasma gondii* using PCR techniques in comparison with ELISA
 - Dengue virus in Grenada: seroprevalence and associated risk factors
 - A current appraisal of dengue virus in Grenada – serotype analysis and vector assessment
 - A site receptivity study determining the threat of reintroduction of malaria into Grenada through the study of Anopheline spp. mosquito vectors

- Chlamydial infection among STD clinic attenders in Grenada
- Fever in Grenada
- Mosquitoes and tourism in Grenada
- Effectiveness of a formula feeding/weaning intervention program in preventing transmission of HTLV-1 from seropositive mothers to newborns in Grenada
- A multi-center longitudinal research study of the behavioral significance of the prevalence of HIV-1 infection in pregnant women and their babies on the islands of Grenada and St. Vincent
- A multi-center longitudinal research study of the ethical analysis of informed consent of the prevalence of HIV-1 infection in pregnant women and their babies on the islands of Grenada and St. Vincent
- Determining the role of IL-15 in mediating function of viral-specific CD8+ T cells in the myelopathogenesis of HTLV-1: symptomatic versus asymptomatic patients
- Intestinal protozoan infections in 6-12 year old children in Grenada
- Intestinal helminth infections in 6-12 year old children in Grenada
- The prevalence of intestinal parasites in school children in rural Guyana
- The prevalence of filariasis and its effects on children aged 8-14 in the central corentyne region of rural Guyana
- The prevalence of streptococcal infection in school children aged 5 – 15 years in Grenada, Carriacou and Petit Martinique
- Studies examining the elimination of lymphatic filariasis as a public health problem in Guyana
- Seroprevalence of heartworm infection in dogs in Grenada
- Dengue in Grenada
- Assessing the potential risk factors of dengue and dengue hemorrhagic fever in the tri-island state of Grenada, Carriacou and Petit Martinique
- A comparative study to find out if there is an association between sexual practices and knowledge in adult populations of Botswana and Grenada with the prevalence of HIV/AIDS
- HIV/AIDS in rural Botswana differentiating between informing and educating
- Evaluating the level of perceived fear and desensitization towards HIV/AIDS in Botswana
- Rheumatic Fever in Grenada
- Streptococcal program in St. Vincent
- Isolating T cells from Rheumatic Fever positive blood: immunofluorescent assay of T lymphocytes via fluorescently labeled monoclonal antibodies
- Possible genetic predisposition to Rheumatic Fever: demonstrating the inheritance fashion of non-HLA B lymphocyte alloantigen D8/17, a marker for Rheumatic Fever
- ELISA antibody titres against group A streptococcal M protein moiety and cell wall N-Acetyl-D-Glucosamine in Grenadian Rheumatic Fever patients
- Evaluating the effectiveness of educational methods in the prevention of Rheumatic Fever and knowledge, awareness and practices
- Prevalence of intestinal helminth infections in rural Grenadian school children
- Cystic echinococcosis in Morocco and

Uganda

- Elimination of Lymphatic Filariasis in Guyana Program
- Neglected Tropical Diseases and Rheumatic Fever in Grenada: A project to prevent/eliminate helminthic and rheumatic fever infections among children (5-15 years of age)
- Ferguson, H. (2011-2014). Investigation of Disease in Pre-growout Fish in a Commercial Aquaculture Operation in Ecuador. Produmar, S. A.
- Heath, C., LaBeaud, D., Macpherson, C., & Noël, T. (2016). Characterization of Immune Factors of Chronic Chikungunya Disease. American Society for Tropical Medicine & Hygiene Robert E. Shope International Fellowship.
- broblasts activates matrix metalloproteinases through MAP kinases pathways: A model for astrocytes
- REM sleep and memory
- End of life care in Grenada
- Novel antibiotics from tropical marine environments
- Genetic correlates of the addictive diseases: cocaine, alcohol, and marijuana addiction– Grenada
- An investigation of pediatric botanical medicine for acute respiratory infections
- Efficacy of phage therapy using an in vitro biofilm wound model system
- Degradation of 7 keto cholesterol by Xenohydrolases
- Ecological survival properties of pelagic and benthic indicator microorganisms from the St. John’s river outflow in Grenada

Unique Projects

- Characterization of five amphibians inhabiting Grenada and subsequent isolation and antimicrobial assay of potential antibiotics derived from their skin
- Mona monkey studies in West Africa
- Investigation of medicinal plants in Grenada
- Use of medicinal plants in Grenada
- Medicinal drugs from the sea: what do Grenada’s waters have to offer?
- Beekeeping in Grenada: effects of the mite *Varroa jacobsoni* and its control
- Effects of Grenadian medicinal plants on endemic microbial causes of diarrhoeal diseases
- The neurobiological basis of hypoglycemia-associated autonomic failure
- Stimulation of angiotensin 4 in cardiac fibroblasts
- Greater occipital nerve zones for treatment of occipital neuralgia
- Photovoltaic power generation program
- Review of current biomedical waste management practices in the Organization of Eastern Caribbean States (OECS) Countries
- Microbial diversity in the iron-oxidizing biofilms of soda springs in Grenada
- Circadian cycle of iron-oxidation in warm soda springs in St. Andrew’s, Grenada, West Indies
- Do the microorganisms in the soda spring water derive energy from the oxidation of manganese?
- Novel marine bacteria and their antagonistic properties against medically relevant biofilms

- Physiological characterization of novel marine bacterial species isolated off Grenada
- Characterization of marine sponge-associated bacteria and cytotoxic activity of sponge extracts towards human cancer cells
- Examining HIV/AIDS provider stigma: assessing regional concerns in the islands of the Eastern Caribbean
- Knowledge, attitudes and practice survey for women (baseline survey)
- Caribbean EcoHealth Programme: public and environmental health interactions in food and water-borne illnesses (CEHP)
- Persistent Organic Pollutants
- Implementing Renewable Energy and Preventing Land Degradation: An Intervention in the Nutmeg Industry in Grenada
- Effects of prenatal ethanol exposure on the role of matrix-metalloproteinase mediated neural crest cells in an avian model
- Assessing Medical Students' Behavior, Perception, and Knowledge of UV Exposure and Sunscreen Application in the Caribbean (Grenada)
- Basic Life Support Knowledge and Skill Retention in Pre-Clinical Undergraduate Medical Students
- Student Satisfaction, Comfort and Self-confidence in a Simulation Lab Practice Session
- Reducing marine Litter in the Wider Caribbean: Developing and Implementing Best Waste Management Practices
- Ethical Issues and Challenges in Global Population Health Research Partnerships
- Disaster Management in Grenada: Northumbria University Student Research
- Baseline Coral Reef Monitoring Program for Sandy Island Oyster Bed Marine Protected Area Mooring Buoy Installation Project
- Genome annotation in microorganisms and metagenomic libraries as a part of an undergraduate curriculum
- Molecular identification of marine Vibrio isolated in Grenada
- Occurrence of Antibiotic-resistant Fecal Indicators in Coastal waters of Southern Grenada
- Investigation of disease in pre-growout fish in a commercial aquaculture operation in Ecuador
- Revitalizing the Nutmeg Industry in Grenada.
- Drug Demand Reduction: A Caribbean University Interdisciplinary and Integrated Proposal.
- The Bioethics of Health and Climate Change in the Caribbean
- Reach Institute for Children at SGU
- Outreach Activities in South Sudan
- UNFCCC Clean Development Mechanism (CDM) Caribbean Regional Collaborating Centre (RCC) at St. George's University.
- Student Fellow Stipend Agreement - American Humane Association (A. Werners) \$4,000
- Forde, M., Tomsons, S., Gomez, A. & Morrison, K. (2014). Ethical Issues and Challenges in Global Population Health Research Partnerships. International Development Research Centre. \$15,000.
- Sealy, H., Solis-Garcia, K. & Waechter, R. (2014). Capacity Building on Carbon Accounting and Clean Technologies Intern-

- ship for Renewable Energy Post Graduate Students. GIZ Renewable Energies and Energy Efficiency in the Caribbean (REETA). \$5,500.
- Thomas-Purcell, K. & Richards, C. (2014-2015). Grenadian Women’s Perspectives on Screening for Breast and Cervical Cancer. Nova Southeastern University – Kenyon Award
- Ferguson, H. (2011-2014). Investigation of Disease in Pre-growout Fish in a Commercial Aquaculture Operation in Ecuador. Prodimar, S. A.
- Gibson, K. (2015). Student Chapter Student Associate AVMA Faculty Advisor Program. American Veterinary Medical Association.
- Kotelnikova, S., Morrall, C., Sealy, H., & Waechter, R. (2015-16). Woburn Clarke’s Court Bay Water Quality Improvement Demonstration Site Concept. The Nature Conservancy.
- Morrall, C., Waechter, R., Campbell, E., & Nimrod, S. (2014-). In-country Project Coordinator for the Eastern Caribbean marine Managed Areas Network (ECMMAN) Project. The Nature Conservancy.
- Noël, T. (2016). Inter-American Institute for Cooperation on Agriculture.
- Radix, R. (2012-2015). Grenada School Nutrition Study. International Development Research Centre.
- Waechter, R. & Landon, B. (2014-2016). A Community-based Conscious Discipline Program to Reduce Corporal Punishment in the Caribbean. Grand Challenges Canada – Saving Brains Program.
- Waechter, R., Mitchell, D. & Aire, T. (2014-2015). Restoration and Community Co-Management of Mangroves (RECCOMM) in the Northern Telescope Coastal Area. GIZ Integrated Climate Change Adaptation Strategies (ICCAS) Grenadaps.
- Zap, A. & Rush, M. (2015). Thyroid Hormone Concentrations in Galapagos Giant Tortoises. Morris Animal Foundation - Veterinary Students Scholar Program.

Publications

Books (0)

Books and Book Chapters (2)

- Macpherson C.C., Bidaisee S., Macpherson C.N.L. (2016). Environmental Harms in Distant Polar Regions and Small Island Developing States. In: Ed. Macpherson, CC. Bioethical Insights into Values and Policy: Climate Change and Health. Springer Press, NY. 127-142. 2016.
- Rush Elizabeth Marie and Morena Wernick. “Foundations in clinical pathology” Book Chapter: in Chapter 13. Advances in clinical pathology and diagnostic medicine. Current Therapy in Avian Medicine and Surgery. 1st Ed. 2016. Elsevier. St Louis, MO.

Journal Articles (18)

- Akpinar-Elci M, Nguyen M, Bidaisee S, Elci OC. Pesticide Exposure in the Caribbean: A Case from Nutmeg Processing, The Journal of Environmental Health, January/February 2016, 78 (6)
- Bidaisee S., 2016. Sexual and reproductive health education: A case for inclusion in the curriculum of primary schools in the Caribbean. Int Public Health J 2016;8(3):00-0
- Del Pozo, J., Mishra, N., Kabuusu, R., Cheetham-Brow, S., Eldar, A., Bacharach, E., Lipkin, W.I. and Ferguson, H.W. (2016). Syncytial hepatitis of tilapia (*Oreochromis niloticus* L.) is associated with ortho-

- myxovirus-like virions. *Veterinary Pathology*, On-line August 10th.
- Farmer, K., James A., Naraine, R., Dolfin, G., Sylvester, W., Amadi, V. Kotelnikova, S. (2016). Urinary Tract Infection *Escherichia coli* Is Related to the Environmental *Escherichia coli* in Their DNA Barcoding and Antibiotic Resistance Patterns in Grenada. *Advances In Microbiology*, 6:33-46.
- Forde M, Martin EF, Mitchell G, Bidaisee S., 2016. Public health response and lessons learned from the 2014 Chikungunya epidemic in Grenada. *Revista Panamericana de Salud*
- Gallo, R.C, Willems, L. and Hasegawa, H...Macpherson, C.N.L, et al (2016). Screening transplant donors for HTLV-1 and -2. *Blood* 2016 :blood-2016-09-739433; doi:10.1182/blood-2016-09-739433
- Gibson, K.E., Fitzpatrick, D.M., Stone, D., Noel, T.P., Macpherson, C.N.L. (2016). Vector-borne diseases in the Caribbean: History and current status. *CAB Reviews* 11 (022). Doi:10.1079/PAVSNNR 2016 11022.
- Gonzalez D., Bidaisee S., 2016. Uncovering the Needs of Underserved Areas in Arequipa, Peru: Community Perspectives. *West Indian Medical Journal*, DOI is 10.7727/wimj.2016.066
- Herath, T., Ashby, A., Jayasuriya, N., Bron, J., Taylor, J., Adams, S., Richards, R., Weidmann, M., Ferguson, H.W., Taggart, J., Migaud, H., Fordyce, M. & Thompson, K. (2016). Impact of Salmonid alphavirus infection in diploid and triploid Atlantic salmon (*Salmo salar*) fry. In press. *Plos one*.
- Herath, T.K., Ferguson, H.W., Weidmann, M., Bron, J.E., Thompson, K.d., Adams, A., Richards, R.H. (2016). Pathogenesis of experimental salmonid alphavirus infection in vivo: an ultrastructural insight. *Veterinary Research*. (on line: [http:// www. veterinaryresearch.org/content/47/1/7](http://www.veterinaryresearch.org/content/47/1/7)).
- Keku E, Denny V, Zahedi I, Deliso M, Glasgow L, Russell H, Bidaisee S (2016). Stray dog control and zoonotic disease prevention in Grenada, West Indies: Implications for rabies control. *Journal of Epizootiology and Animal Health in West Africa* (2016) vol. 12, Special issue
- Macpherson, C., Noël, T., Fields, P. J., Jungkind, D., Yearwood, K, Simmons, M., Widjaja, S., Mitchell, G., Noël, D., Bidaisee, S., Myers, T. E., LaBeaud, A. D. (2016), Clinical and Serological Insights from the Asian Lineage Chikungunya Outbreak in Grenada, 2014: An Observational Study. *Am J Trop Med Hyg* pii: 16-0122; Published online August 15, 2016.
- Naraine, R., Charles, A. , Walcotte, T., Findley, L., Kvostova, E., Alleyne, S., Williams, J., Ramirez, J., Im, D. , Tau, F., Joseph, A., McEven, A. , Kotelnikova, S. (2016). Characterization of CRISPR-Cas Operons and spacer elements in the acidophilic Archaeum *Ferroplasma acidarmanus fer1*. *Oxford Journal Of Viral Evolution*. March, 2016, vol.1. Suppl.2
- Resnick J, Bidaisee S, Durgampudi PK, Keku EO (2016) The Dangers of Smallpox in Modern Day Bioterrorism. *J Translational Diagn Technol*. 1(3), 21-26
- Rizgalla, J. Brown, J.E., Shinn, A.P., Herath, T.K., Paladini, G. Ferguson, H.W. (2016). Ulcerative dermatitis in wild dusky grouper *Epinephelus marginatus* (Lowe) from Libyan Waters. *J. Fish diseases* (on line May,4, 2016)
- Rizgalla, J., Shinn, A.P., Ferguson, H.W., Paladini, G., Jayasuyira, N., Taggart, J. & Bron, J.E. (2016). A novel use of social media to evaluate the occurrence of skin lesions affecting wild dusky grouper, *Epinephelus marginatus* (Lowe, 1834), in Libyan coastal waters. In press, *J Fish Dis*.

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- Bidaisee, S., Modica, J., Swope, J. (2016). Achieving Five Times the Retention in MOOCs.. Association of Schools and Programs in Public Health (ASPPH) 2016 Annual Meeting. Arlington, Virginia, March 20th to 22nd, 2016.
- Bidaisee, S., Myles, D., Philipe, J., Macpherson, C. (2016). Post Disaster Community Health Assessment: Case of Onaville, Haiti. Trinidad and Tobago Medical Association, Medical Research Conference. July 24th, 2016, Port of Spain, Trinidad.
- Busch S., Bidaisee S., Hegamin-Younger C., Macpherson C.N.L. Exploring Exposure and Symptomatic Differences of Chikungunya Virus in the Adult Population in Grenada. 61st Annual CARPHA Health Research Conference, June 21st – 26th 2016, Turks and Caicos Islands.

Abstracts/Presentations at International Conferences (31)

- Bidaisee, S. (2016), Global Learning: A One World One Health Perspective. NAFSA, 2016 Meeting, Denver, USA.
- Bidaisee, S. (2016). 2nd International Health Care Management Conference, Kings College, PA, USA, October 11 - 14, 2016
- Bidaisee, S. (2016). One Health One Medicine: A Global Health Approach. Chitkara University, Global Week, October 17th to 21st, 2016, Chandigarh, India
- Bidaisee, S. (2016). Research and Statistics: Just like a Bikini! Presented at the Trinidad and Tobago Medical Association. Trinidad, November 24, 2016.
- Bidaisee, S. (2016). Research and Statistics: Just like a Bikini! Presented at the Trinidad and Tobago Medical Association. Trinidad, November 24, 2016.
- Bidaisee, S., Macpherson, C. (2016). Effective- Heath, C.J., Lowther, J., Noël, T.P., Mark-George, I., Boothroyd, D.B., Mitchell, G., MacPherson, C., LaBeaud, A.D. (2016). Characterization of risk factors for chronic chikungunya disease, in Grenada, West Indies. Presented at the 65th Annual Meeting of the American Society for Tropical Medicine and Hygiene, Atlanta, USA, 13-17 November.
- Heath, C.J., Lowther, J., Noël, T.P., Mark-George, I., Boothroyd, D.B., Mitchell, G., MacPherson, C., LaBeaud, A.D. (2016). Characterization of risk factors for chronic chikungunya disease, in Grenada, West Indies. Presented at the 65th Annual Meeting of the American Society for Tropical Medicine and Hygiene, Atlanta, USA, 13-17 November.
- Heath, C.J., Noël, T.P., Waechter, R., Lowther,

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- Hudson, A., Wekerle, C., Ellenbogen, S. Goldstein, A., Waechter, R., & Stewart, S. (2016). Dynamics and Outcomes of Child Sexual Abuse: Explaining links between Childhood Sexual Abuse and Problem Drinking in Adolescent Girls and Boys. Symposium presented at the International Society for the Prevention of Child Abuse and Neglect Congress: Calgary, Alberta, Canada. August 2, 2016.
- Ince, D., Baldeo, R., Harvey, O., Adams, D., Kotelnikova, S., Sealy, H., Morrall, C., Waechter, R.,
- Farmer, K., Matthew, M., & Enoe, J. (2016). An Integrated Approach to Water Quality Management in Marine Protected Areas. Presented at the 69th Gulf and Caribbean Fisheries Institute Conference: Grand Cayman, Cayman Islands.
- Kabuusu, R. (2016). American Public Health Association 2016, USA, October 29-November 2, 2016
- Lambert M.A. and Macpherson C.N.L. Towards a More Efficient and Safer Global Flow of Well-Trained Medical Doctors. The Association for Medical Education in Europe (AMEE) Conference, August 27th – 31st 2016, Barcelona.
- Landon, B. & Waechter, R. (2016). Reducing Corporal Punishment with Saving Brains Grenada. Presented at the International Congress on Psychology: Yokohama, Japan, July 23-29, 2016.
- Landon, B., & Waechter, R. (2016). Saving Brains Grenada: Corporal Punishment & Family Violence, Neurodevelopment, Conscious Discipline. Presented at Caribbean regional Conference on Psychology: Port-Au-Prince, Haiti.
- Lantz, M., Bidaisee, S. (2016). The effects of pet ownership on academic achievement among veterinary students at St. George's University. Merial-NIH Symposium, July 28-31, 2016, Columbus, OH.
- Macpherson C.N.L. Role of Ultrasound in the epidemiology of infectious diseases. Pavia University: Short course on ultrasound in the tropics: course for physicians and veterinarians. Approved and recognized by WHO. 4 lecture hours, February 2nd-7th, 2016.
- Macpherson C.N.L., Lambert M.A. Global accreditation is the path to the safe global movement of medical practitioners. The 12th International Conference on Medical Regulation (IAMRA), September 20th – 23rd 2016, Melbourne, Australia.
- Macpherson, C. (2016). Ethics consultation on Zika, PAHO, Washington, DC, April 4-7, 2016
- Macpherson, C., Dawson, A., Jamrozik, E., and Jennings, B. (2016). How Climate Change Compounds Social Injustice, 13th World Congress of Bioethics (IAB), 13th to 17th June, 2016
- Morrall, C. (2016). Gulf and Caribbean Fisheries Institute Meeting, Cayman Islands, November 7-11, 2016
- Myles O., Bidaisee S., Philippe J., Meltzer V., Macpherson C.N.L., A Community and Environmental Health Assessment of Onaville Haiti. 61st Annual CARPHA Health Research Conference, June 21st – 26th, 2016, Turks and Caicos Islands.
- Scribner, R., Radix, R., Noël, T., Andal, R., Andal, N., Radix, C., Frank, R., Benjamin, J., James, J., Benjamin, R., Waechter, R., Leonard, C., & Sothern, M. (2016). Absent Generational Effect of Adolescent Obesity in a Middle Income Country with High

- Rates of Adult Obesity. Presented at the Obesity Society's Annual Meeting: New Orleans, Louisiana. October 31-November 4, 2016
- Solomon, N. (2016). 17th Conference of the International Academy of Investigative Psychology, New York City, May 13-14.
- Solomon, N., Zeyhle, E., Kachani, M., Macpherson, C.N. (2016). Observations on the natural history of cystic echinococcosis in untreated and albendazole-treated patients, American Society of Tropical Medicine, November 13-17, 2016. Atlanta, Georgia USA
- Waechter, R. (2016). The Role of Learning Institutions and Academia in Health Equity and Social
- Determinants of Health. Presented at the World Health Organization Technical Meeting on Action Across Sectors and Health in All Policies: Geneva, Switzerland.
- Waechter, R., Landon, B., Cyrus, D., Brathwaite, S., Orlando, L., Martin, T. & Charles, V. (2016).
- A Community-based Conscious Discipline Program to reduce Corporal Punishment in the Caribbean. Presented at the Grand Challenges 2016 Meeting: London, UK.
- Waechter, R., Landon, B., & Bailey, B. (2016). Conscious Discipline and Saving Brains Grenada. Global Summit on Childhood: Creating a Better World for Children and Youth through Sustainability, Social Innovation, and Synergy, Costa Rica, March 31 - April 3, 2016
- Graduate Seminars (34)**
- Peter Mark, (Chief Consultant Psychiatrist at the Psychiatry Center North Sealand, Denmark.): "Forced hospitalization" January 13th, 2016.
- Udo Schuklenk, (Professor of Philosophy and Ontario Research Chair in Bioethics, Department of Philosophy Queen's University Canada): "Treatment resistant depression and assisted dying" January 20th, 2016.
- Hugh Sealy: "The Climate Change Negotiations: What happened in Paris and what next?" January 27th, 2016.
- Barbara Landon: "Licks, Spanks, Lashes, Beatings: The Long and Short Term Effects of Corporal Punishment" February 3rd, 2016.
- Victor Amadi, Pathobiology Department, School of Veterinary Medicine: "Salmonella in Wild and Domestic Animals in Grenada: Serovars and Antimicrobial Susceptibility" February 17th, 2016.
- Sarah Elsea, (FACMG Director, Biochemical Genetics Laboratory, Medical Genetics Laboratories, Distinguished Professor, Department of Molecular and Human Genetics Baylor College of Medicine): "Exploring and defining neurodevelopmental disorders through the integration of phenotypes, genes, and family needs" February 24th, 2016.
- Victor Amadi, (PhD Student): "Salmonella, Campylobacter, Escherichia coli, spirochetes (Helicobacter, Brachyspira), Giardia and Cryptosporidium in the feces of dogs in Grenada, and drug resistance among Salmonella, Campylobacter and Escherichia coli species" March 2nd, 2016.
- Rick Addante, (School of Behavior & Brain Sciences, The University of Texas at Dallas): "Brain states related to performance" March 16th, 2016.
- Camille Coomansingh, (PhD student): "Evaluation of factors contributing to anthelmintic resistance in sheep and goats in Grenada, West Indies" March 21st, 2016.
- Jennifer Friedman, (Professor of Pediatrics and Epidemiology), Warren Alpert Medical School of Brown University, Hasbro Chil-

- dren's Hospital, Lifespan Center for International Health Research (CIHR): "The global burden of disease due to helminthes" March 22nd, 2016.
- Jonathan Kurtis, (Director, Center for International Health Research, Professor, Department of Pathology and Laboratory Medicine, Associate Director, Transfusion Medicine and Coagulation Center for International Health Research, Rhode Island Hospital, Brown University School of Medicine: "Novel Vaccines for Pediatric Falciparum Malaria" March 23rd, 2016.
- Richard Kabusu: "Epidemiological and diagnostic investigations into outbreaks of syncytial hepatitis associated with Orthomyxovirus-like viruses in tilapia" March 30th, 2016.
- Damian Greaves: "Evidence-based management of Caribbean health systems: barriers and opportunities" April, 6th, 2016.
- Fevzi Akinci, (Associate Dean, William G. McGowan School of Business, King's college, Pennsylvania): "Global Trends and Opportunities in Healthcare Management: King's College Experience" April 13th, 2016.
- Michael Snosek, (PhD Student): "The fascial anatomy of the retropharyngeal region and its clinical relevance" April 25th, 2016.
- Patricia Raythe, (DVM/MSc student): "A serosurvey of Letospora in owned and stray dogs in Grenada, West Indies" April 26th, 2016.
- Trevor Paul Noël, (PhD Candidate): "Elimination of the Neglected Tropical Diseases in the Western Hemisphere with Particular Reference to the Soil Transmitted Helminths" April 29th, 2016.
- William Nelson, (Founder and President, Tetracore, Inc.): "The Challenge of Bringing Point-of-Care Testing to Any Health Care Setting to Help Control an Outbreak: Zika?" May 11th, 2016.
- Satesh Bidaisee: "It Does Not Take Balls: Fighting Testicular Cancer!" May 11th, 2016.
- Sean Philpott-Jones, (Director and Associate Professor of Bioethics, The Bioethics Program at Clarkson University and Icahn School of Medicine at Mount Sinai): "Concussive Head Trauma in High Impact Competitive Sports" August 17th, 2016.
- Nadia Solomon, (MSc student): "Observations on Cystic Echinococcosis and Evaluation of a Control Programme in Turkana, Kenya" September 5th, 2016.
- William Nelson, (Founder and President, Tetracore, Inc.): "Zika Diagnosis: Current Developments" September 14th, 2016.
- Dondrae Coble, (Clinical Veterinarian and Associate Professor, Department of Preventive Medicine, The Ohio State University School of Veterinary Medicine): "Animal Subjects in Research" September 21st, 2016.
- Marco Brenciaglia, (MD/MSc student): "Zika in Grenada: An observational study" October 4th, 2016.
- Edward Tronick, (Professor of Psychology, College of Liberal Arts Director, Child Development Unit University of Massachusetts, Boston): "Epigenetics and how early life experiences/advertisity gets under the skin" October 5th, 2016.
- Jonathan Ashcroft, (SGUSOM Class of 2010): "Ebola Research in Sierra Leone: Ethical concerns in Medicine and Public Health" October 12th, 2016.
- Kerry Mitchell: "Stabilisation of metals in soils and sediments contaminated by metals using biomass" October 19th, 2016.
- Jermain Thomas, (MSc student): "Helicobacter pylori: antibiotic resistant strains in Grenada" October 26th, 2016.
- Clifton Maxwell, (SGU Alumnus 2016): "Overcoming Climate Change With Per-

maculture at SGU” November 2nd, 2016.

Helga Valdmanis Toriello, (Distinguished Professor Department of Pediatrics and Human Development Michigan State University): “Clinical relevance of somatic and germline mosaicism” November 9th, 2016.

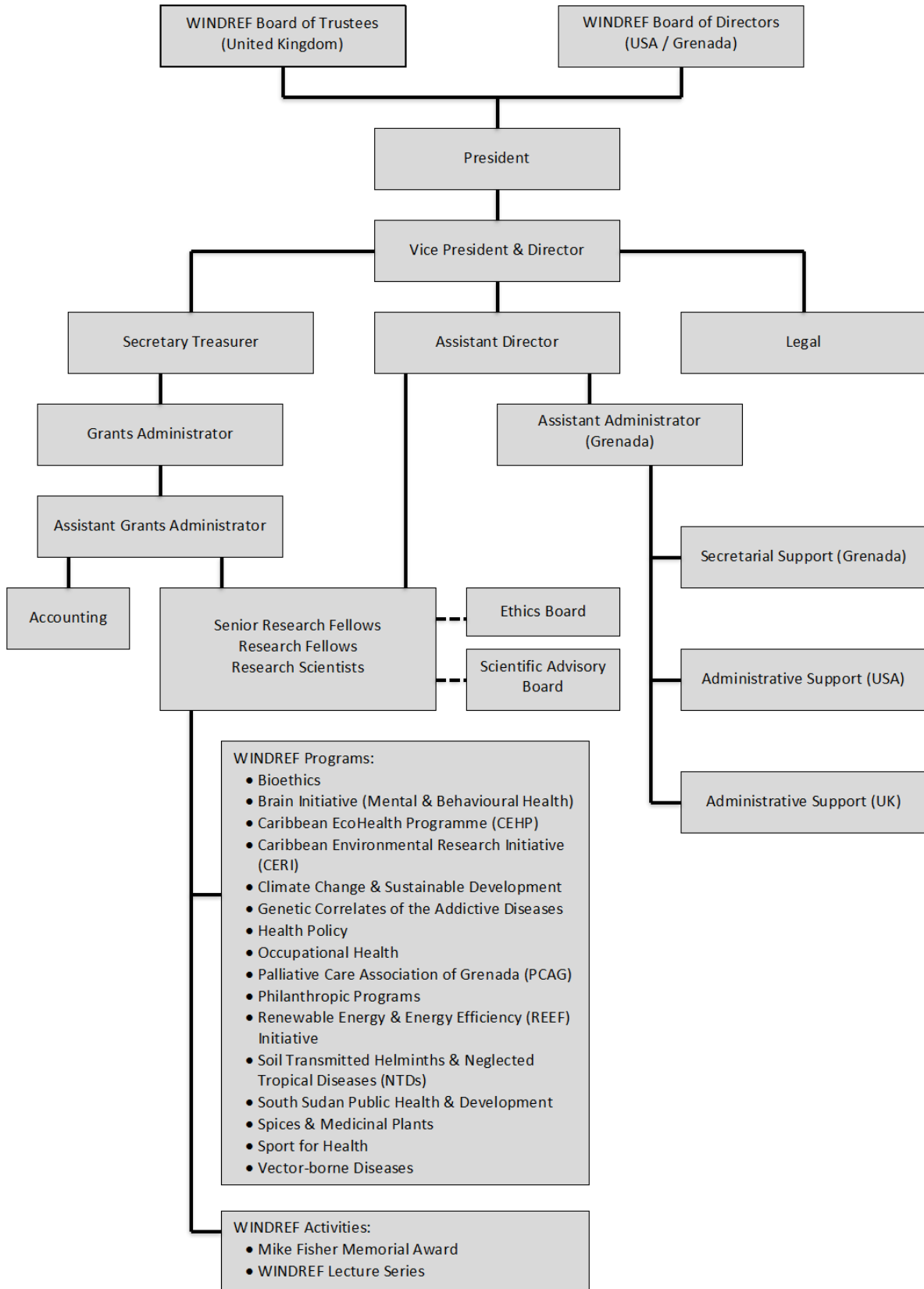
Rosemary Statkus and Nataliia Gurenko, (McGill Interns): “Nataliia: What is the best approach for the management of Gestational Diabetes? Rosemary: The role of sugar in the development of chronic disease” November 16th, 2016.

Shekinah Joy Morris, (MSc student): “To evaluate and analyze the antibacterial effect of plant extracts against bacterial pathogens of small ruminants” November 23rd, 2016.

Mercedes Miccio, (MSc student): “Effect of methadone on esophageal reflux, analgesia and sedation in comparison with morphine in dogs undergoing ovariohysterectomy” November 30th, 2016.

Wayne Sylvester, (PhD student): “One Health Zoonoses: Toxocara spp” December 7th, 2016.

WINDREF Organizational Chart



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