

Annual Report - 2014

Award ID: 1068676

Institution: North Carolina State University

Title: IGERT- Genetic Engineering and Society: The Case of Transgenic Pests

Principal Investigator(s)

Name: Fred L. Gould

Project Years Active: 2011-2012, 2012-2013, 2013-2014

Co-Principal Investigator(s) or Trainee/Associate Advisor(s)

Name: Andrew R. Binder

Project Years Active: 2012-2013, 2013-2014

Role in Project: Trainee/Associate Advisor

Name: Matthew M. Booker

Project Years Active: 2012-2013, 2013-2014

Role in Project: Trainee/Associate Advisor

Name: Zachary S. Brown

Project Years Active: 2013-2014

Role in Project: Trainee/Associate Advisor

Name: Yasmin J. Cardoza

Project Years Active: 2013-2014

Role in Project: Trainee/Associate Advisor

Name: Jason A. Delborne

Project Years Active: 2013-2014

Role in Project: Trainee/Associate Advisor

Name: John R. Godwin

Project Years Active: 2012-2013, 2013-2014

Role in Project: Trainee/Associate Advisor

Name: Kevin Gross

Project Years Active: 2013-2014

Role in Project: Trainee/Associate Advisor

Name: Nick Haddad

Project Years Active: 2011-2012, 2012-2013, 2013-2014

Role in Project: Co-PI and Trainee/Associate Advisor

Name: Nora Haenn

Project Years Active: 2011-2012, 2012-2013, 2013-2014

Role in Project: Co-PI

Name: William C. Kimler
Project Years Active: 2013-2014
Role in Project: Trainee/Associate Advisor

Name: William Kinsella
Project Years Active: 2011-2012, 2012-2013, 2013-2014
Role in Project: Co-PI and Trainee/Associate Advisor

Name: Jennifer Kuzma
Project Years Active: 2013-2014
Role in Project: Trainee/Associate Advisor

Name: Alun Lloyd
Project Years Active: 2011-2012, 2012-2013, 2013-2014
Role in Project: Co-PI and Trainee/Associate Advisor

Name: Marce D. Lorenzen
Project Years Active: 2012-2013, 2013-2014
Role in Project: Trainee/Associate Advisor

Name: Lisa McGraw
Project Years Active: 2013-2014
Role in Project: Trainee/Associate Advisor

Name: Carolyn R. Miller
Project Years Active: 2013-2014
Role in Project: Trainee/Associate Advisor

Name: Melinda S. Morrill
Project Years Active: 2012-2013, 2013-2014
Role in Project: Trainee/Associate Advisor

Name: Nils Peterson
Project Years Active: 2013-2014
Role in Project: Trainee/Associate Advisor

Name: Mitch A. Renkow
Project Years Active: 2013-2014
Role in Project: Trainee/Associate Advisor

Name: Mark D. Robinson
Project Years Active: 2013-2014
Role in Project: Trainee/Associate Advisor

Name: Max J. Scott
Project Years Active: 2012-2013, 2013-2014
Role in Project: Trainee/Associate Advisor

Name: Walter N. Thurman
Project Years Active: 2012-2013, 2013-2014
Role in Project: Trainee/Associate Advisor

Trainees

Name: Timothy D. Antonelli

Total number of months funded: 23

Project Years Active:

2012-2013 Project Year - Trainee supported for 11 months

2013-2014 Project Year - Trainee supported for 12 months

Name: Gregory A. Backus

Total number of months funded: 11

Project Years Active:

2013-2014 Project Year - Trainee supported for 11 months

Name: Amanda C. Clayton

Total number of months funded: 23

Project Years Active:

2012-2013 Project Year - Trainee supported for 11 months

2013-2014 Project Year - Trainee supported for 12 months

Name: William A. Klobasa

Total number of months funded: 18

Project Years Active:

2012-2013 Project Year - Trainee supported for 11 months

2013-2014 Project Year - Trainee supported for 7 months

Name: Caroline Leitschuh

Total number of months funded: 11

Project Years Active:

2013-2014 Project Year - Trainee supported for 11 months

Name: Andrew C. Ludvik

Total number of months funded: 11

Project Years Active:

2013-2014 Project Year - Trainee supported for 11 months

Name: Elizabeth A. Pitts

Total number of months funded: 11

Project Years Active:

2013-2014 Project Year - Trainee supported for 11 months

Name: Megan E. Serr

Total number of months funded: 11

Project Years Active:

2013-2014 Project Year - Trainee supported for 11 months

Name: Molly S. Storment

Total number of months funded: 23

Project Years Active:

2012-2013 Project Year - Trainee supported for 11 months

2013-2014 Project Year - Trainee supported for 12 months

Name: Rene X. Valdez

Total number of months funded: 11

Project Years Active:

2013-2014 Project Year - Trainee supported for 11 months

Name: Sophia H. Webster

Total number of months funded: 23

Project Years Active:

2012-2013 Project Year - Trainee supported for 11 months

2013-2014 Project Year - Trainee supported for 12 months

Name: Gabriel L. Zilnik

Total number of months funded: 23

Project Years Active:

2012-2013 Project Year - Trainee supported for 11 months

2013-2014 Project Year - Trainee supported for 12 months

Associates

Name: Sarah A. Cash

Project Years Active: 2012-2013, 2013-2014

Name: Rebecca M. Edman

Project Years Active: 2012-2013, 2013-2014

Name: Dona Kanavy

Project Years Active: 2013-2014

Name: Ashley R. Kelly

Project Years Active: 2012-2013, 2013-2014

Name: Meagan Kittle Autry

Project Years Active: 2012-2013, 2013-2014

Name: Arina Loghin

Project Years Active: 2012-2013, 2013-2014

Name: Kate Maddalena

Project Years Active: 2012-2013, 2013-2014

Name: Michael A. Robert

Project Years Active: 2012-2013, 2013-2014

Name: Stacy Roberts

Project Years Active: 2012-2013, 2013-2014

Accomplishments and Contributions of the IGERT

Interdisciplinary Research Achievements

First Achievement: Our 2012 student cohort's group white paper has been selected for publication as the opening chapter entitled "Vector Control Techniques in a Social and Cultural Context" in a compilation book by Dr. Zach Adelman entitled "Genetic Control of Malaria and Dengue". The white paper cum book chapter represents a significant achievement of our interdisciplinary research goals for our first cohort. The global problem of dengue fever is a multi-faceted, complex issue that spans many different disciplines. Effective dengue control and prevention therefore require integrated research from a multitude of disciplines in order to understand this problem from as many angles as possible and within its social and cultural contexts. Through an integrative interdisciplinary approach, this paper provides a comprehensive overview of current technologies used to control dengue fever and addresses the controversial question of whether transgenic technologies should also be used.

Second Achievement: Based on preliminary IGERT data, 4 of our IGERT faculty have received grants to pursue research in other GES-related areas. Fred Gould (with A. A. James (UCI)) received a \$1,000,000 grant (with \$225,000 for NCSU) from the W. M. Keck Foundation for "Evolutionary Consequences of Invasions of Novel Genotypes and Selfish Genetic Elements" (2014-2017). Max Scott received a \$99,870 grant from the North Carolina Biotechnology Center for the project "Development of an engineered strain of spotted wing Drosophila (*D. suzukii*) ideal for a genetic control program" (2013-2014). Jennifer Kuzma: Received a \$173,703 grant from the Alfred P. Sloan Foundation for the project "'Looking Forward to Synthetic Biology Governance': Convergent Research Cases to Promote Policy-Making and Dialogue" (2013-2014). Marce Lorenzen received two grants, one from NSF for \$645,060 for investigating Medea mechanisms (2013-2016) and one from Monsanto for \$744,914 for creating transgenic rootworms (2013-2016).

Third Achievement: Under the auspices of the GES Center, we have been able to make significant advancements in expanding our interdisciplinary research scholarship in the form of our Resident Fellows Program and our History of Genetic Engineering and Society (GES) Project. The purpose of the Resident Fellows Program is to engage faculty already present at N.C. State in GES. Four faculty in Communication, Public Affairs, and Biology, had their Resident Fellows proposals selected this spring and will begin work on their projects over the summer. The GES Oral History Project was green lit this spring and will be spearheaded by Dr. Matthew Booker (History). The GES program at NC State is well positioned to bring together the first generation of genetic engineering and to archive its story for posterity. The program founders know many of the founding generation and faculty are a trusted third party (not industry, not advocacy) with institutional support.

Education Achievements

First Achievement: In our second GES summer course over Summer 2013, students engaged with local researchers, university students and faculty, policy makers, NGOs, and citizens, in the Channel and Farallon Islands off the coast of California on topics associated with the potential role of genetic engineering in the preservation and conservation of endangered species. The course aimed to provide students with an experiential introduction to the topic's various complexities. At the same time, the course established intellectual and social foundations for students' participation in the Genetic Engineering and Society program throughout their doctoral studies. Students also engaged in team-building activities that probed the nature of inter-disciplinary collaboration. Students participated in reading and discussion on ethical decision-making and began to create their own ethical framework in respect to genetic engineering.

Second Achievement: Our successful development and implementation of our final academic course required for the achievement of the GES minor was accomplished during this reporting period. Governance, Systems and Modeling was taught during the Spring 2013 semester and served to give our students a basis in the governance policies, economics, and statistical modeling related to genetic engineering. This course was team taught by three professors across multiple disciplines (Policy, Economics, Biomathematics) and required in-class student presentations. One of our older courses, Emerging Technologies and Society, was altered to accommodate feedback from previous students. Taught during the Spring 2014 semester, it served to give the students a structural framework with which to approach the humanities and social science side of our IGERT. It was team taught by three IGERT faculty (Forestry & Environmental Resources, Anthropology & History) and required student-lead and student-mediated group discussion.

Third Achievement: Our Colloquium continued meeting once every other week for the full duration of the 2013-2014 academic year. Our colloquia involved faculty, staff, students and postdocs from 4 different colleges at NCSU encompassing numerous disciplinary distinctions. We brought in multiple outside speakers to discuss topics from the ethics of synthetic biology and the representation of GM in mainstream media to diversity and gender issues in academia. Exposure to the wide world of genetic modification has allowed us to elevate our conversation from genetic pest management as a focus to apply our discussion to a variety of fields. Our colloquia have also given our GES fellows an opportunity to present multiple times as cohort teams in a generalized academic setting. The Colloquia have also given them a platform by which to receive a wide variety of input on their cohort projects at various stages as their White Paper and Cohort Website have progressed.

Trainee Achievements

First Achievement: Amanda Clayton: will have her preliminary oral defense for her doctoral thesis on May 9, 2014. She presented her first chapter at her department's (Economics) Graduate Research Symposium on January 24, 2014. Her dissertation entitled "Mosquito-borne disease prevention: The determinants of household

participation in *Aedes aegypti* control programs" uses an economically-based interdisciplinary approach to assess household participation in *Aedes aegypti* control programs aimed at decreasing the incidence of dengue fever in the Amazonian city of Iquitos, Peru. She explores how participation varies by the household's expected costs and benefits of control program participation. She found that households with a higher ratio of working-aged females have significantly fewer positive containers and that there is higher compliance during the rainy season. Her results suggest that participation in container control is determined by household demographics and perception of disease transmission risk.

Second Achievement: Tim Antonelli: Along with one of our GES Associates, Ari Loghin, Tim participated in the 2013 Fulbright Global Food Security Seminar organized in Raleigh, NC, in November of 2013. The seminar gathered Fulbright students from a variety of scientific fields such as agriculture, engineering, and biology. The panel discussion on Genetically Engineered Pests: Technical and Societal Issues included four IGERT participants: Dr. Fred Gould (Entomology), Dr. Nora Haenn (Anthropology), Tim (PhD, Biomathematics) and Ari (MS, Anthropology). The panel addressed scientific and social matters. Specifically, Fred presented methods for the genetic management of pests. Nora emphasized concerns with respect to intercultural issues regarding genetic engineering. Tim elaborated on strategies for modeling insect behavior in the wild. Ari brought to the fore a critical analysis of the relations between the stakeholders who produce, implement and consume genetically modified organisms.

Third Achievement: Megan Serr: Megan and Dr. Lisa McGraw (Biology) returned to the Farallon Islands in November 2013 following the 2013 Summer Course to trap and transport wild mice back to their lab at N.C. State for behavioral and genetic research. They also plan to look at what makes these mice such successful invaders on the Farallon Islands, specifically evaluating their endocrine levels compared to other mouse strains. They plan to construct biologically relevant mouse barns and observe mouse behavior in more natural settings. For mate choice, they plan to examine their breeding behavior and compare these behavior to lab mice and other wild mice. For long term use, they plan to mate the Farallon mice with lab strains to determine how wild of a lab strain do is necessary for it to be able to successfully compete in the wild.

International Opportunities: Achievements

Research/Educational Achievement 1: Tim Antonelli: As a visiting lecturer, Tim developed and taught two-week course on mathematical modeling of infectious diseases in Spanish and English to a group of 11 university students at Universidad Católica de Santa María in Arequipa, Peru, from July to August 2013.

Research/Educational Achievement 2: Amanda Clayton: Amanda's dissertation involves continuous collaboration with our governmental partner, NAMRU-6 in Iquitos, Peru. Her continued interaction with Dr. Amy Morrison to access NAMRU's dengue fever transmission control compliance records is essential to the completion of her PhD thesis. Together with with Amy Morrison and Tom Scott, she has identified several areas in which NAMRU-6 is missing important information about household behavior in terms

of the impacts of dengue on the household and in terms of NAMRU survey methods in general. She has applied for funds to travel to Iquitos and Lima in June and July of this coming summer (2014) to collect survey data necessary to fill those knowledge gaps.

Outreach Activities

Title: "Hiring that Crosses Disciplines Can Create New Tensions" Article

Media Outlet/Organization: The Chronicle of Higher Education

Activity Date: 02/24/2014

Description: IGERT Faculty and Fellows were interviewed for the Chronicle of Higher Education's piece on interdisciplinary hiring. The article describes the process and some outcomes of the Chancellor's Faculty Excellence Program, including the GES cluster hires.

Title: BugFest!

Media Outlet/Organization: North Carolina Museum of Natural Sciences

Activity Date: 09/21/2013

Description: Many of our faculty and fellows attend Raleigh's annual BugFest. Each year over 35,000 visitors take the opportunity to interact with entomologists and other scientists. This year, Tim Antonelli presented on "Using Math to Help Control Mosquitoes!"

Title: Growers Meeting

Media Outlet/Organization: North Carolina State Extension Service

Activity Date: 02/20/2014

Description: 3 of our GES faculty attended a growers meeting in Lumberton, NC, with Dominic Reisig and about 90 growers. Topic of discussion was sustainable use of transgenic cotton. We will follow up with a collaboration with Dominic on conducting farmer surveys.

Title: Guest Speaker, Duke University Continuing Studies

Media Outlet/Organization: Duke University

Activity Date: 04/08/2014

Description: Fred Gould gave a guest lecture discussing the diverse biological, social, and political factors affecting acceptance of GM crops and GM insects entitled "Can we manipulate evolution for social good?".

Title: Pints of Science - Historical Cultural Traditions

Media Outlet/Organization: North Carolina Museum of Natural Sciences

Activity Date: 11/26/2013

Description: Spearheaded by GES fellow Gabriel Zilnik and supported by GES PI Dr. Andrew Binder, this is a joint effort between NC State University and the N.C. Museum of Natural Sciences. It is held the last Tuesday of every month at a local bar, Tir Na Nog.

Title: Pints of Science - Insects

Media Outlet/Organization: North Carolina Museum of Natural Sciences

Activity Date: 09/17/2013

Description: Spearheaded by GES fellow Gabriel Zilnik and supported by GES PI Dr. Andrew Binder, this is a joint effort between NC State University and the N.C. Museum of Natural Sciences. It is held the last Tuesday of every month at a local bar, Tir Na Nog.

Title: Pints of Science - Invasive Species and Conservation Biology

Media Outlet/Organization: North Carolina Museum of Natural Sciences

Activity Date: 01/28/2014

Description: Spearheaded by GES fellow Gabriel Zilnik and supported by GES PI Dr. Andrew Binder, this is a joint effort between NC State University and the N.C. Museum of Natural Sciences. It is held the last Tuesday of every month at a local bar, Tir Na Nog.

Title: Pints of Science - Nanostructured Materials

Media Outlet/Organization: North Carolina Museum of Natural Sciences

Activity Date: 08/27/2013

Description: Spearheaded by GES fellow Gabriel Zilnik and supported by GES PI Dr. Andrew Binder, this is a joint effort between NC State University and the N.C. Museum of Natural Sciences. It is held the last Tuesday of every month at a local bar, Tir Na Nog.

Title: Pints of Science - Nanotoxicology

Media Outlet/Organization: North Carolina Museum of Natural Sciences

Activity Date: 02/25/2014

Description: Spearheaded by GES fellow Gabriel Zilnik and supported by GES PI Dr. Andrew Binder, this is a joint effort between NC State University and the N.C. Museum of Natural Sciences. It is held the last Tuesday of every month at a local bar, Tir Na Nog.

Title: Pints of Science - Science Perception in Society

Media Outlet/Organization: North Carolina Museum of Natural Sciences

Activity Date: 03/25/2014

Description: Spearheaded by GES fellow Gabriel Zilnik and supported by GES PI Dr. Andrew Binder, this is a joint effort between NC State University and the N.C. Museum of Natural Sciences. It is held the last Tuesday of every month at a local bar, Tir Na Nog.

Title: Pints of Science - Space

Media Outlet/Organization: North Carolina Museum of Natural Sciences

Activity Date: 10/22/2013

Description: Spearheaded by GES fellow Gabriel Zilnik and supported by GES PI Dr. Andrew Binder, this is a joint effort between NC State University and the N.C. Museum of Natural Sciences. It is held the last Tuesday of every month at a local bar, Tir Na Nog.

Title: Talk on GMOs

Media Outlet/Organization: North Carolina Museum of Natural Sciences

Activity Date: 09/24/2013

Description: Fred gave an informal talk to the public at Irregardless Cafe in Raleigh on the current state of genetically modified organisms.

Publications, Presentations, and Patents

Journal Articles in Refereed Publications

5a. Journal Articles in Refereed Publications

Burrack, H.J. & Chapman, A.V. (2013). Evaluation of biweekly pesticide applications for tobacco budworm (*Heliothis virescens*) management in tobacco (*Nicotiana tabacum* L.) seed production. *Crop Protection*. 45: 117-123.
<http://dx.doi.org/10.1016/j.cropro.2012.12.004>

Burrack, H.J., Fernandez, G., Spivey, T. & Kraus, D.A. (2013). Variation in selection and utilization of host crops in the field and laboratory by *Drosophila suzukii* Matsumura (Diptera: Drosophilidae), an invasive frugivore. *Pest Management Science*.
DOI: 10.1002/ps.3489

Facchinelli, L., Valerio, L., Ramsey, J.M., Gould, F., Walsh, R. K., Bond, G., Robert, M. A., Lloyd, A. L., James, A. A., Alphey, L., & Scott, T. W. (2013). Field Cage Studies and Progressive Evaluation of Genetically-Engineered Mosquitoes. *PLoS NTD*. 7(1): e2001.
doi:10.1371/journal.pntd.0002001

Fitzsimons, H.L., Schwartz, S., Given, F.M., & Scott, M.J. (2013) The Histone Deacetylase HDAC4 Regulates Long-Term Memory in *Drosophila*. *PLoS ONE* 8 (12): e83903. doi:10.1371/journal.pone.0083903

Gatton, M.L., Chitnis, N., Churcher, T., Donnelly, M. J., Ghani, A. C ., Godfray, H. C. J., Gould, F., Hastings, I., Marshall, J., Ranson, H., Rowland, M., Shaman, J., & Lindsay, S. W. (2013). The Importance of Mosquito Behavioural Adaptations to Malaria Control in Africa. *Evolution*. 67:1218-1230.

Groot, A. T., Staudacher, H., Barthel, A., Inglis, O., Schofl, G., Santangelo, R. G., Gebauer-Jung, S., Vogel, H., Emerson, J., Schal, C., Heckel, D. G., & Gould, F. (2013). One quantitative trait locus for intra- and interspecific variation in a sex pheromone. *Molecular Ecology*. 22:1065-1080. DOI:10.1111/mec.12171

Haenn, N., Schmook, B., Reyes Martínez, Y. & Calmé, S. (2014) A Cultural Consensus Regarding the King Vulture?: Preliminary Findings and their Application to Mexican Conservation. *Ethnobiology and Conservation*. 3 (1): 1-22.

Huang, Y., Wan, P., Zhang, H. N., Huang, M. S., Li, Z. H., & Gould, F.

(2013). Diminishing returns from increased percent Bt cotton: The case of pink bollworm. *PLoS ONE* 8(7): e68573. DOI: 10.1371/journal.pone.0068573.

Lee, J.C., Barrantes, L.D., Beers, E.H., Burrack, H.J., Dreves, A.J., Gut, L.J., Hamby, K.A., Haviland, D.R., Isaacs, R., Nielson, A.L., Richardson, T., Rodriguez-Saona, C.R., Shearer, P.W., Stanley, C.A., Walsh, D.B., Walton, V.M., Zalom, F.G., & Bruck, D.J. (2013). Trap designs for monitoring *Drosophila suzukii* (Diptera: Drosophilidae). *Environmental Entomology*. 42 (6): 1348-1355.

Legros, M., Xu, C., Morrison, A., Scott, T.W., Lloyd, A.L., & Gould, F. (2013). Modeling the dynamics of a non-limited and a self-limited gene drive system in structured *Aedes aegypti* populations. *PLoS ONE*, 8: e83354. DOI:10.1371/journal.pone.0083354

McCoy, R. & Haenn, N. (2013) Gentlemen-Type Rules and Back Room Deals in Public Participation: Natural Resource Management and a Fractured State in North Carolina. *Journal of Political Ecology*. 20: 444-459.

Okamoto, K., Robert, M.A., Lloyd, A.L., & Gould, F. (2013). A Reduce and Replace strategy for suppressing vector-borne diseases: Insights from a stochastic, spatial model. *PLoS ONE*. 8 (12):e81860. DOI:10.1371/journal.pone.0081860

Robert, M.A., Okamoto, K., Lloyd, A.L., & Gould, F. (2013). A Reduce and Replace strategy for suppressing vector-borne diseases: Insights from a deterministic model. *PLoS ONE*. 8 (9): e73233. DOI:10.1371/journal.pone.0073233

Rogers, S.R., Tarpy, D.R., & Burrack, H.J. (2013). Multiple criteria for evaluating pollinator performance in highbush blueberry agroecosystems. *Environmental Entomology*. 42 (6): 1201-1209.

Rogers, S.R., Tarpy, D., Toupe, V., Cajamarca, P., & Burrack, H.J. (2013). Encounters between bees influence foraging behavior. *Apidologie*. DOI: 10.1007/s13592-013-0210-0

Scholle, S.O., Ypma, R.J.F., Lloyd, A.L., & Koelle, K. (2013). Viral substitution rate variation can arise from the interplay between within-host and epidemiological dynamics. *American Naturalist*. 182, 494-513.

Smith, D.L., Perkins, T.A., Reiner, R.C., Barker, C.M., Niu, T., Chaves, L.F., Ellis, A.M., George, D.B., Le Menach, A., Pulliam, J.R.C., Bisanzio, D., Buckee, C., Chiyaka, C., Cummings, D.A.T., Garcia, A.J., Gatton, M.L., Gething, P.W., Hartley, D.M., Johnston, G., Klein, E.Y., Michael, E., Lloyd, A.L., Piggot, D.M., Reisen, W.K., Ruktanonchai, N., Singh, B.K., Stoller, J., Tatem, A.J., Kitron, U., Godfray, H.C.J., Cohen, J.M., Hay, S.I., & Scott, T.W. (2014). Recasting the Theory of Mosquito-Borne Pathogen Transmission Dynamics and Control. *Transactions of the Royal Society of Tropical Medicine & Hygiene*. 108, 185-197. DOI:10.1093/trstmh/tru026

Terrapon, N., Li, C., Robertson, H.M., Ji, L., Meng, X., Booth, W., Chen, Z., Childers, C.P., Glastad, K.M., Gokhale, K., Gowin, J., Gronenberg, W., Hermansen, R.A., Hu, H.,

Hunt, B.G., Huylmans, A.K., Khalil, S.M.S., Mitchell, R.D., Munoz-Torres, M.C., Mustard, J.A., Pan, H., Reese, J.T., Scharf, M.E., Sun, F., Vogel, H., Xiao, J., Yang, W., Yang, Z., Yang, Z., Zhou, J., Zhu, J., Brent, C.S., Elisk, C.G., Goodisman, M.A.D., Liberles, D.A., Roe, R.M., Vargo, E.L., Vilcinskis, A., Wang, J., Bornberg-Bauer, E., Korb, J., Zhang, G., Liebig, J. (2014, March). Molecular traces of alternative social organization in a termite genome. *Nature Communications*, 1-12.

Thresher, R. E., Hayes, K., Bax, N. J., Teem, J., Benfey, T. J., & Gould, F. (2013). Genetic control of invasive fish: technological options and its role in Integrated Pest Management. *Biological Invasions*. DOI 10.1007/s10530-013-0477-0

Walsh, R.K., Aguilar, C.L., Facchinelli, L., Valerio, L., Ramsey, J.M., Scott, T.W., Lloyd, A.L., & Gould, F. (2013). Regulation of *Aedes aegypti* population dynamics in field systems: Quantifying direct and delayed density dependence. *The American Journal of Tropical Medicine and Hygiene*, 89, 68-77. DOI:10.4269/ajtmh.12-0378

Yarmand, H., Ivy, J.S., Denton, B., & Lloyd, A.L. (2014). Optimal Two-Phase Vaccine Allocation to Geographically Different Regions under Uncertainty. *European Journal of Operational Research*. 233, 208-219.

Journal Articles in Non-Refereed Publications

5b. Journal Articles in Non-Refereed Publications

Scott, M.J., Pimsler, M.L., & Tarone, A.M. (2014). Sex determination mechanisms in calliphorids (blow flies). *Sexual Development*. 8, 29-37.

Books

5c. Books

Sonenshine, D.E. & Roe, R.M. (2014). *Biology of Ticks, Volume 1*. New York: Oxford University Press. ISBN# 9780199744053

Sonenshine, D.E. & Roe, R.M. (2014). *Biology of Ticks, Volume 2*. New York: Oxford University Press. ISBN# 978-0199744060

Conference Publications

5g. Conference Publications

*Pitts, E. (2013). Participatory Documentation: A Case Study & Rationale. *Proceedings of the Association for Computing Machinery Special Interest Group on Design of Communication (SIGDOC) Conference Proceedings* (pp. 193-194). New York: Association for Computing Machinery.

*Storment, Molly H. (2013). Manufacturing Kairos: Opportunity and Ethos in Emerging Biotechnologies. In J. Goodwin, M. Dahlstrom, & S. Preist (Eds.), *Ethical Issues in*

Science Communication: A theory-based approach (pp. 299-309). Charleston: CreateSpace.

Conference Presentations

5h. Conference Presentations

*Antonelli, T. (2013, November). Estimating Parameters for Deterministic and Stochastic Models of Mosquito Larval Growth. Symposium speaker at the 9th Annual UNCG Regional Mathematics and Statistics Conference, Greensboro, North Carolina.

*Antonelli, T. (2013, November). Mathematical Models of Genetically Modified Insects. Symposium speaker at the Fulbright Global Food Security Seminar, Raleigh, North Carolina.

*Antonelli, T., *Clayton, A., *Stormont, M. H., *Klobasa, W., *Webster, S., & *Zilnik, G. (2013, November). Genetic Pest Management and Society: An interdisciplinary assessment of current and emerging technologies for dengue control. Paper presented at The American Society of Tropical Medicine and Hygiene 62nd Annual Meeting, Washington, District of Columbia.

Burrack, H.J. (2013, November). Overwintering biology of two-spotted spider mites, *Tetranychus urticae*, and their predators in human made microclimates created for strawberry season extension. Poster session presented at the Entomological Society of America Annual Meeting, Austin, Texas.

Binder, A., Cobb, M.D., Johnson-Young, E.A., & M. H. *Stormont. (2013, November). Communication, Attribution, and Emerging Science: How Descriptive Labels Activate Cognitive Schemas to Influence Citizen Attitudes. Paper presented at the 99th annual National Communications Association Convention, Washington, District of Columbia.

Cobb, M.D. (2013, June). Framing Genetically Engineered Mosquitoes as "Sterile": The Impact on Public Opinion. Paper presented at the Iowa State University Summer Symposium on Science Communication: Ethical Issues in Science Communication: A Theory-Based Approach, Ames, Iowa.

Davidson, C.N., Davidson, C.C., Davis, J., Holman, K., *Pitts, E., & Stratton, J. (2014, April), Open Learning, Open Access and the Digital Divide. Paper presented at the Sixth international conference for the Humanities, Arts, Science, and Technology Alliance and Collaboratory (HASTAC), Lima, Peru.

Delborne, J. (2014, March). Science, Democracy, and Public Engagement. Symposium speaker at the International Center for Maize and Wheat Improvement (CIMMYT), Texcoco, Mexico.

Farrell, L., Johnson, N., Jorgenson, D., *Pitts, E., Stallings, L., & Tracy, P. (2014, April). Benefits of Communication Studies Curricula for 21st Century Learners and Employers. Paper presented at the Southern States Communication Association (SSCA) conference,

New Orleans, Los Angeles.

Gould, F. (2014, March). Transición de cultivos genéticamente modificados a insectos genéticamente modificados? Symposium speaker at the Colegio de Postgraduados Campus Montecillo, Mexico.

Gould, F. (2014, April). Genetic engineering of plants, animals and microbes: Biological and social challenges? Symposium speaker at Texas A&M University, College Station, Texas.

Gould, F. (2014, April). NSF sponsored lecture on Genomics and Society. Symposium speaker at Texas A&M University, College Station, Texas.

Gould, F. (2014, April). Genetic Engineering of Our Food and Pests. Symposium speaker at the Osher Lifelong Learning Institute, Duke University, Durham, North Carolina.

Gould, F. (2013, June). What makes a hot button issue? Symposium speaker at the National Academy of Sciences Committee on Public Interfaces in the Life Sciences, Washington, District of Columbia.

Gould, F. (2013, October) Can genetic pest management protect crops, human health, and biodiversity? Symposium speaker at Ohio State University, Columbus, Ohio.

Gould, F. (2013, November). New tools in the pipeline for suppressing dengue: Transgenics. Symposium speaker at the 11th Gates Foundation sponsored meeting, Washington, District of Columbia.

Haenn, N. (2014, March). Who's Got the Money Now?: Myths and Reality in Southern Mexican Conservation-Development. Paper presented at the Dimensions of Political Ecology Conference, Lexington, Kentucky.

Haenn, N., Schmook, B., Calme, S., & Reyes, Y. (2014, February). Conservation Science as Hybrid Knowledge: Social Class and The Transformation of Local Environmental Expertise in Southern Mexico. Paper presented at the 10th Annual Consortium Conference: Consortium in Latin American and Caribbean Studies at UNC Chapel Hill and Duke University, Chapel Hill, North Carolina.

Hardin, J., Bailey, M., Horton, D.L., & Burrack, H.J. (2013, November). Management strategies for *Drosophila suzukii* in highbush blueberry: approaches to meet grower needs. Paper presented at the Entomological Society of America Annual Meeting, Austin, Texas.

Kraus, D. & Burrack, H.J. (2013, November). Influence of host quality of larval competition in *Drosophila suzukii*. Paper presented at the Entomological Society of America Annual Meeting, Austin, Texas.

*Leitschuh, L., *Serr, M., Godwin, J., & McGraw, L. (2014, March). Predicting Wild

Mouse Behavior: Towards a Novel Mate Choice Strategy. Poster session presented at the Triangle Consortium for Reproductive Biology Conference, National Institute of Environmental Health Sciences, Research Triangle Park, North Carolina.

Lloyd, A.L. (2013, August). Uncertainty Quantification for Epidemic Models. Symposium speaker at the RAPIDD Infectious Disease Dynamics meeting, Isaac Newton Institute, Cambridge, United Kingdom.

Lloyd, A.L. (2013, September). Genetic Control Strategies for Mosquito Borne Diseases. Symposium speaker at the Institute Pasteur, Paris, France.

Loghin, A. (2014, April). Who is an actor? Scientists and their Tools in the Drosophila Laboratory. Paper presented at the AnthroPlus Conference. University of Maryland, College Park, Maryland.

Loghin, A. (2014, March). The Question of Agency: Scientists and their Tools in the Drosophila Laboratory. Poster session presented at the Graduate Student Research Symposium, N.C. State University, Raleigh, North Carolina.

Loghin, A. (2013, November). Genetically Engineered Pests: Technical and Societal Issues. Symposium speaker at the 2013 Fulbright Global Food Security Seminar, Raleigh, North Carolina.

*Ludvik, A. & *Valdez, R. (2013, November). Current Issues Concerning Invasive Mammals and Island Ecosystems. Symposium speakers at the 2013 MEAS/FER Graduate Student Symposium, N.C. State University, Raleigh, North Carolina.

Merchan, H.A. & Burrack, H.J. (2013, July). Do I eat or do I walk? Determining the exposure route of imidacloprid to green peach aphids in cultivated tobacco. Paper presented at the Colombian Entomological Association, Bogota, Colombia.

Merchan, H.A., Allen, N., & Burrack, H.J. (2013, November). Do I eat or do I walk? Determining the exposure route of imidacloprid to green peach aphids in cultivated tobacco. Paper presented at the Entomological Society of America Annual Meeting, Austin, Texas.

Patel, M. & Haenn, N. (2014, March). Do Remittances Benefit Rural Mexican Communities. Paper presented at the 74th Annual Meeting of Society for Applied Anthropology, Albuquerque, New Mexico.

*Pitts, E. & Delborne, J. (2014, May). Regulatory (Mouse) Traps: Social, Cultural and Ethical Issues in Classifying Genetically Modified Mammals. Paper presented at the Governance of Emerging Technologies: Law, Policy and Ethics Conference, Scottsdale, Arizona.

*Pitts, E. (2014, April). Bio-provocations: An Ethnography of Participatory Knowledge Production and Deliberation. Paper presented at the Southern States Communication Association (SSCA) Conference, New Orleans, Los Angeles.

*Pitts, E. (2014, April). Public Engagement and Ordinary Citizens: An Autoethnographic Account. Paper presented at the STGlobal: Science & Technology in Society Conference, Washington, District of Columbia.

*Pitts, E. (2014, April). Critical Making, Biopolitics and Bioaesthetics. Paper presented at the Sixth International Conference for the Humanities, Arts, Science, and Technology Alliance and Collaboratory (HASTAC), Lima, Peru.

*Pitts, E. (2013, October). Participatory Documentation: A Case Study & Rationale. Paper presented at the Association for Computing Machinery Special Interest Group on the Design of Communication (SIGDOC) 2013 Conference, Greenville, North Carolina.

*Pitts, E. (2013, October). Considering Digital Learning Technologies for Nontraditional Students: A Diffusion-Based Framework. Paper presented at the 10th Annual Conference of the International Society for the Scholarship of Teaching and Learning (ISSOTL), Raleigh, North Carolina.

Robert, M.A. (2013, October). Models as aids for the design and interpretation of experiments: the case of transgenic female-killing cage trials. Symposium speaker at the Imperial College London Centre for Environmental Policy, London, United Kingdom.

Robert, M.A. (2013, October) Genetic strategies for controlling the dengue vector, *Aedes aegypti*: mathematical models in the design, development, testing, and implementation of control strategies. Symposium speaker at the Imperial College London, Silwood Park, Centre for Environmental Policy. Ascot, United Kingdom.

Robert, M.A., Okamoto, K., Lloyd, A.L., & Gould, F. (2013, October). Anti-pathogen genes and the replacement of disease vector populations: a model-based evaluation of hybrid strategies. Symposium speaker at The Fourth International Conference on Mathematical Modeling and Analysis of Populations in Biological Systems, Lubbock, Texas.

Robert, M.A., Gould, F., & Lloyd, A.L. (2013, August). Optimal control of female-killing strategies to eliminate the dengue vector, *Aedes aegypti*. Symposium speaker at the MBI Workshop for Young Researchers in Mathematical Biology 2013, Columbus, Ohio.

Robert, M.A., Gould, F., & Lloyd, A.L. (2013, July). Utilizing female-killing strategies in the optimal control of the dengue vector, *Aedes aegypti*. Symposium speaker at the SIAM Annual Meeting, San Diego, California.

Scott, M. (2013, June) Sex determination mechanisms in calliphorids (blow flies). Symposium speaker on the Sex determination in insects, Paris, France.

Scott, M. (2013, November) Developing male-only strains of the screwworm and the Australian sheep blowfly. Paper presented at the Annual meeting of the Entomological Society of America, Austin, Texas.

Scott, M. (2014, November). Towards Genetic Pest Management of *Drosophila suzukii*. Paper presented at WERA 1021: Spotted wing drosophila biology, ecology, and management, Austin, Texas.

*Serr, M. (2014, February). Predicting wild mouse mating behavior: Towards a novel mate choice strategy. Symposium speaker at the Keck Center Symposium, N.C. State University, Raleigh, North Carolina.

*Storment, M. & Ding, H. (2014, May). Risky Rhetoric of an Emerging Disease: A Cross-Cultural Analysis of Dengue Fever in World News. Paper presented at the 16th Biennial Rhetoric Society of America Conference, San-Antonio, Texas.

*Storment, M. (2014, May). New Information Technologies in Emerging Sciences: A Case Study of Cultural and Species Boundary Mutations. Paper presented at the 16th Biennial Rhetoric Society of America Conference, San-Antonio, Texas.

*Storment, M. & Katz, S.B. (2014, May). The Appeal to 'Transparency' in the Regulation of Genetically Modified Insects. Paper presented at the Arizona State University Second Annual Conference on Governance of Emerging Technologies, Scottsdale, Arizona.

*Storment, M. (2014, March). The Rhetoric of Invasion: Cross-Cultural Analysis of Dengue Fever and *Aedes Aegypti* in World News. Paper presented at the 9th Annual Graduate Student Research Symposium, N.C. State University, Raleigh, North Carolina.

Swoboda, K. & Burrack, H.J. (2013, November). Influence of fruit coating on *Drosophila suzukii* oviposition and development and implications for field use. Paper presented at the Entomological Society of America Annual Meeting, Austin, Texas.

*Webster, S.H. (2013, November). Genetic Pest Management and Society: An interdisciplinary assessment of current and emerging technologies for dengue control. Paper presented at the American Society of Tropical Medicine and Hygiene (ASTMH), Washington, District of Columbia.

Partnerships/Collaborations

Government Partner 1

Active Status

Yes

Partner Name

U.S. Naval Medical Research Unit - 6 Peru (NAMRU-6)

Type of government agency

U.S. Federal laboratory or research facility

Funding arrangement for this partner

Other :A separate NIH funded project on Dengue provides a CRADA contract to partner for the purposes of providing services or support of IGERT research related to the NIH project

Activities for this partner/institution

Facilities: IGERT trainees or faculty use a partner organization's facilities for project activities.

Collaborative Research/Teaching: Partner organization's personnel work with IGERT project staff on collaborative research/teaching.

Personnel Exchange: IGERT Trainees, faculty and/or partner organization personnel use each other's facilities or work at each other's sites on an ad hoc or as-needed basis.

Activities for this partner/institution

Continued involvement with the NAMRU-6 research center in Iquitos, Peru, has been critical to the success of two of our students' dissertations. Two fellows from our first cohort, Tim Antonelli and Amanda Clayton, have returned to Peru numerous times to interface with NAMRU-6 personnel in pursuit of field data relevant to their dissertation research.

Other Partner 1

Active Status

Yes

Partner Name

CIMMYT - International Maize and Wheat Improvement Center

Funding arrangement for this partner

Other :In development

Activities for this partner/institution

Facilities: IGERT trainees or faculty use a partner organization's facilities for project activities.

Collaborative Research/Teaching: Partner organization's personnel work with IGERT project staff on collaborative research/teaching.

Personnel Exchange: IGERT Trainees, faculty and/or partner organization personnel use each other's facilities or work at each other's sites on an ad hoc or as-needed basis.

Activities for this partner/institution

Researchers and administrators at CIMMYT have interfaced via phone, email and in person with a group of our IGERT faculty to help build the framework for the 2014 Summer Course in Mexico as well as future more formal collaborations. Four of our faculty visited CIMMYT over spring break and participated in a two-party dialogue about approaches to address societal issues related to their activities in developing transgenic maize. Students and faculty will visit CIMMYT again during the summer course for further discussions and as a means to develop a more detailed plan for collaboration.

Other Partner 2

Active Status

Yes

Partner Name

UN FAO Food and Agriculture Organization

Funding arrangement for this partner

No funding/direct financial interaction is involved in this partnership.

Activities for this partner/institution

Collaborative Research/Teaching: Partner organization's personnel work with IGERT project staff on collaborative research/teaching.

Personnel Exchange: IGERT Trainees, faculty and/or partner organization personnel use each other's facilities or work at each other's sites on an ad hoc or as-needed basis.

Internships: IGERT Trainees or faculty work in a partner's facilities specifically as interns.

Activities for this partner/institution

FAO personnel will help with the teaching of our upcoming summer 2014 IGERT course. In the future we hope to have students do internships with FAO and we also are planning to work with FAO on development of policies on GMOs. We have had correspondence and skype conversations with FAO personnel. From there we had the Chancellor of N.C. State send a letter to the Director General of FAO requesting development of a formal collaboration. This has initially enabled one FAO researcher to be given leave time in order to teach in our summer course. We expect this to lead to further formal interactions.

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