Hawai‘i Experimental Tropical Forest

2015 Annual Report

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The Forest Service of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives -- as directed by Congress --to provide increasingly greater service to a growing Nation.

Dedicated to Melissa K. Dean, HETF Coordinator (2010 – 2016)

The development and implementation of the HETF Annual Report would not have been possible without the imagination and diligence of Melissa "Mel" Dean. Mel masterfully designed this critically important element of communication and Program performance at the HETF, and she positively influenced the direction of the HETF in many other (innumerable) ways. Her deep passion for the success of the HETF, and her unfaltering work on the details of the operation of the HETF are deeply appreciated and admired throughout Hawai'i, and will be appreciated by those who benefit from the HETF, for generations - Mahalo nui loa Mel!

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List of Acronyms

DHHL - Department of Hawaiian Homelands
DLNR - Hawai‘i Department of Land and Natural Resources
DOFAW - Hawai‘i Division of Forestry and Wildlife
FR - Forest Reserve
FBS - Forest Bird Sanctuary
HETF - Hawai‘i Experimental Tropical Forest
HIPPNET - Hawai‘i Permanent Plot Network
HFNWR - Hakalau Forest National Wildlife Refuge
IPIF - Institute of Pacific Islands Forestry
LAC - Laupāhoehoe Advisory Council
LAU - Laupāhoehoe Unit of the Hawai‘i Experimental Tropical Forest
LCPCS - Laupāhoehoe Community Public Charter School
NARS - Natural Area Reserve System
NREM – Natural Resources and Environmental Management
PAC - Pu‘u Wa‘awa‘a Advisory Council
PSW - Pacific Southwest Research Station
PWW - Pu‘u Wa‘awa‘a Unit of the Hawai‘i Experimental Tropical Forest
RCUH – Research Corporation of the University of Hawai‘i
RTC - Research Technical Committee for the Hawai‘i Experimental Tropical Forest
SP- State Parks
UHH - University of Hawai‘i at Hilo
UHM - University of Hawai‘i at Mānoa
USDA - United States Department of Agriculture
USGS - United States Geological Survey
USFS - United States Forest Service
HYCC – Hawai‘i Youth Conservation Corps

Acknowledgements

The establishment and administration of the Hawai‘i Experimental Tropical Forest (HETF) has been successful due to the support and hard work of many individuals. First, we would like to recognize Alex Friend, Ric Lopez, Lisa Hadway, Steve Bergfeld, and Scott Fretz for their leadership and support in 2015. The U.S. Department of Agriculture, Forest Service (USFS) would like to thank the State of Hawai‘i including the Board of Land and Natural Resources, the Division of Forestry and Wildlife and State Parks for their cooperation in the administration of the HETF. In particular we would like to thank the following State staff in 2015 for their efforts to reach agreements, provide valuable feedback, and help move forward the processes needed to effectively administer the HETF’s mission: Nick Agorastos, Ian Cole, Charmian Dang, Gordon Heit, Cynthia King, Sheri Mann, Joey Mello, Wesley Matsunaga, Kevin Moore, Elliott Parsons, Lyman Perry, Tanya Rubenstein, Lisa Shizuma, Hans Sin, Anya Tagawa, and Dean Takebayashi. Mahalo to Cheyenne Perry for working with the HETF Planning Group and as an HETF partner via Mauna Kea Watershed Alliance. Special thanks to the additional USFS employees who have tirelessly worked to support the HETF’s success in their respective capacities in 2015 including: Chris Ida, Rommel Tangalo, Tom Cole, Susan Cordell, Sherri Eng, Kainana Francisco, Chris Ida, Christian Giardina, Dean Oshiro, William Nielson, Randy Shrank, and Jeannie Stoner. Special thanks to James Akau, Kainana Francisco, Cheyenne Perry and Christian Giardina for their time and energy towards education and outreach activities and guidance. Mahalo also, to Bob Masuda who continues to support HETF operations and growth. Additionally, we acknowledge the Laupāhoehoe and Pu‘u Wa‘awa‘a Advisory Council members for their important role in the guidance of HETF activities.

Introduction

The Hawai‘i Experimental Tropical Forest (HETF) was established in 2007 via a Cooperative Agreement with the State of Hawai‘i, Department of Land and Natural Resources (DLNR). The HETF overlays existing DLNR managed lands and includes two Units: the Laupāhoehoe Wet Forest, totaling 12,343 acres (4,990 ha), and the Pu‘u Wa‘awa‘a Dry Forest, totaling 38,885 acres (15,736 ha) (Figure 1). The USDA Forest Service (USFS), Pacific Southwest Research Station in Hilo, Institute of Pacific Islands Forestry (IPIF), works with the DLNR – Division of Forestry and Wildlife (DOFAW) and State Parks to cooperatively manage research and education activities within the HETF. The HETF is part of a network of USFS Experimental Forest and Range units across the United States (http://www.fs.fed.us/research/efr/).

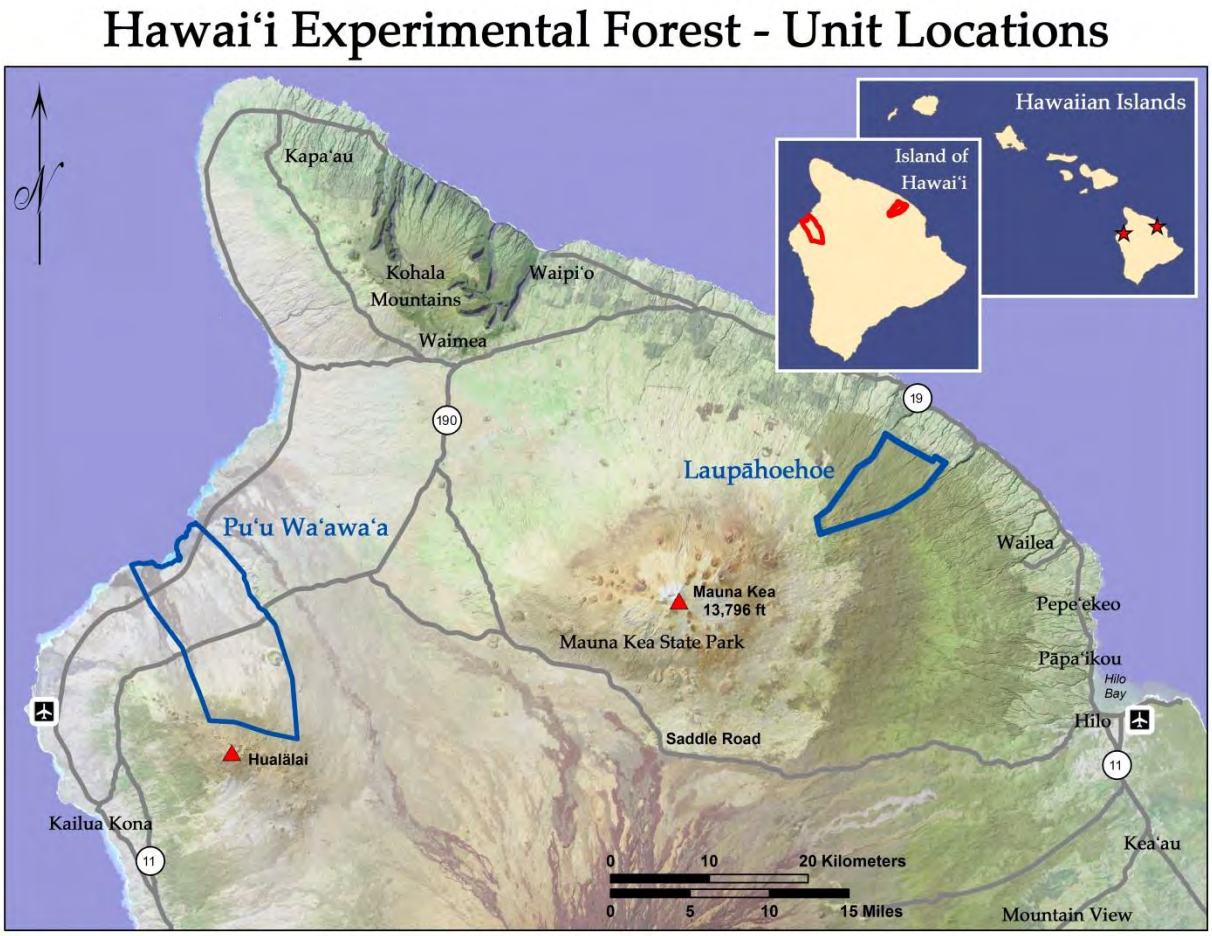


Figure 1: Map of Hawai‘i Island highlighting the Pu‘u Wa‘awa‘a and Laupāhoehoe Units of the HETF.

The Laupāhoehoe Experimental Forest Unit is located on the east side of Hawai'i Island (Figure 2) and incorporates 4,449 acres (1,800 ha) of DOFAW managed land designated as Forest Reserve and 7,894 acres (3,195 ha) of land designated as Natural Area Reserve (NAR). This Unit contains native-dominated forested landscapes from lowland forest at 2,300 feet (700 m) above sea level extending through four life zones to almost 6,200 feet (1,890 m) in elevation. Laupāhoehoe contains magnificent examples of tropical rain forest and is the habitat of numerous endangered plant and animal species.

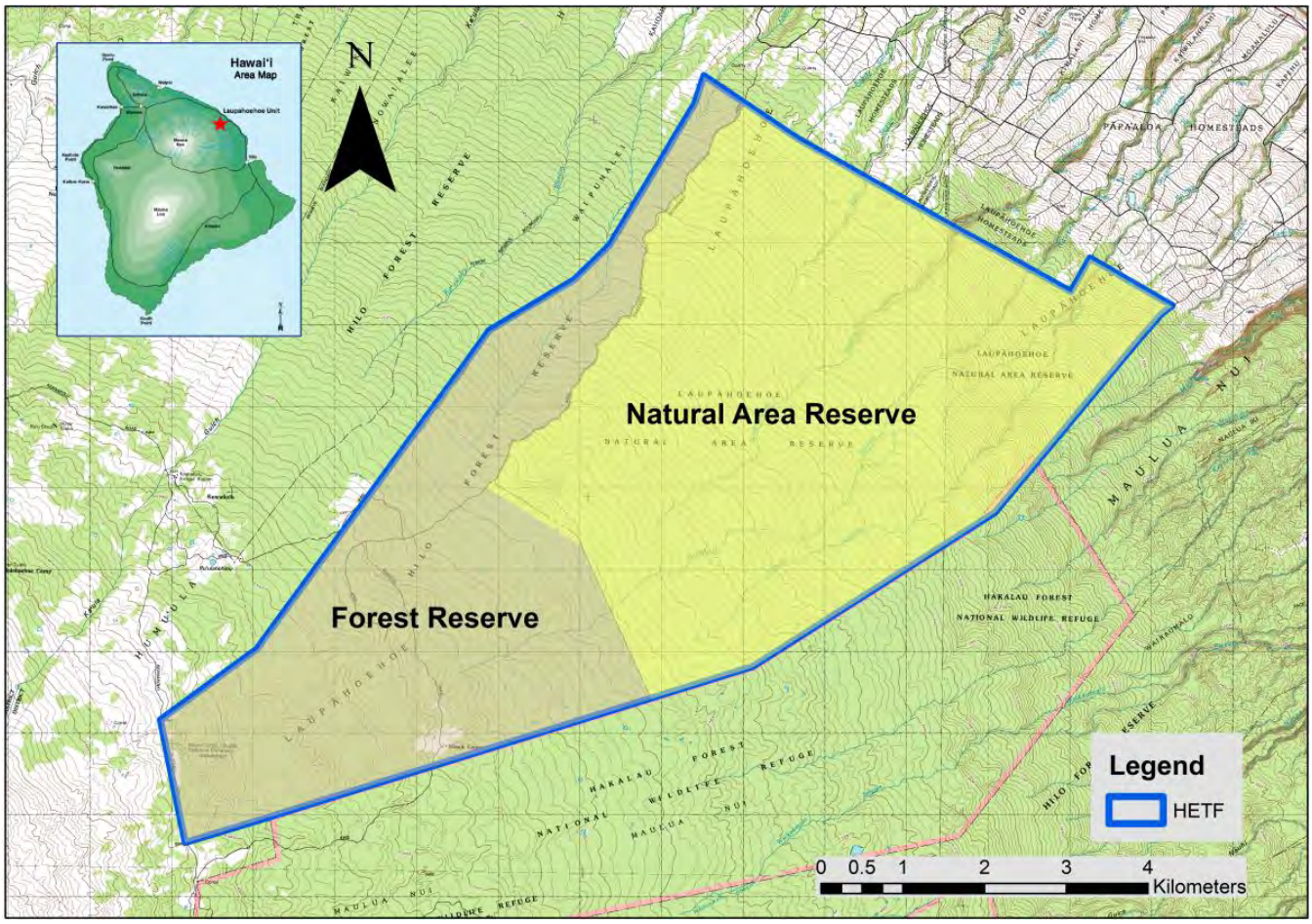


Figure 2: Map of the Laupāhoehoe Unit of the HETF indicating State land designations.

The Puʻu Waʻawaʻa Experimental Forest Unit is located in North Kona on Hawaiʻi Island (Figure 3) and incorporates three DLNR land designations. Approximately 31,475 acres (12,743 ha) are designated as Forest Reserve and together with the 3,806 acre (1,542 ha) Forest Bird Sanctuary (Wildlife Sanctuary), are managed through DOFAW. The remaining 3,530 acres (1,430 ha) are managed by the DLNR Division of State Parks. In addition there are approximately 74 acres (30 ha) of private inholdings within the HETF boundary. Tropical dry forests are considered among the most endangered forest types in the world, and in Hawaiʻi the few remaining remnants are severely threatened by wildfire, invasive plant species, and non-native ungulates.

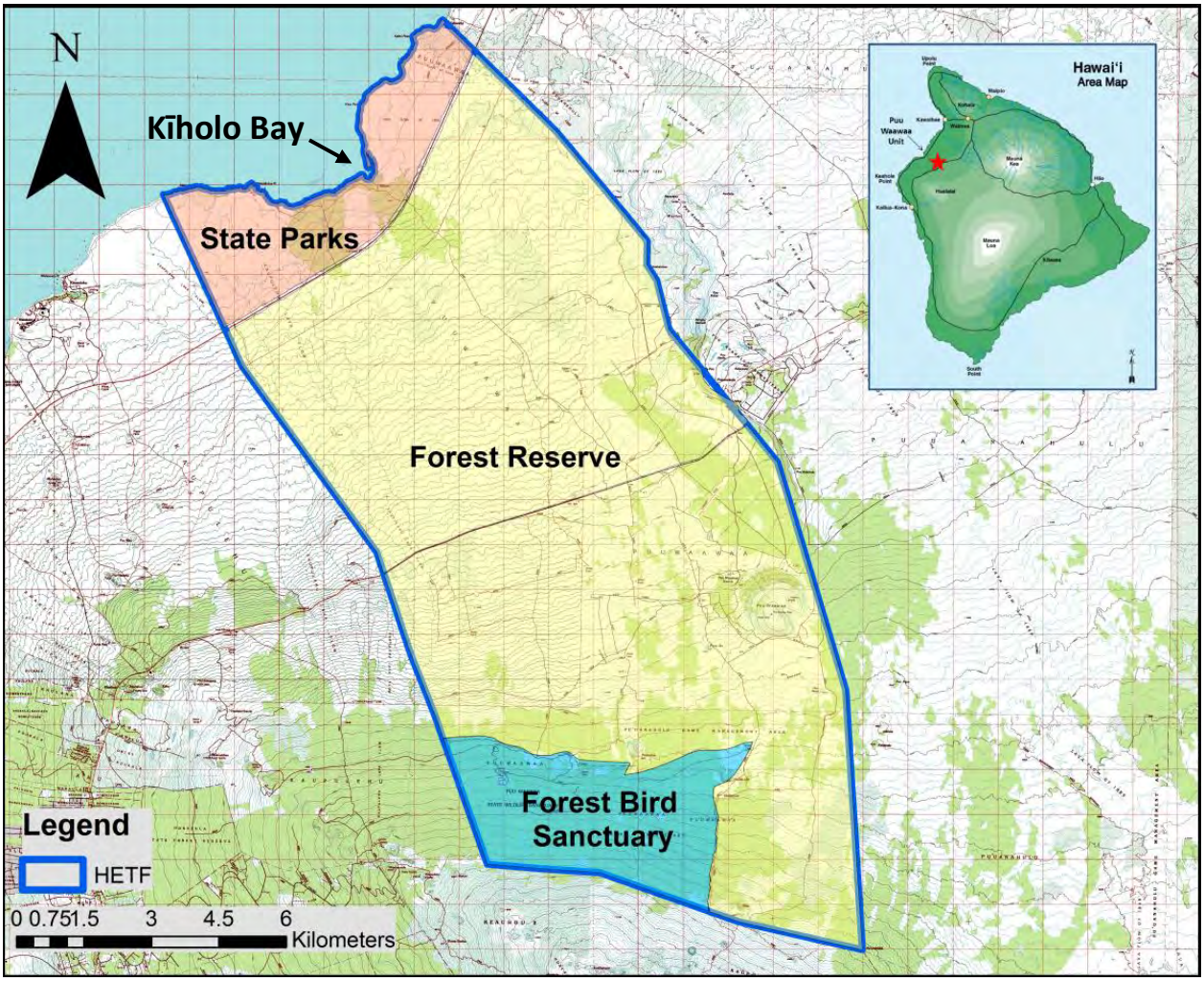


Figure 3: Map of the Puʻu Waʻawaʻa Unit of the HETF indicating State land designations.

The HETF's mission is to provide landscapes, facilities, and data/information to support research and education activities contributing to a better understanding of how to conserve and manage the biological diversity and functioning of tropical forest and stream ecosystems as well as to understand the human dimensions of natural resources conservation and management. The HETF represents a significant contribution in the global effort to understand and protect some of the most threatened and endangered ecosystems in the world. This can be accomplished in the following ways: facilitating research by providing research areas, facilities and information; fostering an environment for interaction and the exchange of information among scientists and to those outside the scientific community, and providing education and demonstration opportunities for those interested in tropical forest studies and management.

The report information herein is focused on the research and education activities that took place within the HETF in 2015 including annual reports received from researchers. Activity data from the previous four years is included in graphical data where relevant. Also included is information related to HETF facilities, research infrastructure and administration including concerns, comments, and challenges that took place relating to operations. Additional information regarding the HETF's history, future plans and annual reports as well as other resource documents can be found online at www.hetf.us.

Administration

Per the HETF Cooperative Agreement, "owing to the many values and benefits that arise from research, education and demonstration on the HETF and elsewhere, the Parties (*the USFS and the State of Hawai'i*) further agree they will consult and reach agreements with each other to coordinate research, management, and education activities." The HETF Planning Group was established to fulfill this objective and includes the USFS-HETF Line Officer, the USFS-HETF Science Lead, the USFS-HETF Facilities Manager, the Hawai'i Island DOFAW Branch Manager, the Hawai'i Island Natural Area Reserves Program Manager, the Hawai'i Island Forestry Program Manager, East and West Hawai'i Island Wildlife Biologists, the Pu'u Wa'awa'a coordinator, and two to three external partners. See Appendix C, for a list of HETF related personnel.

Permitting

Permit applications for research and education activities are reviewed by a subset of the HETF Planning Group, the Research Technical Committee (RTC), which includes the USFS-HETF Line Officer, the Hawai'i Island DOFAW Branch Manager, the USFS-HETF Science Lead, the Natural Area Reserve Hawai'i Island Manager, the Forest Reserve Hawai'i Island Manager, East and West Hawai'i Island Wildlife Biologists, and the Pu'u Wa'awa'a coordinator. Permit processing and tracking is coordinated and administered by HETF staff. Signing authority for all permits within DOFAW managed lands lies with the Hawai'i Island DOFAW Branch Manager. All research permits are valid for one year and require an annual report. In Pu'u Wa'awa'a research permitting for the HETF is limited to land activities. Research activities that take place in water including up to the tide line are under the jurisdiction of the DLNR-Division of Aquatic Resources and the Office of Conservation and Coastal lands (OCCL). Permits within State Parks are issued by State Parks Hawai'i Island District Superintendent.

Community Advisory Councils

Per the HETF Cooperative Agreement, "the Parties will consult with scientists, managers, general citizens, and local community members concerning ongoing research activities. Existing State sanctioned advisory councils may be utilized for this purpose." The Pu'u Wa'awa'a Advisory Council (PAC) has been in existence since 2002. The Laupāhoehoe Advisory Council (LAC) was formed in December 2010. Both councils participate in research permit application review and their comments and/or recommendations are provided to the RTC during the review process. See Appendix C, for a list of HETF advisory council members.

Planning

In 2015, the LAC reviewed a second internal draft of the Laupāhoehoe Forest Management Plan. A public draft management plan was released in March 2016 and is currently undergoing an Environmental Assessment process.

Funding

In addition to USFS staff time focused on HETF administration and development of the draft Laupāhoehoe Forest Management Plan, funds were expended on the HETF related activities and programs described below.

21st Century Conservation Corps (21CSC) – 21CSC is a national initiative to engage young people and returning veterans to protect, restore, and enhance America's Great Outdoors (http://21csc.org/). In 2014, the HETF was awarded $103K to support 21CSC partners in temporary professional development opportunities. Additional funds totaling $25K were awarded to support 21CSC position in 2015. Two youth were supported in 21CSC positions in 2015 working with MKWA and DOFAW at Pu‘u Wa‘awa‘a respectively. In addition, BIISC successfully leveraged 21CSC funds to support multiple crew members focused on *Albizia* eradication.

Education/Outreach/Safety – $2,800 in general operating funds were spent towards tools and hand gloves for education and outreach activities, supplies for the Center in Laupāhoehoe, and general field supplies such as hard hats, safety vests, etc. for use at Pu‘u Wa‘awa‘a.

State Management and Research Activities

As mentioned previously, HETF lands are managed cooperatively by IPIF, DOFAW and State Parks. State management activities and research and monitoring activities performed by State staff do not require HETF permits and are not tracked within this annual report. Management activity reports for each State land designation (Forest Reserves, NARS, Wildlife Sanctuary and State Parks) are available via annual reports to the Legislature. For information on the aforementioned reports, visit http://hawaii.gov/dlnr/reports-to-the-legislature.

Facilities

Laupāhoehoe

HETF support facilities for the Laupāhoehoe Unit are present in two locations within the town of Laupāhoehoe but outside the forest boundary. The Laupāhoehoe Science and Learning Center (Center) is located on 55 acres of old sugar cane lands within the Laupāhoehoe community, approximately four miles from the HETF boundary. Facilities include a bunkhouse, kitchen, restrooms, and classroom/meeting space. The facility site offers opportunities for research, education, and demonstration. A weather station, installed in 2009, is located onsite.

Pu‘u Wa‘awa‘a

There are plans to build dedicated HETF facilities within Pu‘u Wa‘awa‘a including a bunkhouse with kitchen, restrooms and classroom/meetings space for Pu‘u Wa‘awa‘a.

As part of the Pu‘u Wa‘awa‘a Construction Project, the IPIF is proposing to conduct the following activities:

- Construction of a bunkhouse building of approximately 1,100 square feet. This building would include double occupancy bunkhouse space for up to 10 visiting scientists, restrooms, kitchen facilities, and common use areas.

- Construction of an education and demonstration pavilion of approximately 400 square feet suitable for conference, meeting, and classroom use.
- Construction of an equipment storage building of approximately 400 square feet.
- Designation of an occasional-use tent area for up to 15 individuals subject to Forest Service directives and policies.

Improvement of approximately 2,500 feet of access drive and construction of parking areas for 10 vehicles (overflow parking for occasional large events would include off-site parking with shuttle service and use of the margins of the old runway on site). Provision of electrical and water utility connections and a waste water disposal system to serve the above facilities. An overhead electric line runs near the site, and connection to a private potable water system may be available. We will also analyze alternative sources such as solar power with generator backup, rainwater catchment, and hauling potable water.

The proposed site (Figure 4) was selected due to its suitable topography, the presence of potential building sites free of native plants, available access with modest road improvements, low scenic impact, and central location within the Pu‘u Wa‘awa‘a Unit. The site straddles an abandoned airstrip. Past airstrip development and a long history of grazing by domestic livestock and feral goats has altered the site’s vegetation. Currently non-exclusive use of specific DOFAW owned buildings are available for HETF related meetings and activities.

Visit http://www.hetf.us/page/projects_plans/ for more details.

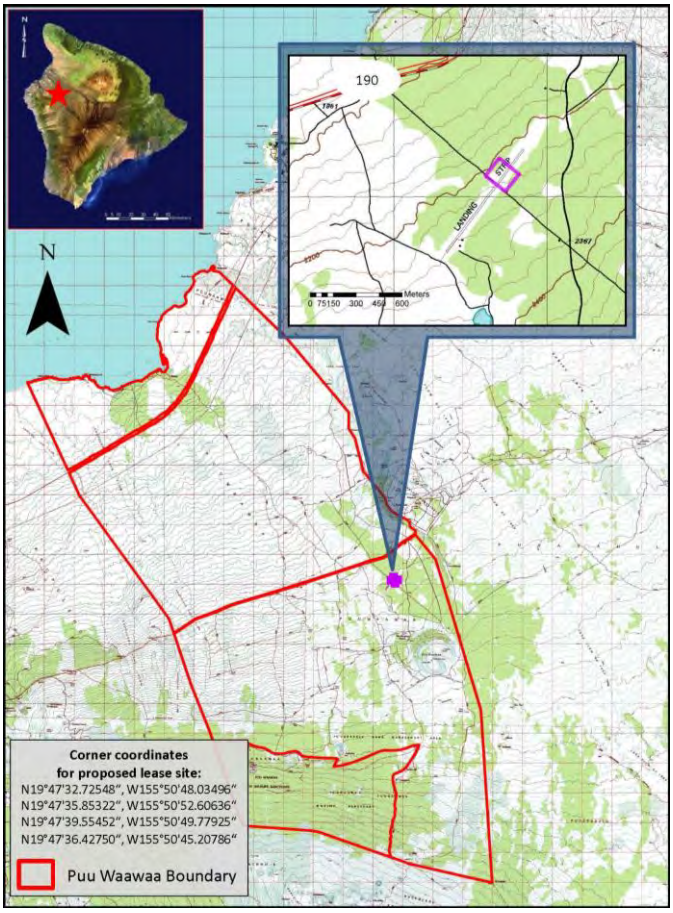


Figure 4: Proposed Pu‘u Wa‘awa‘a facilities site

Research Infrastructure/Databases

Long term climate monitoring equipment has been installed in both Units and the Laupāhoehoe Unit also includes hydrology monitoring equipment. HETF specific infrastructure was installed under Categorical Exclusions, and Decision Memos are on file with the USFS. The HETF climate stations are part of the EPSCoR-ENDER (Experimental Program to Stimulate Competitive Research - Environmental Dynamics and Ecosystem Responses) Climate Network, an island-wide network of climate stations at locations across the island of Hawai‘i.

Laupāhoehoe Unit equipment includes a stream gauge in Manowai‘ōpae, Kaiwilahilahi, and Ka‘awali‘i streams (outside the forest boundary and managed by the USFS) and a free standing aluminum weather station located within the Forest Reserve. The purpose of the stream gauge is to measure natural stream flows, water quality and sediment in a non-destructive manner. The weather station, installed in 2009, extends 10 feet (3 m) above the forest canopy and collects daily rainfall, temperature, relative humidity, wind-speed, solar radiation (sunlight), soil moisture, soil temperature, and wind direction.

The Pu‘u Wa‘awa‘a Unit hosts multiple weather stations including two in the Forest Reserve, installed in 2003 (RAWS station) and 2011, and one in the Forest Bird Sanctuary, installed in 2012. In addition to the Decision Memo on file for station installation, an Office of Conservation and Coastal Lands, District Use permit is also on file at the USFS.

Information and links to access HETF climate data is found here: http://www.hetf.us/page/climate/

Long term vegetation plots are available in both Units including:

- The Hawai‘i Permanent Plot Network (HIPPNET), http://www.hippnet.hawaii.edu/
- Forest Inventory and Analysis (FIA), http://www.fia.fs.fed.us/

Additionally, State management infrastructure (fencing) to protect plants is found within both Units. Detailed information regarding this infrastructure is found within the management plans for each unit.

- Pu‘u Wa‘awa‘a - http://www.puuwaawaa.org/index.html
- Laupāhoehoe - A public draft was released in April 2015: http://dlnr.hawaii.gov/ecosystems/nars/hawaii-island/laupahoehoe-2/

NEON

NEON is a long-term, continental scale science and education project sponsored by the National Science Foundation (http://neoninc.org/). Twenty eco-climatic domains, each of which represents different regions of vegetation, landforms, climate and ecosystem performance, have been selected across the U.S. Within these domains, NEON infrastructure and sensor systems will be used to collect site-based data about climate and atmosphere, soils, streams and ponds, and a variety of organisms. NEON uses distributed sensor networks, coordinated airborne observations and experiments – integrated by a communications, command, and control system – to collect ecological data. Each domain will host a fully instrumented core site in a minimally managed “wildland” area to operate for the 35 year lifetime of NEON and two “relocatable” sites will operate for a limited duration of 15 years.

Hawai‘i was selected as NEON’s ‘Domain 20’. In December 2014, NEON received an ‘Approval in Concept’ from the BLNR for establishing Hawai‘i’s core site within the Upper Waiakea Forest Reserve and the relocatable sites within Pu‘u Wa‘awa‘a. In 2015, the Pu‘u Wa‘awa‘a relocatable sites were dropped as NEON sites due to lack of funding. NEON continues be solidly committed to the Pacific Domain 20 and to the Waiakea site, with the decision being to only to remove Pu‘u Wa‘awa‘a. Accordingly, NEON will occur in association with the HETF because of its science mission, and will reside outside of the boundaries of the HETF.

2015 Climate Data Summary

This section contains available summary data for the HETF climate stations located within the Forest Reserve in Laupāhoehoe and the Forest Bird Sanctuary in Pu‘u Wa‘awa‘a and associated with the Hawai‘i Permanent Plot Network (HIPPNET), http://www.hippnet.hawaii.edu/.

Laupāhoehoe

Table 1: Mean annual rainfall, temperature, and relative humidity at Laupāhoehoe climate station.

YEAR	Rainfall (mm)	Temperature (C°)	Relative Humidity (%)
2015	5067	16.7 (±0.5)	89.2 (±1.0)
2014	4533	16.6 (±0.4)	88.3 (±1.0)
2013	3458	15.9 (±0.4)	86.5 (±0.9)
2012	3057	15.0 (±0.3)	86.2 (±1.7)
2011	4205	15.4 (±0.2)	85.1 (±1.1)
Mean	4064 (±362)	15.9 (±0.2)	87.1 (±0.5)

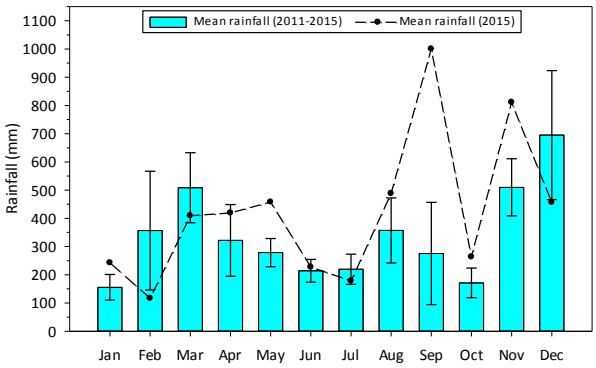


Figure 5: Mean rainfall for 2011-2015 compared to 2015 in Laupāhoehoe

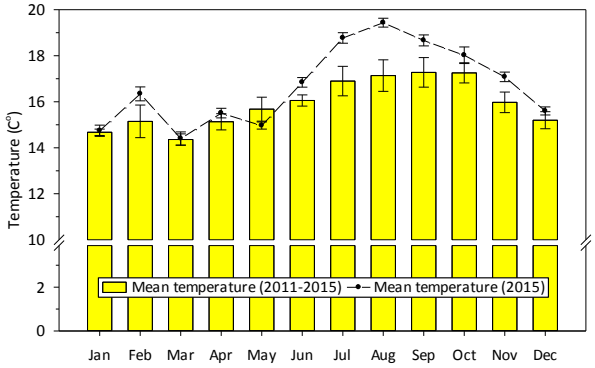


Figure 6: Mean temperature for 2011-2015 compared to 2015 in Laupāhoehoe

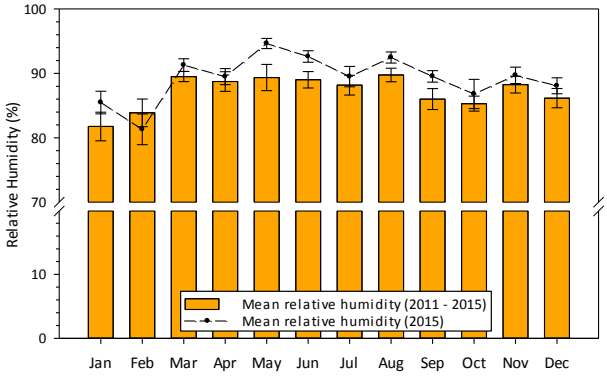


Figure 7: Mean relative humidity for 2011-2015 compared to 2015 in Laupāhoehoe

Pu‘u Wa‘awa‘a

Table 2: Mean annual rainfall, temperature, and relative humidity at Pu‘u Wa‘awa‘a climate station

YEAR	Rainfall (mm)	Temperature (C°)	Relative Humidity (%)
2015	1530	14.9 (±0.5)	83.8 (±2.9)
2014	815	14.4 (±0.3)	84.0 (±2.0)
2013	477	13.8 (±0.3)	83.2 (±1.5)
Mean	941 (±311)	14.4 (±0.2)	83.7 (±1.3)

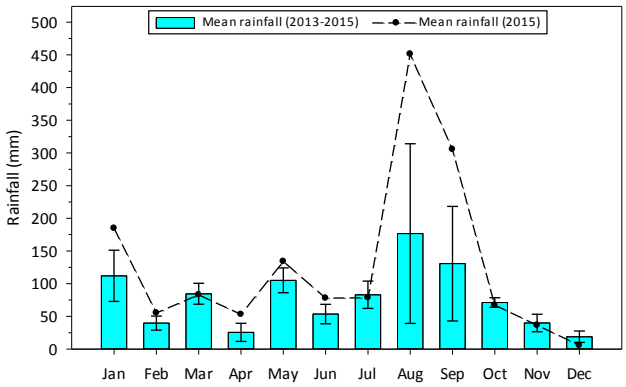


Figure 8: Mean rainfall for 2011-2015 compared to 2015 in Pu‘u Wa‘awa‘a

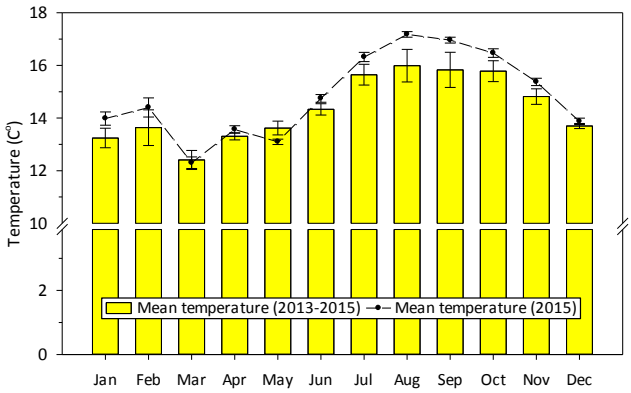


Figure 9: Mean temperature for 2011-2015 compared to 2015 in Pu‘u Wa‘awa‘a

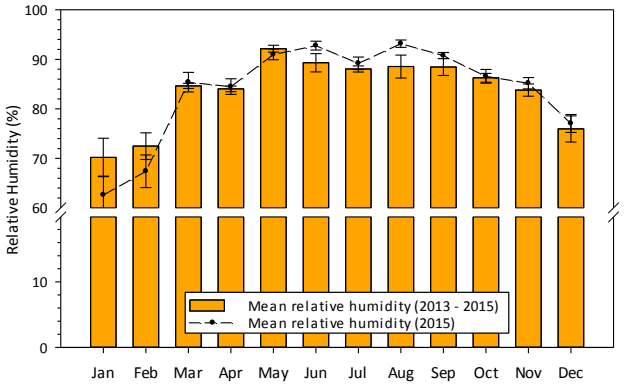


Figure 10: Mean relative humidity for 2011-2015 compared to 2015 in Pu‘u Wa‘awa‘a

2015 Research Summary

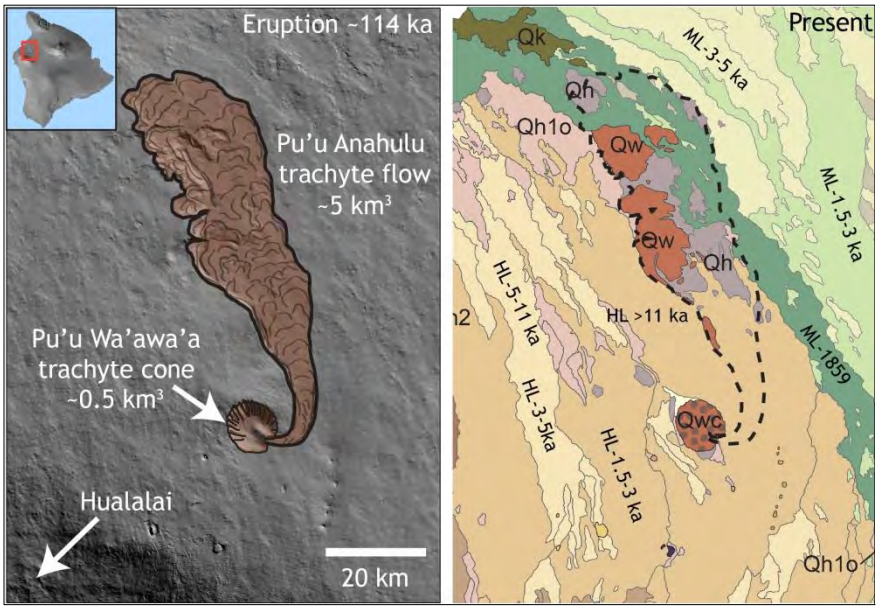
Twenty four research applications were submitted and approved in 2015. Twenty three projects were initiated (eighteen renewals and five new), and one project was uninitiated. See project summaries provided with research applications in Appendix A, and detailed information regarding research projects in Appendix B. HETF-related journal articles were published in the Journal of Vegetation Science, Geochimica et Cosmochimica Acta, Marine Ecology Progress Series, Biological Invasions, Ecological Applications and more. See HETF Related Citations section of this report for a complete list. Maps indicating the 2015 active research sites grouped by primary investigator within each Unit are provided in Figure 11 and Figure 12. Project overviews can be found in Table 4. Projects listed in hibernation refer to inactive research plots (closed permits) but with plot markers remaining in the field in anticipation of future measurements. A few of the 2015 research projects are highlighted below.

- ***Operational Disease Screening Program for Resistance to Wilt in Acacia koa in Hawai'i*** - Aileen Yeh of the Hawai'i Agriculture Research Center is collecting seed from wild populations of *Acacia koa* in the Pu'u Wa'awa'a and Laupāhoehoe Units for use in nursery screening trials to test for disease resistance. The goal of this project is to develop eco-region specific koa seed sources for restoration and reforestation. Collected seed will be used to determine resistance of individual trees, families and localities to the *Fusarium oxysporum* which is the putative causal agent for koa wilt. Seeds were collected from additional Hawai'i Island sites in 2015 including Kaiwiki, Kaumana, Pi'ihonua, Kalopa, Kukaiau, and Pa'auilo. Seeds from 50 trees (families) were collected. In the previous nursery screening trial of Hawai'i Island seeds, resistance ranged from 20% to 80% in the 27 windward sources, compared to 85-90% in selected Maunawili sources, and 96% from one of the other eco-region selections on Hawai'i Island.

Fusarium Resistance Screening Trial. Seedling family on the left has low resistance, while the family on the right shows high resistance.

- ***Field Investigation of the Pu'u Anahulu Lava Flows*** - The Pu'u Wa'awa'a volcanic cone formed ~114,000 years ago on the northern flank of Hūalalai volcano (Hawai'i Island), and it is hypothesized that the Pu'u Anahulu lava flows were produced during the same eruption. This eruption is unique in Hawai'i in that it is one of the only known eruptions that produced true pumice (a very porous glassy rock) as well as obsidian (almost exclusively made of dense glass). The erupted rock is also of a chemical composition that is very different from the typical lavas that erupt from Hawai'i (e.g. Kilauea basalts), and this type of magma has a tendency to generate explosive eruptions more readily. Thomas Shea from the University of Hawai'i at Mānoa, is working to answer this simple question: Are the cone and flows related in time (i.e. same

eruption) and in nature (i.e. same magma)? The first field campaign was completed in 2013-2014 to sample the rocks from Pu'u Wa'awa'a, he now plans to sample the lava flows from the Pu'u Anahulu area for a comparative study. In particular, past reports of pumice rock possibly interbedded between different parts of the Pu'u Anahulu flow will be verified, since those may provide proof that the pumice-producing cone and the dense rock-producing flow were erupted simultaneously. Rock samples collected during field work will be used for bulk chemical analysis at the University of Hawai'i. Thin rock sections will also help determine similarities and differences in the crystal content of the Pu'u Anahulu trachyte and Pu'u Wa'awa'a samples previously collected. As part of his HETF community give back, Mr. Shea created an informational brochure (See Appendix E) about Pu'u Wa'awa'a that is available to all visitors at the informational kiosk at Pu'u Wa'awa'a's main gate.



Location of the study area and hypothesis for the eruption sequence that generated the Pu'u Wa'awa'a cone and Pu'u Anahulu flow about 114,000 years ago. (Left) Digital elevation model showing what the cone and flow may have looked like originally. (Right) The same cone-flow association at the present time, partly buried under more recent lava flows.

- ***Albinism Transcriptomics of Cave-adapted Planthoppers*** - William Jeffery of the University of Maryland is studying cave planthoppers of the genus *Oliarus* to determine whether the same or different genes have been affected to control loss of melanin pigmentation (albinism) and whether this is a beneficial adaption to lava tube life because of a relationship to increased catecholamine synthesis. Catecholmines, such as dopamine and epinephrine, are neurotransmitters or hormones that assist the brain to perform behaviors, such as those required for feeding in resource poor environments like caves. This research is a continuation of the research previously conducted with *Oliarus polyphemus* from Kaumana Cave, near Hilo, HI. During the previous study it was discovered that *O. polyphemus* and an unrelated Croatian cave planthopper species have both lost pigmentation by blocking of the first step in the melanin biosynthesis pathway. The next question in his research, asks if the genes controlling both full and partial de-pigmentation are the same or different in closely related but independently evolved cave planthopper species. Mr. Jeffery will also test the hypothesis that lava tube life requires an increase in catecholamines, as was previously found to be the case for cavefish living in Mainland limestone caves. The pigmented cave species needed to continue this work are *Oliarus lorettae*, described from Ana Limo Kipo Cave in Kīholo State Park, and *Oliarus makaiki*, described from Yellow Jacket Cave in the Pu'u Wa'awa'a Unit, which show different levels of reduced pigmentation that are desirable for comparative analysis with completely albino *Oliarus polyphemus*. The genes that function in pigment development in these partially pigmented species will be determined by transcriptome analysis and compared with the corresponding gene profile in albino *O. polyphemus*. Catecholamine levels will also be evaluated across the three cave planthopper species.

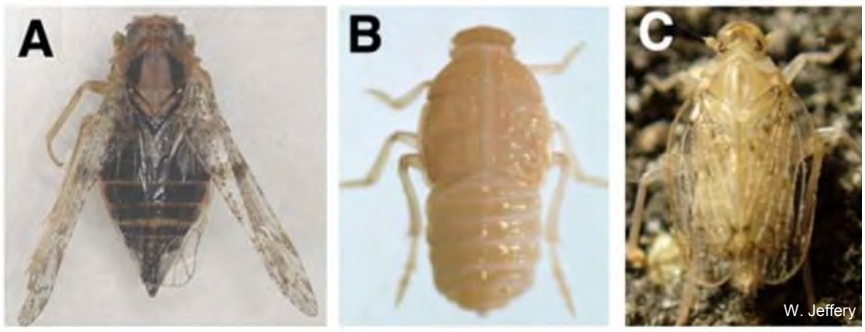


Figure: A. Surface dwelling (non-Hawaiian) pigmented Oliarus species. B. Cave dwelling albino *O. polyphemus* (instar) from Kaumana Cave. C. Cave dwelling partially depigmented *O. lorettae* (adult) from Ana Lino Kipo Cave.

- ***Soil Carbon Cycling Across a Hawaiian Mineralogical Gradient*** - Soil carbon in forests is an important bank of stored carbon, helping reduce carbon dioxide in the atmosphere and mitigate climate change. However, our understanding of what controls carbon storage in soils, and how long different carbon molecules can be stored, is very limited. Long-term storage of carbon in forest soils has been referred to as "stabilization." Carbon stabilization is determined by interactions among physical, chemical, and biological controls, like soil type and microbial community composition. Daniela Cusack, assistant professor at University of California at Los Angeles, heads this project and her goal is to significantly advance our understanding of how microbial and soil minerals interact with different carbon molecules to regulate the long-term storage of carbon in soils across a variety of tropical ecosystems in Hawai'i. Her research will help us understand which ecosystems processes increase carbon storage in tropical ecosystems, which is of global concern in the context of climate change. She is using a 1 to 2 year "soil column" study across 4 sites in Hawai'i that have large variation in soil mineralogy and microbial communities, including Hawai'i Volcanoes National Park, Kohala, Hawi, and the Laupāhoehoe Unit. To observe how carbon is moved into soils and stored, she will add 3 different sterile carbon compounds (compounds which occur naturally in soils: glucose, glutamine, charcoal). To track the fate of the added carbon, she will use carbon labeled with the stable, naturally occurring 13C carbon atom. Small quantities of this carbon (< 5 mg) will be added to the surface of soils. To contain the added carbon, she will use 25-cm long soil columns inserted into the soil. The carbon was added during the summer of 2015, collection of the soil columns will occur in 2016 and 2017. During this period, carbon measurements will be made within the cores twice per year.

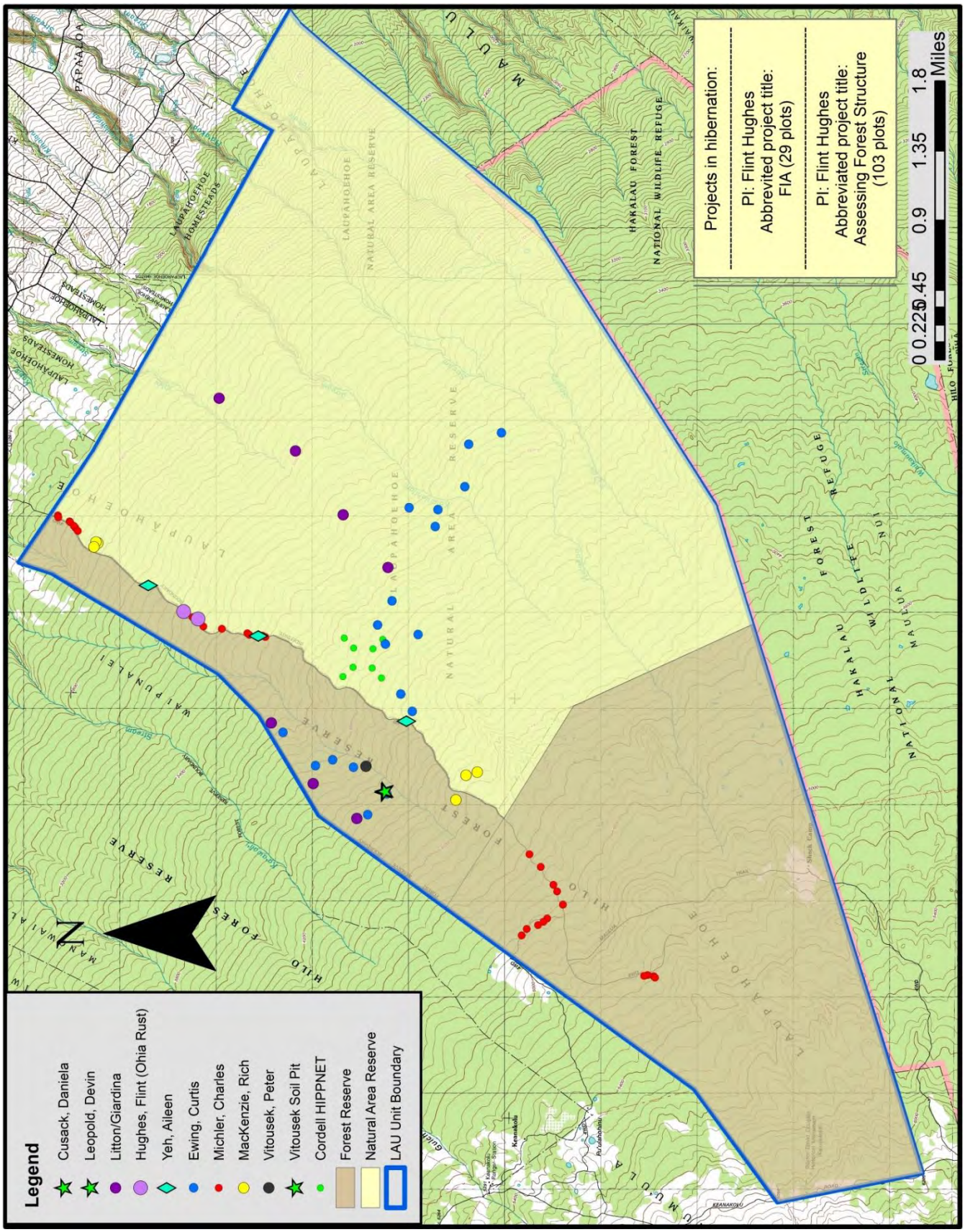


Figure 11: Map indicating active 2015 research projects within the Laupāhoehoe Unit.

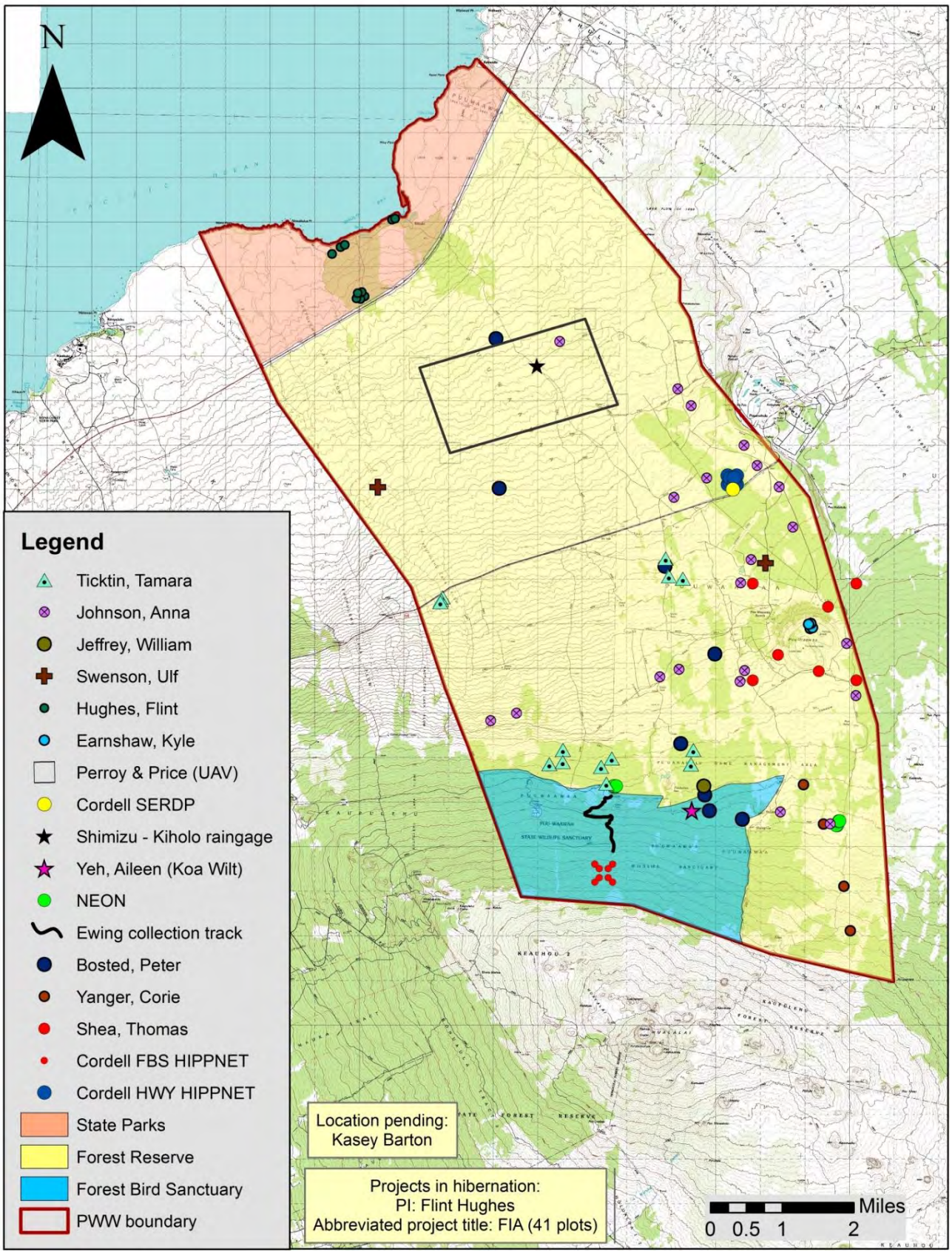


Figure 12: Map indicating active 2015 research projects within the projects within the Puʻu Waʻawaʻa Unit.

Research projects can be restricted to specific State land designations or occur within multiple State land designations. Seven of the 23 projects initiated in 2015 were located in the Laupāhoehoe Unit, thirteen occurred within the Pu‘u Wa‘awa‘a Unit, and three research projects were conducted in both Units (Table 3). Figure 13 shows the percentage of 2015 HETF research projects grouped by State land designation. In Pu‘u Wa‘awa‘a research permitting for the HETF is limited to land activities. Research activities that take place in water including the tide line are under the jurisdiction of the DLNR-Division of Aquatic Resources. Figure 14 shows research affiliation for projects within the HETF over a five-year period 2011-2015.

Table 3: Total number of research projects initiated in the HETF per year and grouped by Unit from 2011-2015.

Year	Laupāhoehoe Unit Only	Pu‘u Wa‘awa‘a Unit Only	Both HETF Units	Total # of Projects Initiated
2015	7 (31%)	13 (58%)	3 (11%)	23
2014	5 (33%)	6 (40%)	4 (27%)	15
2013	15 (52%)	11 (38%)	3 (10%)	29
2012	8 (44%)	8 (44%)	2 (12%)	18
2011	5 (42%)	5 (42%)	2 (16%)	12
Total	**40**	**44**	**14**	**98**

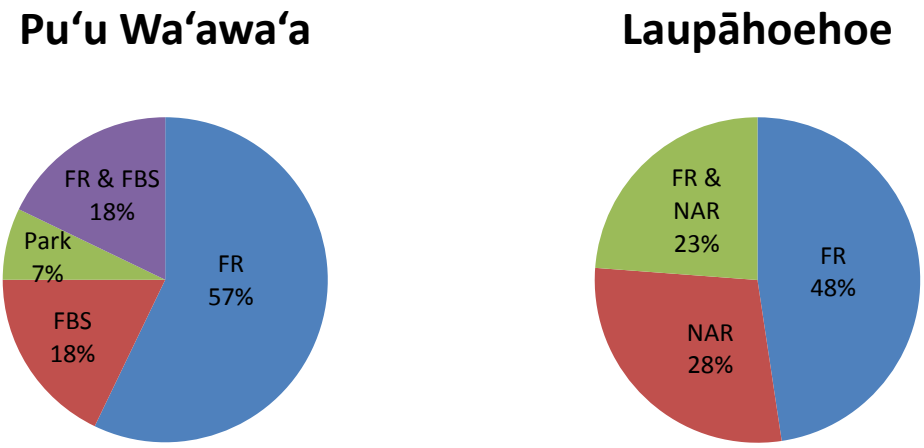


Figure 13: Percentage of HETF research projects grouped by State land designation in 2015. (NAR=Natural Area reserve, FR=Forest Reserve, FBS=Forest Bird Sanctuary)

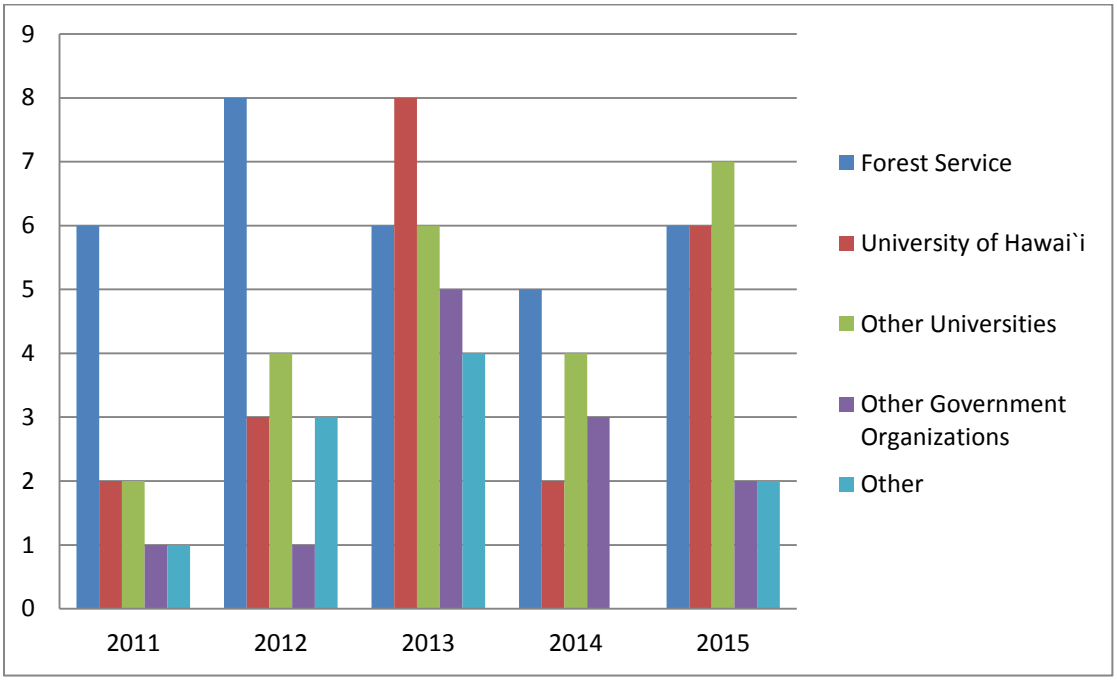


Figure 14: Affiliation for research projects initiated and ongoing within the HETF from 2011-2015.

Table 4: Research project overviews including, principal investigator, project title, and 1=presence or 0=absence within subunit.

Principal Investigator	Project Title	Laupāhoehoe		Pu‘u Wa‘awa‘a		
		FR	NAR	FBS	FR	SP
Barton, Kasey	Population variation in pua kala defenses	0	0	0	1	0
Bosted, Peter	Lava Tube location, photo-documentation, and resource evaluation on Pu‘u Wa‘awa‘a and Pu‘u Anahulu	0	0	1	1	0
Cordell, Susan	Hawai‘i Permanent Plot Network	1	1	1	1	0
Cordell, Susan	The potential for restoration to break the grass/fire cycle in dryland ecosystems in Hawai‘i	0	0	0	1	0
Cusack, Daniela	Soil Carbon Cycling Across a Hawaiian Mineralogical Gradient	1	0	0	0	0
Earnshaw, Kyle	Adaptiveness of heteroblasty in two populations of Acacia koa in response to light availability	0	0	0	1	0
Ewing, Curtis	Community assembly & diversification of Hawaiian Arthropods	1	1	1	1	0
Hughes, Flint	Forest disease monitoring for the Ōhi’a rust disease affecting Ōhi’a trees	1	0	0	0	0
Hughes, Flint	Quantifying dynamics and magnitude of water loss from kiawe forests in North Kona – Kīholo Bay	0	0	0	0	1
Jeffrey, William	Albinism Transcriptomics of Cave-adapted Planthoppers	0	0	0	1	1
Johnson, Anna	Tracking the impact of species introductions and extinctions on ecological interaction networks	0	0	0	1	0
Leopold, Devin	Local adaptation in an ericoid mycorrhizal symbiosis	1	0	0	0	0
Litton/Giardina	An Experimental Test of the impacts of rising temp on C input, allocation, and loss in model forests	1	1	0	0	0
Lou, Hongyan	NEON FIU and FSU Site Characterization	0	0	1	1	0
MacKenzie, Rich	Quantifying the effects of ungulates and invasive Strawberry Guava (*Psidium cattleianum*) on sediment runoff in Hawaiian wet forests	1	1	0	0	0
Michler, Charles	Acacia Koa environment genomics	1	0	0	0	0
Perroy/Price	Meeting Hawaii's Natural Resource Challenges with Unmanned Aerial Vehicles and Geovisualization	0	0	0	1	0
Shea, Thomas	Field Investigation of the Pu’u Anahulu Lava Flows	0	0	0	1	0
Shimizu, Ben	Operation and maintenance of Kīholo raingage	0	0	0	1	0
Swenson, Ulf	Biogeographic history of the Hawaiian endemic Planchonella sandwicensis	0	0	0	1	0
Ticktin, Tamara	Linking local ecological knowledge, ecosystem services and climate change	0	0	0	1	0

Principal Investigator	Project Title	Laupāhoehoe		Pu‘u Wa‘awa‘a		
		FR	NAR	FBS	FR	SP
Vitousek, Peter	Sources and fates of nutrients on a substrate age gradient across the Hawaiian archipelago and their consequences for forest dynamics.	1	0	0	0	0
Yanger, Corie	Examining the effects of invasive thrips infestation on natural and planted Hawaiian Myoporum seedlings	0	0	0	1	0
Yeh, Aileen	Operational Disease Screening Program for Resistance to Wilt in Acacia Koa in Hawai‘i	1	1	1	1	0

Laupāhoehoe Science and Learning Center (Center)

As mentioned previously, the Center is housed on 55 acres of old sugar cane lands. HETF infrastructure like the Center are envisioned to provide a center for demonstration, education, training, and outreach on tropical forestry, conservation biology, and natural resources research and management.

‘Ōhi'a Common Garden

Dr. Christian Giardina and Kainana Francisco of the USFS, in collaboration with Liam Mueller, Dr. Joe Bailey, and Dr. Jennifer Schweitzer at the University of Tennessee, established an ‘Ōhi‘a Common Garden at the Center in the summer of 2014. The common garden serves multiple purposes including community engagement and research platform as well as reforestation of degraded lands at the Center. The team planted over 800 native ‘ōhi‘a trees in the common garden in conjunction with the education and outreach program Ulu Lehulehu (The Million ‘Ōhi‘a Initiative) whose mission is to connect Hawai‘i’s youth to ‘ōhi‘a trees.

The ‘Ōhi‘a Common Garden will help answer interesting science questions about how long-term forest fragmentation (>100 years) affects ‘ōhi‘a genetics. The trees were all created from cuttings taken from ‘ōhi‘a that occur in the center and edge of forest kīpuka, or forest fragments created by lava flows, as well as from ‘ōhi‘a trees colonizing the lava matrix between kīpuka. The team selected these trees because they noticed that there were differences in trees between sites, and thought these differences could be controlled genetically. Over 1000 ‘ōhi‘a from these different locations were raised in a greenhouse for two years. The team found that location definitely affected genetics. Trees from kīpuka centers grew faster and taller than edge trees or matrix trees even though all the trees were grown in a common environment (same soils and greenhouse). The next step is to see how these differences continue as the trees mature into larger individuals. In the future, the common garden will allow participants to learn about ‘ōhi‘a and its importance to the health of the forest, participate in service learning opportunities such as outplantings and/or caring for the ‘ōhi‘a (weed/grass control), which supports both the research and education efforts of the ‘ōhi‘a common garden.

2015 Education, Outreach and Access Activity Summary

This section highlights various non-research program activities, as well as specific Unit education, outreach, and access details that occurred within the HETF in 2015.

Youth Conservation Corps (YCC)


Participants of the 2015 Inter-Tribal Youth Climate Leadership Congress.

Youth Conservation Corps programs in Hawai'i are administered by Kupu, a nonprofit community organization (www.kupuhawaii.org). IPIF participates in three Kupu AmeriCorps/Youth Conservation Corps (YCC) programs: The Gateway Program is a 7 week summer team experience designed for young adults (ages 17-20). Team members complete hands-on fieldwork at various worksites. The Frontiers Program provides a more in-depth individual 8-week summer experience at a single worksite that best matches the individual's interests. The Extended Internship Program (EIP) offers an intensive entry-level 11-month experience in preparation for a career in the conservation field. Individuals work one-on-one with an environmental agency that best matches their interests. See Appendix D, for more detailed YCC information.

2015 was the fourth year the HETF supported YCC Gateway teams. Gateway program members gained introductory experience in all aspects of natural resource management, working in both HETF Units, as well as other conservation areas managed by agency partners, such as the DOFAW, Big Island Invasive Species committee, Mauna Kea Watershed Alliance, and The Nature Conservancy. IPIF supported two Gateway teams as well as one Frontiers intern, and one EIP.

One Gateway team attended the first Inter-Tribal Youth Climate Leadership Congress (ITYCLC) in Shepherdstown, West Virginia for a week-long conference on the effects of climate change on tribal communities. Nearly 100 Alaska Native, American Indian, and Native Hawaiian high school students were in attendance, representing over 20 tribes from across the nation. The USFS team members, included: Jadelynn Akamu, Ylliana Hanato, Alisha Keli'i, and Aaron Knell (see photo above). Attendance to the conference was sponsored by the USFS.


YCC team members preparing lei and other items in preparation for the 2015 Inter-Tribal Youth Climate Leadership Congress.

Manaulu Manowai'ōpae

The USFS is a partner with Laupāhoehoe Community Public Charter School (LCPCS) and works with the school's teachers and administration on ways to integrate curriculum with hands on experience both in and out of the classroom. Graduate student James Akau has been working with the LCPCS to increase student exposure to local natural and cultural resources, and teach conservation and restoration through the Manaulu Manowai'ōpae program. Most of the program activities occur within the Laupāhoehoe Unit, the Laupāhoehoe Science and Learning Center, and on the LCPCS campus. Manaulu Manowai'ōpae also provides additional resources (i.e. transportation, equipment, guest speakers, etc.) to support

ongoing programs that occur at the school and within the community. Values of *aloha ʻāina* (love for the land), long-term *kokua* (help; aid), *kakoʻo* (support) and *laulima* (many hands) are practiced when restoring the land.

Laupāhoehoe Unit

Fifteen participants on one trip visited the Laupāhoehoe Unit in 2015 (Table 5). A further breakdown of trip totals, and affiliation and type from 2011-2015 is detailed in Figures 15-17. *Laupāhoehoe Community Public Charter School* students, as part of the Manaulu Manowai'ōpae program, hiked up Spencer trail into the Natural Area Reserve, to the 800 plot that was set up in 2009 by the Forest Service to monitor impacts of Climate Change on C input, allocation, and loss in model forests. The focus of the trip was restoration work, mainly invasive species removal (strawberry guava, koster's curse, and ginger). Most of the work was done by hand removal with gloves, but loppers and saws were supplied to the more adept students. Discussions included forest health and restoration.

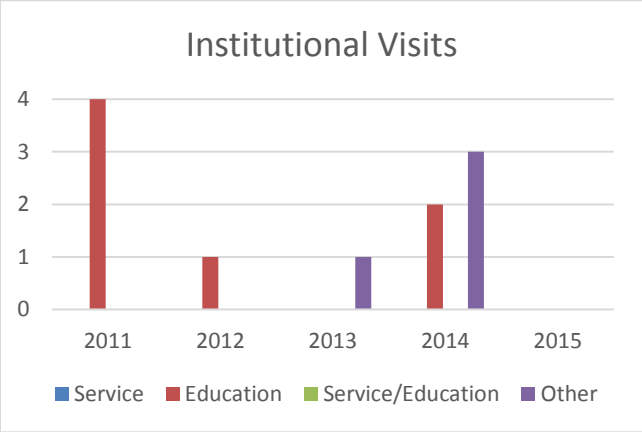


Figure 15: Number and type of Institutional visits taken in the Laupāhoehoe Unit from 2011-2015.

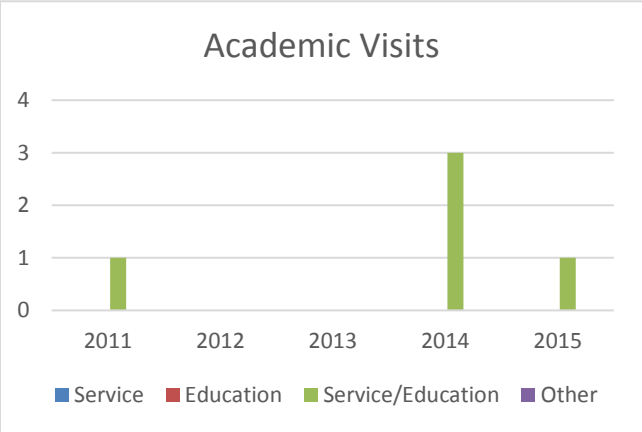


Figure 16: Number and type of Academic visits taken in the Laupāhoehoe Unit from 2011-2015.

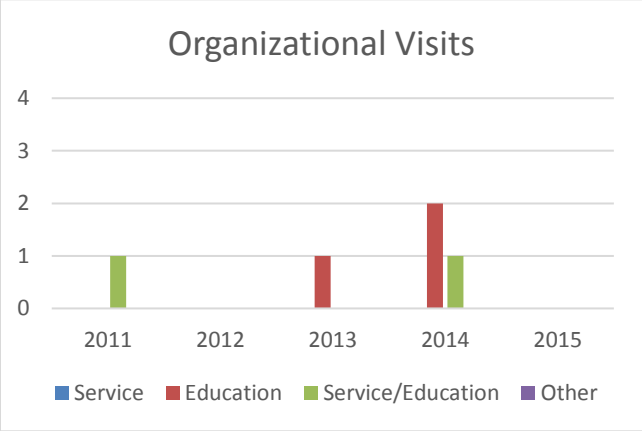


Figure 17: Number and type of Organizational visits taken in the Laupāhoehoe Unit from 2011-2015.

Table 5: Information relating to 2015 education/service/other trips taken in the HETF Laupāhoehoe Unit.

Organization		Participant Age	Activity	Service Provided	Contact	Date	Group Size
Laupāhoehoe Community Public Charter School	School	Ages 11-17	Education/Service	Removal of invasive species & old research materials	James Akau	3/5/2015	15

Pu‘u Wa‘awa‘a Unit

Three hundred and ninety four participants on 16 trips visited the Pu‘u Wa‘awa‘a Unit in 2015 (Table 6). The high number of participants, compared to the Laupāhoehoe Unit, who are able to visit, work, and learn in Pu‘u Wa‘awa‘a is in a large part due to the presence and availability of onsite DOFAW staff that lead, participate in, and facilitate these activities. The existing road and facility infrastructure in Pu‘u Wa‘awa‘a Forest Reserve also play an important role in making these trips possible. The continued presence and availability of onsite staff is necessary for Pu‘u Wa‘awa‘a to be able to continue to support this level of public interaction. A further breakdown of trip totals, and affiliation and type from 2011-2015 is detailed in Figures 18-20. A few of the 2015 HETF education trips to Pu‘u Wa‘awa‘a are detailed here.

- *Waiakea High School* & Hawai‘i Community College’s Early College Program students visited Pu‘u Wa‘awa‘a in June. Students discovered the natural, historical, and contemporary resources of the area through place-based learning. The groups learning outcomes were ones of reflection and life-planning that is reflective of the coursework of IS105 - College and Life Exploration and Planning. Students participated in a service learning project and learned about conservation’s relation to college, career, and community readiness. The Early College Program allows high school students to earn six or more college credits before they graduate from high school.

- *USFS* and DOFAW jointly hosted a Hawai‘i Conservation Conference (HCC) service learning opportunity. Participants learned about ongoing management strategies and challenges for dry forests, a research project focused on finding the best habitat qualities for threatened and endangered plants and cultural history and stories associated with Pu‘u Wa‘awa‘a and the surrounding lands. Participants also took part in a native tree planting, and toured restoration areas.

- *Pu‘u Wa‘awa‘a* hosted an ‘Every Kid in a Park’ event where students from the Hawai‘i Technology Academy and their families (25 participants), were given the opportunity to connect with nature by spending the day planting native and endangered species. Every Kid in a Park is a national youth initiative to get all 4th graders and their families to experience the places that are home to our country’s natural treasures, rich history, and vibrant culture.

Guiding gentle hands to help rebuild the dry forest.

- *Boy Scouts of America*, Troop 27, visited Pu‘u Wa‘awa‘a as part of their efforts to complete requirements for earning their hiking badge. In order to do so, the boys are required to complete five 10 mile hikes, and Pu‘u Wa‘awa‘a was chosen as a site for one of those hikes. Other topics of discussion included native birds, hiking safety, leave no trace, and orienteering.

- *USFS* coordinated and sponsored an educational/service project for Malamalama Waldorf School's eighth graders. Partners included The Nature Conservancy and Hui Aloha Kīholo, as they hosted students on a visit to ancient Hawaiian fishponds within the Puʻu Waʻawaʻa ahupuaʻa. The students removed invasive algae and leaf sediment to reduce sediment load and improve water quality for fish growth. Revitalizing the fishponds creates protective shelters for fish, green sea turtles and other species associated with coral reef habitats in the surrounding bay.

- *Run for the Dry Forest*, the 9th annual Puʻu Waʻawaʻa Run for the Dry Forest took place in October. The event included education and outreach focused on Rapid ʻŌhiʻa Death (ROD) a newly identified disease that has killed large numbers of native ʻōhiʻa trees (Metrosideros polymorpha) in forested and residential areas on Hawai`i Island. Informational booths as well as a "ROD squad" were set up to educate participants while sanitizing the shoes of both runners and spectators.

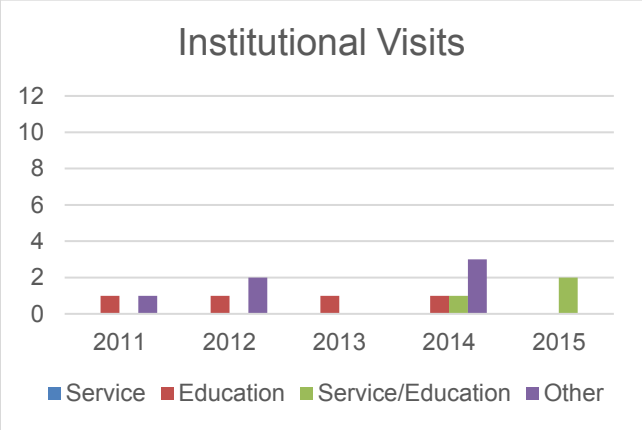


Figure 18: Number and type of Institutional visits taken in the Puʻu Waʻawaʻa Unit from 2011-2015.

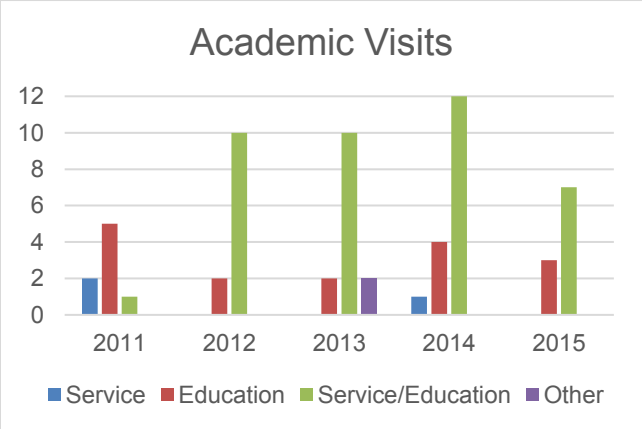


Figure 19: Number and type of Academic visits taken in the Puʻu Waʻawaʻa Unit from 2011-2015.

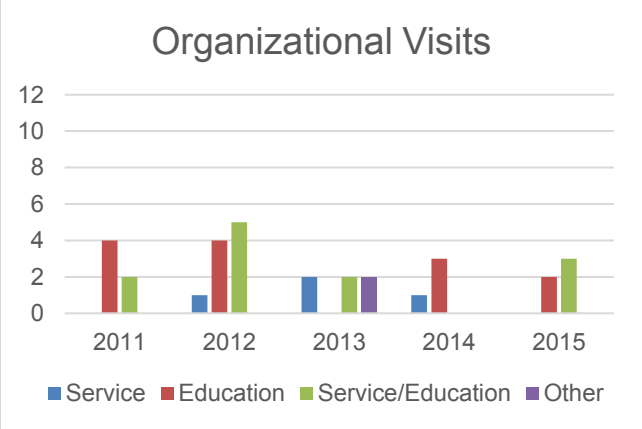


Figure 20: Number and type of Organizational visits taken in the Puʻu Waʻawaʻa Unit from 2011-2015.

Organization		Participant Age	Activity	Service Provided	Contact	Date	Group Size
Honoka'a High & Intermediate School	School (DOE)	Intermediate grades 6-8	Edu/Service	Outplanting, weeding, and watering	Cindy Navarro-Bowman	1/5-6/2015	35
Cornell Earth & Environmental Systems Field Program	School	College	Edu/Service	Water outplantings	Alexandra Moore	1/26/2015	22
Honoka'a High & Intermediate School	School (DOE)	Intermediate grades 6-8	Edu/Service	Outplanting, weeding, and watering	Cindy Navarro-Bowman	3/24/2015	34
UH Hilo, Dept. of Geography and Env. Studies	School	College	Education		Jonathan Price	4/18-19/2015	18
Honoka'a High & Intermediate School	School (DOE)	Intermediate grades 6-8	Education		Cindy Navarro-Bowman	4/19/2015	30
Boy Scouts of America, Troop 27	Non-profit	Ages 11-17	Education		Marcie Neubecker	5/2/2015	14
Waikoloa Dry Forest Initiative	Non-profit	Adult	Edu/Service	Outplanting, weeding, and trail building	Jen Lawson	5/22-23/2015	15
Boy Scouts of America, Troop 78	Non-profit	Ages 11-17	Edu/Service	Outplanting	Jon Hayashi	5/23-25/2015	35
Waiakea High School & Hawaii Community College	School (DOE)	High School / College	Edu/Service	Outplanting	Andrew Frias	6/25-27/2015	25
DLNR-DOCARE Hunter Education Program	State Agency	Ages 11-17	Edu/Service	Conservation work	Andrew Choy	7/22-26/2015	33
Atherton YMCA	Non-profit	Ages 11-17	Edu/Service	Outplanting	Keahi Kaawa	7/29/2015	13
Hawaii Conservation Alliance	Non-profit	Adult	Edu/Service	Outplanting	Mel Dean	8/7/2015	38
Hawai'i Technology Academy	School (Charter)	Intermediate grades 6-8	Edu/Service	Outplanting	Tina Flower	10/1/2015	35
Malamalama Waldorf School	School (Private)	Intermediate grades 6-8	Edu/Service	Removed debris from anchialine ponds	Victoria Gold	11/12/2015	10
UHH College of Agriculture	School	College	Edu/Service	Outplanting	Russell Shioshita	11/14/2015	7
UH - Windward Community College (WCC)	School	College	Education		Floyd McCoy	11/30/2015	30

Table 6: Information relating to 2015 education/service/other trips taken in the HETF Pu'u Wa'awa'a Unit.

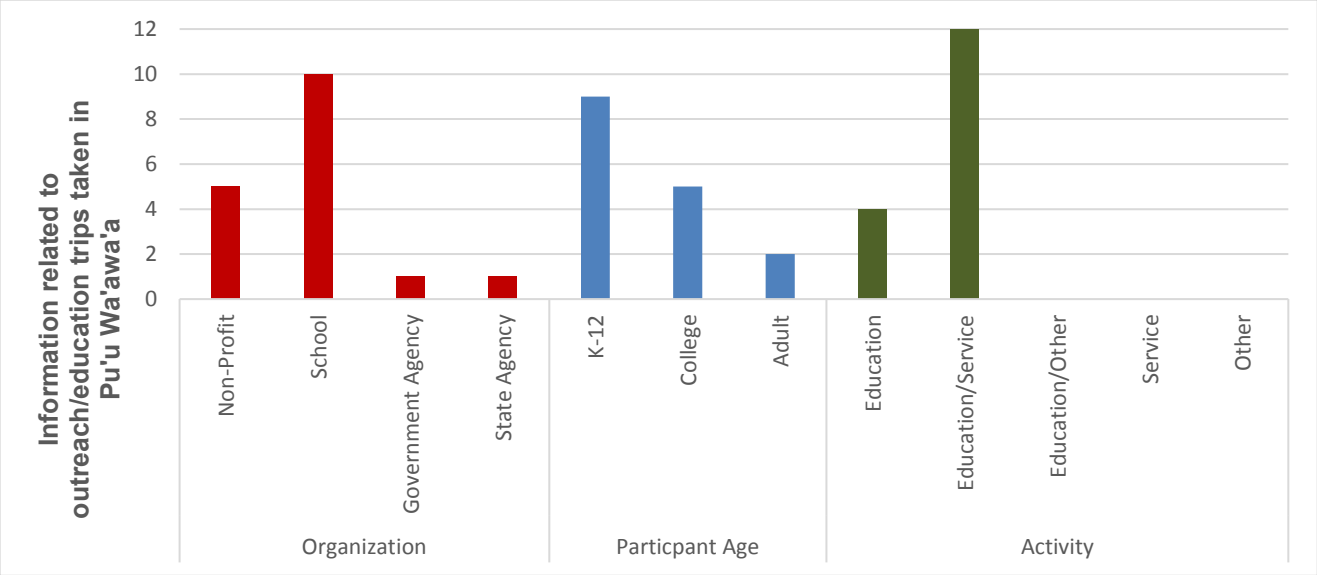


Figure 21: Information relating to the types of groups, age of participants, and types of activities performed during outreach/education trips taken within the Pu‘u Wa‘awa‘a Unit in 2015.

Laupāhoehoe Science and Learning Center

One hundred and thirty-nine participants on seventeen trips visited the Laupāhoehoe Science and Learning Center (Center) in 2015 (Table 7). A few of the 2015 Center activities are detailed here.

- *Mauna Kea Watershed Alliance (MKWA)* held a partnership meeting at the Center which helped strengthen relationships and facilitate partnership communication. The meeting was followed by a lunch and hike to the Laupāhoehoe Forest boundary via Spencer trail. The IPIF is a signed member of the MKWA Memorandum of Understanding.

Partners of the Mauna Kea Watershed Alliance outside the Laupahoehoe Forest boundary.

EIP members participants at the ‘Ōhi'a Common Garden.

- *The USFS* hosted Kupu’s Extended Internship Program (EIP) members in the ‘Ōhi’a Common Garden. The members participated in a service learning project and were oriented on topics such as: forest and culture; native species and their threats; watersheds; and careers in restoration.

- *Laupāhoehoe Community Public Charter School’s* seventh and eighth graders participated in the Manaulu Manowai’ōpae program, taking four trips to the Center. Students spent time working in the ‘Ōhi'a Common Garden with project partners Dr. Joe Bailey and Dr. Jen Schweitzer from the University of Tennessee. They also practiced riparian restoration in the gulch by removing invasive species; learned their cardinal directions and orienteering.

Students from Laupāhoehoe Community Public Charter School clearing invasive ginger from the streams edge.

Table 7: Information relating to 2015 activities held at the Laupāhoehoe Science and Learning Center.

Organization/Project	Participant Age	Activity Description	Dates	# of People
Facility Use - Day				
University of Tennessee	Adult	Data collection and maintenance of ʻŌhiʻa Common Garden	7/13-7/27/2015	1
Mauna Kea Watershed Alliance	Adult	Partnership meeting	9/15/2015	15
Facility Use - Overnight				
HETF - USFS/DOFAW Laupāhoehoe Management Plan	Adult	Archeaology surveys in Laupāhoehoe Forest	5/26-5/28/2015	6
Interaction of stream flow and invasive species on nutrient dynamics in Hawaiian streams	Adult	Stream sampling	6/15-8/15/2015	1
HYCC	Adult	USFS HYCC teams worked onsite at the LSEC as well as in Laupāhoehoe Forest	7/6-7/23/2015	5
HYCC	Adult	USFS HYCC teams worked onsite at the LSEC as well as in Laupāhoehoe Forest	7/6-7/8/2015 & 7/20-7/23/2015	5
Atherton YMCA	Adult	Conservation/Restoration projects with USFS and partners	7/27-8/2/2015	14
Interaction of stream flow and invasive species on nutrient dynamics in Hawaiian streams	Adult	Stream sampling	8/15-9/15/2015	1
UHH Keaholoa	College	Site Restoration	10/2-10/4/2015	17
University of Tennessee	Adult	Data collection and maintenance of ʻŌhiʻa Common Garden	10/7-10/28/2015 11/2-11/16/2015 12/2-12/8/2015	2
Land Use				
Kupu	High School/College	Orientation for KUPU EIP interns	10/1/2015	18
USFS	Intermediate grades 6-8	Maintenance of ʻŌhiʻa Common Garden and/or site restoration	10/15/2015	28
USFS	Intermediate grades 6-8	Maintenance of ʻŌhiʻa Common Garden and/or site restoration	10/21/2015	10
USFS	Intermediate grades 6-8	Maintenance of ʻŌhiʻa Common Garden and/or site restoration	10/28/2015	9
USFS	Intermediate grades 6-8	Maintenance of ʻŌhiʻa Common Garden and/or site restoration	12/2/2015	7

2015 Concerns, Comments, and Challenges

Laupāhoehoe

Submitted by researchers via annual reports:

- Weather. Wind and rain. Koa looper. *(A. Yeh)*

Pu‘u Wa‘awa‘a

Submitted by researchers via annual reports:

- We encountered routine natural challenges including avoiding native vegetation when entering the caves and crossing the flows, accessing the cave entrances (some are overhung, others are overgrown with vines and trees), and not disturbing fossil bird bones and other natural features (roots, tree trunks) found in the caves. *(P. Bosted)*
- We would love to be able to get rid of all weeds, if we had the manpower. *(S. Cordell)*
- Grass control has been difficult, but control every three months has worked. *(K. Earnshaw)*
- Our main challenge was probably driving time within the site, although signage and clear roads instructions were a great help, as was having access to the GPS tracks for the existing roads. One piece of information that could have helped reduce travel time would have been knowing the positions of the gates for the mauka fenced areas. *(T. Ticktin)*
- While working in the HETF, my biggest challenge has been trying to collect data from plants that are exposed to ungulates. I also was unable to complete twelve months of data collection from seedlings located along the bulldozed road because many were unintentionally sprayed by herbicide during weed control efforts. *(C. Yanger)*

Prior HETF Concerns, Comments and Challenges still ongoing:

- How do the new Wildlife Administration rules apply to the existing USFS permit to use State lands?
  The cooperative agreement and the permit to use state lands were finalized before the new wildlife administrative rules were approved. How these now apply to the USFS permit to use state lands, needs to be revisited. There may be a need to revise the cooperative agreement/permit to use state lands.

2015 Annual Reports Received

Annual reports received from researchers are listed alphabetically in this section. Annual reports are due within one year of project initiation. The included annual reports were submitted either with renewal applications or at the termination of a research project and pertain to the previous year's work. All information submitted in these annual reports, are included as is. Report citations are limited to the current year, for a complete list of citations please visit the HETF citations list online at http://hetf.us/page/publications/.

We do not add any diacritical marks, correct punctuation, capitalization or grammatical errors.

Bosted, Peter and Douglas Medville - Lava tube location, survey, and resource evaluation on Pu`u Wa`awa`a and Pu`u Anahulu

Submitted: 12/20/2015

Project Location(s): Pu‘u Wa‘awa‘a Forest Reserve and Forest Bird Sanctuary
HETF Annual Report for Project Period: 01/2015-11/2015

Status Update *(including any significant findings):*
In 2015, there were 35 days of field trips, with an average number of 4 participants per field trip. A total of 5 miles of lava tube passage were mapped and photographed, and about 30 new entrances were found (see attachment). The caves are in three general areas in accordance with the permit.

1. Forest Bird Sanctuary. About 2.5 miles of passage were added to the Ambigua/Delissea/Hapuu system in the FBS. While some of the passages had been scouted previously by Jon Giffin, most of them appear to be new discoveries. The entrances are generally very rich in ferns, trees, and plants. Many ongoing passages remain to be explored in this new section of the system, shown in red in the accompanying figure.

2. Mauka Subunit. About 2 miles of passage were added to the Ambigua/Delissea/Hapuu system in the mauka submit. The total length of all the passages in this system is now 13 miles. While some of the passages had been scouted previously by Jon Giffin, most of them appear to be new discoveries. One new set of Branta Rhuax (extinct Hawaiian goose) bones were found (see attachment). Many ongoing passages remain to be explored in this new section of the system, shown in red in the accompanying figure.

3. Makai Subunit. An 8' deep pit (Road Ledge Pit) on the mauka shoulder of Rt 19 was entered and found to not continue. About 300 feet mauka, an entrance led to a small cave (Road Ledge Cave) that approached, but did not connect to Road Ledge Pit, even though the sound of highway traffic was heard from inside the cave. Also visited were entrances about 1.5 miles mauka of Rt 19, via the lower end of the Old Kiholo Road. One entrance along an old cattle trail, led to about 375 feet of low passage while the other led to 275 feet of passage. Neither cave contained any cultural materials or evidence of prior visitation.

The focus of the work continues to be the documentation of the extent and contents of the caves on P`uu Wa`awa`a through the completion of cartographic surveys, overlays of passages and entrances onto topographic maps and aerial images, and maintenance of spreadsheets that document cave names, locations, and features. Work in 2015 has begun on a set of documentary photographs keyed to map locations on a multi-sheet map Atlas. This information is provided to the HETF and DOFAW on a routine periodic basis.

Timeline *(including overall expected completion date):*

This project was begun January 1, 2011. The expected completion date is open ended, depending on the needs of the HETF. There is enough work to last several more years.

Changes to Methodology *(or other aspects of the project):*

Starting in 2015, we have been recording the nearest survey station for documentary photographs, as well as the direction the camera was pointing, and the names of the people in the photos (if any).

Noteworthy Observations (including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area):

Threatened and endangered species were not observed by us in the lava tubes. However, several new entrances were found in the area where the original Delissea discovery was made. A plant expert might well find new occurrences of Delissea or other rare and endangered plants. Fossil bird bones were observed in some of the caves in the mauka subunit; this is not unexpected in this area. In the mauka subunit, a wall was built across an opening to prevent cattle from falling into the lava tube. German ivy and banana poka are common in most of the cave entrances. The GPS locations of invasive Kahili Ginger and Silver Oak in the Bird Sanctuary were provided to the area manager.

Challenges *(encountered while working in the HETF):*

We encountered routine natural challenges including avoiding native vegetation when entering the caves and crossing the flows, accessing the cave entrances (some are overhung, others are overgrown with vines and trees), and not disturbing fossil bird bones and other natural features (roots, tree trunks) found in the caves.

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.):*

"Cattle Trail Cave and Broken Shell Cave #3", by Doug Medville, HSS Newsletter #38 (Fall, 2015).

Cordell, Susan - Hawai‘i Permanent Plot Network - All sites

Submitted: 1/31/15

Project Location(s): Laupāhoehoe Forest Reserve and Natural Area Reserve; Pu‘u Wa‘awa‘a Forest Reserve and Forest Bird Sanctuary
HETF Annual Report for Project Period: 1/1/2014-12/31/14

Status Update *(including any significant findings)*:
Our long-term goal in the Hawai‘i Permanent Plot Network (HIPPNET) is to establish and maintain several large-scale, permanent plots in native-dominated forest across elevation and precipitation gradients throughout the Hawaiian Islands. Long-term forest dynamics plots have been established worldwide; these plots establish Hawaii as part of the Center for Tropical Forest Science (CTFS) network (www.ctfs.si.edu). The Laupāhoehoe plot represents montane wet forest, the Pu'u Wa'awa'a plot represents montane mesic forest, and the Mamalahoa plot represents ohia dry forest. In 2014 we finished our 5-year resurvey of the 4-ha Laupāhoehoe plot, and did annual resurveys of the 1 ha Mamalahoa and Pu'u Wa'awa'a plots annually.

When all species are combined, the average growth rate was 0.17 cm/yr (3-yr avg) 0. at Laupāhoehoe, 0.15 cm/yr (2-yr avg) at PWW, and 03-yr avg) at Mamalohoa. However, there are very strong differences among years, and within a site there can be a 5-fold difference in growth among years. At Laupāhoehoe inter-annual growth rates are correlated with minimum, maximum, and average temperature. Growth rate is also highly dependent on species, with koa (Acacia koa) being the fastest growing species. The long-term nature of these data will serve as an important baseline to understand how Hawaiian forests function and to understand how they are impacted by climate change and invasive species.

Sapflux rates appear to be greater in koa than in ohia. However, given the amount of time the leaves are wet, and the number of failed sensors, more data is required to make definitive conclusions.

Climate stations are located adjacent to each of the three permanent plots, and are recording a variety of climate-related information including: air temperature, relative humidity, solar radiation, soil moisture and temperature, and others. Data are now being downloaded remotely via modem on a daily basis. Efforts are underway to create an automated QA/QC procedure to screen and organize data so it can be made available publicly.

Timeline *(including overall expected completion date)*:
Because of the slow growth of Hawaiian trees and the considerable climate variations year-to-year, we plan to keep collecting data as long as funds exist.

Changes to Methodology ***(or other aspects of the project)***:
None in 2014**.**

Noteworthy Observations ***(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)***:
No new observances of T & E species were noted. However, the non-native banana poka and German ivy seem to be expanding at Pu'u Wa'awa'a Sanctuary plot. We will continue to eliminate weeds as feasible. For our invasive treatment we focused on any residual banana poka in the canopy, poka larger than seedling height, and fire weed. There are still a lot of poka seedlings and we were surprised to see that cape ivy is now climbing up the dead poka vines from the last treatments. The ivy has the potential to smother mid story trees and shrubs. We did not have the time or resources to take care of cape ivy or poka seedlings in the plot.

Challenges *(encountered while working in the HETF)*:
We would love to be able to get rid of all weeds, if we had the manpower.

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)*:

Conference presentations:

Association of Tropical Biology and Conservation, June 2013, San Jose, Costa Rica: Inman-Narahari, Faith, Ostertag, Rebecca, Asner, Gregory, Cordell, Susan, Hubbell, Stephen P., and Sack, Lawren. Niche differentiation of tree seedlings in tropical wet forest.

Ecological Society of America, August 2012, Portland, OR: Inman-Narahari, Faith, Ostertag, Rebecca, Cordell, Susan Cordell, Giardina, Christian P., Hubbell, Stephen P., Sack, Lawren. Density-dependent seedling mortality varies with light availability and species' abundance in wet and dry tropical forests.

Ecological Society of America, August 2012, Portland, OR: Ostertag, Rebecca, Cordell, Susan, Giambelluca, Thomas, Giardina, Christian, Inman-Narahari, Faith, Litton, Creighton, Sack, Lawren, VanDeMark, Joshua. Decoupling of tropical forest structure and diversity: stand characteristics, growth, and mortality in wet and dry Hawaiian forests and global comparisons.

Hawai‘i Conservation Conference, August 2011, Honolulu: Ostertag, Rebecca, Inman-Narahari, Faith, Cordell, Susan, Giardina, Christian, Sack, Lawren. Structure of wet and dry Hawaiian forests of low diversity: global comparisons across tropical forests.

Hawai‘i Conservation Conference, August 2011, Honolulu: VanDeMark, Joshua, Cordell, Susan, Giambelluca, Thomas, Giardina, Christian, Litton, Creighton, Inman-Narahari, Faith, Ostertag, Rebecca, Sack, Lawren. Long term dynamics in Hawaiian forests: The first glimpse of forest demography from the Hawai’i Permanent Plot Network (HIPPNET).

Hawai‘i Conservation Conference, August 2011, Honolulu: Inman-Narahari, Faith, Ostertag, Rebecca, Cordell, Susan, Giardina, Christian, Murphy, Molly, Wailani-Nihipali, Kahealani, Sack, Lawren. What's going down and what's coming up: seed rain and seedling establishment of native species in Hawaiian wet forest.

Nāhelehele Dry Forest Symposium, February 2011, Keauhou: Inman-Narahari, Faith, Ostertag, Rebecca, Cordell, Susan, Giardina, Christian, Murphy, Molly, Wailani-Nihipali, Kahealani, Sack, Lawren, Pālamanui: a native dominated dry forest.

Botanical Society of America, August 2010, Providence, RI: Inman-Narahari, Faith, Ostertag, Rebecca, Cordell, Susan, Giardina, Christian, Sack, Lawren. Hawai'i permanent plot network: first census results and ongoing research.

Botanical Society of America, August 2010, Providence, RI: Inman-Narahari, Faith, Ostertag, Rebecca, Cordell, Susan, Giardina, Christian, Sack, Lawren. Seedling dynamics in native dominated Hawaiian rain forest.

Hawai'i Ecosystems Meeting, July, 2010, Hilo: Inman-Narahari, Faith, Ostertag, Rebecca, Cordell, Susan, Giardina, Christian, Sack, Lawren. Tree regeneration and physiology across forest types.

Ecological Society of America, August 2009, Albuquerque, NM: Nelson-Kaula, Kehauwealani, Inman-Narahari, Faith, Ostertag, Rebecca, Giardina, Christian, Cordell, Susan, Sack, Lawren. Electronic data collection methods for tree and seedling census data in forest dynamics plots.

Ecological Society of America, August 2009, Albuquerque, NM: Inman-Narahari, Faith, Nelson-Kaula, Kehauwealani, Ostertag, Rebecca, Cordell, Susan, Giardina, Christian Sack, Lawren. Regeneration patterns in a native dominated Hawaiian montane wet forest.

Publications:

Ostertag, R., F. Inman-Narahari, S. Cordell, C.P. Giardina, and L. Sack. 2014. Forest structure in low-diversity tropical forests: a study of Hawaiian wet and dry forests. PLoS ONE 9(8): e103268. doi:10.1371/journal.pone.0103268.

Inman-Narahari, F., R. Ostertag, G. P. Asner, S. Cordell, S.P. Hubbell, and L. Sack. 2014. Trade-offs in seedling growth and survival within and across tropical forest microhabitats. Ecology and Evolution, doi: 10.1002/ece3.1196.

Anderson-Teixeira, K., S. Davies, A. Bennett, E. Gonzalez-Akre, H. Muller-Landau, S. Wright, K. Abu Salim, A. Almeyda Zambrano, J. Baltzer, Jennifer, Y. Basset, N. Bourg, E. Broadbent, W. Brockelman, S. Bunyavejchewin, D. Burslem, N. Butt, M. Cao, D. Cárdenas, K. Clay, S. Cordell, X. Deng, M. Detto, Matteo, X. Du, A. Duque, D. Erikson, C. Ewango, G. Fischer, C. Fletcher, C.P. Giardina, G. Gilbert, N. Gunatilleke, S. Gunatilleke, Z. Hao, W. Hargrove, T. Hart, B. Hau, F. He, F. Hoffman, Forrest, R. Hower, S. Hubbell, F. Inman-Narahari, Faith, P. Jansen, M. Jiang, M. Kanzaki, D. Kenfack, S. Kibet, M. Kinnaird, K. Král, J. Kumar, A. Larson, Y. Li, X. Li,S. Liu, S. Lum, J. Lutz, K. Ma, D. Maddalena, J-R. Makana, Y. Malhi, Yadvinder. T. Marthews, R. Mat Serudin, Rafizah, S. McMahon, W. McShea, H. Memiaghe, X. Mi, T. Mizuno, J. Myers, V. Novotny, A. de Oliveira, P. Ong, D. Orwig, R. Ostertag, J. den Ouden, G. Parker, R. Phillips, A. Rahman, L. Sack, K. Sri-ngernyuang, Kriangsak, R. Sukumar, I-F. Sun, W. Sungpalee, S. Tan, S. Thomas, D. Thomas, J. Thompson, B. Turner, M. Uriarte, R. Valencia, M. Vallejo, A. Vincentini, T. Vrška, X. Wang, G. Weiblen, A. Wolf, H. Xu, X. Wang, S. Yap, J. Zimmerman. Global Change Biology. 2014. CTFS-ForestGEO: A worldwide network monitoring forests in an era of global change. Global Change Biology, doi: 10.1111/gcb.12712.

Murphy, M.J., Inman-Narahari, F., Ostertag, R., Litton, C.M. 2014. Invasive feral pigs impact native tree ferns and woody seedlings in Hawaiian forest. Biological Invasions 16:63-71.

Cordell, Susan - The potential for restoration to break the grass/fire cycle in dryland ecosystems in Hawaii

Submitted: 4/30/2015

Project Location(s): Pu'u Wa'awa'a Forest Reserve
HETF Annual Report for Project Period: 05/2014-05/2015

Status Update *(including any significant findings, please limit to 600 words*)**:**
2,184 threatened and endangered plants were outplanting during the 2014-2015 permit period within the Pu'u Wa'awa'a unit.

Timeline *(including overall expected completion date)***:**
All outplanting activities has concluded at the time. We will continue to monitor plants for height, health, survival every 12 weeks. Additional measurement will include photosythesis, quantum yeald, specific leaf area, reproduction, and recruitment semi-annually. Under extreme climatic conditions we will irrigate plants as required under the the USFWS T&E permit regulations.

Changes to Methodology *(or other aspects of the project)***:**
No changes occurred within the permit year.

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)***:**
The current outplant survival is 90%. We have observed extensive natural regeneration of Silene lanceolata (T&E Species) and Spermolepis hawaiiensis (T&E Species) thus indicating that the outplants have begun producing viable seeds

Challenges *(encountered while working in the HETF)***:**
No significant challenges have occurred during this permit year.

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)***:**

Mapping habitat suitability for restoration and at-risk plant reintroduction. California Native Plant Society Conservation Conference ,San Jose, California January 13-17th 2015

Questad, E.J., S. Cordell, J. Kellner, G. Asner, S. Brooks, A.Uowolo, K. Kinney. Remote mapping of habitat suitability for at-risk plant species restoration and reintroduction in the Hawaiian Dry Forest Nahelehele Dry Forest Symposium, Kailua-Kona, Hawaii Feburary 27th 2015

Earnshaw, Kyle - Adaptiveness of heteroblasty in two populations of Acacia koa in response to light availability

Submission Date: 04/30/2015

Project Location(s): Pu'u Wa'awa'a Forest Reserve
HETF Annual Report for Project Period: 05/2014 - 05/2015

Status Update *(including any significant findings)*:
At this point, with less than a year's worth of data from the project, few conclusions can be drawn. As expected, seedlings survival has been positively associated with light availability. The local population has had much higher survival (70%) than the non-local population (40%). Interestingly, we have had 24% and 35% infection rates with rust fungus for the non-local and local populations, respectively. The high infection rates of underplanted seedlings are probably a result of high infection rates in the koa overstory under which the current seedlings are planted. We do not have a spatial analysis of infection rates done at this time. The average heights for non-local and local populations are 64 cm and 83 cm, respectively. The project, as a whole, is proceeding as expected.

Timeline *(including overall expected completion date)*:
One year measurements will be completed during the beginning of July. Ideally, two more sets of measurements would be completed at six month intervals after this, with an end date of July 2016.

Changes to Methodology *(or other aspects of the project)*:
None.

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)*:
None.

Challenges *(encountered while working in the HETF)*:
Grass control has been difficult, but control every three months has worked.

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)*:
None.

Gillespie, Rosemary for Curtis Ewing - Community Assembly & Diversification of Hawaiian Arthropods

Submitted: 11/14/2014

Project Location(s): Laupāhoehoe Forest Reserve and Natural Area Reserve; Pu‘u Wa‘awa‘a Forest Reserve and Forest Bird Sanctuary
HETF Annual Report for Project Period: 08/2013-08/2014

Status Update *(including any significant findings)*:
We carried out research in both Laupāhoehoe and in Pu’u Wa’awa’a. We provide reports for each separately below. Our Pu’u Wa’awa’a collections were limited to a single two day collecting trip bt Dr. Curtis Ewing targeting insect “Focal Taxa” in three families, sap beetles (Coleoptera: Nitidulidae), plant hoppers (Hemiptera: Delphacidae) and jumping plant lice (Hemiptera: Psyllidae). Laupāhoehoe collections targeted two of the three “Focal Taxa” and general quantitative collections spread throughout the period of time covered under the permit. During this period we chose six plots within each of our three sites and completed canopy, soil and leaf litter collections.

Timeline *(including overall expected completion date)*:
This is a 5 year project that commenced in July 2013. We expect filed work to be completed by Fall 2015. Processing of samples and analysis will continue until the end of the project in 2018.

Changes to Methodology *(or other aspects of the project)*:
No changes

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)*:
Endemic Nitidulidae were collected from Kokia flowers.

Challenges *(encountered while working in the HETF)*:
None

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)*:
Ewing, C.P. (2014). Dimensions in Biodiversity: Arthropod Community Assembly & Diversification of Hawaiian Arthropods and the Focal Taxon Prosopeus inauratus (Coleoptera: Nitidulidae). Tropical Conservation Biology and Environmental Science M.S. Program Weekly Seminar.

Ewing, C.P., et al. (2014). Patterns in Population Structure, Gut Fungi and Host Plant Use in Endemic Hawaiian Sap Beetles across the Big Island. Island Biology Conference, Honolulu, HI.

Ewing, C.P., et al. (2014). Assembly of Arthropod Communities in Hawaii: A Combined Theoretical and Empirical Approach. Hawaii Conservation Conference, Honolulu, HI.

Cotoras, D., Gillespie, RG 2014. Understanding the initiation of adaptive radiation using comparative phylogeography of spiders. Island Biology 2014 - An International Conference on Island Evolution, Ecology, and Conservation, Honolulu HI.

Rominger, A., Goodman, K., Lim, J., Valdovinos, F., Armstrong, E., Bennett, G., Brewer, M., Cotoras, D., Ewing, C., Harte, J., Martinez, N., O'Grady, P., Percy, D., Price, D., Roderick, G., Shaw, K., Gruner, D.,

Gillespie, RG. 2014 Community assembly on isolated islands: Macroecology meets evolution. Island Biology 2014 - An International Conference on Island Evolution, Ecology, and Conservation, Honolulu HI.

Kennedy, S, Clavel, J, Gillespie RG 2014. Niche partitioning in Hawaiian web-building Tetragnatha spiders. Island Biology 2014 - An International Conference on Island Evolution, Ecology, and Conservation, Honolulu HI.

Hiller, A., Roesch Goodman, K., Gillespie RG 2014. Diversification of Hawaiian Swordtail Crickets, an Approach using Ecological Niche Modeling. Island Biology 2014 - An International Conference on Island Evolution, Ecology, and Conservation, Honolulu HI.

Gillespie, R.G., M. Brewer, D. Cotoras, C.P. Ewing, D.S. Gruner, K.R. Goodman, J. Harte, K.N. Magnacca, N.D. Martinez, R. Nielsen, P.M. O'Grady, D. Percy, D.K. Price, D. Rabosky, G.K. Roderick A. Rominger, and K.L. Shaw (2013). Community level approach to understanding speciation in Hawaiian lineages.. Hawaii Ecosystems Meeting, Hilo, HI. Honolulu, HI.

Gillespie, R.G., M. Brewer, D. Cotoras, C.P. Ewing, D.S. Gruner, K.R. Goodman, J. Harte, K.N. Magnacca,N.D. Martinez, R. Nielsen, P.M. O'Grady, D. Percy, D.K. Price, D. Rabosky, G.K. Roderick A. Rominger, and K.L. Shaw (2013). Assembly Of Arthropod Communities In Hawaii: Can We Predict Future Response Given A Modified Dynamic?. Hawaii Conservation Conference. Honolulu, HI.

Gruner, D.S., R.G. Gillespie, J. Harte, N.D. Martinez, R. Nielsen, P.M. O'Grady, D. Percy, D.K. Price, D. Rabosky, and K.L. Shaw (2013). Using an island chronosequence to explore evolutionary community assembly.. 11th INTECOL International Congress of Ecology. London, UK.

Hughes, R. Flint - Forest disease monitoring for the Ohi'a rust disease affecting Ohi'a trees

Submitted: 03/24/2015

Project Location(s): Laupāhoehoe Forest Reserve
HETF Annual Report for Project Period: 05/2010 - 04/2015

Status Update *(including any significant findings)*:
We are still collecting and compiling data for analysis. Data being collected includes climate (Temperature and Relative Humidity), rust infestation levels, and the effects on the mature and seedling Ohi'a.

Timeline *(including overall expected completion date)*:
Monitoring is taking place every 60 to 75 days and is expected to continue for at least another year or two, based on findings and funding.

Changes to Methodology *(or other aspects of the project)*:
None.

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)*:
The Ohi'a rust is present in the HETF Laupāhoehoe forest and has been for several years. This invasive species is infecting mature Ohi'a and Ohi'a seedlings. There have been no observed Ohi'a deaths from the rust at this time.

Challenges *(encountered while working in the HETF)*:
None that are noteworthy.

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)*:
None, as of yet.

Hughes, Richard Flint - Quantifying dynamics and magnitude of water loss from Kiawe forests in North Kona - Kīholo Bay

Submitted: 04/28/2015

Project Location(s): Pu'u Wa'awa'a State Parks
HETF Annual Report for Project Period: 04/2014-04/2015

Status Update *(including any significant findings)*:
In arid systems phreatophytes are often among the most effective invaders due to their capacity to access and exploit groundwater resources otherwise unavailable to native vegetation. On Hawai'i Island, a non-native phreatophyte, Prosopis pallida (kiawe) has invaded extensive dry lowland areas following its introduction in the 19th century. To better understand the influence of this invader on the host ecosystem, and vice versa, we determined transpiration characteristics of P. pallida by monitoring sap flux of mature individuals over an 18 month period on the arid leeward coast of Hawai'i Island. Daily sap flux increased with increasing atmospheric vapor pressure deficit (D), and exhibited no clear response related to rainfall events or prolonged drought. Annual transpiration (i.e., 308 mm) was 80% higher than rainfall. Stomatal conductance decreased with increasing vapor pressure deficits more slowly than the theoretical stomatal conductance-D relationship that assumes stomatal regulation of leaf water potential above a critical level. While daily peak stomatal conductance was relatively high, it nonetheless appeared limited by high leaf-level intrinsic water use efficiency (net photosynthetic rate per stomatal conductance), suggesting a constraint to unlimited groundwater absorption. In this young volcanic environment where rainfall is low and quite episodic, the success of this species likely stems from its anisohydric strategy even at the risk of cavitation, and it is altering the nutrient and hydrological cycling of the areas where it is dominant.

Groundwater levels in arid environments are dropping worldwide due to human extraction, and precipitation events are predicted to become rarer and more intense in many arid areas with global climate change. These changes will likely alter both primary productivity and plant–soil nutrient cycles. To better understand the nature of such alterations, we examined effects of groundwater availability on plant–soil nitrogen (N) cycling in areas invaded by the N-fixing phreatophyte, Prosopis pallida, on the dry leeward coast of Hawai'i Island. Our aims were to quantify effects of groundwater availability to P. pallida on rates of litterfall N inputs and accretion in soils and to quantify effects of groundwater availability on N mineralization and leaching rates of inorganic N under natural rainfall conditions and simulated rain events. Stem water d18O values indicate that P. pallida trees in lowland plots accessed shallow groundwater, while in upland plots they relied solely on rainfall. During drought periods, P. pallida at upland plots experienced water stress, evidenced by lower stem water potentials, higher water-use efficiency, and lower predawn photosynthetic performance than at lowland plots. Prosopis pallida basal area was 5.3 times greater at lowland plots, and these plots exhibited 17 times higher carbon (C), 24 times higher N, and 35 times higher phosphorus (P) additions via litterfall, indicating that productivity of this phreatophyte was decoupled from rainfall where groundwater was present. Total N mass in soils was 4.7 times greater where groundwater was accessible, supporting the case that groundwater access increased N2 fixation at a stand level. In contrast, N mineralization and leaching losses from soils, though substantially greater in lowland relative to upland areas, were strongly controlled by rainfall. Results provide clear examples of how invasive species with particular functional attributes (i.e., N-fixing phreatophytes) exploit otherwise inaccessible resources to dramatically alter the functioning of the systems they invade and how anthropogenic changes to hydrological processes can also alter ecosystem-level impacts of biological invasions. Results also illustrate a mechanism by which regional groundwater drawdown may reduce soil nutrient accretion and availability in arid regions.

Invasive nitrogen-fixing plants often increase nutrient inputs to both terrestrial and aquatic ecosystems via litterfall, and these effects may be more pronounced in areas lacking native N2-fixers. We examined organic matter and nutrient inputs to anchialine ponds on Hawai'i Island's leeward coast from an invasive, N2-fixing tree, Prosopis pallida, and a native, non N2-fixing tree, Thespesia populnea. We quantified: 1) tree basal area and stem density surrounding the ponds, and 2) nutrient content and quantity of P. pallida and T. populnea litter inputs. We correlated inputs from tree litter with concentrations of phosphate, nitrate, ammonium, dissolved organic carbon (C), and total dissolved N and phosphorus (P) in anchialine pond water. Basal area, stem density, litterfall mass and C inputs did not differ due to canopy species composition. Although concentrations of N in P. pallida leaf litter were 28 percent higher than T. populnea, this did not translate to higher N inputs to P. pallida dominated ponds. In contrast, P concentrations were three times greater in T. populnea litter than P. pallida litter, and this was associated with a positive correlation between pond water phosphate concentrations and T. populnea size and abundance. Results suggest non-fixing T. populnea exhibited greater influence on water quality than did invasive N2-fixing P. pallida. High background groundwater N concentrations, relative to those of P, may contribute to T. populnea's P-rich litter having a stronger influence on the functioning of Hawai'i's anchialine pond ecosystems than N-rich litter from P. pallida.

Anthropogenic changes to nutrient supply, numbers and behavior of grazers and interactions of these factors are known to change epilithon composition and biomass. In brackish waters, these changes occur across wide-ranging abiotic conditions (e.g. nutrient concentrations and salinity), which may alter their relative impacts on microphytobenthic communities. Such mediating processes are poorly understood, particularly in tropical brackish ecosystems. We examined the separate and interactive effects of nutrient additions and grazer exclusion on epilithon composition and biomass in eutrophic Hawaiian anchialine pools between contrasting levels of salinity and concomitant nutrient-rich groundwater influence (2.3 to 22.0 ppt; nitrite + nitrate, 6.3 to 102.6 µM; soluble reactive phosphorus, <0.5 to 5.18 µM). Across these conditions, we found no significant effects of nitrogen (N) and phosphorus (P) enrichment treatments on chlorophyll a, biomass (ash-free dry mass) or autotrophic index (i.e. autotrophy) of epilithon communities, and nutrient addition did not alter the effects of grazing pressure. However, autotrophy and epilithon biomass were lower in low salinity, high groundwater influenced pools, and both were strongly reduced by grazing in all pools. Furthermore, effects from grazing pressure on relative autotrophy were more pronounced in low salinity, high groundwater influenced pools. Our results suggest that (1) grazing is the primary driver of epilithon composition and biomass across these nutrient-enriched systems, (2) microphytobenthic communities in these systems are not N or P limited irrespective of co-varying salinity and background nutrients and (3) selective feeding by endemic grazers mitigates potential bottom-up forces from salinity or increased nutrient-enriched groundwater influence on autotrophy in epilithon communities.

Timeline *(including overall expected completion date)*:
All research activities have been concluded except for the decompostition experiment which is planned to continue to 2017.

Changes to Methodology *(or other aspects of the project)*:
No change

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)*:
None

Challenges *(encountered while working in the HETF)*:
None

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)*:

DUDLEY, BD, HUGHES, RF, OSTERTAG, R. 2014. Groundwater availability mediates the ecosystem effects of an invasion of Prosopis pallida. Ecological Applications, 24(8), pp. 1954–1971

Sakihara, TS, Dudley, BD, MacKenzie RA, Beets JP. 2015. Endemic grazers control benthic microalgal growth in a eutrophic tropical brackish ecosystem. MARINE ECOLOGY PROGRESS SERIES Vol. 519: 29–45.

Hughes, R. Flint - Using FIA plots to determine the degree and distribution of Koa tree (Acacia koa) mortality and understory vegetation change in response to current, widespread defoliation events by the koa looper moth (Scotorythra paludicola) on Hawaii Island

CLOSE OUT REPORT

Submitted: 10/26/2015

Project Location(s): Laupāhoehoe Forest Reserve and Natural Area Reserve; Pu‘u Wa‘awa‘a Forest Bird Sanctuary
HETF Annual Report for Project Period: 10/2014 - 10/2015

Status Update (including any significant findings):
This project has been completed. Our results from the project indicated that the impacts of widespread defoliation events by the native moth, Scotorythra paludicola, while dramatic during and shortly after the outbreak event, did not lead to substantial levels of mortality of Acacia koa individuals in the long term. Although we did see increased levels of A. koa mortality following outbreak events, they were, on average, low (i.e., 8% of total stems). This becomes particularly evident when compared to the greater mortality levels in associated native Metrosideros polymorpha trees (i.e., 21% mortality) which were not in any way defoliated during S. paludicola outbreaks. We also did not detect increases in cover of non-native or invasive species in response to S. paludicola outbreaks. Collectively, these are positive outcomes for the persistence of Hawaii's native A. koa populations; though many other forces may be negatively impacting these forests (e.g., non-native pathogens, grazing, feral ungulates) outbreaks of S. paludicola do not appear to be among them.

Timeline *(including overall expected completion date):*
This project has been completed.

Changes to Methodology *(or other aspects of the project):*
None

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area):*
None

Challenges *(encountered while working in the HETF):*
None

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.):*
Poster presented at 2014 Forest Health and Monitoring Project

Leopold, Devin - Local adaptation in an ericoid mycorrhizal symbiosis

Submitted: 6/11/2015

Project Location(s): Laupāhoehoe Forest Reserve
HETF Annual Report for Project Period: 8/2014-8/2015

Status Update *(including any significant findings*):
Under the current permit, roots from 12 young *Vaccinium calycinum* plants were harvested and used for the isolation and identification of symbiotic ericoid mycorrhizal fungi (EMF). EMF were abundant in *V. calycinum* roots and included many fungi known to form ericoid mycorrhizal associations, and some unknown or poorly described taxa. Notably, a single fungal species in the family Trechisporales, which have not previously been identified as mycorrhizal, was highly abundant in *V. calycinum* roots at Laupāhoehoe. Work to confirm the mycorrhizal status of this isolate under controlled conditions is currently underway.

High throughput, Illumina metabarcoding of fungi associated with *V. calycinum* roots was also completed with samples collected under the current permit. Community analysis of these samples shows that communities at nutrient rich sites (including Laupāhoehoe) were more similar to each other than nutrient poor sites and that diversity of ERM fungi increases with soil age across the Hawaiian Long Substrate Age Gradient.

Ongoing work will include the collection of cuttings and soils at HETF, as described in the original permit, to test for local adaptation between plants and fungi.

Timeline *(including overall expected completion date)***:**
Field work at the Laupāhoehoe HETF site will be completed by August, 2016.

Changes to Methodology *(or other aspects of the project)***:**
None.

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)***:**
None.

Challenges *(encountered while working in the HETF)***:**
None.

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)***:**
Aug 1, 2015: *Nutrient availability influences the community composition of root-associated fungi from an ericoid host plant across a 4 myr chronosequence.* The Eighth International Conference on Mycorrhiza. (Oral presentation).

Litton, Creighton M. and Dr. Christian P. Giardina - An experimental test of the impacts of rising temperature on carbon input, allocation, and loss in model forests

Submitted: 05/5/2015

Project Location(s): Laupāhoehoe Forest Reserve and Natural Area Reserve
HETF Annual Report for Project Period: 06/2015 - 06/2016

Status Update *(including any significant findings)*:
Results from this study are providing an increasingly detailed picture of how carbon cycling in tropical wet forest will respond to rising mean annual temperature. First, we found that total carbon input (GPP) increases with mean annual temperature, which supports several prior global, cross-site analyses. Second, we found that all component carbon fluxes increase with mean annual temperature. Third, we found that rates of leaf litter decomposition increased with mean annual temperature, as did the rate of nitrogen release from decomposing leaf litter which may indicate an increase in nutrient cycling rates. Finally, we found that as temperature increases, the fraction of GPP that is partitioned to belowground decreases, most likely in response to an increase in nutrient cycling and availability at higher mean annual temperatures. This is important because carbon that is partitioned belowground has the greatest chance of being stabilized as long-lived soil carbon, where it can reside for hundreds to thousands of years and buffer atmospheric CO2 concentrations. One common prediction of the impact of rising temperature for terrestrial carbon cycling has been that rising temperatures will increase soil carbon decomposition, and thus result in a positive feedback between warming and increased decomposition of soil carbon. Soil carbon is a particularly important component of forest carbon cycling because soils store more carbon than vegetation and the atmosphere combined on a global scale and, thus, soils are critical in regulating global climate. Importantly, we found that the flux of carbon into (litterfall; belowground carbon flux) and out of (soil respiration) soil increases with mean annual temperature, indicating that soil carbon cycling will increase as temperature rises. However, contrary to prior predictions we found that soil carbon storage does not vary with mean annual temperature, indicating that rising temperature will not result in increased soil carbon decomposition and a positive feedback to climate change, at least in tropical montane wet forests.

Timeline *(including overall expected completion date)*:
The research being conducted with this permit is long-term, and ongoing. As such, no specific completion date for the research exists at this point.

Changes to Methodology *(or other aspects of the project)*:
In past permit renewal applications, we proposed to expand the existing 20 x 20 m plots and install resin bag lysimeters in each plot, neither of which was ever initiated. We no longer plan to expand plots or install resin lysimeters. We also proposed to conduct a leaf litter decomposition experiment in past permit renewal applications. This litter decomposition experiment has been completed and published (Bothwell et al. 2014), and we have removed all materials related to the litter decompostion experiment.

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)*:
No noteworthy observations or challenges were observed during the past year.

Challenges *(encountered while working in the HETF)*:
Nothing noteworthy.

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)***:**

Bothwell, L.D., Selmants, PC., Giardina, C.P., and Litton, C.M. 2014. Leaf litter decomposition rates increase with rising mean annual temperature in Hawaiian tropical montane wet forests. PeerJ 2:e685 https://dx.doi.org/10.7717/peerj.685

Giardina, C.P., Litton, C.M., Crow, S.E., and Asner, G.P. 2014.Warming-related increases in soil CO2 efflux are explained by increased below-ground carbon flux. Nature Climate Change 4:822-827.

Selmants, P.C., C.M. Litton, C.P. Giardina and G.P. Asner (2014). Ecosystem carbon storage does not vary with mean annual temperature in Hawaiian tropical montane wet forests. Global Change Biology 20:2927-2937.

Mascaro, J., Litton, C.M., Hughes, R.F., Uowolo, A., Schnitzer, S.A. 2014. Is logarithmic transformation necessary in allometry? Ten, one-hundred, one-thousand-times yes. Biological Journal of the Linnean Society 111:230-233.

Michler, Charles - Acacia koa environmental genomics

Submitted: 12/28/15

CLOSE OUT REPORT

Project Location(s): Laupāhoehoe Forest Reserve
HETF Annual Report for Project Period: 01/2015-01/2016

Status Update *(including any significant findings):*
We have not returned to the site to collect seeds as planned due to funding/personnel constraints. This is a close out report. We will reapply for a permit when project activities resume.

Timeline *(including overall expected completion date):*
None

Changes to Methodology *(or other aspects of the project):*
None

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area):*
None

Challenges *(encountered while working in the HETF):*
None

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.):*
None

Perroy, Ryan and Jonathan Price - Meeting Hawaii's Natural Resource Challenges with Unmanned Aerial Vehicles and Geovisualization

Submitted: 04/26/2015

Project Location(s): Pu'u Wa'awa'a Forest Reserve
HETF Annual Report for Project Period: 05/2014 - 05/2015

Status Update *(including any significant findings)*:
To date we have conducted six FAA-sanctioned UAV flights within our PWW study area, using a small fixed-wing platform carrying a modified point-and-shoot camera sensitive in either the visible or near-infrared (NIR) portions of the electromagnetic spectrum. Photo orthomosaics and digital surface models were produced covering ~123 acres of the study area at <5cm resolution, focusing efforts on mapping wiliwili trees. The flights were conducted during late 2014, and we are very interested in conducting repeat flights to capture vegetation changes. In addition to species identification applications, we are also interested in using the collected imagery to try and quantify things like fire grass fuel continuity with Clay Trauernicht.

Timeline *(including overall expected completion date)*:
10/11/14 Initial flights, no useable mosaics
10/25/14 Successful flights, NIR camera malfunction
11/14 - Present Image processing, flight planning for future work
Over the next year we would like to conduct at least one more flight over PWW, to re-image areas covered in Oct. 2014 under different leaf phenologic conditions and to expand our area of coverage. Our expected completion date for these additonal activities would be May, 2016, barring any unforseen developments or complications.

Changes to Methodology *(or other aspects of the project)*:
Our initial two flights did not produce any useable imagery due to a lack of overlap between successive images. We have since modified our UAV flight operational practices and increased the overlap. We are also developing a net system for capturing the UAV in the air upon landing, rather than the manufacturer's typical belly landing. This is dramatically limiting the amount of wear and tear on our equipment.

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)*:
Dr. Jon Price identified a previously unknown small adult uhiuhi tree, displaying previous reproductive material but no seeds or flowers at the time of observation.

Challenges *(encountered while working in the HETF)*:
Our UHH field vehicle suffered a flat tire on our last trip to PWW. Have since bought a new set of off-road tires. We also experienced a camera malfunction during one of our flights and had to get a replacement near-infrared camera.

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)*:
To date we have no refereed publications from this work, but have work in preparation and have presented our initial results at the following three conferences:

Perroy, R., Price, J., and Turner, N., (2015) Exploring conservation resource and environmental science applications with UAVs, Hawaii Association of Watershed Partnerships Meeting, February 5, Honolulu, HI.

Price, J., (2015) Using drones to track the health of wiliwili at Puʻu Waʻawaʻa, Nāhelehele Dryland Forest Symposium, February 27, Kailua-Kona, HI.

Perroy, R., and Turner, N., (2015) Conservation and Resource Management Applications with UAVs, Conservation Connections Talk Story Hawaii Conservation Alliance, April 21, Hilo, HI.

Swenson, Ulf - Biogeographic history of the Hawaiian endemic Planchonella sandwicensis

Submitted: November 6, 2015

CLOSE OUT REPORT

Project Location(s): Pu'u Wa'awa'a Forest Reserve
HETF Annual Report for Project Period: August 2015

Status Update *(including any significant findings):*
One collection of Planchonella sandwicensis was assembled at the old airplane hangar. The collection had yellow fruits with 1 to 3 viable seeds in each fruit (images attached). Leaf material is now in the molecular laboratory at the Swedish Museum of Natural History for DNA extraction and analyses. Preliminary, however, I don't believe P. sandwicensis is represented by one species across the Hawaii Islands, probably three, and this collection does not belong to the nominal type (P. sandwicensis). This means that the threat status of this and the other Planchonella species in Hawaii will change.

Timeline *(including overall expected completion date):*
This is a Close Out Report. Fieldwork completed. Molecular work and analyses during 2016. Publications expected in 2017.

Changes to Methodology *(or other aspects of the project):*
None

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area):*
None

Challenges *(encountered while working in the HETF):*
None

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.):*
None

Rickman, Ronald and Ben Shimizu - Operation and Maintenance of the Kīholo rain gage

Submitted: 03/12/15

Project Location(s): Pu'u Wa'awa'a Forest Reserve
HETF Annual Report for Project Period: 04/01/14 - 03/11/15

Status Update *(including any significant findings*)**:**
Complete record of rainfall was recorded and transmitted during the period. The gage is serviced by Ben Shimizu and Vaughn Kunishige (both USGS employees)

Timeline *(including overall expected completion date)***:**
Open - I will complete permit renew application ASAP.

Changes to Methodology *(or other aspects of the project)***:**
None

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)***:**
Annual precipitation for calendar year 2014 was 20.14 inches. The largest daily rainfall for 2014 was 2.05 inches recorded February 18, 2014. The largest daily rainfall for 2015 (as of March 11, 2015) was 2.34 inches recorded January 3, 2015.

Challenges *(encountered while working in the HETF)***:**
None

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)***:**

Historic and real-time rainfall data can be found on the USGS web pages at http://hi.water.usgs.gov

Ticktin, Tamara - Linking local ecological knowledge, ecosystem services and climate change

Submission Date: 04/10/2015

Project Location(s): Pu'u Wa'awa'a Forest Reserve
HETF Annual Report for Project Period: 05/28/2014-05/27/2015

Status Update *(including any significant findings)*:
In June 2014, we conducted initial reconnaissance and discussions with Elliott Parsons to identify appropriate sampling locations within Pu'u Wa'a Wa'a Forest Reserve. We then set up plots in four different vegetation cover types: mauka restored (Waihou I), mauka unrestored (Waihou II and Henahena), makai restored ('Oweowe) and makai unrestored (Lama Kauila). We established three plots per cover type, except for in Henahena where only two plots were sampled. The total number of plots we established was 14 . We calculated species richness, speices diversity, cover and % invasive species for both overstory and understory (separately and together) for each plot, and overall for each cover type. We wil be integrating this data with economic costs, calcalutions of water yield and run-off, and marine data from Kiholo, to project best management for the ahupua'a in the present and under future climate change.

Timeline *(including overall expected completion date)*:
The end date for the overall project is December 2015. We plan to take further measurements in the plots in the six months. We aim to share our results with resource managers (in this case DOFAW managers) and community members to get feedback in September 2015. In December 2015 we will provide our final results, which will provide resource managers and communities with ecological, hydrologic and economic information to make decisions on resource use management now and in the future.

Changes to Methodology *(or other aspects of the project)*:
The plot dimensions were originally to be 5 m X 5 m. Upon further discussion and observation of the overall terrain, we modified these to 10 m by 50 m transects, subdivided into five 10 m X 10 m subplots for the measurement of canopy trees and canopy cover. We randomly placed a 5 X 5 m subplot nested further within each of these, in order to measure understory species and cover.

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)*:
Endangered species: An individual of Solanum incompletum was seen flowering in 'Oweowe. However, it was not within any of the sampled plots.

Invasive species: Senna occidentalis was found in Waihou II, and Gomphocarpus physocarpus was found in 'Oweowe. As they were only in these sites, they may be new arrivals.

Challenges *(encountered while working in the HETF)*:
Our main challenge was probably driving time within the site, although signage and clear roads instructions were a great help, as was having access to the GPS tracks for the existing roads. One piece of information that could have helped reduce travel time would have been knowing the positions of the gates for the mauka fenced areas.

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)*:

Vitousek, Peter - Sources and fates of nutrients on a substrate age gradient across the Hawaiian archipelago and their consequences for forest dynamics

Submitted: 02/02/2015

Project Location(s): Laupāhoehoe Forest Reserve
HETF Annual Report for Project Period: 01/2014 – 12/2014

Status Update *(including any significant findings)***:**
We fenced an open soil pit that we maintain at the site, and collected tree tags and unused lysimeters from the site. We took a class to the site; they described the soil, sampled, and analyzed it. They also collected vegetation data on transects, for comparison with other sites along the gradient in Volcano, Kohala, and Kokee on Kauai.

Timeline *(including overall expected completion date)***:**
2020

Changes to Methodology *(or other aspects of the project)***:**
We are no longer fertilizing trees in the site, and we do not intend to do so in the future. We will continue to collect soils in the site, and to evaluate the effects of past fertilization through foliar and soil analyses.

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)***:**
Nothing in our site; watching guava creep up Blair Road over the years is disconcerting.

Challenges *(encountered while working in the HETF)***:**
None.

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)***:**

Thompson, A., Amistadi, M.K., Chadwick, O.A., and J. Chorover. Fractionation of yttrium and holmium during basaltic soil weathering. Geochimica et Cosmochimica Acta 119: 18-30.

Tweiten, M., S. Hotchkiss, P. Vitousek, J. Kellner, O. Chadwick, and G. Asner. Volcanic substrate and canopy disturbance influence the species composition and resilience of a Hawaiian montane wet forest. Journal of Vegetation Science 25: 734-749.

Yanger, Corie - Investigating the level and rate of invasive thrips infestation on spatially varied natural and planted Hawaiian Myoporum seedlings

Submitted: 11/18/2015

Project Location(s): Pu'u Wa'awa'a Forest Reserve
HETF Annual Report for Project Period: 12/2014-12/2015

Status Update *(including any significant findings)*:
As of March 30, 2015 I had collected twelve months of naio tree data and eight months of natural naio seedling data at Pu'u Wa'awa'a Forest Reserve. Over time, infestation ratings per branch per tree increased while total reproduction (flowers, young fruits, ripe fruits, and brown/dried fruits) decreased. By twelve months, mean reproductive count was significantly lower for trees with greater than 33 percent infestation (Class 0: 9.1 reproductive units/branch/tree, Class 1: 8.1 reproductive units/branch/tree, Class 2: 4.8 reproductive units/branch/tree, Class 3: 0.4 reproductive units/branch/tree). Trees in Classes 0 and 1 maintained 33 percent or less infestation throughout the study, while trees in Class 2 displayed average infestation ratings between 33 to <66 percent. By the end of the study, about 25 percent of the 400 monitored branches were dead due, apparently, to thrips damage and most of those dead branches were on trees in Class 3. Trees in Class 0 and Class 1 appeared to show similar flowering and fruiting patterns throughout the study, suggesting that these trees experienced comparable conditions with regard to infestation pressure. These data also suggest that naio reproductive output (especially flower production) is maintained on trees with less infestation. By eleven months, trees in Class 3 possessed only raisins (brown, dried fruits), and by twelve months, the number of raisins had declined. These findings suggest that for trees with high levels of infestation, we can expect to see complete reproductive loss -first the loss of flowers and eventually the loss of old fruits. Monthly infestation patterns for naio in Classes 0 and 1 suggest that (despite a 5-6 year infestation) there are some naio trees at Pu'u Wa'awa'a Forest Reserve which sustain relatively little damage from thrips. Looking at the pattern in flowering and fruiting for trees sustaining little thrips damage, it appeared that drought conditions may have influenced a slight decline in reproduction and this is being further investigated.

I have monitored a total of 139 seedlings at Pu'u Wa'awa'a Forest Reserve. By the last reading at eight months, maximum height recorded was 63 centimeters, with mean seedling height at 22.9 cm. Ninety eight percent of seedlings were damaged by thrips, and more than 90 percent of seedlings also sustained damage from other insects such as aphids, leaf miners, and chewing insects. Of the seedlings damaged by thrips, 42 percent sustained Class 3 infestation damage. Taller seedlings appeared to have more thrips damage than shorter seedlings. Average monthly growth rates were calculated for three seedling height classes: 3.3 cm (seedlings <10 cm in height), 5.3 cm (seedlings 10-25 cm in height), and 2.3 cm (seedlings >25 cm in height), although these rates still need to be compared to level of thrips damage. After eight months, seedling survival rate was 88 percent, which suggests that naio seedlings are able to survive for months despite damage from one or more insects.

Due to confounding factors (e.g., multiple insect damage, water stress) the impact of thrips on natural naio seedling survival and growth rate is still unclear.

Timeline *(including overall expected completion date)*:
I have collected naio tree and natural seedling data for the purposes of my project. I expect to have data analysis complete by January 2016, and final word from my committee that no other field data are needed. Should I require further data collection, I will be using methods stated in my permit renewal request or submitting an amendment.

Changes to Methodology *(or other aspects of the project)***:**
For naio tree monitoring, I ended up monitoring 40 trees, with ten representative individuals for each of four infestation classes. I also marked branches with aluminum tags and flagging. Changes were approved by the Pu'u Wa'awa'a Coordinator, Elliott Parsons. For seedling monitoring, I had to tag most seedlings in the recently bulldozed road because seedlings beyond the road were too sparse. All seedling locations were marked with a GPS unit and tags were covered to avoid attracting ungulates. These changes were also approved by Elliott Parsons. Due to logistical constraints, the greenhouse component of this study was kept in Volcano.

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)***:**
I have observed that despite the presence of ungulates, seedlings (of Dodonaea viscosa, Sophora chrysophylla, Osteomeles anthyllidifolia, and Myoporum sandwicense) seem to readily sprout.

Challenges *(encountered while working in the HETF)***:**
While working in the HETF, my biggest challenge has been trying to collect data from plants that are exposed to ungulates. I also was unable to complete twelve months of data collection from seedlings located along the bulldozed road because many were unintentionally sprayed by herbicide during weed control efforts.

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)***:**

Yanger, C., and R. Ostertag. July 2014. Impacts of an invasive introduced insect on Hawaiian Myoporum reproduction and seedling growth and survival. Association for Tropical Conservation Biology Annual Meeting, Cairns, Australia. Oral presentation.

Yanger, C., and R. Ostertag. June 2014. Impacts of invasive thrips infestation on Hawaiian Myoporum reproduction and seedling establishment. Island Biology Meeting, Manoa, Hawaii. Poster presentation.

Yanger, C.. July 2015. Impacts of invasive thrips on Hawaiian Myoporum (naio) reproduction. Hawaii Ecosystems Projects Meeting, Hilo, Hawaii. Oral presentation.

Yeh, Aileen - Operational Disease Screening Program for Resistance to Wilt in Acacia Koa in Hawaii

Submitted: 02/19/2015

Project Location(s): Laupāhoehoe Unit: Forest Reserve; Natural Area Reserve and Pu‘u Wa‘awa‘a Forest Reserve and Wildlife Sanctuary
HETF Annual Report for Project Period: 02/2014-02/2015

Status Update *(including any significant findings)*:
This project is ongoing. Seed was obtained from Puuwaawaa bird sanctuary and FR, but we still need to find more mother trees to collect seed from.

We were able to collect seed from two trees in Laupāhoehoe NAR and FR. Seed was very difficult to find, mainly because of moth damage, and wind. Seed from each mother tree must be kept separate for the reistance screening trials.. HARC manages a network of 1 to 3 year old koa wilt resistant plantings on Oahu, Maui and Hawaii Island. Various silvicultural prescriptions were conducted at these sites, including thinning, pruning and weed and pest control. Growth data from the Maunawili and Haleakala Ranch sites was collected in the Fall of 2014. Thinning is underway at some of the sites, and the goal is to thin all the sites for form. T In general, the sites will be thinned 2-3 years after planting.

Hawaii Island Seed Collection

HARC is working with the State of Hawaii DLNR-DOFAW to establish a wilt resistant, low elevation, windward Hawaii Island koa population. In the fall of 2014, seed from this region was collected and processed. Seed production in the region was minimal as very few trees had seed, likely as a result of the recent koa moth outbreak on Hawaii Island. In total, HARC was able to collect sufficient seed from approximately 30 mother trees in the region.

Timeline *(including overall expected completion date)*:
12/30/2016

Changes to Methodology *(or other aspects of the project)*:
No changes

Noteworthy Observations *(including the presence of T&E species, new observances of invasive species, and/or human activity or disturbances in the area)*:
There was very little koa seed at Laupāhoehoe in 2014. The Koa moth defoliated most of the trees, and it was observed the catepillars defoliated other speicies such as ohia if they were under the koa trees.

Challenges *(encountered while working in the HETF)*:
Weather. Wind and rain. Koa looper

Bibliography of Publications *(Publications should include work that was done in the HETF, including gray literature, conference presentations/posters, etc.)*: None.

HETF Related Citations

Citations listed below have been submitted since the publication of the 2014 HETF Annual Report through either project annual reports or direct submission. Only published research is listed below; see specific researcher annual reports for publication in press or preparation, presentations, poster information, etc. Visit the HETF website http://www.hetf.us/page/publications/ for a complete list of citations received to date.

Dudley, BD, Hughes, RF, Ostertag, R. Groundwater availability mediates the ecosystem effects of an invasion of Prosopis pallida. *Ecological Applications*, 24.8 (2014): 1954–1971

Murphy, M.J., Inman-Narahari, F., Ostertag, R., Litton, C.M. 2014. Invasive feral pigs impact native tree ferns and woody seedlings in Hawaiian forest. *Biological Invasions* 16.1 (2014): 63-71.

Lawson SS, Michler CH, Inman-Narahari F, and Friday JB. Acacia koa gene expression along elevation and precipitation gradients. September 2014. *Tropical Hardwood Tree Improvement and Regeneration Center E-Newsletter* Fall 2014. (http://www.trophtirc.org/projects/acacia-koa-gene-expression-along-elevation-and-precipitation-gradients.html#.VEp9WfnF9MU Site visited: October 24, 2014)

Lawson SS. Remember Koa? We Have Updates! May 2014. *Hardwood Tree Improvement and Regeneration Center E-Newsletter* 7:1. (http://htirc.org/ Site visited: October 24, 2014)

Sakihara, TS, Dudley, BD, MacKenzie RA, Beets JP. 2015. Endemic grazers control benthic microalgal growth in a eutrophic tropical brackish ecosystem. *Marine Ecology Progress Series* Vol. 519 (2015): 29–45.

Thompson, A., Amistadi, M.K., Chadwick, O.A., and J. Chorover. Fractionation of yttrium and holmium during basaltic soil weathering. *Geochimica et Cosmochimica Acta* 119 (2013): 18-30.

Tweiten, M., S. Hotchkiss, P. Vitousek, J. Kellner, O. Chadwick, and G. Asner. Volcanic substrate and canopy disturbance influence the species composition and resilience of a Hawaiian montane wet forest. *Journal of Vegetation Science*, 25.3 (2014): 734-749.

Appendix A – HETF Project Summaries

Project summaries received from researchers are listed alphabetically by primary PI's last name in this section. We do not add any diacritical marks, correct punctuation, capitalization or grammatical errors.

Barton, Kasey - Population variation in pua kala defenses

Island plant defense against herbivores is poorly understood but important given the severe impact invasive animals have on island plants. Pua kala (Argemone glauca) is an example of an apparently well defended native Hawaiian plant. Characterizing levels of defense traits and their variation across populations on different islands can provide important insights into why and how this plant maintains its defense traits. As part of an archipelago-wide survey of pua kala defenses, I request permission to measure morphological traits in field plants as well as collect seeds for further greenhouse studies so that latex, alkaloids, prickles, and photosynthetic traits can be measured and compared to pua kala from other islands.

Bosted, Peter - Lava Tube location, photo-documentation, and resource evaluation on Pu‘u Wa‘awa‘a and Pu‘u Anahulu

This is a continuation of a long term-project to identify and survey lava tube caves on Pu`u Wa`awa`a. We aim to describe and document significant resources in these lava tubes, including biological features (roots, flora growing in entrances and skylights, cave life, slimes), geological resources (flow linings, lava stalactites, lava balls), and cultural features (e.g., constructed walls, gourd cradles, stepping stone trails). Examples of the research questions being asked include: what is the aerial extent of the lava tubes within the 3,000-5,000 year old flow field that exists on mauka Pu`u Wa`awa`a, how do the lava tube complexes relate to each other (i.e., are they segments of one large tube system or were they emplaced separately), what is the aerial distribution of fossil bird bones within the lava tubes (i.e., bones are generally clustered within 30 meters of skylights; over what vertical range are these bones found), are threatened or endangered native species found and protected in the sheltered collapse entrances/skylights to the lava tubes; where are the passages with extensive tree roots (which support a large range of cave-adapted species).

Cordell, Susan - Hawai‘i Permanent Plot Network (HIPPNET)

To maintain a network of permanent forest dynamic plots across the island of Hawai‘i for purposes of forest and climate inventory, and monitoring. There are three existing plots within the HETF and this is a renewal for those plots. Two of the plots are located in the Puuwaawaa section of the HETF, one at approximately 5000ft in the Forest Bird Sanctuary, and the other just below the Mamalahoa Highway (see attached maps). The third is located in the Laupāhoehoe NAR just south of Blair road at around 3000ft (see attached map). The Puuwaawaa plots are each 100 m x 100 m. and the Laupāhoehoe plot is 200 m x 200 m. These plots have been mapped, with each woody plant > 1 cm in diameter tagged and mapped (see methods section below). Using the methods outlined below, each year we plan to resurvey the entire area of the Puuwaawaa plots and 10% of the Laupāhoehoe plot, with a full resurvey at Laupāhoehoe every five years. Each of these plots also has an adjacent climate monitoring station (see descriptions below and attached maps). We will continue maintenance and data collection from these remote weather stations throughout the duration of the project. We have installed (per HETF amendment 8/28/2013) Granier sapflow probes to evaluate hourly, daily and seasonal variation in precipitation on stand growth, water use and water-use efficiency by measuring sap flux per unit sapwood area, canopy conductance, transpiration per unit leaf area and water-use efficiency in approximately 20 trees in each of two sites: the Pu‘u Wa‘awa‘a Wildlife Sanctuary site and the Laupāhoehoe forest site. The forest plots will be re-censused on a regular schedule and climate data will be collected simultaneously. The plots have been established using protocols developed for tropical and temperate forests worldwide. BACKGROUND:

Many ecological questions can be ideally addressed in Hawai‘i due to its exceptional natural setting and resources—including diverse habitats across striking gradients, a 90% endemic flora, and ecosystems interfacing from uplands down to coast. To address currently critical ecological, and resource management questions, this infrastructure is essential. The most pressing need is for the ability to make long-term measurements as well as intensive short-term studies at well-defined sites, characterized to the highest standards applied to scientific forest sites around the world. To this end, our group has developed 3 long-term forest plots, the Hawai‘i Permanent Plot Network (HIPPNET). This plot network will enable the collection of essential data related to (1) Global change (i.e. climate impacts, community dynamics, invasive species); (2) Ecohydrology - linkages between forest-water-atmosphere; (3) Ecosystem services; (4) Remote sensing; (5) Restoration; (6) Comparative forest ecology; (7) Community structure and organization; (8) Population genetics and evolutionary ecology of forest plants and correlation with field performance; (9) Biogeochemical processes.

Cordell, Susan - The potential for restoration to break the grass/fire cycle in dryland ecosystems in Hawai‘i

Our study will provide basic scientific information and practical tools for managing and restoring tropical dry forest landscapes in Hawai‘i. Results will increase the capacity to restore native forests, thereby reducing wildfire and enhancing habitat for threatened and endangered species. Through remote sensing we are assessing the historical and current condition of the two major dry forest landscapes on the island of Hawai‘i (PTA and PWW) and providing information to assess their restoration potential. Products currently being developed include historical maps of dry forest cover change and state-of-the-art high resolution maps of vegetation cover, habitat suitability, species dominance, and fire fuel cover for purposes of setting a clear baseline for potential restoration efforts. To improve our understanding of altered fire regimes and devise methods to break the grass/wildfire cycle, we are using both remote sensing and field based experiments. At the landscape scale, we have developed use of high temporal frequency satellite imagery to monitor near real-time fire fuel conditions. Field experiments have provided baseline information on small-scale fuel conditions and potential fire behavior within a range of remnant dry forest community types. Field experiments are designed to simultaneously develop strategies for restoration of native species and test the effectiveness of restoration as a tool to reduce fine fuel loads and potential fire danger. We are using our newly developed Habitat Suitability Map (HSM) to help guide effective threatended and endangered species (TER-S) outplanting efforts. We have developed topographic models derived from airborne Light Detecting and Ranging (LiDAR) data that accurately predict habitat suitability for existing Threatened, Endangered, and At-Risk plantspecies (TER-S) in dry habitats. We have been funded by the Department of Defense to demonstrate how these models can also inform TER-S outplanting programs to increase plant performance and survival TER-S. These species will be planted at the Pohakuloa Training Area (PTA) in Hawai‘i and the PuuWaawaa Forest Reserve.

Cusack, Daniela - Soil Carbon Cycling Across a Hawaiian Mineralogical Gradient

Soil carbon in forests is an important bank of stored carbon, helping reduce carbon dioxide in the atmosphere and mitigate climate change. However, our understanding of what controls carbon storage in soils, and how long different carbon molecules can be stored, is very limited. Long-term storage of carbon in forest soils has been referred to as “stabilization.” Carbon stabilization is determined by interactions among physical, chemical, and biological controls, like soil type and microbial community composition. At the heart of this project is the goal to significantly advance our understanding of how microbial and soil minerals interact with different carbon molecules to regulate the long-term storage of carbon in soils across a variety of tropical ecosystems in Hawai’i. This research will help us understand what ecosystems processes increase carbon storage in tropical ecosystems, which is of global concern in the context of climate change. We will use a 1 to 2 year “soil column” study across 4 sites in Hawai’i that have large variation in soil mineralogy and microbial communities, including Volcanoes, Kohala, Hawi, and hopefully

Laupāhoehoe. To observe how carbon is moved into soils and stored, we propose to add 3 different sterile carbon compounds (compounds which occur naturally in soils: glucose, glutamine, charcoal). To track the fate of the added carbon, we will use carbon labeled with the stable, naturally occurring 13C carbon atom. Small quantities of this carbon (< 5 mg) will be added to the surface of soils. To contain the added carbon, we will use 25-cm long soil columns inserted into the soil. We will add the carbon during the summer of 2015, and then we will collect the soil columns in 2016 and 2017. During this period, we will come and make carbon measurements within the cores twice per year. There are no expected environmental impacts when adding these naturally occurring sterile carbon compounds to soils.

Earnshaw, Kyle - Adaptiveness of heteroblasty in two populations of Acacia koa in response to light availability

Currently, koa, Acacia koa Gray, is managed in Hawai‘i using single age systems. This system takes advantage of koa’s fast growth and shade intolerance. It, however, creates homogenous canopies and may be part of the reason that koa in plantations often has poor form. Regenerating koa in multiple-aged systems may allow for improvement of bird habitat, through increased canopy complexity, and improvement of systems for koa management. This project addresses how differences in the timing and degree of heterophylly (multiple leaf forms) and heteroblasty (the transition from one form to another) in two populations of koa, Acacia koa Gray, affect adaptability. It examines how variability in light and water affect these characteristics to different degrees based on selection pressures inherent in the ecosystems in which the specific populations evolved. Performance, expressed in growth rates, and survival are used to assess the flexibility of each population. During the upcoming year, as the project concludes, these data will be analyzed by the timing of leaf form change to assess the importance of variation in timing for performance and survival. In addition to providing valuable insights on the importance of light intensity, further elucidating the role of plasticity in climate adaptation, and providing improved metrics for estimating canopy structure in koa plantations, this study will, from the perspective of Hawaiian Forestry, provide data on the capacity of koa from contrasting climates to be managed under mixed systems. In July of 2013, 3-4 month old koa seedlings were planted under a sparse koa canopy of 10-12 year old koa. Seedlings were marked with PVC piping so that each seedling could be identified. Additionally, one Onset HOBO tipping bucket rain gauge was installed to monitor water availability.

Ewing, Curtis - Community assembly & diversification of Hawaiian Arthropods

The aim of the project, a large, NSF-funded effort, is to figure out how communities of arthropods come together over time – is there a predictable sequence of arrival (both in the short- and long term) and does this differ between trophic levels? Is there a point at which biodiversity reaches a stable state and prior to this, are communities more vulnerable to invasion? The particular importance of the work is that it will provide understanding of how communities come together, and the role of ecology (migrating into a community, trophic level) and evolution (adaptation and speciation) in determing the composition of species in a community. This in turn will provide information on sensitivity to invasion and probability of speciaiton and extinction. To achieve our goal we will merge two very different areas of research to understand patterns of biodiversity, (1) a broad ecological approach focused on particular locations, which provides insights into how species assemble and interact in an ecological community, and (2) an evolutionary approach, which examines how a given species group adapts, multiplies, or declines over time. The first approach addresses the diversity and abundance of species at a site and what are the kinds of predator-prey or other interactions between species. The second approach allows assessment of the rate at which a given lineage of organisms can adapt and diverge, including changes in abundance through time. We are integrating these two approaches using a system of age-structured communities in Metrosideros mesic to wet forest at multiple sites on the youngest island of Hawai‘i and comparing these to communities on the older islands of Maui, Molokai and Kauai. Within Hawai‘i Island, because it is still forming geologically, lineages of organisms are actively diversifying, and their communities and food

webs are actively changing. Thus, variables relevant to entire communities can be measured at multiple "slices in time" over the period of community formation. Most team members have studied Hawaiian insects and spiders for a decade or more, and this research will certainly add to our basic knowledge of the evolution and ecology of endemic species. New taxonomic discoveries are almost certain, and ultimately the research will yield open access data and detailed species lists for each of studied sites.

Hughes, Flint - Forest disease monitoring for the Ōhi'a rust disease affecting Ōhi'a trees

To research and provide a detailed on-the-ground look at how Ohi'a rust effects Ohi'a seedling recruitment, growth rates of mature trees, and tree vitality/mortality within different types of Ohi'a-domindated forests as part of a larger study including sites located across the windward side of Hawai'i Island.

Objectives:

1. Assess level/degree of potential damage by the Ohi'a rust to mature ohia trees in forests of varying successional stages and environment conditions on the windward coast of Hawai'i Island.

2. Evaluate conditions that may be predisposing Ohi'a to the rust infection and impact, and whether the rust infection is constrains seedling regeneration and will be responsible for long-term Ohi'a stand declines.

3. Determine the potential impact of Ohi'a rust on Ohi'a seedling mortality along successional and environmental gradients.

4. Provide baselines of Ohi'a health in selected forest stands for long-term Ohi'a rust disease surveillance.

Additional sites are located in the following forest reserves (FR's) and are included in this research project on a DNLR/DOFAW permit:

- Keauohana FR
- Waiakea FR "Stainback"
- Hilo FR- "Pi'ihonua" section
- Humu'ula FR
- Kohala FR

Hughes, Flint - Quantifying dynamics and magnitude of water loss from kiawe forests in North Kona – Kīholo Bay

The amount of groundwater removed from the aquifer annually by Kiawe trees was quantified within each of two forest stand types (upland and lowland). Kiawe stands may be taking a significant portion of groundwater flow in this area; groundwater that would otherwise be available to native plant species or pass onto near shore coral reefs. This work investigated; 1) calculation of sap flow at both mauka and makai areas. Sap flow probes were in place on a total of 30 trees (i.e., 15 Kiawe trees in at the makai stand and 15 Kiawe trees in the mauka stand, providing data to a datalogger and battery box at each of the upland and lowland sites. This equipment will be entirely removed by the end of June, 2015; 2) calculations of Kiawe biomass at both upland and lowland areas; These measurements have been completed.3) calculations of the proportion of total water flow through Kiawe trees that comes from groundwater and rainfall sources in mauka and makai sites; all three-monthly collections of kiawe stem segments and groundwater are now complete. 4) Measurement of weather data at both sites. This data collection is complete; weather stations will be removed by the end of June 2015. Measurements of Kiawe leaf chemistry are complete. These measurements were necessary to gain information both on the physical (weather) and chemical factors that restrict growth of Kiawe, helping us to understand where they may spread, and how they may function as Hawai'i's climate changes. The amount of nitrogen (a soil nutrient commonly included as a component of fertilizer, but produced naturally by Kiawe trees) released from leaves and stems that fall from Kiawe trees was examined at all plots (U1-U5 and L1-L5). This

nutrient production by Kiawe trees is not a natural process in Hawaiian dry forests (at least not in the quantities produced by Kiawe) and hence may be altering both the soil chemistry, and the chemistry of groundwater in this area. We quantified these effects by collecting litter in litter traps and measuring soil available N at each of the ten study sites.; they may be detrimental to native species both on land, and in near-shore marine environments that receive groundwater inputs. To do this we have deployed 40 0.18 m2 permeable plastic trays (to collect fallen leaves and branches), and 30 8 cm long PVC soil tubes (to examine soil chemistry changes) at plots U1-U5 and L1-L5. This work is now complete and trays have been removed. We have also deployed sets of small mesh bags containing P. pallida leaf litter each of the 5 mauka and 5 makai study plots. This experiment is enabling us to examine decomposition and nutrient release rates of the dominant vegetation inputs into the system (i.e., kiawe leaves and fine woody debris). This work is being carried out by Dr. Elliot Parsons with Mr. Travis Sowards and will continue through 2017.

Jeffrey, William - Albinism Transcriptomics of Cave-adapted Planthoppers

The purpose of this activity to collect specimens of the cave planthoppers of the genus Oliarus to determine whether the same or different genes have been affected to control loss of pigmentation (albinism) and whether this is a beneficial adaption to lava tube life because of a relationship to increased catecholamine synthesis. Catecholmines are hormones, such as dopamine and ephnephrine, that assist the brain to perform behaviors, such as those required for feeding in resource poor environments like caves. This research is continuation of the research previously conducted with Oliarus polyphemus from Kaumana Cave, near Hillo, HI, and which has been published (see Bilandzija et al., 2012, reference 1 below). During the previous study, Dr. Bilandzija and I discovered that O. polyphemus and an unrelated Croatian cave planthopper species have both lost pigmentation by blocking of the first step in the melanin biosynthesis pathway. The next question in this research, which is the activity requested in this permit, would ask if the genes controlling both full and partial de-pigmentation are the same or different in closely related but independently evolved cave planthopper species. The latter are the species that we ask permission to collect. We will also test the hypothesis that lava tube life requires an increase in catecholamines, as we have previous found to be the case for cavefish living in Mainland limestone caves (Bilandzija et al., 2013, reference 2 below). The pigmented cave species we will need to continue this work are Oliarus lorettae, described from Ana Limo Kipo Cave in Kiholo State Park, and Oliarus makaiki, described from Yellow Jacket Cave, in the Pu'u Wa' awa'a Unit, which show the relative reduction in pigmentation desirable for comparative analysis with completely albino Oliarus polyhemus. Only collections of 5 specimens from each location will be done.

Johnson, Anna - Tracking the impact of species introductions and extinctions on ecological interaction networks

The study of species interaction networks adds important information about the functional role of species within biological communities to our ongoing efforts to understand the factors which maintain biodiversity. Plant-pollinator interaction networks provide valuable ecological services and are also likely to be particularly susceptible to disruption as a result of species invasions and extinctions. My proposed research tracks the impact of species compositional shifts on pollination networks over 100 years, using an extensive herbarium collection of the flora of the Hawaiian Islands, collected by botanist Joseph C. F. Rock from 1909-the early 1920's. This project leverages a unique herbarium collection and also works in an ideal model system: oceanic islands are strongly impacted by species invasions and extinctions but also possess relatively simple pollination networks, allowing the study of entire flowering communities. I will reconstruct historic pollination networks from herbarium specimens collected in dry tropical forest regions and then resample contemporary dry tropical forest flowering plant communities along an invasion gradient, focusing on the Pu'u Wa'awa'a area where Rock historically conducted numerous sampling trips. I will collect deposited pollen on floral stigmas to construct pollen transport networks that

document pollination mediated plant-plant interactions. When pollinators visit flowers, they often deposit pollen from other species they have visited (heterospecific pollen), in addition to pollen from the same species (conspecific pollen), allowing the reconstruction of these interaction networks. I will compare historic networks to contemporary networks to assess 1) whether network connectivity is lost at a proportionally slower rate than species in island pollination networks and 2) whether invasive plant species facilitate retention of network connectivity by connecting native species to one another. The resulting data will provide valuable insight into the ways that complex biological systems respond over long time periods to perturbations related to human disturbances, and will provide direct, quantitative measures of the impact of species compositional shifts on pollination quantity and quality. The proposed field sampling in the Pu'u Wa'awa'a dry forest unit of the Hawai'i Experimental Tropical Forest will be conducted along a contemporary invasion gradient of plots within the region, ranging from highly invaded by exotic grass species to relatively intact native communities. At each sampling site, 5, 50 meter transects will be established, marked by GPS coordinates and flags. Floral diversity and abundance will be surveyed along each transect and floral stigmas will be collected from a random selection of flowering individuals for each species present. Surveys will be conducted periodically from April-September 2016, with follow-up surveys potentially conducted during the spring and summer of 2017. Pollen will be removed from floral stigmas and then counted and identified to species, to construct separate pollen transport networks for each surveyed plot. Contemporary networks will be compared to historic networks to assess whether species interaction networks have changed in structure as species were gained and lost over time. In addition, this study will create a pollen reference library that will be made available for other researchers' use through the Bishop Museum at the University of Hawai'i.

Leopold, Devin - Local adaptation in an ericoid mycorrhizal symbiosis

The goal of the proposed research is to study local adaptation of *Vaccinium calycinum* ('Ōhelo kau lā'au) and the beneficial fungi, ericoid mycorrhizal fungi (EMF), associated with their roots. Despite longstanding recognition of the importance of local adaptation as a fundamental evolutionary process, and increasing recognition that mycorrhizal fungi are important drivers of ecosystem productivity and diversity, understanding of local adaptation in the context of these mutualistic symbioses is limited. *V. calycinum* and EMF make an ideal study system for a number of reasons. First, *V. calycinum* occurs in many Hawaiian tropical montane forests as the only host for EMF symbionts. This provides a simplified study system, without complex networks of interacting species, as is common with other forms of mycorrhizal symbiosis. Second, *V. calycinum* occurs across the Hawaiian Islands, spanning a wide range of soil conditions. Because the mycorrhizal symbiosis is important for nutrient uptake, variation in nutrient availability is likely to drive local adaptation of the symbiosis. This research will seek to answer two primary questions; 1. How does the EMF community associated with *V. calycinum* vary in composition and structure with nutrient availability? 2. Does nutrient limitation drive local adaptation between *V. calycinum* and its symbiont community? The study will involve populations at six sites across Hawai'i, which span a wide range of nutrient availability, only one of which is located in the HETF. The first phase will involve characterizing the EMF communities associated with *V. calycinum*. This will require harvesting 12 small plants (< 1 m tall) at each location to collect roots. A portion of these roots will be used to isolate pure cultures of EMF for experimental manipulation. The remainder will be used to isolate fungal DNA and characterize the entire fungal community using metagenomic sequencing. The second phase will involve a greenhouse study, in which vegetative cuttings and soils will be collected from each site and combined with the ERM symbionts in sympatric and allopatric groupings. Plant and fungal growth will be monitored to determine whether sympatric groupings outperform allopatric combinations. The impact at HETF will be minimal and will require no more than 5 trips to the site, in total. *V. calycinum* is abundant at the site and the harvest of 12 small plants will have no significant impact on the population. In addition, plants chosen for harvest will be distributed over a wide area, limiting the impact. Cuttings will be taken from an additional 12 plants, using clean shears to prevent the spread of disease. Plants chosen for

harvesting cuttings will be large, healthy plants and no more than 10% of actively growing tissue will be removed. Only small holes (~ 25 X 25 cm X 10 cm deep) will be needed to recover sufficient roots and soil. In addition, only ~2 cu.ft. of soil will be removed for phase 2 of the study. All holes will be back-filled with surrounding soil and litter to avoid creating a tripping hazard. No markers or materials will be left at the field site.

Litton, Creighton & Christian Giardina - An Experimental Test of the impacts of rising temp on C input, allocation, and loss in model forests

The research described in this permit renewal application is the extension of an ongoing, long-term project to understand how climate change in the form of rising temperature will impact the structure and function of tropical wet forests. We plan to continue the same measurements and protocols as used in past years. Carbon storage in the terrestrial biosphere exceeds that in the atmosphere by a factor of four, and represents a dynamic balance among carbon input, allocation, and loss. This balance is being altered by climate change, with important implications for terrestrial carbon storage and, hence, atmospheric CO2 levels and global climate. However, the response of terrestrial carbon cycling to warming remains poorly quantified, especially in the tropics. This is particularly important because tropical forests account for a ~40% of global terrestrial carbon storage and ~35% of global terrestrial productivity and, as such, tropical forests play a very important role in regulating global climate. This study is examining how rising mean annual temperature will impact carbon input, allocation, loss, and storage in native Hawaiian wet forests along a 5.2°C mean annual temperature gradient. Results from research along this model ecological gradient greatly enhance capacity to predict how terrestrial ecosystems, in particular tropical forests, will respond to warming over the next century. The 5.2°C mean annual temperature gradient is arrayed across nine permanent plots spanning a temperature range from 13.0-18.2°C in the Hawai'i Experimental Tropical Forest (State of Hawai'i and USDA Forest Service) and the Hakalau Forest National Wildlife Refuge (US Fish and Wildlife Service). In addition to examining how rising mean annual temperature will impact the carbon balance of the world's most productive forests (i.e., tropical wet forests), this study is a novel global change research platform that has attracted multiple national and international collaborators, providing critical data to the global change community, including scientists, policy makers, and land managers. This study has also enhanced graduate and postdoctoral training and undergraduate science education at a Native Hawaiian serving institution and fostered collaboration between the University of Hawai'i and the USDA Forest Service on the recently established Hawai'i Experimental Tropical Forest.

Lou, Hongyan - NEON FIU and FSU Site Characterization

The National Ecological Observatory Network (NEON, Inc.) is a non-profit, continental-scale observatory for discovering and understanding the impacts of climate change, land-use change, and invasive species on ecology. NEON will gather long-term data on ecological responses of the biosphere to changes in land use and climate, and of feedback with the geosphere, hydrosphere and atmosphere. The NEON Observatory is the first initiative in the biological sciences to be supported through the National Science Foundation's Major Research Equipment and Facilities Construction fund. This research application pertains to the initial FIU (Fundamental Instrument Unit) site characterization and possible FSU (Fundamental Sentinel Unit) characterization. The ultimate goal of the FIU site characterization work is to identify how the NEON sites should be laid out. In particular, where the towers will be located and how the soil plots should be oriented. FIU staff will collect measurements of soil moisture and temperature with a small hand held probe. This activity will leave virtually no impact on the ecosystem. Once collected, statistical evaluations of data will be conducted. The result of the statistical analysis will allow FIU staff to determine the optimal placement and orientation of NEON's tower and soil plots. The goal of FSU characterization is to georeference vegetation types and to record a general layout of the site. This involves a FSU staff member collecting GPS coordinates and documenting vegetation.

MacKenzie, Rich - Quantifying the effects of ungulates and invasive Strawberry Guava (Psidium cattleianum) on sediment runoff in Hawaiian wet forests

Invasive species are having a negative impact on native Hawaiian forests across all Hawaiian Islands. On the Island of Hawai'i, invasive strawberry guava (Psidium cattleianum) is expanding into the understory and outcompeting native species, altering habitat availability and ecosystem function. Additionally, invasive ungulates, noteably feral pigs (Sus scrofa), disrupt the soil structure, consume native vegetation, and create wallows that mosquitoes use to breed. Both strawberry guava and feral pigs are believed to negatively affect water quality in Hawaiian watersheds by increasing sediment loads in surface runoff, yet few studies have examined these factors together to isolate the primary causes driving these changes. The degradation of water quality in streams and wetlands are serious threats to native Hawaiian ecosystems and have been identified by the Natural Area Reserve system as priorities for research. We established long-term study sites (8 to 10 years) to measure sediment runoff from strawberry guava invaded forest and native ohia-dominated forest. Within each forest type (native vs invaded), we created study sites that consist of two plots. One plot is a 3 x 7 m, fenced area that keeps out all pigs, while the other plot is open and allows pigs to access. Within each of these paired (fenced vs open) plots, we installed 1.2 x 4 meter runoff plots. Runoff plots were created by driving in plastic, lawn edging until the top of the edging was approximately 2 inches from the top of the forest soil. Edging was installed at the tops and sides of each runoff plot. At the bottom of the plot, we installed a galvanized steel collector that allowed all of the water running off the plot to fill a 5 gallon bukcet. Paired plots were installed in three native forest areas and three strawberry guava invaded forest areas. During the first year of the project, our equipment collected water flowing off of each runoff plot during major storm events. The water was returned to the lab and the amount of sediment was measured to determine how pigs and strawberry guava affect sediment runoff in native and invaded forests. We also measured how much water reached each runoff plot using tipping buckets attached to the fence posts surroudning the runoff plots. For 2015, we anticipiate continuing to measure surface runoff from our 8 runoff plots 1-4 times, depending on funding and availability of personnel.

Michler, Charles - Acacia Koa environment genomics

Our primary research objective is to understand genetic variation in Acacia koa across environmental gradients (elevation and precipitation). This information is important to assist with developing ""ecozones"" for selective breeding of koa to increase restoration and plantation success.

This project will address the following questions:

Q1. What genetic differences occur among koa populations along elevation and precipitation gradients on Hawai'i Island?

Q2. Are there specific genes related to koa environmental adaptations to site conditions?

Q3. What correlations exist between koa phenotype and genotype under different environmental conditions?

For this project, we have collected samples of koa leaves for genomic analysis from trees growing across environmental conditions on Hawai'i Island, including in the Laupāhoehoe HETF. We request permission to collect additional leaf samples, seeds, and phenology measurements from trees previously sampled for geneomic analysis. This work is essential to understand correlations between koa phenotype and genotype (Q3).

Perroy, Ryan & Jon Price - Meeting Hawai'i's Natural Resource Challenges with Unmanned Aerial Vehicles and Geovisualization

We are using Unmanned Aircraft Vehicles (UAV) to capture aerial photography over Pu'u Wa'awa'a Forest Reserve Makai Subunit to monitor invasive species, conduct biomass estimations, evaluate vegetation health, and to generally assess the use of this technology for environmental monitoring.

Research activities include flying a small UAV over the study area and temporarily placing portable ground control markers out in the landscape. Research Questions: What is the feasibility of identifying and detecting endemic Hawaiian plants using ultra-high resolution imagery collected with Unmanned Aircraft Systems? Can classification of complex ecological communities be improved with the use of Unmanned Aircraft? These questions are important to address as UAVs have the potential to economically capture critical environmental data at spatial and temporal resolutions previously unattainable.

Shea, Thomas - Field Investigation of the Pu'u Anahulu Lava Flows

The Pu'u Wa'awa'a volcanic cone formed ~114,000 years ago on the northern flank of Hualalai volcano (Big Island of Hawai'i), and it is hypothesized that the Pu'u Anahulu lava flows were produced during the same eruption (see Figure 1 attached). This eruption is unique in Hawai'i in that it is one of the only known eruptions that produced true pumice (a very porous glassy rock) as well as obsidian (almost exclusively made of dense glass). The erupted rock is also of a chemical composition that is very different from the typical lavas that erupt from Hawai'i (e.g. Kilauea basalts), and this type of magma has a tendency to generate explosive eruptions more readily. The field work proposed will answer the simple question: Are the cone and flows related in time (i.e. same eruption) and in nature (i.e. same magma)? Since a first field campaign was already completed in 2013-2014 to sample the rocks from Pu'u Wa'awa'a, we now plan to sample the lava flows from the Pu'u Anahulu area for a comparative study (see Figures 2 and 3 for study area). In particular, past reports of pumice rock possibly interbedded between different parts of the Pu'u Anahulu flow will be verified, since those may provide proof that the pumice-producing cone and the dense rock-producing flow were erupted simulatenously. The rocks collected during field work will be cut and made into both thin sections, and aliquots will be used for bulk chemical analysis at the University of Hawai'i. Thin sections will also help determine similarities and differences in the crystal content of the Pu'u Anahulu trachyte and Pu'u Wa'awa'a samples previously collected.

Shimizu, Ben - Operation and maintenance of Kīholo raingage

The rain gage was installed in 2002. The gage records rainfall in increments of 0.01 inches and these files are processed and archived by the USGS. The USGS follows strict protocols for calibration and operation of the gage to ensure high-quality data. Field visits are made every 2 months to service the gage. Rainfall data are available to the public at http://hi.water.usgs.gov. The gage has been operational since 2002 and is in good working order. No destructive sampling is involved with the operation of this gage.

Swenson, Ulf - Biogeographic history of the Hawaiian endemic Planchonella sandwicensis

Sapotaceae are an important component of rainforests in all tropical regions. Planchonella is the largest genus with some 110–130 known species in Australasia and the Pacific. In a recent fossil-calibrated divergence time estimate of Australasian and Pacific Sapotaceae, it was proposed that Planchonella most likely originated in the Australian continent (including New Guinea) some 43 Ma. Planchonella sandwicensis is endemic to the Hawaiian archipelago and is very variable in habit, leaf, and fruit morphology. So far, three accessions from Hawai'i were used in our study; two from Oahu and one from Kauai, and the oldest split is estimated to 8.8 Ma (5.2–12.9 Ma), that is, older than the islands they inhabit. This result prompted us to raise several interesting questions. Is P. sandwicensis actually older than the islands it inhabits? Is this due to Sapotaceae are an important component of rainforests in all tropical regions. Planchonella is the largest genus with some 110–130 known species in Australasia and the Pacific. In a recent fossil-calibrated divergence time estimate of Australasian and Pacific Sapotaceae, it was proposed that Planchonella most likely originated in the Australian continent (including New Guinea) some 43 Ma. Planchonella sandwicensis is endemic to the Hawaiian archipelago and is very variable in habit, leaf, and fruit morphology. So far, three accessions from Hawai'i were used in our study;

two from Oahu and one from Kauai, and the oldest split is estimated to 8.8 Ma (5.2–12.9 Ma), that is, older than the islands they inhabit. This result prompted us to raise several interesting questions. Is P. sandwicensis actually older than the islands it inhabits? Is this due to the movement across a hotspot? Are the oldest populations found on the oldest island or did it disperse between the islands despite the order of origin? Is the observed morphological variation possible to correlate with geography, formally recognized species, or is it random. In other words, can more than a single taxon be recognized? Answers to these questions are also important whether island endemic taxa can be used (or should be avoided) as calibration points in divergence time estimates. To address these issues we would like to sample from 7-10 populations of P. sandwicensis from each Hawaiian Island. We will evaluate variations in morphology and will sequence multiple molecular markers to evaluate the biogeographic history of the species in Hawai‘i. Permits are currently being submitted for collections across all Hawaiian Islands. Dr. Ulf Swenson (Sweden) and Professor Christopher Havran (USA), seek permission to collect P. sandwicensis (Sapotaceae) at Pu`uwa`awa`a, Hawai`i. We would like to sample from one or two populations of P. sandwicensis spaced 2-3 km apart. Two to three 30–50 cm long branches, pruned down to five herbarium samples, will be removed from one tree in each population and will be deposited in five herbaria: S, BISH, CAU, PTGB and P. Leaf fragments dried in silica gel for DNA analysis, will also be removed from the population. Our fieldwork in Hawai‘i is scheduled to 3-9 August 2015. No markers or equipment will be left in the field.

Ticktin, Tamara - Linking local ecological knowledge, ecosystem services and climate change

Human and natural systems are interlinked in complex ways. Understanding how these ‘social-ecological’ systems are resilient to climate change is one of the most pressing problems of our world today. This is especially true for coastal communities in the Pacific Islands, which are extremely vulnerable to the effects of climate change. We are an interdisciplinary team partnering with other scientists and resource managers to study social-ecological resilience to climate change in Hawai'i and Fiji. Using a combination of long-term existing social and ecological datasets, new data and experiments, and state-of the art climate and ecosystem service models, we ask: How will different land and ocean uses affect social-ecological resilience and ecosystem services in linked ridge-reef settings, under different climate change scenarios? To answer this question we focus on three watersheds - Ha'ena (Kauai) and Pu'u Wa'a Wa'a/ Ka'ūpūlehu (Hawai'i), and Kubulau (Vanua Levu, Fiji). This project involves gathering new and compiling existing terrestrial and marine ecological data, economic data and cultural data. We are applying for this permit to carry out the portion of this project that involves terrestrial vegetation surveys in Pu'u Wa'a Wa'a. Specifically we are carrying vegetation surveys of the different vegetation types to characterize them in terms of the current and future ecosystem services they provide, and in terms of their capacity to enhance resilience to climate change. These surveys include identifying and measuring height and DBH of all native and non-native vegetation in the canopy, midstory and understory in each main land cover/land use. We will use our vegetation survey data to determine some ecosystem services, indicators of resilience, and some of the associated cultural values/uses. By combining the terrestrial and marine data, and the economic and cultural data for each watershed, with climate change projections for each region, we will build models to identify which combinations of land and ocean uses can maximize social-ecological resilience and sustainability under climate change scenarios. Models will be based on InVEST (Integrated Valuation of Environmental Services and Tradeoffs) software tool developed by the Natural Capital Project (www.naturalcapitalproject.org). We will use the climate change projections already available for Hawai'i on projected changes in: the distribution and density of native and invasive species, sea level rise and ocean warming and acidification. These models will allow us to evaluate trade-offs and synergies within watersheds and among scenarios in terms of the amount of services, as well as indicators of resilience. It will allow us to identify how “stable” the services provided by given land-use may be over climate change scenarios. We will identify a series of “optimum” scenarios – those that appear to maximize resilience indicators (at the watershed scale) and emphasize the values identified to

be of interest to community members, land managers, owners. This research is expected to have direct benefits to society by enhancing local capacity in decision making to manage coastal areas for sustainability, and contributing to policy development in resilience and adaptation to climate change.

Vitousek, Peter - Sources and fates of nutrients on a substrate age gradient across the Hawaiian archipelago and their consequences for forest dynamics

We use a site within the Laupāhoehoe Forest as a point on an age gradient across the Hawaiian Islands, with all sites at similar elevation and rainfall but varying in soil age from ~ 300 years near Volcanoes National Park to ~ 4.1 million years near Kokee, Kauai. Our site at Laupāhoehoe is at 1200 m elevation, west of Blair Road, between the road and the Waipunalei boundary. The Laupāhoehoe site is the largest-stature and highest-nutrient forest along the gradient, and so it gives us a clear idea of what forests can be, given those conditions of elevation and rainfall. Our main focus is understanding what controls soil fertility, plant productivity, and biological diversity along the range from fairly new rock to ancient soils. At sites along this gradient (including Laupāhoehoe), we have fertilized trees with individual and combined nutrients, so that we can identify and understand which nutrients constrain forest growth at different stages; we measure tree growth and microbial activity in response to fertilizer addition. This work includes measurements of biological processes (decomposition, organic matter chemistry) in addition to growth. We also determine plant and microbial diversity in these sites. This research is integrated with aircraft-based remote sensing studies of vegetation, and with analyses of pollen profiles in depressions within the forest to determine vegetation history. The fertilized trees are marked with tags and orange flagging, and (due to frequent sampling) we maintain an open soil pit (that since September 2014 has been fenced to prevent animals from getting into it) in the core site.

Yanger, Corie - Examining the effects of invasive thrips infestation on natural and planted Hawaiian Myoporum seedlings

Invasive non-native insects are an increasing problem for native systems. Plant-eating species are an important group of introduced insects because they can cause large amounts of visible damage, especially if the target plant is widespread and abundant. On Hawai‘i Island, an invasive insect called Myoporum thrips is attacking the native naio tree. The insects are causing widespread leaf damage and tree loss across the dry forest where naio makes up roughly half of the forest canopy, including at Pu‘u Wa‘awa‘a Forest Reserve. Researchers have been monitoring the thrips’ damage to mature naio trees for the past three years. However, there is little information about how the thrips affect naio flower and fruit production, and seedling growth and survival. It is important to understand how thrips affect these reproductive characters because current mature naio trees must eventually be replaced through successful naio seed production and seedling growth. To understand how invasive Myoporum thrips impact naio tree flower and fruit production, I propose to continue monitoring mature naio trees from my original permit. To understand how the thrips impact naio seedling growth and survival, I propose to continue one study at Pu‘u Wa‘awa‘a Forest Reserve and to begin a second study. For the first study, I will continue to measure natural native seedlings between 4500 and 5100 ft in elevation. For the next six months, I will visit the tagged seedlings and measure: height, percentage of thrips damage, and percentage of other insect damage. Seedling locations have measurements of biological processes (decomposition, organic matter chemistry) in addition to growth. We also determine plant and microbial diversity in these sites. This research is integrated with aircraft-based remote sensing studies of vegetation, and with analyses of pollen profiles in depressions within the forest to determine vegetation history. The fertilized trees are marked with tags and orange flagging, and (due to frequent sampling) we maintain an open soil pit (that since September 2014 has been fenced to prevent animals from getting into it) in the core site.

Yeh, Aileen - Operational Disease Screening Program for Resistance to Wilt in Acacia Koa in Hawai‘i

We are collecting seed from wild populations of Acacia koa around the island to be used in nursery screening trials testing for resistance to *Fusarium oxysporum*, the putative causal agent for Koa Wilt. This seed will be screened in the nursery to determine resistance of individual trees, families and localities to the *F. oxysporum*. Seed will be collected, using pruning poles. Our target for collection is for approximately 225 seeds (not pods) from each of 10 trees at each site location (75 seeds for the nursery trial and 150 seeds for the field trials). We will have one site location per indicated State land designation. (ie 10 trees from Pu‘u Wa‘awa‘a forest reserve, 10 trees from the Pu‘u Wa‘awa‘a forest bird sanctuary, 10 trees from Laupāhoehoe forest reserve and 10 trees from the Laupāhoehoe NAR). We have sufficient seed from the Pu‘u Wa‘awa‘a Forest Bird Sanctuary site, but may need to collect more seed from the original trees if they show promise of resistance. We were not able to collect seed from enough trees at Laupāhoehoe in 2014 because of the moth defoliation and poor seed set.

Appendix B – 2015 Research Detail

Laupāhoehoe Unit

Laupāhoehoe Forest Reserve Sub-Unit

Principle Investigator: Cordell, Susan	**Permit Duration:** Feb 23, 2015 to Feb 22, 2016
☐ **New Permit** ☐ **Renewal** ☒ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Hawai'i Permanent Plot Network (HIPPNET)	
Affiliation: USDA Forest Service	
PI Contact Info: scordell01@fs.fed.us; (808) 854-2628	
Dates of Anticipated Results: Indefinite	**Publications, etc. Received:** Yes ☒ No ☐
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Cusack, Daniela	**Permit Duration:** Jun 1, 2015 to May 31, 2016
☒ **New Permit** ☐ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☒ LAU-FR ☐ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Soil Carbon Cycling Across a Hawaiian Mineralogical Gradient	
Affiliation: UCLA	
PI Contact Info: daniela.cusack@gmail.com; (303) 859-3837	
Dates of Anticipated Results: June 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☐ Yes ☒ No ☐ Renewal ☐ Completion ☒ New Permit	

Principle Investigator: Ewing, Curtis	**Permit Duration:** Jan 29, 2015 to Jan 28,2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Community assembly & diversification of Hawaiian Arthropods	
Affiliation: University of Hawai'i at Hilo	
PI Contact Info: cpe1@hawaii.edu; (707) 373-0937	
Dates of Anticipated Results: July 2018	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Hughes, Flint	**Permit Duration:** Apr 28, 2015 to Apr 27, 2016
☐ **New Permit** ☐ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☒ LAU-FR ☐ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Forest disease monitoring for the Ōhi'a rust disease affecting Ōhi'a trees.	
Affiliation: USDA Forest Service	
PI Contact Info: fhughes@fs.fed.us; (808) 933-8121 x 117	
Dates of Anticipated Results: Mar 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Leopold, Devin	**Permit Duration:** Aug 3, 2015 to Aug 2, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☒ LAU-FR ☐ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Local adaptation in an ericoid mycorrhizal symbiosis	
Affiliation: Stanford University	
PI Contact Info: devin.leopold@gmail.com; (603) 702-1203	
Dates of Anticipated Results: Aug 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Litton, Creighton	**Permit Duration:** Jun 30, 2015 to Jun 29, 2016
☐ **New Permit** ☐ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☐ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: An Experimental Test of the impacts of rising temp on C input, allocation, and loss in model forests.	
Affiliation: University of Hawai'i at Manoa	
PI Contact Info: litton@hawaii.edu; (808) 956-6004	
Dates of Anticipated Results: Jun 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: MacKenzie, Rich	**Permit Duration:** Jan 1, 2015 to Dec 31,2015
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☐ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Quantifying the effects of ungulates and invasive Strawberry Guava (Psidium cattleianum) on sediment runoff in Hawaiian wet forests	
Affiliation: USDA Forest Service	
PI Contact Info: rmackenzie@fs.fed.us; (808) 854-2616	
Dates of Anticipated Results: July 2020	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Michler, Charles	**Permit Duration:** Jan 1, 2015 to Dec 31, 2015
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☒ LAU-FR ☐ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Acacia Koa environment genomics	
Affiliation: USDA Forest Service, Department of Forestry and Natural Resources, Purdue University; Director if the Hardwood Tree Improvement and Regeneration Center (HTIRC)	
PI Contact Info: michler@purdue.edu; (765) 496-6016	
Dates of Anticipated Results: Dec 2015	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Vitousek, Peter	**Permit Duration:** Feb 23, 2015 to Feb 22, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☒ LAU-FR ☐ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Sources and fates of nutrients on a substrate age gradient across the Hawaiian archipelago and their consequences for forest dynamics.	
Affiliation: Stanford University	
PI Contact Info: vitousek@stanford.edu; (650) 725-1866	
Dates of Anticipated Results: 2020	**Publications, etc. Received:** Yes ☒ No ☐
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Yeh, Aileen	**Permit Duration:** Apr 28, 2015 to Apr 27, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Operational Disease Screening Program for Resistance to Wilt in Acacia Koa in Hawai'i.	
Affiliation: Hawai'i Agriculture Research Center	
PI Contact Info: ayeh@hawaii.rr.com; (808) 936-2671	
Dates of Anticipated Results: Feb 2018	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Laupāhoehoe Natural Area Reserve Sub-Unit

Principle Investigator: Cordell, Susan	**Permit Duration:** Feb 23, 2015 to Feb 22, 2016
☐ **New Permit** ☐ **Renewal** ☒ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Hawai'i Permanent Plot Network (HIPPNET)	
Affiliation: USDA Forest Service	
PI Contact Info: scordell01@fs.fed.us; (808) 854-2628	
Dates of Anticipated Results: Indefinite	**Publications, etc. Received:** Yes ☒ No ☐
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Ewing, Curtis	**Permit Duration:** Jan 29, 2015 to Jan 28,2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Community assembly & diversification of Hawaiian Arthropods	
Affiliation: University of Hawai'i at Hilo	
PI Contact Info: cpe1@hawaii.edu; (707) 373-0937	
Dates of Anticipated Results: July 2018	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Litton, Creighton	**Permit Duration:** Jun 30, 2015 to Jun 29, 2016
☐ **New Permit** ☐ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☐ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: An Experimental Test of the impacts of rising temp on C input, allocation, and loss in model forests.	
Affiliation: University of Hawai'i at Manoa	
PI Contact Info: litton@hawaii.edu; (808) 956-6004	
Dates of Anticipated Results: Jun 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: MacKenzie, Rich	**Permit Duration:** Jan 1, 2015 to Dec 31,2015
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☐ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Quantifying the effects of ungulates and invasive Strawberry Guava (Psidium cattleianum) on sediment runoff in Hawaiian wet forests	
Affiliation: USDA Forest Service	
PI Contact Info: rmackenzie@fs.fed.us; (808) 854-2616	
Dates of Anticipated Results: July 2020	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Yeh, Aileen	**Permit Duration:** Apr 28, 2015 to Apr 27, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Operational Disease Screening Program for Resistance to Wilt in Acacia Koa in Hawai'i.	
Affiliation: Hawai'i Agriculture Research Center	
PI Contact Info: ayeh@hawaii.rr.com; (808) 936-2671	
Dates of Anticipated Results: Feb 2018	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Pu‘u Wa‘awa‘a Unit

Pu‘u Wa‘awa‘a Forest Reserve Sub-Unit

Principle Investigator: Barton, Kasey	**Permit Duration:** Sep 30, 2015 to Sep 29, 2016
☐ **New Permit** ☐ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Population variation in pua kala defenses	
Affiliation: University of Hawai‘i at Manoa	
PI Contact Info: kbarton@hawaii.edu; (808) 956-8028	
Dates of Anticipated Results: Sep 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☐ Yes ☒ No ☐ Renewal ☐ Completion ☒ New Permit	

Principle Investigator: Bosted, Peter	**Permit Duration:** Jan 1, 2015 to Dec 31,2015
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Lava Tube location, photo-documentation, and resource evaluation on Pu‘u Wa‘awa‘a and Pu‘u Anahulu	
Affiliation: Hawai`i Speleological Survey	
PI Contact Info: bosted@jlab.org; (808) 315-1297	
Dates of Anticipated Results: Dec 2015	**Publications, etc. Received:** Yes ☒ No ☐
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Cordell, Susan	**Permit Duration:** Feb 23, 2015 to Feb 22, 2016
☐ **New Permit** ☐ **Renewal** ☒ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Hawai‘i Permanent Plot Network (HIPPNET)	
Affiliation: USDA Forest Service	
PI Contact Info: scordell01@fs.fed.us; (808) 854-2628	
Dates of Anticipated Results: Indefinite	**Publications, etc. Received:** Yes ☒ No ☐
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Cordell, Susan	**Permit Duration:** Jun 1, 2015 to May 31, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: The potential for restoration to break the grass/fire cycle in dryland ecosystems in Hawai‘i.	
Affiliation: USDA Forest Service	
PI Contact Info: scordell01@fs.fed.us; (808) 854-2628	
Dates of Anticipated Results: 2017	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Earnshaw, Kyle	**Permit Duration:** Jun 1, 2015 to May 31, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Adaptiveness of heteroblasty in two populations of Acacia koa in response to light availability.	
Affiliation: Purdue University, TropHTIRC	
PI Contact Info: kearnsha@purdue.edu; (484) 824-4642	
Dates of Anticipated Results: July 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Ewing, Curtis	**Permit Duration:** Jan 29, 2015 to Jan 28,2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Community assembly & diversification of Hawaiian Arthropods	
Affiliation: University of Hawai‘i at Hilo	
PI Contact Info: cpe1@hawaii.edu; (707) 373-0937	
Dates of Anticipated Results: July 2018	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Johnson, Anna	**Permit Duration:** Aug 31, 2015 to Aug 30, 2016
☒ **New Permit** ☐ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Tracking the impact of species introductions and extinctions on ecological interaction networks.	
Affiliation: University of Pittsburgh	
PI Contact Info: annalj12@gmail.com; (717) 321-4945	
Dates of Anticipated Results: Aug 2017	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☐ Yes ☒ No ☐ Renewal ☐ Completion ☒ New Permit	

Principle Investigator: Lou, Hongyan	**Permit Duration:** Feb 23, 2015 to Feb 22, 2016
☒ **New Permit** ☐ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: NEON FIU and FSU Site Characterization	
Affiliation: NEON, Inc.	
PI Contact Info: hluo@neoninc.org; (720) 836-2403	
Dates of Anticipated Results: Feb 2015	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☐ Yes ☒ No ☐ Renewal ☐ Completion ☒ New Permit	

Principle Investigator: Perroy, Ryan	**Permit Duration:** Jun 1, 2015 to May 31, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Meeting Hawai'i's Natural Resource Challenges with Unmanned Aerial Vehicles and Geovisualization.	
Affiliation: University of Hawai'i at Hilo	
PI Contact Info: rperroy@hawaii.edu; (808) 932-7259	
Dates of Anticipated Results: May 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Shea, Thomas	**Permit Duration:** Apr 28, 2015 to Apr 27, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Field Investigation of the Pu'u Anahulu Lava Flows	
Affiliation: University of Hawai'i at Mānoa	
PI Contact Info: tshea@hawaii.edu; (808) 956-9819	
Dates of Anticipated Results: Mar 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Shimizu, Ben	**Permit Duration:** Apr 28, 2015 to Apr 27, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Operation and maintenance of Kīholo raingage	
Affiliation: US Geological Survey	
PI Contact Info: bhshimz@usgs.gov; (808) 690-9574	
Dates of Anticipated Results: Mar 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Swenson, Ulf	**Permit Duration:** Apr 28, 2015 to Apr 27, 2016
☒ **New Permit** ☐ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Biogeographic history of the Hawaiian endemic Planchonella sandwicensis.	
Affiliation: Swedish Museum of Natural History	
PI Contact Info: ulf.swenson@nrm.se; +46 70 2469 223	
Dates of Anticipated Results: Aug 2015	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☐ Renewal ☒ Completion ☒ New Permit	

Principle Investigator: Ticktin, Tamara	**Permit Duration:** Sep 30, 2015 to Sep 29, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Linking local ecological knowledge, ecosystem services and climate change.	
Affiliation: University of Hawai'i at Manoa	
PI Contact Info: ticktin@hawaii.edu; (808) 956-3928	
Dates of Anticipated Results: Jun 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: William, Jeffery	**Permit Duration:** Jan 1, 2015 to Dec 31,2015
☒ **New Permit** ☐ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☒ PWW-Park	
Research Title: Albinism Transcriptomics of Cave-adapted Planthoppers	
Affiliation: Department of Biology, University of Maryland	
PI Contact Info: jeffery@umd.edu; (240) 421-3764	
Dates of Anticipated Results: Dec 2015	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☐ Yes ☒ No ☐ Renewal ☐ Completion ☒ New Permit	

Principle Investigator: Yanger, Corie	**Permit Duration:** Jan 1, 2015 to Dec 31, 2015
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☐ PWW-Park	
Research Title: Examining the effects of invasive thrips infestation on natural and planted Hawaiian Myoporum seedlings	
Affiliation: University of Hawai'i at Hilo, TCBES Graduate Student	
PI Contact Info: cmyanger@hawaii.edu; (808) 430-0913	
Dates of Anticipated Results: Sep 2015	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Yeh, Aileen	**Permit Duration:** Apr 28, 2015 to Apr 27, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Operational Disease Screening Program for Resistance to Wilt in Acacia Koa in Hawai‘i.	
Affiliation: Hawai‘i Agriculture Research Center	
PI Contact Info: ayeh@hawaii.rr.com; (808) 936-2671	
Dates of Anticipated Results: Feb 2018	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Pu‘u Wa‘awa‘a Forest Bird Sanctuary Sub-Unit

Principle Investigator: Bosted, Peter	**Permit Duration:** Jan 1, 2015 to Dec 31,2015
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Lava Tube location, photo-documentation, and resource evaluation on Pu‘u Wa‘awa‘a and Pu‘u Anahulu	
Affiliation: Hawai`i Speleological Survey	
PI Contact Info: bosted@jlab.org; (808) 315-1297	
Dates of Anticipated Results: Dec 2015	**Publications, etc. Received:** Yes ☒ No ☐
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Cordell, Susan	**Permit Duration:** Feb 23, 2015 to Feb 22, 2016
☐ **New Permit** ☐ **Renewal** ☒ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Hawai‘i Permanent Plot Network (HIPPNET)	
Affiliation: USDA Forest Service	
PI Contact Info: scordell01@fs.fed.us; (808) 854-2628	
Dates of Anticipated Results: Indefinite	**Publications, etc. Received:** Yes ☒ No ☐
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Ewing, Curtis	**Permit Duration:** Jan 29, 2015 to Jan 28,2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Community assembly & diversification of Hawaiian Arthropods	
Affiliation: University of Hawai'i at Hilo	
PI Contact Info: cpe1@hawaii.edu; (707) 373-0937	
Dates of Anticipated Results: July 2018	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: Lou, Hongyan	**Permit Duration:** Feb 23, 2015 to Feb 22, 2016
☒ **New Permit** ☐ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: NEON FIU and FSU Site Characterization	
Affiliation: NEON, Inc.	
PI Contact Info: hluo@neoninc.org; (720) 836-2403	
Dates of Anticipated Results: Feb 2015	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☐ Yes ☒ No ☐ Renewal ☐ Completion ☒ New Permit	

Principle Investigator: Yeh, Aileen	**Permit Duration:** Apr 28, 2015 to Apr 27, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☒ LAU-NAR ☒ LAU-FR ☒ PWW-FR ☒ PWW-FBS ☐ PWW-Park	
Research Title: Operational Disease Screening Program for Resistance to Wilt in Acacia Koa in Hawai'i.	
Affiliation: Hawai'i Agriculture Research Center	
PI Contact Info: ayeh@hawaii.rr.com; (808) 936-2671	
Dates of Anticipated Results: Feb 2018	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Pu‘u Wa‘awa‘a State Park Reserve (Kīholo) Sub-Unit

Principle Investigator: Hughes, Flint	**Permit Duration:** Jun 1, 2015 to May 31, 2016
☐ **New Permit** ☒ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☐ PWW-FR ☐ PWW-FBS ☒ PWW-Park	
Research Title: Quantifying dynamics and magnitude of water loss from kiawe forests in North Kona – Kīholo Bay.	
Affiliation: USDA Forest Service	
PI Contact Info: fhughes@fs.fed.us; (808) 933-8121 x 117	
Dates of Anticipated Results: Apr 2016	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☒ Yes ☐ No ☒ Renewal ☐ Completion ☐ New Permit	

Principle Investigator: William, Jeffery	**Permit Duration:** Jan 1, 2015 to Dec 31,2015
☒ **New Permit** ☐ **Renewal** ☐ **Permanent (contingent upon approval)** ☐ **No Valid Permit**	
Project Location(s): ☐ LAU-NAR ☐ LAU-FR ☒ PWW-FR ☐ PWW-FBS ☒ PWW-Park	
Research Title: Albinism Transcriptomics of Cave-adapted Planthoppers	
Affiliation: Department of Biology, University of Maryland	
PI Contact Info: jeffery@umd.edu; (240) 421-3764	
Dates of Anticipated Results: Dec 2015	**Publications, etc. Received:** Yes ☐ No ☒
Annual Report Received: ☐ Yes ☒ No ☐ Renewal ☐ Completion ☒ New Permit	

Appendix C – 2015 HETF staff and related members

USFS Staff

USFS-HETF Line Officer - Dr. Ric Lopez
USFS-HETF Science Lead - Dr. Susan Cordell
USFS-HETF Education Lead - Dr. Christian Giardina
USFS-HETF Facilities Manager - Dean Oshiro
HETF Project Manager - Mel Dean
HETF Resource Associate - Tabetha Block

DOFAW Staff

Hawai'i Island DOFAW Branch Manager - Steve Bergfeld
Hawai'i Island Natural Area Reserves Program Manager - Nick Agorastos
Hawai'i Island Forestry Program Manager – Jay Hatayama
(The Forestry Program Manager's vacancy was filled in August 5, 2015.)
The following people acted in rotation during the interim.

- Christopher Graper: December 29 - January 2, 2015
- Don Yokoyama: January 5, 2015 - January 30, 2015
- Lyman Perry: February 2, 2015 - February 27, 2015
- Christopher Graper: March 2, 2015 - March 27, 2015
- Jay Hatayama: March 30, 2015 - April 24, 2015
- Don Yokoyama: April 27, 2015 - May 22, 2015
- Lyman Perry: May 25, 2015 - June 19, 2015
- Christopher Graper: June 22, 2015 - July 17, 2015
- Jay Hatayama: July 20, 2015 - August 4, 2015

East Hawai'i Island Wildlife Biologist - Joey Mello
West Hawai'i Island Wildlife Biologist -

- Hans Sin: January 1, 2015 to April 5, 2015
- Kanalu Sproat: April 6, 2015 to present

Pu'u Wa'awa'a coordinator – Elliott Parsons
State Parks Hawai'i Island District Superintendent - Dean Takebayashi

Laupāhoehoe Advisory Council Members

Cultural Resources:

- Pi'i La`eha
- OPEN

Education:

- Paki Nahale-a
- OPEN

Hawai'i Community at Large:

- David Montgomerie
- Scot Sanderson

Laupāhoehoe Community at Large:

- Derwin Ignacio (served 12/2010 to 9/2015)
- Judi Steinman

Natural Resource Management:

- Bill Stormont
- Chris Yuen

Recreation:

- Darus Ignacio
- Paul Dias (served from 12/2010 to 8/2015)

Scientific Research:

- Jonathan Price
- Robert Nishimoto

Pu‘u Wa‘awa‘a Advisory Council Members

Hui ‘Ohana mai Pu‘u Anahulu a me Pu‘u Wa‘awa‘a:

- Lehua Alapai
- OPEN

Cultural Expert:

- Hannah Kihalani Springer

Neighboring Landowner:

- Mary Metcalf

Natural Resource Specialists:

- Michael Tomich
- Susan Cordell
- Jon Giffin

Recreational Use Specialists:

- Alan Nakagawa
- Bob Okawa
- Frank Sayre

Business/Ecotourism Specialist:

- Chris Yuen

Grazing Specialists:

- Jeff Lee
- OPEN

Grant Writing Expertise:

- Tina Arapkiles

Appendix D – Youth Conservation Corps 2015 Summary

HILO TEAM C

Team Leader: Maya Chong

Site Manager: Shea Uehana, Field Supervisor

Site: Hawai'i Permanent Plot Network Plot
YCC Crew: USFS Hilo Team C
Total number of work days (including travel): 3
Activities:

- Participated in an orientation/safety briefing.
- Discussed the protocols for retagging trees.
- Learned about the history of the Palamanui plot.
- Manually retagged trees – replacing deteriorated string with more durable marine grade aluminum wire (~14,000 trees in the plot).

Recommended changes/suggestions/comments:
None.

Site Manager: Bill Buckley, Big Island Invasive Species Committee (BIISC) - Albizia Project Coordinator

Site: Akaka Falls State Park
YCC Crew: USFS Hilo Team C
Total number of work days: (including travel): 2
Activities

- Participated in an educational orientation, discussing the background of *Albizia* including: its origin; why it was planted in Hawai'i; why it's a problem; and an overview of the BIISC *Albizia* program including current outreach efforts in *Albizia* stricken communities, how and why the program got started and why it's important.
- Received a general safety overview including: safe pesticide application, sharp hand tools, falling branches, etc.; how to treat *Albizia* safely with the use of hatchet and pesticide; and safe navigation through the forest including the how to use a GPS for treatment purposes.
- Walked transects with the aid of a GPS and compass with experienced crew members.
- Treated every *Albizia* encountered (733 total treated on almost 10 acres).

Recommended changes/suggestions/comments:
The YCC crew was awesome. We really loved having them and hope to have another crew next year.

L-R: Before and after photos of Albizia work done with Big Island Invasive Species Committee.

Site Manager: Elliott Parsons, DOFAW, Puʻu Waʻawaʻa Coordinator

Site: HETF Puʻu Waʻawaʻa Unit
YCC Crew: USFS Hilo Team C
Total number of work days (including travel): 4
Activities:

- Removal of invasive woody shrubs and grasses.
- Removal of dead wood off of a firebreak.
- Fence and trail building.
- Removed dead wood off of about 2 miles of fuel breaks around Henahena fence alignment.
- Controlled approximately a half-acre of fountain grass in Hauaina for outplanting.
- Removed invasive woody shrubs over about an acre in preparation for outplanting.
- Constructed two separate ungulate proof exclosures protecting two uhiuhi (about 250 feet of fence) at Waikoloa Dry Forest Initiative

Work Sites:
Hauaina Conservation Unit, Henahena Fire Fuel Break, and Waikoloa Dry Forest Initiative Preserve

Recommended changes/suggestions/comments:
None.

Site Manager: Rebecca Most, The Nature Conservancy (TNC) Marine Coordinator, Hawaiʻi Island

Site: Kīholo Bay, Puʻu Waʻawaʻa Ahupuaʻa
YCC Crew: USFS Hilo Team C
Total number of work days (including travel): 5
Activities:

- Completed annual Vegetation survey - 50 transects surveyed for canopy and understory cover.

- Cleared invasive vegetation - ~ 60 cubic yards of invasive vegetation (kiawe and ironwood) cleared and burned
- Monitored water quality - 20 stations monitored
- Discussed the area of Kīholo (history, landscape, mo‘olelo)
- Assisted in trapping invasive invertebrate
- Assisted in surveying benthic invertebrate
- Participated in a beach clean-up

USFS Hilo C team with other YCC members at Kīholo.

Recommended changes/suggestions/comments:
The team was super respectful, hardworking and had great attitudes!

Site Manager: Riley De Mattos, RCUH-NREM Natural Resource Technician

Site: HETF Laupāhoehoe Unit and the Laupāhoehoe Science and Learning Center (Center)
YCC Crew: USFS Hilo Team C
Total number of work days (including travel): 4
Activities:

- Removed 3 acres of old fenced enclosures.
- Controlled Himalayan raspberry from approximately 2 acres.
- Constructed a half mile trail to Shack camp through the Tropical Ash forest in Laupāhoehoe Forest.
- Cleared brush and invasive plants from Center.
- Weeded and assisted with a study in the ‘ōhi‘a common garden.

Recommended changes/suggestions/comments:
None.

Site Manager: Cheyenne Perry, Mauna Kea Watershed Alliance (MKWA)

Site: Kanakaleonui Bird Corridor
YCC Crew: USFS Hilo Team C
Total number of work days (including travel): 4
Activities:

- Bucked down a ponderosa pine that fell near Kanakaleonui Cabin.
- Helped maintain rustic housing infrastructure.

- Outplanted 286 native trees; 23 a‘ali‘i (Dodonaea), 35 aweoweo, 100 koa (Acacia), 90 mamane (Sophora), and 38 iliahi; and 30 sandalwood (Santalum), 20 stenogyne (native mint), 5 kupaoa (Dubautia), and 1 aweoweo (Chenopodium).
- Cleaned up Kanakaleonui Cabin area.
- Visited the David Douglas monument in the upper portion of the Laupāhoehoe Unit of the HETF.
- Collected koa seed used fir future outplanting.

Recommended changes/suggestions/comments:
Everything went smoothly, also we were able to install a water pump and shower at the cabin but it’s still very much like camping.

HILO TEAM D

Team Leader: Tim Housman

Site Manager: Aleysia Kaha, Kupu EIP Intern

Site: Various locations
YCC Crew: USFS Hilo Team D
Total number of work days (including travel):
Activities:

- Visited various locations in preparation for the Inter-tribal Congress and discussed the effects of climate change on tropical forests and streams, and the role of afforestation in mitigating these effects.
- Worked with UH Hilo professor Ryan Perroy who introduced the team to different tools used in geography to gauge climate science through mapping.
- Hiked through Kaumana trail and learned about the phenology of the native forest and its relationship to the native birds.
- Discussed the area of Mauna Kea (including the history and long-term restoration efforts and the necessity for integration of both native Hawaiian intelligence and current methodologies in resource management).
- Outplanted 100 ‘iliahi plants (sandalwood).
- Compared and contrasted native and Polynesian introduced gardens and discussed how landscape shapes us and how we shape it.

Recommended changes/suggestions/comments:
None.

Site Manager: Aleysia Kaha, Kupu EIP Intern

Site: West Virginia, Inter-Tribal Congress
YCC Crew: USFS Hilo Team D
Total number of work days (including travel): 5
Activities:

- Participated in a week of intensive education and peer-to-peer trainings.
- Engaged in small group activities with different tribes to address the impact of climate change on tribal communities.
- Sight-seeing at the Capitol – visited the Aerospace museum, Native American Museum, and Natural History Museum.

Recommended changes/suggestions/comments:
None.


Attendees of the 2015 Inter-Tribal Youth Climate Leadership Congress (ITYCLC)

Site Manager: Riley De Mattos, RCUH-NREM Natural Resource Technician

Site: HETF Laupāhoehoe Unit
YCC Crew: USFS Hilo Team D
Total number of work days (including travel): 4
Activities:

- Removed 3 acres of old fenced enclosures.
- Controlled Himalayan raspberry from approximately 2 acres.
- Constructed a half mile trail to Shack camp through the Tropical Ash forest in Laupāhoehoe Forest.
- Cleared brush and invasive plants from Center.
- Weeded and assisted with a study in the ʻōhiʻa common garden.

Recommended changes/suggestions/comments:
None.

Site Manager: Elliott Parsons, DOFAW, Puʻu Waʻawaʻa Coordinator

Site: HETF Puʻu Waʻawaʻa Unit
YCC Crew: USFS Hilo Team D
Total number of work days (including travel): 4
Activities:

- Hand cleared invasive woody shrubs over a half acre space in preparation for out-planting in the Hauaina Restoration Unit.
- Hand cleared approximately 4 miles of tree tobacco off the main fire break at Puʻu Waʻawaʻa.
- Outplanted native Hawaiian plants (62 koa (Acacia koa), 17 māmane (*Sophora chrysophylla*), 52 kōlea (*Myrsine lessertiana*), 58 pilo (*Coprosma montanus*), and 11 ʻiliahi (*Santalum paniculatum*)).

Recommended changes/suggestions/comments:
None.

Site Manager: Riley De Mattos, RCUH-NREM Natural Resource Technician

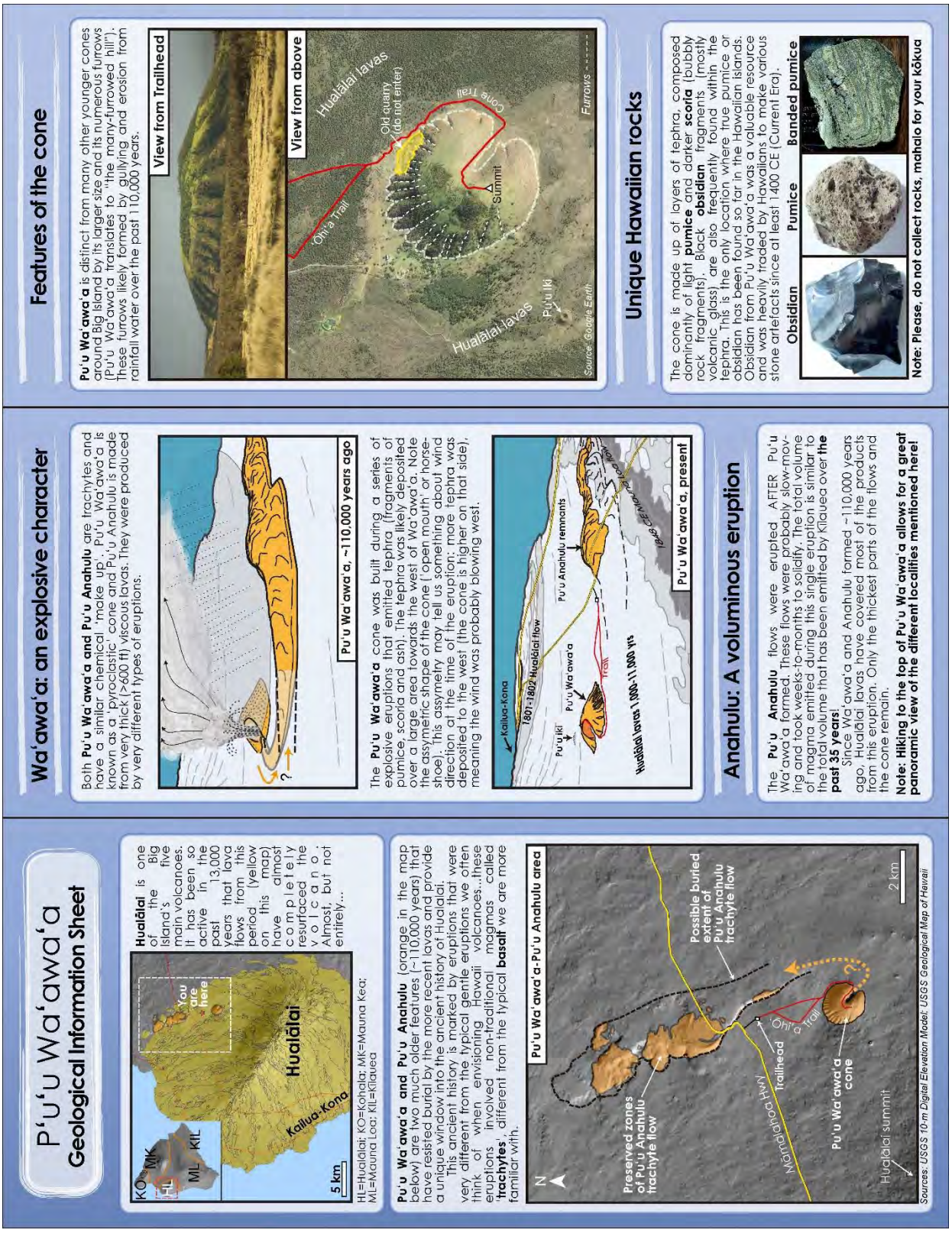
Site: HETF Laupāhoehoe Unit
YCC Crew: USFS Hilo Team D
Total number of work days (including travel): 4
Activities:

- Removed old fence enclosures.
- Removed invasive species via hand pulling (banana poka & Himalayan blackberry).

Recommended changes/suggestions/comments:
None.

Hilo D team removed 5 old fenced research exclosures in the Laupāhoehoe Unit that were in disrepair. The HETF made a commitment to the community to remove old research infrastructure and this was a significant haul.

Appendix E – Pu‘u Wa‘awa‘a Brochure by Thomas Shea



Pu'u Wa'awa'a Questions & Answers

Q. What is so special about Pu'u Wa'awa'a?

A. It is an unusual volcanic cone with unusual eruption materials (pumice, obsidian) that produced, along with the Pu'u Anahulu flows, one of the largest single eruptions known in Hawai'i (~3.5 km³). It is also the only surface remnant of the ancient history of Hualālai volcano (prior to 13,000 years ago). The Wa'awa'a area also offers a unique opportunity to observe a native Hawaiian dryland forest (www.puuwaawaa.org/files/Halapepe.pdf and www.puuwaawaa.org/files/Ohiacone.pdf for more information).

Q. How dangerous were eruptions like Pu'u Wa'awa'a?

A. Very dangerous. The tephra falling from the eruption plume and accumulating on the ground may have been several meters thick for several kilometers around the Pu'u Wa'awa'a cone. There is also evidence that "pyroclastic density currents" (rapidly-moving, ground-hugging mixtures of hot gas and tephra) were produced during these eruptions.

Q. Can similar explosive eruptions occur around Hualālai in the near future?

A. Very unlikely. Several similar eruptions have occurred at Hualālai (now covered by younger lavas) from ~90,000-120,000 yr BP (Before Present), but none since. Other smaller explosive eruptions (those that generate the smaller basaltic cones scattered around Hualālai) are more likely to occur.

Help preserve Pu'u Wa'awa'a by not disturbing plants or animals, or picking up rocks. Do not enter the quarry (very frequent rockfalls).

Questions? comments?
tshea@hawaii.edu

More information on Pu'u Wa'awa'a (history, trails) available at:

http://www.puuwaawaa.org/

https://www.facebook.com/PuuWaawaa

http://www.hetf.us/page/puu_waa_waa/

http://dlnr.hawaii.gov/forestry/frs/reserves/hawaii-island/puuwaawaa/

Use barcodes below for quick website access

Acknowledgements

- Project supported by the National Science Foundation (NSF-EAR grant 1250366)
- Field collaboration from Division of Forestry and Wildlife's Elliott Parsons and the Hawaiian Experimental Tropical Forest (HETF)

PWW main site | PWW Facebook | DNLR Page

Information Pamphlet

P'u'u Wa'awa'a

A window into Hualālai's Explosive Past

A geological pamphlet
by **Thomas Shea**
Dept. of Geology & Geophysics
University of Hawai'i at Mānoa

UNIVERSITY of HAWAI'I MĀNOA

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY

Appendix F – Metadata

- All information submitted by researchers, i.e. annual reports, research affiliation, title, etc., are included as is. We do not add any diacritical marks, correct punctuation, capitalization or grammatical errors.
- Research affiliations are broken down into five groups: Forest Service, University of Hawai‘i (Hilo and Mānoa campuses), other Universities, other Government Organizations, and Other. The ‘other’ category was added in 2011 and includes societies, organizations, museums, institutions, and clubs, etc.
- Educational permits are grouped into three categories: Academic (Universities, K-12 grade schools, home schools, etc.), Institution (all federal and state agencies) and Organization (i.e. Boy Scouts of America, Media visits, E Mau Nā Ala Hele, Three Mountain Alliance, Mauna Kea Watershed Alliance, etc.).
- Within the educational permit categories the activities include: education, service, education/service (this is when an education trip also includes a service portion) and other (which includes trainings, surveys (engineer, archaeological, plot or private) as well as site visits, tours, media visits and Hawaiian cultural practices such as Ho‘olaulea).
- All new and renewal permit applicants are required to submit an annual report within one year of completion or at the time of renewal.
- Any approved research permit amendments are rolled into the original HETF permit.