CTAHR Research News

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Greg Bruland collecting a soil core from a wetland site on the island of Hawai'i.

Protecting Hawaii's watersheds

Awards galore!

CTAHR Centennial celebration continues

In this issue

CTAHR
Office of Research

College of Tropical Agriculture and Human Resources
3050 Maile Way
Gilmore Hall 202
University of Hawaii at Manoa
Honolulu, HI 96822 USA
ph 808.956.4142
fx 808.956.9150
research@ctahr.hawaii.edu
www.ctahr.hawaii.edu

CRN staff
James R. Hollyer
Jackie Tani

From the Associate Dean and Associate Director for Research

It's hard to believe another semester is over! Since CRN will also take a summer vacation for the months of June and July, we have delayed our publishing date for the May issue to provide latest news on the new Farm Bill. The final language of the bill that came out of conference includes both ADAP and TSTAR programs. This means when the new Farm Bill is enacted, these two programs will no longer be considered Congressional special grants – although we will still have to continue working with our Congressional delegation to put money into these programs each year.

Dr. Greg Bruland is our featured story teller this month. Dr. Bruland is a relatively new faculty member in our Department of Natural Resources and Environmental Management (NREM). Although CTAHR is rooted in production agriculture, we have gradually added extensive research, teaching and extension programs in the natural resources and environmental management throughout the years. The department received its formal approval from the Board of Regents in January 2000. NREM faculty members who have graced the cover of CRN included Drs. Ali Fares (May 2006) and Chennat Gopalakrishnan (September 2007). Greg's research is in the areas of watershed management, land-based threats to coastal ecosystems, and wetland ecology, fulfilling CTAHR's mission to protect and enhance environment and Hawai'i's resources. Greg joined CTAHR in 2006, and has quickly established a very productive research program, publishing his research results, securing grant support, and mentoring graduate students. Dr. Bruland will emerge as a national leader in his expertise areas in the coming years. We are certainly pleased that we have Greg as a CTAHR faculty to serve the needs of college and the state.

ORS Director Yaa-Yin Fong visited CTAHR twice last month to interact with our faculty and staff on proposal and grant related issues. Lisa Matsunaga from the Office of Technology Transfer and Economic Development (OTTED) presented a seminar to CTAHR staff this month. As one of four licensing associates in OTTED, CTAHR is Lisa's responsibility. She has prepared a short piece with links for information about OTTED and the services they provide and Lisa will also be making office visits to individual faculty members. Please contact Lisa to set up a meeting if you need additional information. We will continue to bring other guests to visit us in the fall semester.

You must have heard how the increasing food prices globally have triggered riots in several countries. To prevent hoarding, Wal-Mart and Costco have recently imposed limits on rice purchases. Corn-based ethanol has been implicated as a major contributor to the current food crisis. I have summarized the information available so far and links for your information.

Finally, Doug has assembled a collection of news-worthy items in the Calabash for your consumption. Have a well deserved summer vacation, everyone! CRN will also take a break for the summer. See you again in August!

C.Y. Hu
Associate Dean and Associate Director for Research

Preventing Degradation of Hawai‘i’s Watersheds with New Technologies and Mauka to Makai Linkages

By Greg Bruland
Assistant Professor
Department of Natural Resources and Environmental Management

Sampling of water quality and fish community composition at Kanaha Pond on the Island of Maui. Pictured from left are NREM graduate students Meris Bantilan-Smith (Northshore, Oahu) and Dashiell Dunkell (Santa Cruz, CA), visiting sabbatical researcher Dr. Dharni Vasudevan (Bowdoin College), and Greg Bruland. Graduate students in the Bruland lab not pictured in this article include Noelani Puniwai (Hilo, HI), Carolyn Unser (Fairfield, CT), Gwen DeMent (Chicago, IL), Sandy Margriter (Charleston, SC), and Lesley Jantz (Yorktown, VA).

I can’t think of a better place to conduct watershed-scale research than the Hawaiian Islands. Hawai‘i’s watersheds are relatively small, well-defined, and include a variety of land-use and climatic combinations. In these watersheds, the implementation of a best management practice (BMP) – such as a riparian buffer or sediment detention basin by a single landowner – may be detected at the watershed outlet in a relatively short time scale. In the massive Mississippi River watershed, on the other hand, it would be impossible to see the effect of a single landowner’s choice to implement a BMP at the watershed outlet. Hawai‘i’s unique watershed characteristics provide a tremendous opportunity for research and collaboration with federal, state and private landowners. Although watershed managers and policy makers are now realizing the importance of addressing land-sea connections, native Hawaiians had figured this out hundreds of years earlier with their practice of the mauka (ridge) to makai (reef) ahupua‘a management system.

My research centers around the goal of ensuring a sustainable and healthy environment that extends from

mauka to makai across the watersheds of Hawai‘i. I am interested in applying spatially- and temporally-explicit technology and advanced statistical techniques to soil and water conservation; watershed management; and coastal ecology and management in order to better manage watersheds and to protect costal zones from the effects of agriculture, urbanization and feral ungulates. I believe that effective watershed management should utilize the latest developments in global positioning systems (GPS), geographic information systems (GIS), geostatistics, and visible near infrared (VNIR) diffuse reflectance spectroscopy (DRS). These technologies allow for research over larger scales and with greater resolution than has been previously possible. They will help us characterize the status and degradation of soil and water quality at the watershed scale, while also giving growers, landowners, managers, economists, and scientists powerful methods to identify critical source areas of sediment and nutrient loss, as well as optimal sites for best management practice implementation.

For further details and updates on this research please visit: www.ctahr.hawaii.edu/brulandg/. Some of my current research projects are described in more detail below.

NREM graduate student Chad Browning (Indianapolis, IN) and Greg Bruland working with our Visible Near Infrared (VNIR) diffuse reflectance spectrometer.

NREM grad student Chad Browning emptying a runoff collection bucket in Manoa Valley.

Emerging Technologies for Soil and Water Conservation in Hawai‘i

An ongoing challenge for the state of Hawai‘i is maintaining fertile soils against the backdrop of steep slopes, intense tropical precipitation, expansion of invasive biota and a diversifying agricultural economy. To address this challenge, I am developing visible near infrared diffuse reflectance spectroscopy (VNIR DRS) methods for rapid soil assessment. VNIR DRS is an exciting new technology that has the potential to revolutionize soil characterization by allowing for soil samples to be scanned quickly, inexpensively and non-destructively. The spectra produced from these scans can be related to various soil properties with the use of chemometric modeling. I envision this research leading to the development of a spectral library for the soils in Hawai‘i and the greater-Pacific. This library will be used to develop predictive models that allow for scanning and measurement of a variety of properties such as soil carbon, CEC and texture. The data generated from these models can be incorporated into a GIS framework that will allow us to work over larger scales with greater resolution than has ever been previously possible. GPS will allow sites to be sampled repeatedly over time to investigate temporal changes in properties such as soil carbon. Integrating the processing capabilities of DRS within the spatially-explicit GIS and GPS context has tremendous potential to help growers, managers, and scientists characterize the status and degradation of soil and water quality at watershed scales. The scanning of Hawaiian soils with VNIR DRS is currently underway in my laboratory. I am also working with Drs. Sabine Grunwald, Nick Comerford, and Willie Harris (University of Florida) to develop spectral libraries and chemometric models for other subtropical areas of the U.S.

A native plant growth experiment on coconut fiber coir logs at Mauka Campus. NREM graduate student Carolyn Unser is conducting her M.S. thesis work on this project.

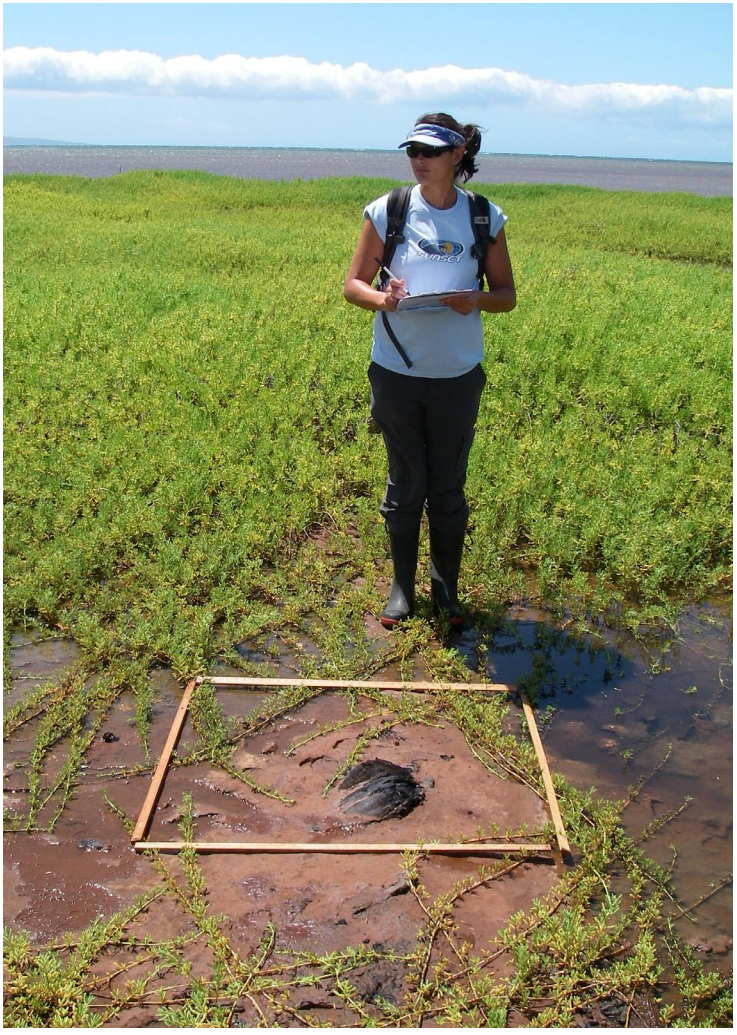
Innovative BMPs for Erosion Control and Water Quality Maintenance

Effective mauka to makai management of watersheds involves the identification of critical source areas of sediments and nutrients. Here in the forested areas of Mānoa Valley, feral pigs have been observed to disrupt the understory and litter layers, increase soil erosion, and alter nutrient cycling. Feral pigs not only cause significant onsite damages; they also cause serious offsite problems. For example, pig-derived sediments travel downslope and downstream during rain events and eventually are deposited in coastal areas. One study estimated that as much as 75% of the sediments in the Ala Wai Canal originate from erosion in the forested areas of the Mānoa watershed (HI DoH 1993). To address this issue, **Dr. Carl Evensen (NREM)** and I are collaborating on a project funded by the USDA National Integrated Water Quality Improvement Program to assess the effects of feral pigs and fencing on erosion, runoff, and water quality in Mānoa Valley. Feral pig populations in Mānoa Valley have increased rapidly and been the subject of recent community meetings. While feral pig eradication and fencing programs have been carried out for decades in Haleakalā and Hawai‘i Volcanoes National Parks, little research has been conducted in other Hawaiian watersheds to document the effects of feral pigs on water quality.

NREM graduate student **Chad Browning** established 8 paired fenced and unfenced runoff plots and sampled runoff during 4 storm events from November 2007 – February 2008. Initial results revealed significant differences in mean total suspended solids (TSS) in runoff across the 4 months, with the greatest amounts occurring in February. Overall, at the majority of sites, TSS were higher in unfenced plots suggesting that feral pigs are increasing erosion and sediment transport in the Mānoa watershed. These results provide

some of the first quantitative information that can be used to help watershed managers formulate a response to feral pig activity. As the relationship between pigs and watershed damage becomes clearer, values can be assigned to policy instruments, such as fencing, in terms of avoided damages. Overall, this project provides a unique opportunity to quantify how feral pigs affect Hawaiian watersheds, examine management and policy options, and gain a better appreciation for the social, cultural and economic dimensions of this issue. Furthermore, feral ungulates are a concern not only in Mānoa but also in many other Hawaiian and Pacific Island watersheds.

Streambank erosion is also a concern for Hawaiian watersheds as sediment loads increase exponentially during storm events, and much of this sediment ends up in coastal zones where it can have detrimental effects on coral reefs. A collaborative project with Andy Hood and Kristin Duin (Sustainable Resources Group International, Inc.), funded by the Department of Health 319 Clean Water Act Grant, involves the development of innovative practices for streambank erosion control. We are specifically investigating the effectiveness of installing coconut fiber coir logs planted with native riparian vegetative species in streams, in order to control erosion, take up nutrients, and provide habitat restoration. Coir logs have been used for erosion control in the continental U.S. but have not yet been tested in Hawai‘i. NREM graduate student **Carolyn Unser** is conducting an experiment to test the growth and nutrient uptake of four native plant species under three nutrient levels. Based on this experiment, coir logs will be grown in a local greenhouse and placed into two streams in Waimanalo to help provide erosion control, uptake nitrogen (N), and reintroduce native plants. If successful, this technique could be implemented in other streams statewide.



NREM graduate student Meris Bantilan-Smith sampling vegetation at a coastal wetland on the island of Moloka‘i.

Coastal Lowland Wetlands: A Critical Land-Sea Linkage in Hawai‘i

Much of the research in Hawai‘i to date has focused either on terrestrial ecosystems, such as the wet and dry forests, or on marine ecosystems, such as coral reefs. In contrast, coastal lowland wetlands have received much less attention. This knowledge gap is problematic because coastal lowland wetlands serve as a vital linkage between terrestrial and marine ecosystems. Much of the water, sediment and nutrients generated and transported from terrestrial ecosystems will pass through coastal wetlands before making it to the ocean. Furthermore, coastal wetlands provide important ecosystem services such as storing floodwaters, trapping sediments and retaining nutrients. Coastal ecosystems in Hawai‘i are under tremendous pressure, and the need for effective coastal zone management will only increase in this era of global climate change, sea level rise, and development.

Effective management needs to draw on baseline ecological data, however little if any data is available for Hawai‘i’s coastal wetlands. To address this need, I am currently leading an interdisciplinary team of researchers including Dr. Richard MacKenzie (USFS Institute of Pacific Islands Forestry), Adonia Henry (US Fish & Wildlife Service), and others on an EPA-funded project that compares the water quality and habitat functions of restored (RW), created (CW), and

natural (NW) coastal lowland wetlands in Hawai‘i. The first phase of the project involved sampling vegetation, soils, water quality and fish communities of 40 wetland sites across the Hawaiian Islands.

An NREM graduate student, **Meris Bantilan-Smith** recently finished her M.S. thesis that focused on the vegetation and soil data from this project. Of the 102 plant species she identified across 40 sites, only 18 were native, indicating that most coastal lowland wetland sites in Hawai‘i are highly impacted by invasive vegetation. She also determined that RWs and CWs had significantly higher bulk density (BD) and significantly lower soil organic matter (OM) than NWs. These differences have important implications for fertility, root penetration, plant growth and nutrient retention. Another NREM graduate student, **Gwen DeMent**, is comparing the phosphorus (P) sorption capacity of these wetland soils. To date, she has found significant differences in P sorption in RWs/CWs versus NWs.

The water quality results from this project revealed tremendous variability in physical and chemical parameters. We will continue to assess this variability with quarterly samplings at a subset of 20 sites over the next two years. Initial results of the fish community sampling indicated that, across each of the 5 main Hawaiian islands, greater than 80% of the fish biomass was comprised of invasive species. For some islands, no native fish species were observed at any sites. As these systems are highly impacted by invasive species, increased management, restoration and monitoring are needed. In July, I will be co-chairing a symposium at the 2008 Hawai‘i Conservation Conference that is focused on the ecology and management of Hawai‘i’s coastal wetlands that will include speakers from Marine Corps Base Hawai‘i, NRCS, USGS, USFS, Hawai‘i Pacific University, National Tropical Botanical Garden, and UH Mānoa.

Finally, in order to help taro farmers more efficiently apply N-based fertilizers, **Dr. Jonathan Deenik (TPSS)**, myself and others are seeking funding to investigate the role of a previously-unknown component of the nitrogen (N) cycle – anaerobic ammonium oxidation or anammox – in Hawaiian taro ecosystems.

In Hawai‘i, increasing demands for improved soil and water conservation, integrated watershed management, and mitigation of land-based threats to coastal zones will require interdisciplinary research and the strengthening of linkages between terrestrial and marine environments. I look forward to continuing to work with those in CTAHR, and beyond, to address these critical environmental challenges.

Greg Bruland

Hometown: Santa Cruz, CA
Joined CTAHR: 2006
Educational History: B.S. (1997) in Environmental Chemistry from Principia College; Ph.D. (2004) Wetland Ecology and Management, Nicholas School of the Environment and Earth Sciences, Duke University.
Specialization: Soil and Water Conservation and Coastal Ecology and Management
Current Work: Quantifying the effects of feral pigs on erosion, runoff, and water quality in Hawaiian forests; Evaluating the use of coir logs for streambank erosion control and native species propagation; Assessing the vegetation, soils, water quality, and fish communities of coastal lowland wetlands in Hawai‘i; Calibration and validation of visible near infrared diffuse refelctance spectroscopy for rapid assessment of soil properties in Hawaii and other tropical and subtropical soils.
Languages Spoken: English

Selected Grants

Assessment and Monitoring of the Water Quality and Habitat Functions of Natural, Restored, and Created Wetlands of the Hawaiian Islands; *U.S. Environmental Protection Agency* - $143,713.

Innovations in Stream Phytoremediation and Erosion Control of Degraded Stream Banks; *319 Clean Water Act Grant Fund* - $200,000 (Bruland Subcontract $63,502).

Rapid Assessment and Trajectory Modeling of Changes in Soil Carbon Across a Southeastern Landscape; *USDA/CSREES/NRI* - $398,706 (Bruland Subcontract $41,700).

Selected Publications

Bantilan-Smith, M., **Bruland, G.L.**, R.A. MacKenzie, C. McGuire, C. Ramsey, and A. Henry. An Assessment of the vegetation and soils of coastal lowland Hawaiian wetlands. In review with *Wetlands*.

Bruland, G.L. 2008. Coastal Wetlands: Function and Role in Reducing Impact of Land-Based Management. Chapter 5, In A. Fares and A.I. El-Kadi (Eds.), *Coastal Watershed Management*, WIT Press, Southhampton, UK.

Bruland, G.L., C.J. Richardson, and S.C. Whalen. 2006. Spatial variability of denitrification potential and related soil properties in created, restored and paired natural wetlands. *Wetlands* 26:1042-1056.