Pacific Island Network
Inventory & Monitoring Program

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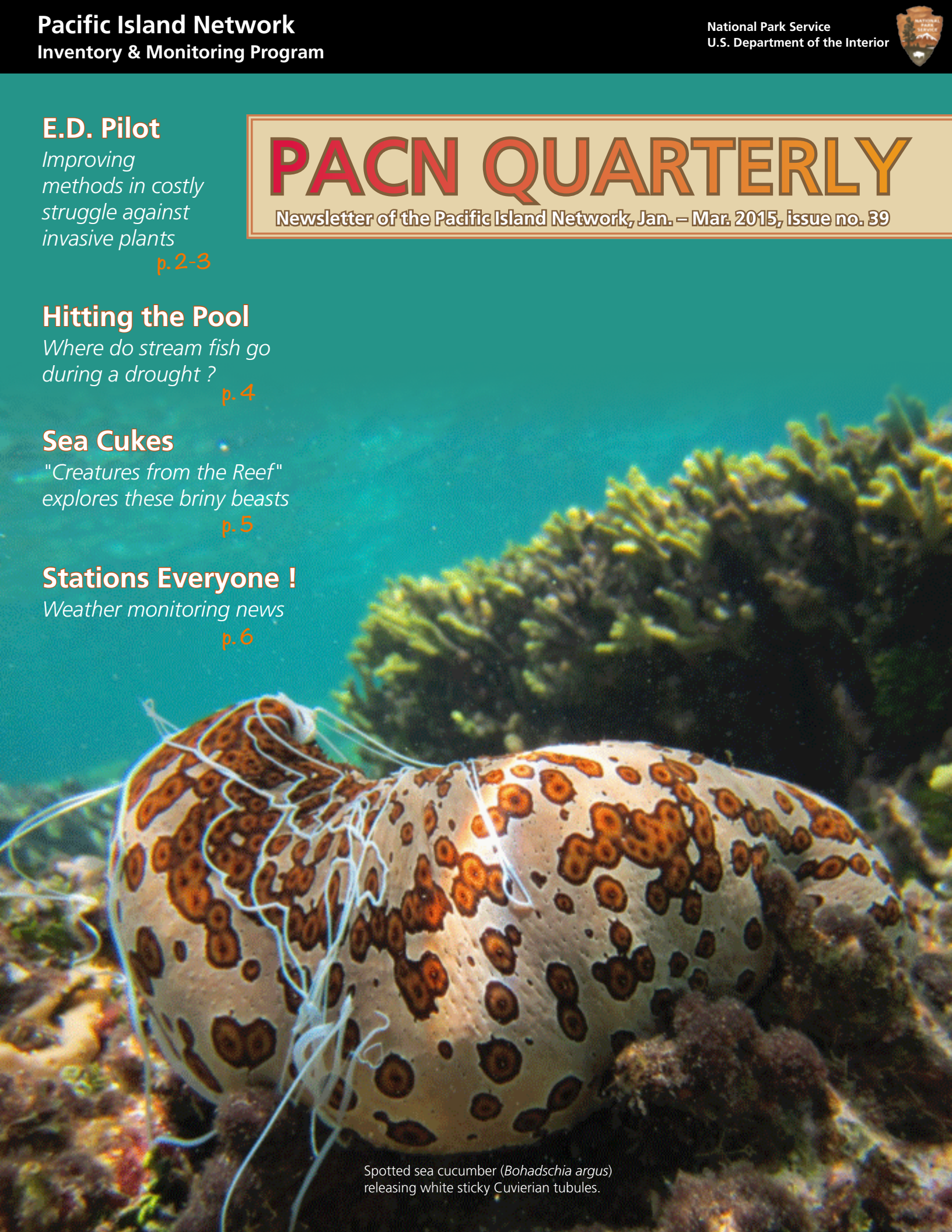


Spotted sea cucumber (*Bohadschia argus*) releasing white sticky Cuvierian tubules.

Early Detection Pilot Studies

Pilot studies help refine monitoring methods in the costly struggle against invasive plant species

Aggressive, non-native plants – or invasive species as you may commonly hear them called, are one of the biggest threats to the spectacular endemic plant communities in Pacific island national parks. While Hawai‘i Volcanoes (HAVO), Haleakalā (HALE), and many other parks have long recognized the threat invasive plants pose and declared war on them, these battles are costly, time consuming, and sometimes plant invasions pass the point of no return.

The Pacific Island Network Inventory and Monitoring Program (I&M) has been active in HAVO, HALE, and other Pacific island parks documenting the presence of non-native and native plant species on vegetation maps and within focal plant communities through long-term plot monitoring. While these data provide park managers valuable information on non-native plant species over time, they do not include targeted surveys of critical invasion corridors (e.g., roads, trails, fence lines) where new non-native plants are most likely to establish. Because detecting and eliminating potential invasive species before they become widely established is the most cost effective, and sometimes the only opportunity to eradicate these invaders, the I&M Program is developing an early detection monitoring protocol. Early detection allows resource managers to aggressively target newly established plants and stop the invasion before it starts.

This past summer and fall, I&M initiated three early detection pilot studies at HAVO and HALE. The objectives of these studies were: (1) to provide the parks immediate data on new species encountered; (2) test the proposed monitoring methods for systematically searching for, finding, and reporting new non-native plant species; and (3) develop time and cost estimates on small scales before implementing these methods network wide. HAVO requested a study in the summit area of the park as this is where the greatest visitor impacts are felt. Simultaneously, I&M initiated a pilot study at HALE along trails to compliment ongoing park funded road surveys. Finally, the largest pilot study was conducted at HAVO within the Kahuku Unit.

Kahuku was acquired by HAVO in 2003, and while initial biological inventories were conducted, Kahuku is less well studied than older sections of the park. The agricultural history and range of diverse climates and habitats makes Kahuku a prime target for the introduction and colonization of invasive plants. Kahuku contains almost 130 miles of roads and trails... far too much for a two person crew to survey in the time allotted for the pilot study. As a result, the busiest roads and trails were given the highest priority. The crew walked these roads and trails, and anytime an unknown plant was encountered, a GPS point and photos were taken. A sample was also collected when necessary. Once these unknown species were identified, they were compared to lists of species currently known to exist in the Kahuku Unit, the rest of HAVO, and Hawai‘i Island in general. This way the crew could ascertain whether the species in question was just unfamiliar to the surveyors, or was actually a newly established non-native plant species.

Surveying for about one month, crews covered over 76 miles of roads and trails in Kahuku. Depending on what was found and road/trail conditions, crews were able to survey up to 6 miles/day, and cover nearly all the high traffic areas. So what did they find. . .a lot!

In total, survey crews found 30 unreported species in areas of Kahuku: 11 species new to Kahuku, 3 species new to HAVO, and 1 species new to the Big Island! The species new to the Big Island is the grass, *Dicanthium annulatum*, and will be added to the HAVO species database along with the three other species new to the park. In general, most of the encountered species were grasses and herbs that often produce large amounts of small seeds which are easily spread. In addition, the highest densities of new species found generally corresponded to the roads and trails with the highest rates of use, which is not surprising.

So what’s next? HAVO staff are taking a good look at the list of new species found during the pilot study surveys, and will attempt to identify if any of these species pose a risk of becoming invasive. Any species identified as high risk will be targeted for eradication. Meanwhile, I&M is evaluating the effectiveness of this study to enhance the Early Detection of Invasive Plants protocol and the feasibility of instituting early detection at a larger scale throughout HAVO and other the Pacific island national parks.

-M. Wasser, NPS Botanist (HAVO)
-A. Ainsworth, NPS Botanist (I&M)

Threat found at HAVO Summit

As part of the pilot study, I&M botanists surveyed approximately 19 miles of highly trafficked trails around the Kīlauea summit. These included paths and parking lots stretching from Jagger museum to Kīlauea Iki. In terms of non-native species, the residential area by Volcano House proved to be the most interesting. Surveyors documented several planted ornamentals, including this Syzygium species. After reporting this plant to HAVO, we learned that park management is planning to eradicate this individual since it belongs to the highly invasive family, Myrtaceae.

-M. Simon, NPS Biotech (I&M)

Threat found at HALE

Forest & Kim Starr

Wahlenbergia gracilis

Over 12 days between the months of September and November 2014, I&M biologists Elizabeth Urbanski and Michelle Osgood conducted a pilot study of the Early Detection protocol at Haleakalā National Park. Approximately 40 miles of trails were surveyed throughout the summit district of the Park. The survey resulted in the observation of 3 plant species in 4 locations that were determined to fit early detection criteria at HALE. Strawberry guava, one of the park’s most prolific invaders was found in a new location along the Kaupō trail. A plant never previously recorded in the park called *Wahlenbergia gracilis*, was found off trail in the front country.

-E. Urbanski, NPS Biotech (I&M)

Hitting the Pool

Headlines often mention climate change causing coral bleaching and sea level rise, but what happens to Hawaii streamlife?

Changes in weather patterns affect the quantity and quality of the water, which has profound effects on our native stream animals. In the Hawaiian Islands, the total amount of rain is expected to decrease as the impacts of climate change manifest. However, the frequency and severity of storms are expected to increase. Rigorous studies have prompted us to anticipate that there will be more rain in the summer months (the "dry" season) and less rain during the winter months (the "rainy" season). This will cause significant variation in stream discharge, the amount of water flowing from the stream. This predicament also threatens the native stream fish, shrimp, and snails that rely on a connection to the ocean in order to complete their life cycles.

All of Hawaii's native stream animals are amphidromous, which means larvae hatch in the stream then wash out to the ocean where they develop for up to a few months. The juveniles then return to the stream and mature into adults. Decreases in rainfall lead to more frequent drought conditions, which could interrupt this crucial stream-ocean connection. This occurrence limits both the larvae from washing out to the ocean as well as limiting juveniles from recruiting back up into streams. In addition, many stream animals become relegated to pools in times of low flow.

Near the mouth of a stream at Haleakalā National Park

Left: "Normal" flow conditions

Right: Drought conditions

A decrease in overall rainfall may increase drought events that can lead to changes in water quality. Oxygen is an important water quality parameter that is critical for all life. Stream animals obtain all their oxygen from what is dissolved in the water. With less water flow, the temperature of the water can increase. Warmer water absorbs less oxygen than colder water because gases dissolve better in colder water. Additionally, with reduced flow there is reduced oxygenation of the water from tumbling over waterfalls or around rocks. Lack of flow and warmer temperatures promote plant and algal growth, which consumes even more oxygen. The algae eventually die and decompose, further depleting oxygen stores.

Though some animals may be able to tolerate severe low oxygen levels, even moderately low oxygen levels can affect their reproduction because egg production requires significant oxygen. Many organisms, especially fish, are very oxygen –dependent and could die if not enough oxygen is available to them.

In an effort to track the health of stream animals in the throes of a changing climate, the Inventory & Monitoring Program monitors stream animal populations as well as water quality parameters (including dissolved oxygen) in streams at Haleakalā NP, Kalaupapa NHP, War in the Pacific NHP, and the NP of American Samoa. Let's hope these fragile animals aren't forced to hit too many warm, oxygen-depleated pools as the climate changes.

–A. Farahi, NPS Biological Science Technician (I&M)

Sea Cucumbers

Creatures from the Reef

This quarter we are featuring holothuroids or "sea cucumbers." Sea cucumbers, along with sea stars, sea urchins, brittle stars (ophiuroids), and sea lilies (crinoids), are members of the phylum Echinodermata. The name echinoderm in Greek means "spiny skin," and was originally used to describe sea urchins which have large obvious spines. Most sea cucumbers are soft and squishy, so why might they be part of this phylum? Sea cucumbers have small bone-like structures in their skin called ossicles. These ossicles come in many different shapes and sizes (from rod-shaped to button-shaped) and are often used to tell different species apart from one another. Along with ossicles, sea cucumbers are unique in that they have a bone-like ring around their mouth where their tentacles attach.

Spotted Sea Cucumber (*Bohadschia argus*) releasing white sticky Cuvierian tubules.

Sea cucumbers come in all shapes and sizes. They can be "L"-shaped, "U"-shaped, flask-shaped, web-like, tailed and – even – "pig"-shaped (such as the deep-sea Scotoplanes species). Most coral reef sea cucumber species are either thick and round or long like a rope. Some are microscopic, while some can grow to over 9.8 feet!

Along with their many forms, sea cucumbers also display a variety of unusual defensive mechanisms. Some sea cucumbers release white, sticky, anally-discharged filaments called Cuvierian tubules when they are disturbed. It is believed that sea cucumbers uses these Cuvierian tubules to entangle predators when they are attacked. Other sea cucumber species can shed large pieces of their body wall to escape predators. "Anal teeth" are another unique defensive adaptation that some sea cucumbers have developed; the small hard "teeth" which line the cloacal (posterior) opening are believed to have evolved as a response to certain parasitic fish, known as pearlfish.

Sea cucumbers that live in warm water are commonly dioecious meaning that there are two distinct sexes. At certain times in the year females and males will 'spawn' or release their eggs or sperm into the water, where they will unite and develop into larvae. Some sea cucumber larvae are non-feeding, while others will feed while they drift or swim around in the water. After a certain amount of time, these larvae will transform from a bilateral (two-sided) to a pentaradial (five-sided) body plan and settle to the bottom as tiny adults. A few warm-water sea cucumbers will sometimes split in half to reproduce.

There are over 2,000 species of sea cucumbers in the ocean with many more yet to be discovered. So get out to your coral reef and look for some sea cucumbers!

–A. Miller, NPS (WAPA)
Biological Science Technician

Pearsonothuria graeffei getting reading to spawn (release either eggs or sperm into the water).

Stations Everyone

Climate and Weather Affect Everything We Monitor

Climate and weather touch benthic marine communities through warmer ocean temperatures which affect coral growth; and permutations can affect whole reef ecosystems. Precipitation directly affects freshwater animal communities, plant communities, and water quality. Bird breeding cycles can be affected by the changes in seasons, and the list goes on. One of the primary goals of climate and weather monitoring is to determine the status and trends of weather patterns and long-term climate regimes so managers can make informed decisions about the conditions existing in each national park. Similarly, monitoring of weather and climate may provide an early warning of abnormal conditions.

It is therefore very important to get accurate and consistent data from our weather stations. To be useful for statistical analysis, this generally means collecting data more than 85% of the days of the year (300 days or more). The importance of the permanent location of an individual weather station can't be overemphasized either. All long-term (climate change) data is only of value if the station never moves.

Climate/Weather Stations

The Pacific Island Network (PACN) primarily relies on two kinds of weather stations, COOP (Cooperative Observer Program) and RAWS (Remote Automated Weather Stations). COOP stations are checked by specific personnel and gauges need to be read daily. We are grateful for the folks that do this work at the parks. RAWS stations send data via the GOES (NOAA geostationary server) satellite network to WRCC (Western Regional Climate Center) for validation and are then downloaded to the web, where we can retrieve it for specific analyses. Currently, all 10 PACN climate stations (RAWS) are operational and transmitting data every hour to WRCC. These data are then distributed via the internet to various agencies, and also to the public.

RAWS data: http://www.raws.dri.edu/index.html
COOP data: http://www.nws.noaa.gov/om/coop/wfo-rfcmap.htm

In June of 2013, the RAWS climate station at Pu'ukoholā Heiau National Historic Site (PUHE) was vandalized. A new station (above) was installed in January, 2015.

Overview of Island Climate

Climate is generally mild at our monitored national park sites in the Pacific islands. Weather patterns are largely controlled by island geomorphology and the surrounding Pacific Ocean. The ocean temperatures vary only about six degrees throughout the year, from lows near 73° in March to 80° in August. Because there are no continents nearby, weather systems are moderated by the ocean. Seasons are not strongly differentiated either. Two seasons prevail in Hawaii; summer (April through October) and winter (November through March). Dry and wet seasons somewhat correlate with summer and winter, respectively. The wet season in American Samoa is from October through April, and from July through November in the Marianas Islands (Saipan and Guam). Interestingly, in Hawaii, the coldest months are not December and January as they are in the continental United States, but February and March. Cold winds come from the Arctic but the lower temperatures arrive one to two months later due to the lag in the Pacific Ocean's temperature.

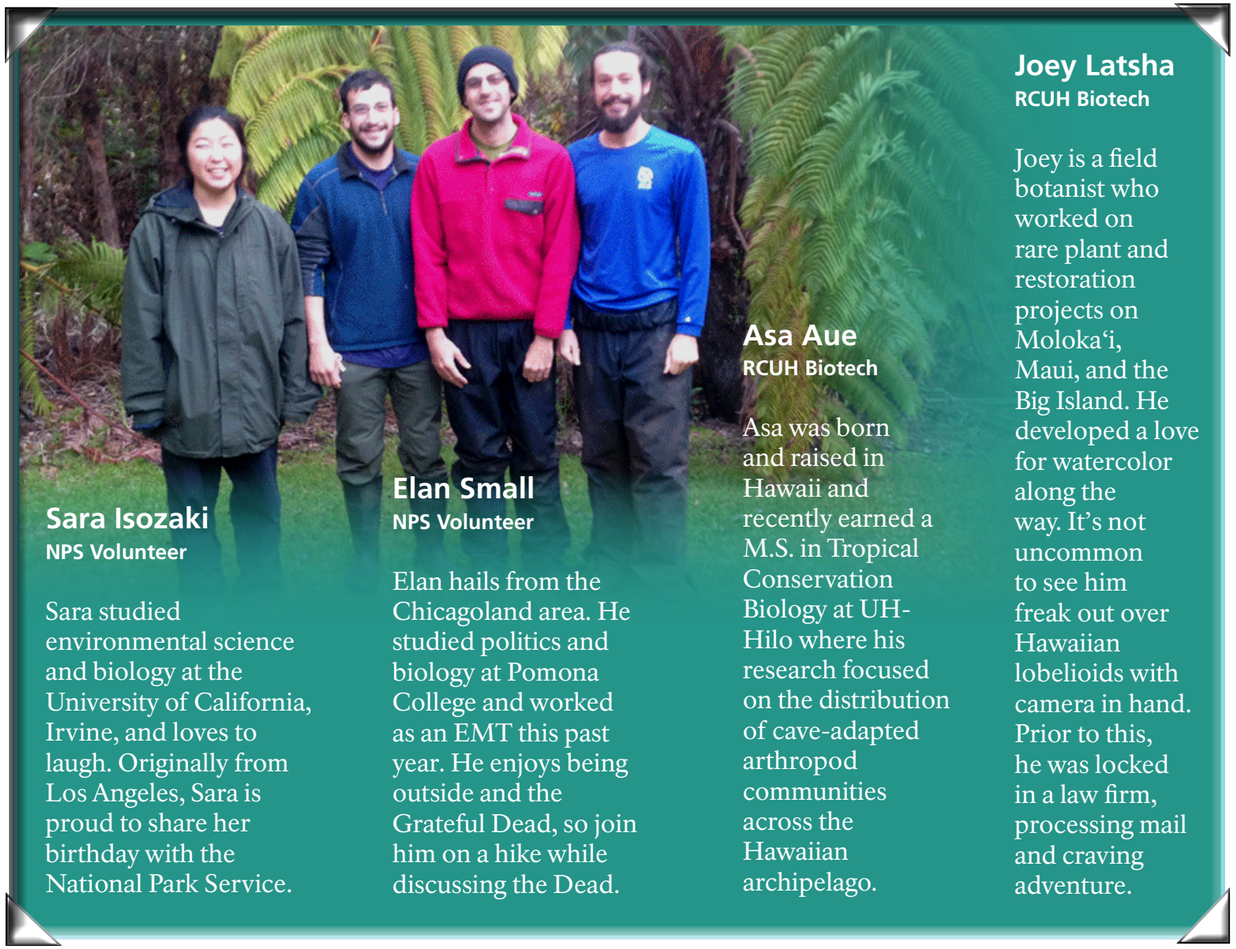
–S. Kichman, NPS GIS Specialist (I&M)

New Staff

Amanda McCutcheon, NPS Biological technician

Amanda recently joined I&M as an Aquatic Biological Technician stationed at Kaloko-Honokōhau NHP. Quite a change from growing up in a small town in the Pocono Mountains of Pennsylvania. She completed her B.S. in Biology at Moravian College in Pennsylvania, and along the way she had the opportunity to study tropical marine ecology on the Caribbean island of Bonaire. After completing her B.S., Amanda returned to Bonaire as a teaching assistant with the marine ecology program. Next, Amanda traveled to Guam to undertake a M.S. in Biology at the University of Guam Marine Laboratory. While completing her degree, Amanda worked as a STEP Biotech at War in the Pacific NHP on Guam. She also met her husband Justin on Guam, and they later moved to Honolulu in 2013. Now, Amanda lives on the Big Island and is eager to learn about all the unique biological and cultural aspects of her new island home.

Amanda takes a water sample by pumping water though a filter on the sun-soaked landscape of Kaloko-Honokōhau NHP.



Sara Isozaki
NPS Volunteer

Sara studied environmental science and biology at the University of California, Irvine, and loves to laugh. Originally from Los Angeles, Sara is proud to share her birthday with the National Park Service.

Elan Small
NPS Volunteer

Elan hails from the Chicagoland area. He studied politics and biology at Pomona College and worked as an EMT this past year. He enjoys being outside and the Grateful Dead, so join him on a hike while discussing the Dead.

Asa Aue
RCUH Biotech

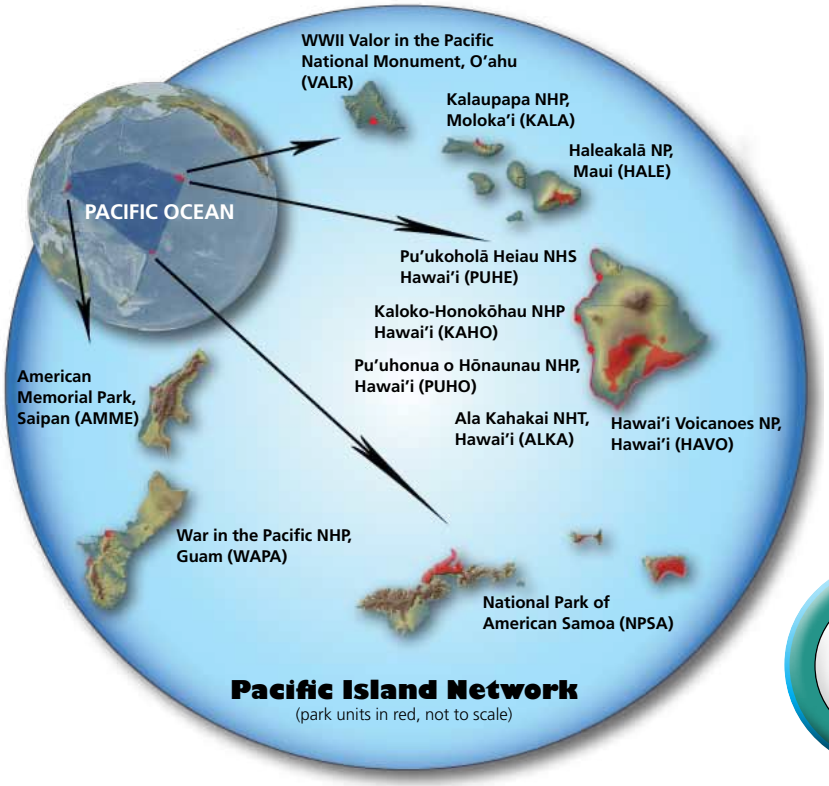
Asa was born and raised in Hawaii and recently earned a M.S. in Tropical Conservation Biology at UH-Hilo where his research focused on the distribution of cave-adapted arthropod communities across the Hawaiian archipelago.

Joey Latsha
RCUH Biotech

Joey is a field botanist who worked on rare plant and restoration projects on Moloka'i, Maui, and the Big Island. He developed a love for watercolor along the way. It's not uncommon to see him freak out over Hawaiian lobelioids with camera in hand. Prior to this, he was locked in a law firm, processing mail and craving adventure.

Field Schedule

	April	May	June
Landbirds monitoring	HAVO		
Invasive plants	HAVO	HAVO	HAVO
Vegetation communities	HAVO	HAVO	HAVO
Water quality	HALE	NPSA, KALA, WAPA, AMME	W. Hawaii
Stream animals			
Groundwater		AMME, KAHO	
Benthic marine	NPSA	NPSA	
Marine fish	NPSA	NPSA	
Climate (on-going)	All Parks----------	----------	----------



Recent Reports

Water Quality in the Streams of NPSA, 2009-2011
Coastal Strand Plant Community Monitoring (KAHO), 2011

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The National Park Service (NPS) has implemented natural resource inventory and monitoring (I&M) on a servicewide basis to ensure all park units possess the resource information needed for effective, science-based management, decision-making, and resource protection.

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NOTE: Unless indicated all photos and articles are NPS.

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