



# Seaworthy Science

Breakthrough Marine Science Research is Reshaping Natural Sciences

**It was a whale of a tale.** Just ask marine biologist Kristi West, Ph.D., assistant professor of biology and head of Hawai'i Pacific University's marine mammal stranding team, the state of Hawai'i's only response team authorized by the National Oceanic and Atmospheric Administration (NOAA) to handle beached whales and dolphins that die on Hawai'i's shores. West and her team of student assistants were alerted this summer with a call about the extraordinary find on a Kahuku beach—the largest sperm whale ever stranded on O'ahu, estimated at 65-foot long and weighing 10 tons.

The stranded whale was highly decomposed, and West's team participated in pulling the carcass off the shore. The team recovered parts of the stranded whale—a seven-foot skull bone, three-foot long ribs, several vertebrae, teeth, and more—and took them back to the University's Hawai'i Loa campus for their continuing research.

Around the same time this past summer, David Hyrenbach, Ph.D., assistant professor of oceanography and expert on the Hawaiian albatross, started studying the ingestion of plastic debris from the ocean by these majestic seabirds. Using satellite tracking and diet analysis, Hyrenbach recently

participated in an unsuspected discovery working with HPU graduate students.

While previous tracking studies have shown that black-footed albatross breeding in the Northwest Hawaiian Islands confine their foraging trips to the productive continental shelf waters off the west coast of North America, birds tagged in Kure Atoll (the northwestern-most colony in the Hawaiian Archipelago) ventured instead into the Northwest Pacific, beyond longitude 180 West. These birds, which foraged along the seamounts north of their colony, delivered large amounts of plastic to their chicks. After breeding, the tagged birds travelled as far away as the Aleutian Islands, Japan, and the west coast.



“Plastic debris as far as California and Japan can end up in the stomach of a baby albatross from the Northwestern Hawaiian Islands,” says Hyrenbach, one of several HPU faculty doing research at Oceanic Institute, the 56-acre applied marine science research facility, which is an affiliate of HPU.

## A New Chapter for Natural Sciences

West and Hyrenbach are part of a recent cohort of marine science researchers who are ushering in a new era for the College of Natural Sciences. Joining HPU two years ago as college dean, Alissa J. Arp, Ph.D., also became HPU's first vice president of research. As such, she has been hiring faculty, such as Hyrenbach, on board since January 2008,





Left: Pygmy sperm whale stranded in Kihei, Maui, April 2007; Bottom: Taking measurements of stranded whale



### Whales Up Close

Like firefighters on the alert, West's whale stranding team, consisting of about 20 graduate and undergraduate students, has found rewards in always being prepared for the unexpected. Since becoming NOAA's authorized response team in July 2006, the HPU team has been collecting the state's most extensive and systematic samples from stranded marine mammals. Together with the opportunistic samples collected in earlier years, the HPU collection, aided by West's collaborations with national and international scientists, contributes to worldwide whale research with unique samples, analyses, and archival material on Pacific whales.

West's breakthrough work on the pygmy sperm whale in Hawai'i, the first study to investigate the diet of this little known marine mammal, would not have been possible without strandings. Pygmy sperm whales, whose scientific name is *Kogia breviceps*, can be mistaken for sharks due to the false gills located on their bodies. Between 1963 and 2008, there is documentation of 35 strandings of pygmy sperm whales in the Hawaiian Islands.

While these shy, 12-foot whales are the second most frequently stranded species in Hawaiian waters, "they are rarely seen and

who enhance the department with expertise and experience in research.

"We have launched the college's first master's of science degree program, now in its second year, and distinguished by a marine science emphasis. We are also expanding our strong undergraduate programs in other areas, including the pre-medical and life sciences," says Arp.

Focusing on the marine sciences was a natural in Hawai'i, which offers a huge, natural laboratory for hands-on learning, says Arp, herself a marine biologist. Studies from the State Education and Environment Roundtable have shown that students who interact with the natural world as a teaching tool

improve their test scores and are involved in solving real-life problems.

Both West and Hyrenbach's research focuses on what scientists call "mega-fauna," large long-lived animals near the top of the food web. These creatures connect the researchers' work directly with management and conservation. "Whales are so huge and need so much food, they serve as good indicators of the health of the whole ocean ecosystem," says West.

"I like to think of albatrosses as biological sensors," adds Hyrenbach. "They are far-ranging oceanic foragers susceptible to natural and man-made impacts. Thus, studying their movements and diet helps us monitor the changing marine environment."





Left: HPU marine mammal stranding team, Hawai'i Loa campus; Left, below: Stomach contents of pygmy sperm whale

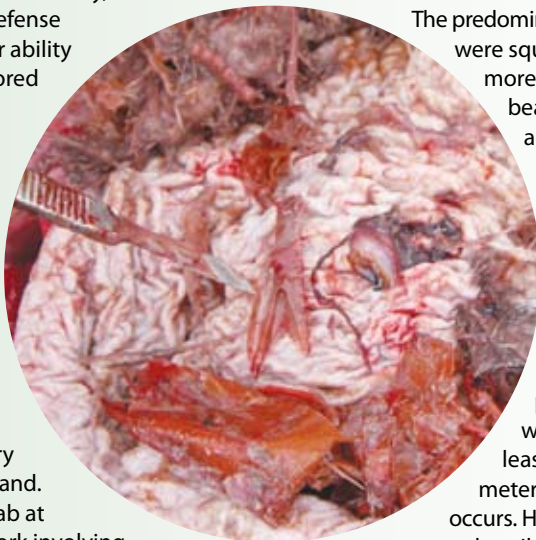
difficult to study in the wild, and impossible to retain in captivity, which makes this work more significant in determining the status of this animal," says West.

They are difficult to observe in the ocean because of their small size, long dive durations, cryptic behavior, and a tendency to avoid vessels. Additionally, a distinguishing defense mechanism is their ability to eject a dark colored liquid, much like squid "ink."

Funded by NOAA, West and her team collected samples from recent strandings on Lana'i, Maui, Moloka'i, and Midway and have historical data on strandings on every major Hawaiian island. Once back in the lab at Hawai'i Loa, the work involving necropsies and tissue samples, much of it done by students, may seem icky and smelly to the average person, says West with a smile.

Finding more than 700 prey items and identifying over 50 different species of squid, fish, and shrimp in stomach contents during six necropsies, West's resulting study,

using data collected primarily from 2000 to 2008 and accepted for publication in 2008, not only showed how deep pygmy sperm whales were diving, but gave other researchers studying these prey new knowledge about where many species of squid, deep water fish, and deep water shrimp existed in the Pacific.



The predominant prey remains were squid beaks, with more than 550 lower beaks identified among the stomach contents. By analyzing the vertical distribution of the whale's primary prey, this research indicates that pygmy sperm whales dive to at least 600 to 1,200 meters where foraging occurs. However, the depth range described for the whales

only represents the minimum depth that pygmy sperm whales dive. The prey found in the stomachs is also likely to be found in waters that exceed 1,000 meters, the poorly studied deep ocean realm. While certain prey items tell us that the whales spend a significant amount of time foraging in the deep sea, the whales tell us about the presence of squid species never before reported from Hawaiian waters.

Whitney White, a 2008 HPU graduate with a B.S. in Marine Biology, is one of two graduate students who help West train other students and operate the marine mammal stranding program and who actively participate in the resulting research. The San Diego native and water sports enthusiast took West's marine mammals class in 2006, found her niche, and volunteered to help with the startup of HPU's stranding program. On West's recommendation, White also got an internship to study dolphins with the Smithsonian Institute. West herself had done post-doctoral work there, training with researchers who had pioneered mammal-stranding responses in the 1970s that inspired her own interest in Hawai'i's little known marine mammals.

White is currently a student in HPU's M.S. in Marine Science program. Working with government agencies, airlines, transportation services, and other researchers, she has "gained a respect for the teamwork required by the stranding program. Working with these awesome animals up close also gives me a deeper respect for them and a desire to find out why they stranded." For her efforts, she has earned co-authorship credit on published scientific research reports, including the breakthrough pygmy sperm whale diet study.

### On the Wings of Albatrosses

While West took to the ocean's depths, oceanographer Hyrenbach took to the air with the study of seabirds. In particular, the worsening worldwide conservation status of albatrosses is a global pressing concern that motivates Hyrenbach's research and student interest.

"Seabirds are really ideal to study large ocean features because they cover so much ground during their far travels. Their ability to sample the ocean over very large scales of space make them valuable indicators of what the ocean is doing," says Hyrenbach, who studies the ocean through "the stomach of the albatross."

According to Hyrenbach, very little is known about where oceanic birds find and collect much of the man-made debris they ingest. Over the years, studies of

seabirds have revealed increasing trends of ingestion of plastic debris. For example, a survey of seabirds breeding in Alaska conducted in the early 1970s and the late 1980s revealed increases in the total number of species ingesting plastic, and the mean number of plastic particles ingested by individual birds. Unfortunately, similar comparisons and trends are not available for Hawaiian species.

“Plastic is a great invention and should be treated as a valuable commodity, instead of a discardable material for one-time use.



*Black-footed albatross bolus, Kure Atoll*

Courtesy State of Hawai'i, Department of Land and Natural Resources, DOFAW

It is estimated that today about 90 percent of floating ocean debris is plastic, ranging from tiny scraps the size of rice grains to cigarette lighters, light-sticks, and tooth-brushes. These items are all found in albatross chicks from Hawai'i," says Hyrenbach.

As with West's research, diet offers Hyrenbach key clues to the ocean's mysteries and sustainability. And like the work with whales, studying the diet of albatrosses can be exciting and adventurous, as well as stinky and gross. It involves examining the stomach contents of dead seabirds and the undigestible materials, including the remains of natural food items they regurgitate. All of the plastic these far-ranging seabirds feed their young is packed into a bolus and thrown up before the chicks depart the colony. Analyses of Laysan and black-footed albatross boluses from Kure Atoll in 2000 found plastic in every sample.

Andrew Titmus is one of three graduate students working with Hyrenbach. Titmus' work involves necropsies of dead birds, analysis of chick boluses, and use of ultrasound on live birds. It also challenges him to work with data from satellite tracking and ocean samples from research cruises to "try to integrate different types of data that will be meaningful to looking at the entire system."

In his first year in HPU's M.S. in Marine Science program, Titmus has a strong interest in conservation and human effects on ocean ecosystems.

"I'm excited to be working on tracking plastics in seabirds, because it's the kind of science I like to see, not in isolation, but as an important step in finding what we need to do about our ocean pollution problems," says Titmus.

His master's program emphasis on fundamentals has been beneficial in teaching him "how to be a scientist," he says. And the research gives him hands-on experience, the possibility of authentic, real-life impact, and the ability to be responsible and productive, from start to finish, while learning, he adds.

**"It's about connecting the marine sciences to where we live and work—the land and sea interface."**

Dr. Alissa J. Arp

Hyrenbach is quick to point out that the albatross plastic ingestion research is still focused on documenting the patterns and that "there is much more we don't know." Researchers lack the understanding of how much the effects of plastic ingestion, including stomach obstructions and lacerations, dehydration, and the leaching of noxious chemicals, is affecting seabird populations.



*Tagged black-footed albatross*

Courtesy Sophie Webb, Oikonos

However, the rising incidence of plastic debris in many long-lived North Pacific seabirds suggests this is a pervasive phenomenon that warrants further investigation, he says. Like West, Hyrenbach works collaboratively with other scientists in universities and government agencies, such as NOAA and NGOs (nongovernmental organizations).

### On the Horizon

The work of West and Hyrenbach represents the leading edge of where marine science is heading at HPU's College of Natural Sciences.

"It's about connecting the marine sciences to where we live and work—the land and sea interface. Ultimately, we aim to foster an appreciation of how we incorporate the richly diverse natural flora and fauna of O'ahu into our science curriculum and learning experiences," says Arp.