The public is invited to our annual, free Open House to be held Tuesday, August 2, from 1:00 to 5:00 PM at the Flathead Lake Biological Station, a Center of Excellence of The University of Montana.

The open house is a great opportunity for the community and area visitors to learn about what we do, explore our facilities and grounds and partake in special activities.

This year we have new research displays about North Fork Flathead River Conservation, Flathead Lake Monitoring and Food Web, Aquatic Invasive Species, Shallow Groundwater Quality in the Kalispell Valley, and Remote Sensing and GIS. We will also be demonstrating web resources and other information on our website such as local weather and lake data. The science and hands-on natural history displays are community and kid friendly.

Lake boat tours/research demonstrations take place at 1:05, 2:05, 3:05 and 4:05 PM. Short informative talks about 100 years of Flathead Lake Food Web will be presented before each boat trip along with exciting news about research buoys that will soon be streaming web-accessible lake and weather data to the community and scientists alike.

At 3:15 PM, Dr. Jack Stanford, Director and Bierman Professor of Ecology, will give a presentation on "What We Do at the Biological Station."

And what would make a great day at the Station better? This year we are adding a Geocaching activity called 'Caching In on FLBS Natural Treasure' with some treats for kids of all ages that join in the fun.

In a protected cove on Flathead Lake’s east shore, UM operates the oldest active biological station in the United States.

Only six years younger than the 118-year-old University itself, Flathead Lake Biological Station has collected data about the lake since 1899. The state of Montana was just 10 years old when Morton J. Elrod, UM’s first biology professor, established the first station near Bigfork and began recording information about the lake and its fishery.

More than a century later at Yellow Bay, where the station moved in 1908, scientists such as Bonnie Ellis continue and expand on Elrod’s work. They use those archives started by Elrod to produce important research.

The National Academy of Sciences earlier this year published an article by Ellis and others demonstrating how the introduction or invasion of nonnative organisms, even in a lake as large as Flathead, can lead to significant – and sometimes surprisingly rapid – changes in an aquatic ecosystem.
This archive, which has been very detailed since the late 1970s, shows how invaders have altered the lake’s food web and how important nutrients are to the food web,” says Ellis, a research assistant professor in limnology at UM. “We didn’t think to go back more than 100 years until we had first looked at the past 30.”

That led to an article titled “Long-term effects of a trophic cascade in a large lake ecosystem” written by Ellis, biological station Director Jack Stanford and more than a half-dozen other scientists and researchers.

Their findings also were featured in *Nature*, an international weekly journal of science, earlier this year.

A trophic cascade, as Ellis describes it, is “the theory that when you alter predator and/or prey in an ecosystem, you can alter the abundance, biomass or productivity of a population, community or trophic level across more than one link in that food web.”

Enter opossum shrimp – *Mysis diluviana* – into Flathead Lake.

UM scientists have long led the way in documenting the effects of the establishment of the mysid shrimp in Flathead Lake in the 1980s. It brought about the collapse of the lake’s kokanee salmon fishery, but the exact mechanisms for the demise of the kokanee were not well understood.

There’s an interesting back story to all that, but a more important breaking story up front. Because what this new research suggests is that the introduction of shrimp also can be tied to the explosion in the nonnative lake trout population and indirect effects that cascaded through the food web.

For their article Ellis and her nine coauthors – including biological station research scientist James A. Craft – divided the lake’s history into four distinct periods.

“Put it all together and you get the entire picture of how the food web in the lake has changed,” Ellis says.

The first, the native period, existed before 1920, when only 10 species of native fish are known to have lived in Flathead despite the introduction of 14 nonnative fish from 1890 to 1920. Then the kokanee period ran from 1920 to 1984. Early in that period anglers began to report the nonnative lake whitefish and kokanee, and by 1940 kokanee replaced cutthroat trout as the dominant catch of anglers. Toward the end of this period, native cutthroat remained at low densities, nonnative lake whitefish continued to expand and nonnative lake trout remained at low densities.

Interestingly, the next period lasted but four years.

“The population of opossum shrimp in the lake exploded from 1985 to 1988,” Ellis says. “During that time the population of kokanee in the lake fell and never recovered, bull trout declined and lake trout came to be the dominant top predator. At the same time as the kokanee crashed, bald eagles that concentrated in large numbers in Glacier National Park to feed on the spawning salmon dispersed to other regions where prey was more abundant.”

This also is the time when primary productivity – the production of organic compounds via photosynthesis – shot up by 21 percent. While the opossum shrimp numbers quickly dropped to about a third of what they were at their peak in 1986, primary productivity has not gone down.

The time from 1989 to the present has been labeled the “mysid-lake trout period.” It’s two decades where today’s latest Flathead ecosystem has settled somewhat into its routines.

For all intents and purposes, Ellis says, we’ve had “two different lakes and two different food webs – before *Mysis* and after *Mysis*.”

Ellis witnessed the changes that can come quickly in a body of water as a youngster. Growing up in Orange, Texas, across the river from Louisiana, she and her brothers would bait the string on their bamboo poles with bacon and fish the local bayous for blue crab.

“We lost our favorite site to discharge from a pulp mill,” she says.

But that loss sparked her interests, and Ellis came to UM and the biological station in 1977 to study the limnology of Flathead Lake. She never left and eventually earned her doctorate.

So she was there when the opossum shrimp planted by Montana Fish, Wildlife and Parks in lakes to the north – ironically, in an effort to increase kokanee populations – made their way into Flathead.

“They came from Waterton Lake, where they’re native,” Ellis says, “and they were put in Kootenay Lake to try and increase the size and numbers of rainbow trout.”
Instead, in Kootenay the shrimp increased the size and numbers of the kokanee salmon. “Fish managers figured, ‘Great, we’ll add it to a lot of lakes to stimulate kokanee populations,’” Ellis says. But Kootenay was unique, she says. The contours of the bottom of the lake and its currents pulled the Mysis shrimp off the bottom and into shallow bays where the kokanee could feed on them during the day. In other lakes – and most certainly in Flathead – the shrimp could stay on the bottom of the lake away from the sight-feeding kokanee during the day and come up at night to feed. Because both Mysis and kokanee prefer the same zooplankton, it was believed early on that competition for the same prey caused the decline in kokanee. But the deep-water lake trout, which had been introduced 80 years earlier but had never gotten much of a foothold in Flathead, suddenly had an abundant new food source, Mysis, on the lake bottoms where little previously was available. Lake trout flourished, and recent research shows the voracious fish decimated the kokanee fishery and concerns grow that native fishes may be in peril. The change in the fishery promoted a rapid shift in community structure, resulting in a trophic cascade affecting bald eagles, fish, zooplankton and algae. “Understanding trophic cascades requires that long-term data sets be formalized by robust models because of the extreme complexity of interactions,” Ellis and her coauthors wrote in their article. “One important challenge is to determine the tipping point for what might be the next ecosystem state as the community continues on its internally driven dynamics, and as external drivers such as climate change and direct human intervention (a lake trout reduction program is under way, for example) further force the system.” The findings by Ellis and her counterparts are very important to Flathead Lake but have serious implications for other bodies of water around the globe as well. The science? It’s backed by more than a century of data collected by researchers at UM’s Flathead Lake Biological Station.

Local residents and area visitors often call with inquiries. Topics are varied—lake temperature and currents, good fishing spots, species identification and invasive species, water quality, weed control, shoreline erosion and more commonly, who needs to know about big blobs of green stuff floating in the water, foam and rows of eerie yellow scum? Others call in with some surprising questions—who removes livestock swimming in the lake, how do you prevent raccoons from eating the siding on your house, can someone get the skunk out of the window well, and where do I report sightings of moose or “Flattie” the Flathead Lake Monster? In this very direct way, Biological Station employees help the public with every inquiry connecting citizen with science expertise found at the Station or by providing contact information and ideas for who to call. Most travelers on the east shore of Hwy 35 drive past the entrance to Flathead Lake Biological Station. One morning, a lifelong resident stopped because he had been wondering what in the heck we do here. He said, “Always saw the sign, just had to know after 88 years of not knowing.” The three members of his party signed the visitor’s log, received a brief overview of the Station and spent time viewing slides of FLBS field research sites at the FLBS Kiosk. They also visited the museum, took a self-guided tour, and picked up informative handouts about Flathead Lake. Our faculty and research staff also spend time with Flathead stakeholders at informal gatherings or at formal meetings with area resource managers and legislators. And, they are often invited by area groups to deliver presentations at public or regional educational forums. The Flathead Lake Biological Station is actively involved in the community.
From a distance it looks like a small horsepower outboard motor, minus the propeller, that UM researcher Mark Lorang attaches to his raft.

Except Lorang apparently puts it into the water upside-down.

This, however, is no Evinrude outboard motor in the hands of a confused boater.

It’s an Acoustic Doppler Velocity Profiler – commonly referred to as an ADP – that Lorang attaches. Most of the rest of the world uses them to calculate stream discharge, which measures the water volume flowing past a certain point.

Lorang, an associate professor of geomorphology at UM’s Flathead Lake Biological Station, saw far more possibilities in the technology.

It’s taken 10 years to perfect, but Lorang has developed new software that uses data collected from the ADP to create three-dimensional pictures of river systems – almost as if he has diverted rivers, as well as their banks and bottoms, through a hospital CT scanner.

The brightly colored images the software outputs present a fascinating and multifaceted picture of how a river works, almost foot by foot.

“Anyone can collect the data,” Lorang says. “It’s how you put it together that matters.”

That was the hard part – developing software that transforms the data from the ADP into the easy-to-read 3-D images that could eliminate the need for conventional hydraulic modeling.

Mark Lorang calls it the River Analyzer. Joe Fanguy, director of technology transfer at UM’s Office of Research and Development, calls it a potential business that could create Montana jobs.

Hired to determine how a river in Washington would behave if riprap at a state campground was removed, Lorang faced a challenge.

“I needed a great-big three-dimensional view to do the evaluations,” he says. “They wanted me to show how much of the campground would flood and how much spawning habitat would be created if the riprap was taken out.”

To do that, he invented River Analyzer, which merges a river’s ADP hydraulic data with a Global Positioning System – airborne and satellite remote sensing data – to create a dynamic 3-D model of a river.

Programmer Chris Gotschalk, one of Lorang’s research partners, helped code the software that produces the pictures from the data.

With the River Analyzer, Lorang can accurately measure large sections of river to provide information and evaluate where a river might change its course or scour its bed, which are important outcomes for many river projects. Lorang says his invention was first used while evaluating a campground site on the Dosewallips River, located in Washington on the Olympic Peninsula.

The detailed 3-D view of the river’s depths and velocities near the campground helped Lorang predict for Washington officials what would happen if the riprap was removed.

“I needed it for my research,” Lorang says, “but by the time I had built it, it was obvious it would be beneficial to many other people.”

From fisheries biologists to dam operators, River Analyzer could be an important tool.

“The real beachhead of good that can be accomplished is it could help determine how to maximize

(Continued on page 5)
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hydroelectric power production while limiting the impact to ecology,” Lorang says. “We haven’t had a tool that uses real data rather than model estimates to predict how a river will change as we alter its flow. Now we do. This will help us predict the effect of river flow on streambeds, banks and ecosystems.”

The initial project analyzed a relatively short section of the Dosewallips, but any distance can be covered. Lorang has since created a 3-D model for 26 miles of the Flathead River north of the point where it discharges into Flathead Lake – and he could similarly map the entire Mississippi if needed.

“Not every piece of data is good,” Lorang admits. “There can be problems with both the ADP and GPS signals, or the boat spinning too fast or rocking too much. We spent a good year looking at quality control, so we can flag data that’s suspect.”

On the other hand, he notes, “We’ve gone through Class IV rapids with it and gotten beautiful data. Now for 26 miles I can slice and look at the three-dimensional flow of the river meter by meter.”

The pictures are bright – think of the often-colorful images associated with Doppler radar weather reports on television. Only in this case, the various colors don’t show precipitation or thunderstorms; they reveal where rivers run fast, where they run slow and all speeds in between.

From dark blue (slow) to bright red (fast), a rainbow that includes light blue, dark green, light green, yellows and oranges indicates a river’s velocity at any given point and at any given depth.

And he can do it anywhere in the world someone needs such a picture of all or part of a river.

With his single ADP, Lorang says he could sample the Clark Fork River as it runs through Missoula in a day. He could couple that with satellite imagery to create a complete 2-D map of the depth and flow patterns.

“In three to five days, I could get a complete 3-D picture of the Clark Fork, from Hellgate Canyon to the Bitterroot,” he says. “That’s impossible to do with conventional hydraulic modeling.”

So here was Lorang, having developed an unconventional use for Acoustic Doppler Velocity Profilers for his own purposes, but imagining countless other projects where the new technology could be invaluable.

“But I’m a researcher,” he says. “I don’t know how to go from this to finding investors and setting up a company.”

And that’s where Fanguy’s UM department comes in.

“We encourage faculty to think about commercial applications to their research,” Fanguy says. In Lorang’s case, he saw “the potential to create jobs through groundbreaking technology.”

After some initial discussions, Fanguy had Lorang explain the River Analyzer concept to UM’s Commercialization Advisory Board. The seven-person group is made up of one faculty member, Associate Professor Michael Braun of the University’s School of Business Administration, and professionals from the private sector – a business attorney, an entrepreneur and people involved in private equity and venture capital firms.

Then several student-led teams from UM’s business school became involved in the process, conducting market research and exploring potential business models under the direction of faculty members Klaus Uhlenbruck and Jakki Mohr.

That all led to a dramatic shift in the business plan for River Analyzer. Originally conceived as a company that would sell the software that does the work, it’s now seen as a company that would do the work, period – contracting its services out to gather, process and sell the data.

“IT’s shifted from a software sales model to a service-based model,” Fanguy says. “We’re actively working with Mark and his team to put together a commercialization package that will allow him to take it to market.”

It took an entire UM team to get to the point of being ready to launch, Lorang says, including researchers, students, business school faculty, an advisory board and the technology transfer office.

Fanguy says there’s still a long way to go, but River Analyzer illustrates how research-derived technology has the potential to not only launch new businesses, but also provide learning experiences for students.

“Who knows?” Fanguy says. “It’s possible that one of our business school students ends up working for a River Analyzer company.” And it all started when someone wondered what would happen if some riprap was removed.

– By Vince Devlin

Reprinted from Spring 2011 Research View

STORM WAVES OR TSUNAMIS?

Wave competence (maximum size of particle that the wave can transport) is of great interest to Dr. Mark Lorang and others. Understanding how waves move large material, e.g., boulders and massive rock fragments (megaclasts), great distances inland can reveal information about where to and ‘not to’ develop coastal/shoreline lands.

In a recent paper in Marine Geology (2011 283:90–97), Dr. Mark Lorang provides a simple wave-competence approach—a mathematical tool box—to determine the likelihood of one causal mechanism over another, storm wave versus tsunami, in transporting boulder and megaclasts found inland or upslope from coastal shorelines. He illustrates this with a conceptual example of a well-developed boulder beach located on the Napali coast on the Hawaiian Island of Kauai.
This spring, Dr. F. Richard (Ric) Hauer, nominated by Dr. Jack Stanford along with the support of other colleagues and Max Baucus, received The University of Montana’s Distinguished Scholar Award for 2011. Nominations for this award may be made by deans, department chairs and faculty members to honor UM faculty who have made outstanding contributions in the areas of research, creativity or other scholarly activities.

At the April 27 UM Employee Recognition Day ceremony in Missoula, faculty and staff awards were presented. Hauer attended the event and also received many encouraging words from colleagues like “congratulations and much deserved.” Later, he enjoyed a celebratory dinner with friends.

Hauer joined UM in 1986, and in 2004, Ric was appointed as the Professor of Limnology at Flathead Lake Biological Station. He divides his time between teaching, outreach and researching the moving waters of the Crown of the Continent doing novel work. Ric incorporates progressively higher technology including hyperspectral, digital and IR tools to conduct remote sensing research from aircraft. Hauer continues to champion educational programs serving as advisor to MS and PhD students, and teaching field ecology courses to undergraduates and land managers alike.

Since 2009, he has guided the development of a new graduate program at the Station, and since 2008, has served as UM’s Director of the NSF-EPSCoR Program, which has substantially increased research capacity at UM in Ecological, Environmental and Ecosystem Sciences.

Hauer’s many other accomplishments factored into this award: a lifetime of publications, reports, books including the seminal text, Methods in Stream Ecology (2nd edition); over $18M in research funding; former President of the North American Benthological Society; symposia organizer; invited speaker and presenter at science and outreach events; ad hoc reviewer for prestigious journals and more.

Hauer graciously accepted this award and responded, “I am grateful to be honored as The University of Montana's Distinguished Scholar for 2011. There is nowhere else that has a greater intersection of quality of university, faculty, and environment than here at The University of Montana. I am thankful to have the privilege of devoting my professional life in the Ecological Sciences, and to that end to contribute to the academic enterprise and scholarship at The University of Montana. I am particularly grateful to my colleagues at Flathead Lake Biological Station for their continued support and inspiration.”

SHALLOW GROUNDWATER STUDY

You may have seen Biological Station researchers (Dr. Bonnie Ellis in white Tyvek suit and Tyler Tappenbeck) over the past two years sampling wells in the Kalispell Valley. These activities were part of a study conducted by the Flathead Lake Biological Station for the Flathead Basin Commission.

The primary objective of this study was to provide additional information about water quality in the Flathead Valley shallow alluvial aquifer to County and State health officials, particularly in the region that has not been sewer and where residents still obtain drinking water from shallow wells. This study will provide baseline data for future monitoring efforts.
**APPLIED GENETICS—**
**A DIFFERENT KIND OF SEARCH AND RESCUE**

Gordon Luikart, Associate Professor at Flathead Lake Biological Station, uses leading genetic technologies to study ungulates (hooved animals), carnivores, amphibians and fishes. This spring, he presented a paper titled, “Genomics and the Future of Fisheries Management” at the 44th Annual Meeting of the Montana American Fisheries Society (AFS) meeting. The paper, prepared with colleagues Stephen Amish, Fred Allendorf and Robb Leary, examines how new genetic technologies can improve fisheries conservation and management and what range of research questions can be addressed through molecular genetic approaches.

Gordon notes in his presentation that an increase in the number and chromosomal distribution of DNA markers has improved the ability of researchers to identify locally adapted populations by allowing detection of resistance to pathogens and tolerance of higher stream temperatures. Second, the discovery of more diagnostic markers between species and subspecies has improved the capability to detect hybridization, identify genes influencing fitness of hybrids, and monitor the spread of “invasive” genes from nonnative species such as rainbow trout. And third, genetic restoration and transplants can be facilitated using approaches that track which source populations are most successful at achieving restoration goals, e.g., augmentations (“genetic rescue”) of small, isolated populations.

The theme for the 44th Annual Meeting was about conserving native fish that compete with thriving nonnative sport fishes populations. Craig Barfoot, MT AFS 2011 President and fisheries biologist with the Confederated Salish and Kootenai Tribes Natural Resources Department, pointed out that one of many challenges to resolving this conservation issue is insufficient tools for researchers. Gordon was right on the mark with his talk on how genetic technologies might provide useful approaches for researchers in their pursuit to solve one of the greatest fish management challenges in this region and elsewhere.

In a 2010 invited review in *Nature Reviews Genetics*, Fred Allendorf, Paul Hohenlohe, and Gordon Luikart, Associate Professor at Flathead Lake Biological Station, address “Genomics and the future of conservation genetics.” (Genomics is the study of the complete set of genetic material of an organism.)

In this article, authors explain “We will soon have complete genome sequences from thousands of species, as well as from many individuals within species. This coming explosion of information will transform our understanding of the amount, distribution and functional significance of genetic variation in natural populations. Now is a crucial time to explore the potential implications of this information revolution for conservation genetics and to recognize limitations in applying genomic tools to conservation issues. We identify and discuss those problems for which genomics will be most valuable for curbing the accelerating worldwide loss of biodiversity. We also provide guidance on which genomics tools and approaches will be most appropriate to use for different aspects of conservation.”

A schematic diagram (left) in this article describes the difference between traditional conservation genetics and using new genomics tools to achieve conservation solutions.

“Traditional conservation genetics, using neutral markers, provides direct estimates of some interacting factors (blue). Conservation genomics can address a wider range of factors (red). It also promises more precise estimates of neutral processes (blue) and understanding of the specific genetic basis of all of these factors.

For example, traditional conservation genetics can estimate overall migration rates or inbreeding coefficients, whereas genomic tools can assess gene flow rates that are specific to adaptive loci or founder-specific inbreeding coefficients.”

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*Figure 1, Courtesy of authors Allendorf, Hohenlohe and Luikart. From 2010. Nature Reviews Genetics 11: 697–709.*
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For donations by credit card, go to: http://umt.edu/flbs/Community/Campaign.aspx

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