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## Our Mission

To serve the Flathead Lake region, the state of Montana, the nation, and the world by advancing a cutting-edge research, education, and outreach platform for limnology, ecology, and environmental science at Flathead Lake.

We meet this mission via three main activities:

advanced **research**,  
sustained **monitoring**,  
and **education** at all  
levels.

## Advancing the future of aquatic ecology on the shore of Flathead Lake

While 2017 will be long remembered in the Flathead and around western Montana for the extended fire season and the smoke it brought, here at the Bio Station we'll remember it as the year that we grew our faculty team to full strength and the Bio Station truly embarked on a new era of research discovery and field-based learning from our home base in Yellow Bay. This magazine showcases some of the highlights from the past year.

We continue to pursue the cutting edge of **research**, building on the legacy established by Jack Stanford. During 2017, the Bio Station maintained active grants from the National Science Foundation, NASA, US Fish and Wildlife Service, Montana Department of Environmental Quality, and the Simons Foundation (among others). We submitted numerous grant proposals totaling more than \$10M (fingers are crossed for good outcomes!). Our researchers published 46 papers in rigorous scientific journals during the past year, helping to keep the Bio Station and UM in the academic limelight. Read more about some of this work inside.

Our **summer session** program is thriving, with new courses, increased enrollment, and enthusiastic students from around the country and world. Our **internship** program expanded and we really enjoyed the energy that these students brought to the station and the substantial contributions they made.

We continue to watch the lake diligently via our **Flathead Lake Monitoring Program** (FMP); catch up on the latest with Shawn Devlin's report (page 5). 2017 will also be remembered as the year when our attention to the threat of Aquatic Invasive Species (AIS) was stepped up as we implemented more intensive sampling for invasive mussel eDNA and Cody Youngbull completed development of his revolutionary field DNA detector.

Finally, we will remember 2017 as another year in which the Flathead Lake community engaged enthusiastically with the Bio Station. For that support, we are so very grateful!

Jim Elser (Director)



Tom Bansak (Assistant Director)



## Rainbow trout genetic invasion

The invasion or introduction of a new species provides one of the richest opportunities for “natural experiments” in evolutionary biology. Hybridization and biological invasions are also among the most serious threats to worldwide biodiversity and the persistence of many native species, including Montana’s state fish, the westslope cutthroat trout (*Oncorhynchus clarkii lewisi*).

With support from the National Science Foundation, Montana Fish, Wildlife & Parks, USGS, and Trout Unlimited, FLBS faculty member **Gordon Luikart** and FLBS / USGS scientist **Clint Muhlfeld** are developing and applying novel genomics technologies (thousands of DNA markers) to assess the ecological and evolutionary mechanisms affecting hybridization between introduced rainbows and native cutthroats. They are also assessing how this might affect trout adaptation to a changing climate across western North America. Results are being used by managers to protect, conserve, and restore native cutthroat trout populations across diverse landscapes, while also advancing the fields of genomics, evolutionary ecology, and climate change.



## Stoneflies in River Floodplains Dimensions of Biodiversity Project

With a grant from the National Science Foundation’s Dimensions of Biodiversity program, FLBS scientists are investigating the vulnerability of insect communities in river floodplains.

River floodplains are among the most biodiverse yet endangered landscapes on earth due to human-caused habitat disturbance, shifts in river flow regimes, and climate change. Floodplains provide important habitat for aquatic and terrestrial organisms from microbes, insects, and fish, to amphibians, birds, elk, and grizzly bears. Unfortunately, many species are disappearing from river floodplains before we can even document their existence or describe their characteristics, gene diversity, and importance within the greater food web (e.g., which insects are food for fish or birds?).

River floodplains are very complex because of the diverse types of habitats found there. The main river, side

channels, ponds, and springs all have different temperatures and habitat characteristics and are interconnected with underground gravel beds (the aquifer) that underlie the entire floodplain. These aquifer habitats are connected via underground water flow for more than two miles away from the main river. These different habitats support highly diverse invertebrate communities that are almost entirely unstudied using



genetic techniques.

This research focuses on stoneflies, which are very exciting to study in river floodplains because there are different species that are adapted to living in the aquifer compared to the main river. This study will quantify biodiversity vulnerability of the river channel and aquifer

stonefly species in relation to variation in habitat conditions (i.e., temperature, dissolved oxygen).

This work is being conducted on floodplains of the Middle Fork, North Fork, and main Flathead Rivers in Montana, as well as on floodplains of the Methow River in Washington. This research is building on 40+ years of past work on the Nyack Floodplain, which is a

focal site for our study. This study is led by Principal Investigator, **Gordon Luikart**, co-PIs **Brian Hand**, and **Jack Stanford**, and postdoctoral scholar **Rachel Malison**,

as well as many other collaborators and students. The team’s exceptional field crew collected thousands of river and aquifer stonefly samples from April-October 2017.

More details can be found at our webpage <https://flbs.umt.edu/urls/dob>



## SensorSpace: a maker space for environmental scientists

With support from the National Science Foundation's Field Stations and Marine Laboratories program, during 2017 the Bio Station completed purchases of an array of advanced equipment to establish a brand new facility at FLBS: SensorSpace.

Led by Research Professor **Cody Youngbull**, SensorSpace is a facility to enable researchers (at FLBS, UM, and beyond) to design, fabricate, and test their own environmental sensors. SensorSpace is also staffed by scientists/engineers **Rod McNeil** and **Zane Lindstrom**.

Major equipment and capacities available include:

- CNC mill
- 3D printers
- optical table
- fluorescence microscope
- soft lithography
- microcontrollers

Software includes SolidWorks, AutoCAD, Eagle CAD, APEX, and ASAP.



**SENSORSPACE**  
FLATHEAD LAKE BIOLOGICAL STATION

In summer 2018, Cody will teach a course in sensor design and fabrication, targeting biology as well as engineering students. The facility has also been featured prominently in FLBS' 2017 grant applications as it provides unprecedented capability to develop and produce research-quality sensors at low cost, as well as opportunities for creative training of students working on research projects.

## The Breath of Rivers Bob Hall

How does a river breathe?

**Bob Hall**, in collaboration with the USGS, answers this question using long time series of dissolved oxygen data for US rivers.



New computational methods allow them to estimate riverine photosynthesis and respiration for hundreds of days in hundreds of rivers, greatly expanding our understanding of the rates of river metabolism.

## Small Creatures: Huge Impact Matt Church

**Matt Church's** research focuses on the ecology and biogeochemistry of aquatic microorganisms, including ongoing work in oceans and lakes. He is a founding investigator in the Simons Collaboration on Ocean



Processes and Ecology (SCOPE). In addition, he has begun studying microorganisms in Flathead Lake and has already found some exciting results.

## A nursery of newborn lakes

### Q: What lives in lakes that are < 50 years old?

Due to ongoing climate warming, glaciers around the world are shrinking. Our Montana glaciers are no exception. During the past two summers, FLBS Director **Elser** and others, including Research Professor / USGS scientist **Clint Muhlfeld**, **Joe Giersch** (USGS), and **Tyler Tappenbeck** have visited newly formed lakes at the foot of glaciers in Glacier National Park, focusing especially on lakes in the Sperry basin and Upper Grinnell Lake. Some of these lakes have never been sampled before. The data are providing a basis for research papers as well as proposal submissions to gain funding to further advance this work.



FLBS and USGS scientists in the Sperry Glacier basin. This picture won First Prize in the Scientists in Action category in ASLO's photo contest!

## Monitoring with Environmental DNA

Since early detection offers the only hope of invasive mussel eradication, the Bio Station ramped up its eDNA monitoring program dramatically following the State's announcement of detections elsewhere in Montana. Starting in the fall of 2016 and continuing seasonally (spring, summer, fall) throughout 2017, the Bio Station, with partners including the Confederated Salish and Kootenai Tribes and the Flathead Lakers, have been analyzing multiple samples from more than 30 sites around Flathead Lake (see map) plus samples from 40+ additional lakes around western Montana. These sampling efforts have been



led by FLBS Research Specialist **Phil Matson**. The majority of funding for this early detection monitoring on Flathead Lake has been via philanthropic giving from shoreline homeowners. So thank you for making this possible! It is worth it, because as the saying goes: “an ounce of prevention is worth a pound of cure”.



## Aquatic Invasive Species Preventing Quagga and Zebra Mussel Invasion

The Bio Station views aquatic invasive species (AIS) as one of the greatest threats to Flathead Lake and the waters of Montana. Flathead Lake's biological community has already been impacted dramatically by nonnative, introduced and invasive species for over 100 years.

Today, FLBS is very concerned about the arrival of new aquatic invasive species, in particular zebra and quagga mussels, to Flathead Lake and the state of Montana. These mussels are game changers that have not been eradicated from a water body once they are well established. Ecologically, they eat the majority of available food which can result in fish population crashes and significant disruption to the biological community. From a water quality perspective, they can cause harmful algae blooms in the shoreline areas where we spend our time. They disrupt recreation by covering beaches

with razor-sharp shells that can cause infections and can negatively affect boating and fishing opportunities.

Economically, by growing on infrastructure and clogging pipes they disrupt and dramatically increase costs associated with water delivery and power production. These costs are passed along to the users of water and electricity – basically everyone. Total potential impacts of the mussels on the Pacific Northwest were recently estimated to be above six billion dollars.

The Bio Station has been studying AIS and working to prevent their arrival in the Flathead for years. FLBS scientists have been part of a Flathead Watershed AIS

Working Group for nearly a decade and have made innumerable presentations to educate local residents, politicians, agency managers, and other stakeholders about this threat. FLBS staff members have been monitoring for AIS around the Flathead and western Montana for decades, and over the last five years our faculty and

scientists, in particular FLBS Professor **Gordon Luikart** and the personnel in the Montana Conservation Genetics Lab, have been developing and using new environmental DNA tests to look for newly arrived AIS. With many local partners, the Bio Station has been collecting and analyzing DNA samples from numerous sites in Flathead Lake plus an additional 40+ lakes around western Montana. Fortunately to date, no new AIS, including zebra and quagga mussels, have been found.

To date we have not detected any zebra or quagga mussel DNA in our Flathead Lake samples.

## The FMP Team



# Flathead Lake Monitoring Program (FMP)

Flathead Lake remains one of the most pristine and beautiful waterbodies in the country. Our monitoring data shows trends in improved water clarity with water transparency measurements of roughly 32 feet on average in 2017 (46 feet was the maximum observed). These values rate Flathead Lake as one of the clearest lakes in the world. Over the last decade, monitoring data has shown decreasing phosphorus concentrations (good) and increasing nitrogen concentrations (bad) and 2017 was no different. These opposing trends in

nutrient concentrations continue to drive the lake towards phosphorus limitation and are setting up a very interesting ecological scenario that researchers at FLBS are watching closely.

*Mysis* (opossum shrimp) abundances were low in 2015–2016 and this appears to be the case for 2017 as well. After a period of ups and downs about 5 years ago, *Mysis* abundances seem to have leveled off for a few years at a low value. FMP has added monthly *Mysis* sampling events at three sites to follow growth and population dynamics as

they relate to depth. This work allows researchers at FLBS to actively monitor and study how this important organism may be adapting its life history strategies and how this may affect the ecology of Flathead Lake.

FMP will continue to be a strong steward and keen observer of the Flathead Lake ecosystem. The long-term dataset will act as a safeguard against water quality degradation in Flathead Lake. Thanks to our donors for helping to **KEEP IT BLUE!**



Tyler Tappenbeck



Jim Craft



Shawn Devlin

## Fire impacts

**Q: What are potential impacts on Flathead Lake from this summer's fires?**

**A:** A major part of FMP is to monitor atmospheric deposition both in dry deposition and through precipitation. Our data show that this year's intense fire season and smoky skies were a major source of nitrogen to the lake. FMP will continue to study how regional drivers such as the fire season and land use changes may be affecting Flathead Lake.



Smoke on the water (at Yellow Bay in August 2017)

## Summer Undergraduate Internships

Summer brought seven undergraduate interns to the station. Six interns were from the University of Montana and one was from Brown University.

Students came from a range of academic disciplines and worked on a variety of projects including: chemistry, aquatic ecology, microbiology, data modeling, website development, and outreach.

In addition to working on their own project, all interns were exposed to the wide variety of research projects happening at the station through weekly seminars and group field trips. They also shared what they learned with the public at our annual research cruise and open house.

“The internship gave me very unique and marketable skills.”



“I had the freedom to pursue my vision for my project.”



Students learned about ecology from our faculty in the great outdoors of northwest Montana. Students in all classes visited diverse landscapes including grasslands at the National Bison Range, alpine meadows in Glacier National Park, flood plains along the Middle Fork of the Flathead River, and midnight sampling on Flathead Lake. Our students learned practical field methods, how to design and conduct field-based ecological investigations, as well as central concepts of modern ecology.

Two new courses were taught this summer. *Aquatic Microbial Ecology* was taught by our new faculty member, **Matt Church**. His goal with this class was to provide a conceptual foundation and hands-on field and laboratory training in modern methods of aquatic microbial ecology. *Drones for Water Research* took advantage

of FLBS GIS specialist **Diane Whited's** partnership with Swiss scientist **Michael Doering**. The goals of this course were to introduce and expose students to close range remote sensing in freshwater ecosystems. Sensing involved unmanned aerial or aquatic vehicles, autonomously or remotely operated and equipped with

**Forty-nine students from 23 universities, 20 states, and 3 countries participated in the 2017 Summer Session.**

## Summer Session Learning While Doing

various sensors such as NIR (Near infrared), TIR (Thermal infrared), or ADP (Acoustic Doppler Profiler)

Other courses taught this summer included: *Field Ecology*, *Conservation Ecology*, *Landscape Ecology*, *Alpine Ecology*, *Forest and Grassland Ecology*, *Lake Ecology*, and *Stream Ecology*.

Our summer seminar series, “Data and Donuts”, included presentations ranging from black widow spider behavior to plant physiology.



“To say this summer was an epic adventure doesn't even begin to do it justice. Here's to the summer of a lifetime.”

## K-12 Programs

The Flathead Lake Aquatic Research and Education Program (FLARE) started this year by **Monica Elser** and **Holly Church** brought 550 students to the station for newly developed hands on activities focused on aquatic ecology research. An additional 330 students visited the station in partnership with the Flathead Lakers' Watershed Stewards program. This program included learning stations staffed by Bio Station educators and Flathead Lakers volunteers.

FLBS educators brought

programs directly to elementary through high schools in the Flathead Lake regions. Almost 700 students learned about various topics ranging from the importance of aquatic food webs to understanding the genetics of trout hybridization.

The Bio Station education team also developed new learning stations for the annual open house and participated in the Arlee Powwow Science Tent.

Successful grant proposals to the Applied Materials Foundation and the

Greater Polson Community Foundation allowed our K-12 programs to purchase modern scientific equipment for use by students during field trips to the station.



## Science On Tap

### Q: What is Science on Tap?

A: Science on Tap is our partnership with the Flathead Lakers to bring science to our community at a local brewery. Scientists from the region presented a broad range of topics from Loons to River Metabolism. What could be better than science and beer? On average 60 people attend each event.



### Q: Where and when is Science on Tap?

A: Science on Tap is held first Tuesday of each month. Flathead Lake Brewing Company has hosted most of these events, although during the busy summer season we also held them at Finley Point Grill and Glacier Brewing Company. Current information is available at our website: <http://www.scienceontapflathead.org/>

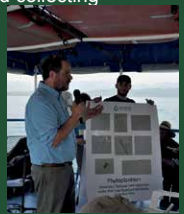
## Open House August

Over 300 people visited FLBS during our Open House. Riding on the *Jessie B* is always a hit, especially when Monte is along for the ride. Mussel-sniffing dog demonstrations, viewing plankton up close, plankton races, making food web necklaces, and our new Nyack floodplain display kept all ages busy and informed about the lake and our important work.



## Research Cruise July

Great food, drinks, music, and science combined to make our annual research cruise a success. This year, in addition to presentations by our scientists and collecting samples from the *Jessie B*, the passengers were able to meet our undergraduate interns. These students helped to make the event run smoothly and shared first-hand experiences of doing research at the Bio Station.





**FLATHEAD LAKE  
BIO STATION**  
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## Immersive Learning

In the tradition of FLBS founder Morton Elrod, associate professor **Matt Church** engages summer session students through hands-on lessons about Flathead Lake's microbial communities.

## Our public events

### • Open House

Every August, come and see our beautiful facilities, do some “hands-on” science activities, meet our faculty, staff, and students, and get an update on the state of the lake and the Bio Station. Come early and get a boat ride on the *Jessie B*!

### • The Research Cruise

In July, we embark from Lakeside on the *Far West* for a cruise that features great food, refreshing beverages, live music, and a good dose of science. Come along to learn from our scientific staff and students as we rendezvous with the *Jessie B* and discuss how to keep Flathead Lake blue.

### • Science On Tap Flathead

On the first Tuesday of every month, we partner with the Flathead Lakers to host an informal science presentation at a local pub. Topics range from osprey to oil trains to oxygen metabolism. Join us!

### • Data and Donuts

During the first four Mondays of our summer session, scientists from FLBS, Montana, and around the world give a one hour lecture on an exciting research topic. It is a good chance to learn while enjoying a tasty pastry or two.

**Visit our website at [flbs.umt.edu](http://flbs.umt.edu) for more information and to sign up for our e-newsletter.**