

TWINE LINE

The educational newsletter of Ohio Sea Grant, covering issues, events, and research related to Lake Erie and the Great Lakes

Entering the Zone

Aquatic Nuisance Species, Combined Sewers, Agricultural Run-Off, and Low Water Levels May be to Blame for Dead Zone Frequency in Lake Erie

When the Cuyahoga River caught on fire in 1969, the nation watched in amazement as the body of water and symbol of the Great Lakes burned. Phosphorus mainly from sewage treatment plants and agricultural run-off was deemed the problem and the nation wondered how officials would rectify it. Scientists and regulators quickly responded by strategically placing pollution monitoring stations on the Lake's tributaries, upgrading sewage treatment plants, and establishing phosphorus loading targets for the Lake. The Lake reacted to these adjustments with better water quality, an improved fishery, and the return of the mayfly.

But phosphorus levels have risen since 1995, bluegreen algae has returned, and dissolved oxygen has been dropping to create the largest area of low oxygen or "dead zone" since the early '80s.

Scientists thought they had the problem licked by phosphorus controls, but if trends continue for another three years, Lake Erie may confront problems similar to what it had in the '60s and '70s.

This isn't new to Lake Erie. It has experienced these no oxygen zones on and off for years. However, the difference in the last few years has been the consistency and the magnitude of these anoxic areas. Even with phosphorus reduction practices in place, we're still getting areas of anoxia. And recently, we've been getting them consistently and for longer periods of time.

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Special Insert: 2003 Calendar

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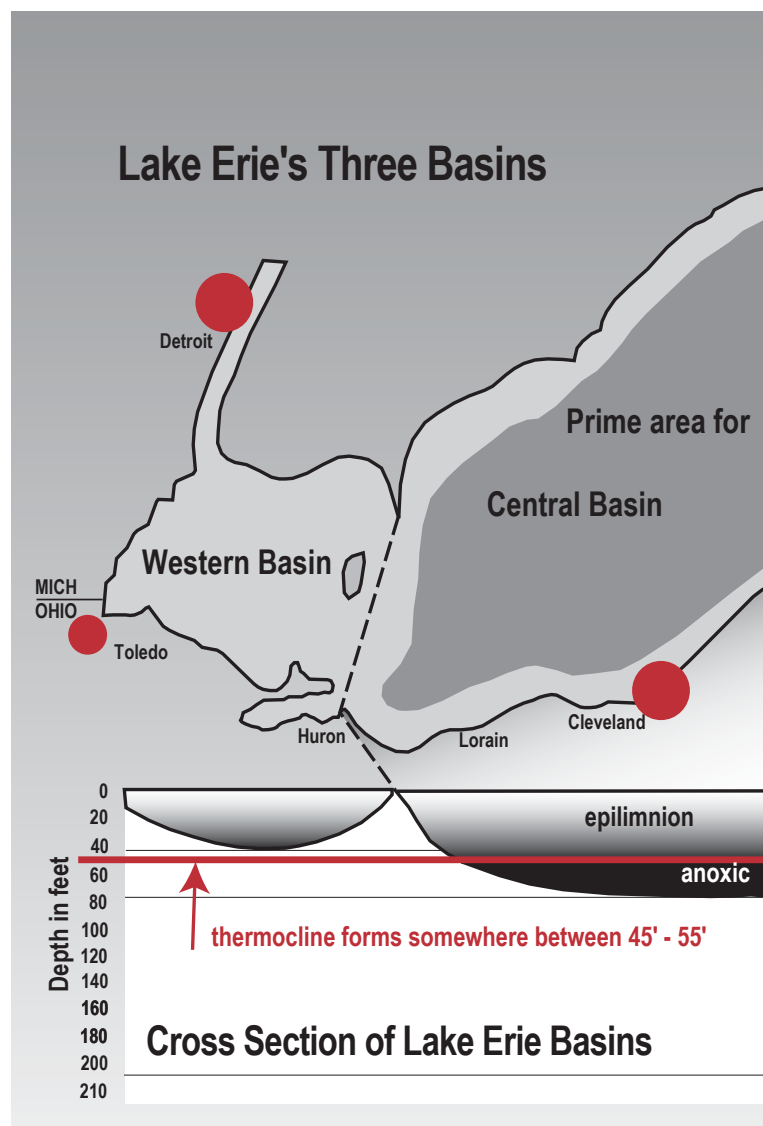
Lake Erie's Geology

Lake Erie is divided into three basins based on shape and depth. The Western Basin is the area west of Sandusky with an average depth of only 24 feet. The area east of Erie, Pennsylvania is the Eastern Basin, averaging 80 feet in depth and containing the deepest point in the Lake (212 feet). The Central Basin is the large area between Sandusky and Erie with an average depth of about 60 feet. While the Western and Eastern Basins have irregular bottoms with a lot of variation in depth, the Central Basin's bottom is very flat.

Thermocline in Lake Erie

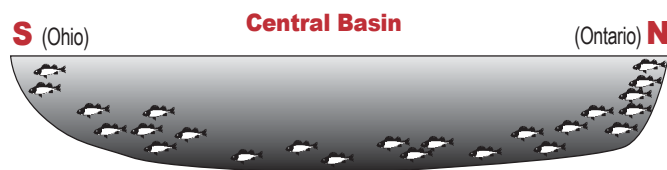
When the surface water is warmed by the summer sun, Lake Erie forms temporary layers. The warmer surface water known as the epilimnion is lighter and "floats" on top of the cold bottom layer or hypolimnion. The line of rapid temperature change between these two layers is called the thermocline and typically forms around 45 to 55 feet from the surface of the Lake. The cold bottom layer of the Central Basin is the home of the dead zones. Based on the depths of the three basins, the Western Basin is too shallow to have a thermocline except on rare occasions. Although the Eastern Basin will have a thermocline, there will be more water (and thus, more oxygen) below it in the cold bottom layer because it is so deep.

At the time the thermocline forms in the spring, there is plenty of dissolved oxygen in the Central Basin's bottom layer. Due to its depth, there is often no way to replenish oxygen in this cold bottom layer until the thermocline disappears in the fall. Oxygen that was present when the thermocline formed, is used by organisms living in this area throughout the summer. Phosphorus from sewage treatment plants and agricultural run-off fertilizes algae in the Lake. When that algae sinks to the bottom and decomposes, the process of decomposition uses up too much oxygen and that portion of the Lake becomes anoxic. If we could reduce the amount of algae, we could reduce the amount of oxygen required to decompose it.



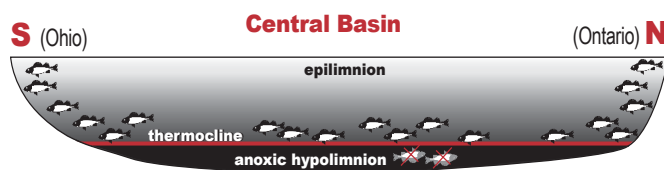
How the "dead zone" may impact aquatic life in Lake Erie

Lake with no stratification (Fall/Spring)

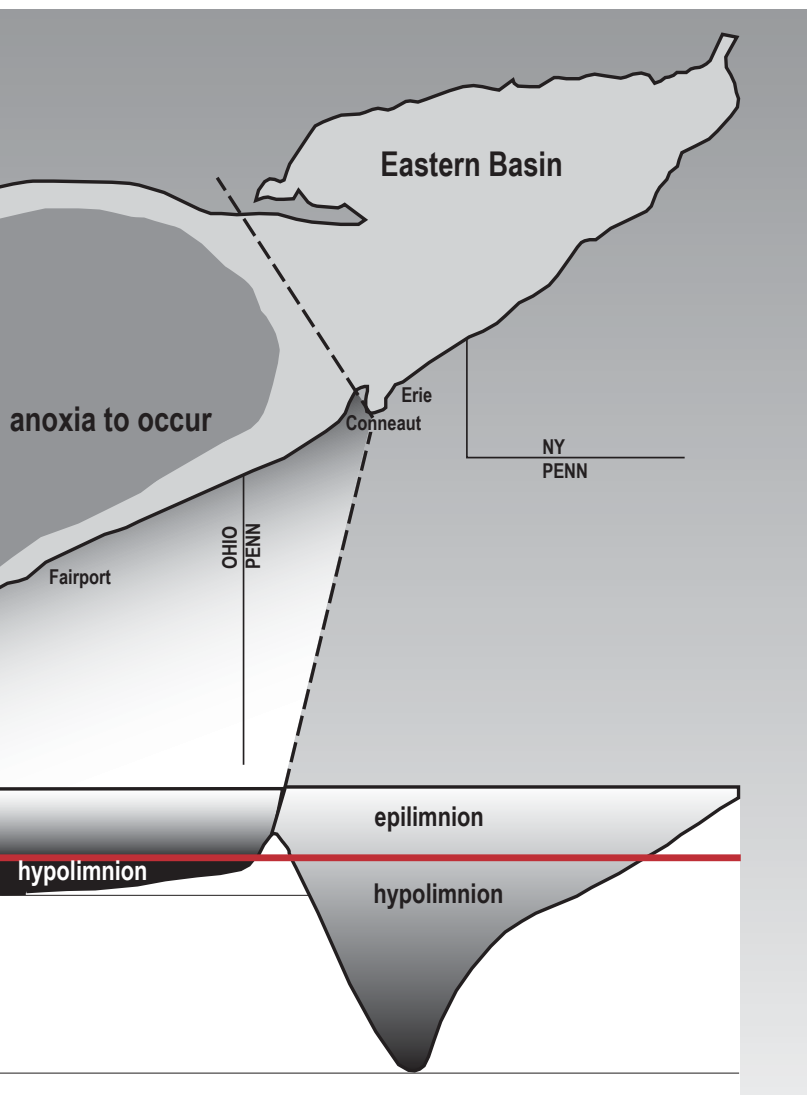


When no stratification (temperature layering) is present, oxygen levels will be sufficient from surface to bottom. Fish location will depend upon the location of food sources and preferred or typical habitats for a given fish species. During the spring, some species will be found closer to shore and in shallower depths for spawning. Food, however, will be the dominant variable in location.

Stratified lake with anoxic hypolimnion (July/August)

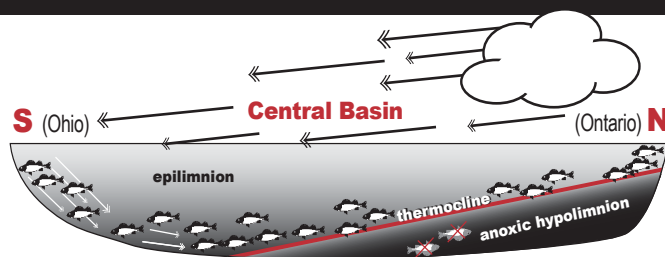


When stratification occurs the lake separates into 2 distinct layers, a warm top layer (epilimnion) and cooler bottom layer (hypolimnion) with a thermocline (area of rapid temperature change in between layers) forming somewhere from 45 to 55 feet. If anoxic conditions develop in the hypolimnion, fish will seek higher oxygen levels by rising up and into or above the thermocline, or by moving shoreward into shallower water depths, also above the thermocline. Temperatures inside and above the thermocline are cooler than the surface layer, with an abundance of forage species also preferring this cooler, oxygenated water. Fish and other aquatic life not able to escape the anoxic zone will suffocate. Food, however, still remains the critical variable for fish location.



Adapted from the *Lake Erie Report*, Department of the Interior, 1968

Wind driven rotation of thermocline



If anoxia develops within the hypolimnion, fish kills may occur during periods of sustained high winds from northerly and southerly directions. For example, a strong north wind for a number of days piles the warm surface layer up on the south shore. This forces the thermocline deeper and causes the cold bottom layer to flow to the north shore, pushing anoxic water into shallow depths and trapping fish, resulting in a fish kill on the north shore. The same may happen on the Ohio shoreline with strong, sustained south winds. Strong spring and fall winds, however, generally occur before the development of, or after the breakup of the thermocline when there is plenty of oxygen throughout the water column.

Possible Causes of the "Dead Zone"

The combination of aquatic nuisance species, combined sanitary and storm sewers, agriculture run-off, warm temperatures, and low water levels may be increasing the frequency and area of the anoxic zone in Lake Erie, according to Ohio Sea Grant and EPA researchers. It is likely that further efforts to reduce phosphorus loading will solve the problem. However, research is currently underway in an effort to definitively answer this question.

Human contributions to high phosphorus levels and the ensuing dead zone have plagued Lake Erie for many years. Ohio State University researchers noted the first dead zone off Sandusky Bay as early as 1930. In the 1960s and 1970s, thousands of tons of phosphorus from sewage treatment plants and other sources were dumped in the Lake, causing the entire lake to be declared dead as oxygen was eliminated from up to 90 percent of the bottom waters in the Central Basin.

Researchers in the early days of the Ohio State's Center for Lake Erie Area Research (CLEAR) focused on this problem, which led to the phosphorus reduction strategies. Phosphorus loading was reduced from 29,000 metric tons in 1969 to the target of 11,000 metric tons by the 1980s. This ultimately led to the recovery of Lake Erie.

Since the mid-1990s scientists have observed phosphorus levels in the Lake increasing again. Many are looking at the official phosphorus loading estimates and questioning how accurate they are. Because the figures are based on estimates and volunteer reporting by polluters, they may be lower than what is actually going into the Lake.

It is also probable that zebra mussels may be, in part, to blame for the anoxic state of the Lake. As they process organic matter, they excrete phosphorus into the water column where it can be repeatedly used, instead of allowing it to settle out into the sediments. "The recycling of phosphorus again fuels the growth of plants that die, sink to the bottom, consume more oxygen, and the cycle repeats," states Dr. David Culver, an Ohio Sea Grant researcher. Culver and others have observed that quagga mussels are rapidly replacing zebra mussels and that quagga mussels may release more phosphorus than zebra mussels.

In addition to aquatic species, heavy rains this spring may have increased phosphorus loading to the Lake from agricultural runoff and sewage overflows. Unfortunately, there are still many sewer systems in existence where storm sewers are combined with sanitary sewers. In these cases, whenever there is a significant rain, raw sewage (and phosphorus) is dumped into the environment.

The dead zone problem is also exacerbated by low water levels that reduce the thickness and volume of the hypolimnion, and, therefore, the amount of oxygen it can hold. Some of the problems that have been observed include: low dissolved oxygen levels around Stone Laboratory in 2001, an area of anoxia observed in the Central Basin in 2001, loss of mayflies near Cleveland in 2001 and 2002, and cloudy water (poor visibility) near the artificial reefs in Cleveland (observed periodically since 1999).

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ASK Your Agent

Sponsored by Ohio Sea Grant Extension

For answers to Lake Erie -related questions, visit the Lake Erie Information Discussion Board at www.sg.ohio-state.edu/discus

Walter Williams, Cleveland

How can I get my community to become environmentally friendlier?

by Walt Williams, Ohio Sea Grant Extension

The saying that an old habit is hard to break holds true with local communities. For far too long, economic prosperity was seen in terms of bricks and mortar, capital investment, and job creation. Nowhere in the equation was there a place to make our communities environmentally friendlier. In order for a community to develop an environmental conscience, a grass roots effort must be waged.

Participate in a Storm Drain Labeling Program

This program is an effective way to inform the public about the direct link between what they do on their property and the health of their watershed. Kits are available to groups or individuals and include permanent vinyl decals, adhesive, and instructions. The decal states in prominent letters "NO DUMPING - DRAINS TO RIVER" and is placed next to storm drains. This statement lets the public know that hazardous household products (cleaning products, car oil, paint, etc.) should not be poured down a storm/sewer drain. To obtain a kit, contact your municipality's Sewerage and Drainage Division. Also, in the Cleveland area and many other Ohio cities, combined storm and sanitary sewers allow raw (untreated) sewage to enter every time it rains.

Challenge Developers to Adopt Techniques That Are Easier on the Environment.

As we develop and alter the landscape to create higher density housing on smaller plots of land, developers have not historically considered maintaining the natural landscape. It is far too easy to bulldoze and flatten the land instead of incorporating the valley and peaks within a housing development. As a result both water quantity and water quality are negatively impacted. Increased runoff causes more frequent flooding which decreases water infiltration. Less groundwater recharge decreases the base flow of water to streams. In addition, more pollution generated from our land use is delivered to our waterways.

Suggest that planners reduce road widths in order to cut down on impervious surfaces, and reduce (often eliminate) curbing to reduce concentration of runoff. In the process, we can heighten traffic "calming" and enhance neighborhood character. When curbs are a necessity, suggest vegetated buffers that will absorb contaminants before they enter our waterways.

Remember, before beginning efforts to improve a community's environmental friendliness, always discuss project ideas with local officials first. **TL**

For Your Information

September Water Levels

Lake Erie's level declined during September. The mean level was 571.03 feet which is 0.36 foot lower than last month's mean level and 0.39 foot below normal. The 2002 level is 0.69 foot higher than the September 2001 level and 1.83 feet above the Low Water Datum elevation reference system. **TL**

Web Site of Interest

To understand lake ecology, check out an on-line limnology primer, <http://wow.nrri.umn.edu/wow/under/primer/index.html>. This 21-page-primer provides a general background to Water on the Web by introducing the basic concepts necessary to understand how lake ecosystems function. The reader is later referred to a list of texts and journals for more in-depth coverage of the science of freshwater ecosystems. **TL**

National Ocean Sciences Bowl

The National Ocean Sciences Bowl is a competition for high school students on topics related to the study of the oceans. High schools in Ohio and the surrounding area are invited to compete in the Penguin Bowl hosted by Youngstown State University on March 1, 2003. In addition to a regional prize, the winning team from each competition will receive an all-expense paid trip to San Diego for the national competition in April. The registration deadline is November 29th. Contact Ray Beiersdorfer at ray@cc.ysu.edu or 330.941.1753. **TL**

New Steelhead Angler Survey

Ohio Sea Grant has initiated a Lake Erie Tributary Steelhead Angler Survey. A first of its kind, the survey will document the economic contributions of the steelhead fishery using information collected from steelhead anglers. Steelhead fishing has become a growing all-year sport for Lake Erie. Anglers on the following Lake Erie tributaries will be targeted: Conneaut Creek, Ashtabula River, Arcola Creek, Grand River, Chagrin River, Cuyahoga River, Rocky River, the Vermilion River, and other smaller tributary streams and creeks. Anglers will be contacted in person while out on the water about participating in the survey, and those who agree will have the survey mailed to them. The survey will include questions about how many trips steelhead anglers make; how much time they spend fishing per outing; how many fish they catch; and how many they keep. All responses will be confidential. The survey will continue from winter 2002 to spring 2003 as weather conditions allow. Results will be analyzed and reported next summer to local county visitor bureaus, angling groups, the ODNR, Division of Wildlife and others interested. This project is sponsored by the Ohio Sea Grant College Program, the Lake Erie Protection Fund, Ohio State University Extension, the Lake County Visitors Bureau, the Central Basin Steelheaders, and the Emerald Necklace Chapter #133 of Trout Unlimited. **TL**

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Seasonal Averages of Phytoplankton Algae Wet Weight in Lake Erie's Central Basin

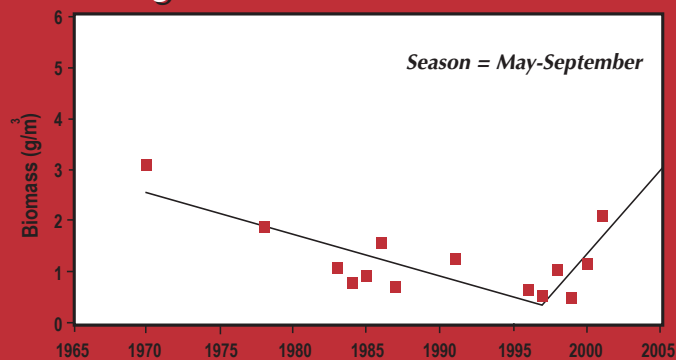


Chart information compiled by Dr. David Culver from four published studies (1970-1992) and his own data since 1995.

Current Research Efforts

In early 2001, Ohio Sea Grant publicized information about a number of unusual readings researchers were getting in Lake Erie. This got the attention of U.S. EPA's Great Lakes National Program Office (GLNPO) in Chicago, as they were also getting unusual readings from Lake Erie. Ohio Sea Grant and GLNPO arranged to jointly host a meeting in Chicago on December 13, 2001 where Lake Erie researchers in the U.S. and Canada were invited to participate. As a result of this meeting, GLNPO designated \$500K for a special research project on Lake Erie this past summer (This project involves about 30 investigators. The Principal Investigators are Jan Ciborowski from the University of Windsor, and Gerald Matisoff from Case Western Reserve University).

As part of the special research project, Ohio Sea Grant and the U.S. EPA's Great Lakes National Program Office supported a graduate level Great Lakes limnology course and research cruise this summer. EPA committed its research vessel, the 180-ft *Lake Guardian*, for one week during which Ohio State University offered a Stone Lab course (co-funded by Ohio Sea Grant) on the vessel while the research was being done.

On the July 2002 cruise, Dr. Culver directed water quality analysis of the lake's nutrient levels and experiments to determine zebra and quagga mussels' phosphorus excretion rates. Culver and a group of researchers found oxygen levels of 3.5 ppm at the bottom at a site north of Cleveland, one of 11 sites sampled in the central basin. This concentration is too low for many fish, and at the time indicated a possible initiation of a dead zone in August.

The zebra mussel invaded Lake Erie first, but recent results show that quagga mussels have outcompeted them in all three basins. Dr. Culver's preliminary results showed that both mussels excreted phosphorus, but the quagga mussel may excrete more than equivalent-sized zebra mussels. The results suggest that both zebra and quagga mussels recycle phosphorus, and as their populations continue to grow, so will high levels of phosphorus that contribute to Lake Erie's dead zone.

Future Concerns and Needs

Climate change has exacerbated the dead zone problem in Lake Erie. Since 1997 the water level has gone down by three to four feet. It is important to understand the implications of low water levels because the reduction comes primarily from the cold bottom layer. Therefore, as the water level goes down, the volume or thickness of this layer is reduced, the oxygen reservoir is reduced, and as a result, the area of anoxia will increase and last longer each year. This will hurt fish populations, the charter and commercial fisheries, boating and tourism industries, and public health.

Legislative support is needed to conduct the necessary research to confirm the scientific community's beliefs about this situation. The current GLNPO project should be expanded and continued for at least two more years. Specifically, the following actions are needed to enhance knowledge about the dead zone and its prevention:

- Accurate measurement of phosphorus loading on all of the Great Lakes on a continual basis.
- Research to determine how best to reduce phosphorus loading.
- Research to determine if there is a link between the dead zone and the botulism problems observed in the Eastern Basin.
- Support for developing new technologies to address the oxygen problem, control zebra/quagga mussels and other aquatic nuisance species, remove nutrients at sewage treatment plants, and reduce agricultural runoff.

Because Lake Erie is the shallowest and warmest of the Great Lakes, it is an indicator of what the Great Lakes in general can expect. Now is the time to develop models to extrapolate research results to other bodies of water so that natural resource professionals can be prepared and take preventative actions before problems occur. **TL**

Jeffrey M. Reutter, Dave Kelch, Jill Jentes Banicki, and Frank Lichtkoppler from Ohio Sea Grant contributed to this article.



Gustav Verderber



Matt Thomas

Dear Friends,

As a former student and current employee of Stone Lab, I have seen many changes here on Gibraltar. FOSL has participated in many of these improvements by providing both financial and organizational support. Most importantly, they have given their time and effort through countless volunteer hours of assistance to the Lab. I have been a witness to only seven of those twenty years of service. In that time I have seen some of the improvements including increasing summer enrollment to over 200 students a year, moving the library back to Gibraltar, celebrating the 100th year of teaching on the lake, renovating Cooke Castle, purchasing a new research boat, and donating tens of thousands of dollars for scholarships and equipment.

None of these improvements would have been possible without you. You are an important part of this island campus, whether you were a former student, provided needed donations, or just read the articles to learn more about Lake Erie. By giving your support you have expressed interest in the role Ohio Sea Grant and Stone Laboratory play in the health and understanding of Ohio's greatest natural resource, Lake Erie. I can only hope that you continue to show support in the years to come.

I have some big shoes to fill as incoming FOSL President. I will do my best to keep the momentum of the past 20 years going and promise to keep you updated on the events of the upcoming year.

Sincerely,
Matt Thomas
FOSL President
thomas.347@osu.edu

FRIENDS OF STONE LABORATORY

20 Years of Service



Stacks to the Future

by Bruce Leach, Biological Sciences Librarian and Head, Biological/Pharmacy Library

Not long ago, former Stone Lab Associate Director and Professor Emeritus, Ronald Stuckey brought me a picture taken in the Stone Lab Library some time during the late 1930s. Back in those days, the Library was located on the third floor of the Stone Laboratory Building, in what is now the lecture hall. The picture shows a student intently browsing in a collection that doesn't appear to be much smaller than what we have right now.

The picture reminded me, that the library resources available to students at Stone Lab, had really changed very little from that time, until about fifteen years ago when index databases like the Aquatic Sciences and Fisheries Abstracts became available on CD-ROM. A few years later, we started using fax transmissions to supplement the weekly courier shipments of materials from Columbus to Stone Lab during the summer quarter. Since then, the pace of change has been astounding.

Thanks to the arrival of high-speed network lines at the Lab, the library services that we are able to provide have changed dramatically. We still maintain a paper collection of books and journals (that won't change much for quite a while), but now we offer access to hundreds of online databases and thousands of online journals. Now, students can do some of their library research from the computer lab right across the hall from the physical library stacks. Students, who bring their own computers, can even work from their dorm rooms at the Lab!

Even with all of the online resources that are now available, students and faculty still need materials that are not available on Gibraltar Island in any format. Until recently, filling these needs in a timely manner was difficult. Now, any Stone Lab student or faculty member who uses e-mail can send a request directly to the staff in the Biological Sciences/Pharmacy Library in Columbus. Using software developed at OSU, we are able to scan an article, and then upload it immediately to our Web server. The software automatically sends an e-mail message back to the requestor giving them directions on how to retrieve the article from a special web site we have created just for this purpose.

The Stone Lab Library may not look very different than it did in the 1930s, but it's certainly not your grandfather's library anymore! **FOSL**

Open House Weekend

While the weather threatened and the rain did fall several times, the 5th annual Open House came off without a hitch. Visitors came steadily throughout the afternoon aboard both the *Biolab* and *Gibraltar III*. While on Gibraltar, they were offered a taste of the type of learning that takes place at Stone Lab. Visitors were also offered guided tours of Gibraltar to learn something of the history, mission and activities at Stone Lab. The first floor of Cooke Castle was open for visitors to explore and ask questions relating to its past and future. In addition to the activities on Gibraltar, the South Bass lighthouse was open for touring. While visibility was not the greatest, the view from the top of the lighthouse was still worth the climb. Approximately 600 visitors took advantage of the Open House to visit these normally "off-limits" facilities.

The annual FOSL membership meeting was held immediately after the Open House. While the reception started at Waldock Gazebo, the festivities were moved to the Dining Hall just as the skies opened up with a deluge of rain and a tremendous show of lightning. Dick Lorenz, FOSL President; Dr. Jeff Reutter, Stone Lab Director; John Hageman, Lab Manager; and Steve Martin, Manager of Housing and Food Services gave reviews of the past year. Several people were recognized for their generous support of Stone Lab. Dr. John Crites was recognized for his unwavering support of student research. The donation of the use of his artwork allowed the Friends to establish a new research endowment. Phyllis Crites, John's wife and a supporter of Stone Lab in her own right, was honored with a Director's Award to recognize her many years of unselfish support. John Tripp, stepping down as Treasurer of FOSL after 8 years, was also presented with a Director's Award. Dick Lorenz was presented a Superior Leadership Award in recognition of his long-term support of Stone Lab as a two term President. Jeff Reutter also honored FOSL by inducting the Friends into the Stone Lab Hall of Fame.

Next year's festivities have already been scheduled for September 6-7, 2003. This will coincide with the Put-in-Bay Historic Weekend, so there will be many interesting activities going on throughout the islands. Mark your calendars now. **FOSL**

Stone Lab Enhancement Grant Arrives

Great news!! We have received a grant of \$348,000 from NOAA with the help of Senator DeWine to enhance the equipment and facilities used by students and researchers at Stone Laboratory. We are already in the process of purchasing 3 new vans for student field trips and research, 30 microscopes, 5 computers, and radar units for the *BioLab* and *Gibraltar III*. We will be enhancing our public education and outreach program by constructing a large educational kiosk on South Bass Island near our main office and Research Building and will do some major renovating in the first floor wet lab of the Research Building. If we can make the dollars go far enough and possibly get some additional private donations, we will also be purchasing other equipment items and furnishings for the classrooms and a small research vessel to replace the Polyp and the Sis. Thank you, Senator DeWine and NOAA!! **FOSL**

2002 FOSL Board

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Summer 2002

This past summer was yet again another success. A total of 199 students attended classes at Stone Lab including 71 superior high school students and 128 college-level students. A total of 21 different courses were taught, with Introductory Aquatic Biology being offered four times. This year, FOSL helped to support 49 students with scholarships totaling over \$17,700.



In Memory of Franz T. Stone

One of our best friends and strongest supporters, Franz T. Stone, passed away in Buffalo, NY on September 1st at the age of 95. Franz's father, Julius Stone, a long-time president of the OSU Board of Trustees, donated Gibraltar Island to the University in 1925. The Laboratory is named after Julius' father. Franz and his wife Kate, who died in December 2000, were truly wonderful people and an inspiration to us all in their strong supporter of research and education at the Laboratory. In addition to being an extremely successful industrialist and patron of the arts, Franz and Kate created the Franz T. Stone Research Endowment at Stone Laboratory and contributed regularly to the Director's Fund and our scholarship program. Franz and Kate were inducted into the Stone Laboratory Hall of Fame at the beginning of our Centennial Celebration on June 23, 1995.

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FRIENDS OF STONE LABORATORY

OHIO'S LAKE ERIE LABORATORY SINCE 1895

F. T. Stone Laboratory

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Franz Theodore Stone Laboratory, Ohio's Lake Erie laboratory, offers intensive, hands-on university field courses from June to August in biology, geology, education, and natural resources. Workshops and group field studies are offered from mid-April through October. Research in aquatic, terrestrial, and island sciences has been conducted year round since 1895. Stone Laboratory's association with other programs based at The Ohio State University—the Ohio Sea Grant College Program, the Great Lakes Aquatic Ecosystem Research Consortium (GLAERC), and the Center for Lake Erie Area Research (CLEAR)—has made it an important research facility. Stone Laboratory is located on Gibraltar Island, across the harbor from Put-in-Bay.

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