FINAL REPORT

LAKE ERIE PROTECTION FUND PROJECT SG 129-00

Tracking Rapid Population Change of Burrowing Mayflies in the Central Basin of Lake Erie

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Submitted to the Ohio Lake Erie Commission
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Executive Summary

Burrowing mayflies (*Hexagenia limbata* and *H. rigida*) repopulated the western basin of Lake Erie (Sandusky to Toledo, Ohio) beginning in the early 1990s, and they began to repopulate the nearshore waters of the central basin in Ohio (west of Huron to the Pennsylvania state line) in the late 1990s, as documented by previous Lake Erie Protection Fund projects. The return of these mayflies to Lake Erie signals important progress in the rehabilitation of this Great Lake. Prior to this Small Grant project conducted in 2000, earlier surveys of the distribution and density of the mayfly nymphs beginning in 1997 indicated that they were primarily recolonizing the sediments west of Euclid, Ohio.

Because of persistent stormy weather conditions in May and early June 2000, collections could not be made prior to the beginning of the annual emergence of the nymphs from the sediments. The resulting data reflect that situation in that a maximum of only one nymph was collected at any station, equivalent to five nymphs per square meter, as opposed to as many as 48 per square meter in 1999. However, 2000 was the first year that nymphs were found widely distributed along the shoreline from the westernmost to the easternmost sites. Because of the late collections in 2000, nymph densities and the number of locations where nymphs appeared were probably lower than they would have been had samples been collected prior to emergence. Continuation of the annual sampling program is recommended in order to confirm that *Hexagenia* is successfully recolonizing its native habitat.

Introduction

Burrowing mayflies of the species *Hexagenia limbata* and *H. rigida* were historically an important component of the animal community in the bottom of the western basin of Lake Erie and parts of the central and eastern basins. It was a major part of the diets of several fishes. Massive pollution of the lake in the first three-fourths of the twentieth century apparently led first to a large increase in the abundance of the burrowing mayflies as their food supply increased, and later to their rapid disappearance as oxygen depletion in or near the sediment, and perhaps the build-up of toxic contaminants, increased. These conditions and events are presented in greater detail in previous reports provided to the Ohio Lake Erie Office (Krieger 1999, 2000) that are available on its Web page (http://www.epa.state.oh.us/oleo/lepf/lepf_08-94_final.htm). In the early 1990s, *Hexagenia* showed evidence that it was repopulating parts of the western basin, and studies ensued in 1993 and later years to determine the extent of its range expansion and the increase in its density in the western basin. The results of those studies have been published in several journals (Krieger et al. 1996, Madenjian et al. 1998, Schloesser et al. 2001) and in presentations at scientific and public symposia.

Because the density of the mayfly population in the western basin was increasing rapidly, we proposed in 1996 to begin to sample the central basin sediments to determine whether nymphs were present in the shallower nearshore zone and, if so, their densities. Through grant LEPF 97-30, we sampled nearshore sediments in May and June of 1997 through 1999. A citizen monitoring program called Mayfly Watch was conducted through that grant at the same time to monitor the appearance and duration of winged *Hexagenia* on shore.

It appears that the *Hexagenia* population in the western basin has largely recovered. After peaking at an average abundance in the western basin of about 450 nymphs m^2 in 1997, the population dipped to about 150 nymphs m^2 in 1998 but rebounded to around 310 nymphs/m^2 in 1999, and 400 in 2000 (1999 and 2000 data courtesy of D. Schloesser, USGS). Meanwhile, we found only about 1 nymph m^2 in 1997 and 1998 in the nearshore areas of the central basin, and an increase to 4 nymphs/m^2 in 1999. The 1999 results showed a sudden upsurge in the abundance of nymphs in the nearshore area of the central basin west of Euclid, but not eastward to Conneaut, Ohio (Figure 1).

Thus, it appeared that the central basin population was beginning to respond in the same manner as the western basin population, but later, and primarily in the western part of the basin. The objective of the present grant, SG 129-00, was to provide continuity in the sampling of *Hexagenia* nymphs in the central basin from Sandusky to Conneaut in order to document the apparent trend of increasing distribution and abundance. Sampling in 2000 was believed to be pivotal in demonstrating whether the nymph population is indeed recovering in the central basin.

Methods

As in our previous studies on *Hexagenia* nymphs, transportation to the sampling stations was provided by Mr. Chris Muzinic of the U.S. Geological Survey's Lake Erie Biological Station aboard the *R/V Pike*. The stations were visited from west to east on 12 June (1 station), 13 June (8 stations), 14 June (8 stations), 22 June (3 stations), and 23 June 2000 (7 stations), for a total of 27 stations (Table 1). Mr. Muzinic and two technicians from Heidelberg College collected four replicate sediment samples at each station using an Ekman grab (21 cm x 21 cm). Each sample was rinsed through a standard No. 30 screen (0.60 mm mesh openings). Nymphs found in the sample residues were placed in small vials on ice. The residues were put in 500-mL wide-mouth jars, were preserved in 5% formaldehyde, and were returned to the Water Quality Laboratory, where they were observed for additional mayflies. Nymphs found in the field were rinsed and were frozen. Those nymphs as well as others found in the preserved samples will be measured and weighed (as dry biomass) at a later time for comparison of length:biomass relations among stations.

Results and Discussion

The stations where *Hexagenia* nymphs were found and their densities in 2000 and previous years are shown in Figure 1. The density at all stations where they were found was 5 nymphs/m^2, which represents a single nymph found in a total of four replicate samples. The geographic range of nymphs in the nearshore zone was much greater than in any of the three previous years, extending from Sandusky to Conneaut, with a gap in the Fairport Harbor area.

Because no nymphs were found east of Euclid in 1999, the data were divided into two groups – those stations west of Euclid and those to the east (Table 2). The average density of nymphs west of Euclid was higher than that east of Euclid in 1997, 1998, and 1999. In fact, east of Euclid the average was zero in 1998 and 1999. However, in 2000 the average density was nearly twice as great east of Euclid than to the west. The fact that 18 stations were in the western group and only 9 stations were in the eastern group in 2000 may have had some effect on that comparison. Prior to 2000, the percent of stations where nymphs were found was generally greater west of Euclid. In 2000, only one-fourth of the western stations revealed nymphs, while one-half of the eastern stations did.

Stormy lake conditions throughout most of May and June most likely played a role in the low densities found. Rather than beginning sampling in the first week in June as would be desirable, we were delayed until nearly the middle of June. At that time, a substantial proportion of the nymphs had already begun to emerge. Therefore, nymph densities and the number of locations where nymphs appeared were probably lower than they would have been prior to the onset of emergence. Sampling earlier than the first week in June is not feasible most years, even if the weather permits, because of other sampling priorities of the USGS in May in the western basin.

Benefits and Information Dissemination

Governmental agencies and the public continue to be interested in the increased presence of the large *Hexagenia* mayflies, and interest peaks a few weeks prior to and during the summer emergence. Reporters and writers interviewed by the project director during 2000 and the first half of 2001 are listed in Table 3, and the resulting articles are shown in Appendix A. In addition, a few individual citizens have called regarding the mayfly swarms. For example, in May 2001 a resident near the shore of Maumee Bay wanted to know when the swarms would occur because she wanted to schedule her child's high school graduation party at another time.

Dissemination of the project results has occurred in several ways. The project director has made several presentations and has been co-author on another one during this project period. They are listed in Table 4, and copies of the published abstracts corresponding to those presentations appear in Appendix B.

Acknowledgments

Mr. Chris Muzinic provided transportation to all sampling stations and made the difficult decisions regarding suitable weather for sampling. Heidelberg College student technicians who assisted in the field collections and follow-up in the laboratory were Seth Hothem, Jason Stengel, and Elizabeth Toot. Susan Martin of the Lake Erie Biological Station and Nancy Miller of the Water Quality Laboratory also provided field assistance.

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Schloesser, D. W., K. A. Krieger, J. J. H. Ciborowski, and L. Corkum. 2001. Recolonization and possible recovery of burrowing mayflies (Ephemeroptera: Ephemeridae: *Hexagenia* spp.) in Lake Erie of the Laurentian Great Lakes. *J. Aquatic Ecosystem Stress and Recovery.* (In press)

Table 1. Coordinates and depths of stations sampled for *Hexagenia* nymphs in the nearshore zone of the central basin of Lake Erie, 1995 through 2000.

STATION	N LATITUDE	W LONGITUDE	DEPTH, latest yr	YEARS SAMPLED					
				95	96	97	98	99	00
BRD15	41°24.37'	82°29.52'	38'			√	√	√	√
CP1	41°30.01'	82°38.07'	37'				√	√	√
CP2	41°26.60'	82°.35.00'	34'				√	√	√
CP3	41°25.71'	82°35.04	28'				√	√	√
LV52	41°27.30'	82°24.00'	45'			√		√	√
LV52s	41°26.14'	82°22.54'	40'				√		
LV56	41°27.30'	82°21.10'	43'			√		√	√
LV56b	41°27.00'	82°20.86'	43'				√		
LV66	41°28.75'	82°11.17'	33'			√	√	√	√
LV66b	41°28.79'	82°11.10'	34'						
LV67	41°29.77'	82°11.17				√			
LH1	41°28.50'	82°11.10'	32'						√
BRD16	41°30.11'	82°09.74'	40'			√			
BRD16b	41°29.57'	82°09.46'	38'				√	√	√
AV1	41°32.50'	82°01.00'	50'					√	√
RR1	41°29.49'	81°50.38'	15'		√	√			
RR1b	41°29.83'	81°51.72'	40'				√	√	√
RR2	41°30.59'	81°40.32'			√				
CW80	41°29.83'	81°45.33'	30'			√	√		
CW81	41°30.80'	81°45.33'	45'				√	√	√
CW82	41°32.88'	81°45.84'	55'					√	√
EW1	41°29.72'	81°43.94'	10'		√				
CE84	41°29.83'	81°43.50'	27'	√	√	√	√	√	√
CE85	41°30.30'	81°42.75'	30'	√			√	√	√
CE87	41°30.95'	81°41.67'							
CW88	41°31.50'	81°42.70'	47'				√	√	√
CW89	41°32.00'	81°43.92'							
CW89s	41°30.95'	81°43.60'	43'				√		
CE90	41°31.60'	81°40.50'		√					
CE91	41°32.25'	81°39.33'	30'			√	√	√	√
CE92	41°32.70'	81°40.50'	25'					√	√
CE92b	41°32.25'	81°40.45'	42'				√		
BRD17	41°29.98	81°48.86'							

Table 1. Continued.

STATION	N LATITUDE	W LONGITUDE	DEPTH latest yr	95	96	97	98	99	00
CE93	41°33.23'	81°41.67'							
CE97	41°34.40'	81°39.25'							
CE97b	41°33.20'	81°38.03'	40'				√		
CE99	41°35.70'	81°34.58'				√			
CE99b	41°36.08'	81°34.25'	35'				√		
CE100	41°36.20'	81°35.83'	50'				√	√	√
BRD18	41°45.47'	81°19.22'	32'			√	√	√	√
FP111	41°46.10'	81°18.40'	41'			√	√	√	
FH1	41°45.95'	81°16.91'	23'			√	√	√	√
FP116	41°47.17'	81°16.80'	46'			√			
FP116b	41°46.92'	81°16.87'	40'				√	√	
AS124	41°52.25'	81°00.40'	48'			√			
AS124b	41°52.35'	80°59.25	41'				√	√	
BRD19	41°54.38'	80°49.42'	34'			√			
BRD19b	41°54.55'	80°49.49'	40'				√	√	√
AS135	41°56.39'	80°47.58'	56'			√			
AS135s	41°52.95'	80°55.60'	41'				√	√	√
AS139b	41°56.35'	80°47.60'	35'						
AS139c	41°54.89'	80°48.31'	37'				√	√	√
AH1	41°55.10'	80°47.65'	35'			√			
AH1b	41°55.15'	80°47.70'	28'				√	√	√
AH2	41°54.92'	80°47.30'	32'			√		√	
AH2b	41°54.92'	80°47.36'	25'				√		√
CN1	41°59.90'	80°34.00'	52'					√	√

Table 2. Changes from 1997 through 2000 in the density of *Hexagenia* nymphs and the proportion of sampling sites were nymphs were found in the central basin of Lake Erie.

Year	Ave. Number nymphs per sq. meter		Percent of Sites with nymphs	
	West of Euclid	East of Euclid	West of Euclid	East of Euclid
1997	2.4	0.6	10%	11%
1998	1.5	0	21%	0%
1999	5.9	0	44%	0%
2000	1.3	2.4	26%	50%

Table 3. Reporters and writers interviewed regarding *Hexagenia* during 2000 and through mid-June 2001.

Name & Phone	Affiliation	Date
Kim Bates	***Toledo Blade***	6/11/01
Linda Culler	*Sandusky Register*	6/8/01
Tom Henry	*Toledo Blade*	~9/12/00
Jenni Laidman	***Toledo Blade***	5/27/00
Art Weber	***Milbury Press, Maumee Bay Press***	5/4/00. 6/14/01
Ohio Lake Erie Office	*Fund Focus*	summer 2000

Table 4. List of presentations on the project results made during the project period.

Event/Place	Title of Presentation	Date
Lake Erie Conference Sandusky, OH	*Toledo-Cleveland-Buffalo Wings: Mayflies in our Future*	7 Sep 2000
Lakeside Heritage Society Lakeside, OH	*Mayflies – Boon or Bane*	8 July 2001
Twine Line Ohio Sea Grant	*Mayfly Storms – a Summer 2001 Event?* (article)	about July 2001
Annual Meeting International Assoc. of Great Lakes Research	*Estimated flux of nutrients and contaminants associated with* Hexagenia *mayflies in western Lake Erie* (5th author with J.J.H. Ciborowski)	June 2000
49th Annual Meeting North American Benthological Society	*Recolonization of the central basin of Lake Erie by burrowing mayflies (Ephemeridae:*Hexagenia *spp.) and impact on fish diets*	7 June 2000

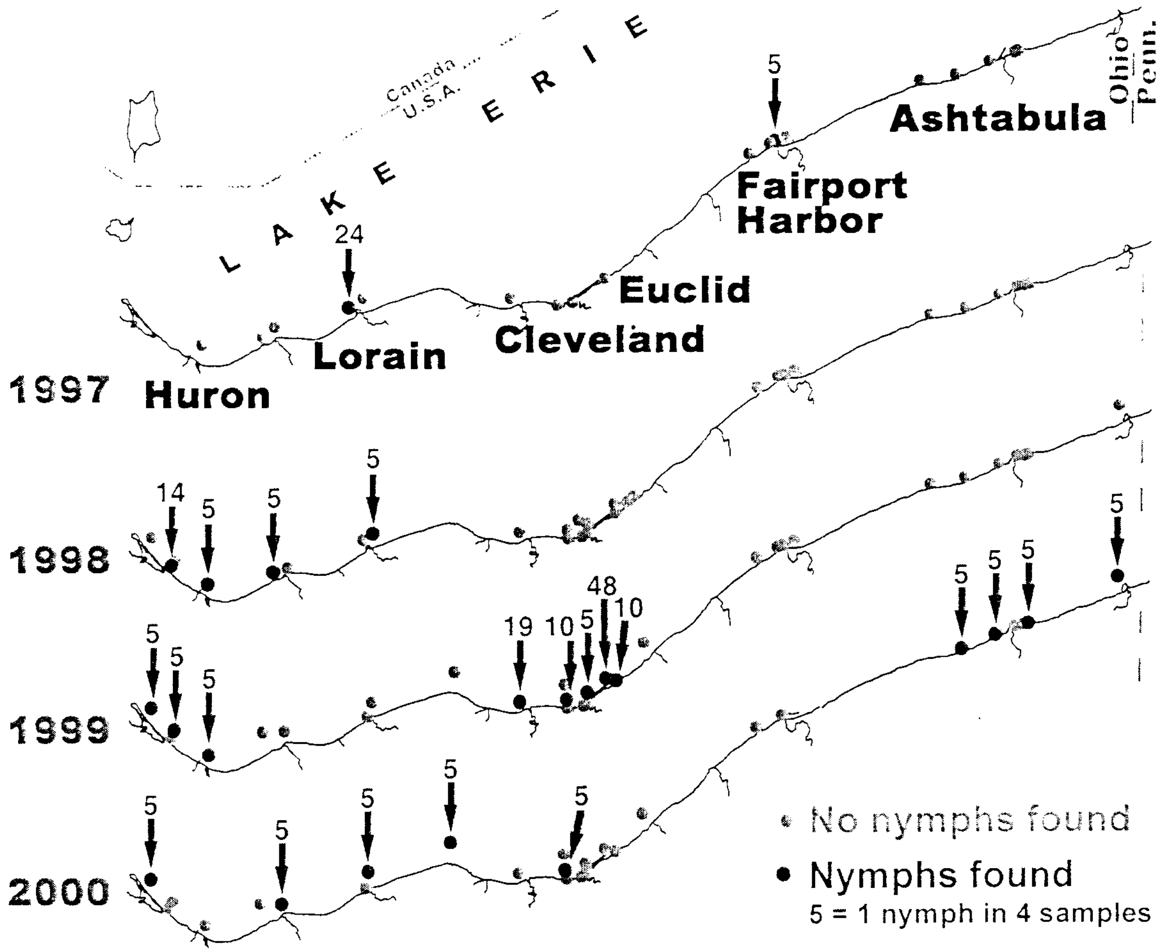
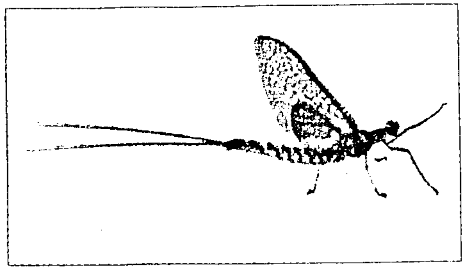


Figure 1. Stations sampled for *Hexagenia* nymphs 1997 through 2000, and the densities (individuals per square meter) where nymphs were found.

Appendix A. Articles Featuring this Project

The Blade 5 June 2000

Mayflies mean much to health of Lake Erie



BLADE PHOTO BY DIANE HIRES

Peak mayfly emergence is predicted for June 17, although some have already hatched

Burrowing mayflies
Hexagenia limbata
Hexagenia rigida

BY JENNI LAIDMAN
BLADE SCIENCE WRITER

How many mayflies are enough?

That depends entirely on one's point of view.

If you live out at Point Place, where the mayflies dangle like nervous Spanish moss from every tree, home, and human during the annual hatch, the "enough'" stage was met a long time ago.

If you're a mayfly — unlikely to be reading the newspaper, one has to admit, but stay with me for a minute — there are never "enough'" mayflies. The more the merrier doesn't even begin to sum it up. Mayflies could darken the skies like flocks of minuscule passenger pigeons, and you would only begin to celebrate — as much as a creature that neither eats nor drinks is capable of partying. Of course, there is that sex thing. But no beer.

And passenger pigeons aren't a half-bad analogy, if you think about it. We'll get back to that in a minute.

If you're Kenneth A. Krieger, a biology professor at Heidelberg College, mayfly swarms are not the important thing to count in calculating "enough.'" It's the mayflies in the mud that matter — mayfly nymph that live underwater, breathe through gills and eat the teeny-tiny stuff that falls to the lake floor.

This is the mayfly's long childhood. The adults that plague us live only a day, fulfilling the prediction of their kind. They belong to the order Ephemerdae, as in ephemera.

Dr. Krieger says 200 to 249 mayfly nymph per square meter of Lake Erie mud — a meter is about 39 inches — is an excellent number to find. A group advising the governor — probably folks who live down in Columbus and have NO idea what it means to be in the middle of a hatch — say more than 450 nymphs per square meter is best.

As anyone who lives on the Great Lakes shores probably knows, a mayfly hatch is a good thing, after

See MAYFLIES, Page 2 ►

Mayflies

► Continued from Page 1

a fashion.

When Lake Erie died in the 1950s and 1960s, the mayflies died with it. But the lake's swan song looked like the best of times for some lake creatures. It began with a superabundance of phosphorus and nitrogen in the lakes. This fertilized algae. The feasting algae grew like crazy. But all good things must end, and eventually the algae died. When it died, it decomposed. When it decomposed, it used up dissolved oxygen. When it used up oxygen in the water, everything else suffocated. Including the mayflies and the walleyes.

But mayflies also shared in the boom part of this boom-and-bust, Dr. Krieger said. When algae was overabundant, mayfly nymph pigged out. A scrape of Lake Erie bottom brought up as many as 9,000 mayfly nymph per square meter of mud. In short, super-high numbers of mayfly nymph are an early sign that the crash is coming, not a sign of ecosystem health. And that's why Dr Krieger hopes the state will change its mind on how many mayflies are "enough.'" Too many is just too many.

Then there's the mayfly's point of view. Mayfly, like the passenger pigeon, performed a trick that seems impossible to imagine. They went from zillions to zero in a zeason, er, season.

Forgive the cliche, but it's a "strength-in-numbers" sort of behavior. For mayflies and passenger pigeons, it's believed, the bigger the crowd, the smaller the likelihood of being eaten.

While mayfly swarms seem like flags attracting predators, research shows that the larger the swarm, the fewer the number of mayflies that end their short dying lives as lunch. And that's why mayflies like the big numbers, and why passenger pigeons traveled in mythical mobs. It was safer.

BLADE PHOTO BY HERRAL LONG

Mayflies can be a disgusting burden. Christina Rice had to clean them up outside a Point Place gas station last year.

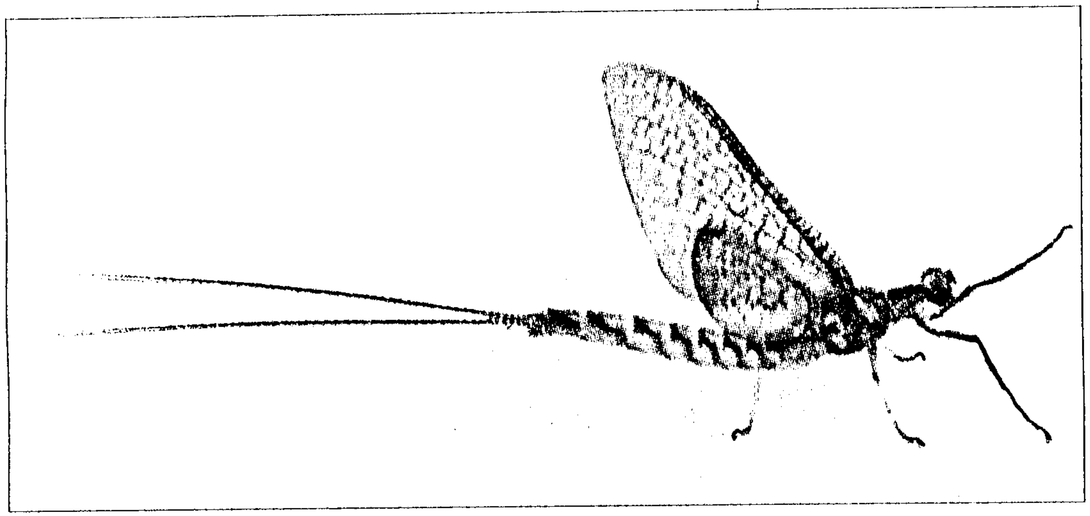
Of course, passenger pigeon numbers ultimately proved their undoing in the face of that most rapacious predator: Us. Once humans slaughtered a few billion birds, the last couple million no longer had enough eyes and ears per flock to carry on. The rest is history.

Mayflies almost followed them. Fortunately, insects like the biggest numbers even on bad days. That left a stalwart bunch of survivors hanging out in the last healthy puddles of Lake Erie waiting for better days. Which are now.

By the way, although the peak mayfly emergence falls around June 17, the bugs are already starting to congregate — as much as they can, considering their 24-hour adult life stage. The hatch began May 24 in Put-in-Bay.

The Blade, Toledo, OH, 13 Sep 00, Section A, p. 1

Lights, changing wi. ds reduce mayfly invasion



BLADE PHOTO

Mayflies, a favorite food of fish and birds, are an indicator of Lake Erie's water quality.

BY TOM HENRY and KIM BATES
BLADE STAFF WRITERS

SANDUSKY — Contrary to popular belief, there might be a safe and effective way to shoo away annual mayfly swarms: Cross your fingers and hope the skinny, winged insects get blown over to Canada.

Dr. Kenneth Krieger, a senior research scientist at Heidelberg College's nationally recognized water quality laboratory in Tiffin, said strong, shifting winds were likely the reason why Port Clinton — a lakefront community in Ottawa County known for getting hammered by mayflies each summer — didn't have many of the insects this year.

"The mayfly problem this year was not as bad as it was in the past," Port Clinton Mayor Tom Brown said. "The weather played a major role. ... We are better equipped to handle any problem than we were in 1996 when they were at their worst."

See *MAYFLY, Page 4* ▶

Mayfly

▶ *Continued from Page 1*

That's when the city had 35 truckloads of mayflies scraped from the streets, compared with less than one truckload this year.

Officials in other area lakefront communities, such as Put-in-Bay and Washington Township, adjacent to the Point Place area, said they noticed a decrease in the insects this season.

"We're used to a mess," Ken Kay, a Washington Township trustee, said. "But I didn't think it was that bad this year."

"It wasn't horrible," Put-in-Bay Mayor John Blatt said. "We had some off and on for a month. Last year, it was everyday for two months."

So where did the bulk of this year's mayflies end up?

They converged on a tiny rural lakefront community formerly known as Colchester, which was a pair of townships near the southern Ontario shoreline. About 30 miles southeast of downtown Detroit, the townships were incorporated Jan. 1, 1999, with the inland cities of Harrow, Ont., and Essex, Ont., to form a new city called Essex.

Cheryl Bondy, Essex deputy clerk, said the swarm was the largest she had ever seen and prompted a research project by the University of Windsor.

"This was the first year I can remember our public works crews were power-washing sidewalks."

Dr. Krieger said the historic Colchester area was plastered because the bugs are so light they get carried off by wind.

"They're really not strong fliers," he said.

If anyone should know, it's Dr. Krieger. He is rather fond of mayflies and arguably surpasses all Ohioans in terms of looking forward to each summer's crop.

The bugs have been the focus of his research since 1992. For three years, he led a research project from Toledo to Conneaut, O., in which volunteers formed a "Mayfly Watch" and did just that — watched for mayflies.

During a presentation last week at the Ohio Lake Erie Commission's annual conference, Dr. Krieger said mayfly numbers have held steady after a peak in 1997 and appear to be headed toward equilibrium.

One new development could be their distribution.

Lake Erie's fertile western basin between Toledo and Sandusky remains their preferred locale. The western basin's warm, shallow water makes it a productive place for fish to spawn.

Mr. Brown credited the decrease in mayflies to the weather and to Port Clinton's new weapon: controlling the lights. City officials can turn off the lights themselves, preventing the mayfly attraction.

"We are able to cut them on and off when we know they are coming," the mayor said. The city paid about $15,000 for the light switches using a grant from the Ohio Lake Erie Commission.

Mayflies are now being spotted as far east as Erie, Pa,. and Buffalo, which was unheard of.

Dr. Krieger said he isn't sure whether it's a new development, or whether the flies were so scarce east of Cleveland that nobody took notice until told to look for them.

Mayfly nymphs have been found in lake sediment as far east as Conneaut, Dr. Krieger said. Nymphs are the bug equivalent of children, except they burrow in lake sediment for two years.

Research into nymphs in Erie and Buffalo is incomplete, he said.

Mayflies are a favorite food of fish and birds. The flies provided up to 5 per cent of the diet of one type of perch in a 1998 study, but came packed with more nutrition than one would expect from a source of food that small, Dr. Krieger said.

Mayflies are an indicator of the lake's water quality. Sensitive to environmental stresses, they were virtually wiped out after excessive sewage discharges and farm runoff in the 1960s and 1970s allowed algae to proliferate and rob the lake of oxygen.

A study from 1997 through 1999 showed 277 mayfly nymphs per square meter in Lake Erie's western basin. Between 200 and 250 nymphs per square meter is excellent, Dr. Krieger said.

Blade staff writer Jason Williams contributed to this report.

101 Uses for a Mayfly?

Communities and LEPF Grants Support Mayfly Projects

Mayor Thomas Brown of Port Clinton, Ohio remembers the fateful day as if it were yesterday. "It was June 25, 1996 at 9:20 p.m. at True-Lay Memorial Stadium. I was presenting awards for a Drum and Bugle Corps competition when a dark cloud appeared over the stadium. This cloud turned out to be a swarm of mayflies that descended on the crowd. Many people in the audience were screaming and swatting, others were laughing as everything in sight became coated with mayflies. I continued with my presentation, although I was covered from head-to-toe with "June bugs". As I handed the award to the group leader, he saluted and we must have looked like two statues made of mayflies."

That day the city of Port Clinton experienced the type of mayfly hatch that had not been seen there since the early 1950's. Dubbed the "Bug Day of '96" by locals, it was only a sign of things to come. The large swarm of mayflies was actually a positive indicator that the water quality in Lake Erie had improved, but area residents were not happy with the mess created in their town.

This dilemma led to the award of a Lake Erie Protection Fund (LEPF) Grant of $25,592.00 to the City of Port Clinton for a first-of-its-kind project titled "Sanitary Mayfly Disposal Through Composting". A special sanitary landfill license had to be obtained and a unique "sifter" designed to separate trash from the mayflies that are scooped from the streets. The collected mayflies are then mixed with mulch and other organic materials and processed into compost for the use of city landscaping crews and residents. Additionally, educational programs and signage were developed to inform residents about the "dos and don'ts" of dealing with mayflies. City-wide blackouts are encouraged during peak hatch times to keep mayflies from swarming toward light sources. The LEPF grant even helped fund special electrical switches that allow city safety service crews to easily turn off street lights to keep the mayflies at bay. Cleanup is now quick and efficient, and free soil amendments are derived as a bonus. The project has been deemed a success.

Mayor Thomas Brown of Port Clinton (complete with "mayfly hat") stands in front of the city's LEPF Mayfly Composting site.

According to Mayor Brown, "The people of Port Clinton are pleased that we've taken a perceived nuisance and done something positive with it. Citizens here are educated and very cooperative in terms of helping with the project. Being the first mayfly composting site in the country, we are very proud to be a model city for other communities facing the same problem and we are glad to share whatever we learn from this process."

In addition to the Port Clinton site, Dr. Ken Krieger of Heidelberg College in Tiffin, Ohio is conducting his own mayfly research thanks in part to LEPF grants. In the last six years, Dr. Krieger has received several grants to study and track the increase of mayfly populations in the western and central basins of Lake Erie. Dr. Krieger is hoping to answer the questions of how these population changes will effect the ecology of the Lake Erie waters and coastal region, and especially the feeding habits of fish in these areas.

Continued on page 3

Dr. Samuel Speck is New Chair of Ohio Lake Erie Commission

A new Chair of the Ohio Lake Erie Commission was selected at the Commission's quarterly meeting held on June 21, 2000. In accordance with state laws, the Commisson votes to rotate the chair · between its Board members at the beginning of each fiscal year. Dr. Samual W. Speck, Director of the Ohio Department of Natural Resources, was chosen to begin his new duties as of July 1 for the Fiscal Year 2001.

Dr. Speck has a long history of public service, management, and legislative experience. Before being appointed as the Director of ODNR by Governor Bob Taft in February 1999, he had been President of Muskingum College since 1988. Dr. Speck served in Ohio's General Assembly for 13 years, as a state representative from 1971 to 1976, and as a state senator from 1977 to 1983. As a member of the State House of Representatives, he was the primary author of Ohio's Strip Mine Reclamation Act, and also sponsored legislation to create separate divisions of Forestry and Natural Areas and Preserves within ODNR.

Prior to serving as President of Muskingum College in New Concord, Dr. Speck was the associate director of the Federal Emergency Management Agency under President Ronald Reagan. He received his master's and doctoral degrees in government from Harvard University.

As Director of ODNR, Dr. Speck is responsible for the management of Ohio's 73 state parks, 20 state forests, and 118 state nature preserves; oversight of hunting, fishing and recreatinal boating; promotion of recycling and litter prevention; management of the state's soil, water, mineral, and geological resources; and directing the Ohio Civilian Conservation Corps. ✦

Ohio Lake Erie Commisson

The Commisson is comprised of the Directors of the following Ohio agencies:

- Environmental Protection Agency
- Department of Natural Resources
- Department of Health
- Department of Development
- Department of Transportation
- Department of Agriculture

Fund Focus (continued from page 4)

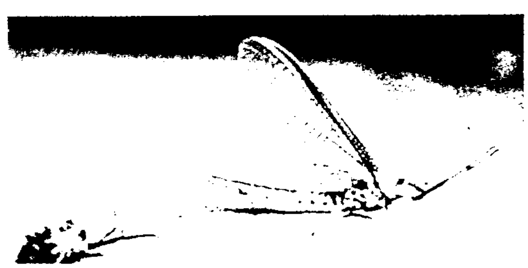
Dr. Krieger's research has shown that burrowing mayfly larvae found in near-shore sediments have increased from near zero/m^2 in 1991 to near historic readings of approximately 400 larvae/m^2 in the last few years. Data indicates that mayflies in the western basin of Lake Erie may have reached their carrying capacity, while mayflies in the central basin continue to expand their densities in an eastward direction.

The diets of four forage fishes (trout perch, silver chub, spottail shiner, and emerald shiner) were studied in both the western and central basins. The stomach contents of collected fish were recorded, and it was determined that the diets of three species of western basin fish included burrowing mayfly larvae. These same species found in the central basin have not yet included mayfly larvae in their diets. This difference corresponds with the respective densities of mayflies in each basin. If mayfly populations continue to increase in the central basin, fish in this area may take advantage of mayflies as a food source as fish in the western basin already have, thus potentially providing another link in the Lake Erie food chain.

As part of these projects, a "Mayfly Watch" program was initiated. Volunteers at 30 stations along the lakeshore from Huron to Conneaut searched for winged adult mayflies and/or their shed skins at set times of the day and night. The Mayfly Watch study, now in its third year, has tracked a further eastward extension of the mayfly populations.

"Public interest in this mayfly research has been the greatest of any project I have been involved with. It has been enjoyable working with the people along the shoreline," says Dr. Krieger.

In all of these mayfly projects, public support and LEPF grants have made the difference. ✦



Appendix B. Abstracts of Presentations Made during this Project Period

IAGLR Abstract #1821

Session #3
Contributed
Oral

CIBOROWSKI, J.J.H.[1], CORKUM, L.D[1]., GRGICAK, A[1]., CHASE, M.E[1]., SCHLOESSER, D.W[2]., AND KRIEGER, K.A[3]. [1]Great Lakes Institute for Environmental Research, University of Windsor, Windsor, ON, N9B 3P4. [2]Biological Resources Division, US Geological Survey, Ann Arbor, MI, 48105. [3]Water Quality Laboratory, Heidelberg College, Tiffin, OH, 44883.

Estimated flux of nutrients and contaminants associated with *Hexagenia* mayflies in western Lake Erie.

Hexagenia mayflies, absent from western Lake Erie since the 1960s, were observed at isolated locations in 1991. Benthic surveys documented range expansion of *Hexagenia* larvae from west to east, and two- to four-fold annual increases in density to >2,000 m^{-2} at some sites in 1997. At this time, larvae occupied over 85% of soft substrates in western Lake Erie and had basin-wide mean ("SE) density of 350 ("31, n=58) larvae m^{-2}, equivalent to abundances in the 1940s. Benthic biomass in spring 1997 was estimated to be up to 100 kg/ha (wet mass).

We determined the importance of *Hexagenia* larvae as agents of nutrient and contaminant flux by multiplying yearly abundance/biomass estimates by literature reports of P content and processing rates and contaminant burdens relative to annual lake loading estimates. We estimate 1997 larval production to mobilize 18 ug/m^2/yr total PCBs, equivalent to 85% of annual aerial loadings. Secondary production up to 250 kg/ha/yr (wet mass), and estimated dissolved P production of up to 16 mg/m^2 /d suggests that *Hexagenia* larval populations likely contribute significantly to both food web dynamics and nutrient budgets of the western basin.

Presented at the annual meeting of the International Association for Great Lakes Research, June 2000.

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Habitat utilization by fluvial cyprinids (*Macrhybopsis aestivalis*, *Notropis jemezanus*, *Notropis simus*) was studied at two spatial scales within the middle Rio Pecos, NM at low to moderate discharge (0.2 to 7.0 m^3/s). Channel type discriminated macrohabitats (reaches, 44.0 to 122.0 river km). Year round distribution, abundance, and population structure surveys over eight years determined that fluvial cyprinids were most persistent, abundant, and demographically intact within active sandbed reaches. Mean depth/velocity of individual seine hauls (1.5 to 54.0 m^2) discriminated mesohabitats. Analysis of 1839 hauls from 20 sampling trips over five years concluded that fluvial cyprinids utilized swift mesohabitat compared to other fishes but exhibited broad mesohabitat preference. Availability of preferred mesohabitat was similar between reaches and did not correspond with fluvial cyprinid reach preference. Qualitative observations deduced that microhabitat distribution and abundance varied between reaches and did correspond with fluvial cyprinid reach preference. Sediment transport regimes (bedforms) in active sandbed reaches sustained high microhabitat heterogeneity that was lacking in inactive reaches. Increased understanding of fluvial cyprinid microhabitat utilization in relation to bedforms is critical for conservation since sediment transport regimes are constrained by water and sediment supply.

(364) DOMINANT TO ENDANGERED? HISTORICAL CHANGES IN YELLOWCHEEK DARTER AND ASSOCIATED FISHES IN THE LITTLE RED RIVER HEADWATERS.

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The yellowcheek darter (*Etheostoma moorei*) is an endemic species of north-central Arkansas, found only in four headwater streams of the Little Red River above Greers Ferry Lake. Headwater inundation as the result of the formation of Greer's Ferry Lake in 1962 has lead to habitat reduction and spatial isolation of yellowcheek populations. Despite these habitat changes, the yellowcheek was the most abundant riffle fish during a 1979-1980 status survey. A more recent study found genetic and meristic differences among populations of yellowcheek, and noted increasing difficulty in obtaining study specimens. During 1999-2000, we used kick seining and electroshocking to determine current yellowcheek abundances. In stark contrast to the earlier study, yellowcheek densities were extremely low and confined to small low and mid-stream reaches which largely sustained flow throughout the year. Where yellowcheek have been captured, they are now a distant fifth in abundance compared to other riffle fishes, suggesting that declines are more likely a species rather than community phenomena.

(365) POTENTIAL INTERACTIONS BETWEEN EURASIAN RUFFE AND ROUND GOBIES IN THE GREAT LAKES: PREY AND HABITAT PREFERENCES.

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The Laurentian Great Lakes have been subject to numerous human-mediated species invasions, including zebra mussels (*Dreissena polymorpha*), Eurasian ruffe (*Gymnocephalus cernuus*), and round gobies (*Neogobius melanostomus*). This "exotic triad" could significantly impact benthic communities as distributions converge. Ruffe and gobies may also compete with native fish such as yellow perch (*Perca flavescens*) for food, refuge, and spawning sites. Our hypothesis is that ruffe and gobies will consume similar invertebrate prey, but gobies will also prey on zebra mussels. We tested this hypothesis in laboratory aquaria supplied with 13 macroinvertebrate taxa. Both ruffe and gobies preferred soft-bodied taxa and avoided hard-bodied taxa. However, consumption of zebra mussels was highest in treatments containing gobies. Larger numbers of preferred taxa were eaten when gobies and ruffe coexisted. Ruffe collected from Lake Superior also preferred soft-bodied taxa, while gobies from Lake Michigan preferred zebra mussels. Habitat preferences of ruffe and gobies were examined in laboratory tanks during the light and dark. Both ruffe and gobies preferred cobble and plants at all times, and ventured into sand only in the dark when the fish were most active. Understanding the complex interactions among native and exotic fishes may yield insight into current benthic community structure.

(366) RECOLONIZATION OF THE CENTRAL BASIN OF LAKE ERIE BY BURROWING MAYFLIES (EPHEMERIDAE: *HEXAGENIA* SPP.) AND IMPACT ON FISH DIETS.

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Burrowing mayflies (*Hexagenia* spp.) repopulated soft sediments of the western basin of Lake Erie in the 1990s. We predicted (1) that as the ecosystem recovery of Lake Erie continued, they would recolonize their native habitat in the central basin by spreading eastward from the western basin, and (2) that forage fishes in both basins would feed on the mayfly nymphs increasingly as the density of nymphs increased. A volunteer Mayfly Watch program along the central basin lakeshore in the summers of 1997 through 1999 assisted in detecting the presence of winged *Hexagenia* at expected very low densities. The number of nymphs in nearshore sediments and of winged forms onshore increased between 1997 and 2000. Three of four forage fishes (trout perch, *Percopsis omiscomaycus*; silver chub, *Hybopsis storeriana*; spottail shiner, *Notropis hudsonius*) fed on the nymphs in the western basin, but only spottail shiners were found to have consumed nymphs in the central basin, perhaps because of the relatively low density of nymphs. The biomass of the nymphs consumed in the western basin comprised a far greater proportion of the diet (e.g., ≤ 82% in trout perch) than the number of nymphs consumed (≤ 5% in trout perch).