Return of the Mayfly: An Indicator of an Improving Habitat

FACT SHEET

Pennsylvania Sea Grant, as part of the National Sea Grant Program, promotes efforts to improve the environmental and economic health of Pennsylvania's coastlines.

Focusing on the Lake Erie and Delaware River watersheds, Pennsylvania Sea Grant works to increase public awareness of coastal environmental and economic issues through extension, communication, applied research, and education activities.

The National Oceanic and Atmospheric Administration (NOAA) administers the National Sea Grant College Program. Pennsylvania Sea Grant is also supported by the Pennsylvania State University and the Commonwealth of Pennsylvania.

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Background Mayflies are abundant throughout the world (Figure 1). The presence of the nymph (aquatic stage) of this insect in stream or lake sediment is an indication of good water quality because of their sensitivity to pollution. Mayflies were very abundant in Lake Erie waters until the early 1950s when pollution from various sources contaminated the sediment. The discharge of nutrients into Lake Erie caused excessive growth of nuisance algae. As the algae died and rained down on the sediment, oxygen was depleted. This depletion of oxygen led to anoxic (without oxygen) sediments. These sediment conditions were detrimental to mayflies and a drastic decline in the population ensued.

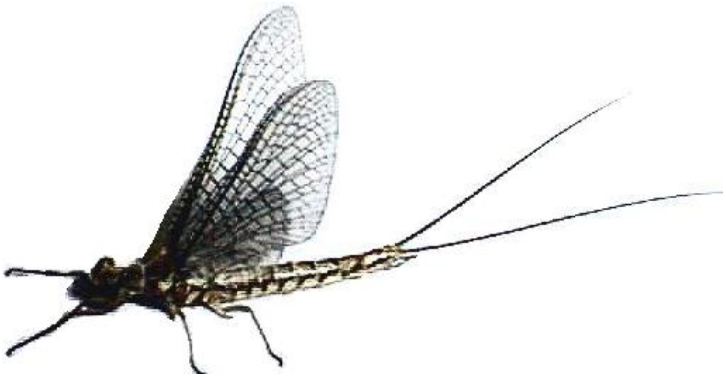

Figure 1. ***Hexagenia*** **spp. (adult)**

In 1972, the International Water Quality Agreement was developed between the United States and Canada to curb pollution. As a result of that agreement and other pollution abatement programs established by the bordering states and Canadian provinces, mayflies are now making a comeback along the shores of Lake Erie. The massive resurgence of these mayflies was first noticed in the shallow western basin in 1994 and has now moved to the central and eastern basins. The presence of mayflies is an indication that pollution controls established on Lake Erie have greatly improved the water quality and sediment conditions. In 1997, the return of the large mayfly, *Hexagenia* spp. provided continued signs that the water quality was good enough to support large populations of this insect. And the numbers for 1999 assured us that the mayflies were firmly established.

The Connection between Mayflies and Lake Erie Before severe pollution plagued Lake Erie, mayflies were familiar to most lakeshore dwellers. Several kinds of mayflies lived in the soft bottom mud of shallow regions of the lake; others crawled on submersed bedrock and boulders along the shoreline and the shallow reefs of the western basin. However, only one type, *Hexagenia*, known locally in the United States as "Canadian sailor" usually drew the attention of the non-biologist. Winged *Hexagenia* emerge from the lake, often synchronously and in huge numbers, forming

swarms along and inland of the shoreline. The insects don't bite, but their swarms are generally considered a nuisance. They are attracted to and congregate under bright lights, and decomposing piles of the insects smell fishy and serve as breeding grounds for flies. Swarms of *Hexagenia* can also pose a traffic hazard. Thousands of mayflies resting on the pavement in the glow of streetlights get flattened by cars, making the roads dangerously slick.

Hexagenia virtually disappeared from Lake Erie in the mid-1950s, but in a surprise comeback, the insect reappeared in the western basin in the early 1990s. Now, its numbers are once again commanding public attention. At least one south shore city on the western basin posted road signs in the summer of 1996 warning motorists of slippery conditions due to the "mayfly hatch." In June of the same year, *Hexagenia* caused a brownout over much of northwestern Ohio when many of them were attracted to the lights of a major electrical substation near the lake shore, settled on the equipment, and conducted electricity across the insulators. Although in general there appears to be no direct impact on human health caused by the mayfly swarms, a few accounts refer to an allergic reaction called "Junebug fever". For most people, though, the mayfly swarms are just an annoyance, as the insects fly into people's mouths, or land on their clothes, or crawl into their hair and behind their eyeglasses.

Before their disappearance in the 1950s, the bottom-dwelling nymphs of *Hexagenia* were important in the diets of Lake Erie sport and commercial fishes. In addition, these larger fish ate forage fishes, which also ate *Hexagenia*. Fishes that fed on nymphs included yellow perch (*Perca flavescens*), freshwater drum (*Aplodinotus grunniens*), channel catfish (*Ictalurus punctatus*), trout perch (*Percopsis omiscomaycus*), spottail shiner (*Notropis hudsonius*), silver chub (*Hybopsis storerianus*), and mooneye (*Hiodon tergisus*). The nymphs were especially easy prey for most kinds of fish when they swam from the bottom sediments up to the surface of the lake to molt. Fish also seized the winged mayflies as they rested on the water or flew over it. On shore, many birds devoured them, making *Hexagenia* an important part of both the aquatic and near-shore food webs. With its comeback, evidence since the early 1990s indicates that *Hexagenia* once again is becoming a major component in the diets of several Lake Erie fishes, including yellow perch, freshwater drum, and trout perch.

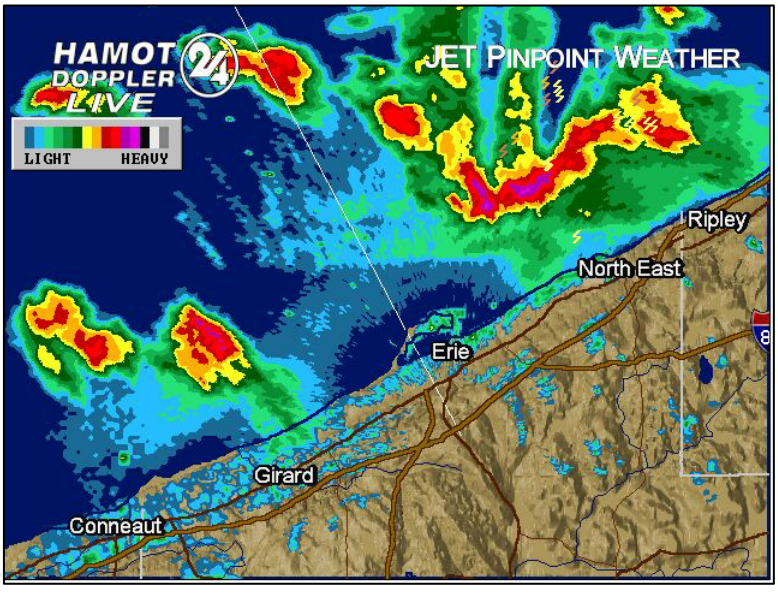

Figure 2. Doppler Radar Image

Using Doppler Radar to Monitor Mayfly Adults Ed Masteller, Professor emeritus of Biology at Penn State Erie, has been monitoring mayfly adults along the Pennsylvania shores of Lake Erie from 1997 – 2002. Dr. Masteller began counting the mayflies by hand in 1997 and 1998, switching to high technology methods in summer 1999, when mayflies were so numerous that meteorologists Dave Call and Tom Atkins monitored swarms of mayfly adults on Doppler radar at local television station WJET-TV. Radar has been used to study insect flight and migration in other areas; however, this is one of the first times they have been seen on Doppler radar (Figure 2). Doppler radar is a high-powered pulse of radio waves of known frequency that bounces off a target and is returned at a weaker signal (Figure 3). Doppler radar also incorporates the concept of the Doppler shift. The Doppler shift is a compression of sound waves that change the original pitch or tone of the sound. For example, a car's horn approaching you will rise in pitch as it comes closer and consequently drop in pitch after it passes you. With Doppler radar, the combination of echo and Doppler shift information can determine the location of an object (echo) and its velocity (Doppler shift).

A transmitting antenna also functions as the receiving antenna. Any object encountered produces an echo causing a point of light to appear on the screen, which remains visible as phosphorescent afterglow until fresh echoes are picked up on the next revolution of the scanning antenna. The brightness of this image depends on the reflecting power of the object, allowing the size, distance, and altitude of the object to be determined. The time delay for the reflection to appear on the screen determines distance. The signature is defined as the shift in return echo for each object and will have a specific color related to intensity.

For further information on using Doppler radar to track insects refer to the radar entomology Web site that shows large individual insects (moths, grasshoppers) and concentrations of smaller insects such as migrating Monarch butterflies, locusts, midge swarms, honeybee, and bumblebee foraging**. (***http://www.ph.adfa.edu.au/a-drake/trews/ww_re_hp.htm*)

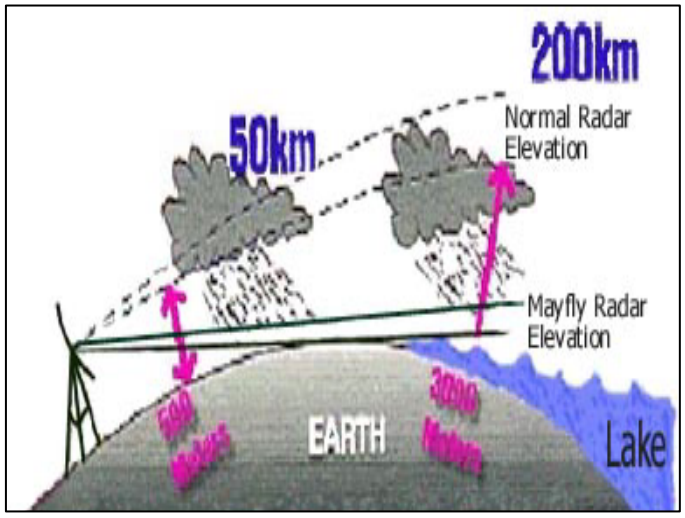

Figure 3. Doppler Radar Schematic

<u>Life History of Mayflies</u> The juvenile or nymph stage lives in the lake sediment and feeds on particulate matter (Figure 4). They construct a U-shaped burrow or tunnel in the sediments as their temporary home and make their burrow larger as they continue to grow. While in the burrow, the nymphs move their abdominal gills in undulating movements keeping the burrow oxygenated. This stage lasts from one or two years depending on species and temperature conditions.

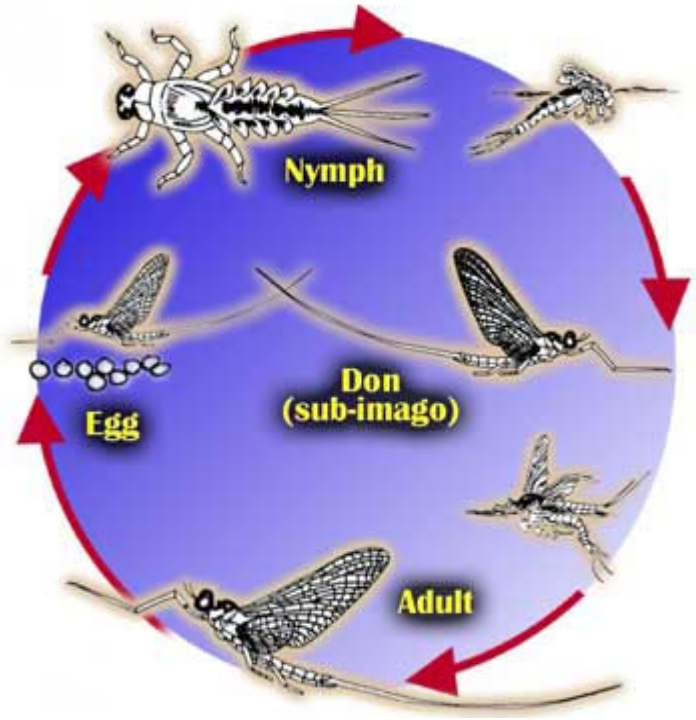

Figure 4. Mayfly Life Cycle: Image courtesy of http://www.kidfish.bc.ca/mayfly_cycle.htm

During July 2000 and again in June 2001, efforts were made to locate *Hexagenia* nymphs. Few specimens were found in the 2000 samples; with larger populations of nymphs located in 2001 about five miles east of Presque Isle at a depth of over 40 feet.

As the nymphs continue to grow, they go through a molting process (ecdysis), in which they shed their exoskeleton and form a new one. Nymphs may undergo as many as 30 molts before emerging as adults. When the nymph is ready for emergence, it leaves the burrow at dusk and swims to the surface. There, the exoskeleton splits and the fully winged subimago (sub-adult) emerges and flies to a hard surface for its final molt to adulthood.

Adult mayflies appear on Lake Erie as early as the first week of June and emerge sporadically until September. They have a single purpose: mating. The mating of mayflies occurs at dusk, at which time males congregate in huge swarms, which

attract females. After mating, the females deposit their eggs (up to 8,000) on the lake surface and die. The eggs then sink to the bottom of the lake and after several days to several months; depending on water temperature, hatch into the nymph stage. The life span of the adult mayfly is approximately 72 hours

Human Impacts and Interactions The increased presence of mayfly nymphs and subsequent emergence of adults has led to positive and negative effects along the shoreline.

Positive Effects:

- Their return to the food chain is very important to the ecological balance of native fish communities.
- Their return is a sign that pollutants are decreasing lake wide.

Negative Effects:

- Electrical blackouts can occur when mayflies interfere with electrical transfer by gathering on electrical substations.
- Local businesses cope with piles of dead adults, having to sweep the insects from their sidewalks for safety reasons. Disposal of these insects has become a problem.
- Highway departments have had to post signs warning motorists of slick highway conditions due to the accumulation of dead mayflies on roadways.

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