

Plankton Survey System (PSS) Observations during Strong and Weak Plume Events



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Introduction

The plankton survey system (PSS) consists of an optical plankton counter (OPC), CTD, and fluorometer mounted on a V-fin (Fig. 1). It is being deployed in the EEGLE program to map out vertical distribution of temperature, light attenuation, chlorophyll fluorescence, and zooplankton number, size, and biomass as it is towed in a vertically undulating mode along nearshore-offshore transects in the southern basin of Lake Michigan (Fig. 2). We have attempted to sample all transects during pre-plume, plume, and post-plume cruises and the Muskegon and St. Joseph transects monthly throughout the year to put plume studies into a larger seasonal context. In this poster we demonstrate the power and limitations of the PSS by contrasting results from strong (March 1998) and weak (March 1999) plume events (Fig. 3).



Figure 1. The plankton survey system being put over the side of a research vessel.

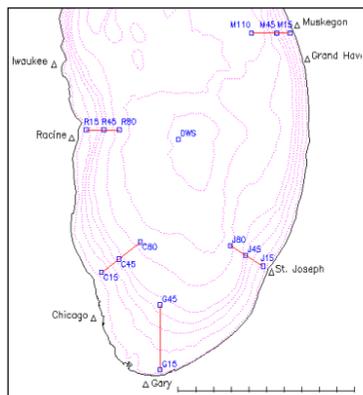


Figure 2. Location of EEGLE sampling stations and transects in southern Lake Michigan.

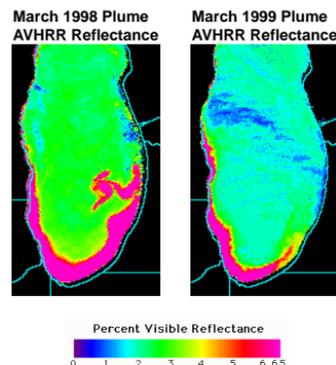


Figure 3. Satellite images of percent visible reflections captured by NOAA AVHRR satellites during the plume events of March 1998 and March 1999.

Methods

The PSS was towed in a vertically undulating mode by raising or lowering the V-fin at a rate of ~ 0.25 m s⁻¹ as the ship traveled at 2 – 2.5 m s⁻¹. Net tows for zooplankton and water samples for chlorophyll and total suspended solids were taken at stations shown on transects (Fig. 2) for comparison with the PSS. Chlorophyll concentrations given here are nominal concentrations derived from a non-linear regression between fluorometer voltage and chlorophyll concentration for a laboratory culture of the diatom *Stephanodiscus*.

Results

March 1998

The extent of the very intense plume can be seen in the light attenuation (LA) measurements at the St. Joseph and Gary transects (Fig 4B and 4C). High suspended-sediment concentrations in the plume saturated the LA meter and prevented the OPC from counting zooplankton inside the plume. The Muskegon transect, chosen as a “control” transect outside of the influence of the plume, showed only a weakly developed plume. The smaller biomass of zooplankton near the surface is suggestive of smaller zooplankton near the surface since zooplankton counts were uniformly distributed. The St. Joseph transect showed high nominal chlorophyll concentration inshore.

March 1999

The plume was only evident on the Gary transect. LA output, because of a change in OPC configuration to deal with high sediment concentrations, is 9.3 times lower for a given concentration of suspended solids than the LA values given in 1998. Zooplankton counts were fairly uniformly distributed, but varied a bit among transects. Nominal chlorophyll concentration in the plume was lower than in other areas. Only subtle differences were seen in chlorophyll and zooplankton distribution patterns between day (Figure 5B) and night (Figure 5C) at St. Joseph. The somewhat lower chlorophyll values seen near the surface during the day are probably a result of photochemical quenching.

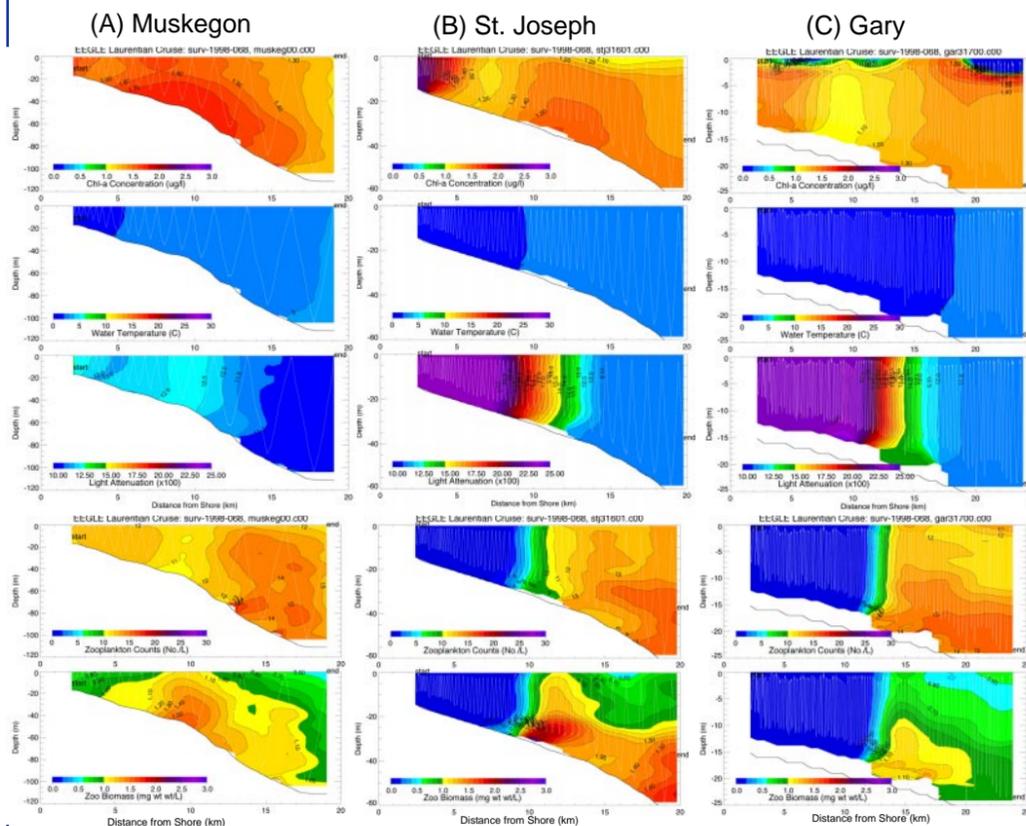


Figure 4 (A-C). Results of plankton survey system tows on Muskegon (A), St. Joseph (B), and Gary (C) transects during March 1998, a strong plume year. The white sinusoidal line on each panel traces the path taken by the OPC.

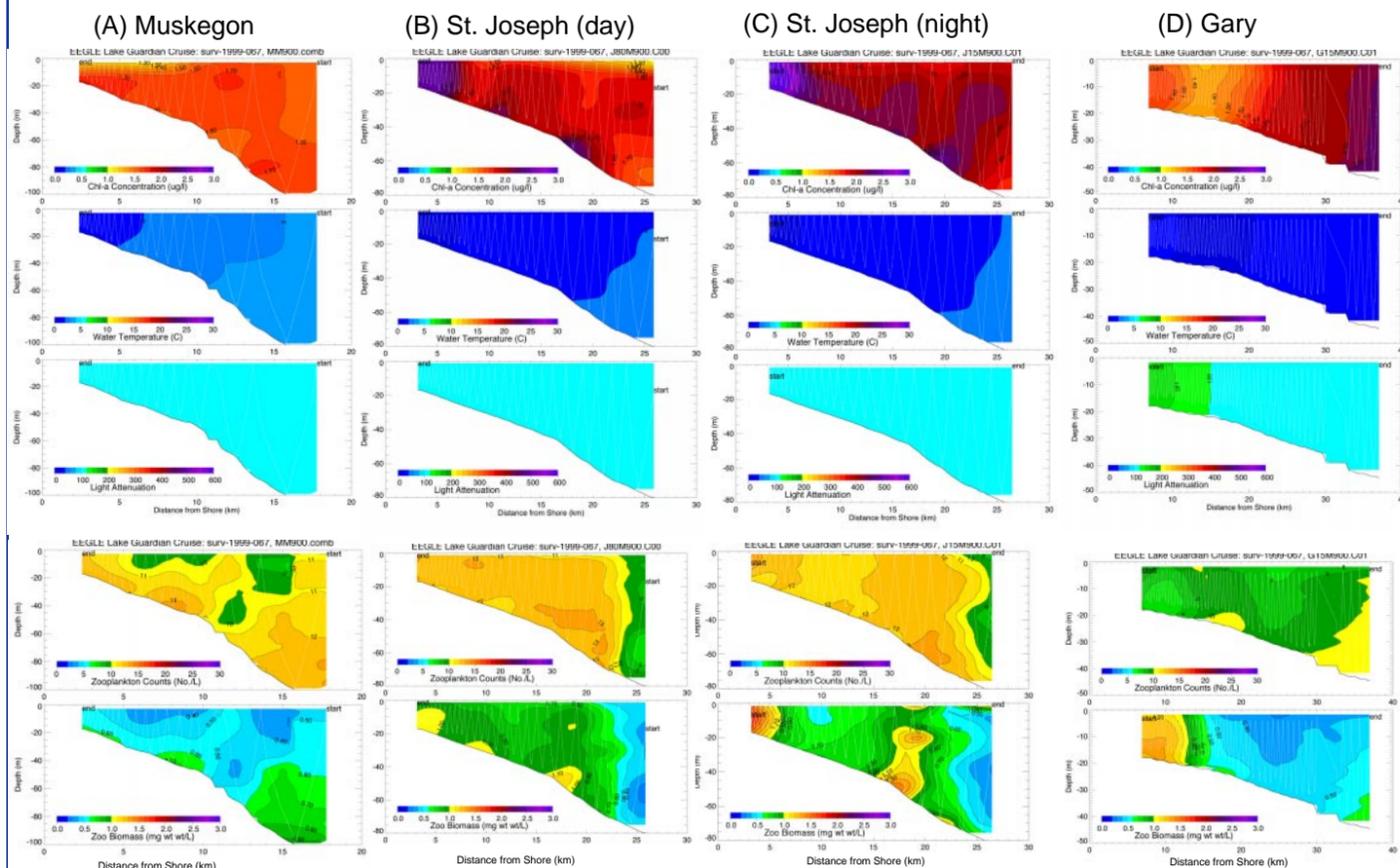


Figure 5 (A-D). Results of plankton survey system tows on Muskegon (A), St. Joseph (day) (B), St. Joseph (night) (C), and Gary (D) transects during March 1999, a weak plume year. The white sinusoidal line on each panel traces the path taken by the OPC.

Discussion

Comparison of 1998 and 1999

- LA measurements showed the plume was distributed from surface to bottom in areas where it existed, and that the event was more intense in 1998.
- Zooplankton counts were very similar between 1998 and 1999 transects; however, zooplankton biomass was considerably lower in 1999. This may represent a shift from *Diaptomus* spp. to cyclopoids, which are generally smaller than *Diaptomus*, and a shift from large to small species of *Diaptomus* (see poster of Agy et al.).
- Nominal chlorophyll concentrations were higher in 1999 than 1998. Is this related to the plume itself or to release from grazing pressure from *Diaptomus* and from ciliates, which would be especially vulnerable to predation from cyclopoids?

Value of the PSS

- The PSS allowed us to map out fine-grain distribution of plankton, fluorescence, and LA that could not have been done by conventional sampling by nets and water bottles.
- However, conventional sampling is necessary to say what zooplankton are present and to calibrate the LA meter and fluorometer.

Future work

- Nominal chlorophyll distributions will be replaced by more realistic values derived from chlorophyll vs. fluorometer regressions derived from field data.
- OPC counts, OPC size distributions, and OPC biomass will be compared to respective microscope counts and measurements of preserved zooplankton from net tows to “calibrate” OPC response.
- Monthly transects will be run at St. Joseph and Muskegon to better define the seasonal pattern of plankton abundance and distribution.
- We will install a PAR sensor on the PSS to map out spatial fields of PAR and the PAR extinction coefficient to aid in interpretation of the effects of the plume on light climate and of PAR on zooplankton distribution.