ENV Report 31 - ***Physiological effects on freshwater mussels (Family: Unionidae) of intermittent exposure to physical effects of navigation traffic*** by Barry Payne and Andrew Miller

ABSTRACT

Commercial navigation traffic in large inland waterways can cause brief episodes of increased turbulence and suspended solids - both of which are potentially deleterious to essentially sessile, filter-feeding mussels. Predicting the consequences of traffic to mussels is difficult due to the intermittent, brief nature of changed physical conditions. Previous laboratory studies by Aldridge et al. (1987) and Payne and Miller (1987) indicated that aspects of physiological energetics, including filtration rate, respiration rate, nitrogen excretion rate, O:N ratio, and tissue condition index, are sensitive indicators of potential deleterious consequences of traffic effects on mussels. Aldridge et al. (1987), using very high suspended solids concentrations and frequencies of disruption, showed an additive effect of increased suspended solids to turbulence and provided evidence that the frequency of intermittent disturbance was important. In their short-term experiments, upward shifts in O:N by mussels in the most severely stressed treatment groups proved to be the best indicators of shifts toward a negative bioenergetic balance. In longer term studies of turbulence effects (Payne and Miller (1987), mussels under the most severe stress (continuous high turbulence) showed reduced tissue-to-shell mass ratios.

In the present study, turbulence effects were investigated in an experiment long enough to elicit such tissue condition index changes, using an array of frequencies of exposure treatments that spanned the range likely to be encountered by mussels in the upper Mississippi River. Frequency of intermittent exposure to high turbulence levels had no relationship to deleterious condition changes in terms of filtration rate, respiration rate, nitrogen excretion rate, O:N, or tissue condition index. Additional short-term laboratory experiments were conducted to investigate additive effects of suspended solids to turbulence, using frequencies of exposure and levels of suspended solids much more realistic than those of Aldridge et al. (1987). Evidence of an additive effect of suspended solids was more equivocal than in the harsher experiments of Aldridge et al. (1987). Physiological disruption was slightly greater when high suspended solids concentration accompanied intermittent turbulence. The tendency was for downward shifts in nitrogen excretion and upward shifts in O:N. However, this tendency was not manifest in all species within an experiment nor among experiments for particular species. Although some statistically significant shifts were measured, major changes in metabolic condition generally were not indicated. No changes in tissue condition occurred. Studies of shell valve gape behavior indicated that mussels sometimes responded to navigation traffic effects by slightly closing their shell for a brief period. However, such behavior is varied substantially among mussels and for an individual over time.

In general, physical habitat disruption associated with routine navigation traffic tends to elicit minor shifts upward in O:N and measurable changes in shell gape behavior. These are relatively subtle physiological responses - consistent with the subtlety of brief, infrequent episodes of turbulence and elevated TSS. Although such responses can be elicited and measured, their biological significance appears to be slight. Results of all laboratory experiments have been summarized in a series of curves which relate potential level of stress to a mussel versus the four possible effects of commercial vessel passage: low and high turbulence without suspended solids, high turbulence plus high suspended solids, and high turbulence plus very high suspended solids.