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Project Summary

Sediment Suspension and Resuspension from Small Craft Induced Turbulence

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The objective of this study was to determine if small vessels operating in shallow waters have any measurable effects in producing increased turbidities by the resuspension of fine sediments that may affect submerged aquatic vegetation (SAV).

A two-phase approach was used consisting of field tests in a suitable sub-estuary of Chesapeake Bay and laboratory measurements of propeller effects. During field trials, two different vessel types were used to make passes at set speeds over known water depths. Before and after measurements of light extinction and transmission, and determinations of gravimetric suspended sediment were used to identify effects. Laboratory experiments were conducted to delineate the contribution of propellers to possible resuspension. These experiments were conducted using laser-doppler anemometry to map the turbulence field produced by propeller action.

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This Project Summary was developed by Judy Broersma of EPA's Chesapeake Bay Program, Annapolis, MD, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Causative factors for the widespread disappearance of SAV in the Chesapeake Bay, beginning in the early seventies, have been the subject of intense study Many mechanisms have been hypothesized to explain this disappearance, including increased sediment loads caused by hurricane-produced runoff, the increasing reliance on herbicides in farm operations, nonpoint source pollution resulting from extreme pressures to develop the coastal zone, and increased turbidities from increased use of Bay waters and tributaries by recreational watercraft. No single factor appears to be responsible for the stresses causing reduction in SAV growth, but each mechanism should be investigated to find the possible and most significant synergistic effects of several interacting processes.

Small vessels operating in shallow waters or with wakes travelling outward to reach shallow waters may have measurable effects in producing increased turbidities as a result of the resuspension of sediments. The amount of time required for the sediment to settle out of the water column depends on particle size, background turbulence, and motion that may retard the settling rate and produce significant lateral transport of the resuspended sediment.

The disturbance may have an effect on rooted SAV if the erosive forces are of sufficient magnitude to displace organic detritus and inorganic silts and muds normally stabilized by the rooted

plants. Direct damage to the root may subsequently result. If the resuspended particles are small and have long settling times, they contribute to increased light extinction in the water column, possibly reducing the photosynthetic rate of SAV. Sediments may also settle onto the leaf structures of the plants and further reduce photosynthesis and respiration, thereby limiting productivity and placing further stress on the bed.

Laboratory and empirical field studies were used to assess variables such as depth to which effects can be felt, the relative magnitude of the suspension, and possible impact (of a biological nature) of propeller generated sediment resuspension

Procedure/Methodology

Field trials were made at three sites that have reasonably uniform water depths, minimum variation of bottom sediments with a high percentage of small-sediment particles (<60 u), available prior data or natural changes in suspended sediments, and available support facilities

Using two vessels, a 6.7 meter speedboat and a 9 meter tugboat, passes at set speeds chosen for maximum wave-making were made between series of buoys at each site. Before and after light extinction and eight transmission measurements of water sediment samples were obtained for gravimetric determination.

Laboratory experiments to measure the changes in water particle motion due to the effect of a boat propeller were conducted to predict the distribution of stress sufficient for sediment resuspension. The results of these observations were graphed and analyzed statistically.

Results/Conclusions

Light extinction measurements give the most statistically reliable and consistent results. They also show a correspondence to the laboratory results allowing formulation of a tentative hypothesis concerning the most significant variables that affect sediment resuspension.

Transmissionmeter readings, taken concurrently with photometer measurements, corroborate measurements of light extinction coefficients. The relatively lesser effects of the boat having the least propeller immersion is apparent, and is borne out by statistical comparison.

The gravimetric determination of suspended sediments returned little statistically significant data but does follow the pattern established by the photometer results.

The resuspension of sediments in the path of a small craft is influenced by water depth, depth of immersion, size of the propellér, the advance ratio, and the wave-making tendency of the vessel. The depth to which stirring is sufficient appears to be quite limited In this study, at depths of greater than two meters, reduction in SAV productivity was calculated at about one percent.

However, the depths to which boating effects allow sediment resuspension coincide with depths where SAV growth is limited in Bay waters Comparison of SAV maps suggests that areas of least SAV distribution and slowest recovery are also areas of greatest boating congestion. No conclusive studies have been done on this correlation. Sandy sediments predominate close to shore in waters less than 2.5 meters deep, and fine clay-like silts and muds are ubiquitous in deeper waters. Such distribution may have a protective effect for SAV beds in high wave/wake energy environments.

Recommendations

It is tentatively recommended that ecologically sensitive areas be investigated for the presence of fine sediments (<60 u) Such areas should be protected from excessive traffic, particularly deep-draft, high-powered craft.

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***William A. Cook** was the EPA Project Officer (for information, see below).*
The complete report, entitled "Sediment Suspension and Resuspension from Small-Craft Induced Turbulence," (Order No. PB 82-265 489; Cost: $9.00, subject to change) will be available only from:
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