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# Environmental Effects of Dredging Technical Notes



## FACTORS INFLUENCING BIOACCUMULATION OF SEDIMENT-ASSOCIATED CONTAMINANTS BY AQUATIC ORGANISMS; GLOSSARY AND BIBLIOGRAPHY

PURPOSE: This is the fourth technical note in a series of four which outlines and describes the principal factors that determine uptake and retention of chemicals by aquatic organisms. The first three notes in the series describe factors relating to contaminants, sediment and water, and biota. This note contains a glossary of terms and a bibliography of key and recent publications in the scientific literature containing supporting data and discussion on each topic. The information contained herein is intended to assist Corps of Engineers environmental personnel in activities requiring a working knowledge of concepts and terminology in the subject of chemical uptake, retention, and elimination by aquatic organisms exposed to contaminated sediments.

BACKGROUND: Bioaccumulation is the general term used to refer to the uptake and storage of chemicals by organisms from their environment through all routes of entry. Bioaccumulation includes bioconcentration, which is the direct uptake of chemicals from water alone, and is distinguished from biomagnification, which is the increase in chemical residues taken up through two or more levels of a food chain. Assessments of the potential for bioaccumulation of toxic substances associated with dredged sediments are often required in evaluations of permit requests. Thus, familiarity with the fundamental physical, biological, and chemical factors affecting bioaccumulation is necessary for performing evaluations of the ecological impacts of dredging operations. Additionally, a basic understanding of the concepts and terminology of bioaccumulation is increasingly required of environmental personnel who are involved in dredging and disposal operations which may involve contaminated sediments and legal personnel involved with regulation and litigation.

These notes are intended to serve as a source of basic information and to provide a guide to the scientific literature for each topic discussed. The emphasis is on factors affecting bioaccumulation of sediment-associated chemicals. A brief discussion of each factor is given and a list of references is provided. The references are extensive and frequently bear on more than one topic. An effort has been made to select both historically important works and the most recent research reports in each area. Numbers in parentheses following the subject headings locate the references for each subject. Papers referenced are alphabetized for each subject for each identification of those most pertinent to the reader's interest.



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The subjects discussed in these notes reflect current research for which new findings constantly appear in the literature. Consequently, the discussions and interpretations are based on inference and best judgment regarding the interactions of factors influencing bioaccumulation and represent the best understandings of the authors. Readers are encouraged to consult the literature cited.

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## Glossary

Absorption: assimilation of a chemical into biological tissue by capillary, osmotic, chemical, or solvent action.

Adsorption: condensation of gases, liquids, or dissolved substances on the surfaces of solids.

Assimilation efficiency: speed and effectiveness with which a chemical in food is incorporated into the tissues of an organism.

Bilipid: membrane formed of two separate sheets of lipid molecules which orient themselves so that the polar headgroups are exposed to the outer aqueous environment and the nonpolar tails are exposed to each other.

Bioaccumulation potential: equilibrium concentration of a foreign compound that could result in an organism's tissues given unlimited time and an absence of degradative and gradient effects.

Bioavailability: extent to which the fraction of the total chemical in the environment is available for uptake by an organism.

Biphasic: having two separate and distinct stages or periods.

Body burden: total concentration of a chemical in an organism taken up from the environment.

Cation: positively charged ion.

Cationic exchange capacity: extent to which negatively charged groups of a sediment matrix are able to exchange one cation for another.

Coprecipitate: inclusion of ions in a precipitation reaction by physical association rather than chemical bonding.

Complexation: bonding of metal ions with organic molecules.

Conjugation: addition reactions in which large chemical groups or entire compounds such as sugars and amino acids are covalently added to endogenous or foreign organic chemical compounds in metabolic detoxication.

Conservative: reaction that is not destructive to the reactants or catalysts involved.

Crystal matrix: highly ordered and highly stable arrangement of atoms or molecules that is necessary for the formation of a crystalline solid.

Detoxication: rendering of a toxic substance harmless, usually through metabolic processes and by excretion; detoxication can precede and thus prevent toxic effects.

Detoxification: correction of a state of intoxication.

Dissociated: state of a chemical compound that has been broken down into its simpler constituents.

Dissociation constant: constant that describes the difference in concentration at equilibrium between the dissociated and undisassociated forms of a chemical combination.

Divalent: having a valence or oxidation number of two.

Electron-withdrawing: molecule or group on a molecule that carries a full or partial positive charge by virtue of which it acts to pull electrons from other molecules.

Electronegative: having a tendency to attract electrons especially in the formation of an electrovalent bond.

Endogenous: normally occurring in an organism.

Ferric: substance composed of, relating to, or containing iron, especially substances in which the iron is trivalent.

Free ion: unbound charged particle in solution.

Functional group: an assemblage of atoms that imparts chemical activity to a molecule.

Humic material: complex heterogeneous substance produced in soils and aquatic sediments by the decay and decomposition of organic matter, chiefly of plant origin.

Hydrolysis: double decomposition reaction involving the splitting of water into its ions and the formation of a weak acid or base or both.

Hydrous oxides: amorphous, noncrystalline and permeable structures composed primarily of the oxides of iron and manganese and formed on mineral particles.

In situ: in the natural or original position.

Induction: stimulation of synthesis of enzymes through an increase in available substrate for enzymatic action.

Ion-exchange resin: permeable solid containing chemically bound charged groups to which ions are electrostatically bound and exchangeable with other ions of like charge.

Ionic strength of solution: relative concentration of charged particles in a solution.

Labile fraction: portion of a compound that readily undergoes physical, chemical, or biological change.

Manganic: substance composed of, relating to, or containing manganese, especially those in which the manganese is trivalent.

Micelle: water-soluble molecular aggregate composed of molecules containing both polar and nonpolar components that form with the polar units oriented to the outside of the aggregate and the nonpolar groups to the inside.

Normalization: expression of concentration data for a chemical in a complex mixture on the basis of one component of the mixture that is thought to account for most of the association of the chemical with the mixture.

One-compartment model: kinetic model in which the organism is considered as an integrated unit in terms of uptake and elimination; individual internal distribution and disposition rates are not considered.

Organometalloid: complex formed by binding of a metallic ion with an organic ligand.

Partitioning: distribution of a chemical between two immiscible solvents or phases.

Passive equlibration: equalization of concentration of a chemical substance on both sides of a membrane without the use of energy consuming processes.

Perfusion: pumping of a fluid through an organ or a tissue.

Polyvalent: substance that can have more than one valence state.

Protonation: uptake of hydrogen ions by a molecule to give an overall positive charge.

Steady state: state at which the competing rates of uptake and elimination of a chemical by an organism are equal and the net exchange of chemical is zero.

Substrate: chemical, usually a biogenic macromolecule, that serves as a reactant in biochemical transformation processes.

Van der Waals/London forces: relatively weak electrostatic attraction between atoms and molecules arising from fluctuations in their electron distributions as the electrons circulate in their orbitals.

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