

## Hazards Decontamination And Replacement Of Pcb A Comprehensive Guide

Organic pollutants continue to be a major hazard in the environment. Often difficult to measure accurately and to deal with effectively, these compounds feature more and more prominently in courses on environmental toxicology and environmental sciences. This much needed book is a companion to the highly praised Principles of Ecotoxicology. It covers organic pollutants in greater depth and detail than has been covered in a textbook before. The first part covers issues such as: chemical warfare metabolism of pollutants in animals and plants environmental fate, and effects within ecosystems This is followed by discussion of particular pollutants such as: organochloride insecticides PCBs dioxins organometallic compounds polycyclic aromatic hydrocarbons anticoagulant rodenticides amongst others. The book concludes with coverage of ecotoxicity testing, biomarkers and bioassays and future prospects for improved assessment of the dangers these compounds pose. It breaks new ground in offering a concise source of information on these compounds at a level suitable for senior undergraduates and postgraduates. Professionals working within the fields of environmental toxicology and environmental science will also find it a valuable reference.

This book originated in a series of cross-disciplinary conversations in the years 1984-1990 between the editor, who is a physician-researcher involved in clinical and laboratory research, and a dioxin toxicologist. During the years in which the conversations took place, an extraordinary amount of new scientific literature was published related to dioxins, defined for purposes of this text as the chlorinated dibenzo-p-dioxins, dibenzofurans, polychlorinated biphenyls (PCB's) and other compounds that are structurally and toxicologically similar to 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), the most extensively studied and most toxic of this group of chemicals. Dioxins also began to interest not only chemists and toxicologists, but also specialists from diverse disciplines such as wildlife and environmental science, immunology, neuroscience, public health, epidemiology, medicine, government, law, sociology, and journalism. Specialists from such varied disciplines, while familiar with their own literature, frequently did not have time to follow the dioxin literature outside their specialty area. In addition, each specialty had unique knowledge, methods, and perspectives. Cross disciplinary conversation was necessary, but all too frequently, specialists from the various disciplines did not speak the same language, resulting in misunderstanding.

Most industrial and hazardous waste management resources cover the major industries and provide conventional in-plant pollution control strategies. Until now however, no book or series of books has provided coverage that includes the latest developments in innovative and alternative environmental technology, design criteria, managerial decision making. International concern in scientific, industrial, and governmental communities over traces of xenobiotics in foods and in both abiotic and biotic environments has justified the present triumvirate of specialized publications in this field: comprehensive reviews, rapidly published research papers and progress reports, and archival documentations. These three international publications are integrated and scheduled to provide the coherency essential for nonduplicative and current progress in a field as dynamic and complex as environmental contamination and toxicology. This series is reserved exclusively for the diversified literature on "toxic" chemicals in our food, our feeds, our homes, recreational and working surroundings, our domestic animals, our wildlife and ourselves. Tremendous efforts worldwide have been mobilized to evaluate the nature, presence, magnitude, fate, and toxicology of the chemicals loosed upon the earth. Among the sequelae of this broad new emphasis is an undeniable need for an articulated set of authoritative publications, where one can find the latest important world literature produced by these emerging areas of science together with documentation of pertinent ancillary legislation. Research directors and legislative or administrative advisers do not have the time to scan the escalating number of technical publications that may contain articles important to current responsibility. Rather, these individuals need the background provided by detailed reviews and the assurance that the latest information is made available to them, all with minimal literature searching.

The use of biotechnical processes in control of environmental pollution and in hazardous waste treatment is viewed as an advantageous alternative or adduct to physical chemical treatment technologies. Yet, the development and implementation of both conventional and advanced biotechnologies in predictable and efficacious field applications suffer from numerous technical, regulatory, and societal uncertainties. With the application of modern molecular biology and genetic engineering, there is clear potential for biotechnical developments that will lead to breakthroughs in controlled and optimized hazardous waste treatment for in situ and unit process use. There is, however, great concern that the development of these technologies may be needlessly hindered in their applications and that the fundamental research base may not be able to sustain continued technology development. Some of these issues have been discussed in a fragmented fashion within the research and development community. A basic research agenda has been established to promote a sustainable cross-disciplinary technology base. This agenda includes developing new and improved strains for biodegradation, improving bioanalytical methods to measure strain and biodegradation performance, and providing an integrated environmental and reactor systems analysis approach for process control and optimization.

CHOICE Award Winner Transport and transformation processes are key for determining how humans and other organisms are exposed to chemicals. These processes are largely controlled by the chemicals' physical-chemical properties. This new edition of the Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals is a comprehensive series in four volumes that serves as a reference source for environmentally relevant physical-chemical property data of numerous groups of chemical substances. The handbook contains physical-chemical property data from peer-reviewed journals and other valuable sources on over 1200 chemicals of environmental concern. The handbook contains new data on the temperature dependence of selected physical-chemical properties, which allows scientists and engineers to perform better chemical assessments for climatic conditions outside the 20–25-degree range for which property values are generally reported. This second edition of the Handbook of Physical-Chemical Properties

and Environmental Fate for Organic Chemicals is an essential reference for university libraries, regulatory agencies, consultants, and industry professionals, particularly those concerned with chemical synthesis, emissions, fate, persistence, long-range transport, bioaccumulation, exposure, and biological effects of chemicals in the environment. This resource is also available on CD-ROM

Technologies for hazardous waste destruction (including nuclear, hospital and chemical waste) based on thermal plasma processes: state of the art and perspectives. Economic and environmental aspects. Overview of plasma generating devices, diagnostics and modelling. Evaluations of co-products generations, heat and metal recovery, slag vitrification and industrial feasibility. Contents: Production of Thermal Plasma (P Fauchais) Measurements of Temperatures in Thermal Plasma (P Fauchais) Review of Thermal Plasma Research and Development for Hazardous Waste Remediation in the United States (S F Paul) Design of a Plasma Torch for Toxic Waste Treatments (G Bonizzoni) The PERC™ Process for Hazardous Waste Treatment (A Blutke) Industrial Treatment of Waste Materials Using Tetronics Plasma Systems (J Williams) New Incineration and Melting Facility for Treatment of Low Level Radioactive Wastes in Switzerland (W Hoffelner et al.) Conversion of Liquid Toxic Waste by Means of a Plasma Reactor (Z A Janasz et al.) Are Plasma Incineration of Surrogate Radioactive Wastes (C Giroid et al.) Modelling of Plasma Treatment of Dispersed Charge for Vitrification of Activated Wastes (L I Krasovskaya) Progresses in a Plasma Torch Design for Hazardous Waste Treatment at the University of Milan (R Benocci et al.) MHD Model of a Free Burning Arc (R Benocci et al.) Multifluid Description and the Bohm Criterion for Multi-Species Plasmas (M S Benilov) Theory and Design of an Enthalpy Probe Diagnostic System (R Benocci et al.) Generation of Fine Particles at High Concentration in Thermal Plasma (A Krasenbrink et al.)

Readership: Undergraduates and graduates in physics or engineering. keywords: Plasmas; Hazardous Waste; Radioactive; Bohm Criterion

Chlorinated Organic Micropollutants addresses the sources, environmental cycles, uptake, consequences and control of many of the more important chlorinated organic micropollutants, including PCBs, PCDDs, PCDFs and various chlorinated pesticides, all of which have given widespread cause for concern in relation to their environmental persistence and high toxicity, and their potential for adverse effects on humans and wildlife. Rational decision making over chlorinated organic micropollutants in the environment must be based upon sound science. This volume draws upon the expertise of some of the most distinguished workers in the field, to review current knowledge of the sources, environmental concentrations and pathways, human toxicity and ecotoxicology, and control methods for these groups of compounds. Chlorinated Organic Micropollutants gives a unique and valuable compilation of information on an extremely important group of environmental pollutants. It is fully up-to-date, and will provide a comprehensive overview of this topical subject that will be useful for years to come, to academic, student and professional alike.

This book contains the papers presented at the First International Conference on Environmental Engineering and Renewable Energy held in Ulaanbaatar, Mongolia in September 1998. The main aim of the conference was to give an opportunity to scientists, experts and researchers from different fields to convene and discuss environmental and energy problems and also be informed about the state of the art. Today, environmental protection is increasingly becoming a matter of global priority now that the tendency towards sustainable development is growing. The main concept of sustainable development is to fulfill both the demand of today's generation and cater for the requirements of future generations. Hence, sustainable development requires sound management of those environmental and research and development technologies which have low environmental impact and which promote the use of renewable sources. Renewable energies are the only environmentally benign sources of energy and are available at any site and any time of the year. Moreover, the utilization of renewable sources of energy can contribute to the increasing energy demand and also advance the improvement of life standards in rural areas, where it is difficult to establish a permanent connection with central electricity systems. Application and adoption of emerging renewable energy technologies in rural and remote areas cannot be successful without transfer of knowledge, information and know-how. Environmental engineering involves research and application of technologies to minimize the undesirable impact on the environment. In recent years, there has been a growing interest in environmental engineering problems in order to focus on theoretical and experimental studies on atmospheric pollution, water management and treatment, waste treatment, disposal and management.

The study of the relationship between environmental pollution and human health is in its infancy. The number of substances and mixtures that have been identified in uncontrolled hazardous waste sites or that have been in advertently released into the environment is large and data on how these substances are modified as they interact with one another as they migrate through soil, air, and water are limited. There are also limits on our understanding of how these substances may be ingested, inhaled, or absorbed by people. The complexity of possible interactions between biological, chemical, and physical components in a given environment makes it virtually impossible to evaluate the potential for adverse biological effects adequately in the laboratory. Other, more comprehensive methods which provide realistic and interpretable results must be used. Many scientists believe that humans represent the ultimate sentinel species of a toxic exposure resulting from environmental pollution, however such exposures may also severely impact environmental health. There exists a wide variety of organisms in the natural environment that could be used to provide an early warning for potential human health effects as well as to indicate adverse ecological effects. The issue of effective utilization of sentinel species for environmental monitoring is a rapidly developing area of research which has grown in importance during the last decade.

As the global nature of pollution becomes increasingly obvious, successful hazardous waste treatment programs must take a total environmental control approach that encompasses all areas of pollution control. With its focus on new developments in innovative and alternative environmental technology, design criteria, effluent standards, managerial dec

Over the last decade and a half, an environmental conference series has emerged to become one of the major international forums on the chemical aspects of environmental protection. The forum is called Chemistry for the Protection of the Environment (CCPE). The sponsors of this CPE series have included the Chemical Societies of Poland, France, Belgium, Italy, and the U.S.A., the European Federation of Chemical Societies, the American Institute of Chemical Engineers, the American Society of Testing and Materials, the International Ozone Association, the United Nations Industrial Development Organization, the Ministries of the Environment of Poland, France, Belgium, and Italy, US Environmental Protection Agency, more than twenty universities and institutes of higher learning, and five academies of sciences. The first meeting in this series was organized in 1976 at the Marie Curie-Sklodowska University in Lublin, Poland. The conference dealt with various physicochemical methodologies for water and wastewater treatment research projects that were jointly sponsored by US EPA and Poland.

The authorship of this book is comprised of a total of 65 experts of worldwide repute, originating from 13 different countries and representing various scientific disciplines such as human and veterinary medicine, agricultural sciences, (micro)biology, pharmacology/toxicology, nutrition, (food) chemistry and risk assessment science. In 25 chapters the various chemical hazards - 'avoidable' or 'unavoidable' and possibly prevailing in major foods of animal origin [muscle foods (including fish), milk and dairy, eggs, honey] - are identified and characterised, the public health risks associated with the ingestion of animal food products that may be contaminated with such xenobiotic chemical substances are discussed in detail, and options for risk mitigation are presented. This volume targets an audience with both an industry and academic background, and particularly those professionals who are (or students who aspire to become) involved in risk management of foods of animal origin.

This book adds to the environmental politics and policy literature by conducting a comprehensive investigation of business influence in agenda building and environmental policymaking in the United States over time. As part of this investigation, the author presents an analysis of six cases in which private firms were involved in disputes concerning pollution control and natural resource management. In addition to determining how much business interests influence environmental and natural resource policy, the book tests possible explanations for their level of success in shaping the government's agenda and policy. The study offers a general conceptual framework for analyzing the influence of corporate America over environmental policymaking. The research then explores how much firms have influenced Congress, the U.S. Environmental Protection Agency and certain natural resource agencies, and the courts on environmental and natural issues since the beginning of the environmental movement in 1970. No other study has examined the ability of business to influence environmental policy in all three branches of government and in such detail.

This book was developed from the proceedings of the American Chemical Society, Division of Agricultural & Food Chemistry, subdivision of Natural Products Symposium "Biosynthesis and Metabolism of Secondary Natural Products" held in Atlanta, Georgia, April 1991. The objective of the conference was to bring together people from apparently diverse fields, ranging from biotechnology, metabolism, mechanistic organic chemistry, enzymology, fermentation, and biosynthesis, but who share a common interest in either the biosynthesis or the metabolism of natural products. It is our intention to help bridge the gap between the fields of mechanistic bio-organic chemistry and biotechnology. Our thanks go to Dr. Henry Yokoyama, co-organizer of the symposium, the authors who so kindly contributed chapters, the conference participants, and to those who assisted in the peer review process. We also thank the financial supporters of the symposium: ACS/AGFD, NIH General Medical Sciences, and the agricultural, pharmaceutical, biotechnology, and chromatography companies. A full list of the supporting corporations and institutions is given on the following page. Pharma-Tech and P.C., Inc. are manufacturers of instrumentation for high-speed countercurrent chromatography. We thank the Agricultural Research Service and the U. S. Department of Agriculture for granting me permission to co-organize the conference and for us to complete the book. Richard J. Petroski Susan P. McCormick USDA, ARS, National Center for Agricultural Utilization Research Peoria, IL 61604 June 10, 1992 vii CONTENTS ANTIBIOTICS Polyketide Synthetases: Enzyme Complexes and Multifunctional Proteins Directing the Biosynthesis of Bacterial Metabolites from Fatty Acids. . . . . 3 . . . . .

This book provides up-to-date information on chlorinated organics in the environment that can be used in monitoring, impact assessment, and decision-making processes. The text assists readers in predicting the potential for organic contamination as well as the critical medium of exposure to the health of the ecosystem and humans. Toxicity profiles provided for each chemical allow for evaluation of the short- and long-term effects on the environment. Discussions of environmental residues and pertinent worldwide regulations help readers compare chloroorganic contamination in different areas and analyze the associated regulatory approaches. Chlorinated Organic Compounds in the Environment begins with an introduction to chlorinated organic compounds and discussions of fate processes and environmental migration, based on their physical properties and processes. Next, the text focuses on chlorinated aliphatic hydrocarbons; chlorinated aromatic hydrocarbons-monocyclic and polycyclic compounds; and chlorinated biocides, phenols, dioxins, and furans in the environment. The North American and International regulations and advisories in the management of chlorinated organic compounds are reviewed in Chapters 3-8. The last two chapters of the book deal with prioritization for regulatory and monitoring assessment and regulatory decision-making processes. A glossary and comprehensive subject index makes terms easy to understand and find throughout the text. Environmental managers, regulatory personnel, scientists, and students will gain a broader understanding of environmental problems and how they can be applied to different disciplines such as chemistry, life sciences, and engineering with this important reference.

In April 2000 researchers from around the world met in Lexington, Kentucky to bring together the very latest information on the chemistry and biological effects of the environmental pollutants known as Polychlorinated Biphenyls (PCBs). The result is a comprehensive and extensive treatment of the very latest findings on all significant subjects relating to PCBs and their health risks. The thorough introduction and sixty-two scientific papers presented here represent the most up-to-date research by scientists in government, private industry, and academia. Contained in this volume are the proceedings of the international conference on the "Genetic Toxicology of Complex Mixtures," held from July 4-7, 1989, in Washington, DC. This meeting was a satellite of the "Fifth International Conference on Environmental Mutagens" and the seventh in a biennial series of conferences on "Short-term Bioassays in the Analysis of Complex Environmental Mixtures." Our central objective in calling together key researchers from around the world was to extend our knowledge of the application of the methods of genetic toxicology and analytical chemistry in the evaluation of chemical mixtures as they exist in the environment. This conference emphasized the study of genotoxicants in air and water, and the assessment of human exposure and cancer risk. The latest strategies and methodologies for biomonitoring of genotoxicants (including transformation products) were described in the context of the ambient environment. Source characterization and source apportionment were discussed as an aid to understanding the origin and relative contribution of various kinds of complex mixtures to the ambient environment. Similarly, investigations of genotoxicants found in the indoor environment (sidestream cigarette smoke) and in drinking water (chlorohydroxyfuranones) were given special attention in terms of their potential health impacts. New molecular techniques were described to enable more precise quantitation of internal dose and dose to-target tissues. The emphasis of presentations on exposures/effects assessment was on integrated quantitative evaluation of human exposure and potential health effects. The Energy Policy Act of 1992 called on the National Academy of Sciences to conduct a study and provide

recommendations for reducing the costs of decontaminating and decommissioning (D&D) the nation's uranium enrichment facilities located at Oak Ridge, Tennessee; Raducah, Kentucky; and Portsmouth, Ohio. This volume examines the existing plans and cost estimates for the D&D of these facilities, including such elements as technologies, planning and management, and identifies approaches that could reduce D&D costs. It also assesses options for disposition of the large quantities of depleted uranium hexafluoride that are stored at these sites.

This updated and expanded Second Edition of Dr. Erickson's Analytical Chemistry of PCBs appears a decade after the first and is completely revised and updated. The changes from the First Edition reflect the significant growth in the area and a growing appreciation of the importance of PCB analysis to our culture. This book is a comprehensive review of the analytical chemistry of PCBs. It is part history, part annotated bibliography, part comparison, and part guidance.

Featuring a new chapter on analyst/customer interactions and several new appendices, the Second Edition is an invaluable resource for both chemists with no experience in PCB analysis and seasoned PCB researchers. All topics have been more thoroughly treated and updated in this new edition to reflect advances made in the last decade, especially:

The first comprehensive guide to all surface and dermal sampling methods. Written by one of the nation's foremost sampling experts, this authoritative guide offers an integrated approach that combines surface and dermal sampling methods with air and biological monitoring techniques.

Proceedings of the Eighth Annual Conference of the Air Resources Information Clearinghouse held in Washington, D.C., December 5-6, 1991

Examining tissue residues of contaminants in biota reveals the movement of contaminants within organisms and through food chains as well as the context for understanding and quantifying injuries to organisms and their communities. Yet tissue concentrations of some contaminants are especially challenging to interpret and the ability of today's analytical chemists to provide reliable analytical data of most important environmental contaminants often surpasses the ability of ecotoxicologists to interpret those data. Offering guidance on the ecotoxicologically meaningful interpretation of tissue concentrations, Environmental Contaminants in Biota, Interpreting Tissue Concentrations, Second Edition is updated with current data and new ways of analyzing those data as well as additional contaminants not previously considered.

Beginning with a history of wildlife toxicology and data interpretation, chapters cover a wide range of contaminants and their hazardous and lethal concentrations in various animals including DDT, Dioxins, PCBs, and PBDEs in aquatic organisms; methylmercury, selenium, and trace metals in fishes and aquatic invertebrates; and pharmaceuticals and organic contaminants in marine mammals. The book considers the impact of Polychlorinated Biphenyls, Dibenzo-p-Dioxins and Dibenzofurans, and Polybrominated Diphenyl Ethers; cyclodiene; and other organochlorine pesticides in birds and mammals. Later chapters examine the effects and analysis of lead, cadmium, and radionuclides in biota. With thousands of published research papers reporting tissue concentrations each year, Environmental Contaminants in Biota, Interpreting Tissue Concentrations, Second Edition gives ecotoxicologists the ability to draw actionable value regarding the toxicological consequences of those concentrations and relate tissue concentrations quantitatively to injury: the core of ecotoxicology.

Poly Chlorinated Biphenyls (PCBs) are dielectric liquids which have been widely used in various industries for more than 50 years because of their supposed nonflammability and their chemical inertness. Recent accidents all over the world have shown PCBs can burn and their combustion by products (dioxines, furanes, etc.) are highly toxic. In fact, confusion has been created in the public mind between the dangers and hazards induced by PCBs themselves and those generated by their byproducts. Meanwhile, PCB pollution and toxicity is a major concern for regulating agencies, such as EPA in the United States and industry. Most Western countries now ban PCB production and strictly control their use. However, enormous amounts of PCB remain in use and their safe handling, destruction and replacement are heavy burdens for industrial users. PCB pollution and its side effects are the subject of various studies with recent conferences devoted to these PCB studies. Thus a large body of specialized information now exists on the environmental, medical, biological and safety aspects of PCB handling, use, cleaning and decontamination. However, no single comprehensive publication is yet available which deals with all the problems associated with PCBs. The major objective of the present book is to provide such a guide for PCB users. One interest of this book is that it brings together the point of view of scientists from widely different backgrounds: biologists, physicians, environmentalists, toxicologists, chemists, electrical engineers, etc.

Industrial manufacturers are increasingly using very high pressure water jets for the cleaning and breaking up of materials. Until recently, the demolition of reinforced concrete has been a long and difficult process, but developments in the design and use of high pressure water jets have made this a cleaner and faster process with many other applications in civil, construction and environmental engineering. Andreas Momber, a well known expert in water jet and abrasive water jet cutting technology has produced a unique and comprehensive book dealing with the fundamentals of the hydrodemolition process. Coverage includes equipment, processes, surface quality aspects, demolition with abrasive water jets, pulsed liquid jets, alternative applications and safety aspects. This book will help you to... •Understand the hydrodemolition process and its rewards, enabling you to achieve a cleaner, faster process in the demolition of concrete surfaces and reinforced concrete. •Learn when and where hydrodemolition can be used •Understand the costs, advantages and safety aspects involved •Apply the technique to new applications in your industry such as cleaning and waste management •Purchase the appropriate equipment, cutting time and maintenance costs \* Written by a well known expert in the field of water jet and abrasive water jet cutting technology \* First comprehensive book in the growing area of hydrodemolition of concrete surfaces and reinforced concrete \* Coverage includes the theory and practice of the hydrodemolition process

Field technicians and emergency response personnel are often faced with the dangers of flammable, combustible, and chemically unstable materials. Although there are numerous procedures set forth by regulatory agencies like the Occupational Safety and Health Administration (OSHA), the Environmental Protection Agency (EPA), and the National Institute for Occupational Safety and Health (NIOSH) for effectively and safely dealing with such environmental hazards, up until now there has been no single resource for training in this area. Based on the

author's twenty-plus years of field experience, Hazardous Waste Operations and Emergency Response Manual is a comprehensive text that covers the complete curriculum requirements set forth by OSHA and HazWOPER. Highly accessible and broad in focus, the book is equally useful as a technical resource for training, a hands-on reference for field operations, and a textbook for environmental courses in a variety of areas. Coverage includes: Methods recommended by professional societies and regulatory agencies including the National Fire Protection Association, OSHA, EPA, and NIOSH Practical examples and assignments in each chapter to supplement the text and enhance usefulness to students.

Introduction -- Basics of Hydroblasting -- Hydroblasting equipment -- Steel Surface Preparation by Hydroblasting -- Surface Quality Aspects -- Hydroblasting Standards -- Alternative Developments in Hydroblasting -- References -- Appendix.

Prior to 1979, consideration of the problem of the carcinogenicity of the aromatic amine class of chemicals took place primarily in poster sessions and symposia of annual meetings of the American Association for Cancer Research and analogous international associations. In November 1979 the first meeting concerned with the aromatic amines was held in Rockville, Maryland under primary sponsorship of the National Cancer Institute. The proceedings from this meeting were published as Monograph 58 of the Journal of the National Cancer Institute in 1981. The second meeting in this series, the Second International Conference on N-Substituted Aryl Compounds, was held in March/April of 1982 in Hot Springs, Arkansas. The National Cancer Institute and The National Center for Toxicological Research were the primary sponsors of this meeting. The proceedings were published as Volume 49 of the journal Environmental Health Perspectives in 1983. The third meeting in this series was held in April of 1987 at the Dearborn Hyatt in Dearborn, Michigan. The principal sponsor of this meeting was the Henry Ford Comprehensive Cancer Center of Metropolitan Detroit. The proceedings, Carcinogenic and Mutagenic Responses to Aromatic Amines and Nitroaromatics, were published in 1987 by Elsevier Press. The fourth meeting was held in Cleveland, Ohio, on July 15-19, 1989.

Biological processes in the oceans play a crucial role in regulating the fluxes of many important elements such as carbon, nitrogen, sulfur, oxygen, phosphorus, and silicon. As we come to the end of the 20th century, oceanographers have increasingly focussed on how these elements are cycled within the ocean, the interdependencies of these cycles, and the effect of the cycle on the composition of the earth's atmosphere and climate. Many techniques and tools have been developed or adapted over the past decade to help in this effort. These include satellite sensors of upper ocean phytoplankton distributions, flow cytometry, molecular biological probes, sophisticated moored and shipboard instrumentation, and vastly increased numerical modeling capabilities. This volume is the result of the 37th Brookhaven Symposium in Biology, in which a wide spectrum of oceanographers, chemists, biologists, and modelers discussed the progress in understanding the role of primary producers in biogeochemical cycles. The symposium is dedicated to Dr. Richard W. Eppley, an intellectual giant in biological oceanography, who inspired a generation of scientists to delve into problems of understanding biogeochemical cycles in the sea. We gratefully acknowledge support from the U.S. Department of Energy, the National Aeronautics and Space Administration, the National Science Foundation, the National Oceanic and Atmospheric Administration, the Electric Power Research Institute, and the Environmental Protection Agency. Special thanks to Claire Lamberti for her help in producing this volume.

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