## Contents

Preface ........................................................................................................................................ XIII

Interagency ISOC-HAB Organizing Committee ............................................................ XIV

ISOC-HAB Executive Advisory Committee ................................................................. XIV

Invited Participants ...................................................................................................... XV
  Occurrence Workgroup ........................................................................................ XV
  Causes, Prevention, and Mitigation ...................................................................... XVI
  Cyanotoxin Characteristics Workgroup ............................................................ XVII
  Analytical Methods Workgroup ........................................................................... XVIII
  Human Health Effects Workgroup ...................................................................... XX
  Ecosystem Effects Workgroup .............................................................................. XXI
  Risk Assessment Workgroup ............................................................................ XXII

### Overview

**Chapter 1: An Overview of the Interagency, International Symposium on Cyanobacterial Harmful Algal Blooms (ISOC-HAB): Advancing the Scientific Understanding of Freshwater Harmful Algal Blooms** ................................................................. 1  
*H Kenneth Hudnell, Quay Dortch, Harold Zenick*

**Chapter 2: A Synopsis of Research Needs Identified at the Interagency, International Symposium on Cyanobacterial Harmful Algal Blooms (ISOC-HAB) .................. 17  
*H Kenneth Hudnell, Quay Dortch*

### Occurrence Workgroup

**Chapter 3: Occurrence of Cyanobacterial Harmful Algal Blooms: Workgroup Report** ......................................................................................................................... 45  
*Edited by Anthony Fristachi and James L Sinclair*
  Workgroup Co-chairs: James L Sinclair, Sherwood Hall
Chapter 4: A World Overview-One-Hundred-Twenty-Seven Years of Research on Toxic Cyanobacteria–Where do we go from here? ....105
Wayne Carmichael

Chapter 5: Toxic Cyanobacteria in Florida Waters.........................127
John Burns

Chapter 6: Nebraska Experience .........................................................139
Walker SR, Lund JC, Schumacher DG, Brakhage PA, McManus BC,
Miller JD, Augustine MM, Carney JJ, Holland RS, Hoagland KD, Holz JC,
Barrow TM, Rundquist DC, Gitelson AA

Chapter 7: Cyanobacterial Toxins in New York
and the Lower Great Lakes Ecosystems..............................................153
Gregory L Boyer

Chapter 8: Occurrence Workgroup Poster Abstracts .......................167
Delaware’s Experience with Cyanobacteria in Freshwater Ponds .....167
Humphries EM, Savidge K, Tyler RM

Investigation of Microcystin Concentrations and Possible
Microcystin–Producing Organisms in Some Florida Lakes
and Fish Ponds..................................................................................170
Yilmaz M, Phlips EJ

Potentially Toxic Cyanobacteria in Chesapeake Bay Estuaries
and a Virginia Lake ............................................................................172
Marshall HG, Burchardt L, Egerton TA, Stefaniak K, Lane M

Expanding Existing Harmful Algal Blooms Surveillance
Systems: Canine Sentinel ...................................................................174
Chelminski AN, Williams CJ, Hunter JL, Shehee MW

Use of Embedded Networked Sensors for the Study
of Cyanobacterial Bloom Dynamics...................................................176
Stauffer BA, Sukhatme GS, Öberg C, Zhang B, Dhariwal A, Requicha A,
Caron DA

Bloom and Toxin Occurrence.............................................................178
Suseela MR

Cyanotoxins in the Tidewaters of Maryland’s Chesapeake Bay:
The Maryland Experience .................................................................180
Tango P, Butler W, Michael B

Harmful Algal Blooms and Cyanotoxins in
Metropolitan Water District’s Reservoirs..........................................182
Izaguirre G
Causes, Prevention, and Mitigation Workgroup

Chapter 9: Causes, Prevention, and Mitigation
Workgroup Report .................................................................185

Workgroup Co-chairs: Gina Perovich, Quay Dortch, James Goodrich
Workgroup Members: Paul S Berger, Justin Brooks, Terence J Evens,
Christopher J Gobler, Jennifer Graham, James Hyde, Dawn Karner,
Dennis (Kevin) O'Shea, Valerie Paul, Hans Paerl, Michael Piehler,
Barry H Rosen, Mary Santelmann, Pat Tester, Judy Westrick

Chapter 10: Nutrient and Other Environmental Controls of Harmful Cyanobacterial Blooms Along the Freshwater–Marine Continuum ....................................................217

Hans W Paerl

Chapter 11: Global Warming and Cyanobacterial Harmful Algal Blooms.................................................................239

Valerie J Paul

Chapter 12: Watershed Management Strategies to Prevent and Control Cyanobacterial Harmful Algal Blooms ..................................................259

Michael F Piehler

Chapter 13: Cyanobacterial Toxin Removal in Drinking Water Treatment Processes and Recreational Waters..........................275

Judy A Westrick

Chapter 14: Causes, Mitigation, and Prevention
Workgroup Posters.................................................................291

Application of Immobilized Titanium Dioxide Photocatalysis for the Treatment of Microcystin–LR.................................................................291
Antoniou MG, de la Cruz AA, Dionysiou DD

Environmental Conditions, Cyanobacteria and Microcystin Concentrations in Potable Water Supply Reservoirs in North Carolina, U.S.A. .................................................................293
Burkholder JM, Touchette BW, Allen EH, Alexander JL, Rublee PA

Removal of Microcystins using Portable Water Purification Systems ............................................................................295
Edwards C, Ramshaw C, Lawton LA

Multiple Scenarios for Fisheries to Increase Potentially Toxin Producing Cyanobacteria Populations in Selected Oregon Lakes......297
Eilers JM, St Amand A
Removal of the Cyanobacterial Toxin
Microcystin–LR by Biofiltration ........................................................299
   Eleuterio L, Batista JR

Water Quality and Cyanobacterial Management
in the Ocklawaha Chain-of-Lakes, Florida .......................................301
   Fulton RS, Coveney MF, Godwin WF

A Shift in Phytoplankton Dominance from Cyanobacteria
to Chlorophytes Following Algaecide Applications...........................303
   Iannacone LR, Touchette BW

Ultrasonically–Induced Degradation of Microcystin LR
and R.R: Identification of by Products and Effect of
Environmental Factors........................................................................305
   Song W, Rein K, de la Cruz A, O’Shea KE

Cultural Eutrophication of Three Midwest Urban Reservoirs:
The Role of Nitrogen Limitation in Determining
Phytoplankton Community Structure .................................................307
   Pascual DL, Johengen TH, Filippelli GM, Tedesco LP, Moran D

Cyanobacteria in Eutrophied Fresh to Brackish Lakes
in Barataria Estuary, Louisiana...........................................................308
   Ren L, Mendenhall W, Atilla N, Morrison W, Rabalais NN

Chemical Characterization of the Algistic Fraction of Barley
Straw (Hordeum Vulgare) Inhibiting Microcystis Aeruginosa ........310
   Ferrier MD, Waybright TJ, Terlizzi DE

Invertebrate Herbivores Induce Saxitoxin
Production in Lyngbya Wollei..............................................................312
   Thacker RW, Camacho FA

A Comparison of Cyanotoxin Release Following Bloom Treatments
with Copper Sulfate or Sodium Carbonate Peroxydrate...................314
   Touchette BW, Edwards CT, Alexander J

Toxins Workgroup

Chapter 15: Cyanotoxins Workgroup Report ...................................317
   Work Group Co-chairs: Rex A Pegram, Tonya Nichols
   Work Group Members: Stacey Etheridge, Andrew Humpage, Susan LeBlanc,
   Adam Love, Brett Neilan, Stephan Pflugmacher, Maria Runnegar, Robert
   Thacker
   Authors: Rex A Pegram, Andrew R Humpage, Brett A Neilan, Maria T Runnega,
   Tonya Nichols, Robert W Thacker, Stephan Pflugmacher, Stacey M Etheridge, Adam H Love
Chapter 16: Toxin Types, Toxicokinetics and Toxicodynamics .......383
Andrew Humpage

Chapter 17: The Genetics and Genomics of Cyanobacterial Toxicity .................................................................417
Brett A Neilan, Pearson LA, Moffitt MC, Mihali KT, Kaebernick M, Kellmann R, Pomati F

Chapter 18: Determining Important Parameters Related to Cyanobacterial Alkaloid Toxin Exposure ......................453
Love AH

Chapter 19: Toxins Workgroup Poster Abstracts .........................465
Microginin Peptides from Microcystis aeruginosa ..................465
Drummond AK, Schuster T, Wright JLC

Inactivation of an ABC Transporter, mcyH, Results in Loss of Microcystin Production in the Cyanobacterium Microcystis Aeruginosa PCC 7806 .................................................................467
Pearson LA, Hisbergues M, Börner T, Dittmann E, Neilan BA

Analytical Methods Workgroup

Chapter 20: Analytical Methods Workgroup Report ..................469
Workgroup Co–chairs: Armah A de la Cruz, Michael T Meyer

Chapter 21: Cyanotoxins: Sampling, Sample Processing and Toxin Uptake .........................................................483
Jussi A Meriluoto, Spoof LEM

Chapter 22: Field Methods in the Study of Toxic Cyanobacterial Blooms: Results and Insights from Lake Erie Research .............501
Steven W Wilhelm

Chapter 23: Conventional Laboratory Methods for Cyanotoxins ....513
Linda A Lawton, Edwards C

Chapter 24: Emerging High Throughput Analyses of Cyanobacterial Toxins and Toxic Cyanobacteria ........................539
Kaarina Sivonen
Chapter 25: Analytical Methods Workgroup Poster Abstracts ............559

Early Warning of Actual and Potential Cyanotoxin Production........559
Metcalf JS, Morrison LF, Reilly M, Young FM, Codd GA

Detecting Toxic Cyanobacterial Strains in the Great Lakes, USA.....561
Dyble J, Tester PA, Litaker RW, Fahnenstiel GL, Millie DF

A Progressive Comparison of Cyanobacterial Populations
with Raw and Finished Water Microcystin Levels
in Falls Lake Reservoir.................................................................563
Ehrlich LC, Gholizadeh A, Wolfinger ED, McMillan L

Liquid Chromatography Using Ion–Trap Mass Spectrometry
with Wideband Activation for the Determination
of Microcystins in Water................................................................565

Anatoxin–a Elicits an Increase in Peroxidase
and Glutathione S–transferase Activity in Aquatic Plants.............567
Mitrovic SM, Stephan Pflugmacher S, James KJ, Furey A

The mis–identification of Anatoxin–a using Mass
Spectrometry in the Forensic Investigation of
Acute Neurotoxic Poisoning...........................................................569
James KJ, Crowley J, Hamilton B, Lehane M, Furey A

Cyanobacterial Toxins and the AOAC Marine
and Freshwater Toxins Task Force.................................................571
Hungerford JM

Detection of Toxic Cyanobacteria Using the PDS® Biosensor .......573
Allain B, Xiao C, Martineau A, Mandeville R

Development of Microarrays for Rapid Detection of
Toxigenic Cyanobacteria Taxa in Water Supply Reservoirs.........575
Rublee PA, Henrich VC, Marshall MM, Burkholder JM

Characterization of Chronic Human Illness Associated
with Exposure to Cyanobacterial Harmful Algal Blooms
Predominated by Microcystis .......................................................577
Shoemaker RC, House D

ARS Research on Harmful Algal Blooms in SE USA
Aquaculture Impoundments...........................................................579
Zimba PV
Human Health Effects Workgroup

Chapter 26: Human Health Effects Workgroup Report
Workgroup Co–Chairs: Elizabeth D Hilborn, John W Fournie
Workgroup Members: Sandra MFO Azevedo, Neil Chernoff,
Ian R Falconer, Michelle J Hooth, Karl Jensen, Robert MacPhail,
Ian Stewart

Chapter 27: Health Effects Associated with Controlled
Exposures to Cyanobacterial Toxins
Ian R Falconer

Chapter 28: Cyanobacterial Poisoning in Livestock,
Wild Mammals and Birds – An Overview
Ian Stewart, Alan A Seawright, Glen R Shaw

Chapter 29: Epidemiology of Cyanobacteria and their Toxins
Louis S Pilotto

Chapter 30: Human Health Effects Workgroup Poster Abstracts
Serologic Evaluation of Human Microcystin Exposure
Hilborn ED, Carmichael WW, Yuan M, Soares RM, Servaites JC,
Barton HA, Azevedo, SMFO
Characterization of Chronic Human Illness Associated
with Exposure to Cyanobacterial Harmful Algal Blooms
Predominated by Microcystis
Shoemaker RC, House D

Ecosystem Effects Workgroup

Chapter 31: Ecosystem Effects Workgroup Report
Workgroup Co-chairs: John W Fournie, Elizabeth D Hilborn
Workgroup Members: Geoffrey A Codd, Michael Coveney,
Juli Dyble, Karl Havens, Bas W Ibelings, Jan Landsberg, Wayne Litaker

Chapter 32: Cyanobacterial Toxins: A Qualitative
Meta–Analysis of Concentrations, Dosage and Effects
in Freshwater, Estuarine and Marine Biota
Bas W Ibelings, Karl E Havens

Chapter 33: Cyanobacteria Blooms: Effects
on Aquatic Ecosystems
Karl E Havens
Chapter 34: Ecosystem Effects Workgroup Poster Abstracts .......... 751

Local Adaptation of *Daphnia Pulexaria* to Toxic Cyanobacteria .... 751
*Sarnelle O, Wilson AE*

Cytotoxicity of Microcystin-LR to Primary Cultures of Channel Catfish Hepatocytes and to the Channel Catfish Ovary Cell Line ............................................................... 754
*Schneider JE Jr, Beck BH, Terhune JS, Grizzle JM*

Mortality of Bald Eagles and American Coots in Southeastern Reservoirs Linked to Novel Epiphytic Cyanobacterial Colonies on Invasive Aquatic Plants ........................................ 756
*Wilde SB, Williams SK, Murphy T, Hope CP, Wiley F, Smith R, Birrenkott A, Bowerman W, Lewitus AJ*

Investigation of a Novel Epiphytic Cyanobacterium Associated with Reservoirs Affected by Avian Vacuolar Myelinopathy .......... 758
*Williams SK, Wilde SB, Murphy TM, Hope CP, Birrenkott A, Lewitus AJ*

Risk Assessment Workgroup

Chapter 35: Risk Assessment Workgroup Report ...................... 761
*Workgroup Co-chairs: Joyce Donohue, Jennifer Orme–Zavaleta*
*Workgroup Members: Michael Burch, Daniel Dietrich, Belinda Hawkins, Tony Lloyd, Wayne Munns, Jeffery Steeves, Dennis Steffensen, Dave Stone, Peter Tango*

Chapter 35 Appendix A: Multi-Criteria Decision Analysis .......... 817
*Linkov I, Steevens J*

Chapter 36: Effective Doses, Guidelines & Regulations ............ 833
*Michael D Burch*

Chapter 37: Economic Cost of Cyanobacterial Blooms .......... 857
*Dennis A Steffensen*

Chapter 38: Integrating Human and Ecological Risk Assessment: Application to the Cyanobacterial Harmful Algal Bloom Problem ................................................................. 869
*Jennifer Orme-Zavaleta, Wayne Munns Jr.*

*Daniel R Dietrich, Fischer A, Michel C, Hoeger SJ*

Index ...................................................................................................... 915
Cyanobacterial Harmful Algal Blooms: State of the Science and Research Needs
Hudnell, H.K. (Ed.)
2008, XXIV, 950 p. 80 illus., 17 illus. in color., Hardcover
ISBN: 978-0-387-75864-0