

Habitats and Biota of the Gulf of Mexico: Before the Deepwater Horizon Oil Spill

**Volume 2: Fish Resources, Fisheries, Sea Turtles, Avian Resources,
Marine Mammals, Diseases and Mortalities**

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Marine Mammals, Diseases and Mortalities**

Edited by

C. Herb Ward

Rice University, Houston, TX, USA

Authors

Joanna Burger
Yong Chen
William E. Hawkins
Kym Rouse Holzwart
Walter R. Keithly, Jr.

Robin M. Overstreet
Kenneth J. Roberts
Roldán A. Valverde
Bernd Würsig



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Editor
C. Herb Ward
Department of Civil
and Environmental Engineering
Rice University
Houston, TX, USA
wardch@rice.edu



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Preface

The Deepwater Horizon accident and oil spill in the Gulf of Mexico from the Macondo well began on April 20, 2010. Oil flowed into the Gulf for 87 days until the well was capped on July 15, 2010, and declared sealed on September 19, 2010. The United States (USA) Government initially estimated that a total oil discharge into the Gulf of 4.9 million barrels (210 million U.S. gallons) resulted from the spill; however, the estimate was challenged in litigation, reduced to 3.19 million barrels by a trial court, and remains in dispute. A massive cleanup, restoration, and research program followed and continues to the present, mostly funded by BP Exploration & Production Inc. (BP).

The Deepwater Horizon accident and oil spill quickly polarized factions of both the government regulatory and scientific communities, which resulted in a continuing barrage of conflicting opinions and reports in the media and at scientific meetings. In the aftermath of the oil spill, it quickly became apparent that much of the differences in opinion being expressed about biological and ecological effects was based on individual perceptions of the status and health of the Gulf of Mexico before the spill. Because of the very large differences between the Deepwater Horizon oil spill and the next largest oil spill in the Gulf (Ixtoc 1), few comparisons of pre-spill conditions and post-spill effects could be made.

BP funded cooperative research with government agencies on the effects of the Gulf oil spill and external competitively awarded independent research through their \$500 million Gulf of Mexico Research Initiative (GoMRI) program. However, little of the research addressed the status and ecological health of the Gulf of Mexico *before* the Deepwater Horizon accident to serve as baseline to help assess post-spill effects.

Perhaps because of my 30-year background as the founding Editor in Chief of *Environmental Toxicology and Chemistry*, in teaching oil spill cleanup courses in the 1980s, in editing the *The Offshore Ecology Investigation* volume, and my work on tar ball formation from oil spilled in the Gulf, BP asked me to identify potential authors with appropriate expertise to research and write baseline white papers on the status and ecosystem health of the Gulf of Mexico before the Deepwater Horizon accident. Dozens of potential authors were identified and vetted for conflicts. Those selected as authors of white papers were given complete freedom to research and write their papers. I worked with the authors much in the mode of a journal editor to help them develop advanced drafts of their papers suitable for external peer review. As editor I researched and selected the peer reviewers for each paper and worked with the authors to address peer reviewer comments, which at times required preparation of additional text, figures, and tables. Author coordination meetings were held at the James A. Baker III Institute for Public Policy at Rice University.

After most of the white papers had been written, edited, and vetted by peers, BP proposed to publish them as a *SpringerOpen* two-volume series under the Creative Commons License for noncommercial use to promote wide distribution and free access.

In organizing and editing this two-volume series on baseline conditions in the Gulf of Mexico before the Deepwater Horizon oil spill, I have been assisted by Diana Freeman and Mary Cormier at Rice University; Alexa Wenning, Michael Bock, Laura Leighton, Jonathan Ipock^a, and Richard Wenning at Ramboll Environ; and Catherine Vogel who prepared the text and figures for preparation of page proofs by Springer. All involved in writing and editing this book series have been compensated for their time and efforts.

C. Herb Ward, Series Editor

A.J. Foyt Family Chair of Engineering, Professor of Civil and Environmental Engineering, and Professor of Ecology and Evolutionary Biology Emeritus and Scholar in Environmental Science and Technology Policy, Baker Institute for Public Policy, Rice University, Houston, TX.

^aThe late Jonathan “Jon” Ipock (1986-2015) tragically died too young. While working with Ramboll Environ, Inc., he tirelessly obtained documents, compiled data and references, and prepared maps and graphs for Chapter 7 (Offshore Plankton and Benthos of the Gulf of Mexico), Chapter 9 (Fish Resources of the Gulf of Mexico), and Chapter 11 (Sea Turtles of the Gulf of Mexico). During his short career Jon worked at two environmental consulting firms for more than eight years, first as a volunteer student intern, then as an associate ecologist. Jon’s thirst for ecology was endless; he eagerly learned all he could and was one of ecology’s rising stars.

About the Editor

C. Herb Ward

C. Herb Ward is Professor Emeritus at Rice University. He held the A. J. Foyt Family Chair of Engineering and was Professor of Civil and Environmental Engineering in the George R. Brown School of Engineering and Professor of Ecology and Evolutionary Biology in the Weiss School of Natural Sciences. He is now a Scholar in Environmental Science and Technology Policy in the James A. Baker III Institute for Public Policy at Rice University. He received his B.S. (1955) in Biology and Agricultural Science from New Mexico College of Agriculture and Mechanical Arts; his M.S. (1958) and Ph.D. (1960) in Microbial Diseases, Physiology, and Genetics of Plants from Cornell University; and the M.P.H. (1978) in Environmental Health from the University of Texas School of Public Health. He is a Registered Professional Engineer in Texas and a Board-Certified Environmental Engineer by the American Academy of Environmental Engineers. He was the founding Chair of the Department of Environmental Science and Engineering, Chair of the Department of Civil and Environmental Engineering, and the inaugural Director of the Energy and Environmental Systems Institute at Rice University. He also served as Director of the U.S. Environmental Protection Agency (USEPA)-sponsored National Center for Ground Water Research and the U.S. Department of Defense (DoD)-sponsored Advanced Applied (Environmental) Technology Development Facility. Dr. Ward was a member of the USEPA Science Advisory Board and served as Chair of the Scientific Advisory Board of the DoD Strategic Environmental Research and Development Program (SERDP). He is the founding Editor in Chief of the scientific journal *Environmental Toxicology and Chemistry* and led the development of the journal of *Industrial Microbiology and Biotechnology*. He is a Fellow in the American Academy of Microbiology (AAM), Society of Industrial Microbiology and Biotechnology (SIMB), and the Society of Environmental Toxicology and Chemistry (SETAC). Dr. Ward received the Pohland Medal for Outstanding Contributions to Bridging Environmental Research, Education, and Practice and the Brown and Caldwell Lifetime Achievement Award for Environmental Remediation in 2006, the Water Environment Federation McKee Medal for Achievement in Groundwater Restoration in 2007, and the SIMB Charles Thom Award for Bioremediation Research in 2011 and was recognized as a Distinguished Alumnus by New Mexico State University in 2013. He was a coauthor of the 2011 AAM report, *Microbes and Oil Spills*.

About the Authors

Joanna Burger

Joanna Burger is Distinguished Professor of biology at Rutgers University. She received her B.S. from the State University of New York at Albany, M.S. from Cornell University, a Ph.D. from the University of Minnesota, and an honorary Ph.D. from the University of Alaska at Fairbanks. Her main interests are behavioral ecology of vertebrates, environmental monitoring, ecotoxicology, and ecological and human health risk assessment. She has conducted behavioral ecology studies on all continents and has a 40-year study of behavior, population dynamics, and contaminant levels of colonial-nesting seabirds in New Jersey. She has examined the effects of heavy metals, oil, and other environmental factors on behavioral development in the field and laboratory. For 20 years she has worked with the Consortium for Risk Evaluation with Stakeholder Participation to examine ecological and human risk on Department of Energy lands, including the value of ecological resources. She led a biological expedition to the Aleutians to examine seafood safety because of possible radionuclide exposure from the underground nuclear tests performed in the 1970s. Dr. Burger has published over 600 peer-reviewed papers and more than 20 books, including *Behavior of Marine Animals, Seabirds and Other Marine Vertebrates, The Common Tern, The Black Skimmer: Social Dynamics of a Colonial Species, Before and After an Oil Spill: The Arthur Kill, Oil Spills, Protecting The Commons: A Framework for Resource Management in the Americas, The Biology of Seabirds,* and *A Visual Guide to Birds*. She served on several editorial boards, including *Environmental Research, Environmental Monitoring and Assessment, Journal of Toxicology and Environmental Health, Science and the Total Environment,* and *Environmental Bioindicators*. She served on the National Academy of Sciences' Commission of Life Sciences, Board of Biology, Board of Environmental Science and Toxicology, and several National Research Council committees. She served on several other national and international committees for the U.S. Environmental Protection Agency, U.S. Fish & Wildlife Service, and the Scientific Committee on Problems of the Environment (SCOPE). She is a Fellow of the American Ornithologists' Union, the International Union of Pure and Applied Chemistry, and the American Association for the Advancement of Science. She received the Brewster Medal in ornithology, and the Lifetime Achievement Award of the Society of Risk Analysis.

Yong Chen

Yong Chen is Professor of fisheries science in the School of Marine Science at the University of Maine in Orono, Maine. He received his bachelor of agriculture degree (1983) in fisheries science from the Ocean University of China and M.S. (1991) and Ph.D. (1995) degrees in zoology (fisheries ecology) from the University of Toronto in Canada. He started his career as a fisheries stock assessment scientist in the New South Wales Fisheries Department in Sydney, Australia, in 1995. In 1997, he was appointed Assistant Professor and Canadian Natural Science and Engineering Research Council Associate Chair in fisheries conservation at the Memorial University of Newfoundland. He moved to the University of Maine in 2000 and was promoted to the rank of Professor in 2007.

Dr. Chen's research is focused primarily on fisheries ecology, fish population dynamics, and stock assessment. He has extensive expertise working on the spatiotemporal dynamics of fish populations and communities of commercial and recreational importance in the Gulf of Maine (e.g., American lobster, sea urchin, demersal and pelagic finfish), Gulf of Mexico (tilefish habitat), Newfoundland (groundfish fisheries), Oman (finfish surveys), Kuwait

(impacts of the Gulf War on shrimp fisheries), New Zealand (abalone fisheries), Australia (spiny lobster, abalone, and finfish), and China (oceanic squid and tuna fisheries). He has published 135 peer-reviewed papers in scientific journals and many technical and fish stock assessment reports and has received over \$4.5 million in competitive research support. He is a Center for Independent Expert reviewer who is regularly invited to review National Oceanic and Atmospheric Administration stock assessment work. He frequently serves as a scientific consultant and reviewer on fisheries-related programs in the United States, Canada, China, New Zealand, Oman, and Kuwait. He has advised or co-advised 25 M.S. and 11 Ph.D. students, 9 postdoctoral research associates, and 8 short-term visiting Ph.D. students. Dr. Chen is actively involved in community and professional service, including peer reviewer for scientific journals and funding agencies. He is currently a member of the New England Fisheries Management Council's Scientific and Statistical Committee. He is Co-Editor of the *Canadian Journal of Fisheries and Aquatic Sciences*.

William E. Hawkins

William E. Hawkins is Professor Emeritus in the Department of Coastal Sciences at the Gulf Coast Research Laboratory (GCRL) of the University of Southern Mississippi. He retired from GCRL in 2011 as Director of the institution, which he served for more than 30 years. His undergraduate degree was from Mississippi State University and graduate degrees from the University of Mississippi Medical Center. He conducted his dissertation research at GCRL, and after receiving his doctorate he went to teach in the Department of Medical Anatomy and Embryology at the State University of Utrecht in the Netherlands and conduct research in the Centre for Electron Microscopy. On returning to the United States, he taught in the College of Medicine of the University of South Alabama then rejoined the Gulf Coast Research Laboratory in 1979 where he remained until he retired. At GCRL his research focused on the pathobiology of marine organisms, particularly the use of fish in studying disease processes. Technologies using the Japanese medaka for cancer research developed by him and colleagues at GCRL received millions of dollars in competitive grant support. He was instrumental in the development of the Thad Cochran Marine Aquaculture Center at GCRL, a more than \$40M research facility built on the GCRL Cedar Point Campus. He led the recovery of GCRL from the effects of Hurricane Katrina and taught a graduate level course on the effects of that storm on the Mississippi Gulf Coast and the responses of individuals and institutions such as GCRL to the disaster.

Kym Rouse Holzwart

Kym Rouse Holzwart was a Senior Science Advisor and Certified Senior Ecologist at ENVIRON International Corporation in Tampa, Florida, when the chapter on sea turtles was written. She is now a senior environmental scientist with the Southwest Florida Water Management District. She has more than 30 years of experience as an ecologist and limnologist designing, managing, and participating in applied research projects. She has B.S. degrees in biology (1985) and limnology (1986) and an M.S. in biological sciences (1993) from the University of Central Florida. She worked for the St. Johns River Water Management District (SJRWMD), in Orlando, Florida (1987–1993), on a wide variety of tasks from permitting to enforcement and compliance, water quality sampling, and evaluating wetlands. Her M.S. thesis research, funded by the Water Management District, addressed the bioaccumulation of heavy metals by fish inhabiting storm water treatment ponds. She was a research ecologist at Oak Ridge National Laboratory (1993–1996) and participated in large environmental and ecological risk assessment projects.

Ms. Rouse Holzwart has experience in aquatic ecosystem assessment; environmental toxicology; water quality, sediment, and biological sampling; environmental permitting; and

ecosystem services valuation. She has been involved in numerous ecological risk assessments evaluating the effects of contaminants, introduced species, and other disturbances on mammals, birds, fish, reptiles, amphibians, invertebrates, and plants. In addition, she has designed, managed, and conducted numerous environmental toxicology studies in aquatic and terrestrial ecosystems, including studies on reptiles and fish, with particular emphasis on the accumulation and effects of heavy metals. Her research has focused on aquatic ecosystems in the southeast United States and Florida. She has published more than 50 papers in the scientific literature and has coauthored hundreds of technical reports. She currently serves on the Ecological Society of America Board of Professional Certification, the Society of Environmental Toxicology and Chemistry Ecotoxicology of Amphibians and Reptiles Advisory Group, the Council of the Florida Academy of Sciences as Biological Sciences Section chair and councilor at large, and the Florida Lake Management Society Board of Directors.

Walter R. Keithly Jr.

Walter R. Keithly earned a doctoral degree in food and resource economics at the University of Florida in 1985 specializing in environmental and natural resource economics. He then accepted and currently holds a faculty appointment in the Department of Agricultural Economics and Agribusiness at Louisiana State University. Since joining Louisiana State University, he has authored or coauthored more than 100 papers covering a wide range of topics relevant to fisheries and coastal management. Recent fisheries-related research interests have focused on:

1. Effects of increasing shrimp imports on prices received by Gulf of Mexico shrimp fishermen
2. Factors determining location choice by Gulf of Mexico shrimp fishermen
3. The influence of *Vibrio vulnificus* on dockside oyster prices in the Gulf of Mexico and other producing regions of the United States
4. Analysis of quality and its influence on seafood demand
5. Industry perceptions related to the Gulf of Mexico red snapper catch share program

Other research interests have included (1) analysis of factors determining wetland values in Louisiana, (2) analysis of incentives that can be provided to wetland owners to encourage protection/rehabilitation of coastal wetland properties, and (3) the influence of bounties on the harvest of nutria. He frequently gives presentations at academic and industry-oriented meetings and serves on numerous federal committees, including as chair of the Standing Scientific and Statistical Committee and the Socioeconomic Committee of the Gulf of Mexico Fishery Management Council. He has also served on the Caribbean Standing and Scientific Statistical Committee of the Caribbean Fishery Management Council.

Dr. Keithly often serves as consultant to state, federal, and international organizations, including the Food and Agricultural Organization of the United Nations, the National Oceanic and Atmospheric Administration, and, most recently, the state of Maryland where he provided an economic review of the introduction of nonindigenous oysters to the Chesapeake Region. He has been an expert witness on numerous occasions where he has estimated financial losses due to natural resources damage.

Robin M. Overstreet

Robin M. Overstreet is Professor Emeritus at the University of Southern Mississippi (USM) in the Department of Coastal Sciences on the Gulf Coast Research Laboratory (GCRL) campus. He graduated with a B.A. in biology from the University of Oregon in 1963 and an

M.S. and Ph.D. in marine biology from the Institute of Marine Sciences, University of Miami (now the Rosenstiel School of Marine and Atmospheric Science), in 1966 and 1968, respectively, followed by a National Institutes of Health postdoctoral fellowship in parasitology at Tulane Medical School. He spent 45 years of his professional career at the GCRL, which became part of USM in 1998 where he was a Full Professor. He garnered almost \$20M in extramural support for his own research, collaborated on a total of about \$50M in research funding for GCRL and USM, and was advisor to numerous graduate students from USM and several other universities. He published over 300 peer-reviewed research papers in his primary fields of research (1) parasitology and diseases, (2) aquaculture and fisheries science, and (3) environmental biology and neoplasms. He has three *Digenea* genera named after him and 27 species of patronymics. Since 1969, he has studied parasites, including viral agents, in penaeid shrimps and other crustaceans as well as other invertebrates, fishes, other lower vertebrates, and warm-blooded animals. He still has students, technicians, space, and an active research program including work on crustacean viral infections, but focusing on parasites. Robin has received several awards including Fellow of the American Academy of Microbiology, academic and applied research awards from USM, and leadership positions and awards from different parasitological and fisheries societies. He also was a Visiting Professor at the University of Queensland, Curtin University, and University of Rome. He enjoys tennis, old Fords, and photography.

Kenneth J. Roberts

Kenneth J. Roberts is Associate Vice-Chancellor Emeritus of the Louisiana State University AgCenter. He received B.S. (1966) and M.S. (1968) degrees in agricultural economics from Louisiana State University. He earned a Ph.D. (1973) in natural resource economics from Oregon State University where he also taught as an Instructor. His academic and professional career continued on the faculty of Clemson University where he was Associate Professor with tenure in the Department of Agricultural Economics. He was an Assistant Program Manager for the National Sea Grant Program in the National Oceanic and Atmospheric Administration while on sabbatical leave from Clemson University. In 1978 Dr. Roberts accepted a joint marine economics research and extension service position at Louisiana State University with the Louisiana State University Sea Grant College Program. With an interest in leadership development among Louisiana's agricultural and fisheries food producers, processors, and service industries, he became Director of the endowed Agricultural Leadership Development Program at the university. He was appointed Associate Vice-Chancellor of the Louisiana State University AgCenter, which he held until retirement in 2008.

Dr. Roberts' professional career has included both extension service and research in the fields of fisheries economics, seafood processing and marketing, and the economics of pond and recirculating aquaculture. He published frequently in these fields, but his most cherished accomplishments were those related to service on public agency and policy-shaping groups such as the South Atlantic Fishery Management Council and the Gulf of Mexico Fishery Management Council (GMFMC). Dr. Roberts became Vice-Chairman and then Chairman of the GMFMC. Collectively, he has been a member of the Councils' Scientific and Statistical Committees for over three decades. He has also provided expert advice via the GMFMC's Socioeconomics Scientific and Statistical Advisory Committee and controlled access committees regarding red snapper and grouper fishery management plan amendments. The U.S. Secretary of Commerce appointed Dr. Roberts to the Marine Fisheries Advisory Committee (MAFAC) to participate in the shaping of recommendations on marine aquaculture, controlled access to fisheries, and other emerging issues. A year 2020 plan for the National Marine Fisheries Service was developed.

Roldán A. Valverde

Roldán A. Valverde is Professor in the Department of Biology at Southeastern Louisiana University. He received his B.S. degree (1985) from the Universidad Nacional of Costa Rica and his Ph.D. in zoology (1996) from Texas A&M University. During his doctoral studies, he studied endocrine stress responses of arribada olive ridleys at Nancite Beach. Following his doctoral degree, he worked as leader of the Green Sea Turtle Tagging Program at Tortuguero, Costa Rica. He then pursued postdoctoral training in the Department of Biology, University of Michigan, studying the neuroendocrine mechanisms of amphibian metamorphosis. He accepted an academic position at Xavier University of New Orleans in 2001 and moved to his current position at Southeastern Louisiana University in 2004. Dr. Valverde is primarily a sea turtle biologist with training in comparative and integrative endocrinology. His main academic interests focus on the endocrine stress response of turtles and on the nesting ecology of sea turtles. His research combines laboratory experimental work with captive-raised and wild red-ear slider (*Trachemys scripta*) turtles examining the effects of organic pollutants on turtle physiology. His sea turtle work includes nesting ecology and reproductive and stress physiology, mainly of olive ridley sea turtles. Much of his work on olive ridley nesting ecology is conducted with collaborators in Costa Rica.

Dr. Valverde has 21 peer-reviewed publications, including one book chapter, over 40 coauthored presentations at professional meetings, 15 invited presentations, and several sea turtle workshops and training courses geared to Latin Americans. He has directed 21 graduate students and 12 undergraduates at Southeastern Louisiana University or Latin American institutions. Over the years, he has received 13 extramural research grants and 10 intramural grants to support his research and graduate training program. He has reviewed manuscripts for several scientific journals, served as a reviewer for National Science Foundation grant programs (UMEB, GK-12, and REU), and served on the editorial board of the *Marine Turtle Newsletter*. Dr. Valverde is a member of the International Sea Turtle Society, for which he served as a board member since 2010 and as President in 2014.

Bernd Würsig

Bernd Würsig holds the George P. Mitchell '40 Chair of Sustainable Fisheries and is Regents' Professor at Texas A&M University (TAMU). He was recently honored by appointment as University Distinguished Professor at TAMU. He received his B.S. (1971) in zoology from Ohio State University and Ph.D. (1978) in an interdisciplinary doctoral program at Stony Brook University. After going through the professor ranks at Moss Landing Marine Laboratories in California (1981–1989), Dr. Würsig became the inaugural Chair of the Texas A&M System's Marine Biology Graduate Program, an interdisciplinary entity among three campuses. Würsig teaches undergraduate and graduate courses on marine mammalogy, specializing in behavior and behavioral ecology. He has published widely in the popular literature as part of teaching endeavors, such as for the *Journal of Natural History* and *Scientific American*, and he has been advisor to numerous movies made for television on nature interpretation, as well as the IMAX movie *Dolphins* in 2000 that was nominated for an Academy Award for Best Documentary Short Subject. He also leads field courses on marine birds and mammals in New Zealand.

Professor Würsig has published more than 150 peer-reviewed papers in scientific journals and 6 books and has been senior advisor to 70 graduate students. He and his students and postdoctoral fellows have studied cetaceans, pinnipeds, and sea birds on all continents, with present focus primarily on social strategies of dusky dolphins in New Zealand, western gray whales in far east Russia, Indo-Pacific humpback dolphins in Hong Kong, humpback whales in Puerto Rico, small cetaceans of the Mediterranean Sea, diversity of cetaceans of southern

California, and bottlenose dolphins in the Gulf of Mexico. Recent books are *The Encyclopedia of Marine Mammals*, 2nd Edition (with Bill Perrin and Hans Thewissen, 2009), and *The Dusky Dolphin: Master Acrobat Off Different Shores* (with Melany Würsig, 2010). Bernd and Melany enjoy their gardens in New Zealand, the Arizona desert, and coastal South Texas, three marvelously different biomes.

External Peer Reviewers

Charles M. Adams

Food and Resource Economics
University of Florida
Gainesville, FL, USA

John B. Anderson

Sedimentology and Earth Science
Rice University
Houston, TX, USA

Susan S. Bell

Marine and Restoration Ecology
University of South Florida
Tampa, FL, USA

William F. Font

Fish Ecological Parasitology
Southeastern Louisiana University
Hammond, LA, USA

Mark A. Fraker

Marine Mammal Ecology
TerraMar Environmental Research LLC
Ashland, OR, USA

Jonathon H. Grabowski

Ecology and Fisheries Biology
Northeastern University
Boston, MA, USA

Frank R. Moore

Bird Migration and Ecology
University of Southern Mississippi
Hattiesburg, MS, USA

Pamela T. Plotkin

Sea Turtle Behavioral Ecology
Texas A&M University
College Station, TX, USA

Steve W. Ross

Marine Fish Ecology
University of North Carolina
Wilmington, NC, USA

Roger Sassen

Marine Geochemistry
Texas A&M University
College Station, TX, USA

Greg W. Stunz

Marine Biology and Fisheries
Texas A&M University
Corpus Christi, TX, USA

John H. Trefry

Chemical Oceanography
Florida Institute of Technology
Melbourne, FL, USA

Edward S. Van Vleet

Chemical Oceanography
University of South Florida
St. Petersburg, FL, USA

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