Released on March 21, 2005

Scientific Consensus Statement on Marine Ecosystem-Based Management

Prepared by scientists and policy experts to provide information about coasts and oceans to U.S. policy-makers

Executive Summary: **The current state of the oceans requires immediate action and attention. Solutions based on an integrated ecosystem approach hold the greatest promise for delivering desired results. From a scientific perspective, we now know enough to improve dramatically the conservation and management of marine systems through the implementation of ecosystem-based approaches.**

Coastal and ocean ecosystems are vitally important to U.S. interests and they are at risk. Over half of the U.S. population lives along the coast, and more than $200 billion in economic activity was associated with the ocean in 2000.[1] Despite their economic significance, U.S. oceans, like those around the world, are changing in unprecedented ways. Recently, the Pew Oceans Commission and the U.S. Commission on Ocean Policy concluded that a combination of human activities on land, along the coasts, and in the ocean are unintentionally but seriously affecting marine ecosystems by altering marine food webs, changing the climate, damaging habitat, eroding coastlines, introducing invasive species, and polluting coastal waters. These changes threaten the ability of ocean ecosystems to provide the benefits Americans expect from marine ecosystems. Currently, each activity or threat is typically considered in isolation; coordinated management of cumulative impacts is rare. **Both commissions call for a more comprehensive, integrated, ecosystem-based approach to address the current and future management challenges of our oceans**. Both commissions describe ecosystem-based management as the cornerstone of a new vision for healthy, productive, resilient marine ecosystems that provide stable fisheries, abundant wildlife, clean beaches, vibrant coastal communities and healthy seafood for all Americans.

WHAT IS ECOSYSTEM-BASED MANAGEMENT FOR THE OCEANS?

Ecosystem-based management is an integrated approach to management that considers the entire ecosystem, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors. Specifically, ecosystem-based management:

- emphasizes the protection of ecosystem structure, functioning, and key processes;
- is place-based in focusing on a specific ecosystem and the range of activities affecting it;
- explicitly accounts for the interconnectedness within systems, recognizing the importance of interactions between many target species or key services and other non-target species;
- acknowledges interconnectedness among systems, such as between air, land and sea; and
- integrates ecological, social, economic, and institutional perspectives, recognizing their strong interdependences.

1 U.S. Commission on Ocean Policy (2004) Appendix C: Living Near and Making a Living from the Nation's Coasts and Oceans

BACKGROUND

The scientific understanding of marine ecosystems has advanced considerably over the last few decades. We now have a much greater appreciation of how the oceans support and sustain human life by providing services such as seafood; medicine; nutrient cycling; water purification; protection of shores from erosion and storm damage; moderation of climate and weather; recreation; and spiritual, religious, and other nonmaterial benefits. The interactions among species within ecosystems generate these services. Healthy, intact, resilient marine ecosystems have a greater capacity to provide the full range of benefits that Americans say they want from oceans.

Management that emphasizes the protection of ecosystem structure, functioning, and key processes is much more likely to ensure the long-term delivery of these important services. From a governance perspective, implementation of an ecosystem approach will enable more coordinated and sustainable management of activities that affect the oceans. Ecosystem-based management should reduce duplication and conflicts, and in the long run will likely be more cost-effective. A delay in implementing management based on an ecosystem approach will result in continued conflicts over resources, degradation of ocean ecosystems, disruption of fisheries, loss of recreational opportunities, health risks to humans and wildlife and loss of biodiversity.

This document reflects our scientific understanding about marine ecosystems and the concepts of ecosystem-based management, specifically (1) what the term 'ecosystem-based management' means, (2) what is an ecosystem, (3) core scientific knowledge about ecosystems, (4) key elements of ecosystem-based management, and (5) actions consistent with an ecosystem approach.

WHAT IS AN ECOSYSTEM?

An ecosystem is a dynamic complex of plants, animals, microbes and physical environmental features that interact with one another. Humans are an integral part of ecosystems, marine and terrestrial. The "interconnectedness" within and among ecosystems is provided both by the physical environment (for example, currents transporting larvae from one part of the ecosystem to another) and by biological interactions (for example, kelps or seagrasses creating habitat or predators consuming prey).

Ecosystems come in many sizes, often with smaller systems embedded within larger ones. For example, a kelp forest in southern California represents a small habitat ecosystem that is nested within the larger California Current Large Marine Ecosystem. At the largest scale, ecosystems are often categorized as Large Marine Ecosystems (LMEs). Approximately 64 LMEs have been recognized globally, and 10 of these are in U.S. waters[2]. The boundaries of each LME are defined primarily by oceanographic and topographic features. All LMEs include multiple habitats such as sandy beaches, kelp forests, rocky shores, seagrass beds, or pelagic habitat. Individuals of a few marine species spend their entire life within a single habitat such as a kelp forest, but most have larval or juvenile stages that are transported across habitats but within an LME. Thus, even if the adult stage is sedentary, the individual uses multiple habitats within an LME over its lifespan.

[2] The 10 Large Marine Ecosystems within the U.S. Exclusive Economic Zone (in whole or in part) are the Beaufort Sea, Chukchi Sea, Eastern Bering Sea, Gulf of Alaska, California Current, Insular Pacific Hawaiian, Gulf of Mexico, Caribbean Sea, South East U.S. Continental Shelf, and North East U.S. Continental Shelf.

Some wide-ranging animals, including certain large fish, sea turtles, and marine mammals, cross LME boundaries just as migrating birds move across tundra, forest and prairie ecosystems on land.

CORE SCIENTIFIC KNOWLEDGE ABOUT ECOSYSTEMS

Our scientific understanding of ecosystems in general, and marine systems specifically, has advanced substantially over the last few decades. A wealth of experience with ecosystem-based management on land is available to inform implementation of marine ecosystem-based management. The following are key concepts that form the foundation for an ecosystem approach to management.

- **The key interactions among species within an ecosystem are essential to maintain if ecosystem services are to be delivered.** Ecosystems are highly interactive and strongly linked. Removing or damaging some species can dramatically affect others and disrupt the ability of the system to provide desired services. However, not all interactions are equally important. The consequences of some species' interactions strongly influence the overall behavior of ecosystems. Small changes to these key interactions can produce large ecosystem responses. For example, the absence of large-bodied predators at the apex of marine food webs can result in large-scale changes in the relative abundances of other species. Ecosystem-based management therefore entails identifying and focusing on the role of key interactions, rather than on all possible interactions.

- **The dynamic and complex nature of ecosystems requires a long-term focus and the understanding that abrupt, unanticipated changes are possible.** The abundances of species are inherently difficult to predict, especially over longer time periods, in part because they may change abruptly and with little warning. For example, decadal-scale changes (such as the North Atlantic Oscillation or the Pacific Decadal Oscillation) significantly alter ecosystem dynamics and population sizes. Such long-term changes tend to be less predictable because they are associated with large-scale environmental changes. Management must thus anticipate and be able to adjust to these changes.

- **Ecosystems can recover from many kinds of disturbance, but are not infinitely resilient.** There is often a threshold beyond which an altered ecosystem may not return to its previous state. The tipping point for these irreversible changes may be impossible to predict. Thus, increased levels of precaution are prudent as ecosystems are pushed further from pre-existing states. Features that enhance the ability of an ecosystem to resist or recover from disturbance include the full natural complement of species, genetic diversity within species, multiple representative stands (copies) of each habitat type and lack of degrading stress from other sources.

- **Ecosystem services are nearly always undervalued.** Although some goods (fish and shellfish) have significant economic value, most other essential services are neither appreciated nor commonly assigned economic worth. Examples of services that are at risk because they are undervalued include protection of shorelines from erosion, nutrient recycling, control of disease and pests, climate regulation, cultural heritage and spiritual benefits. Current economic systems attach no dollar values to these services; they are typically not considered in policy decisions and many are at risk.

KEY ELEMENTS OF ECOSYSTEM-BASED MANAGEMENT

The U.S. Commission on Ocean Policy and the Pew Oceans Commission articulated a number of key elements of marine ecosystem-based management. They include:

- Make protecting and restoring marine ecosystems and all their services the primary focus, even above short-term economic or social goals for single services. Only intact, healthy ecosystems can provide the complete range of benefits that humans want and need over long periods of time.
- Consider cumulative effects of different activities on the diversity and interactions of species.
- Facilitate connectivity among and within marine ecosystems by accounting for the import and export of larvae, nutrients, and food.
- Incorporate measures that acknowledge the inherent uncertainties in ecosystem-based management and account for dynamic changes in ecosystems, for example as a result of natural oscillations in ocean state or shifts in the frequency or intensity of storms. In general, levels of precaution should be proportional to the amount of information available such that the less that is known about a system, the more precautionary management decisions should be.
- Create complementary and coordinated policies at global, international, national, regional, and local scales, including between coasts and watersheds. Ecosystem processes operate over a range of spatial scales, and thus appropriate scales for management will be goal-specific.
- Maintain historical levels of native biodiversity in ecosystems to provide resilience to both natural and human-induced changes.
- Require evidence that an action will not cause undue harm to ecosystem functioning before allowing that action to proceed.
- Develop multiple indicators to measure the status of ecosystem functioning, service provision and effectiveness of management efforts.
- Involve all stakeholders through participatory governance that accounts for both local interests and those of the wider public.

ACTIONS CONSISTENT WITH ECOSYSTEM-BASED MANAGEMENT

Implementing ecosystem-based management will involve many steps and the use of diverse tools. The following overarching actions are consistent with an ecosystem-based approach to management. Some of these individual steps are already being taken in the U.S. and around the world. However, they have not been implemented in a comprehensive, integrated way. Enough is known now about marine ecosystems to put an ecosystem-based approach into practice immediately.

- Initiate **ecosystem-level planning** that involves multiple stakeholders and takes into account the cumulative impacts of multiple important human activities on ecosystems, as well as the effects of long-term environmental changes.

- Establish **cross-jurisdictional management goals** through formal agreements and mechanisms across local, state, federal and tribal authorities. Goals within ecosystem-based management should reflect interagency management at all levels, as opposed to focusing on specific jurisdictions within an ecosystem (for example, parks, refuges, and sanctuaries).

- Initiate **zoning** of regions of the ocean, for example LMEs, by designating areas for particular allowable uses in both space and time, including networks of fully protected marine reserves and other types of marine protected areas. Zoning that reduces conflict among users of different services should account for and integrate the effects of key activities. This regional planning should be carried out in a comprehensive manner. Area-based management approaches are valuable tools for coordinating the management of multiple uses within the larger land- or seascape context. **Networks of marine reserves** are uniquely capable of protecting biodiversity and habitats, producing the large-bodied individuals who contribute disproportionately to reproductive output, providing insurance against management uncertainties, and providing a benchmark for evaluating the effects of activities outside of reserves.

- Expand and improve the coordination of **habitat restoration** in coastal ecosystems such as wetlands, seagrass beds, and kelp and mangrove forests where habitats have been lost or ecosystem functioning has been diminished. These activities, currently under the purview of a plethora of governmental agencies, should be coordinated in a comprehensive manner that considers their cumulative effects on ocean and coastal ecosystems and includes a rigorous program of research, monitoring and evaluation.

- Adopt **co-management** strategies in which governments (federal, state, local, and tribal) and diverse stakeholders (local resource users, academic and research scientists, conservation interests, community members with traditional knowledge, and other stakeholders) share the responsibility for management and stewardship. Potential advantages include decision-making that is better informed, more flexible, and incorporates traditional ecological knowledge.

- Incorporate **adaptive management** into ecosystem plans as an approach to learning from management actions that allows for scientifically based evaluation, testing of alternate management approaches, and readjustment as new information becomes available from carefully designed monitoring programs. Management should explicitly acknowledge that our current understanding is incomplete and will continue to improve. Likewise, institutions must be adaptable when ecosystems or knowledge change.

- Establish **long-term ocean and coastal observing, monitoring and research** programs to collect continuously and integrate relevant biogeophysical, social, and economic data. These programs are needed to understand better the workings of marine ecosystems, changes in ocean dynamics, and the effectiveness of management decisions.

If you would like to add your name to this statement and are an academic with a PhD or JD degree and based at a US institution, please contact Karen McLeod (karen.mcleod@science.oregonstate.edu)

Citation for this statement:

McLeod, K. L., J. Lubchenco, S. R. Palumbi, and A. A. Rosenberg. 2005. Scientific Consensus Statement on Marine Ecosystem-Based Management. Signed by 219 academic scientists and policy experts with relevant expertise and published by the Communication Partnership for Science and the Sea at http://compassonline.org/?q=EBM.

APPENDIX A: FREQUENTLY ASKED QUESTIONS

WHAT BENEFITS DO HUMANS DERIVE FROM MARINE ECOSYSTEMS?

Humans depend upon oceans and coasts for their existence and well-being. Marine ecosystems benefit humans by providing services such as food (fish, shellfish and seaweed); medicines; water purification; protection of shorelines from erosion and storm damage; control of diseases and pests; nutrient cycling; moderation of climate and weather; recreation; and spiritual, religious and other nonmaterial benefits. The interactions within an ecosystem produce these services. Each ecosystem provides a range of services.

HOW DO HUMANS IMPACT MARINE ECOSYSTEMS?

Humans affect marine ecosystems through a wide variety of activities on land, on the coasts, and in the ocean. The impacts of these activities interact, often in synergistic ways. Land-based activities have major impacts on marine ecosystems via run-off and atmospheric deposition of nutrients and chemical pollutants, alteration of coastal habitats such as wetlands and estuaries, alteration of flows of water and sediment to coastal areas, deposition of marine debris, and global climate change. Among coastal and oceanic activities (such as aquaculture, coastal development, fishing, military activities, and shipping), fishing has the most obvious impact. Ecosystem effects of fishing result from the removal of substantial amounts of life, reduction of the average size and age of individuals within a population (thereby reducing productive capacity), removal of a large percentage of top predators (thereby altering the function of marine food webs), collateral damage to non-target species (often including endangered species) via bycatch, and degradation or destruction of bottom habitats by some fishing gear. These can in turn affect the structure and functioning of ecosystems, reduce productivity of the system, and impede the delivery of services.

IS 'ECOSYSTEM-BASED MANAGEMENT' DIFFERENT FROM 'ECOSYSTEM MANAGEMENT'?

The term "ecosystem management" implies that it is possible to control and manage an entire ecosystem. In view of the fact that humans cannot control ocean currents or most animals within a marine ecosystem, it is scientifically more accurate to speak of "ecosystem-based management" or an "ecosystem approach to management." Ecosystem-based management focuses on managing human activities, rather than deliberately manipulating or managing entire ecosystems.

HOW DOES 'ECOSYSTEM-BASED MANAGEMENT' (EBM) DIFFER FROM 'ECOSYSTEM-BASED FISHERY MANAGEMENT' (EBFM)?

EBM and EBFM are different, but complementary. Managing individual sectors, such as fishing, in an ecosystem context is necessary but not sufficient to ensure the continued productivity and resilience of an ecosystem. Individual human activities should be managed in a fashion that considers the impacts of the sector on the entire ecosystem as well as on other sectors. The longer-term, integrated, cumulative impacts of all relevant sectors on an ecosystem must be evaluated, with a mechanism for adjusting impacts of individual sectors.

APPENDIX B: GENERAL REFERENCES

Bertness, M.D., S.D. Gaines, and M.E. Hay (eds.). 2001. *Marine Community Ecology.* Sinauer, Sutherland, MA.

Chapin III, F.S., E.S. Zavaleta, V.T. Eviners, R.L. Naylor, P.M. Vitousek, H.L. Reynolds, D.U. Hooper, S. Lavorel, O.E. Sala, S.E.Hobbie, M.C. Mack, and S. Diaz. 2000. Consequences of changing biodiversity. Nature 405:234-242.

Christensen, N.L., Bartuska, A.M., Brown, J.H., Carpenter, S.R., D'Antonio, C.M., Francis, R., Franklin, J.F., MacMahon, J.A., Noss, R.F., Parsons, D.J., Peterson, C.H., Turner, M.G., Woodmansee, R.G. 1996. The report of the Ecological Society of America committee on the scientific basis for ecosystem management. Ecological Applications 6:665-691.

Cicin-Sain, B. and R.W. Knecht. 2000. *The Future of US Ocean Policy: Choices for the New Century*. Island Press, Washington DC.

Costanza, R., Andrade, R., Ataunes, P., van den Belt, M., Boersma, D., Boesch, D.F., Catarino, R., Hanna, S., Limburg, K., Low, B., Molitor, M., Pereira, J.G., Rayner, S., Santos, R., Wilson, J., and M. Young. 1998. Principles of sustainable governance of the oceans. Science 281:198-199.

Ecosystem Principles Advisory Panel. 1999. Ecosystem-based fishery management: a report to Congress by the Ecosystem Principles Advisory Panel, National Marine Fisheries Service, Washington DC.

Link, J.S. 2002. What does ecosystem-based fisheries management mean? Fisheries 27:18-21.

Mangel, M., L.M. Talbot, G.K. Meffe, M.T. Agardy, D.L. Alverson, J. Barlow, D.B. Botkin, G. Budowski, T. Clark, J. Cooke, R.H. Crozier, P.K. Dayton, D.L. Elder, C.W. Fowler, S. Funtowicz, J. Giske, R.J. Hofman, S.J. Holt, S.R. Kellert, L.A. Kimball, D. Ludwig, K. Magnusson, B.S. Malayang III, C. Mann, E.A. Norse, S.P. Northridge, W.F. Perrin, C. Perrings, R.M. Peterman, G.B. Rabb, H.A. Regier, J.E. Reynolds III, K. Sherman, M.P. Sissenwine, T.D. Smith, A. Starfield, R.J. Taylor, M.F. Tillman, C. Toft, J.R. Twiss, Jr., J. Wilen, and T.P. Young. 1996. Principles for the conservation of wild living resources. Ecological Applications 6:338-362.

Millennium Ecosystem Assessment. 2005. Island Press, Washington DC; http://www.MAweb.org

NRC (National Research Council). 1999. *Our Common Journey: A Transition Toward Sustainability*. National Academy Press, Washington DC, 363 pp.

NRC (National Research Council). 1999. *Sustaining marine fisheries*. National Academy Press, Washington DC, 184 pp.

Pew Oceans Commission. 2003. *America's Living Oceans: Charting a Course for Sea Change*. Pew Oceans Commission, Arlington, VA.

Pikitch, E.K., C. Santora, E.A. Babcock, A. Bakun, R. Bonfil, D.O. Conover, P. Dayton, P. Doukakis, D. Fluharty, B. Heneman, E.D. Houde, J. Link, P.A. Livingston, M. Mangel, M.K. McAllister, J. Pope, K.J. Sainsbury. 2004. Ecosystem-based fishery management. Science 305:346-347.

Sherman, K., L. M. Alexander, and B. D. Gold, eds. 1990. Large Marine Ecosystems: Patterns, Processes, and Yields. American Association for the Advancement of Science, Washington DC.

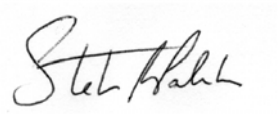
U.S. Commission on Ocean Policy. 2004. *An Ocean Blueprint for the 21st Century*. Final Report of the U.S. Commission on Ocean Policy to the President and Congress, Washington DC.

The following scientists and policy experts have approved this statement. All hold either Ph.D. or J.D. degrees and are based at U.S. academic institutions.[3]

Initial Signatories

Karen L. McLeod
Oregon State University

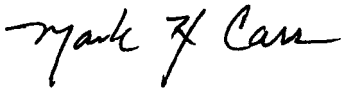
Jane Lubchenco
Oregon State University



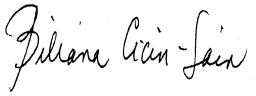
Stephen R. Palumbi
Stanford University

Andrew A. Rosenberg
University of New Hampshire

Donald F. Boesch
University of Maryland



Mark H. Carr
University of California, Santa Cruz



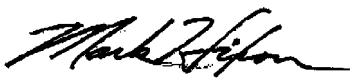
Biliana Cicin-Sain
University of Delaware

David O. Conover
Stony Brook University

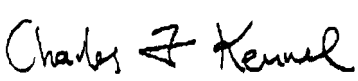
Larry B. Crowder
Duke University

David L. Fluharty
University of Washington

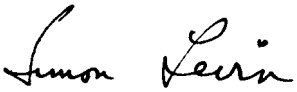
Steven D. Gaines
University of California, Santa Barbara



Mark A. Hixon
Oregon State University



Charles F. Kennel
Scripps Institution of Oceanography



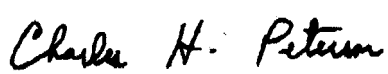
Simon A. Levin
Princeton University

[3] Institutions are listed for purposes of identification only.

Jeffrey S. Levinton
Stony Brook University

Marc Mangel
University of California, Santa Cruz

John C. Ogden
Florida Institute of Oceanography
and University of South Florida

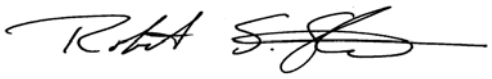


Charles H. Peterson
University of North Carolina, Chapel Hill

Ellen K. Pikitch
University of Miami

Nancy N. Rabalais
Louisiana Universities Marine Consortium

Enric Sala
Scripps Institution of Oceanography



Robert S. Steneck
University of Maine

Robert R. Warner
University of California, Santa Barbara

Additional Signatories

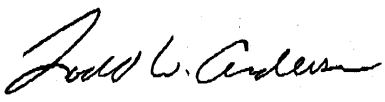
Satie Airamé
University of California, Santa Barbara

Alice Alldredge
University of California, Santa Barbara

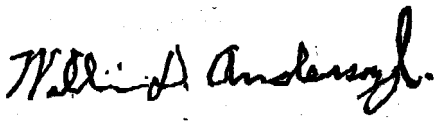
Dennis M. Allen
University of South Carolina

Richard Ambrose
University of California, Los Angeles

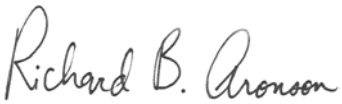
Don Anderson
Woods Hole Oceanographic Institution



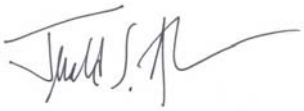
Todd W. Anderson
San Diego State University



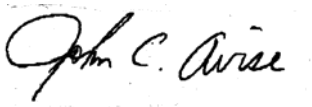
William D. Anderson, Jr.
College of Charleston



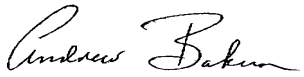
Richard B. Aronson
University of South Alabama



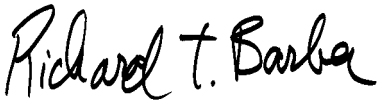
Jerald S. Ault
University of Miami



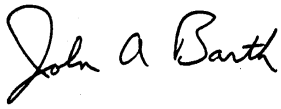
John C. Avise
University of Georgia



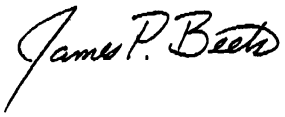
Andrew Bakun
University of Miami



Richard T. Barber
Duke University

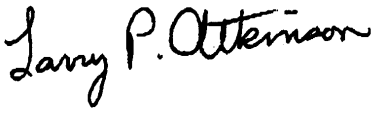


Jack A. Barth
Oregon State University

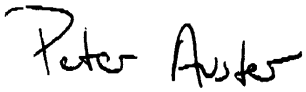


James P. Beets
University of Hawaii at Hilo

Richard S. Appledorn
University of Puerto Rico



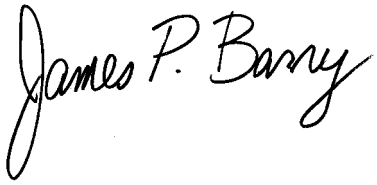
Larry P. Atkinson
Old Dominion University



Peter J. Auster
University of Connecticut

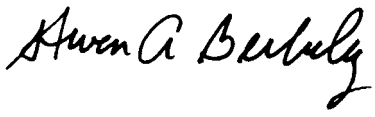
Matthew P. Ayres
Dartmouth College

Paul H. Barber
Boston University



James P. Barry
Monterey Bay Aquarium Research Institute

Robert C. Beardsley
Woods Hole Oceanographic Institution



Steven A. Berkeley
University of California, Santa Cruz

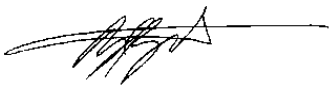
Eric L. Berlow
University of California, San Diego

Mark D. Bertness
Brown University

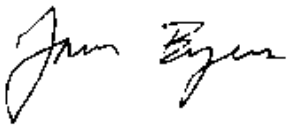
Carol A. Blanchette
University of California, Santa Barbara

P. Dee Boersma
University of Washington

Malcolm J. Bowman
Stony Brook University

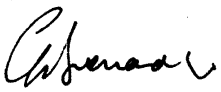


Beth Bryant
University of Washington



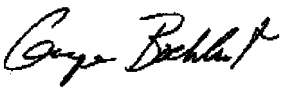
James E. Byers
University of New Hampshire

Stephen R. Carpenter
University of Wisconsin

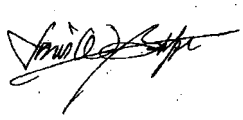


Giacomo Bernardi
University of California, Santa Cruz

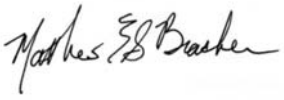
Charles Birkeland
University of Hawaii at Manoa



George Boehlert
Oregon State University

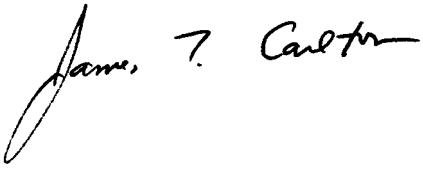


Louis W. Botsford
University of California, Davis

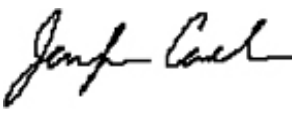


Matthew E. S. Bracken
University of California, Davis

Ronald S. Burton
Scripps Institution of Oceanography



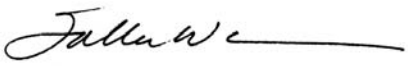
James T. Carlton
Williams College



Jennifer Caselle
University of California, Santa Barbara

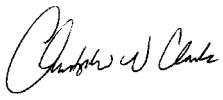
Francis Chan
Oregon State University

Celia Y. Chen
Dartmouth College

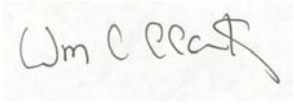


Sallie W. Chisholm
Massachusetts Institute of Technology

Norman L. Christensen, Jr.
Duke University



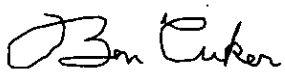
Christopher W. Clark
Cornell University



William C. Clark
Harvard University

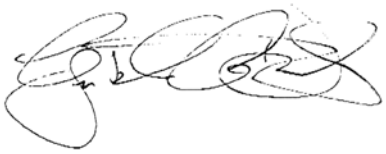
Felicia C. Coleman
Florida State University

Keith R. Cooper
Rutgers University



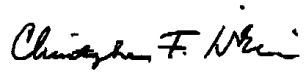
Benjamin E. Cuker
Hampton University

Lisa M. Curran
Yale University

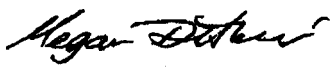


Gretchen C. Daily
Stanford University

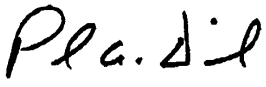
Paul K. Dayton
Scripps Institution of Oceanography



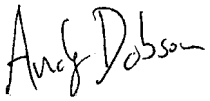
Christopher F. D'Elia
University of South Florida



Megan N. Dethier
University of Washington

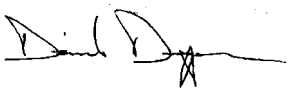


Paul A. Dinnel
Western Washington University

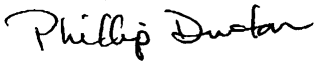


Andrew P. Dobson
Princeton University

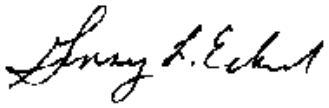
Jenifer E. Dugan
University of California, Santa Barbara



David O. Duggins
University of Washington



Phillip Dustan
College of Charleston

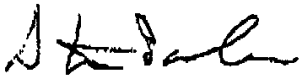


Ginny L. Eckert
University of Alaska, Southeast

Paul R. Ehrlich
Stanford University

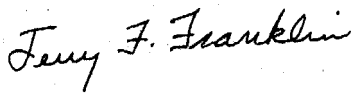
Richard B. Emlet
University of Oregon

Ron J. Etter
University of Massachusetts

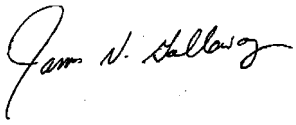


Stephen C. Farber
University of Pittsburgh

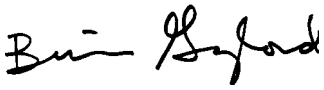
Graham Forrester
University of Rhode Island



Jerry F. Franklin
University of Washington



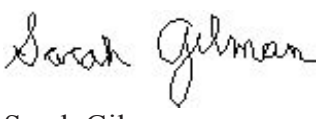
James N. Galloway
University of Virginia



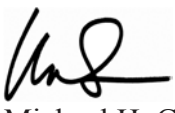
Brian Gaylord
University of California, Davis

Leah Gerber
Arizona State University

Anne E. Giblin
Marine Biological Laboratory, Woods Hole



Sarah Gilman
University of South Carolina



Michael H. Graham
Moss Landing Marine Laboratories,
California State Universities

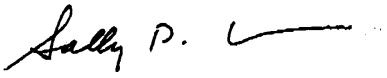
J. Frederick Grassle
Rutgers University

Charles H. Greene
Cornell University

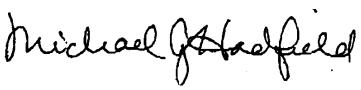
Nancy B. Grimm
Arizona State University

Richard K. Grosberg
University of California, Davis

Donald R. Gunderson
University of Washington



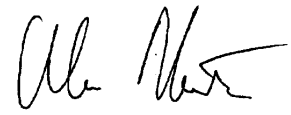
Sally D. Hacker
Oregon State University



Michael G. Hadfield
University of Hawaii at Manoa

Benjamin S. Halpern
University of California, Santa Barbara

C. Drew Harvell
Cornell University



Alan Hastings
University of California, Davis

Mark E. Hay
Georgia Institute of Technology

Brian Helmuth
University of South Carolina

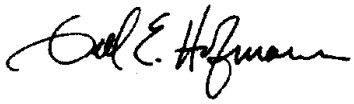
Selina Heppell
Oregon State University

Scott A. Heppell
Oregon State University

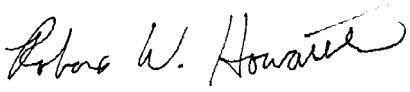
Carlton H. Hershner
Virginia Institute of Marine Science

Helen Hess
College of the Atlantic

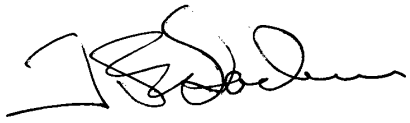
John E. Hobbie
Marine Biological Laboratory, Woods Hole



Gretchen E. Hofmann
University of California, Santa Barbara

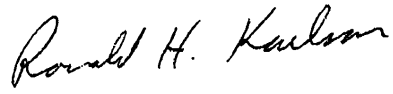


Robert W. Howarth
Cornell University



Jeremy B. C. Jackson
Scripps Institution of Oceanography

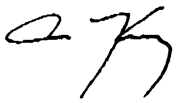
Peter A. Jumars
University of Maine



Ronald H. Karlson
University of Delaware

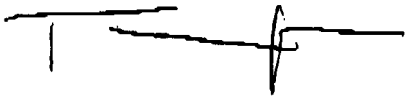
Les Kaufman
Boston University

Judith T. Kildow
California State University, Monterey Bay

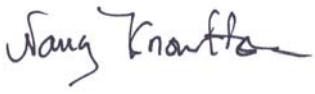


Ann Kinzig
Arizona State University

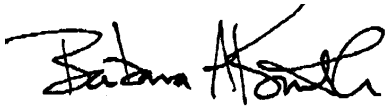
Bjorn Kjerfve
Texas A & M University



Terrie Klinger
University of Washington



Nancy Knowlton
Scripps Institution of Oceanography



Barbara A. Knuth
Cornell University

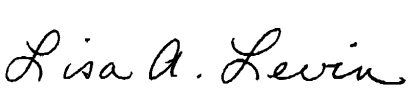
Mimi A.R. Koehl
University of California, Berkeley

Christopher C. Koenig
Florida State University

Gordon H. Kruse
University of Alaska, Fairbanks

Rikk Kvitek
California State University, Monterey Bay

Hunter S. Lenihan
University of California, Santa Barbara

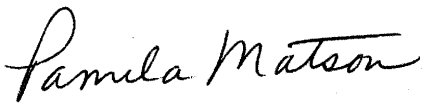


Lisa A. Levin
Scripps Institution of Oceanography

David E. Lincoln
University of South Carolina

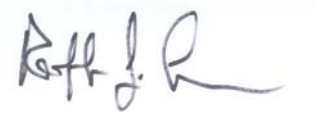
Milton Love
University of California, Santa Barbara

Lawrence P. Madin
Woods Hole Oceanographic Institution



Pamela Matson
Stanford University

Jerry McCormick-Ray
University of Virginia



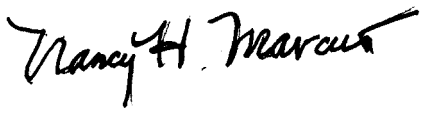
Ralph J. Larson
San Francisco State University

Heather Leslie
Princeton University

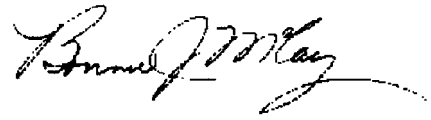
Gene E. Likens
Institute of Ecosystem Studies

Romuald N. Lipcius
Virginia Institute of Marine Science

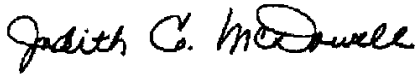
Christopher Lowe
California State University, Long Beach



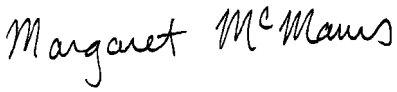
Nancy H. Marcus
Florida State University



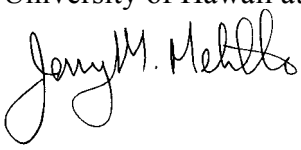
Bonnie J. McCay
Rutgers University



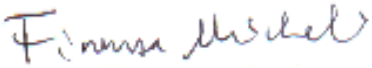
Judith E. McDowell
Woods Hole Oceanographic Institution



Margaret Anne McManus
University of Hawaii at Manoa



Jerry M. Melillo
Marine Biological Laboratory, Woods Hole

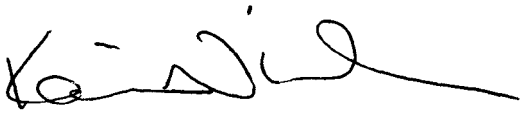


Fiorenza Micheli
Stanford University

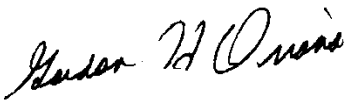
Kristen L.D. Milligan
Oregon State University

Steven G. Morgan
University of California, Davis

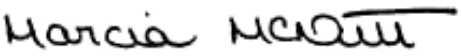
Roz L. Naylor
Stanford University



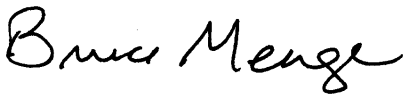
Karina J. Nielsen
Sonoma State University



Gordon H. Orians
University of Washington

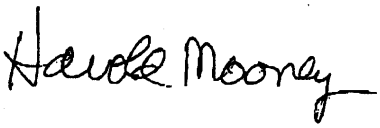


Marcia K. McNutt
Monterey Bay Aquarium Research Institute



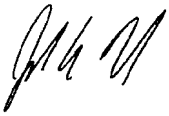
Bruce A. Menge
Oregon State University

Kathy Ann Miller
University of California, Berkeley



Harold Mooney
Stanford University

Steven N. Murray
California State University, Fullerton

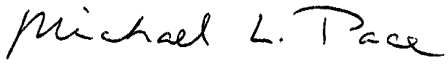


Joseph E. Neigel
University of Louisiana-Lafayette

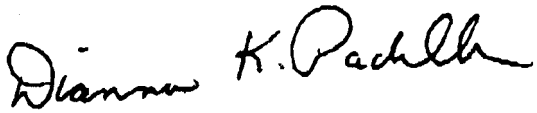
Mark D. Ohman
Scripps Institution of Oceanography

Gail Osherenko
University of California, Santa Barbara

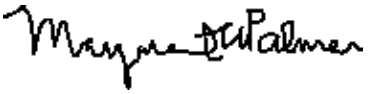
David W. Owens
College of Charleston



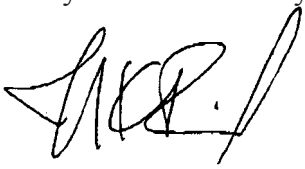
Michael L. Pace
Institute of Ecosystem Studies



Dianna K. Padilla
Stony Brook University



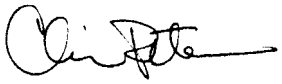
Margaret A. Palmer
University of Maryland



Julia K. Parrish
University of Washington

Gustav Paulay
University of Florida

Linwood H. Pendleton
University of California, Los Angeles



Christopher W. Peterson
College of the Atlantic

Catherine Ann Pfister
University of Chicago

Stuart L. Pimm
Duke University

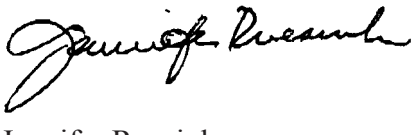
Mary E. Power
University of California, Berkeley

H. Ron Pulliam
University of Georgia

G. Carleton Ray
University of Virginia

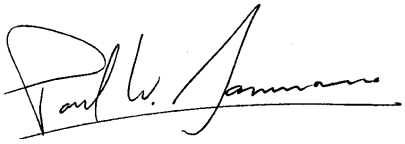
Robert H. Richmond
University of Hawaii at Manoa

Alison Rieser
University of Maine School of Law



Jennifer Ruesink
University of Washington

J.B. Ruhl
Florida State University of College of Law

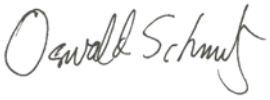


Paul W. Sammarco
Louisiana Universities Marine Consortium

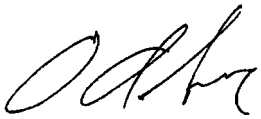
Gorka A. Sancho
College of Charleston

Eric Sanford
University of California, Davis

Donald Scavia
University of Michigan

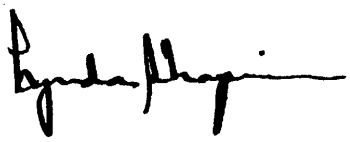


Oswald J. Schmitz
Yale University



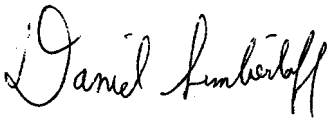
David H. Secor
University of Maryland

Alan Shanks
University of Oregon



Lynda P. Shapiro
University of Oregon

Sandra E. Shumway
University of Connecticut

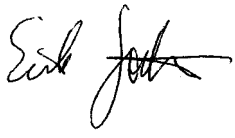


Daniel Simberloff
University of Tennessee

Craig R. Smith
University of Hawaii at Manoa

L. David Smith
Smith College

George N. Somero
Stanford University



Erik E. Sotka
College of Charleston

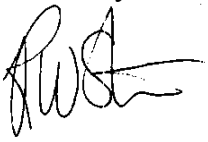
Wayne P. Sousa
University of California, Berkeley

J. Gustave Speth
Yale University

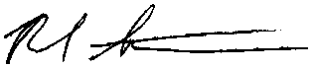
Su Sponaugle
University of Miami

John J. Stachowicz
University of California, Davis

Eleanor Sterling
American Museum of Natural History

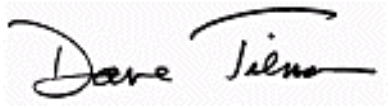


Robert W. Sterner
University of Minnesota



Richard R. Strathmann
University of Washington

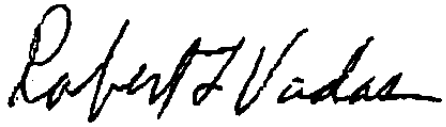
William J. Sydeman
Scripps Institution of Oceanography



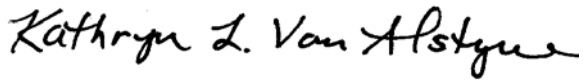
G. David Tilman
University of Minnesota

Sean K. Todd
College of the Atlantic

Alan R. Townsend
University of Colorado, Boulder



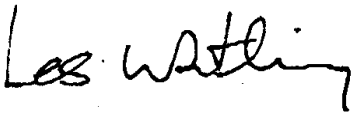
Robert L. Vadas
University of Maine



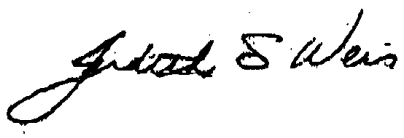
Kathryn L. Van Alstyne
Western Washington University

Cindy Lee Van Dover
College of William and Mary

Libe Washburn
University of California, Santa Barbara



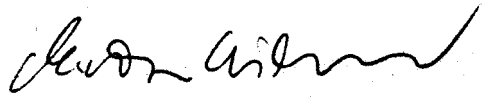
Les Watling
University of Maine



Judith S. Weis
Rutgers University

Gerald M. Wellington
University of Houston

Ali Whitmer
University of California, Santa Barbara



Martin Wikelski
Princeton University

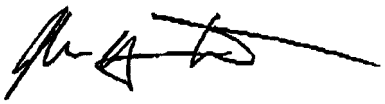
Susan L. Williams
University of California, Davis

A.O. Dennis Willows
University of Washington

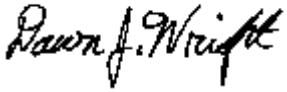
James Wilson
University of Maine

Jon D. Witman
Brown University

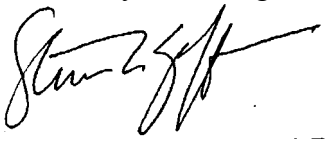
Sarah Ann Woodin
University of South Carolina



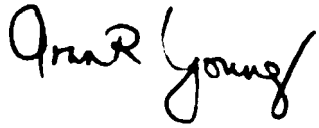
J. Timothy Wooton
University of Chicago



Dawn J. Wright
Oregon State University



Steven L. Yaffee
University of Michigan



Oran R. Young
University of California, Santa Barbara

Joy Zedler
University of Wisconsin

Richard G. Zingmark
University of South Carolina