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An Annotated Bibliography

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UNIVERSITY OF FLORIDA

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Economics of Harmful Algal Blooms (HABs):

An Annotated Bibliography

by

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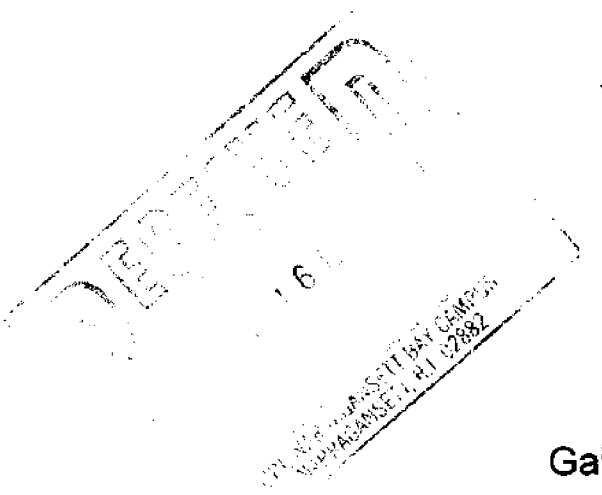

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INTRODUCTION

Harmful Algal Blooms or HABs), including red tides, occur when the population of a particular marine algal species rapidly increases. With this "bloom", toxins produced by these algae likewise increase and can result in shellfish contamination, fish kills, and create respiratory irritation for humans located near the shoreline. The biological losses associated with a HAB are compounded by the economic costs borne by the affected local residents, tourists, government, and businesses.

Regions experiencing a HAB may incur losses and expenditures due to the environmental effects caused by the HAB. Losses and expenditures in the form of commercial fishery losses, reduced tourist expenditures, clean-up costs, and health related expenditures are some of the more common economic effects. These impacts can result in further negative economic impacts throughout the local economy as industry sectors closely linked to marine-related activities absorb the resultant loss in business activities. The economic consequences of a HAB can also produce "halo" effects in which products and regions not affected by a HAB are also negatively impacted.

The purpose of this bibliography is to briefly outline literature which addresses HAB economic impacts. Few stand alone economic studies exist that provide estimates of HAB economic impacts. Much of the economic estimates available in the literature are from scientific studies on HABs (i.e. scientific journal articles). Generally, these estimates are formed by HAB scientists in appreciation of the economic effects of the HAB under investigation. Studies which provide an in-depth economic survey of HABs are few and include the comprehensive studies by Anderson et al. (1998) and Kahn and Rockel (1988).

This document does not provide a complete listing of all HAB economic impact literature. HAB economic analyses are very disaggregate since most estimates are formed within the context of a larger scientific investigation. Local and state agencies also calculate HAB economic impacts for regional uses. Given these limitations, it is highly probable that many estimates were overlooked and not included herein. Nevertheless, the goal was to provide a thorough listing of the U.S. HAB economic impact literature. Although not included in this bibliography, literature on oil spill impacts and other coastal externalities can be useful resources in evaluating HAB economic impacts.

FORMAT

Citations are presented in a brief format with title, author, source, and year. An economic abstract is given for each article. The review spans from the 1970s to late 1990s and includes only U.S. sources. The abstract briefly highlights only the economic content of the document. Hence, in most cases, the abstract does not accurately represent an overall synopsis of the work. It is important to keep in mind date of publication when considering loss estimates given the time value of money (i.e. a dollar 15 years ago is worth more than a dollar today). Citations are presented in chronological order - with most recent works presented first.

Citations

TITLE: Harmful Algal Blooms in Florida.
AUTHOR: Steidinger, K.A., J.H. Landsberg, C.R. Tomas, and J.W Burns.
SOURCE: Harmful Algal Bloom Task Force Technical Advisory Group.
YEAR: 1999
ABSTRACT: Technical resource report submitted to Florida Harmful Algal Bloom Task Force. Description of six HAB types. *Gymnodinium Breve* identified as most serious HAB for Florida with an estimated minimum $15-25 million in economic losses each year.

TITLE: Status of U.S. Harmful Algal Blooms: Progress Towards a National Program.
AUTHOR: Federal Interagency Report - Department of Commerce and National Oceanic and Atmospheric Administration (NOAA).
SOURCE: National Oceanic and Atmospheric Administration Document
YEAR: 1998
ABSTRACT: Document prepared in response to House Committee on Appropriations request to outline interagency efforts and progress in HAB research. Brief section on economic impacts reports losses of $100 million per year nationally due to HABs. Other cited figures include losses of $50 million annually due to PSP contamination in Alaska shellfish; domoic acid intoxication of clams and crabs in Oregon and Washington State resulting in losses of $15-20 million in 1991; $7 million in losses due to a 1980 PSP outbreak in Maine; and $20 million in losses per each *G. Breve* bloom that occurs in southwest Florida based on the 1974 study by Habas and Gilbert.

TITLE: Harmful Algal Bloom and Hypoxia Research and Control Act of 1998.
AUTHOR: Report of the Senate Committee on Commerce, Science, and Transportation.
SOURCE: 105th Congress Calender No. 667, Report 105-357, U.S. Government Printing Office, Washington D.C.
YEAR: 1998
ABSTRACT: Concise description of HABs and their economic impacts at the national level. Preliminary estimates presented in report are $45 million in average annual impacts nationally over 1987-1993 period. Including "multiplier" effects these impacts are stated to exceed $100 million per year ($1 billion/decade). Methods of impact calculation not discussed

TITLE: *Pfiesteria*'s Economic Impact on Seafood Industry Sales and Recreational Fishing.
AUTHOR: Lipton, D.W.
SOURCE: Unpublished Manuscript. Presented at Pfiesteria: Where Do We Go From Here? - Center for Agriculture and Natural Resource Policy Conference, University of Maryland Center for Agriculture and Natural Resource Policy
YEAR: 1998
ABSTRACT: Report of survey conducted to measure the effects of negative publicity on seafood sales. An estimated $43 million in sales were lost due to public concern for seafood safety in 1997. The author recognizes this effect may be distributional in that substitutes for seafood may have enjoyed increased sales. Impacts to the recreational fishing industry were also evaluated using the National Marine Fisheries Service Recreational Fishing Survey

TITLE: Estimated Annual Economic Impacts Resulting from Harmful Algae Blooms (HABs) in the United States.
AUTHOR: Anderson, D.M., P. Hoagland, Y. Kaoru, and A.W. White.
SOURCE: Unpublished manuscript. Woods Hole Oceanographic Institution. Woods Hole, MA.
YEAR: 1998
ABSTRACT: Comprehensive effort to quantify economic losses of HAB events. Loss estimates determined from published data, local expert correspondence and personal communication. Annual economic impacts for the U.S. over the 1987-92 period were calculated at $20 million in public health impacts, $10 million in commercial fishery impacts, $6 million in recreation/tourist impacts, and $2.5 million in monitoring/management impacts. The authors recognize the lack of economic studies on HABs and the potential need for a true economic cost study.

TITLE: Harmful Algal Blooms in Coastal Waters: Options for Prevention, Control, and Management.
AUTHOR: Boesch, D.F., D.M. Anderson, R.A. Horner, S.E. Shumway, P.A. Tester, T.E. Whitledge
SOURCE: NOAA Coastal Ocean Program, Decision Analysis Series No. 10.
YEAR: 1997
ABSTRACT: Document focusing on management of HABs. Assessment conducted through three regional meetings in Texas, Washington, and Florida. Options to prevent, control, and mitigate HAB impacts in the subject regional areas are discussed and evaluated. The panels' recognized a consistent lack of regional economic impact assessments and a need to examine the types of impacts produced.

TITLE: The Ecology and Oceanography of Harmful Algal Blooms
AUTHOR: Anderson, D.M., and D.J. Garrison (Eds.)
SOURCE: Limnology and Oceanography Journal. v. 42 n.5 pt.2.
YEAR: 1997
ABSTRACT: Entire issue devoted to HABs. Primary focus on biology of HABs with some mention of economic impact. Noteworthy articles include: a comprehensive discussion of *G. Breve* red tide blooms by P.A. Tester and K.A. Steidinger; a good preface describing HABs and the recent evolution of research in this area; and an article by Burkholder and Glascow addressing *Pfiesteria* biology and impacts (including a brief economic discussion). Most HAB U.S. experts contributed articles to this document.

TITLE: Turning Back the Harmful Red Tide
AUTHOR: Anderson, D.M..
SOURCE: Nature, v.388, pp.513-14.
YEAR: 1997
ABSTRACT: Along with Boesch et al.(1997), one of few articles that discuss control and management of HABs rather than biology and ecology of the organism.

TITLE: Economic Impact of Neuse River Closure on Commercial Fishing.
AUTHOR: Diaby, S.
SOURCE: Unpublished Manuscript. North Carolina Division of Marine Fisheries
YEAR: 1996
ABSTRACT: Analysis with data from Division of Marine Fisheries Trip Ticket Program and personal interviews. Primary impacts from a 1995 *Pfiesteria* outbreak were decreased purchases of seafood products by surveyed dealers. Dealer purchases went from 73 percent of total commercial catch to 47 percent of total catch after the infestation.

TITLE: ECOHAB: The Ecology and Oceanography of Harmful Algal Blooms - A National Research Agenda
AUTHOR: Anderson, D.M. (Workshop Chair)
SOURCE: Woods Hole Oceanographic Institution, Woods Hole, MA.
YEAR: 1995
ABSTRACT: Document outlining goals and objectives of the national ECOHAB program and its respective elements. Section on economic impacts summarizes the findings of several HAB economic assessments including many cited here.

TITLE: Toxic Algae Contamination and Demand for Shellfish: A Case Study of Demand for Mussels in Montreal
AUTHOR: Wessells, C.R., C.J. Miller, P.M. Brooks.
SOURCE: Marine Resource Economics. V. 10, pp. 143-159
YEAR: 1995
ABSTRACT: Estimation of shellfish demand model considering effects of a domoic acid contamination. Ordinary least squares (OLS) demand models were estimated regressing negative and positive contamination article counts on quantity demanded. Demand was found significantly affected by information variables (e.g. news articles) that report on contamination.

TITLE: The Algal Bloom Problem in Australian Waterways: An Economic Appraisal
AUTHOR: Herath, G.
SOURCE: Review of Marketing and Agricultural Economics. v. 63, n. 1, pp.77-86.
YEAR: 1995
ABSTRACT: Evaluation of Algal Bloom Problems from a classic externality perspective. Economic agents which dispose of phosphorus in waterways cause external effects upon other users of water through algal blooms. The paper discusses the potential of various externality policy instruments including property rights, taxes, water pricing and tradeable permits. Principles are more applicable to fresh water environments where fertilizer use is more directly linked to algal blooms.

TITLE: Estimated Costs of Paralytic Shellfish, Diarrhetic Shellfish and Ciguatera Poisoning in Canada
AUTHOR: Todd, E.C.D.
SOURCE: In P. Lassus et al. (eds). Harmful Marine Algal Blooms. Lavoiser Intercept Ltd., pp. 831-834.
YEAR: 1995.
ABSTRACT: Study of the medical and labor productivity costs associated with three forms of seafood poisoning: PSP, DSP, and Ciguatera. Combined, there is approximately 525 annual cases of these seafood illnesses in Canada. The

annual medical costs associated with these cases is $670,000. In addition, product monitoring and analytical costs run $3.3 million annually.

TITLE: Noxious Phytoplankton Blooms and Marine Salmon Culture in Puget Sound, Washington.
AUTHOR: Horner, R.A., J.R. Postel, and J.E. Rensel
SOURCE: In J.R. Forbes (ed.), Pacific Coast Research on Toxic Marine Algae. Canadian Technical Report on Hydrographic Ocean Science. v.135, pp. 59-61.
YEAR: 1991
ABSTRACT: Similar to the case reported in Rensel et al. (1989), in some years HABs have impacted salmon aquaculture in British Columbia and Washington State causing $4 to $5 million in losses per year.

TITLE: An Expatriate Red Tide Bloom: Transport, Distribution, and Persistence
AUTHOR: Tester, P.A., R.P. Stumpf, F.M. Vukovich, P.K. Fowler, and J.T. Turner.
SOURCE: Limnology and Oceanography. v.36. pp. 1053-1061
YEAR: 1991
ABSTRACT: A red tide (*G. Breve*) bloom which typically affects S.W. Florida was transported via the Gulf Stream to the North Carolina coast in 1987-88. Approximately 50 percent of oyster and 95-98 percent of clamming waters were closed. Economic losses to the local area were estimated at $25 million.

TITLE: A Review of the Effects of Algal Blooms on Shellfish and Aquaculture.
AUTHOR: Shumway, S.E.
SOURCE: Journal of the World Aquaculture Society. v. 21. pp. 65-104.
YEAR: 1990
ABSTRACT: A comprehensive review of the HAB problem with focus on their shellfish and aquaculture effects. The paper includes a section on "Economic Threat" and provides a summary of reported economic loss estimates in a table format. The economic loss estimates reported in the Shumway table are generally from biologically oriented papers. Also, the document gives a brief summary of the HAB economic loss literature included in the table.

TITLE: Auditing the Impact of Toxic Algal Blooms on Oysters
AUTHOR: Shumway, S.E., J. Barter and S. Sherman-Caswell
SOURCE: Environmental Auditor. v. 2, n.1, pp. 41-56
YEAR: 1990
ABSTRACT: Includes a table and discussion summarizing HAB induced economic loss estimates to the oyster industry. Presentation of economic loss estimates in table format similar to Shumway (1990).

TITLE: Effects of Phytoplankton Blooms on Salmon Aquaculture in Puget Sound, Washington: Initial Research
AUTHOR: Rensel, J.E., R.A. Horner, and J.R. Postel
SOURCE: Northwest Environmental Journal. v.5, pp.53-69
YEAR: 1989
ABSTRACT: A HAB affected salmon aquaculture resulting in a loss of approximately 250,000 salmon in 1987. This fish kill equates to roughly $500,000 in economic losses.

TITLE: Measuring the Economic Effects of Brown Tides
AUTHOR: Kahn, J. and M. Rockel
SOURCE: Journal of Shellfish Research. v. 7, n. 4, pp.677-682.
YEAR: 1988
ABSTRACT: Perhaps the only paper which analyzes HAB economic costs through development of an economic welfare measure, or partial equilibrium model. The sum of consumer and producer surplus measures are developed through estimation of a supply and demand function for a commercial bay scallop industry in New York. The brown tide could potentially eliminate the bay scallop industry valued at approximately $1.99 million. Calculation of economic surplus measures account for people that value the resource above the market price and considers the opportunity cost of resources used in the industry. Ways to address losses to the recreational sector are discussed

TITLE: PSP Toxins in the Pacific Coast States: Monitoring Programs and Effects on Bivalve Industries
AUTHOR: Nishitani, L. and K. Chew
SOURCE: Journal of Shellfish Research. v. 7. pp. 653-669.
YEAR: 1988
ABSTRACT: This article documents the PSP problem in the Pacific coastal states. The effect PSP HABs have on shellfish industries within these states is outlined and discussed.

TITLE: Paralytic Shellfish Poisoning in Maine: Monitoring a Monster
AUTHOR: Shumway, S.E., S. Sherman-Caswell, and J. Hurst.
SOURCE: Journal of Shellfish Research. v.7, pp. 643-652
YEAR: 1988
ABSTRACT: Account of PSP outbreaks in Maine. The 1980 outbreak caused an estimated $7 million in costs. Similar, or even more severe, PSP outbreaks have occurred with some frequency in Maine.

TITLE: Various
AUTHOR: Various
SOURCE: Journal of Shellfish Research.. v. 7, n. 4.
YEAR: 1988
ABSTRACT: This issue is devoted to HABs. Outside of Kahn and Rockel (above), other articles in this issue address biological aspects of HABs

TITLE: Economic Impact of Paralytic Shellfish Poison on the Oyster Industry in the Pacific United States
AUTHOR: Conte, F.S.
SOURCE: Aquaculture. v. 39. pp. 331-343.
YEAR: 1984
ABSTRACT: General discussion of PSP factors that affect the oyster market. Means by which PSP can affect the west coast shellfish industry are examined in detail. A 1980 PSP outbreak in California is used as a case study. Good discussion on need for education and monitoring to assure nonaffected products and nonaffected geographic areas are not disparaged.

TITLE: Alaska's Shellfish Industry
AUTHOR: Neve, R.A., and P.B. Reichardt.
SOURCE: In E.P. Ragelis (ed.) Seafood Toxins. American Chemical Society Symposium. Series 262. Washington, D.C. pp. 53-58.
YEAR: 1984
ABSTRACT: Discusses opportunity costs due to persistent HAB presence. Alaska's shellfish industry is unable to develop due to PSP contamination resulting in an estimated $50 million annually in forgone economic benefit. The inability to develop and utilize this resource due to PSP contamination is one of few HAB opportunity costs discussed in literature. The HAB in this case prevents the opportunity to develop the Alaska shellfish industry.

TITLE: A preliminary investigation of the Economic Effects of the HAB of 1973-1974 on the West Coast of Florida.
AUTHOR: Habas, E.J. and C. Gilbert
SOURCE: In Proceedings of the First International Conference on the Toxic Dinoflagellate Blooms, V.R. Lo Ciero (ed.) The Massachusetts Science and Technology Foundation.
YEAR: 1975
ABSTRACT: Economic loss estimates of the 1971 and the 1973-74 red tide (*G. Breve*) outbreaks in southwest Florida. Estimation methods included personal interview, review of publications, and accountant records. Total costs of the 1971 Florida red tide was estimated at $20 million. Approximately $18.5 million of this total were tourist related losses. The additional $1.5 million in losses were from commercial fisheries and from businesses that

service and supply the hotel/motel industry. The article also provides descriptions of the affected sectors (e.g. clean-up, tourist industry, public health, etc.).

TITLE: The Economic Halo of a HAB
AUTHOR: Jensen, A.C.
SOURCE: In Proceedings of the First International Conference on the Toxic Dinoflagellate Blooms, V.R. Lo Ciero (ed.) The Massachusetts Science and Technology Foundation
YEAR: 1975
ABSTRACT: Detailed discussion of the economic consequences of a red tide event on unaffected regions and products. Case study of the 1972 New England red tide that affected the shellfish market not only in New England but in other unaffected states as well (e.g. New York). Paper examines consumer overreaction, economic implications, and information system policies.

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