

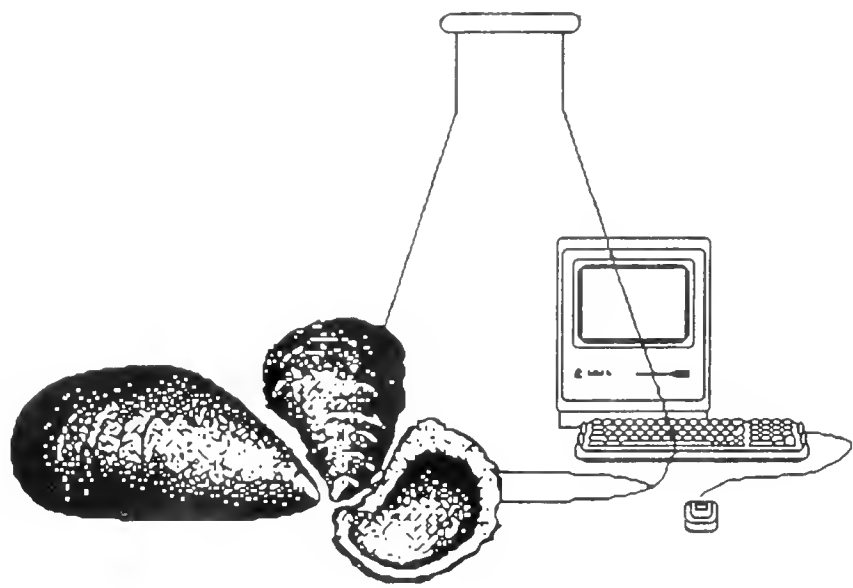
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NOAA Technical Memorandum NOS ORCA 63

**National Status and Trends Program  
for Marine Environmental Quality**



**Mussel Watch Worldwide Literature Survey - 1991**



Rockville, Maryland  
November, 1991

**noaa** NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

National Ocean Service  
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Coastal Monitoring and Bioeffects Assessment Division  
Office of Ocean Resources Conservation and Assessment  
National Ocean Service  
National Oceanic and Atmospheric Administration  
U. S. Department of Commerce  
Rockville, Maryland

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## Notice

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NOAA Technical Memorandum NOS ORCA 63

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Adriana Y. Cantillo



Rockville, Maryland  
November, 1991

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# Mussel Watch Worldwide Literature Survey - 1991

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## ABSTRACT

The NOAA National Status and Trends Program includes the Mussel Watch Project in which mussels or oysters and sediments are collected from more than 240 sites in U. S. coastal waters. The bivalves and sediments are analyzed for more than 70 analytes including organic chemicals, selected major and minor elements, and ancillary parameters. This bibliography is the result of the compilation of a comprehensive collection of worldwide literature on the use of marine mussels or oysters as sentinel organisms for the study of coastal contamination. Information gathered will be used to compare results with those of the NS&T Mussel Watch Project. Five electronic bibliographical databases were searched and extensive manual searching was done to compile more than 1200 citations. An extensive index of species name, geographical location and analytes is included.

## I. INTRODUCTION

One of the principal components of the NOAA National Status and Trends (NS&T) Program is the Mussel Watch Project in which mussels or oysters and sediments are collected from more than 240 sites in U. S. coastal waters. The bivalves and sediments are analyzed for a large suite of organic chemicals, selected major and minor elements, and ancillary parameters. The more than 70 analytes are listed in Table 1. The Mussel Watch Project is currently in its 6th year of operation. Descriptions of the program, sampling sites, and analytical results have been published. Current information on the NS&T Program can be obtained by writing the National Status and Trends Program.

The purpose of this bibliographic search is to compile a comprehensive collection of worldwide literature on the use of marine mussels or oysters as sentinel organisms for the study of coastal contamination. This compilation will be used to compare the results of such studies to those of the NS&T Mussel Watch Project.

## II. DESCRIPTION OF LITERATURE SEARCH

Five electronic bibliographical databases in the DIALOG<sup>1</sup> system were searched in March of 1991 (Table 2). They were: BIOSIS PREVIEWS, CA SEARCH, NTIS, OCEANIC ABSTRACTS and AQUATIC SCIENCE ABSTRACTS. The complete description of these databases, including the journals and other types of publications abstracted, as well as time coverage, can be found in the DIALOG "blue sheets" and chapter descriptions. CA SEARCH is the electronic equivalent of Chemical Abstracts, while AQUATIC SCIENCE ABSTRACTS is that of Aquatic Science Abstracts, and BIOSIS PREVIEWS is that of

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<sup>1</sup> DIALOG is available worldwide. In the United States, contact Dialog Information Services, Inc., 800 334 2564. Outside the United States, contact Dialog International Marketing, telex 334499, fax 415 858 7069.

Biological Abstracts. NTIS is prepared by the U. S. Dept. of Commerce and has no equivalent printed form. In addition, manual searching of Chemical Abstracts was done covering volumes 1 (1907) through 115 (issue 10) (1991). Major investigators in the field of marine mussel watch studies worldwide have been contacted for comments and suggestions.

The search strategy was designed to select citations mentioning mussels or oysters and any of the chemicals found in Table 1. The name and Chemical Abstracts Registry numbers of all the chemicals were used in the search strategy. The search was limited to citations in English. The major and trace element search was limited to citations published after 1976 due to the large number of entries found. As the compilation progressed, however, papers on other environmentally significant chemicals (such as dioxins), papers and reports in languages other than English, and older citations, were

Table 1. Chemicals determined as part of the NOAA National Status and Trends Program

<b>Polycyclic aromatic hydrocarbons</b>	<b>Chlorinated pesticides other than DDT</b>				
Biphenyl	Aldrin		Dieldrin		
Naphthalene	cis-Chlordane		trans-Nonachlor		
1-Methylnaphthalene	Heptachlor		Lindane		
2-Methylnaphthalene	Heptachlor epoxide		Mirex		
2,6-Dimethylnaphthalene	Hexachlorobenzene				
Acenaphthene	<b>Polychlorinated biphenyls</b>				
Acenaphthylene	PCB-8      PCB-18      PCB-28				
1,6,7-Trimethylnaphthalene	PCB-44      PCB-52      PCB-66				
Fluorene	PCB-101      PCB-105      PCB-118				
Phenanthrene	PCB-128      PCB-138      PCB-153				
1-Methylphenanthrene	PCB-179      PCB-180      PCB-187				
Anthracene	PCB-195      PCB-206      PCB-209				
Fluoranthene	<b>Elements</b>				
Pyrene	Ag	As	Cd	Cr	Cu
Benz(a)anthracene	Hg	Ni	Pb	Sb	Se
Chrysene	Sn	Zn			
Benzo[a]pyrene	<b>Tributyltin species</b>				
Benzo[e]pyrene	Tributyltin [bis(tri-n-butyltin)oxide]				
Perylene	Dibutyltin (degradation product)				
Dibenz[a,h]anthracene	Monobutyltin (degradation product)				
Benzo[b]fluoranthene					
Benzo[k]fluoranthene					
Indeno[1,2,3-cd]pyrene					
Benzo[g,h,i]perylene					
<b>DDT and metabolites</b>					
2,4'-DDD	4,4'-DDD				
2,4'-DDE	4,4'-DDE				
2,4'-DDT	4,4'-DDT				

Table 2. Databases searched

Database	Time coverage	Producer
AQUATIC SCIENCE ABSTRACTS	1978-1991	Cambridge Scientific Abstracts
BIOSIS PREVIEWS	1969-1991	BIOSIS, Inc.
CASEARCH	1967-1991	American Chemical Society
NTIS	1983-1991	National Technical Information Services
OCEANIC ABSTRACTS	1964-1991	Cambridge Scientific Abstracts

added to the database. Extensive use was made of the Mussel Watch studies literature compilation of Kidder (1977). Future updates of the search will include non-English citations and searches of other electronic databases.

### III. NOAA MUSSEL WATCH BIBLIOGRAPHIC DATABASE

The results of the electronic search were edited for relevancy to the Mussel Watch concept and entered into the Apple Macintosh version of PRO-CITE<sup>2</sup>, a bibliographic software system. The database resides at the NOAA National Ocean Service/Office of Ocean Resources Conservation and Assessment/Coastal Monitoring and Bioeffects Assessment Division (CMBAD), and will be updated on an ongoing basis.

When available, scientific species name, geographical location of the study, and chemicals have been added to the citation as index terms. In many instances, the bivalve species is not available either in the abstract or the key words stored in the electronic database. In such cases, only the generic terms "mussel" or "oyster" are found. The citation information has been checked against a printed source whenever possible to correct errors resulting from limitations of the electronic databases,<sup>3</sup> and refine index terms. Organometallic species are listed as families. All the tributyltin compounds, for example, are indexed under organotins. If a paper covers a specific geographical area, then the location name, state/province and country were used in the index. For example, papers on Port Phillip Bay are indexed under the Bay name, Victoria and Australia. Papers covering large geographical areas such as synthesis papers of French or U. S. Mussel Watch Programs, are indexed using only the name of the country.

This compilation contains more than 1200 citations. Printed copies of the citations in the database are being collected at the Coastal Monitoring and Bioeffects Assessment Division office in Rockville, MD.

### IV. RESULTS AND OBSERVATIONS

<sup>2</sup> PRO-CITE, Personal Bibliographic Software, Inc., PO Box 4250, Ann Arbor, MI 48106.

<sup>3</sup> BIOSIS, one of the electronic databases covering the field of biology, lists some older citations in capital letters, omitting the use of italics or underlining for species names, and adding or omitting words in the titles.

The "classic" Mussel Watch studies of the 1970's in the United States were performed using the common blue mussel, *Mytilus edulis*, or the American oyster, *Crassostrea virginica*. These species are not available worldwide or indeed U. S.-wide. Therefore, other sentinel organisms, including various species of mussels (i.e., *Mytilus galloprovincialis*, *Mytilus californianus*, *Modiolus modiolus*, *Perna viridis*, and others), and oysters (i.e., *Crassostrea edulis*, *Crassostrea gigas*, and others) have been used. In cases where these mussels or oysters were not available, other molluscan species have been sampled but papers based on such samples have not been included in this bibliographic database. An exception is the case of the use of *Arca zebra* (commonly known as the turkey wing) in tropical waters since mussels and oysters are not found in large populations in some of these areas. The species cited in the bibliographic database are listed in Table 3.

Mussel Watch studies in freshwater bodies, such as those in the Great Lakes (North America), Lake Balaton (Hungary), and other locations, have not been included in the bibliographic database.

Complete citation information and citation number are listed in Appendix I in alphabetical order of the first author. The citation number is listed to the left of the entry. The subject indices are cross referenced to citation number in Appendix II.

Citations relevant to Mussel Watch studies but covering species other than mussels or oysters, and chemicals other than those listed in Table 1 are listed in Appendix III and are not included in the indices.

## V. REFERENCES

Abbott, R. T. (1974) American Seashells. Van Nostrand, New York. 663 pp.

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Table 3. Bivalve species cited in the Mussel Watch Bibliographic Database

Species	Common name	Length (mm)	Range
<i>Arca zebra</i> (Swainson 1833) <sup>1,2</sup>	Turkey wing	70	Southeastern U. S. to Brazil, Bermuda
<i>Aulacomya ater</i> (Molina 1782) <sup>1</sup>	Black ribbed mussel	150	Southeastern and southwestern South America
<i>Aulacomya maoriana</i> (Iredale 1915) <sup>3</sup> *	Maori mussel	80	New Zealand
<i>Brachydontes demissus plicatulus</i> +	Ribbed mussel	-	Eastern and Pacific U. S.
<i>Brachydontes variabilis</i>	Mussel	-	Lebanon
<i>Choromytilus meridionalis</i> (Krauss 1848) <sup>4</sup> †	Mussel	150	South Africa
<i>Crassostrea angulata</i> (Lamarck 1819) <sup>5</sup>	Portuguese oyster	180	Portugal and introduced elsewhere
<i>Crassostrea brasiliiana</i> (Lamarck 1819) <sup>6</sup> ✖	Oyster	-	Brazil
<i>Crassostrea commercialis</i> †	Rock oyster	-	Pacific
<i>Crassostrea corteziensis</i> (Hertlein 1951) <sup>7</sup> †	Oyster	90	California to Panama
<i>Crassostrea cucullata</i> †	Rock oyster	-	Pacific
<i>Crassostrea edulis</i> ★	Edible oyster	-	Eastern U. S., Western Europe and Mediterranean
<i>Crassostrea gasar</i> (Adonson) <sup>8</sup> †	Oyster	80-120	West Africa
<i>Crassostrea gigas</i> (Thunberg 1793) <sup>1,2</sup>	Pacific oyster	150	Western Canada to California, Japan and introduced elsewhere
<i>Crassostrea glomerata</i> (Gould 1850) <sup>1</sup>	Auckland rock oyster	90	New Zealand
<i>Crassostrea laperousei</i> (Schrencki 1861) <sup>9</sup> ▲	Oyster	350	Pacific
<i>Crassostrea lugubris</i>	Oyster	-	Thailand
<i>Crassostrea madrasensis</i>	Oyster	-	India
<i>Crassostrea margaritacea</i> (Lamarck 1819) <sup>4</sup>	Cape rock oyster	180	South Africa to Mozambique
<i>Crassostrea rhizophorae</i> (Guilding 1828) <sup>1</sup> ✖	Caribbean edible oyster	75	West Indies to Brazil
<i>Crassostrea rivularis</i> (Gould 1850) <sup>10</sup>	Oyster	-	Indo-Pacific
<i>Crassostrea virginica</i> (Gmelin 1791) <sup>1,2</sup>	Eastern oyster	85	Gulf of St. Lawrence to Caribbean, Gulf of Mexico and introduced elsewhere
<i>Geukensia demissa</i> (Dillwyn 1817) <sup>2</sup> +	Ribbed mussel	-	Eastern and Pacific U. S.

Table 3 (cont.)

Species	Common name	Length (m m)	Range
<i>Gryphaea angulata</i>	Portuguese oyster	-	Europe
<i>Isognomon alatus</i> (Gmelin 1791) <sup>1,2</sup>	Flat tree-oyster	75	Southeastern Atlantic U. S., Caribbean to Brazil, Bermuda
<i>Isognomon isognomon</i> (Linné 1758) <sup>1,1</sup>	Tree oyster	150	Tropics
<i>Malleus meridianus</i> (Cotton 1930) <sup>1,1</sup>	Hammer oyster	150	Australia
<i>Modiolus auriculatus</i> (Krauss 1848) <sup>4</sup>	Mussel	50	Indo-Pacific to South Africa
<i>Modiolus barbatus</i> (Linné 1758) <sup>5</sup>	Bearded horse mussel	60	Britain and Mediterranean
<i>Modiolus capax</i> (Conrad 1837) <sup>2,7</sup>	Fat horse mussel	80	California to Peru
<i>Modiolus demissus</i> +	Ribbed mussel	-	Eastern and Pacific U. S.
<i>Modiolus modiolus</i> (Linné 1758) <sup>1,2</sup>	Northern horse mussel	130	Arctic to mid latitudes
<i>Modiolus neozelanicus</i>	Mussel	-	New Zealand
<i>Mytella falcata</i> (d'Orbigny 1846) <sup>1</sup>	Falcate swamp mussel	70	Western Mexico to Ecuador, Venezuela to Uruguay
<i>Mytella strigata</i> (Hanley 1843) <sup>12</sup>	Mussel	40	Mexico to El Salvador, Venezuela to Argentina
<i>Mytilus afer</i>	Mussel	-	Atlantic and Mediterranean
<i>Mytilus californianus</i> (Conrad 1837) <sup>1</sup>	California mussel	200	Alaska to Mexico
<i>Mytilus coruscus</i> (Goud 1861) <sup>10</sup>	Hard shell mussel	130	Japan
<i>Mytilus demissus</i> (Dillwyn 1817) <sup>13</sup> +	Ribbed mussel	50-100	Gulf of St. Lawrence to Southeast Florida
<i>Mytilus demissus plicatus</i> +	Ribbed mussel	-	-
<i>Mytilus edulis</i> (Linné 1758) <sup>1</sup>	Blue mussel	75	Subarctic seas worldwide
<i>Mytilus edulis aoteanus</i> (Powell 1958) <sup>3</sup>	Mussel	60-120	New Zealand
<i>Mytilus edulis chilensis</i>	Mussel	-	Chile
<i>Mytilus edulis planulatus</i> (Lamarck 1819?) <sup>3</sup>	Mussel	120	New Zealand and Australia
<i>Mytilus galloprovincialis</i> (Lamarck 1819) <sup>1</sup>	Mediterranean blue mussel	100	Western Europe and Medi- terranean
<i>Mytilus magellanicus</i>	Mussel	-	Peru
<i>Mytilus minimus</i>	Mussel	-	Egypt
<i>Mytilus obscurus</i>	Mussel	-	Australia

Table 3 (cont.)

Species	Common name	Length (mm)	Range
<i>Mytilus platensis</i> (Orbigny 1846) <sup>6</sup> ●	Mussel	60	Southern Brazil to Argentina
<i>Mytilus smaradignus</i> ▼	Mussel	-	-
<i>Mytilus striagata</i>	Mussel	-	Mazatlan
<i>Mytilus trossulus</i>	Mussel	-	Russia
<i>Mytilus viridis</i> (Linné 1758) <sup>1</sup>	Green mussel	50	Indo-Pacific
<i>Ostrea angasi</i> (Sowerby 1871) <sup>11</sup> ☆	Oyster	200	Australia and Tasmania
<i>Ostrea angulata</i>	Oyster	-	Mediterranean
<i>Ostrea circumpecta</i>	Oyster	-	Japan
<i>Ostrea edulis</i> (Linné 1758) <sup>1,2</sup>	Edible oyster	80	Eastern U. S., Western Europe and Mediterranean
<i>Ostrea equestris</i> (Say 1834) <sup>2,6</sup> ★	Crested oyster	50	Virginia to Caribbean to Brazil
<i>Ostrea gigas</i> ▲	Pacific yster	-	-
<i>Ostrea heffordi</i> (Finlay 1928) <sup>3</sup>	Oyster	40-50	New Zealand
<i>Ostrea lurida</i> (Carpenter 1864) <sup>1,2</sup>	Native Pacific oyster	60	Alaska to Baja California
<i>Ostrea lutaria</i> (Hutton 1873) <sup>3</sup>	Bluff oyster	70-100	New Zealand
<i>Ostrea piculata</i>	Oyster	-	Thailand
<i>Ostrea sandvicensis</i> (Sowerby 1871) <sup>14</sup>	Hawaiian oyster	50	Hawaii
<i>Ostrea sinuata</i> (Lamarck 1819) <sup>15</sup> ☆	Pt. Lincoln oyster	150	New Zealand, South Australia
<i>Ostrea spinosa</i>	Oyster	-	Japan
<i>Perna canaliculus</i> (Gmelin 1791) <sup>1</sup>	Channel mussel	150	New Zealand
<i>Perna indica</i>	Mussel	-	India
<i>Perna perna</i> (Linné 1758) <sup>1</sup>	Brown mussel	70	West Africa and southern Caribbean
<i>Perna viridis</i> (Linné 1758)	Green-lipped mussel	-	Philippines
<i>Pinctada carcharium</i> (Jamieson 1901) <sup>15</sup>	Shark Bay pearl oyster	120?	South Australia
<i>Pinctada fucata martensii</i> (Dunker) <sup>10</sup> ◆	Japanese pearl oyster	-	Japan
<i>Pinctada margaritifera</i> (Linné 1758) <sup>16</sup>	Black lipped pearl oyster	300	Kuwait and Oman
<i>Pinctada vulgans</i>	Oyster	-	Malaysia
<i>Saccostrea commercialis</i>	Sydney rock oyster	-	Australia
<i>Saccostrea cucullata</i> ◆	Rock oyster	-	Indo-Pacific

Table 3 (cont.)

Species	Common name	Length (m m)	Range
<i>Saccostrea echinata</i> (Quoy and Gaimard 1835) <sup>9</sup>	Spiny oyster	-	Australia, Japan (Pacific?)
<i>Saccostrea glomerata</i> ■	Oyster	-	-
<i>Saccostrea iridescens</i> (Gray in Hanley 1854) <sup>7</sup>	Iridescent oyster	250	Mexico to Peru
<i>Septifer bilocularis</i> (Linné 1758) <sup>1</sup>	Box mussel	250	Indo-Pacific
<i>Stavelia horrida</i> (Dunker 1856) <sup>11</sup>	Hairy mussel	250	Australia
<i>Tiostria lutaria</i> *	Oyster	-	-

- \* *Aulacomya ater maoriana* (Iredale 1915) listed in Powell (1979) may be the same as *A. maoriana*.
- + *Mytilus demissus*, *Mytilus demissus plicatus*, *Modiolus demissus* and *Brachydontes demissus plicatulus* are junior synonyms of *Geukensia demissa*. *Brachydontes* is the currently accepted spelling of *Brachydontes* (Turgeon et al., 1988).
- ‡ Form of *Aulacomya ater* (Kilburn and Rippey, 1982).
- \* *Crassostrea brasiliana* and *Crassostrea rhizophorae* are probably the same species.
- ◆ *Crassostrea commercialis*, *Crassostrea cucullata*, and *Saccostrea cucullata* are the same species. Probably the same as *Ostrea corteziensis*.
- ☆ Same as *Ostrea edulis* (Turgeon et al., 1988).
- ◆ Same as *Ostrea tulipa* Lamarck 1819 (Nicklès, 1950).
- ▲ Junior synonym for *Crassostrea gigas* (Turgeon et al., 1988).
- Probably same as *Mytilus edulis platensis*.
- ▼ Probably same as *Mytilus viridis* (Abbott and Dance, 1982).
- ♣ Same as *Ostrea sinuata* (Cotton and Godfrey, 1938).
- ★ Junior synonym of *Ostrea equestris* (Turgeon et al., 1988).
- ◆ Same as *Pinctada martensii* (Kira, 1965).
- Same as *Crassostrea glomerata* (Powell, 1979).
- \* Same as *Ostrea lutaria*.

1, Abbott and Dance (1982); 2, Turgeon et al., 1988); 3, Powell (1979); 4, Kilburn and Rippey (1982); 5, Tebble (1976); 6, Rios (1985); 7, Olsson (1961); 8, Nicklès (1950); 9, Habe and Ito (1970); 10, Kira (1965); 11, Wells and Bryce (1986); 12, Keen (1971); 13, Abbott (1974); 14, Morris (1966); 15, Cotton and Godfrey (1938); 16, Bosch (1982).



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## VI. ACKNOWLEDGEMENTS

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## APPENDIX I

### Mussel Watch Worldwide Literature

(Chem. Abs. information included for older citations.)

- 1 **Abbe, G. R.** (1982) Growth, mortality, and copper-nickel accumulation by oysters, *Crassostrea virginica*, at the Morgantown steam electric station on the Potomac river, Maryland. J. Shellfish Res., 2(-):3-13.
- 2 **Abbe, G. R., and J. G. Sanders** (1986) Condenser replacement in a coastal power plant: copper uptake and incorporation in the American oyster, *Crassostrea virginica*. Mar. Environ. Res., 19(-):93-113.
- 3 **Abbe, G. R., and J. G. Sanders** (1990) Pathways of silver uptake and accumulation by the American oyster (*Crassostrea virginica*) in Chesapeake Bay. Est. Coastal Shelf Sci., 31(2):113-23.
- 4 **Abdel-Moati, A., and M. M. Atta** (1991) *Patella vulgata*, *Mytilus minimus* and *Hyale prevosti* as bioindicators for Pb and Se enrichment in Alexandria coastal waters. Mar. Pollut. Bull., 22(3):148-10.
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## **APPENDIX II**

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**APPENDIX III**  
**Other Relevant Citations**



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