Supporting Online Material for

Spreading Dead Zones and Consequences for Marine Ecosystems

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Supplemental Online Material

Spreading Dead Zones and Consequence for Marine Ecosystems.

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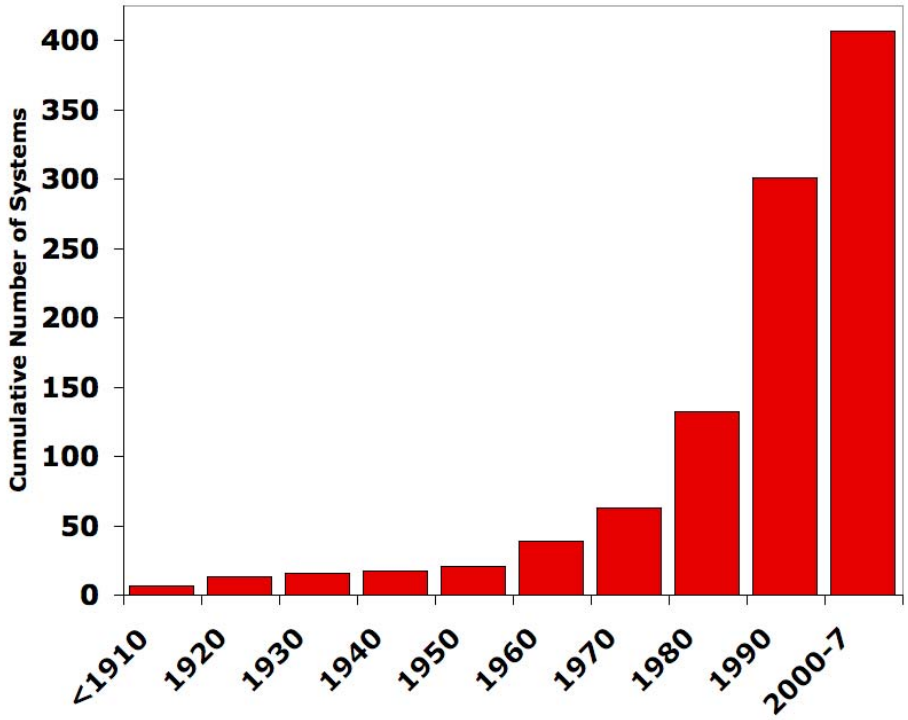

Figure S1. Cumulative increase in dead zones through time reported in the scientific literature. Systems are grouped by decade of first documented account (Table S1). The number of dead zones started to approximately double every ten years starting in the 1960s.

Table S1. Hypoxic areas around the world linked to eutrophication. Hypoxia type is characterized as Episodic: events occurring at irregular intervals >1 year; Periodic: several to many events per year lasting from hours to weeks, also includes daily hypoxia; Seasonal: yearly events related mostly to summer or autumn seasons; Persistent: year-round or near year-round hypoxia. Decade of first or recent data report is an estimate of when hypoxia first started. Area is the maximum reported spatial extent of hypoxia, however, most systems do not have area estimates.

Hypoxia type	System	Country/State	Decade First/Recent Data	Area (km^2)	Benthic Response	Fisheries/Other Response	Comment	Reference
Episodic	North Sea, SE	Denmark	1980		Mortality with annual recolonization	Stressed		Dyer et al. 1983, Westernhangen & Dethlefsen 1983
Episodic	Wismar Bay	Denmark	1980		Mortality with reduced benthos	Stressed		Prena 1995a, 1995b
Episodic	Bude Bay	England	1990	4	Mortality along 12 km of coastline	Die-off of *Nuccella lapillus* and *Cenebra erinacea*	In vicinity of sewage outfall	Gibbs et al. 1999
Episodic	Gulf of Riga	Estonia, Latvia	1980					Karlson et al. 2002, Ojaveera & Andrushaitis 2004
Episodic	Baie de Somme	France	1980		Mass Mortality with multi-year recovery	Collapse of cockle fishery	Eutrophication first became apparent in 1982-85	Desprez et al. 1992 Rybarczyk et al. 1996
Episodic	Bay of Vilaine	France	1990					Le Bris & Glemarec 1995
Episodic	Hohwacht Bay	Germany	1910			Fish killed in nets	Combination of anthropogenic and natural factors.	Gerlach 1990
Episodic	Kalifornien & Schoenberger Strand	Germany	1920			Fish kills	Combination of anthropogenic and natural factors.	Gerlach 1990
Episodic	Donegal Bay	Ireland	2000				low DO from HAB	Silke et al. 2005
Episodic	Tokyo Bay	Japan	1970	683	Mass Mortality	Decline of Mantis shrimp	55-65% of Bay hypoxic July-August	Kodama et al. 2002, 2006
Episodic	Mauritania Coast	Mauritania	1990				Anoxia related to severe dry climate conditions	Le Loeuff 1999
Episodic	East Frisian, Wadden Sea	Netherlands	1990				Debated as to natural or not	Kaiser & Lutter 1998
Episodic	Wadden Sea	Netherlands	1990	3000	Mortality	Decrease in percentage of filter feeders in benthic biomass	Increased macroalgae	de Jonge et al. 1994
Episodic	Cape Rodney, near	New Zealand	1980	8000		Mortality	HAB related to clam weather caused low DO and anoxia	Taylor et al. 1985
Episodic	Paracas Bay	Peru	2000			Mortality	Harmful algal bloom	Kahru et al. 2004
Episodic	Manila Bay	Phillipines	1980				Sewage discharge	Velasquez et al. 2002
Episodic	Volga River Delta	Russia	1990				Harmful algal blooms	Bukharitsin & Luneva 1994
Episodic	Loch Ailort	Scotland	1990		Reduced		Salmon farms	Gillibrand et al. 1996
Episodic	Gullmarsfjord, Alsback Deep	Sweden	1980	25	Mass Mortality with multi-year recovery	Low foram diversity at deep periodically hypoxic/anoxic areas	Hypoxia evolves in autumn and winter.	Gustafsson & Nordberg 2001, Nilsson & Rosenberg 2000
Episodic	Pak Panang Bay	Thailand	2000				Combination of pollution and weather	Foulkes et al. 2007
Episodic	Alamitos Bay	US-California	2000	2				Rabalais 1998

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Episodic	Coyote Creek	US-California	1970	5		Fisherman reported absence of fish and pelagic invertebrates, fish returned after hypoxia ended	Sewage spill	Cloern & Oremland 1983
Episodic	North San Francisco Bay Estuary	US-California	2000			Fish Kill	Anoxia develops	Lehman et al. 2004
Episodic	San Joaquin River	US-California	1960				Sewage discharge	Lehman et al. 2004
Episodic	Connecticut River	US-Connecticut	1990	12			Episodic events in tidal freshwater zone	Bricker et al. 1999
Episodic	Charlotte Harbor	US-Florida	1980	90			Improvements offset by increased nutrients and hurricane disturbance	Turner et al. 2006, Tomasko et al 2006
Episodic	Looe Key	US-Florida	1980		Mortality	Coral mortality	Rainfall events followed by low DO in sea grass and coral reef areas	Lapointe & Matzie 1996 Bricker et al. 2007
Episodic	Tampa Bay near Beacon Key	US-Florida	1990	125		SAV recovering	Improved from nutrient management	Leverone 1995, Lowery 1998, Bricker et al. 2007
Episodic	Lake Pontchartrain	US-Louisiana	1990	421	Reduced	Loss of large clams		Abadie & Poirrier 2000
Episodic	Kennebec & Androscoggin Rivers	US-Maine	2000	56				Bricker et al. 1999
Episodic	Buzzards Bay	US-Massachusetts	1990	3			Summer hypoxia	Bricker et al. 1999
Episodic	Dorchester Bay	US-Massachusetts	1990				Improved from nutrient management	Maciolek et al. 2005
Episodic	Shellbank Basin	US-New York	1990					Rhoads et al. 2001
Episodic	New York Bight	US-New York/ New Jersey	1970	987	Mass Mortality with multi-year recovery	Surf clam/finfish mortality, Avoidance, northward migration of bluefish blocked	Clam weather lead to stratification and bloom	Garlo et al. 1979, Sindermann & Swanson 1980
Episodic	Cape Fear River	US-North Carolina	1990		Reduced	Fish kills		Mallin et al. 1999, Posey et al. 1999
Episodic	Futch Creek	US-North Carolina	2000					MacPherson et al. 2007
Episodic	Hewletts Creek	US-North Carolina	2000				Heavily developed watershed	MacPherson et al. 2007
Episodic	Pamlico Sound	US-North Carolina	1990			Common finfish species (pinfish, spot, croaker) had skin lesions and signs of systemic bacterial infections	Hurricane increased freshwater and nutrient input.	Paerl et al. 2000
Episodic	Long Bay	US-South Carolina	2000				High Cholor a	Koephler et al. 2007
Episodic	Baffin Bay	US-Texas	1980	61				Bricker et al. 1999
Episodic	Bryan Mound, 10 m	US-Texas	1970		Mass Mortality with multi-year recovery	Stressed		Harper et al. 1981, 1991
Episodic	Gulf of Mexico, Freeport	US-Texas	1970	50	Mortality with multi-year recovery	Avoidance, some mortality.		Harper & Rabalais 1995
Episodic	Lavaca & Chocolate Bay	US-Texas	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Episodic	Bryan Mound, 20 m	US-Texas	1980		Mortality with annual recolonization	Decreased diversity and abundance at the onset of hypoxia		Harper et al. 1981, 1991

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Episodic	Morrocoy National Park	Venezuela	1990				Climate and nutrients lead to bloom, resulted in decline in coral cover from 43% to 5%	Isaza et al. 2006
Episodic	Krka Estuary	Yugoslavia	1960		Mass Mortality	Mortality	low DO first reported in 1969	Legovic et al. 1991
Periodic	Harvey Estuary	Australia	1980				Associated with bloom	Hearn & Robson 2001
Periodic	Patos Lagoon	Brazil	2000			Fish kills	Combination of anthropogenic and natural factors.	Marques et al. 2004
Periodic	Gironde Estuary	France	1990					Abril et al. 1999
Periodic	Prevost Lagoon	France	1990		Mass Mortality with annual recolonization	Reduced aquaculture production	Increased macroalgae	Guyoneaud et al. 1998
Periodic	Chinhae Bay	Korea	1970	185		Reduced		Lim et al. 2006
Periodic	Westerschelde Estuary	Netherlands	1990				Industry and live stock farming, DO increase during day produce feedback mechanisms affects denitrification/nitrification.	Irigoien et al. 1999
Periodic	Ria Formosa	Portugal	2000					Nobre et al. 2005
Periodic	Jobos Bay	Puerto Rico	1990					Sanger et al. 2002
Periodic	Koljo Fjord	Sweden	1940		Mortality with annual recolonization	Low foram diversity at deep periodically hypoxic/anoxic areas, low macrofaunal biomass	Periodic hypoxia has been noted sine the 1940s	Gustafsson & Nordberg 1999, Rosenberg et al. 2001
Periodic	Bon Secour Bay	US-Alabama	2000		Mortality	Loss of oyster		Rikard et al. 2000
Periodic	Newport Bay	US-California	1990	0.8				Rabalais 1998
Periodic	San Diego Bay	US-California	1990	4				Rabalais 1998
Periodic	Tijuana Estuary	US-California	2000	0.1				Bricker et al. 1999, Sanger et al. 2002
Periodic	Upper Pond, Elkhorn Slough	US-California	2000	0.4				Bricker et al. 1999
Periodic	Blackwater Landing	US-Delaware	1990					Sanger et al. 2002
Periodic	Pepper Creek	US-Delaware	2000			Fish migrate in and out of creek depending on DO	Daily cycle of DO from supersaturated to hypoxic	Tyler 2004
Periodic	Apalachee Bay	US-Florida	2000	61				Bricker et al. 1999
Periodic	Apalachicola Bay	US-Florida	1990	86				Lowery 1998, Sanger et al. 2002
Periodic	Bayou Chico	US-Florida	1990					Summers et al. 1997
Periodic	Escambia Bay	US-Florida	1990					Summers et al. 1997
Periodic	Florida Bay	US-Florida	2000	2287				Bricker et al. 1999
Periodic	Indian River	US-Florida	2000	253				Bricker et al. 1999
Periodic	Patch Reef	US-Florida	1990		Mortality		Rainfall events followed by low DO in seagrass and coral reef areas	Lapointe & Matzie 1996
Periodic	Pine Channel	US-Florida	1990		Mortality		Rainfall events followed by low DO in seagrass and coral reef areas	Lapointe & Matzie 1996
Periodic	Port Pine	US-Florida	1990		Mortality		Rainfall events followed by low DO in seagrass and coral reef areas	Lapointe & Matzie 1996

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Periodic	Sarasota Bay	US-Florida	2000	33		SAV recovering	Improved from nutrient management	Bricker et al. 1999
Periodic	St. Andrew Bay	US-Florida	2000	34				Bricker et al. 1999
Periodic	St. Joseph Bay	US-Florida	1990		Brittlestar migration	Avoidance		Leonard & McClintock 1999
Periodic	St. Lucie River	US-Florida	1990					Chamberlain & Hayward 1996
Periodic	Ten Thousand Islands North	US-Florida	2000	112				Bricker et al. 1999
Periodic	Ten Thousand Islands South	US-Florida	2000	203				Bricker et al. 1999
Periodic	Sapelo Island	US-Georgia	1990				Daily cycle of DO from supersaturated to hypoxic	Sanger et al. 2002
Periodic	Amite River	US-Louisiana	1990	3	Reduced	Loss of large clams	Part of Lake Pontchartrain.	Bricker et al. 1999
Periodic	Atchafalaya & Vermillion Bays	US-Louisiana	2000	112			Stratification highly significant factor	Bricker et al. 1999
Periodic	Breton & Chandeleur Sounds	US-Louisiana	2000	570				Bricker et al. 1999
Periodic	Calcasieu Lake	US-Louisiana	2000	129				Bricker et al. 1999
Periodic	Wells Inlet	US-Maine	1990				Daily cycle of DO from supersaturated to hypoxic, Submerged aquatic vegetation bed	Sanger et al. 2002
Periodic	Chester River	US-Maryland	1990	34	Mortality with annual recolonization	Avoidance, some mortality	Low DO events occur in June-Aug	Bricker et al. 1999
Periodic	Choptank River	US-Maryland	1990	69			Low DO events occur in June-Sept	Bricker et al. 1999
Periodic	Patuxent River	US-Maryland	1930	58	Mortality with annual recolonization	Avoidance, low egg hatching/larval mortality, bay anchovy eggs killed by hypoxia	Duration and spatial extent of low DO has increased from 1930-79 I	Keister et al. 2000, Breitburg et al 1997
Periodic	St. Leonard Creek	US-Maryland	1990					Summers et al. 1997
Periodic	Boston Harbor	US-Massachusetts	1980	0.8			Improved from nutrient management	Bricker et al. 1999
Periodic	Cape Cod Bay	US-Massachusetts	1990	12			Blooms	Rabalais 1998
Periodic	Waquoit Bay	US-Massachusetts	1990				Daily cycle of DO from saturated to hypoxic	Fritz et al. 1996, D'Avanzo & Kremer 1994
Periodic	East Mississippi Sound	US-Mississippi	2000	181			Stratification highly significant factor	Bricker et al. 1999
Periodic	West Mississippi Sound	US-Mississippi	2000	266				Bricker et al. 1999
Periodic	Berger Basin	US-New York	1970					Rhoads et al. 2001
Periodic	Grassy Bay	US-New York	1970	26			Areas anoxic in June-Aug	Rhoads et al. 2001, Bricker et al. 1999
Periodic	Great South Bay	US-New York	1990	30			Improved, but tidal creeks periodically hypoxic between July and September	Bricker et al. 1999
Periodic	New River	US-North Carolina	2000	21				Bricker et al. 1999

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Periodic	Pages Creek	US-North Carolina	2000					MacPherson et al. 2007
Periodic	South Slough	US-Oregon	1990				Daily cycle of DO from supersaturated to hypoxic	Sanger et al. 2002
Periodic	Narragansett Bay	US-Rhode Island	1950	93			Hypoxic June to September	Bergondo et al. 1950, Deacutis et al. 2006, Bricker et al. 1999
Periodic	Beresford Creek	US-South Carolina	1990					Lerberg et al. 2000
Periodic	Broad River	US-South Carolina	2000	70				Bricker et al. 1999
Periodic	Bull Creek	US-South Carolina	1990					Lerberg et al. 2000
Periodic	Charleston Harbor	US-South Carolina	2000	33			improved wastewater treatment, phosphate ban.	Bricker et al. 1999
Periodic	Deep Creek	US-South Carolina	1990					Lerberg et al. 2000
Periodic	Diesel Creek	US-South Carolina	1990					Lerberg et al. 2000
Periodic	Foster Creek	US-South Carolina	1990					Lerberg et al. 2000
Periodic	James Island Creek	US-South Carolina	1990		Mortality/avoidance	Avoidance		Burnett 1997
Periodic	Malind Creek	US-South Carolina	2000					Gillett et al. 2005
Periodic	New Market Creek	US-South Carolina	1990					Lerberg et al. 2000
Periodic	Okatee Creek	US-South Carolina	2000					Gillett et al. 2005
Periodic	Orange Grove Creek	US-South Carolina	1990					Lerberg et al. 2000
Periodic	Rathall Creek	US-South Carolina	1990					Lerberg et al. 2000
Periodic	Shem Creek	US-South Carolina	1990					Lerberg et al. 2000
Periodic	St. Helena Sound	US-South Carolina	2000	71				Bricker et al. 1999
Periodic	Winyah Bay	US-South Carolina	1990	29				Bricker et al. 1999, 2007
Periodic	Savannah River	US-South Carolina/Georgia	2000	23			Nonpoint sources a factor	Bricker et al. 1999
Periodic	Brazos River	US-Texas	2000	22				Bricker et al. 1999
Periodic	Upper Laguna Madre	US-Texas	2000	293				Bricker et al. 1999
Periodic	Goodwin Island	US-Virginia	1990				Submerged aquatic vegetation bed	Sanger et al. 2002
Periodic	Onancock Creek	US-Virginia	2000					Wang 2005
Periodic	Rappahannock River	US-Virginia	1990	92	Mortality with annual recoloniazation	Avoidance	Some anoxia in summer	Llanso′ 1992
Periodic	Taskinas Creek	US-Virginia	1990					Sanger et al. 2002
Periodic	York River	US-Virginia	1980	43	No response	Avoidance, reduced diversity following low DO event	7 to 8 hypoxic events between June and Sept	Pihl et al. 1991, Diaz et al. 1992, Sagasti et al 2001
Periodic	South Puget Sound	US-Washington	2000	34				Bricker et al. 1999
Periodic	Whidbey Basin & Skagit Bay	US-Washington	1990	26				Rabalais 1998
Periodic/ Seasonal	Palude della Rosa	Italy	1990		Mortality with annual recoloniazation		Increased macroalgae	Tagliapietra et al. 1998
Periodic/ Seasonal	Elkhorn Slough	US-California	1990	1.3				Bricker et al. 1999, Sanger et al. 2002

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Periodic/ Seasonal	Saco Bay	US-Maine	2000	5				Bricker et al. 1999
Periodic/ Seasonal	Great Bay	US-New Hampshire	2000	0.6				Bricker et al. 1999
Seasonal	Cabbage Tree Basin	Australia	1980		Mortality with annual recoloniazation			Rainer & Fitzhardinge 1981
Seasonal	Horseshoe Lagoon	Australia	1990					Donnelly et al. 1999
Seasonal	Chetumal Bay	Belize	2000			Coral reef affected	Untreated sewage, agricultural runoff	Isaza et al. 2006
Seasonal	Conceição Lagoon	Brazil	1980			Fish kills	Anoxia develops	Fonseca 2006
Seasonal	Guanabara Bay	Brazil	1990		Mortality		Tropical	Valentin et al. 1999
Seasonal	Pina Basin	Brazil	1990					Somerfield et al 2003
Seasonal	Rodrigo de Freitas Lagoon	Brazil	1980				Anoxia develops	Marques et al. 2004
Seasonal	Saanich Inlet	Canada	1960					Tunnicliffe 1981
Seasonal	Tracadie & Winter Bays	Canada	2000				Fish farming	Miron et al. 2005
Seasonal	East China Sea	China	1950	15000			Discharge from Yangtze River is source of nutrients	Li & Daler 2004, Wang 2006, Chen et al. 2007
Seasonal	Tolo Harbor	China	1980	80	Mass mortality	Mass mortality	Rapid (several months to one year) winter recovery of fauna	Wu 1982
Seasonal	Als	Denmark	1920	40				Gerlach 1990
Seasonal	Århus Bay	Denmark	1980	1300	Mass Mortality with multi-year recovery	*Nephtys hombergi* (more low DO tolerant) displaced *N. ciliata* after hypoxic event	low DO event killed most of macrofauna; macrofauna recolonized following year	Fallesen & Jørgensen 1991, Josefson & Hansen 2004
Seasonal	Belt Sea	Denmark	1970	2150				Karlson et al. 2002
Seasonal	Coastal waters, Denmark	Denmark	2000	9000			2001 worse hypoxia year recorded, high runoff, low wind	Conley et al. 2007
Seasonal	Flensborg Fjord	Denmark	1980					Josefson & Hansen 2004
Seasonal	Kattegat (NW)	Denmark	1980					Josefson & Hansen 2004
Seasonal	Kattegat (S)	Denmark	1980					Josefson & Hansen 2004
Seasonal	Køge Bugt	Denmark	1980					Josefson & Hansen 2004
Seasonal	Lillebælt N	Denmark	1980					Josefson & Hansen 2004
Seasonal	Limfjord/Løgstør Bredn.	Denmark	1980	440	Mass Mortality with annual recolonization	Demersal fisheries gone.		Jørgensen 1980, Hylleberg 1993
Seasonal	Little Belt	Denmark	1910	450				Gerlach 1990
Seasonal	Mariager Fjord	Denmark	1990	20				Fallesen et al. 2000
Seasonal	Nissum Fjord Inner & Middle	Denmark	1980					Josefson & Hansen 2004
Seasonal	Nivå Bugt	Denmark	1980					Josefson & Hansen 2004

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Seasonal	Odense Fjord Outer Basin	Denmark	1980					Josefson & Hansen 2004
Seasonal	Ringgårdsbassin	Denmark	1980					Josefson & Hansen 2004
Seasonal	Ringkøbing Fjord	Denmark	1980					Josefson & Hansen 2004
Seasonal	Roskilde Fjord	Denmark	1990				85% increase in Nitrogen input from 1950s to 1990s, mainly from fertilizer	Clarke et al. 2003, Flindt et al. 1997
Seasonal	Roskildefjord North	Denmark	1980					Josefson & Hansen 2004
Seasonal	Skagerrak Coast	Denmark	1980				Transboundary transports of nutrients.	OSPAR 2003
Seasonal	Skive Fjord	Denmark	1990					Josefson & Hansen 2004, Conley et al. 2007
Seasonal	Vejle Fjord	Denmark	1980					Josefson & Hansen 2004
Seasonal	Alexandria Harbour	Egypt	1980				Many stressors, maritime activities, agriculture, stored fertilizers, domestic waste, industrial waste	Dorgham et al. 2004
Seasonal	Forth Estuary	England	1960			Fish kills	Improved from nutrient management	Balls et al. 1996, Griffiths 1987
Seasonal	Mersey Estuary	England	1850	25		With recovery fish returned, Salmon runs from 1990s	Improved from nutrient management, Still has annual hypoxia in one spot upriver	Jones 2006
Seasonal	Thames Estuary	England	1920				Worse 1930-1970, Improved from nutrient management	Andrews & Rickard 1980, Arau'jo et al. 1999
Seasonal	Åland archipelago	Finland	1990	70	Mortality with reduced benthos	Reduced abundance, biomass, diversity under algal mats	Algae has increased in this area since the early 1990s	Norkko & Bonsdorff 1996, Karlson et al. 2002
Seasonal	Archipelago Sea	Finland	1990				Fish farming	Kraufvelin et al. 2001
Seasonal	Inre Verkviken	Finland	1970	0.5			Water below 10-15 m becomes anoxic in late summer, but the thickness of the anoxic zone varies year to year	Lindholm 1996
Seasonal	Neva Bay	Finland	1990	300				Karlson et al. 2002
Seasonal	Etang de Berre	France	1970	132			Hydraulic modifications (dam)	Stora & Arnoux 1983
Seasonal	Loire Estuary	France	1990			Mortality of migratory species, mortality of mullet *Liza ramada*		Thouvenin et al. 1994, Abril et al. 2003
Seasonal	Seine Estuary	France	1990				DO deficiency increasing	Garnier et al. 2001
Seasonal	Thau Lagoon	France	1990		Mass Mortality	Mortality/Reduced shellfish production	Semi-intensive aquaculture farming	Mazouni et al. 1996, Chapelle et al. 2000, Souchu et al. 1998
Seasonal	Eckernforde Bay	Germany	1910		Mortality with annual recoloniazation	Mass mortalities 1875, 1931, 1936-37	Benthic community annually goes through a boom-and-crash cycle	Gerlach 1990, Brongersma-Sanders 1957, D'Andrea et al. 1996, Bentley & Nittrouer 1999
Seasonal	Elbe Estuary	Germany	1980			Larval and juvenile fishes less able to escape low DO and result in mortality	Improved from nutrient management	Thiel et al. 1995

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Seasonal	German Bight	Germany	1980	15000	Mass Mortality with annual recolonization	Mortality		Dethlefsen & Westernhagen 1983, Brockmann et al. 1988, Niermann et al. 1990
Seasonal	Kiel Bay	Germany	1960	890	Mass Mortality with annual recolonization	Stressed		Arntz 1981, Rumohr 1986, Weigelt 1990 1991, Oeschger & Storey 1990
Seasonal	Lueback Bay	Germany	1960					Gerlach 1990
Seasonal	Mecklenburg Bay	Germany	1980	1860				Karlson et al. 2002
Seasonal	Pomeranian Bay	Germany	1990	390	Mass Mortality with multi-year recovery	Amphipods disappeared from hypoxic zones	low DO 1st observed in 1994	Powilleit & Kube 1999, Karlson et al. 2002
Seasonal	Oder Lagoon	Germany, Poland	1990					Pohl et al. 1998
Seasonal	Elefsis Bay	Greece	1980	67	Mass Mortality with annual recolonization		Low DO first observed in 1973	Friligos & Zenetos 1988, Theodorou 1996
Seasonal	Gialova Lagoon	Greece	1990	2500	Mortality with annual recolonization		Limited exchange with adjacent lagoon	Arvanitidis et al. 1999
Seasonal	Lough Ine	Ireland	1970		Mass Mortality with annual recolonization			Kitching et al. 1976
Seasonal	Gulf of Aqaba	Israel	1990			High coral mortality	Fish farming	Eden et al. 2003, Erez et al. 2004
Seasonal	Adriatic Sea, northern	Italy	1960	3750	1969 - 1st mass mortality of benthos		Seasonal anoxia increased in 1960; reached maximum in 1981-1987	Justic′ et al 1987, 1993, Barmawidjaja et al. 1995
Seasonal	Goro Lagoon	Italy	1990		Mortality with annual recolonization			Reizopoulou et al. 1996
Seasonal	Orbetello Lagoon	Italy	1990					Lardicci et al. 2001
Seasonal	Venice Lagoon	Italy	1990					Flindt et al. 1997
Seasonal	Gulf of Trieste	Italy, Slovenia, Croatia	1960		Mass Mortality with multi-year recovery	Stressed	Mass mortality recorded in 1974	Stachowitsch 1984, 1991, Simunovic et al. 1999, Justic′ et al 1987, Fedra et al. 1976
Seasonal	Ariake & Isahay Bays	Japan	2000	240			Hydraulic modifications (dam)	Hodoki & Murakami 2006
Seasonal	Beppu Bay	Japan	1970				Enclosed topography	Suzuki 2001
Seasonal	Dokai Bay	Japan	1990	11	Mortality		Low DO is upwelled into shallower areas by winds	Ueda et al. 2000
Seasonal	Funka Bay	Japan	1990			Avoidance		Kimura et al. 2004
Seasonal	Gokasho Bay	Japan	1990	1.0			Combination of anthropogenic (fish farming) and natural factors	Yokoyama 2002
Seasonal	Hakata Bay	Japan	1970	120	Mortality with annual recoloniazation			Karim et al. 2002
Seasonal	Hiuchi Sound	Japan	1970		Mass Mortality	All fauna dead at DO = 0.4 ppm		Sanukida et al. 1984
Seasonal	Ise Bay	Japan	1990	1740	Mortality	Shellfish and fisheries in shallow areas and tidal flats reduced	low DO is upwelled into shallower areas by winds and causes damage.	Nakata et al. 1997
Seasonal	Kumihama Bay	Japan	1980					Yokoyama 1995

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Seasonal	Lake Nakaumi	Japan	1990			Mortality/avoidance		Kasai et al. 2005, Yamamuro et al. 2000
Seasonal	Lake Shinji	Japan	1990		Mass Mortality			Yamamuro et al. 1998
Seasonal	Mikawa Bay	Japan	1980	500	Mortality/avoidance		low DO occurs in summer	Suzuki & Matsukawa 1987, Suzuki 2001
Seasonal	Omura Bay	Japan	1980	100			Enclosed topography	Iizuka & Min 1989
Seasonal	Osaka Bay	Japan	1980		Recruitment on increasing DO		Industrial and domestic discharges	Yokoyama 1995, Suzuki 2001
Seasonal	Seto Inland Sea	Japan	1980		Mortality	Mortality		Imabayashi 1986
Seasonal	Suo-Nada	Japan	1990					Suzuki 2001
Seasonal	Tome Cove	Japan	1980					Tsutsumi 1987
Seasonal	Chonsu Bay	Korea	2000			Reduced		Lim et al. 2006
Seasonal	Kamak Bay	Korea	1900			Reduced		Lim et al. 2006
Seasonal	Jinhae Bay	Korea	2000			Oyster mortality related to DO and red tide	Related to summer algal blooms, annual from 1980s	Lee & Kim 2008
Seasonal	Masan Bay	Korea	2000				Related to summer algal blooms	Lee & Kim 2008
Seasonal	Youngsan Estuary	Korea	2000	3		Reduced		Lim et al. 2006
Seasonal	Bojorquez Lagoon	Mexico	1980				Sewage discharge from city of Cancun	Valdes-Lozano et al. 2006
Seasonal	Oslofjord	Norway	1910	150	Mortality with annual recoloniazation	Reduced		Petersen 1915, Mirza & Gray 1981, Rosenberg et al. 1987
Seasonal	Bilbao Estuary	Spain	1990		Mortality	Some fauna survived with reduced activity		Gonzales-Oreja & Saiz-Salinas 1998, Saiz-Salinas & Frances-Zubillaga 1997
Seasonal	La Coruna Bay	Spain	1990					Lopez-Jamar et al. 1995
Seasonal	Ria San Martin	Spain	2000				Combination of sewage, pulp mill, industry, treatment plant being built by Torrelavega	Puente et al. 2007
Seasonal	Gullmarsfjord, Kilviken	Sweden	1970		Decreased species richness, abundance			Josefson & Widbom 1988, Hendelberg & Jensen 1993
Seasonal	Havstens Fjord	Sweden	1960		Low foram diversity and abundance at deeper hypoxic/anoxic areas		Annual hypoxia or anoxia recorded since 1962	Gustafsson & Nordberg 2000
Seasonal	Laholm Bay	Sweden	1980		Mortality with annual recoloniazation	Mortality		Baden et al. 1990b, Rosenberg & Loo 1988
Seasonal	Skagerrak Coast	Sweden	1950		Mortality	Stressed	Linear decrease in DO since the 1960s	Johannessen & Dahl 1996a, 1996b
Seasonal	St. Anna Archipelago	Sweden	1980	25				Karlson et al. 2002
Seasonal	Swedish West Coast Fjords	Sweden	1980			Stressed		Josefsen & Rosenberg 1988
Seasonal	Kattegat (SE)	Sweden, Denmark	1980	3850	Mass Mortality with multi-year recovery	Reduced demersal fish abundance, Norway lobster collapse	DO lowest in Sept-Oct	Petersen & Pihl 1995, Baden et al. 1990a, Josefson & Jensen 1992, Rosenberg et al. 1992

Hypoxia type	System	Country/State	Decade First/Recent Data	Area (km^2)	Benthic Response	Fisheries/Other Response	Comment	Reference
Seasonal	Bornholm Basin	Sweden, Finland	1950	6793	Mass Mortality with multi-year recovery			Tulkki 1965, Leppakoski 1969, Karlson et al. 2002
Seasonal	Prawn culture ponds	Taiwan	2000		Mortality	Mortality of prawns, reduced growth, depressed immune system in *Macrobrachium rosenbergii*	Decomposition of unconsumed food and feces	Cheng et al. 2002
Seasonal	Lake Tunis	Tunisia	1980			Reduced worm reefs, fish kills, and H2S odor permeates the city of Tunis during the summer	May go back 100s of years	Kelly & Naguib 1984
Seasonal	Black Sea NW Shelf	Ukraine, Romania, Bulgaria	1960	40000	Mass Mortality with annual recolonization	Reduced, now recovering	First reported in the 1960s, Improved from nutrient management in the 1990s	Zaitsev 1993, Bakan & Buyukgungor 2000, Friedrich et al. 2002, Mee 2006
Seasonal	Montevideo Bay	Uraguay	2000					Danulat et al. 2002
Seasonal	Mobile Bay	US-Alabama	1940	1060		Occasional shoreward migration of hypoxia stressed fish and crustaceans (Jubilees)	Stratification highly significant factor	Loesch 1960, Pennock et al. 1994, May, 1973, Engle & Summers 1999
Seasonal	Los Angeles Harbor	US-California	1950		Mass Mortality with multi-year recovery		Improved from nutrient management	Reish 1955, 2000
Seasonal	Monterey Bay	US-California	2000				Combination of anthropogenic and natural factors.	Okey 2003
Seasonal	South San Francisco Bay	US-California	1960				Hypoxia eliminated with sewage treatment plants	Nichols et al. 1986 Bricker et al. 2007
Seasonal	Bald Eagle Creek	US-Delaware	2000			Fish kills	Eutrophication and limited tidal exchange with adjacent body of water	Luther et al. 2004
Seasonal	Delaware River, upper	US-Delaware	1910				low DO first recorded in 1915, Improved from nutrient management	Patrick 1988
Seasonal	Choctawhatchee Bay	US-Florida	1990	156				Lowery 1998
Seasonal	Hillsborough Bay	US-Florida	1980				Improved from nutrient management	Santos & Simon 1980, Johansson & Lewis 1992
Seasonal	Pensacola Bay	US-Florida	1990	76				Lowery 1998
Seasonal	Perdido Bay	US-Florida	1990	64			Stratification highly significant factor	Flemer et al. 1999
Seasonal	St. Johns River	US-Florida	1990		Mortality	Mortality		Mason 1998
Seasonal	Gulf of Mexico LA-TX shelf	US-Louisiana	1970	22000		Avoidance	Area coincides with historic white and brown shrimp fishing grounds	Turner & Rabalais 1994, Justic′ et al. 1996, Sen Gupta et al. 1996, Rabalais et al. 2007
Seasonal	West Hackberry, Gulf of Mexico	US-Louisiana	1980		Mortality with annual recoloniazation			Gaston 1985
Seasonal	Chesapeake Bay Mainstem	US-Maryland	1930	2751	Mortality with annual recoloniazation	Killed crabs in crab pots	Seasonal anoxia detected in sediment record as far back as 1934-1948	Zimmerman & Canual 2000, Newcombe & Horne 1938, Officer et al. 1984, Seliger et al. 1985, Holland et al., 1987, Boesch et al. 2001, Hagy et al. 2004

Hypoxia type	System	Country/State	Decade First/Recent Data	Area (km^2)	Benthic Response	Fisheries/Other Response	Comment	Reference
Seasonal	Patapsco River	US-Maryland	2000					Riedel et al. 1999
Seasonal	Potomac River	US-Maryland	1920	264	Mortality with annual recoloniazation		low DO in May-Sep, increased spatial coverage of hypoxia	Sale & Skinner 1917 Bricker et al. 1999
Seasonal	Dead-end canals	US-Maryland/Delaware	1990	5			Dead-end canal have limited tidal exchange with adjacent body of water, as many as 20 canals	Maxted et al. 1997
Seasonal	Charles River	US-Massachusetts	1980					Taylor 2000
Seasonal	Fore River	US-Massachusetts	1980					Neponset River Watershed Association 2004
Seasonal	Herring River	US-Massachusetts	1980			Fish kills, decline of alewife fishery	Anoxia 1-3 weeks	Portnoy 1991
Seasonal	Barnegat Inlet	US-New Jersey	1990		Mass Mortality with annual recolonization			Moser 1998
Seasonal	Great Egg Harbor River	US-New Jersey	1990					Glenn et al. 1996
Seasonal	Mullica River Estuary	US-New Jersey	1990					Glenn et al. 1996
Seasonal	Townsend-Hereford Inlet	US-New Jersey	1990					Glenn et al. 1996
Seasonal	East River	US-New York	1920				Improved from nutrient management	Parker & O'Reilly 1991
Seasonal	Flushing Bay	US-New York	1990		Mortality			Rhoads et al. 2001
Seasonal	Hudson River	US-New York	1960	65			Improved from nutrient management, no longer hypoxic	Brosnan & O'Shea 1996
Seasonal	Long Island Sound	US-New York	1970	1036		Avoidance, some mortality.	Hypoxic June to September; duration, frequency, spatial coverage all increased since 1987	Howell & Simpson 1994, Welsh et al. 1994, Schimmel et al. 1999, Anderson & Taylor 2001
Seasonal	Mill Basin	US-New York	1990			Avoidance		Rhoads et al. 2001
Seasonal	New York City Harbor	US-New York	1990		Mass Mortality with annual recolonization	Stressed	Improved from nutrient management	Parker & O'Reilly 1991
Seasonal	Norton Basin	US-New York	1990			Avoidance		Rhoads et al. 2001
Seasonal	Raritan Bay	US-New York/New Jersey	1970	55			Improved from nutrient management	Christensen & Packard 1976
Seasonal	Albemarle & Pamlico Sounds	US-North Carolina	1990	464	Mortality	Mortality	Hurricane increased freshwater and nutrient input.	Bricker et al. 1999
Seasonal	Neuse River Estuary	US-North Carolina	1990	230	Mortality/avoidance	Fish kills, mortality of oyster.		Paerl et al. 1995, 1998, Lenihan & Peterson 1998, Lenihan 1999
Seasonal	Pamlico & Pungo Rivers	US-North Carolina	1960	44	Mass Mortality, low macrobenthic diversity and density in summer, recolonization by winter	Mortality		Tenore 1972, Hobbie et al. 1975, Stanley & Nixon 1992
Seasonal	Stono & North Edisto Rivers	US-South Carolina	2000	22				Bricker et al. 1999
Seasonal	Aransas Bay	US-Texas	1990					Lowery 1998

Hypoxia type	System	Country/State	Decade First/Recent Data	Area (km^2)	Benthic Response	Fisheries/Other Response	Comment	Reference
Seasonal	Corpus Christi Bay	US-Texas	1980	123	Reduced	Biomass at hypoxic stations is 96% less than at normoxic stations.	Low bottom DO when bottom salinity was high	Ritter & Montagna 1999, Montagna & Ritter 2006, Montagna & Kalke 1992
Seasonal	Galveston Bay	US-Texas	1990	250				Lowery 1998, Bricker et al. 1999
Seasonal	Matagorda Bay	US-Texas	1990	281				Lowery 1998
Seasonal	San Antonio Bay	US-Texas	1990	109			Stratification highly significant factor	Lowery 1998
Seasonal	Chesapeake Bay, lower	US-Virginia	1980				Lower diversity, lower biomass, lower proportion of deep-dwelling biomass at hypoxia-affected areas	Dauer et al 1992
Seasonal	Hood Canal	US-Washington	1980	238				Paulson et al. 1993, Bricker et al. 2007
Seasonal/ Episodic	Delaware River	US-Delaware	1990			Recovering American shad and striped bass fishery	Improved from nutrient management	Weisberg et al. 1996, Summers et al. 1997
Seasonal/ Episodic	Biscayne Bay	US-Florida	2000	2			Related to releases of freshwater from canals	Bricker et al. 1999
Seasonal/ Episodic	Barataria Bay	US-Louisiana	2000	207				Bricker et al. 1999
Seasonal/ Persistent	Sea of Azov	Russia, Ukraine	1930	8560	Mortality with reduced benthos	Lower production	Prone to stratification, large anoxia 1937, 1946, 1987, 2001	Balkas et al. 1990, Chechum 1998, Debolskaya et al. 2008
Seasonal/ Persistent	Skagerrak coast (Fjords)	Sweden	1920	54			Increased sedimentation of phytoplankton because of decreased grazing by zooplankton	Rosenberg 1990
Seasonal?	Imboassica Lagoon	Brazil	1990				Sewage discharge	Kozlowsky-Suzuki & Bozelli 2002
Seasonal?	Alykes Kitrous Lagoon	Greece	1990		Meiofauna reduced		Eutrophic hypersaline lagoon	Doulgeraki et al. 2006
Persistent	Scheldt Estuary	Belgium	1990					Verlaan et al. 1998
Persistent	St. Lawrence Estuary	Canada	1980	1300		Avoidance	70 year record of declining DO, anoxia formed in last several decades	Gilbert et al. 2005, Benoit et al. 2006
Persistent	Pearl River Estuary	China	2000	20				Dai et al. 2006
Persistent	Gulf of Finland, Deep	Finland	1960	5700	Reduced		Has periods of improved conditions, recolonized after renewal of bottom water	Laine et al. 1997, Andersin & Sandler 1991, Karlson et al.2002
Persistent	Big Glory Bay	New Zealand	2000		Mass Mortality		Salmon farming	Morrisey 2000
Persistent	Gdansk Basin	Poland	1960	1200				Karlson et al. 2002
Persistent	Caspian Sea	Russia, Iran, Azerbaijan, Turkmenistan	1990		Mortality with reduced benthos		Depends on discharge intensity of Volga; high-flow years cause low DO in deep areas.	Dumont 1998
Persistent	Loch Creran	Scotland	1970		Mass Mortality			Gage 1972
Persistent	Sullom Voe	Scotland	1980		Mass Mortality			Pearson & Eleftheriou 1981
Persistent	Arkona Basin	Sweden	1980	1000				Karlson et al. 2002
Persistent	Byfjord	Sweden	1970		Mortality with reduced benthos	Only pelagic species		Rosenberg 1990, Rosenberg et al 1977

Hypoxia type	System	Country/State	Decade First/Recent Data	Area (km^2)	Benthic Response	Fisheries/Other Response	Comment	Reference
Persistent	Gotland Basin, East	Sweden	1960	39600	Mortality with reduced benthos	Low DO prevents development of cod eggs, cod prey reduced (*Saduria entomon* and *Lumpenus lampetraeformis)*	Recolonized after renewal of bottom water	Laine et al. 1997, de Jonge et al. 1994, Karlson et al. 2002
Persistent	Gotland Basin, North	Sweden	1960	14300	Mortality with reduced benthos	Avoidance, mortality/low hatch cod eggs	Recolonized after renewal of bottom water	Laine et al. 1997
Persistent	Gotland Basin, West	Sweden	1960	16100	Mortality with reduced benthos	Avoidance, mortality/low hatch cod eggs	Recolonized after renewal of bottom water	Laine et al. 1997
Persistent	Himmerfjarden	Sweden	1970	11				Savage et al. 2002
Persistent	Stockholm Inner Archipelago	Sweden	1970	60	No Benthos and no recruitment			Rosenberg & Diaz 1993
Persistent	Baltic Sea, Northern	Sweden, Finland	1970			Stressed		Andersin et al. 1978
Persistent	Idefjord	Sweden, Norway	1960	80	Mortality with reduced benthos		Industry (sulfite pulp mill), after closure fjord recovered	Rosenberg 1980
Persistent	Tan Shui Estuary	Taiwan	1990					Jeng & Han 1996
Persistent	Dubai Creek	United Arab Emirates	2000		Low diveristy and abundance, Capitellids dominent		High levels of organic loading from sewage	Saunders et al. 2007
Persistent	Caloosahatchee River	US-Florida	2000	4				Bricker et al. 1999
Persistent	Lower Laguna Madre	US-Texas	2000	28			Sewage and shrimp farming	Bricker et al. 1999
Upwelling	Western Indian Shelf	India	1990				Potential eutrophication led to lower DO in OMZ and expansion of area	Naqvi et al. 2000
Upwelling	California Current System	US-Oregon	2000		Mass Mortality	Mortality	Shifting wind patterns lead to extensive shallow shelf hypoxia	Grantham et al. 2004
Unknown	La Plata River Estuary	Argentina	2000			Change in trophic structure		Nagy et al. 2002
Unknown	Belgian Shelf north of Oostend	Belgium	2000					OSPAR 2003
Unknown	Ebrie Lagoon	Cote d'Ivoire	1980		Loss of biodiversity	Fish kills, loss of trophic structure	Domestic waste and industrial waste from coastal population	Ukwe et al. 2006
Unknown	Chichester Harbour	England	2000					OSPAR 2003
Unknown	Firth of Clyde Estuary	England	1980					Bock et al. 1999
Unknown	Holes Bay	England	2000					OSPAR 2003
Unknown	Humber Estuary	England	1980					Uncles et al. 1998
Unknown	Langstone Harbour	England	2000					OSPAR 2003
Unknown	Lindisfarne NNR Area	England	2000					OSPAR 2003
Unknown	North Sea	England	2000					Ducrotoy et al 2000
Unknown	Pagham Harbour	England	2000					OSPAR 2003
Unknown	Taw Estuary	England	2000					OSPAR 2003
Unknown	Tawe Estuary	England	2000					OSPAR 2003
Unknown	Tees Estuary	England	2000					OSPAR 2003
Unknown	Tresillian & Fal Estuaries	England	2000					OSPAR 2003

Hypoxia type	System	Country/State	Decade First/Recent Data	Area (km^2)	Benthic Response	Fisheries/Other Response	Comment	Reference
Unknown	Ythan Estuary	England	2000					OSPAR 2003
Unknown	Baie d'Arguenon	France	2000					OSPAR 2003
Unknown	Baie de Douarnenez	France	2000					OSPAR 2003
Unknown	Baie de la Frenaye	France	2000					OSPAR 2003
Unknown	Baie de Lannion	France	2000					OSPAR 2003
Unknown	Baie de Morlaix	France	2000					OSPAR 2003
Unknown	Baie de Sainte-Brieuc	France	2000					OSPAR 2003
Unknown	Bassin d'Arcachon	France	2000					OSPAR 2003
Unknown	Boulogne	France	2000					OSPAR 2003
Unknown	Calais	France	2000					OSPAR 2003
Unknown	Canche Estuary	France	2000					OSPAR 2003
Unknown	Concarneau	France	2000					OSPAR 2003
Unknown	Dunkerque	France	2000					OSPAR 2003
Unknown	Ems Estuary	Germany, Netherlands	2000					OSPAR 2003
Unknown	Weser Estuary	Germany, Netherlands	2000					OSPAR 2003
Unknown	Chemu Lagoon	Ghana	1980		Mass Mortality		Domestic waste and industrial waste from coastal population	Ukwe et al. 2006
Unknown	Fosu Lagoon	Ghana	1990					Blay & Dongdem 1996
Unknown	Korle lagoon	Ghana	1980				Domestic waste and industrial waste from coastal population	Ukwe et al. 2006
Unknown	Piges	Greece	1990		Meiofauna reduced			Doulgeraki et al. 2006
Unknown	Porto Lagos Lagoon	Greece	1980					Koutrakis et al. 2004
Unknown	Estero la Jagua	Honduras	1990			Fish kills, decline in artisan fishery of all species, lower CPUE	Shrimp farming	Ward 2000
Unknown	Iranian Bank	Iran	1980					Dumont 1998
Unknown	Bandon Estuary Lower	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Bandon Estuary Upper	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Barrow Estuary	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Blackwater Estuary Lower	Ireland	2000					OSPAR 2003
Unknown	Broadmeadow Estuary	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Cashen Feale Estuary	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Castletown Estuary	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Colligan River	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Dungarvan Harbor	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Fergus Estuary	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Killybegs Harbour	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003

Hypoxia type	System	Country/State	Decade First/Recent Data	Area (km^2)	Benthic Response	Fisheries/Other Response	Comment	Reference
Unknown	Lee (Tralee) Estuary Lower	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Lee (Tralee) Estuary Upper	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Lough Mahon & Lee Estuary	Ireland	1990					Toner et al. 2005
Unknown	Owennacurra Estuary	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Slaney Estuary Lower	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Upper Feale Estuary	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Upper Suir Estuary	Ireland	1990				DO deficiency increased 1995-99	OSPAR 2003
Unknown	Hiroshima Bay	Japan	1990					Kim et al. 1997
Unknown	Mauritius Island	Mauritius	1990			Coral reef affected	Agriculture (sugar cane), untreated sewage (3 dischargers)	Thomassin et al. 1998
Unknown	Dutch Western Scheldt	Netherlands	2000					OSPAR 2003
Unknown	Wester-Ems	Netherlands	2000					OSPAR 2003
Unknown	Inner Belfast Lough & Tidal Lagan	Northern Ireland	2000					OSPAR 2003
Unknown	Strangford Lough Catchment	Northern Ireland	2000					OSPAR 2003
Unknown	Arendal fjord	Norway	2000				Transboundary transport of nutrients and organic matter	OSPAR 2003
Unknown	Drammensfjord	Norway	2000				Small fjord, long residence time in deep water	OSPAR 2003
Unknown	Frierfjord	Norway	2000				Transboundary transport of nutrients and organic matter	OSPAR 2003
Unknown	Kragerøfjord	Norway	2000				Long residence time	OSPAR 2003
Unknown	Sandebukta	Norway	2000				Transboundary transport of nutrients and organic matter	OSPAR 2003
Unknown	Sandefjordsfjord	Norway	2000				Inner part hypoxic	OSPAR 2003
Unknown	Sandnesfjord	Norway	2000				Long residence time in deep water behind sills.	OSPAR 2003
Unknown	Singlefjord	Norway	2000					OSPAR 2003
Unknown	Søndeledfjord	Norway	2000				Long residence time in deep water behind sills.	OSPAR 2003
Unknown	Steindalsfjord	Norway	2000					OSPAR 2003
Unknown	Stølefjord	Norway	2000				Transboundary transport of nutrients and organic matter	OSPAR 2003
Unknown	Tønsbergfjord	Norway	2000					OSPAR 2003
Unknown	Trysfjord & Ofotfjord	Norway	1980			Fish kills during deep water renewals	Long residence time for deep water behind sills.	Dommasnes et al. 1994
Unknown	Mondego River	Portugal	1990					Flindt et al. 1997
Unknown	Ria de Aveiro Lagoon	Portugal	1980					Lopes et al 2005

Hypoxia type	System	Country/State	Decade First/Recent Data	Area (km^2)	Benthic Response	Fisheries/Other Response	Comment	Reference
Unknown	Danshuei River Estuary	Taiwan	1990				Heavy sewage load from Tipia	Lin et al. 2007
Unknown	Izmit Bay	Turkey	1990		Mass Mortality	Mass mortality	Oil spill and fire, sewage discharge	Balkis 2003
Unknown	Weeks Bay	US-Alabama	1990				Mangrove	Sanger et al. 2002
Unknown	Wolf Bay	US-Alabama	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Big Lagoon	US-Florida	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Old River	US-Florida	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Rookery Bay	US-Florida	1990				Mangrove	Sanger et al. 2002
Unknown	St. George Sound	US-Florida	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Watsons Bayou	US-Florida	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Graden Island Bay	US-Louisiana	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Grand Bay	US-Louisiana	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Wax Lake	US-Louisiana	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Jug Bay	US-Maryland	1990					Sanger et al. 2002
Unknown	Back Bay of Biloxi	US-Mississippi	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Tivolie South	US-New York	1990					Sanger et al. 2002
Unknown	Masonboro Inlet	US-North Carolina	1990					Sanger et al. 2002
Unknown	Pettaquamscutt River	US-Rhode Island	1990					Wilkin & Barnes 1997
Unknown	Potters Cove	US-Rhode Island	1990					Sanger et al. 2002
Unknown	Ace Basin	US-South Carolina	1990					Sanger et al. 2002
Unknown	North Inlet-Winyah Bay	US-South Carolina	1990					Sanger et al. 2002
Unknown	Arroyo Colorado	US-Texas	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Upper Galveston Bay Channel	US-Texas	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Offatts Bayou	US-Texas	1930		Mass Mortality	Mortality	First occurrence 1936	Gunter 1942, Engle et al. 1999
Unknown	San Bernard River	US-Texas	1990				Part of regional water quality monitoring program.	Engle et al. 1999
Unknown	Padilla Bay	US-Washington	1990				Submerged aquatic vegetation bed	Sanger et al. 2002

Table S2. Approximate latitude and longitude of the hypoxic systems in Table S1. Obtained from referenced literature or Goggle Earth.

System	Lat.	Long.
Ace Basin	32.56	-80.45
Adriatic Sea, northern	44.76	12.75
Alamitos Bay	33.75	-118.11
Åland archipelago	60.28	19.82
Albemarle & Pamlico Sounds	35.3	-76.11
Alexandria Harbour	31.17	29.86
Als	55.08	9.62
Alykes Kitrous Lagoon	40.37	22.64
Amite River	30.3	-90.56
Apalachee Bay	29.76	-84.77
Apalachicola Bay	29.76	-84.77
Aransas Bay	28.05	-96.99
Archipelago Sea	60.3	22.0
Arendal fjord	58.46	8.77
Århus Bay	56.04	10.56
Ariake & Isahay Bays	32.95	130.25
Arkona Basin	54.94	13.83
Arroyo Colorado	26.36	-97.37
Atchafalaya & Vermillion Bays	29.67	-91.88
Back Bay of Biloxi	30.42	-88.86
Baffin Bay	27.32	-97.53
Baie d'Arguenon	48.6	-2.22
Baie de Douarnenez	48.17	-4.42
Baie de la Frenaye	48.65	-2.3
Baie de Lannion	48.72	-3.57
Baie de Morlaix	48.73	-3.87
Baie de Sainte-Brieuc	48.63	-2.67
Baie de Somme	50.3	1.5
Bald Eagle Creek	38.7	-75.1
Baltic Sea, Northern	58.9	20.5
Bandon Estuary Lower	51.67	-8.5
Bandon Estuary Upper	51.67	-8.5
Barataria Bay	29.52	-90.17
Barnegat Inlet	39.77	-74.09
Barrow Estuary	52.24	-6.96
Bassin d'Arcachon	44.7	-1.15
Bay of Vilaine	47.5	-2.45
Bayou Chico	30.4	-87.26
Belgian Shelf north of Oostend	51.33	3.0
Belt Sea	55.5	11.0
Beppu Bay	33.3	131.54
Beresford Creek	32.9	-79.89
Berger Basin	40.65	-73.82
Big Glory Bay	-46.92	168
Big Lagoon	30.32	-87.36
Bilbao Estuary	43.3	-3.0
Biscayne Bay	25.57	-80.22
Black Sea NW Shelf	45.5	30.3
Blackwater Estuary Lower	52.43	-6.32
Blackwater Landing	39.08	-75.46
Bojorquez Lagoon	21.13	-86.76
Bon Secour Bay	30.3	-87.88

System	Lat.	Long.
Bornholm Basin	55.45	19.13
Boston Harbor	42.34	-70.99
Boulogne	47.07	-2.09
Brazos River	28.97	-95.38
Breton & Chandeleur Sounds	29.78	-89.07
Broad River	32.4	-80.72
Broadmeadow Estuary	53.47	-6.17
Bryan Mound, 10 m	28.9	-95.0
Bryan Mound, 20 m	28.37	-94.68
Bude Bay	50.83	-4.63
Bull Creek	32.83	-80.02
Buzzards Bay	41.7	-70.7
Byfjord	59.03	11.22
Cabbage Tree Basin	-34.09	151.13
Calais	50.96	1.85
Calcasieu Lake	30.02	-93.31
California Current System	44.4	-124.2
Caloosahatchee River	26.62	-81.9
Canche Estuary	50.55	1.55
Cape Cod Bay	41.89	-70.35
Cape Fear River	35	-76.94
Cape Rodney, near	-36.3	174.85
Cashen Feale Estuary	52.48	-9.66
Caspian Sea	41.83	51.08
Castletown Estuary	53.99	-6.22
Charles River	42.38	-71.04
Charleston Harbor	32.91	-79.95
Charlotte Harbor	26.76	-82.13
Chemu lagoon	5.63	0.02
Chesapeake Bay Mainstem	38.74	-76.45
Chesapeake Bay, Lower	37.82	-76.11
Chester River	39.2	-76.1
Chetumal Bay	18.33	-88.08
Chichester Harbour	50.8	-0.92
Chinhae Bay	35	128.58
Choctawhatchee Bay	30.45	-86.32
Chonsu Bay	37.86	125.72
Choptank River	38.69	-76.27
Colligan River	52.1	-7.64
Concarneau	47.87	-3.92
Conceição Lagoon	-27.55	-48.45
Connecticut River	41.35	-72.3
Corpus Christi Bay	27.75	-97.29
Coyote Creek	37.47	-122.0
Danshuei River Estuary	25.17	121.17
Dead-end canals	38.52	-75.06
Deep Creek	32.92	-79.77
Delaware River	40.0	-75.0
Delaware River, upper	39.87	-75.09
Diesel Creek	32.82	-79.96
Dokai Bay	33.88	130.8
Donegal Bay	54.55	-8.51

System	Lat.	Long.
Dorchester Bay	42.31	-71.04
Drammensfjord	59.63	10.42
Dubai Creek	25.19	55.33
Dungarvan Harbor	52.07	-7.58
Dunkerque	51.05	2.37
Dutch Western Scheldt	51.37	3.83
East China Sea	31.0	124.0
East Frisian, Wadden Sea	53.5	5.5
East Mississippi Sound	30.35	-88.36
East River	40.8	-73.92
Ebrie lagoon	5.22	-4.7
Eckernforde Bay	54.5	10.0
Elbe Estuary	53.8	9.1
Elefsis Bay	37.86	23.55
Elkhorn Slough	36.81	-121.78
Ems Estuary	53.5	7.0
Escambia Bay	30.55	-87.16
Estero la Jagua	13.2	-87.4
Etang de Berre	43.45	5.13
Fergus Estuary	52.7	-9.0
Firth of Clyde Estuary	55.7	-4.95
Flensborg Fjord	54.83	9.79
Florida Bay	25.04	-80.73
Flushing Bay	40.63	-73.81
Fore River	42.24	-70.96
Forth Estuary	56.1	-3.5
Foster Creek	32.86	-79.86
Fosu Lagoon	5.12	-1.27
Frierfjord	59.1	9.62
Funka Bay	42.33	140.67
Futch Creek	34.3	-77.76
Galveston Bay	29.41	-94.88
Gdansk Basin	55	19.25
German Bight	54.7	7.0
Gialova Lagoon	21.67	36.97
Gironde Estuary	44.75	-1.0
Gokasho Bay	34.32	136.67
Goodwin Island	37.22	-76.4
Goro Lagoon	44.8	12.4
Gotland Basin, East	57.5	20.1
Gotland Basin, North	57.95	19.96
Gotland Basin, West	58.0	18.0
Graden Island Bay	29.04	-89.12
Grand Bay	29.37	-89.37
Grassy Bay	40.63	-73.79
Great Bay	43.07	-70.87
Great Egg Harbor River	39.3	-74.63
Great South Bay	40.71	-73.05
Guanabara Bay	-23.0	-43.0
Gulf of Aqaba	29.54	34.97
Gulf of Finland, Deep	59.82	25.5
Gulf of Mexico LA-TX shelf	28.83	-91.41
Gulf of Mexico, Freeport	28.95	-95.31
Gulf of Riga	57.63	23.58
Gulf of Trieste	45.0	13.36
Gullmarsfjord, Alsback Deep	58.33	11.33
Gullmarsfjord, Kilviken	58.33	11.33
Hakata Bay	33.6	130.3
Harvey Estuary	-32.67	115.67
Havstens Fjord	58.3	11.77
Herring River	41.93	-70.06
Hewletts Creek	34.19	-77.87
Hillsborough Bay	27.83	-82.43
Himmerfjarden	59.0	17.72
Hiroshima Bay	34.08	132.33
Hiuchi Sound	34.0	133.5
Hohwacht Bay	54.33	10.7
Holes Bay	50.73	-2
Hood Canal	47.56	-123
Horseshoe Lagoon	-36.08	146.93
Hudson River	41.53	-73.99
Humber Estuary	53.55	0.0
Idefjord	59.3	11.1
Imboassica Lagoon	-22.4	-41.7
Indian River	28.11	-80.6
Inner Belfast Lough & Tidal Lagan Impoundment	54.67	-5.6
Inre Verkviken	60.25	20
Iranian Bank	37.36	53.91
Ise Bay	34.66	136.75
Izmit Bay	40.74	28.39
James Island Creek	32.76	-79.94
Jinhae Bay	35.05	128.52
Jobos Bay	17.96	-66.24
Jug Bay	38.45	-76.27
Kalifornien & Schoenberger Strand	54.44	10.4
Kamak Bay	34.68	127.67
Kattegat (NW)	57.51	10.84
Kattegat (S)	56.14	11.52
Kattegat (SE)	56.86	11.46
Kennebec & Androscoggin Rivers	44.03	-69.8
Kiel Bay	54.37	10.53
Killybegs Harbour	54.63	-8.43
Køge Bugt	55.5	12.36
Koljo Fjord	58.25	11.58
Korle lagoon	5.55	-0.22
Kragerøfjord	58.85	9.47
Krka Estuary	15.83	43.5
Kumihama Bay	35.63	134.91
La Coruña Bay	43.4	-8.4
La Plata River Estuary	-35.0	-57.0
Laholm Bay	56.54	12.81
Lake Nakaumi	35.47	133.2
Lake Pontchartrain	30.1	-90
Lake Shinji	35.5	133
Lake Tunis	36.82	10.25

System	Lat.	Long.
Langstone Harbour	50.82	-1
Lavaca & Chocolate Bay	28.58	-98.61
Lee (Tralee) Estuary Lower	52.28	-9.93
Lee (Tralee) Estuary Upper	52.28	-9.93
Lillebælt N	55.66	10.1
Limfjord/Løgstør Bredn.	56.94	9.07
Lindisfarne NNR Area	55.68	-1.78
Little Belt	55.0	10.08
Loch Ailort	56.25	-5.74
Loch Creran	57.3	-5.5
Loire Estuary	47.2	-1.9
Long Bay	33.62	-78.88
Long Island Sound	41.08	-72.88
Looe Key	24.56	-81.41
Los Angeles Harbor	33.74	-118.23
Lough Ine	55.56	-4.9
Lough Mahon & Lee Estuary	51.88	-8.35
Lower Laguna Madre	26.42	-97.36
Lueback Bay	54.03	10.88
Malind Creek	32.32	-80.92
Manila Bay	14.52	120.77
Mariager Fjord	56.65	9.95
Masan Bay	35.17	128.59
Masonboro Inlet	34.16	-77.85
Matagorda Bay	28.5	-96.4
Mauritania Coast	20.0	-17.0
Mauritius Island	-20.25	57.5
Mecklenburg Bay	54.2	11.2
Mersey Estuary	53.35	-2.9
Mikawa Bay	34.61	137.05
Mill Basin	40.6	-73.91
Mobile Bay	30.46	-88.0
Mondego River	40.17	-8.65
Monterey Bay	36.79	-121.9
Montevideo Bay	-34.92	-56.22
Morrocoy National Park	10.82	-68.27
Mullica River Estuary	39.5	-74.33
Narragansett Bay	41.68	-71.33
Neuse River Estuary	35.04	-76.58
Neva Bay	60.09	29.57
New Market Creek	32.82	-79.94
New River	34.64	-77.34
New York Bight	39.96	-73.56
New York City Harbor	40.67	-73.98
Newport Bay	33.62	-117.89
Nissum Fjord Inner & Middle	56.31	8.26
Nivå Bugt	56.02	12.62
North Inlet-Winyah Bay	33.35	-79.19
North San Francisco Bay Estuary	37.63	-122.18
North Sea	58.25	11.45
North Sea, SE	56.1	7.2
Norton Basin	40.6	-73.77
Odense Fjord Outer Basin	55.51	10.55
Oder Lagoon	54.5	14.3
Offatts Bayou	29.28	-94.85
Okatee Creek	32.31	-80.93
Old River	29.8	-85.03
Omura Bay	32.97	129.88
Onancock Creek	37.71	-75.76
Orange Grove Creek	32.81	-79.98
Orbetello Lagoon	42.44	11.2
Osaka Bay	34.65	136.45
Oslofjord	59.4	10.72
Owennacurra Estuary	51.87	-8.2
Padilla Bay	48.52	-122.53
Pages Creek	34.28	-77.79
Pagham Harbour	50.77	-0.75
Pak Panang Bay	8.27	100.07
Palude della Rosa	45.5	12.42
Pamlico & Pungo Rivers	35.42	-76.77
Pamlico Sound	35.4	-75.7
Paracas Bay	-14.0	-76.2
Patapsco River	39.2	-76.5
Patch Reef	24.62	-81.4
Patos Lagoon	-31.1	-51.25
Patuxent River	38.38	-76.51
Pearl River Estuary	23.0	113.6
Pensacola Bay	30.46	-86.97
Pepper Creek	38.56	-75.2
Perdido Bay	30.38	-87.44
Pettaquamscutt River	41.46	-71.45
Piges	40.87	24.65
Pina Basin	-8.08	-34.9
Pine Channel	24.7	-81.41
Pomeranian Bay	54.3	14.0
Port Pine	24.73	-81.41
Porto Lagos Lagoon	41.01	25.14
Potomac River	38.4	-77.09
Potters Cove	41.58	-71.32
Prawn culture ponds	22.0	121.0
Prevost Lagoon	43.5	3.9
Rappahannock River	37.6	-76.35
Raritan Bay	40.48	-74.2
Rathall Creek	32.86	-79.89
Ria de Aveiro Lagoon	40.68	-8.65
Ria Formosa	37.03	-7.78
Ria San Martin	43.4	-4.04
Ringgårdsbassin	55.03	10.44
Ringkøbing Fjord	56.05	8.21
Rodrigo de Freitas Lagoon	-23.98	-46.32
Rookery Bay	26.05	-81.73
Roskilde Fjord	55.8	12.0
Roskildefjord North	55.95	11.98
Saanich Inlet	49.07	-123.53
Saco Bay	43.5	-70.38
San Antonio Bay	28.3	-96.7

System	Lat.	Long.
San Bernard River	28.88	-95.47
San Diego Bay	32.67	-117.14
San Joaquin River	38.05	-121.7
Sandebukta	59.54	10.27
Sandefjordsfjord	59.03	10.27
Sandnesfjord	58.7	9.22
Sapelo Island	31.41	-81.3
Sarasota Bay	27.32	-82.57
Savannah River	32.14	-80.94
Scheldt Estuary	51.25	4.17
Sea of Azov	46.2	37.0
Seine Estuary	49.42	0.25
Seto Inland Sea	33.72	132.45
Shellbank Basin	40.59	-73.92
Shem Creek	32.79	-79.88
Singlefjord	59.08	11.12
Skagerrak coast (Denmark)	57.38	9.72
Skagerrak coast (Fjords)	58.72	10.85
Skagerrak coast (Sweden)	58.25	11.5
Skive Fjord	56.62	9.08
Slaney Estuary Lower	52.34	-6.45
Søndeledfjord	58.73	9.15
South Puget Sound	47.22	-122.81
South San Francisco Bay	37.56	-122.18
South Slough	43.32	-124.32
St. Andrew Bay	30.16	-85.7
St. Anna Archipelago	58.41	16.75
St. George Sound	29.8	-84.69
St. Helena Sound	32.54	-80.39
St. Johns River	30.5	-81.5
St. Joseph Bay	29.79	-85.36
St. Lawrence Estuary	48.7	-68.65
St. Leonard Creek	38.42	-76.49
St. Lucie River	27	-80.3
Steindalsfjord	58.2	8.32
Stockholm Inner Archipelago	59.47	18.78
Stølefjord	58.82	9.43
Stono & North Edisto Rivers	32.64	-80.03
Strangford Lough Catchment	54.35	-5.67
Sullom Voe	60.4	-1.4
Suo-Nada	33.85	131.17
Swedish West Coast Fjords	57.92	11.58
Tampa Bay near Beacon Key	27.74	-82.51
Tan Shui Estuary	25.17	121.42
Taskinas Creek	37.41	-76.71
Taw Estuary	51.08	-4.22
Tawe Estuary	51.62	-3.93
Tees Estuary	54.63	-1.15
Ten Thousand Islands North	25.72	-81.38
Ten Thousand Islands South	25.31	-81.06
Thames Estuary	51.8	0.9
Thau Lagoon	43.67	3.6

System	Lat.	Long.
Tijuana Estuary	32.56	-117.13
Tivolie South	42.03	-73.92
Tokyo Bay	35.93	139.92
Tolo Harbor	20.07	110.3
Tome Cove	20	110.0
Tønsbergfjord	59.2	10.35
Townsend-Hereford Inlet	39.12	-74.71
Tracadie & Winter Bays	46.39	-62.99
Tresillian & Fal Estuaries	50.17	-5.03
Trysfjord & Ofotfjord	58.05	7.7
Upper Feale Estuary	52.44	-9.62
Upper Galveston Bay Channel	29.68	-94.98
Upper Laguna Madre	27.26	-97.39
Upper Pond, Elkhorn Slough	36.81	-121.74
Upper Suir Estuary	52.27	-7.0
Vejle Fjord	55.7	9.68
Venice Lagoon	45.3	12.4
Volga River Delta	45.7	47.9
Wadden Sea	53.82	7.67
Waquoit Bay	41.6	-70.5
Watsons Bayou	30.15	-85.63
Wax Lake	29.6	-91.42
Weeks Bay	29.79	-84.88
Wells Inlet	43.35	-70.55
Weser Estuary	53.33	8.57
West Hackberry	29.67	-93.5
West Mississippi Sound	30.26	-89.02
Wester-Ems	53.5	6.75
Western Indian Shelf	15.5	73.7
Westerschelde Estuary	51.4	3.55
Whidbey Basin & Skagit Bay	48.18	-122.45
Winyah Bay	33.39	-79.26
Wismar Bay	53.9	11.4
Wolf Bay	30.33	-87.6
York River	37.48	-76.75
Youngsan Estuary	34.83	126.4
Ythan Estuary	57.34	-1.96

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