ANTHONY PALAZZOLO, PETITIONER
v.
RHODE ISLAND ex rel PAUL J. TAVARES, GENERAL TREASURER,
and COASTAL RESOURCES MANAGEMENT COUNCIL,
RESPONDENTS
No. 99-2047
On Writ of Certiorari to the Supreme Court of Rhode Island

Brief of Dr. John M. Teal, Dr. Frank Golet, Dr. Jon C. Boothryd, Dr. R. Scott Warren, Dr. Scott Nixon and Dr. Joy Zedler In Support Of Respondent

STATEMENT OF INTEREST

Pursuant to Supreme Court Rule 37, we file this brief with the consent of the parties as amici curiae in support of Respondent , the State of Rhode Island.[1]

Amici are distinguished scientists with special expertise in America's coastal and estuarine ecosystems. Scientists authoring this brief include members of the National Academy of Sciences, and leading authors on estuaries, salt marshes, salt ponds, water quality, coastal barrier systems, and coastal hazards. Amici include scientists who have served on scientific panels advising government bodies on management of coastal ecosystems. Several have direct experience with the Rhode Island Coastal Resources Management Program and are quite familiar with the physical setting of this case and with the scientific and technical issues presented. Appendix A contains a brief biography of each scientist.

SUMMARY OF ARGUMENT

This Court has recognized that "coastal property may present such unique concerns for a fragile land system" that a state may be justified in restricting inappropriate development in the most sensitive and hazardous areas without running afoul of the Fifth Amendment. *Lucas v South Carolina Coastal Commission*, 505 U.S. 1003, 1035 (1992) (Justice Kennedy, concurring). As the majority in *Lucas* pointed out, it is important, when evaluating regulatory takings claims, to

---

[1] This brief was not authored in whole or in part by counsel for a party. The Beldon Fund contributed $2500 towards the cost of preparing and printing this brief.

carefully consider the "degree of harm to public lands and resources, or adjacent private properties, posed by the claimant's proposed activities," as well as "their suitability to the location in question." *Id* at 1031. The following information is intended to provide the Court with a clearer picture of the geographical, ecological, and hazardous conditions that make the salt marsh ecosystem precisely the kind of place that is not suitable for the intensive and poorly planned development Petitioner wishes to put there.

ARGUMENT

A. The Functions and Values of the Salt Marsh Ecosystem.

Viewed from above, the coastline of Rhode Island, like much of the eastern seaboard, reveals a striking mosaic of interconnected geological features and biological systems. Barrier beaches and coastal dunes front the ocean, absorbing the sometimes violent energy of wind and waves in their shifting sands. Behind the dunes lie the great salt ponds, brimming with life, running parallel to the coast like a string of pearls. Arrayed along the back of these barrier ponds and along the tributaries and embayments are the salt marshes, blanketed in tidally-influenced grasses (*Spartina alterniflora*), the principal food factory for this rich estuarine system. Woven into this natural fabric are uplands and dunes, adding still more diversity.[2]

This is a remarkable landscape: dynamic, diverse, productive, beautiful, dangerous. Here the work of nature is spectacularly displayed, bestowing rich gifts upon the human inhabitants. One of the keystones of this coastal environment, and the focus of the controversy here, is the salt marsh ecosystem. Salt marshes are among the most biologically productive ecosystems on earth, rivaling the richest agricultural land in terms of organic output.[3] Salt marshes are the "primary producers" that fuel the complex web of life within the coastal estuarine system, while providing a critical nursery and "refugia" for fish and shellfish of enormous economic and cultural importance.

---

[2] *See generally*, John and Mildred Teal, *Life and Death of the Salt Marsh* (1969) (Hereafter, *Life and Death of the Salt Marsh*); Chabreck, R.H., *Coastal Marshes: Ecology and Wildlife Management*, 21-28 (1988).

[3] Tiner, R.W., Wetlands of Rhode Island, U.S. Fish and Wildlife Service, *National Wetlands Inventory*, 59-60 (1989) (hereafter, *Wetlands of Rhode Island*).

But these systems do much more than simply produce biomass. A partial inventory of the functions and values of this ecological system would include the following.

<u>Fish and Wildlife Habitat</u>

As this Court has previously recognized, wetlands "serve significant natural biological functions including food chain production, general habitat, and nesting, spawning, rearing, and resting sites for aquatic species." *United States v Riverside Bayview Homes, Inc.*, 474 U.S. 121, 134 (1985).

Salt marshes are the crown jewels of wetlands, supporting an extensive complex of terrestrial and marine biological diversity by providing a variety of habitats and landscapes at the edge of the sea.[4] Many different life forms–aquatic, terrestrial, marine, freshwater–come together in this transition zone. The marsh integrates land and sea, pulsing with life in rhythm with the tides.

Approximately 70% of the commercial fisheries in the United States depend on estuaries and salt marshes for nursery or spawning grounds.[5] In 1995, the commercial fishery catch totaled 4.5 million metric tons and was valued at a record $3.8 billion.[6] Seafood is a significant component of the American diet, and a major sector of the economy. In 1995, Americans consumed an average of 15 pounds of seafood per person, and spent a total of $38.6 billion.[7]

Coastal wetlands are crucial for the existence of many birds, ranging from waterfowl, wading birds, and shorebirds to wetland-dependent songbirds. Some spend their entire lives in wetland environments, while others primarily use these areas for breeding, feeding or resting.[8]

---

[4] Teal, J.M., "Salt Marshes: They Offer Diversity of Habitat,"14 *Oceanus* 13 (1996)

[5] *Id.*, at 55. Among the more familiar wetland-dependent fishes are menhaden, bluefish, flounder, white perch, sea trout, mullet, croaker, striped bass, and drum.

[6] *Oceans and Coastal Resources: A Briefing Book*, 23 Congressional Research Service Rep. 97-588ENR (1997) (Hereafter, *Oceans and Coastal Resources*)

[7] *Id.*, at 35.

[8] A recent survey of birds at the Galilee Bird Sanctuary in Narragansett, R.I. revealed 76 species of waterbirds and 42 species of landbirds. Key wetland-dependent breeding birds included Green Heron, American Black Duck, Mallard, Clapper Rail, King Rail, Killdeer, Willet Marsh

The survival of many rare, threatened and endangered plants and animals depends upon coastal marshes. About 50% of the animals and 28% of the plants listed as threatened and endangered species under the Endangered Species Act, 16 U.S.C. 1331, are wetland-dependent.[9] According to the Rhode Island Natural Heritage Program, approximately one-third of all the State's rare plants occur in salt marshes and estuarine waters.[10]

Water Quality

Wetlands help maintain water quality in several ways: (1) by removing, retaining, and transporting nutrients such as nitrates and phosphates, (2) by processing chemical and organic waste, and (3)by reducing sediment loads.[11] Wetlands are particularly good water filters because of their location between fast land and open water. They can intercept runoff from land before it reaches water and help filter-out nutrients, wastes and sediment.[12]

Perhaps the best known demonstration of the purifying capabilities of wetlands is Tinicum Marsh, a 512 acre tidal marsh lying south of Philadelphia, Pennsylvania. Three sewage treatment plants discharge treated waste into the marsh. On a daily basis, the marsh removes 8 tons of biological oxygen demanding waste, 5 tons of phosphorous, 4 tons of ammonia, and 138 pounds of nitrate. In addition, the marsh adds 20 tons of oxygen to the water each day.[13]

Coastal wetlands also play a valuable role in reducing turbidity of flooding waters. This is especially important for aquatic life and for reducing siltation of ports, harbors, rivers, and

---

Wren, and Saltmarsh Sharp-tailed Sparrow. Myshrall, D.H.A. *et al*, *Salt Marsh Restoration Monitoring at the Galilee Bird Sanctuary, Narragansett, R.I.*, 17-19 (2000)

[9] Niering, W.A., "Endangered, Threatened, and Rare Wetland Plants and Animals of the Continental United States,"National Wetlands Newsletter, 16-19 (May-June 1987)

[10] *Id*., at 55.

[11] Lee, G.F. *et al.*, "Effects of Marshes on Water Quality," in *Coupling of Land and Water Systems* (A.D. Hastler, ed.) (1975)

[12] *See generally*, Greeson, P. B. *et al.*, *Wetland Functions and Values: The State of Our Understanding,* Proceedings of the National Symposium on Wetlands, November 7-10, American Water Resources Assn. (1979) (Hereafter, *Wetland Functions and Values*)

[13] *Wetlands of Rhode Island, supra* n 3, at 58.

reservoirs. Removal of sediment load is also valuable because sediments often transport adsorbed nutrients, pesticides, heavy metals, and other toxins.

Flood and Shoreline Erosion Control

Coastal areas are particularly susceptible to floods and storms, as discussed in greater detail below. Coastal marshes and floodplains, because of their strategic location between the open ocean and upland, help protect upland areas from erosion while providing other valuable ecosystem services. Wetland vegetation can reduce shoreline erosion in several ways, including (1) anchoring sediments, (2) dampening wave action through friction, and (3) reducing current velocity through friction.[14] Coastal marshes and barrier beaches are far more resilient to erosion than adjacent upland areas. They tend to recover over time as a result of sedimentation and accretion induced by tidal flow during quiet periods. Uplands, once eroded, have little or no potential for recovery except through human effort. The economic benefits of these functions are substantial. Property owners within the coastal zone receive reciprocal benefits from maintaining the integrity of these natural flood control and storm buffering features of the salt marsh ecosystem.

Climate Control

Wetland soils typically are highly organic and serve as “sinks” for carbon.[15] As these soils are drained or otherwise disturbed, they tend to oxidize, releasing carbon dioxide to the atmosphere and contributing to global warming. An overwhelming majority of scientists now believe that anthropogenic (human) sources of carbon dioxide and other “greenhouse gases” are at least partly responsible for the documented increases in the earth’s temperatures and changing weather patterns around the globe.[16] The Intergovernmental Panel on Climate Change(IPCC), a

---

[14] Knudson, P.L., *et al*., “Wave Dampening in *Spartina Alterniflora* Marshes,” *Wetlands* (Journal of the Society of Wetland Scientists) 2:87-104 (1982)

[15] Friedman, R.M. and DeWitt, C.B., “Wetlands as Carbon and Nutrient Reservoirs: A Spatial, Historical, Social Perspective,” in *Wetland Functions and Values*, *supra* n.12, at 175-85.

[16] As the Chairman of the Intergovernmental Panel on Climate Change recently reported to the United Nations:

> [T]he overwhelming majority of scientific experts, whilst recognizing that scientific uncertainties exist, nonetheless believe that human-induced climate change is

United Nations advisory group comprised of 2500 scientists, recently revised their projected warming trends upwards with a consequent increase in negative environmental impacts from such effects as rising sea levels. It is now widely accepted that sequestration of carbon in natural systems such as wetlands and forests is a critical component of any successful strategy to deal with the pressing problem of global warming.[17]

Recreation and Aesthetics

Many recreational activities take place in or around wetlands. Hunting and fishing contribute significantly to the local and national economies. In 1996, 77 million U.S. residents participated in wildlife-related recreation activities.[18] During that year 35.2 million people fished, 14 million hunted, and 62.9 million enjoyed at least one type of wildlife-watching activity. Expenditures associated with wildlife-related recreation totaled $101 billion in 1996.[19]

It is much harder to put a dollar value on the sheer beauty of the coast, and the sense of awe and wonder it inspires. Perhaps the image painted by naturalist-author John Hay will suffice:

> I sat on the sands and listened to the sonorous heave and splash of low waves. The sun, like a colossal red balloon filled with water, was sinking in to the horizon. It swelled, flattened, and disappeared with a final rapidity, leaving a foaming, fiery band behind it. I suddenly heard the wild trembling cry of a loon behind me, and then saw it fly over heading north. The wind grew cool, after a hot day when the light shone on metallic, glittering slow waters, and sharp, pointed beach grasses clicked together, while I watched the darkness fall around me.[20]

B. The Ecological Effects of Salt Marsh Destruction

> already occurring and that future change is inevitable. It is not a question of whether the Earth's climate will change, but rather by how much, how fast and where.

Report to the Sixth Conference of the Parties of the United Nations Framework Convention on Climate Change, November 20, 2000.

[17] See, IPCC *Special Report on Land Use, Land Use Changes, and Forestry* (1998)

[18] U.S. Fish and Wildlife Service, *1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*, 4 (1997).

[19] *Id.*

[20] John Hay, "An Imagined Frontier," in *The Great Beach* (1964)

According to current estimates by the U.S. Fish and Wildlife Service (USFWS), only 5.1 million acres of estuarine inter-tidal wetlands remain in the coterminous United States.[21] This figure represents about 5 % of the nation's total wetlands resource.[22]

Between the 1950's and 1970's, New England saw a major loss of coastal wetlands. For example, some 10 % of Rhode Island's coastal wetlands greater than 40 acres were filled between 1955 and 1964.[23] In response, coastal states began enacting wetlands protection laws . Rhode Island passed the nation's first Inter-tidal Salt Marsh Act in 1965. P.L. 1965 ch. 140, sec 1, G.L. 1956 sec 2-1 through 2-17. In 1971, Rhode Island became the first state to enact a comprehensive Coastal Resources Management Act, which established the Coastal Resource Management Council (CRMC). P.L. 1971 ch.279 sec 1, G.L. 1956 chapter 23 of title 46. In fact, Rhode Island's concern for protecting coastal resources dates back even further. There were laws on the books as early as 1798 protecting salt ponds. Rev. Pub. Laws, pp 492-97 (1798). Since 1938, the state has prohibited the introduction of "every substance that would injuriously affect the natural and healthy propagation, growth, or development of any fish or shellfish in the waters of the state." G.L. (1938) Ch. 634, Sec 1.

Today the major causes of coastal wetland losses are urban development and encroachment of coastal water caused by dredging projects, impoundments, and sea level rise. The case at bar is an example of the kind of development that would do great damage to our remaining salt marshes. Petitioner seeks permission to construct a bulkhead on the shore of

---

[21] Opheim, T., "Wetland Losses Have Continued but Have Slowed," *National Wetlands Newsletter*, 7-9 (November-December 1997)

[22] Nationwide, wetlands have been disappearing at a rapid rate throughout most of the nation's history. USFWS estimates that 104 million acres remains of the 220 million that existed when the country was first settled. Office of Technology Assessment, *Wetlands: Their Use and Regulation*, 87 (1984). Between the 1950's and 1970's the rate of loss was over 500,00 acres per year. Frayer, W.E., et al, *Status and Trends of wetlands and Deepwater Habitats in the Coterminous United States,* 1950's to 1970's. U.S. Department of Interior (1983). This trend has slowed considerably thanks to stronger wetland protection laws. Between 1985 and 1995, the net loss was 117,000. *See*, Dahl. T.E., *Wetlands: Status and Trends in the Coterminous United States, mid 1970's to mid 1980's* U.S. Department of the Interior, (1991)

[23] The State of Rhode Island Coastal Resource Management Plan, 57 (1990)

Winnapaug Pond and fill approximately 18 acres of salt marsh in order to create a 74 lot subdivision. The marsh on Petitioner's property is part of a 160 acre salt marsh complex that extends form Weekapaug on the east to Misquamicut on the west, bordering the southern shore of Winnapaug Pond. J.A. 7. The record reveals that this is "one of the more valuable tidal salt marshes in Rhode Island." J.A. 35. The marsh is "extremely valuable in terms of plant species that grow there and as habitat for birds." J.A. 35. According to the Field Biologist's report:

> There is overwhelming evidence that the biological communities indigenous to this coastal wetland will be seriously and deleteriously effected (sic) by the proposed filling and bulkheading activity. Valuable wildlife habitat will be destroyed outright, habitat necessary for the survival and maintenance of the shellfish and finfish populations will be lost, and there is a very reasonable probability that a species of bird and two species of plants now listed as species of significance will be eliminated from the area. J.A 4.

The 18 acres of marsh on Petitioner's property represents 12% of the salt marsh associated with Winnapaug Pond. Given the relatively small size (approximately 2000 acres) of the pond's watershed, this is a "highly significant number" according to the expert testimony before the Rhode Island Coastal Resources Management Council (CRMC). (J.A. 35) Filling the marsh "would destroy the natural shoreline protection, decrease sediment trapping and accretion, decrease flood storage, and eliminate or greatly reduce nutrient retention." (J.A. 27)

The impacts on Winnapaug Pond are cause for serious concern. Salt ponds are shallow, productive estuarine embayments separated form the ocean by a narrow barrier spit. They provide prime habitat for commercial and recreational fish and shellfish, as well as resting and feeding stops for waterfowl, wading birds, shorebirds and other wetland-dependent birds migrating along the Atlantic flyway. Rhode Island's salt ponds have been an important source of fish and shellfish for people long before recorded histories. Archeological evidence from the 1600's indicates the tremendous bounty yielded to the native peoples that first used these areas and to the colonists that followed.[24] These ponds have been an important factor in the quality of

[24] Virginia Lee, *An Elusive Compromise: Rhode Island Coastal Ponds and Their People,* 22 (1980)

life for local residents and a prime recreational attraction for tourists in the region.

C. Water Quality and Public Health Impacts of Coastal Development

Rhode Island's salt pond region, which includes Winnapaug Pond, is especially vulnerable to water quality problems related to the density and distribution of development within the relatively small watersheds of the ponds.[25] Bacterial contamination and nutrient enrichment are the primary threats to water quality. Indeed, these are the principal water quality problems of other estuaries all along our nation's coasts. More square miles of estuarine waters are polluted by nutrients and bacteria than any other type of contaminant.[26]

Sewage disposal through septic systems is a major documented source of nitrogen and bacteria loading for many coastal environments.[27] Failing and substandard individual sewage disposal systems (ISDS) and resultant contaminated runoff are the principal sources of bacterial contamination to the salt ponds. In fact ISDS' contribute almost ten times as much as any other source of nitrogen.[28] Most of the existing residential and commercial development in the salt pond region, including the Winnapaug Pond watershed, rely upon ISDS for disposal of sewage. Petitioner's development would also rely on ISDS'. J.A. 8

Excess input of nutrients leads to eutrophication of water bodies. In marine ecosystems nitrogen is the essential nutrient that stimulates plant growth. As nutrient loading increases in salt ponds, massive growth of algae occurs and the dissolved oxygen necessary for aquatic life is depleted. During extreme low oxygen events, hypoxia (less than 3 mg of oxygen per liter) or anoxia (all the dissolved oxygen is consumed) can occur with consequent fish kills, reduced

---

[25] Coastal Resources Management Council, *Rhode Island's Salt Pond Region: A Special Area Management Plan*, 25 (1984).

[26] U.S. Environmental Protection Agency, *National Water Quality Inventory: 1994 Report to Congress* (1995)

[27] Nixon, S.B., *et al.*, *Nutrient Inputs to Rhode Island Coastal Lagoons and Salt Ponds: Final Report to Rhode Island Statewide Planning*, (1982); Nixon and Pilson, "Nitrogen in Estuarine and Coastal Marine Ecosystems," in *Nitrogen in the Marine Environment* (1983)

[28] CRMC, Rhode Island's Salt Pond Region: A Special Management Plan (Maushaug to Point Judith Ponds), ch. 1, at 6 (1999)(Hereafter, *Salt Pond SAMP*) .

biodiversity of fish and shellfish populations, mass mortality of benthic organisms, bacterial slimes, foul smelling odors, and in some cases toxic levels of hydrogen sulfide.[29] Eutrophication of estuaries has become a major issue in Rhode Island and other coastal states.[30]

Excess loading of nitrogen to groundwater also creates serious public health problems. Nitrogen in groundwater takes the form of nitrate, a very stable anion that is relatively unaffected in the subsurface environment. A high level of nitrate in groundwater is a public health problem since groundwater is the sole source of drinking water for public water supplies and private wells throughout the salt pond region.[31] In some areas around salt ponds, nitrate levels already exceed safe thresholds for drinking water.[32]

In inland areas, the solution to these problems might be to build a public sewer system. However, sewer systems encourage high density development and increase runoff contamination of adjacent water bodies. Sewers are an appropriate solution for urbanized areas where other alternatives are no longer available, but not for areas such as the salt pond region where less dense development is both feasible and desirable. Adequate buffer zones are needed around the salt ponds, their tributaries and wetlands to help control nitrogen contamination.[33]

D. The Hazards of Coastal Development

People are drawn to the coast. Nearly 50% of the U.S. population resides in coastal areas.[34] From 1960-1990, the population in U.S. coastal areas increased from 80 to 110 million

---

[29] Nixon, Scott W., "Coastal Marine Eutrophication: A Definition, Social Causes, and Future Concerns," *Ophelia* 41:199-219 (1995)

[30] Virginia Lee and Stephen Olson, "Eutrophication and Management Initiatives for the Control of Nutrient Inputs to Rhode Island Coastal Lagoons," *Estuaries* Vol. 8 No. 2B, 191-202 (1995)

[31] *Salt Pond SAMP, supra* n 28, at Ch 3.

[32] *Id.*

[33] Desbonnet, A.P., *et al*, *Vegetated Buffers in the Coastal Zone: A Summary Review and Bibliography*, University of Rhode Island Coastal Resources Center and Rhode Island Sea Grant, 61 (1994).

[34] *Oceans and Coastal Resources*, supra n 6, at 41.

and is projected to reach 127 million by 2010.[35] Significant economic activity and growth has occurred as coastal residential, commercial, and recreational development has accelerated in recent decades. For example, approximately 50% of annual U.S. residential construction during the past two decades occurred in coastal areas.[36] Much of this development has been encouraged, whether intentionally or not, by government-funded infrastructure developments such as highways, water and sewer service, causeway access, and beach nourishment.[37] Federal programs such as the National Flood Insurance Program and the Federal Disaster Assistance Program have subsidized the risk of loss from floods and storms.[38]

This increasing concentration of development along the Nation's coasts entails a risk to life and property from major storms. For example, hurricane Andrew, one of the most devastating natural disasters to strike the United States, roared across southern Florida and into the low-lying coastal areas of Louisiana in August 1992, destroying 28,000 homes, leaving 180,000 temporarily homeless, and affecting the lives of 275,000 residents of these two states.[39] This one storm did an estimated $30 billion in damage. Hurricane Hugo, the 1989 storm that struck the U.S. Virgin Islands and Puerto Rico, and came ashore at Charleston, South Carolina, caused damage estimated at $6 billion.[40] On average, two hurricanes strike the U.S. coast each year, with two intense storms (like Andrew and Hugo) hitting every three years.

Rhode Island is particularly susceptible to hurricane damage. Unlike many Atlantic coastal states, its ocean shoreline runs east-west and lies exposed to the full force of a tropical storm approaching from the south. It is directly in the path of most hurricanes that reach New

---

[35] *Id.*

[36] *Id.*

[37] The H. John Heinz III Center for Science, Economics and the Environment, *The Hidden Costs of Coastal Hazards*, 19 (2000).

[38] *Id.*

[39] *Id.*, at 65.

[40] *Id.*, at 63.

England before the storm tracks veer east over the North Atlantic, and it is unprotected by large islands such as Long Island, Fisher's Island or Martha's Vineyard that lie off other stretches of mainland to the north and south.[41]

In the Great Atlantic Hurricane of 1938, the southern shore of Rhode Island experienced winds and waves of the greatest speed and height recorded anywhere in New England.[42] Over 300 people lost their lives. Nearly 2000 homes were destroyed. Property damage exceeded $100 million. The storm reshaped the coastline, pushing the large dunes at Weekapaug back fifty feet, eroding the cliffs at Watch Hill by thirty-five feet, and inundating the salt ponds and wetlands. The area around Winnapaug Pond, including the property now owned by Petitioner, was completely flooded out.

According to the U.S. Army Corps of Engineers, 71 hurricanes have struck Rhode Island's shore since 1635 with an average frequency of one every seven years.[43] Of course hurricanes do not stick to any schedule. After the disastrous 1938 hurricane, many of the coastal areas were rebuilt, additional "armoring" was installed, and then Hurricane Carol struck in 1954, killing 19 people, destroying 3800 houses, sweeping the barrier clean, and causing another $90 million in damage.[44]

Hurricanes are not the only threat to coastal development. Sea levels have been steadily rising as a result of thermal expansion of the oceans and the melting of glaciers and ice sheets in response to global warming.[45] Sea level is rising more rapidly along the U.S. coast than

---

[41] Brown, C., "Hurricanes and Shoreline Changes in Rhode Island," in *Hurricane in Southern New England* (Gordon, B. ed) 14-28 (1976)

[42] *Id.*

[43] U.S. Army Corps of Engineers, *Hurricane Survey Interim Report, Narragansett Pier*, Rhode Island, GPO (1960)

[44] *The Providence Journal*, p1 (Sept. 8, 1954).

[45] Global average temperatures have increased by 1.1 degree F since 1900. During that same time period greenhouse gases have increased by 30%. The decade of the 90's was the hottest one on record and 1997 was the hottest year ever recorded. Increased global temperatures are expected to increase the number and severity of extreme weather events such as

worldwide.[46] Studies by EPA and others have estimated that along the Gulf and Atlantic coasts, a one foot rise in sea level is likely by 2050 and could occur as early as 2025. A sea level rise of one-foot would increase the size of the 100 year floodplain in the U.S. from 19,500 square miles to 23,000 square miles, and increase flood damages by 36-58 percent.

Rising sea levels will continue to inundate wetlands and lowlands, accelerate coastal erosion, exacerbate coastal flooding, threaten coastal structures, raise water tables, and increase the salinity of rivers, bays and aquifers. For example, studies have shown that a one meter 3 foot) rise on the Atlantic coast would result in the erosion of from 50 to 100 meters from New England to Maryland. This would enable a 15- year storm to flood many areas that would otherwise only be flooded by a 100- year storm.[47] Nationwide, the total cost of damages from a sea level rise of one meter would be $270-475 billion, ignoring future development.[48]

With potential costs of this magnitude, there will be tremendous social and political pressure to "armor-plate" the beach with levees and bulkheads, and to expand "beach nourishment" projects (i.e. importing replacement sand).[49] But the environmental costs of such engineering would be enormous. Bulkheading and filling along the inland perimeter of a marsh

---

floods, hurricanes and tornadoes. According to the 1995 Report of the IPCC, sea levels are expected to rise by 1 meter by 2100. IPCC, Working Group I, *The Science of Climate Change (Second Assessment Report)* (1995); A. Revkin, "Scientists Now Acknowledge Role of Humans in Climate Change," *The New York Times*, A-1 (October 26, 2000); R. Peters and T. Lovejoy, *Global Warming and Biological Diversity*, xii-xiv (1993)

[46] *See,* Hoffman,J.S., D. Keyes, and J.G. Titus, *Projecting Future Sea Level Rise*, U.S. Environmental Protection Agency (1995); Titus, J.G. and Vijay Narayanan, *The Probability of Sea Level Rise*, U.S. Environmental protection Agency (1995).

[47] Kana, T.W., et al, "The Physical Impact of Sea Level Rise in the Area of Charleston, South Carolina" in Barth and Titus, *Greenhouse Effect and Sea Level Rise: A Challenge for This Generation* (1984)

[48] Titus J.G., *et al*, "Greenhouse Effect and Sea Level Rise: The Cost of Holding Back the Sea," *Coastal Management* 19:171 (1991)

[49] *Id.*, at 209.

prevents inland migration of wetland vegetation as sea level rises.[50] This kind of structural approach would eliminate most of the nation's coastal wetlands. A more prudent approach would be to avoid, or if necessary to restrict, intensive development in high hazard areas such as the one involved here.

States like Rhode Island find themselves caught between opposing forces in dealing with these problems. On the one hand, Congress, in the Coastal Zone Management Act of 1972 (CZMA), 16 U.S.C. 1451, has stated a national policy to "encourage the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone."16 U.S.C. 1452 (1). Such programs must provide for "the protection of natural resources, including wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs and fish and wildlife and their habitat within the coastal zone," as well as "minimize the loss of life and property caused by improper development in flood-prone, storm surge, geological hazard and erosion-prone areas." 16 U.S.C. 1452 (2). As mentioned, Rhode Island led the way by adopting a coastal zone management program one year before enactment of the CZMA.

In 1996, Congress amended the CZMA to add a special program to control "nonpoint" source pollution in the coastal zone.16 U.S.C 1455b. This provision directs states to prepare and adopt "management measures" to control the addition of pollutants from new and existing sources–including septic systems-- that reflect "the greatest degree of pollutant reduction achievable through the application of the best nonpoint pollution control practices," including siting criteria for new development. 16 U.S.C. 1455 b (g) (5). Failure to adopt such controls results in loss of financial assistance to implement the overall CZMA program. 16 U.S.C. 1455 b (c) (3).

Congress has further decreed that, to qualify for insurance coverage under the National Flood Insurance Program, states and local communities must adopt strict floodplain management requirements including performance standards for new construction and a prohibition on unnecessary and incompatible developments in special flood hazard areas as listed on the Flood

[50] *Id.*

Insurance Rate Maps required by the Flood Insurance Act. 42 U.S.C. 4784.

On the other hand, when states like Rhode Island, which has been diligent and thorough in its approach to dealing with these difficult problems, take the steps called for under these national policies and programs, they are sometimes met, as here, with outraged owners of coastal property demanding the right to do the very things that sound coastal management says they should not do. The fact is that Petitioner's property is not an island separate and apart from the rest of the coastal system. Land is not merely a commodity, to be bought and sold; it is also a community of living organisms, human and non-human, to be respected and properly cared for. What happens on Petitioner's land has tremendous spillover effects on other landowners and on the ecological system which supports everything that exists in the coast.

On the Flood Rate Maps the area in which Petitioner's property is located is labeled "V Zone" which stands for "high hazard zone." J.A 26. There is good reason for the label, and the State of Rhode Island had good cause to reject Petitioner's proposal to place still more lives and property at risk from the next storm to come sweeping up the coast.

CONCLUSION

For the foregoing reasons, amici urge the Court to uphold the judgment of the Supreme Court of Rhode Island.

Respectfully submitted,

Patrick A. Parenteau*
Vermont Law School
South Royalton, VT. 05068
802 763-8303

* Counsel of Record
Attorney for Amici Curiae

APPENDIX A
BIOGRAPHIES OF AMICI

Dr. John M. Teal is a Scientist Emeritus at Woods Hole Oceanographic Institution where he was Chair of Biology. He is a recipient of the National Wetlands Award for Science Research from the Environmental Law Institute, U.S. Environmental Protection Agency, U.S. Fish & Wildlife Service, and National Marine Fisheries Service, and the 1999 Odum Award from The Estuarine Research Federation. The author of over 140 scientific publications, his 1969 book, *Life and Death of a Salt Marsh*, played a major role in increasing public awareness of the importance of wetlands. He is a past president of the Society of Wetland Scientists, and is also a member of Ecological Society of America, Estuarine Research Federation, Society for Ecological Restoration, American Association for the Advancement of Science, Ecological Engineering Society, and Society of Limnology and Oceanography

Dr. R. Scott Warren holds the Temple Chair in the Department of Botany at Connecticut College. He received his Ph.D. from the University of New Hampshire, and has worked in tidal wetlands for over 25 years, where his research has focused on salt and brackish marsh vegetation dynamics, impacts of sea-level rise, tidal wetland restoration, and effects of *Phragmites* invasion on angiosperm community structure, invertebrate populations and fish. He teaches courses in tidal marsh-estuarine ecology, and has appeared in numerous peer-reviewed publications and scientific meeting presentations. He is currently on the editorial board of the journal Estuaries and served in a similar capacity for the journal Wetlands from 1992 - 1996. He has been president of the New England Estuarine Research Society, the Northeast Section of the American Society of Plant Physiologists, and a member of the Governing Board of the Estuarine Research Federation.

Dr. Francis Golet is Professor of Wetland Ecology in the Department of Natural Resources Science at the University of Rhode Island. Dr. Golet is co-author of the *Classification of Wetlands and Deepwater Habitats of the United States*, a publication that was adopted as a National Standard by the Federal Geographic Data Committee of the Office of Management and Budget in 1996. His principal areas of research expertise include: wetland classification, wetland wildlife habitat assessment, forested wetland ecology, ecology and conservation biology of wetland songbirds, wetland vegetation dynamics, and wetland restoration. In 1988 he received the Rhode Island Coastal Conservation Award from the Rhode Island Coastal Resources Management Council. For the last 9 years Dr. Golet has been Principal Investigator for one of the largest salt marsh restoration projects in New England, at Galilee, Rhode Island; in 1999 he and his research team received a Coastal America Partnership Award for their accomplishments in this successful project.

Dr. Jon C Boothroyd is a Professor of Geology at the University of Rhode Island and the Rhode Island State Geologist. He served as the National Chair of the Geological Society of America, Northeastern Section, Associate Editor of the *Journal of Sedimentary Research,* Panel member of the Quaternary Geology and Geomorphology Division of the Geological Society of America, and President of the Society for Sedimentary Geology. He is primarily a field geologist specializing in coastal, braided river, and various glacial environments with 35 years of field experience in New England, South Carolina, Alaska, Iceland, Saudi Arabia, Madagascar, Ecuador and Mexico. He wrote the coastal hazards section of the Rhode Island Coastal Resources Management Plan, a special area management plan for the Salt Ponds of Rhode Island, and an atlas and habitat inventory/resource mapping for Narragansett Bay and associated coastlines.

Dr. Joy Zedler is the Aldo Leopold Professor of Restoration Ecology at the University of Wisconsin-Madison Arboretum and Botany Department, and is the Director of Research for the UW-Madison Arboretum. Dr. Zedler's research interests include restoration and wetland ecology, role of biodiversity in ecosystem function, use of mesocosms in wetland research, invasive plants, and adaptive management. She helps edit four peer-reviewed journals (*Ecological Applications, Wetlands Ecology and Management, Ecological Engineering,* and *Ecosystems)*. She is a member of Ecological Society of America, Estuarine Research Federation, Society for Ecological Restoration, Society of Wetland Scientists. Dr. Zedler collaborates on research to improve the effectiveness of salt marsh restoration in southern California, and recently published *Handbook for Restoring Tidal Wetlands* (J. Zedler, ed. 2000. CRC Press).

Dr. Scott Nixon is Professor of Oceanography at the University of Rhode Island, and Director of the Rhode Island Sea Grant program. He is a recipient of the New England Estuarine Research Society award for outstanding contributions to estuarine research, the First "Wiese Lecturer" in Marine Science from the University of Southern Alabama, and the B. H. Ketchum Award for excellence in coastal research from the Woods Hole Oceanographic Institution. He is Co-editor-in-Chief of the journal ESTUARIES, and a member of the National Research Council's Ocean Studies Board, and Committees on the Coastal Ocean, the Role of Terrestrial Ecosystems in Global Change, and the Restoration of the Greater Everglades Ecosystem (Vice Chair). He is also a member of the American Society of Limnology and Oceanography, American Society of Environmental History, and the Estuarine Research Federation, and the author of numerous publications on the coastal ecosystem including, *A Coastal Marine Ecosystem: Simulation and Analysis* (Ecological Studies, 1978), *Coastal marine eutrophication: A definition, social causes, and future concerns*, (Ophelia 1995)