Introduction

An Ocean of Neglect

"This will be the century of the environment. In these next few years, we...will hold the fate of civilization in our hands...and in our minds. Unlike the Cold War, it is not a wrong decision, or an aggressive act, that will spell our doom. It is our inaction that will spell our doom." —Archie ("Chuck") Carr III[1]

"Out of sight, out of mind" is the phrase most applicable when examining the health of oceans along the U.S. coasts. While parts of the U.S. landmass have benefited from designation as federally protected areas, little such status has been granted to the seas. Not until May 2000 did U.S. President Bill Clinton issue an executive order to expand the protection of U.S coastal "marine protected areas" where fishing, offshore drilling, and other "consumptive uses" of marine resources would come under closer scrutiny.[2] Signed into law in August 2000, the order establishes a 16-member commission to study ocean issues and recommend long-term strategies. Though heralded by conservation organizations as a progressive step, the law appears unlikely to produce any quick, tangible results. In late 1999, Tundi Agardy, a marine expert at Conservation International wrote: "The United States has done virtually nothing to conserve this great natural resource or to actively stem the decline of the oceans' health."[3] Although the United States has the highest marine ecosystem diversity of any nation in the world, it has no comprehensive system to protect this unequaled national treasure.[4] Consequently, experts have no doubt that the sea's biological diversity and ecological integrity are in trouble.[5] In fact, government policies toward this most crucial of ecosystems represent an ocean of neglect.

According to experts, the United States has done little to conserve the great natural resources of our oceans. Environmental groups have pressed for ocean "no-take" zones where wildlife can live in tranquillity, free from the threats of big industry and human activity.

This inattention may be costly. The signs are that something is very wrong in the world's oceans, and contamination and alteration of that environment by industries like nuclear power, if left unchecked, may be changing the marine ecosystem beyond redemption. Yet the world's oceans, though critical to life on Earth, are barely understood, and no international body monitors coastal pollution.[6]

Damage to marine ecosystems by commercial industries like nuclear power, more interested in profit than environmental protection, goes largely unobserved and unpunished. Lawmakers tend to focus on hot-button issues most likely to garner public attention and votes. Researchers Robert J. Wilder, Mia J. Tegner, and Paul K. Dayton asked: "Why have lawmakers paid so little attention to the degradation of the sea? It is a case of out of sight, out of mind . . . and most policymakers assume there is little need for concern."[7]

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The damage to marine life caused by the nuclear power industry, which operates 59 reactors on U.S. waterways and oceans using the once-through cooling system, has been sparsely reported and largely overlooked. A typical 1,000-megawatt reactor using the once-through cooling system requires as much as 500,000 gallons of cooling

water a minute, drawn in from our lakes, rivers, and oceans. After cooling the reactor system, the now artificially warmed water is discharged back into the body of water from which it was drawn. This technology was selected as the cheaper alternative to cooling towers that use as little as 20,000 gallons a minute, which the economically beleaguered industry views as too cost-prohibitive to install. Instead, the price is being paid by marine life and the ecosystems on which they depend.

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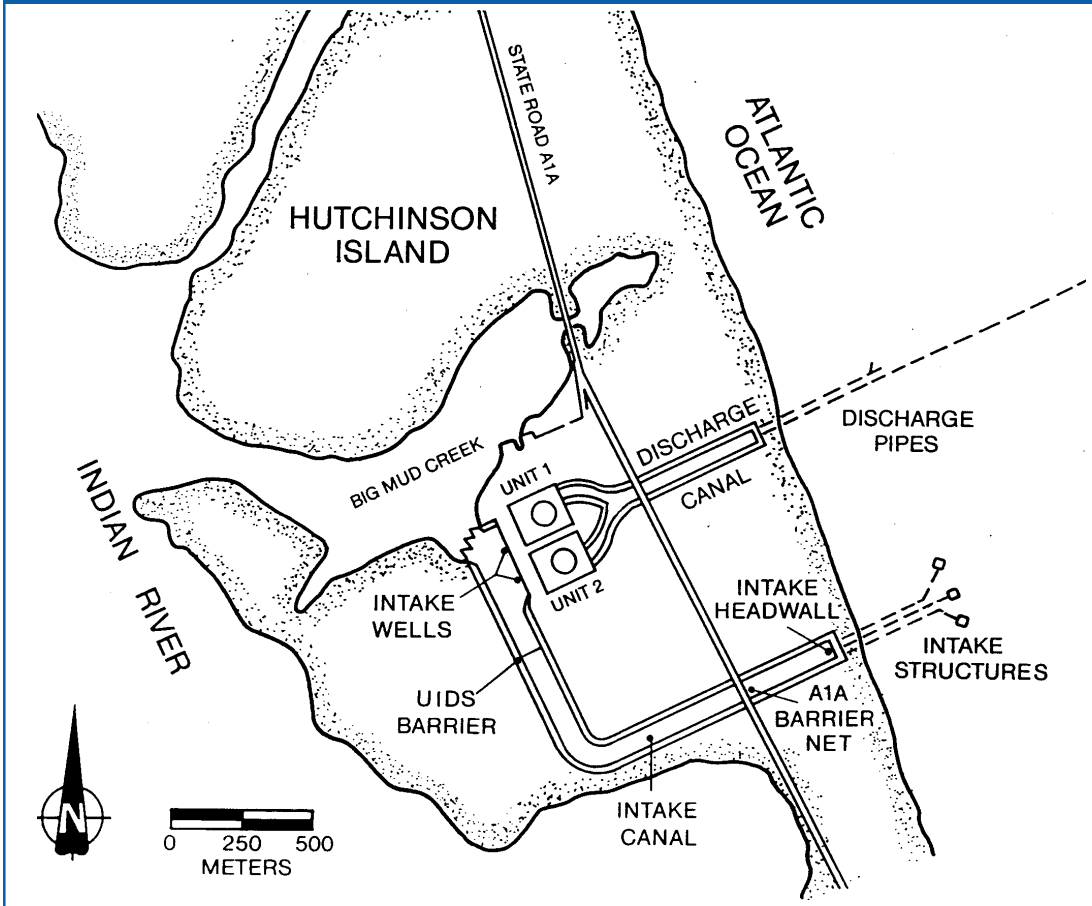
Nuclear power is an inherently dangerous and increasingly uneconomical technology. The risk of catastrophic accident, the unsolved problem of long-lasting radioactive waste, and the economic decline of the industry all have received global attention. But the threat from the routine operation of these facilities to the marine environment and its wildlife is virtually unknown by the public and overlooked by regulators and policymakers. Furthermore, the nuclear industry deliberately obfuscates the problem and misleads the public and decision-makers through its deceptive propaganda, positioning itself as an environmentally friendly technology that is beneficial to wildlife.

In reality, the coolant system's intake structure, which draws water into the plant, has been found to kill wildlife inhumanely and significantly alter or destroy the marine environment. Marine species are sucked

Figure 2: St. Lucie Plant cooling water intake and discharge system



The St. Lucie plant cooling water intake and discharge system. Reactors using this system can draw in as much as one million gallons of cooling water a minute or 3 billion gallons a day before discharging it into the same body of water. At some reactors the discharge water is heated up to 25 degrees F above ambient temperatures.

(entrained) into the plant's cooling canals through an intake canal or tunnel. Larger species, such as sea turtles and seals, have drowned or suffocated during entrainment. Others become impinged against trash rakes or net. Fish larvae, spawn, and fingerlings (young fish), are destroyed by their passage through the plant systems and, when discharged at the end of the cooling process, are described by the industry as "debris."

Endangered sea turtles, creatures that have lived in our oceans for 200 million years, are rapidly dwindling in numbers. Among the common victims at U.S. nuclear power plants are the Kemp's ridley sea turtle (the most severely endangered sea turtle species in the world), the loggerhead sea turtle, and the green sea turtle. Additionally, the endangered West Indian manatee and American crocodile, seals and sea lions, several species of large fish, and a variety of sea birds, some endangered or at risk, have also been found captured or dead in the circulating water systems at atomic reactors.

The degradation of the marine environment as a result of this technology could have serious, and potentially irreversible, repercussions if operation of once-through nuclear reactors is allowed to continue unchecked.

The coolant system discharge structure used by these same reactors presents additional hazards by expelling water warmed to a higher temperature than the water into which it flows. Recent research findings suggest that even small elevations in temperature over long periods can alter the abundance of many species of marine life.[8] Consequently, indigenous species around reactor discharge systems are displaced and replaced by others unnatural to that environment. The warmer waters also attract sea turtles, fish, crabs, sea birds, and other organisms. Periodically, reactors are shut down, the flow of warm water stops, and the temperature of the waterway into which it flows abruptly drops. This can result in cold-stunning of the species occupying the waters. Warmer waters may also present other hazards. Studies have shown decreased reproduction and increased mortality in seabirds coinciding with warmer water.[9]

The degradation of the marine environment as a result of this technology could have serious, and potentially irreversible, repercussions if operation of once-through nuclear reactors is allowed to continue unchecked. Marine ecosystems are home to many kinds of living things that occur nowhere else. Marine species provide a livelihood for millions of people and food, medicines, raw materials, and recreation for billions worldwide; they are intrinsically important.[10] The nuclear industry argues that its negative effects, if any, are localized and temporary, and therefore have no long-term or widespread impact on species. This view is vehemently contradicted by the California Department of Fish and Game:

> The science of ecology has now generally recognized that the destruction or disturbance of vital life cycles or of the balance of a species of wildlife, even though initiated in one part of the world, may have a profound effect upon the health and welfare of people in distant parts; like pollution it does not cease to be of vital concern merely because the problem is created at a distant point.[11]

Clearly, the depletion of these resources by nuclear power and other factors will ultimately harm not only the creatures themselves but the ability of humans to prosper and survive.

An additional hazard results from the cleaning methods used by once-through reactors. When the water intake and discharge pipes become restricted with marine organisms such as mollusks, impeding the plant's efficiency, they are cleansed to eliminate what the industry calls "biofouling." A chemical concentration—usually chlorine or other biocides—is flushed through the system to kill or flush out these impediments. This operation can have grave consequences for the survival of wildlife essential in the food web. For example, chlorines have been found to disrupt the endocrine system of marine animals, affecting reproductive capacity.

Alternatively, reactors may be cleansed by flushing with superheated water or sponge balls. Hot water flushes can kill hundreds of tons of fish and larvae through scalding. Some plants have recorded sponge ball loss onto beaches and into the ocean where there is concern they could be ingested by sea turtles and other marine creatures.[12] Sponge balls are generally rubber balls slightly larger than the condenser inner tubes through which they are injected under pressure as a cleaning mechanism. The differential pressure between the inlet and discharge of the condenser forces the balls through the condenser tubes. Flexible cleaning plugs are used in the same way.

The critical importance of crustaceans and other small marine organisms destroyed in this process is overlooked in favor of plant efficiency. But their destruction may have far-reaching effects on sea creatures higher up the food chain. "We can do great harm to the system without actually endangering a species, by fundamentally altering the habitat or the system itself," wrote Wilder, Tegner, and Dayton.[13]

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However, most of these activities continue unobserved and are self-reported by the industry. Utilities operating reactors capture and kill marine wildlife while the regulatory bodies meant to regulate them provide a virtual "license to kill" by permitting official annual kill numbers deemed unlikely to threaten the survival of a species.[14] Agencies like the Nuclear Regulatory Commission (NRC) and the National Marine Fisheries Service (NMFS) decline to end the destruction or effectively punish infractions and instead raise take limits (quotas of animals the utilities are permitted to capture or kill) to save utilities the financial burden of protective alternatives. This environment of greater regulatory latitude in favor of near-term profit is short-sighted and irresponsible, as Archie Carr, the renowned Florida naturalist, observed:

> The true test will come when . . . it becomes necessary to fight the indifference of most of the world and the active opposition of much of it, to surmount man's ingrained determination to put the far future out of his mind in matters of current profit.[15]

Increased human activities in waterways around reactors, particularly boating and fishing encouraged by plant owners, significantly worsen the plight of wildlife, particularly endangered species, rendering the nuclear industry's continual requests for higher takings even more inappropriate. However, unlike the nuclear industry, the shrimping industry and others engaged in "takings" do not claim to be helping to "protect the environment" or to be living "in harmony" with wildlife. Such external factors are ignored by the nuclear industry, which prefers to view its impact in a vacuum, unrelated to the cumulative effects of damage to marine species and environment. For example, nuclear power operators routinely petition NMFS and NRC for increased numbers in permitted sea turtle captures and kills, further jeopardizing the tenuous survival prospects for a species threatened with extinction.

Instead of accommodating the nuclear industry's financial wishes, regulatory agencies should take heed of the obvious indicators of environmental peril provided by nature itself. In the case of sea turtles, their plight has recently worsened due to an unexplained viral disease, called fibropapillomatosis (FP), now approaching epidemic proportions, particularly among green sea turtles. Scientific opinion is consistent in observing that the disease occurs near areas of heavy human use and in warmer, often contaminated near-shore waters, frequently causing severe immunosuppression in the infected animals. A currently less widespread virus, similar to the bovine fibropapilloma virus, has been observed in manatees, occasional victims of entrainment at nuclear plants. Dolphins in Florida's Indian River, near the St. Lucie nuclear reactors, have manifested

mysterious skin lesions resembling papillomas. These warning signs of potentially devastating epidemics, with a likely human cause, make it even more imperative that nuclear utilities do their part, together with other industries, to halt the activities that harm marine life, especially endangered, species.

Although harming and killing of seals, manatees, and sea turtles is an obvious attention-getter, the destruction of smaller organisms by nuclear power operation will likely have the most severe and long-lasting effect on the marine environment. Wrote Wilder, Tegner, and Dayton:

> Biodiversity at sea is greatest among smaller organisms such as diatoms and crustacea, which are crucial to preserving ecosystem function. Numerous types of plants such as mangrove trees and kelps have equally essential roles but are often overlooked entirely. We look away from the small, slimy and ugly, as well as from the plants, in making marine policy. The new goal must be to consider the ecological significance of all animals and plants.[16]

At present, the destruction of smaller marine organisms and habitat by nuclear power operations is a vastly overlooked and under-regulated area. However, even among endangered species, regulatory oversight may be incomplete, allowing unknown numbers of endangered and threatened animals to be killed at nuclear reactors. According to a study of U.S. nuclear reactor sites, commissioned by NRC in 1997, "the potential exists at every site that undocumented incidental take could occur, primarily because NRC staff and the licensees may not be aware that a threatened or endangered species may be present near a facility."[17]

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Organizations like the Marine Conservation Biology Institute (MCBI) and The Cousteau Society have called for the establishment of marine protected areas—no-take zones where marine species can thrive unthreatened by industrial, commercial, and recreational activities. The signers of a February 2000 'Call for Presidential Action' circulated by MCBI suggested "a benchmark goal of a minimum of 2 percent of U.S. marine waters protected in no-take marine protected areas within 5 years, spread geographically and across biomes."[18] The Sea Turtle Restoration Project advocates similar swimways and no-take zones for sea turtles. These experts and others recognize that swift action must be taken to stop the destruction of marine life before many precious species become extinct.

The prevention of such extinctions has become of paramount importance to scientists such as James W. Kirchner and Anne Weil who believe that "there are intrinsic limits to how quickly global biodiversity can recover after extinction events, regardless of their magnitude. They also imply that today's anthropogenic extinctions will diminish biodiversity for millions of years to come."[19] Kirchner and Weil found that "once ecosystems lose key species, they are not likely to recover their full function and biotic variety in less than about 10 million years."[20]

Implementation of the widely advocated *precautionary principle* offers a compelling solution. A 1993 gathering of leading scholars and other environmental experts in Wisconsin examined the failures of existing regulations to provide adequate protection for human health and the environment, and issued a statement in support of the precautionary principle that recommended:

> When an activity raises the threat of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically [emphasis added]. In this

context, the proponent of the activity, rather than the public, should bear the burden of proof.[21]

Wilder, Tegner, and Dayton also endorse the precautionary principle. They wrote:

> The precautionary principle stands in sharp contrast to the traditional marine policy framework: take as much as can be taken and pollute as much as can be polluted until a problem arises. Rather than wait for the environment to cry for help, the precautionary principle places the burden on fishermen, oil drillers, industry, farmers whose fields run to rivers or shores, and whomever else would exploit the sea, intentionally or not, to avoid harming this precious resource in the first place.[22]

Notes

[1] Archie ("Chuck") Carr, III, "A Century of Sea Turtles," Keynote Address, 20th Annual Symposium on Sea Turtle Biology and Conservation, March 1, 2000, Orlando, FL.

[2] Charles Babington, "Clinton Imposes Reef, Coastline Protections," *Washington Post on-line,* May 27, 2000.

[3] Tundi Agardy, "Creating Havens for Marine Life," *Issues in Science and Technology* (Fall 1999): p.1.

[4] "Safeguarding America's Seas, Establishing a National System of Marine Protected Areas, A Call For Presidential Action," petition circulated by the Marine Conservation Biology Institute, Redmond, WA, February 14, 2000, p. 2.

[5] Ibid., p. 3.

[6] Marine Environmental Research Institute, "Marine Mammal Die-offs," Blue Hill, ME, www.meriresearch.org/monitor.html.

[7] Robert J. Wilder, researcher, Marine Science Institute and lecturer in Environmental Studies Program, University of California; Mia J. Tegner, marine biologist, and Paul K. Dayton, professor of oceanography, both of Scripps Institute of Oceanography, University of California, San Diego, "Saving Marine Biodiversity," *Issues in Science and Technology* (Spring 1999): p.7.

[8] R.D. Sangarin, J.P. Barry, S.E. Gilman, and C.H. Baxter, "Climate Related Change in an Intertidal Community over Short and Long Time Scale,"*Ecological Monographs* 69 (1999): 465–90.

[9] Amy Mathews-Amos and Ewann A. Berntson,"Key Findings of the New WWF/MCBI Report, Turning Up the Heat: How Global Warming Threatens Life in the Sea," MCBI, Redmond, WA, 1999, p. 1.

[10] "Safeguarding America's Seas," p. 3.

[11] California Department of Fish and Game, Legal Department, "In the Matter of WDR Order 90-09 Diablo Canyon Nuclear Power Plant," Memorandum to Regional Water Quality Control Board, February 29, 2000, p. 8.

[12] Florida Power Company, "Biological Assessment for Crystal River," FOIA #2000-0182, Appendix A5, submitted to NRC October 1, 1998, p. 23.

[13] "Saving Marine Biodiversity," p. 2.

[14] For a discussion of the laws and regulations governing these issues, see chapter 6, this report.

[15] Archie Carr, "A Naturalist in Florida, A Celebration of Eden. Essay," *A Dubious Future* (New Haven, CT.: Yale University Press, 1994) p. 233.

[16] "Saving Marine Biodiversity," p. 2.

[17] M.R. Sackschewsky, *Threatened and Endangered Species Evaluation for 75 Licensed Commercial Nuclear Power Generating Plants,* Executive Summary, Pacific Northwest National Laboratory (operated by Battelle for the U.S. Department of Energy), Richland, WA, March 1997, p. iv.

[18] Safeguarding America's Seas, p. 1.

[19] James W. Kirchner, Department of Geology and Geophysics, University of California, Berkeley, CA, and Anne Weil, Department of Biological Anthropology and Anatomy, Duke University, Durham, NC, "Delayed Biological Recovery from Extinctions Throughout the Fossil Record," *Nature* (March 4, 2000), www. nature.com

[20] William K. Stevens, "The 'Hot Spot' Approach to Saving Species," *New York Times*, March 14, 2000.

[21] "Wingspread Statement on the Precautionary Principle," Statement from the work session: Environmentally Induced Alterations in Development: A Focus on Wildlife, December 10–12, 1993, Racine, WI.

[22] "Saving Marine Biodiversity," p. 4.